Explaining Food Insecurity in Sub-Saharan Africa: The Role of Governance and Institutions

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and
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Bringing Rigour and Evidence to Economic Policy Making in Africa

Explaining Food Insecurity in Sub-Saharan Africa: The Role of Governance and Institutions

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Abstract

The burgeoning literature on global food (in)security suggests that sub-Saharan Africa (SSA) is lagging behind the rest of the world despite a period of decline in the prevalence of severe undernourishment. Using panel data covering 34 countries in the region for the period 2000 to 2015, this study examined the correlates and causes of food insecurity in SSA with emphasis on the role of domestic food production, governance, and institutions. The paper also provides evidence on the mediating role of governance by examining how the quality of governance and institutions influence the effectiveness of domestic food production on food insecurity in the region. The paper uses an instrumental variable strategy. The findings suggest that domestic food production and improvements in governance quality, measured by economic freedom and government effectiveness, are fundamental drivers of food security in SSA. We also found that improving the quality of governance would enable countries to better translate domestic food production into reductions in the depth of food deficit and the prevalence of undernourishment. Nonetheless, in the absence of adequate domestic food production, governance reforms alone would be impotent in fostering food security in SSA.

1. Background

Alleviating food insecurity remains a key priority on the global development agenda, as reflected by the second United Nations Sustainable Development Goal (SDG) — "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture by 2030". Globally, food insecurity in the form of hunger and malnutrition declined considerably between the early 2000s and 2010s; however, this trend has reversed over the past half-decade (Vos, 2015; FAO et al, 2020b). According to estimates from the Food and Agriculture Organization of the United Nations (FAO), about 690 million people across the globe were undernourished in 2019 and 98% of hungry people lived in the developing world (FAO et al, 2020b). These numbers are expected to rise further due to the effects of the COVID-19 crisis, raising global concerns of a food security crisis, particularly in developing countries (Amare et al, 2020).

In Africa, chronic food insecurity[1] is about four times higher than in other regions (FAO et al, 2019). The prevalence of severe and moderate undernourishment on the continent is about twice the global average, and more than double the levels recorded in Asia, Latin America and the Caribbean. For example, in 2019, the prevalence of severe undernourishment in the region was 21.3%, compared to 17.8 percent in South Asia (SA) and 9.6% in Latin America and the Caribbean (FAO et al, 2020b). Although the continent experienced a decline in the prevalence of undernourishment between 2000 and 2014, food insecurity has been on the rise in the region since 2015 (Figure 1). The recent global health pandemic could further worsen the situation. Furthermore, the number of undernourished people, which seemingly remained stagnant until 2011, has increased substantially in recent years. As shown in Figure 1, between 2011 and 2018, more than 50 million individuals joined the category of undernourished people on the continent.

The average African performance on food security hides important heterogeneities across sub-regions (Table 1). In Northern Africa, about 9.3% of the population suffer from severe food insecurity as compared to 20.3% in Sub-Saharan Africa (SSA). More than half of the population in SSA suffer from moderate or severe food insecurity compared to 31.1% in Northern Africa. This evidence suggests that food insecurity is more predominant in SSA, and thus calls for a better understanding of the factors influencing the phenomenon in the region.

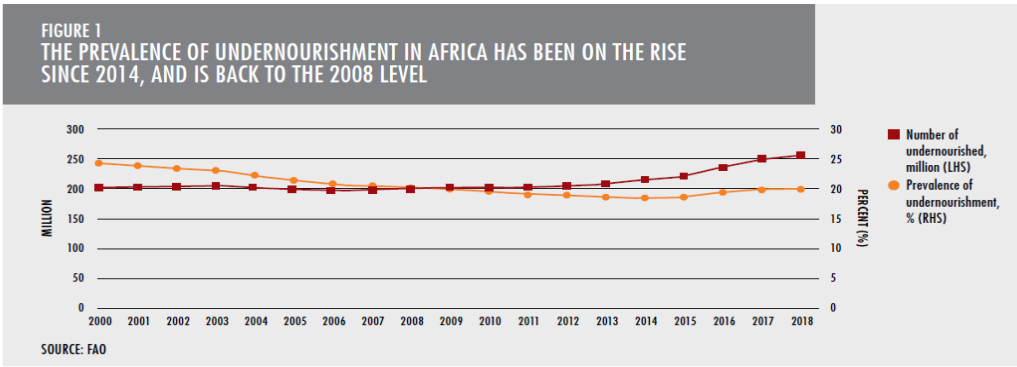
1 The 1996 Rome Declaration of World Food Security defines food security as the availability of food that is nutritionally adequate and acceptable within a given culture at all times for all persons.

Table 1: Prevalence of moderate or severe food insecurity across regions/sub-regions, 2014–2018

Regions/ sub-regions	Prevalence of severe food insecurity in the total population (%)					Prevalence of moderate or severe food insecurity in the total population (%)				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
World	8.3	7.9	8.1	8.6	9.4	22.4	22.4	23.2	24.8	25.8
Africa	16.7	16.8	18.2	18.5	18.3	46.5	46.5	49.4	51.4	50.6
Northern Africa	10.2	9.0	10.4	11.0	9.3	29.7	26.4	30.0	36.8	31.1
Sub-Saharan Africa	18.2	18.6	20.0	20.2	20.3	50.3	51.2	53.9	54.8	55.1
Asia	8.0	7.5	7.1	7.6	9.1	19.4	18.9	18.9	20.6	22.6
Latin America and the Caribbean	7.1	6.4	8.1	9.3	9.2	22.9	25.1	29.4	32.0	31.6

Source: FAO et al (2020a).

Figure 1: Trend in the prevalence of undernourishment (% of the population) and the number of undernourished in Africa, 2000–2018



Source: FAO et al (2020a).

Notwithstanding several continental initiatives, including the African Union (AU) Agenda 2063[2], which aims at sustainable growth and poverty reduction, important barriers remain on the path to achieving food security in the region. Rakotoarisoa

2 See AUC (2015).

et al (2011), for example, identify three main factors at play, namely: arable and agricultural land availability; low productivity and poor infrastructure; and poor quality of governance and institutions.

The first two factors allude to the existing constraints with regards to agriculture and food production. In fact, four out of the seven targets under the SDG 2 are related to raising sustainable agricultural production at the national level[3]. Furthermore, another important characteristic of the food systems in developing countries, which is rarely mentioned in the literature, is ensuring that locally produced foods are efficiently and effectively translated into food security (FAO, 2019a). This situation explains the emphasis on limiting food waste and losses; and hence the SDG 12 target 12.3 calling on governments to halve per capita global food waste at the retail level and reduce food losses along production and supply chains by 2030. Post-harvest losses are particularly acute in SSA (FAO, 2019a), where a large share of the food produced does not find its way to the consumers due to inadequate storage technologies (on-farm and off-farm losses); underdeveloped food processing industries and markets; and infrastructural deficiencies limiting food distribution (Sheahan and Barrett, 2017). For example, in 2013 Cameroon lost 15.3% of the maize produced due to inadequate storage and transportation infrastructures, while Togo lost nearly 14% of this staple food in 2014 for the same reasons (FAO, 2019b). Hence, strengthening the supply chain is critical for food security in the region.

Poor governance and weak institutions have deteriorating effects on food security (Rodrik, 2000; Thorbecke, 2013). Many scholars and development agencies highlight the important role of conflicts, and weak economic governance and institutions, as contributing in various ways to the worsening food insecurity. The economic policies implemented in the 1970s by many SSA countries are often blamed for the poor performance in income growth and agricultural production, which partly led to the economic and food crisis in the 1980s and subsequently to the structural adjustment programmes (SAPs) (Ndulu et al, 2008). These policies targeted import-substitution industrialization and included inefficient regulations and trade restrictions; excessive state controls over resource allocation, agricultural production and marketing; and faulty macroeconomic management (Bates et al, 2013). Hence, the goal of the policy and institutional reforms implemented on the continent since the early 1990s was to boost productivity, growth and ultimately improve the well-being of the population (Heidhues and Obare, 2011; Fosu and Gafa, 2020)[4].

3 Improve agricultural productivity and the income of smallholder farmers through access to productive resources and markets (target 2.3); promote sustainable food production systems and agricultural practices (target 2.4); maintain the genetic diversity of seeds, plants, and animals (target 2.5); and increase investment in the sector (target 2.a).

4 However, there are still ongoing controversies on the actual effects of these neoliberal reforms on food insecurity and some studies argue that the effects have been mixed, with the reforms benefitting cash crops and net producers while worsening the outcomes of the net consumers and smallholder farmers in rural locations (Christiaensen, 2002). Furthermore, others highlight the adverse impacts of the cuts in government expenditure, as part of the "fiscal discipline" component of the SAPs, on public

Although many countries in SSA have implemented notable economic and institutional reforms, weak governance still plays a critical role in the lack of progress in achieving food security in the region (Sahley et al, 2005; Pereira and Ruysenaar, 2012). As observed by Zakout et al (2006) and Rakotoarisoa et al (2011), a large share of arable land remains unused and poorly maintained in SSA, partly due to the failure of land management policies, including land distribution, property rights and ownership problems. Tenure-related dispute and conflicts and unequal access to land in the agriculture sector are often due to the weak quality of land governance and poor institutions for land administration, corruption, lack of property rights enforcement and rule of law (Palmer et al, 2009). Moreover, the low and inadequate sectoral investment, and the poor state of market and transport infrastructure are also important aspects of governance affecting food production in Africa (Rakotoarisoa et al, 2011).

As emphasized by Boyd and Wang (2011), poor governance — in the form of weak institutional capacity, instability, and ineffective public policies — rather than natural conditions, is the primary driver of hunger and malnutrition, due to its potential deleterious effect on food production, supply and distribution. Thus, governance is widely considered as both a "potential driver of, and a potential solution to, situations of food insecurity" (Candel, 2014: 591) in SSA.

Also important in the African context is the role of economic governance and institutions in shaping the extent to which domestic food production translates into food security. In fact, the quality of governance can strengthen or weaken the supply chain for local food producers who are mostly smallholders (Sheahan and Barrett, 2017; FAO, 2019a). For example, policies that provide a conducive business environment for private sector development would not only help to create and strengthen agricultural value chains, but also increase the profits of the food value chain actors and promote greater access to affordable locally produced food through agroprocessing and marketing channels. Furthermore, the inadequate regulation of the food distribution system, poor infrastructure development policies and weak macroeconomic policies resulting in high inflation would likely limit both economic and physical access to food (Gazdar and Mallah, 2013).

On this basis, the overall aim of the study was to examine the correlates and causes of food insecurity in SSA with emphasis on the role of domestic food production, governance and institutions. First, the study looked at the overall determinants of food insecurity, measured by the prevalence of undernourishment and the depth of food deficit. Thus, involved analysing the effect of domestic food production, the levels of economic freedom (measuring economic policies and governance) and its components — namely the size of government; legal systems and property rights; freedom to trade internationally; sound money and regulatory systems — as well as other institutional indicators (namely government effectiveness, control of corruption, voice and accountability, political stability and absence of violence and rule of law)

infrastructure, research and development, agricultural support, and social services (Heidhues et al, 2004; Heidhues and Obare, 2011).

on food insecurity. Second, the study assessed the effect of domestic food production on food insecurity contingent on these governance and institutional variables. Specifically, we hypothesized that improved governance and institutions would accentuate the "food insecurity-reducing" effect of domestic food production. Finally, the paper presented the results of an investigation into the role of food production as a channel through which governance and institutions affect food insecurity in SSA.

The rest of the paper is structured as follows. In Section 2, the importance of the study is discussed. Some stylized facts on food production and governance in SSA are presented in Section 3. Section 4 provides a review of literature on the determinants of food (in)security. A conceptual framework is presented in Section 5 to explain the linkages between food security and its determinants. Section 6 describes the data and the methodology used and Section 7 discusses the estimation results. The robustness checks are provided in Section 8. Section 9 highlights the main findings of the study and concludes with policy implications.

2. Justification of the study

The determinants of food (in)security have been widely studied in the literature. In country-specific and micro-level research, the topics covered include the effect of technology adoption, employment, climate change adaptation and mitigation, social interventions and programmes, and income on food (in)security (Beyene and Muche, 2010; Sacks and Levi, 2010; Anik et al, 2013; Ngema et al, 2018; Sinyolo, 2020; Kansiime et al, 2021). In addition, a panoply of cross-country analyses exists on the subject. For example, Dithmer and Abdulai (2017) investigated the effects of trade openness on food security using a global sample of 151 countries. Bonuedi et al (2020) examined the effects of trade openness and facilitation on food availability and access outcomes in the African context. Sassi (2015) conducted a cross-sectional analysis of the determinants of food insecurity in SSA within a non-parametric spatial analysis framework and, more recently, Ogunniyi et al (2020) investigated the effects of remittances and governance quality on food and nutrition quality in the region, focusing on the role of governance as a moderator of the impacts of remittances on food security. In their analyses, these studies accounted for governance and institutions using the World Bank governance indicators, namely government effectiveness, rule of law, control of corruption, political stability and absence of violence, regulatory quality, and voice and accountability.

Despite the rich extant literature, this study contributes to empirical research in two ways. First, besides the World Bank governance indicators, the study considered additional aspects of governance capturing the extent of economic liberalization not explored by previous studies, but critical within the context of SSA. For example, global economic views on "good economic governance" have shifted from inward-looking (import-substitution) to outward-oriented economic policies (in line with the Washington Consensus). More recently, the emphasis moved to "finding the right balance" between strict State interventionism and pure market economy (Fosu, 2013; Stiglitz, 2016). Many African countries have implemented notable market-oriented reforms over the past two decades in the areas of macroeconomic policies; business regulations; trade and financial liberalization; public administration; judicial system; and property rights enforcement. These important aspects of economic governance, however, are not well captured under indicators such as government effectiveness, control of corruption and rule of law, thus necessitating further investigation.

Economic freedom reflects key aspects of economic neoliberalism and the extent to which the business environment and government policies are market-friendly (Gwartney et al, 2020). The economic freedom variable and its components (the size of government, legal system and property rights, sound money, freedom to trade internationally and regulation) are important for food security in SSA, as they are likely to shape the supply, the availability and the distribution of food. Economic freedom has been identified in the literature as consequential for foreign direct investment, income growth and human development (De Haan and Sturm, 2000; Naanwaab, 2018; Ghazalian and Amponsem, 2019).

Consequently, the inclusion of economic freedom (which captures the size of government, the nature of macroeconomic policies, trade liberalization policies and the legal systems) contributes to the debate on the impacts of neoliberal policies on food security in Africa. It also fills an important gap as empirical assessment of the issue has so far been absent from the literature. Furthermore, the study used two composite indexes, one capturing the quality governance and the other the quality of institutions, by grouping all the variables using the definitions of World Bank (1992) and North (1990)[5]. Thus, by considering a wide range of governance and institutional variables, the study unveils the extent to which different aspects of governance and institutions influence food insecurity in SSA, directly and indirectly through food production.

Second, this research provides important evidence on the mediating role of governance in the region's progress on food security by examining how the quality of governance and institutions influence the effectiveness of domestic food production on food insecurity. While it is widely acknowledged that governance shapes food distribution (via markets and infrastructural development) and affordability (income and prices), thereby easing physical and economic access to food, to the best of our knowledge no other study identifies how the quality of economic governance and institutions influences the extent to which domestic food production is translated into food security.

In fact, adequate food systems require good governance and institutions that ensure well-functioning market and appropriate marketing and distribution systems in order to: (a) minimize post-harvest losses; (b) improve income levels of value chain actors particularly farmers; and (c) enable poor households to have economic and physical access to locally produced food through social programmes and interventions. In addition, investment in infrastructure development would likely improve access to domestically produced foods by reducing transaction delay and losses, facilitating national trade and access to markets (Miller et al, 2011; Tiwari et al, 2016). Furthermore, providing a conducive environment for private sector

5 The governance index is measured using economic freedom index and government effectiveness. Institutions are defined following North (1990) and are measured by rule of law, control of corruption, political stability, voice and accountability.

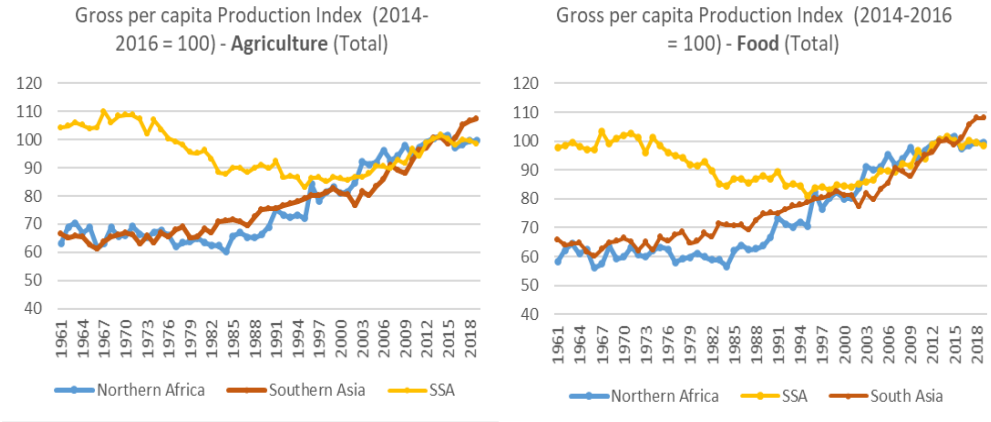
development and entrepreneurship in the agriculture sector is expected to reduce food insecurity by creating effective and efficient agriculture value chains for local farmers (Bonney et al, 2013), fostering the link between domestic food production and food security.

We used a two-stage least squares (2SLS) estimation to examine the effects of domestic food production, economic freedom and the other governance indicators on food insecurity, and unveiled the importance of domestic food production as a channel through which governance and institutions affect food insecurity in SSA. By using 2SLS methodology, this paper not only accounts for the potential endogeneity problem arising from the bi-directional relationship between food (in)security and food production, but also sheds some light on the indirect effects of governance and institutions on food insecurity through the channel of food production (Sala-i-Martin and Subramanian, 2013). Lastly, we assessed the effect of domestic food production on food insecurity contingent on the role of governance and institutions in the region. The robustness of the 2SLS results was checked using the two-step system Generalized Method of Moments (GMM) and the Limited Information Maximum Likelihood (LIML) estimation. The analysis was based on panel data from 34 SSA countries (see Table A1) covering the period 2000–2015.

3. Some stylized facts

Agricultural and food production followed a downward trend in SSA between the early 1970s and the mid-1990s (Figure 2) coinciding with the period of high government interventions, widespread import-substitution policies, political instability and poor growth performance in many African countries (Ndulu et al, 2008; Fosu and Gafa, 2020). This trend reversed from the mid-1990s to 2014 (Figure 2), when governance, agricultural productivity and economic growth generally improved in the region (Bates et al, 2013). Since 2015, however, agricultural and food production have been declining, interestingly consistent with the rise in the food insecurity noted in recent years (Figure 1 versus Figure 2). In contrast, South Asia has maintained a rising trend in production since the early 1980s. As emphasized by Chauvin et al (2012), food insecurity challenges cannot be successfully addressed in SSA without the effective transformation of the agriculture sector.

Figure 2: Agricultural and food production indices across regions, 1961–2019

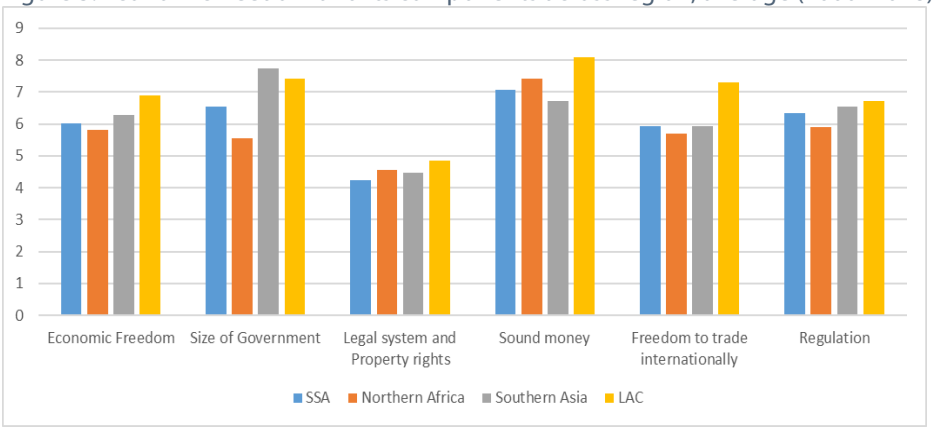


Data source: FAOSTAT (FAO, 2021).

Figure 3 reports the averages of the economic freedom index and its components. The economic freedom index is widely used as an indicator of neoliberal economic policies and economic governance, as it captures the extent to which economic policies and institutions favour free business environment, market competition, openness and property rights enforcement. Despite the notable economic and

institutional reforms, the performance of SSA on the economic freedom index is lower than that of countries in Latin America and South Asia, mainly due to higher State interventions and weak judicial systems and property rights enforcement in the region (Figure 3). Furthermore, SSA performs worse than all the other regions on control of corruption, government effectiveness and rule of law, but enjoys greater political stability, and voice and accountability than Northern Africa (Figure 4).

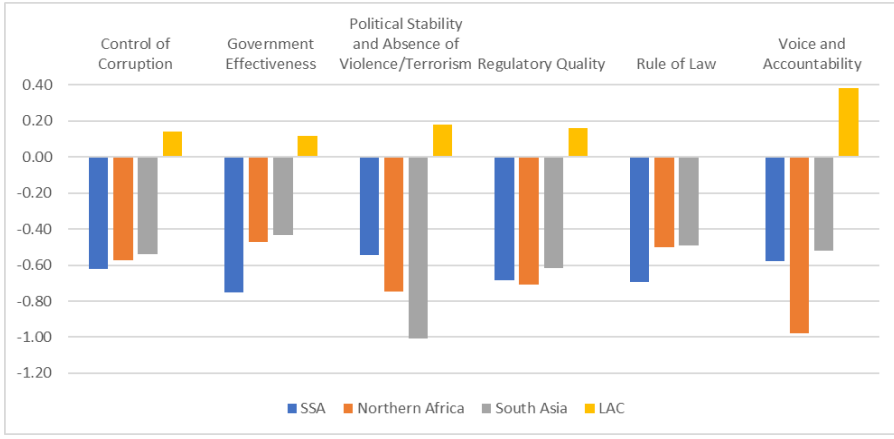
Figure 3: Economic freedom and its components across region, average (2000–2018)



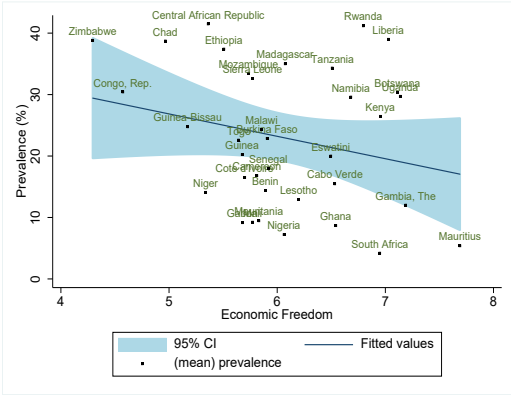
Notes: Authors' computation. The data are obtained from the Fraser Institute and range from 1 to 10, with 1 representing the lowest performance and 10 the highest (Gwartney et al, 2020). For each region, the arithmetic mean is computed over the period 2000–2018.

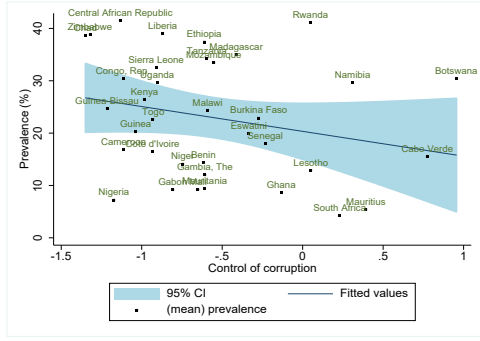
To elaborate more on the relationship between governance/institutional quality and food insecurity in SSA, Figure 5 shows the association between food insecurity, measured by the prevalence of undernourishment, and governance/institutional quality variables. Overall, there seems to be a negative association between the country averages of the prevalence of undernourishment and governance/institutional quality variables in SSA, suggesting that poor performers on governance and institutional quality tend to record high levels of food insecurity, on average. For example, Central African Republic (CAR), Zimbabwe, Chad and Liberia are among the lowest performers on economic freedom, government effectiveness, control of corruption and political stability, and exhibit low levels of food security. Meanwhile, Mauritius, South Africa and Ghana have low prevalence of undernourishment, and are among the best performers on governance and institutional quality variables. While this preliminary evidence suggests the existence of a negative association between food insecurity and governance and institutions, more rigorous empirical investigation is required to support this hypothesis.

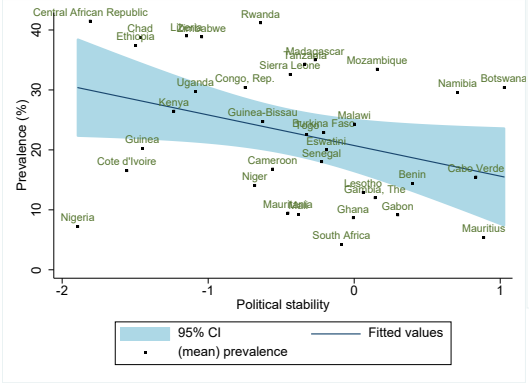
Figure 4: World Bank governance indicators: Control of corruption, government effectiveness, political stability and absence of violence, regulatory quality, rule of law, voice and accountability across regions, average (2000–2019)

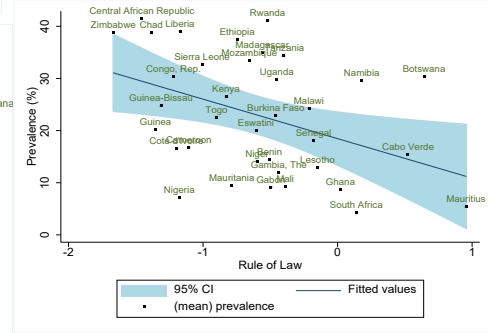


Notes: Authors' computation using data from World Governance Indicators database (World Bank, 2021). The indicators range from -2.5 to 2.5; zero (0) represents the world average. For each region, the arithmetic mean is computed over the period 2000–2019.









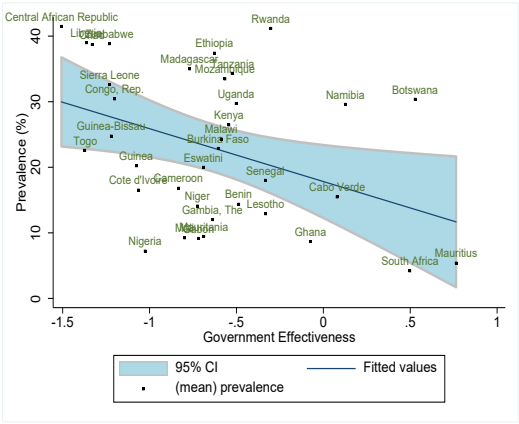


Figure 5: Food security and governance/ institutional quality variables

Notes: Authors' computation using data on the prevalence of undernourishment (% of total population), economic freedom index, government effectiveness, control of corruption, rule of law, and political stability and absence of violence. Data on prevalence of undernourishment is from the FAOSTAT database (FAO, 2020); that on economic freedom is obtained from Gwartney et al (2020). The data on the rest of the variables are from the World Governance Indicators (World Bank, 2020a). The economic freedom index ranges from 1 to 10, with 1 representing the worst performance and 10 the best. Government effectiveness, control of corruption, rule of law and political stability and absence of violence range from -2.5 to 2.5, and the lowest value represents the worst performance on these indicators.

4. Literature review

Theoretical discussion

Food security is defined as the assurance that "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" (Committee on World Food Security (CFS), 2012: 4) . Food security, as defined, emphasizes four main dimensions, namely physical availability, economic and physical access, food utilization and stability. It is often analysed at the global, regional, national, household or individual level.

According to existing literature, various types of strategies can be adopted at national level to ensure sufficient food supply and food security, such as, promoting domestic food production, trade openness and food aid. Periods of famine and food shortages, particularly in Africa and Asia, are often caused by inadequate crop yields due to climatic conditions, natural disaster and overexploitation of resources (Olsson, 1993; Smith et al, 2017). Thus, in recent years agricultural development policies — particularly in SSA, where most of the population is engaged in farming activities — have received increasing support among scholars who argue that adequate investment strategies to boost domestic food production will have a positive influence on both availability and access to food. However, domestic production directly affects food security when farmers consume their own produce. The effect could be indirect through two identified channels, namely income growth and reduction in prices (Johnston and Mellor, 1961; Diao et al, 2010). Furthermore, food security can also increase productivity via its effect on human capital (i.e., health and education), and consequently promote domestic production (Knowles and Owen, 1995; Strauss and Thomas, 1998; Webber, 2002).

With respect to trade-related strategies, several scholars argue that trade leads to poverty reduction and food security, especially in developing countries (Dollar and Kraay, 2004; Chatterjee and Murphy, 2013). Indeed, the food security argument was used to encourage the trade liberalization policies pursued by most African governments in the 1980s. Theory suggests that trade represents an opportunity for countries to specialize in goods in which they have comparative advantage, and import commodities that have relatively higher production costs (Ricardo, 1817). Thus, by boosting their exports, countries acquire enough foreign exchange to purchase on the global market items in which they do not have comparative advantage for local

production, thereby increasing the availability, and access to food through reduction in prices. Theory also indicates that trade liberalization enhances competitiveness and new technology inflows and encourages innovation among domestic farmers. Consequently, openness increases productivity (Briguglio, 1995; Armstrong and Read, 1998; Wacziarg and Welch, 2008). Again, in periods of food shortages, trade (imports) can improve food availability and stabilize food prices, reducing hunger and malnutrition (Dreze and Sen, 1989; Ninno and Dorosh, 2003).

Even though the benefits of trade have been extensively documented, other scholars and activists highlight its negative consequences on small-scale farmers and farm communities, especially in developing countries (Clapp, 2014). The main argument is that trade liberalization reduces demand for locally produced crops, weakening domestic production and threatening farmers' livelihoods in developing countries (Gonzalez, 2004). Furthermore, dependence on imports for food security has been a matter of concern, since import dependency increases the vulnerability of countries to price and supply shocks on the global food market (Armstrong and Read, 1998; Rakotoarisoa et al, 2011).

In the rich and growing literature on the role of institutions and governance in economic growth and development, there seems to be a consensus that good governance and institutional quality matter (Knack and Keefer, 1995; Acemoglu et al, 2012; Bates et al, 2013; Fosu, 2012; Chachu, 2021). In food security literature, the role of governance and institutions is also acknowledged. Several studies highlight that food security is greatly influenced by institutions, government interventions and policies (Dreze and Sen, 1989; Timmer, 1992; Ninno and Dorosh, 2003; Sacks and Levi, 2010).

First, high levels of corruption, weak rule of law and the lack of property rights enforcement leads to inefficiencies and ineffectiveness in the implementation of agricultural policies, including those that aim at ensuring adequate access to food by households. Corruption, lack of property rights enforcement and absence of adequate rule of law influence access to inputs in the agriculture sector, particularly land, access to credit, access to fertilizer, improved technologies, and water allocation. Hence, better institutional quality promotes domestic food production, and the availability and access to food (Fink, 2002). Furthermore, food marketing and distribution, prices and the quality of food are greatly influenced by the quality of institutions. In such cases, weak institutions may engender abusive controls over food and markets by few individuals or interest groups, leading to its scarcity or inequalities in access to food.

Second, inadequate investment in infrastructure and existing deficiencies lead to higher consumer prices, post-harvest losses and ineffective distribution of food. Third, with respect to economic governance, the extent to which government ensures macroeconomic stability, a well-functioning market and adequate economic institutions also matter for food security. For example, the provision of efficient subsidy programmes to farmers, adequate investment in research and development are components of good governance that have considerable implications for domestic food production. Moreover, government effectiveness in the provision of social services affects human capital and productivity, which in turn positively influence

domestic food supply. Furthermore, business-friendly trade and market regulations greatly influence the availability of food and food prices, with implications for affordability and accessibility. While many scholars advocate for orthodox market-oriented policies, others adulate the interventionist type of policies that emphasize food sovereignty (Goletti and Babu, 1994).

Empirical review

Aker and Lemtouni (1999) examined the domestic and global food supply and demand mechanisms by analysing the correlates of food availability in Morocco. In their model specification, food security (i.e., food availability) is explained by food production — measured by cereal production — precipitation, prices, gross domestic product (GDP), inequality, literacy and health indicators. The findings showed that income has a positive effect on food security, while the effect of cereal prices is ambiguous. The study also found no association between food production and food availability.

On the effect of trade on food security, Bonuedi et al (2020) analysed the effects of trade openness of food security outcomes in Africa using data on 45 countries from 2006 and 2015. Trade facilitation was measured by several indicators, such as documentary procedures, time and costs associated with exports and imports. Using the first difference instrumental variable estimator approach, the results showed that poor trade facilitation is a key driver of food insecurity in Africa. The findings also showed that food availability and access are greatly limited by increased documentation requirements and longer export and import timeframes, indicating that reduced delays due to paperwork and border compliance would be an effective trade facilitation reform to improve food security on the continent. Likewise, Dithmer and Abdulai (2017) examined the effects of trade openness and other factors on food security using a cross-country panel comprising 151 countries globally from 1980 to 2007. Food security was defined as dietary energy consumption, while trade openness was defined as the amount of commerce (real exports + imports) as a percentage of real GDP. The estimates from the GMM method used showed that trade openness has a beneficial impact on food security. The authors pointed out that trade liberalization measures that enhance trade volume would improve a country's food security situation. Meanwhile, Huseynov (2019) found that food imports boost food security only in the short term, but not in the long run.

Using data for 17 countries, Sacks and Levi (2010) examined the effect of physical infrastructure, civil bureaucracy, and law and order on individuals' food security status. The study used a multi-level logit regression and found that physical infrastructure, civil bureaucracy, and law and order are crucial in ensuring food security in Africa. Furthermore, Applanaidu and Baharudin (2014) investigated the role of domestic and global supply and demand mechanisms on food security in Malaysia. The authors used a vector autoregressive (VAR) approach. Their model includes food production, fuel production, GDP, real exchange rate, government expenditure on rural development, food price index and population as explanatory variables. The results revealed that only food prices and population size significantly influence food production in the short run.

In the context of SSA, Sassi (2015) analysed the determinants of food insecurity, measured by the prevalence of undernourishment, using cross-sectional data from 40 countries. Using spatial non-parametric analysis, the study distinguished between the effects of global and local determining factors. Based on their conceptual framework, the authors examined the effect of domestic food production, commercial food imports, food assistance, economic access to food and sanitation. The results show that food import, food production and income have a negative effect on food insecurity. In addition, Kaur and Kaur (2016) investigated the factors explaining various components of food security — such as food access, availability, utilization and stability — by analysing pooled data for SSA, South Asia and Latin America covering the period 1990–2012. The explanatory variables include domestic food production, GDP per capita, imports as a share of total export, density of road and rail lines and access to improved water sources. Their findings suggest that income, food production and imports, infrastructure and access to potable water are crucial to attaining food security in these regions.

Several studies also examined the effect of governance on agricultural production and productivity. For example, Bayyurt and Yilmaz (2012) investigated the effect of governance and education on agricultural efficiency using data from 64 developed and developing countries from 2002 to 2008. First, the study used data envelopment analysis (DEA) to compute the level of agricultural productivity in each country. Second, within a panel regression framework using fixed and random effects models, the authors examined the effect of government effectiveness, rule of law, control of corruption, voice and accountability, and political stability on agricultural efficiency. While the results show no significant effect of governance on agricultural productivity in developed countries, in developing nations the findings suggest that regulatory quality positively and significantly affects productivity in the agriculture sector. Similarly, Mandemaker et al (2011) used a sample of 173 countries between 1975 and 2007 to examine the importance of good governance in promoting agricultural production through increases in crop yields as opposed to land expansion. The study considered government effectiveness, rule of law, control of corruption, voice and accountability, regulatory quality and political stability as proxies for governance. Using multivariate regression analysis, the study showed that countries with good governance are more likely to experience production growth due to increases in yield. The authors also found that countries with relatively weak governance tend to experience a greater decline in agricultural production in situations of adverse climate conditions than countries with good governance.

Ogunniyi et al (2020) investigated the effects of remittances and governance quality on food and nutrition quality in the region. The authors used the GMM estimation technique to analyse panel data for 15 countries. Governance was measured using the World Governance Indicators on six dimensions: voice and accountability, corruption control, government effectiveness, political stability, regulatory quality and rule of law. Food security and nutrition security captured the average value of food production and the average dietary energy supply adequacy of a country respectively. From

the analysis, government effectiveness, political stability and the rule of law have favourable impacts on food and nutrition security in SSA. Corruption control was demonstrated to have a strong positive effect on the average value of food production and average dietary energy supply adequacy in SSA.

Building on these existing works, our study considers the index of economic freedom and its components, which reflects economic governance and the extent to which governments in SSA implement market-oriented economic policies, in addition to the World Bank governance indicators. Also, the study used composite indexes capturing the aggregate effect of a combination of governance variables and the indicators of institutions. Furthermore, this research adds to the existing literature by investigating the moderating role of governance on the extent to which domestic food production translates into food insecurity reduction in SSA.

5. Conceptual framework

Figure 6 depicts the drivers of food security at the macro-level. This conceptual framework is adopted from Sassi (2015, 2018), and is related to the framework proposed by Thompson and Metz (1999). As observed in Figure 6, the goal of a well-functioning food economy is to ensure adequate food availability and access to food. Then with adequate food utilization, food security is achieved.

Food availability (the supply of food on the domestic market) is a necessary, but not a sufficient condition for food security. It is a combination of the food produced locally and food stocks, food imports and food aid. Domestic food production is a key factor in determining food supply. It is partly driven by household assets and the availability of farm inputs. According to the literature, a two-way relationship exists between domestic food production and food security. However, growing domestic production may lead to increases in food security by affecting both the supply and household access to food. This effect is direct when the farmer (household) consumes his/her own produce, and indirect mainly through reductions in prices and rising income (Johnston and Mellor, 1961; Diao et al, 2010). With respect to the reducing prices, the increase in food supply — relative to the demand for food — may lead to a fall in food prices, allowing the poor to have greater access to affordable food. Focusing on the rising income, a rise in food production causes an increase in the revenue that accrues to households, especially farm households. Improvements in nutrition and food security lead to increases in domestic food production, since meeting dietary needs (being food secure) has a positive effect on human capital and productivity, which in turn contributes to the growth of domestic food production (Knowles and Owen, 1995; Strauss and Thomas, 1998; Webber, 2002).

As apparent in Figure 6, both food availability and domestic food production are determined by various factors, such as trade, external assistance, external shocks, physical infrastructure, as well as governance and institutional quality. In extant literature, the effect of trade — or trade openness — on food access can be either positive or negative. The relationship between trade and food security can be traced to the discourses on trade liberalization and food sovereignty. First, following the arguments of “trade for food security” proponents, trade openness not only contributes to food security by increasing the availability of food on the domestic market through imports (food imports), but also promotes domestic food production (by enabling the imports of agricultural inputs) thereby improving availability and

access to food by the poorer population (Dollar and Kraay, 2004; Chatterjee and Murphy, 2013). Furthermore, trade is perceived to enhance the quality of food supplied to individuals.

Second, focusing on the negative effect of trade on food security, many scholars posited that openness to trade may inhibit food security in two ways. Openness to trade may discourage the demand for locally produced food with negative consequences for household income — especially farm households — particularly in developing countries and in rural areas, where most people practise subsistence farming. However, countries that are over-dependent on the foreign market for domestic food supply tend to be more vulnerable to external shocks, especially to food price hikes on the global market.[6]

Food aid is often a short-term intervention during famine to quell malnutrition and hunger among populations. Thus, while the effect of external assistance in the form of food aid on food availability may be direct and positive, it may also help improve productivity and thus, food production through its effect on human capital. Nevertheless, food aid may discourage the demand for locally produced food, by altering the taste and preferences of individuals. It, therefore, has a negative effect on domestic food production, food availability and access through the channels discussed earlier in this section.

Negative external shocks may lead to food insecurity. For example, a series of floods disrupt food availability and distribution leading to a rise in food prices with negative consequences for food access. Furthermore, food price hikes on the global market may create food shortages on the domestic market. The effects of external shocks on food security could be either positive or negative, depending on the nature of the shock. Positive shock — for example, good weather and a fall in oil prices[7] — will enhance domestic food production (hence food availability) and access to food via reduction in food prices and income increases while negative shocks are likely to have an opposite effect.

Improvements in the quality of institutions are expected to raise the level food security by promoting greater food supply, and therefore food access, or by operating through domestic food production (Dreze and Sen, 1989; Timmer, 1992; Ninno and Dorosh, 2003). Similarly, good governance promotes domestic production and food security. The state of transport infrastructure, which may also be considered as an aspect of governance[8], is likely to affect the access to markets, delivery of food, prices as well as domestic food production.

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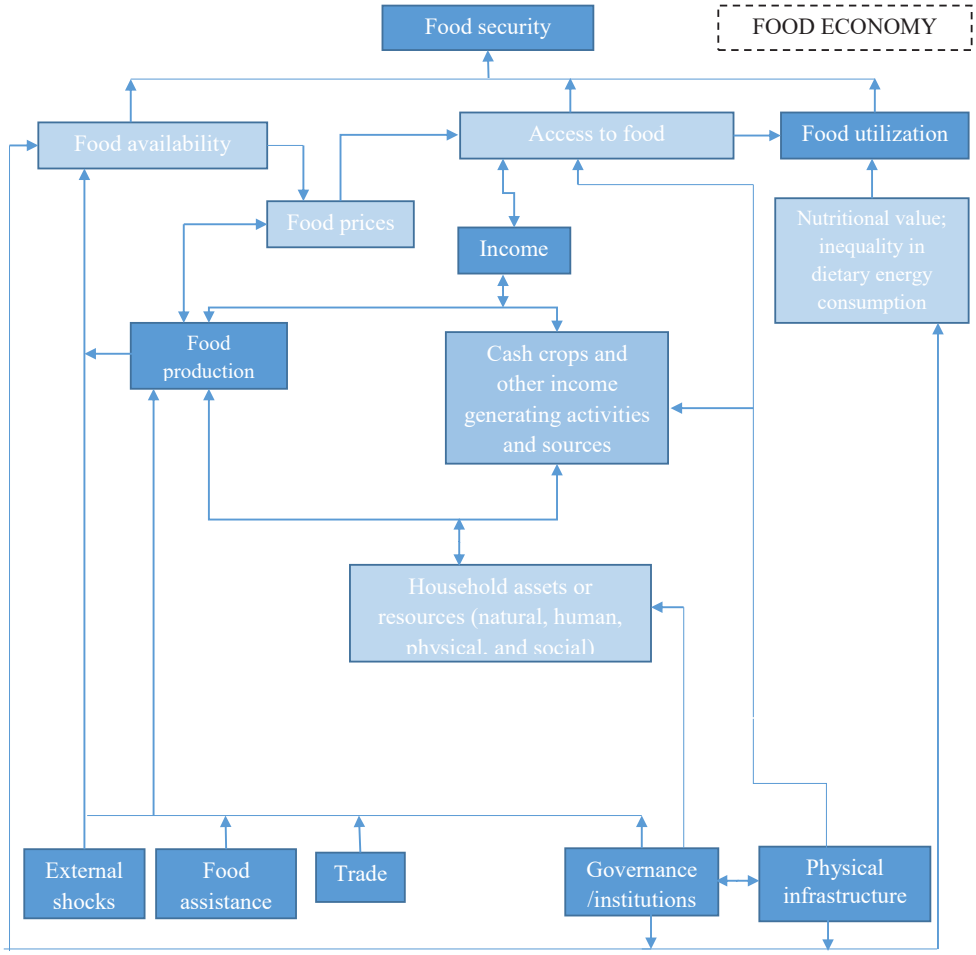
6 An example is the food price shocks of 2007, 2008 and 2010, which led to malnutrition and acute food insecurity in many developing countries, including countries in SSA.

7 Especially in countries that are net importers of oil.

8 In this report, physical infrastructure is separated from the governance and institutions category to make the conceptual framework consistent with the model.

Figure 6: Conceptual framework: Determinants of food security



Source: Authors, adopted from Sassi (2015, 2018).

Globally, periods of political instability and conflicts are associated with food insecurity and famine (Buhaug et al, 2015). First, instability or conflicts negatively affect food security. Food shortages are often due to the reduction in food production when farmers are forced to flee their homes, when access to inputs is prevented for security reasons or food distribution disrupted as the result of conflicts and wars. Furthermore, having lost their income generating activities due to war, most households have difficulty purchasing food, leading to malnutrition and severe food insecurity. Second, food insecurity creates tensions and conflicts within countries. Consequently, there is a bi-directional relation between political stability and conflicts, and food security. With respect to food utilization components, the nutritional intake of individuals in the households and the distribution of dietary energy consumption across individuals are important components of food security that can jeopardize productivity.

6. Methodology and data

Model specification

Based on the conceptual framework adopted from Sassi (2015, 2018), the study specified the following empirical equation, which is a modified version of the model estimated by Sassi (2015).

$$FoodInsecurity_{it} = \alpha + \beta_1 FoodProduc_{it} + \beta_2 Openness_{it} + \beta_3 G_{it} + \beta_4 Infrastrcture_{it} + \beta_5 Income_{it-1} + \beta_6 FoodAid_{it} + \beta_7 ExtShocks_{it} + \beta_8 CoVCons_{it} + \epsilon_i + \mu_{it} \quad (1)$$

$FoodInsecurity$ is captured using the log of depth of food deficit or the prevalence of undernourishment (%) (for more details on the variables see Table 2 and FAO (2018, 2020)). $FoodProduc$ is the level of domestic food production, which is measured using the log of per capita food production index (2014–2016 = 100). $Infrastructure$ represents transport infrastructure and is measured using the transport composite index. The index ranges from 0 to 100 and the lower the value the poorer the state of transport infrastructure. Trade openness, $Openness$, is the sum of exports and imports of goods and services over gross domestic product (GDP). *G* comprises variables that measure economic governance and institutional quality[9] (see Table 2).

To limit multicollinearity and the biases in the coefficients on governance and institutional quality, these variables are mostly included one after the other (separately) in the estimation (see the discussion on the estimation strategy for further details). However, a full model that includes all the indicators of governance and institutions is also reported in the result tables. $Income$ is measured by log of GDP per capita. In Equation (1) the lagged $Income$ is used instead of its actual value to address the potential endogeneity of the variable due to the reverse causality between income and the dependent variable. $FoodAid$ is the log of food aid received and $ExtShocks$ denotes external shocks that a country faces. It is measured by the

9 Although a general specification is presented here, it must be noted that the potential endogeneity of political stability is addressed in the GMM estimation reported robustness check (see Tables B5 and B6).

share of total population that was killed or affected by natural disasters (%) in a given year (see Table 2 for further details); $CoVCons$ is the measure of food utilization proxied by the coefficient of variation of habitual caloric consumption distribution following by Sassi (2015); α is the intercept and β_i (i=1, 2,..,8) is the coefficient on each explanatory variable; ϵ_i represents the unobservable country heterogeneities; and μ_{it} captures the idiosyncratic error terms, which are assumed to be identically and independently distributed across *i* and *t*.

As noted in the previous sections, an important issue related to the estimation of Equation 1 is the problem of endogeneity, especially with respect to domestic food production mainly because of reverse causality since food security can promote domestic food production via productivity. To account for the endogenous nature of food production in Equation 1, we estimated a first stage equation, given as:

$$FoodProduc_{it} = \gamma + \delta_1 Openness_{it} + \delta_2 G_{it} + \delta_3 Infrastructure_{it} + \delta_4 Income_{it-1} + \delta_5 ExtShock_{it} + \delta_6 CoVCons_{it} + (Land + Agric\_empt + Rainfall)_{it}\theta_v + \epsilon_i + \rho_{it} \quad (2)$$

We defined a set of instruments *X* as $Land, Agric\_empt$ and $Rainfall$ representing the log of arable land size, agricultural labour and a dummy variable capturing high level of precipitation in a particular year respectively (see Table 2). θ_v is the coefficient on the three instruments (for $v = 1,2,3$); γ is the intercept; and δ_i (i=1, 2,…,6) is the coefficient on each explanatory variable. $\epsilon_i$is the unobservable country heterogeneity and ρ_{it} the idiosyncratic error term, which is assumed to be identically and independently distributed across *i* and *t*.

For a valid exclusion restriction, *X* is found only in Equation 2. In the 2SLS regression, the predicted values of food production obtained from Equation 2 are then used in the second stage equation. Furthermore, specifying Equation 2 enables us to test whether the quality of institutions and governance has an indirect effect on domestic food production, in addition to any possible direct effects captured in the main equation (Sala-i-Martin and Subramanian, 2013; Bonuedi et al, 2020), thereby providing evidence on the role of domestic food production as a channel of transmission. In addition to a 2SLS, Equation 1 is estimated using LIML approach and a two-step system GMM with stronger sets of instruments (see Section 8).

In Equation 1, β_1, β_3 and β_4 are expected to be negative, meaning that an increase in food production, and improved governance and infrastructural development would lead to a reduction in food insecurity (the depth of food deficit or the prevalence of undernourishment). β_2 and β_6 could be either positive or negative, while β_5 is anticipated to be negative, suggesting that a higher income would boost food security. Since external shock is measured using the share of victims of natural disaster in the total population, the variable capturing the extent of negative shocks that a country faces each year, β_7 is expected to be positive, reflecting the negative effect of such shocks on food security, and β_8 should be positive, as high inequality in the

dietary energy consumption would exacerbate food insecurity. Lastly, in Equation 2, δ_2, δ_3 and δ_4 are also expected to be positive, reflecting the positive effect of good governance or institutional quality, infrastructure development and income on food production; and δ_5 is anticipated to be negative when measured by the proportion of victims of natural disasters reflecting the detrimental effects of negative external shocks on production. δ_6 should be negative, proper food utilization would increase productivity. Meanwhile, δ_1 could be either positive or negative given the lack of clear consensus in the literature on the sign of the effect of the openness on food production.

Defining governance and institutions

The terms institutions and governance are interrelated. Both concepts are often used interchangeably in the literature although they maintain nuances, which we operationalized in this study. We distinguished between governance variables, measures of institutions and the indicator of political instability/conflict.

With respect to "institution", this study adopts the definition of North (1991: 97), who defined institutions as "the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions and codes of conduct) and formal rules (constitutions, laws, property rights)." Hence, according to North (1991), "institutions are the rules of the game" that govern socioeconomic and political interactions in a given society. Based on this definition, indicators of institutional quality would include control of corruption, rule of law and voice and accountability

Existing institutions (formal and informal)[10] condition and reflect the state of governance, defined as 'the play of the game' (Williamson, 1998, 2000). According to World Bank (1992: 1), governance is the "manner in which power is exercised in the management of a country's economic and social resources for development". Hence, governance includes the extent of business-friendly economic management and regulations, and government effectiveness in the provision of social services.

Principal component analysis

The study used the principal component analysis (PCA) method to compute two aggregate indexes using the various dimensions of governance and institutions. We computed a single metric for governance variables (economic freedom and government effectiveness) named governance index, and a second factor using institution indicators (control of corruption, rule of law, and voice and accountability). The composite index enabled us to consider governance or institutions in a holistic way when examining their effects of the key dependent variables.

10 The extant literature highlights the importance of informal institutions in shaping interactions in economic and political systems particularly in traditional societies; however, our discussion focused on formal institutions.

The PCA method aims at compressing a large set of highly correlated variables to a single or a smaller set of latent variables, while maintaining the relevant information contained in each indicator. It is widely used in the empirical literature to minimize multicollinearity resulting from the inclusion of highly correlated institutions and governance variables in estimated models (Asongu and Nwachukwu, 2016). The details on the PCA computation (eigenvalue, proportion and the cumulative shares of variations explained) are reported in the Table A2.

Data

The study considered a sample of 34 countries in SSA. The panel data covers the period 2000 to 2015 (see Table A1 for list of countries). As indicated in Table 2, the data on depth of food deficit and prevalence of undernourishment, per capita food production index and arable land are obtained from FAOSTAT (FAO, 2020). Food aid flows were sourced from the World Food Programme (WFP). The government effectiveness and institutional quality variables — namely rule of law, control of corruption and voice and accountability — and political stability and absence of violence were from the World Governance Indicators (World Bank, 2020a). With respect to economic governance, economic freedom was sourced from Gwartney et al (2020). The transport composite index, measuring physical infrastructure was obtained from the African Infrastructure Index (AfDB, 2019). GDP per capita, population growth rate and information on agricultural employment were obtained from the World Development Indicators (WDI) (World Bank, 2020b). Data on precipitation (rainfall) were from the Climate Change Portal (World Bank, 2020c).

Table 2: Definition of variables and data sources

Variable	Definition	What the variable measures	Data source
Food insecurity variables — *FoodInsecurity*			
Depth of food deficit (kcal/caput/day)	The depth of the food deficit indicates how many calories would be needed to lift the undernourished from their status, everything else being constant. It is in calories per capita per day.	It is an indicator of food insecurity.	FAO (2018)
Prevalence of undernourishment (%)	Prevalence of undernourishment measures the percentage of the population that is at risk of not covering the food requirements associated with normal physical activity. It is in percentages.	It is an indicator of food insecurity.	FAO (2020)
Governance variables — *G*			
Economic freedom index (Summary Index)	Economic freedom index is a summary of the five indexes of the Economic Freedom World Index on: [1] Size of Government; [2] Legal System and Security of Property Rights; [3] Sound Money; [4] Freedom to Trade Internationally; [5] Regulation. The index ranges from 0 to 10, where 0 means the lowest freedom and 10, the highest.	It measures governance.	Gwartney et al. (2020)
Size of government	The size of government measures the extent to which government policy and action (e.g., consumption, investment and tax) crowds out individual choice. It is computed using data on government consumption spending, transfer and subsidies, government investment as a share of total investment, tax rates and state's ownership of assets. It ranges from 0 to 10, where 0 means low size of government.	It is a sub-component of the economic freedom index and measures governance.	Gwartney et al. (2020)
Legal system and security of property rights	Legal system and security of property rights measures how well the protective functions of government are performed in terms of protective people and property rights. It is computed using information on countries' judiciary independence, impartiality of courts, military interference, integrity of the legal system, reliability of the police, and the extent to which property rights are protected by law and contracts enforced. It ranges from 0 to 10, with the lowest score indicating the poorest performance.	It is a sub-component of the economic freedom index and measures governance.	Gwartney et al. (2020)
Sound money	Sound money measures the extent to which the currency performs its functions, including as a store of value and an effective medium of exchange. It is computed using information on the growth of money, the standard deviation of inflation, inflation in most recent year and the freedom to own foreign currency bank account. It ranges from 0 to 10, with the lowest score indicating the poorest performance.	It is a sub-component of the economic freedom index and measures governance.	Gwartney et al. (2020)

Freedom to trade internationally	Freedom to trade internationally measures the extent to which tariff and non-tariff barriers, and other restrictions affect international trade. It is computed using information on tariff rates, regulatory trade barriers, black market exchange rates, and control on movement of capital and people. It ranges from 0 to 10, with the lowest score indicating the poorest performance.	It is a sub-component of the economic freedom index and measures governance.	Gwartney et al. (2020)
Regulation	Regulation measures the level of constraints to business and related activities including employer and employee rights. It is computed using information on country-level credit market regulations, labour market regulations, and business regulations. It ranges from 0 to 10, with the lowest score indicating the poorest performance.	It is a sub-component of the economic freedom index and measures governance.	Gwartney et al. (2020)
Government effectiveness	Government effectiveness index measures the 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. It ranges from -2.5 to 2.5.	It measures governance.	World Bank (2020a)
Governance Index	Principal component analysis (PCA) computation using economic freedom index and government effectiveness	It measures governance.	Authors' computation
Institutional quality variables — *G*			
Control of corruption	Control of corruption index captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, and "capture" of the State by elites and private interests. It ranges between -2.5 to 2.5.	It measures the quality of institutions.	World Bank (2020a)
Rule of law	Rule of law index captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and especially the quality of contract enforcement, property rights, the police, the courts, and the likelihood of crime and violence. It ranges from -2.5 to 2.5.	It measures the quality of institutions.	World Bank (2020a)
Voice and accountability	Voice and accountability index measures the extent to which citizens participate in choosing their government, freedom of expression, freedom of association and a free media. It ranges from -2.5 to 2.5.	It measures the quality of institutions.	World Bank (2020a)
Institution Index	PCA computation using control of corruption, rule of law and voice and accountability.	It measures the quality of institutions.	Authors' computation

Political stability — *G*			
Political stability and absence of violence	Political stability and absence of violence index measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism, and ranges between -2.5 to 2.5.	It is a measure of political stability/conflicts	World Bank (2020a)
Other explanatory variables			
Gross per capita food production index — *FoodProduc*	Gross per capita food production index expresses the relative level of the aggregate volume of food production for each year in comparison with the base period 2004–2006.	It measures domestic food production.	FAO (2020)
Trade openness — *Openness*	Trade openness is the sum of exports and imports of goods and services over gross domestic product (GDP). It is in percentage.	It is a measure of openness.	Authors' computation using data from World Bank (2020b)
GDP per capita (constant 2010 US$) — *Income*	GDP per capita is GDP divided by midyear population. Data are in constant 2010 U.S. dollars.	It measures income.	World Bank (2020b)
Transport Composite Index — *Infrastructure*	Transport composite index is a as a weighted average of two indicators, namely: (1) total paved roads (km) per 10,000 inhabitants; and (2) total road network (in km) per km^2 of exploitable land area.	It measures level of transport infrastructure development and physical access to markets.	The African Infrastructure Index, AfDB (2019)
Food aid — *FoodAid*	Cereals and non-cereals food aid shipments received by a recipient in a year. It is measured in tonnes.	It measures amount of food aid received.	WFP (2020)
Victims of natural disasters — *ExtShocks*	The share of the total population who are killed or affected by natural disasters. It is measured in percentages.	It indicates mortality rates triggered by natural disasters.	Emergency Disasters Database (EM-DAT, 2019)
Coefficient of variation in caloric consumption — *CoVCons*	Coefficient of variation of habitual caloric consumption distribution	It captures the distribution in dietary energy supply.	FAO (2018)
Other variables (instruments) — *X*			
Arable land	Size of arable land available in thousands of hectares	It is a measure of land capital.	FAO (2020)
Agricultural labour	Employment in agriculture (% of total employment)	It measures agricultural labour.	World Bank (2020b)
Three or more months high rainfall dummy	High rainfall dummy is a dummy variable, which takes the value 1 if there is high rainfall in 3 or more months in a year and 0 otherwise. High precipitation for a particular month is defined as monthly rainfall that is greater than the 20-year average of the 6 months with highest level rainfall.	It measures level of rainfall	The climate change portal (World Bank, 2020c)

Descriptive statistics

Table 3 reports the descriptive statistics of the variables defined in Table 2. The country-specific mean values are reported in Table A3. The sample mean for the key outcome variables of interest — prevalence of undernourishment and depth of food deficit — were 23.95% and 174.13 kcal/caput/day respectively, with a larger variation in food deficit than in undernourishment.[11] Hence, about 24% of the population in the SSA

11 The respective coefficients of variation (standard deviation divided by the sample mean) were 0.5 and 0.6.

sample did not attain the minimum dietary energy required for a healthy living. Over 174 kcal/caput/day would be needed to lift them out of undernourishment, on average. Among the countries that recorded low mean prevalence of undernourishment in SSA for the period 2000–2015, the top four were South Africa (4%), Mauritius (5%), Ghana (7%) and Nigeria (7%) (see Table A3). These countries not only recorded the lowest proportion of the population undernourished people, but also their citizens had the lowest calorie shortfall in the region, on average (Table A3). Meanwhile, CAR, Liberia and Zambia were among the most food insecure, with over 40% of their population suffering from undernourishment, and an average calorie shortfall of 317.77, 357.50 and 416.15 kcal/caput/day respectively over the period considered (Table A3).

The economic freedom index, which combines the five subsequent indices indicated in Table 2, had a sample mean value of 6.07 points out of a maximum possible score of 10 and a minimum of zero (0). For the overall sample, the lowest value was 2.95 and the maximum value was 8.15 (Table 3). Zimbabwe recorded the lowest economic freedom index, on average, suggesting the relatively high levels of regulation and restrictions on markets, with weaker enforcement of property rights (Table A3). Other countries with lower economic freedom in 2000–2015 were Chad, Guinea-Bissau and CAR. Conversely, in Mauritius, Uganda, Botswana, Liberia and South Africa economic policy and governance seemed to favour a free business environment, market competition, openness and property rights enforcement (Table A3). This finding, particularly, for Uganda is consistent with existing evidence that the country is among the best implementers of the SAPs in SSA (Fosu and Gafa, 2020).

Focusing on the dimensions of economic freedom, sound money capturing the effectiveness of monetary and macroeconomic policies recorded the highest mean (7.01), followed by the size of government (6.48) and regulation (6.43). The legal system and property rights dimension recorded not only the lowest value, on average, but also the greatest variability across countries and time. This finding suggests that progress on quality of the judicial system and property rights enforcement have not been the same across countries in the region. Furthermore, large cross-country variations were observed in sound money, with a coefficient of variation[12] of 0.21 compared with 0.30 for legal system and property rights; freedom to trade internationally recorded the lowest (Table 3). Hence, substantial heterogeneity exists in the implementation of market-based reforms across countries in the region.

12 The coefficient of variation is obtained by dividing the standard deviation by the mean.

Table 3: Descriptive statistics of the variables

Variables	Mean	Std. dev.	Minimum	Maximum	Obs.
Food security variables					
Prevalence of undernourishment (%)	23.95	12.83	3.60	58.60	544.00
Depth of food deficit (kcal/caput/day)	174.13	103.42	24.00	490.00	544.00
Governance variables					
Economic freedom index (Summary Index)	6.07	0.79	2.95	8.15	484.00
legal system & property rights	4.18	1.27	1.67	7.32	484.00
Sound money	7.01	1.48	0.00	9.67	484.00
Freedom to trade internationally	6.24	0.88	2.06	8.55	484.00
Regulation	6.43	1.00	3.66	8.44	484.00
Size of government	6.48	0.93	4.39	9.21	484.00
Government effectiveness	-0.62	0.58	-1.85	1.05	510.00
Governance index	0.05	1.28	-3.56	3.79	458.00
Institutional quality variables					
Control of corruption	-0.54	0.60	-1.54	1.22	510.00
Rule of law	-0.58	0.63	-2.01	1.08	510.00
Voice and accountability	-0.40	0.66	-1.67	0.98	510.00
Institution index	0.08	1.65	-2.94	3.99	510.00
Political stability and absence of violence	-0.43	0.85	-2.70	1.22	510.00
Other explanatory variables					
Gross per capita food production index	102.84	13.87	54.99	151.30	544.00
Trade ratio or openness	71.59	32.41	21.45	311.35	526.00
Lagged log of GDP per capita	6.88	0.96	5.25	9.27	543.00
Log of food aid	8.09	4.05	0.00	14.25	544.00
Victims of natural disasters	0.02	0.07	0.00	0.50	544.00
Transport composite index	8.44	8.10	0.91	36.63	442.00
Log of coefficient of variation in caloric consumption	-1.23	0.16	-1.47	-0.87	544.00
Log of total arable land	7.66	1.50	3.78	10.52	544.00
Agricultural labour (employment in agric. % total employment)	53.78	21.79	4.60	88.56	544.00
Three or more months high rainfall dummy			0.00	1.00	544.00

Table 3 further shows that SSA falls below the world average (which is zero) on government effectiveness, rule of law, control of corruption, voice and accountability and political stability. On average, the region performed relatively well on political stability and absence of violence (-0.43) and voice and accountability (-0.40) respectively. Mauritius, Botswana, South Africa, Cape Verde and Namibia were consistently among the top performers in government effectiveness, control of corruption, rule of law and political stability; countries, such as Zimbabwe and CAR, were the bottom performers (Table A3).

The mean value for gross per capita food production index, a key explanatory variable, was 102.84, with standard deviation of 13.87 and a minimum of 54.99 and a maximum of 151.30. The measures of trade openness, lagged log of GDP per capita and log of food aid had mean values of 71.59%, 6.88 log points and 8.09 log points respectively. Lesotho, Mauritius, Mauritania, Liberia and Namibia were among the countries with the highest trade to GDP ratio in the region (Table A3). Furthermore, Burkina Faso and Liberia had the largest disparities in habitual caloric consumption in SSA, while South Africa and Senegal had the lowest. The remaining covariates—victims of natural disasters and the transport composite index — had full sample mean values of 0.02% and 8.44 points and standard deviation of 0.07% and 8.10 points respectively (Table 3).

Table 3 also presents summary statistics of the instruments adopted in the relevant econometric specifications. These include log of total arable land, employment in agriculture as a percentage of total employment and a measure of rainfall. Nigeria, Ethiopia, Niger, South Africa and Tanzania had over 10 million hectares of arable land. Mauritius and Cape Verde, small islands, had less than 100,000 hectares (Table A3). Lastly, the agriculture sector accounted for over 50% of the total employment in SSA, reflecting the important role of this sector in the region's economy (Table 3).

Estimation strategy

As previously indicated, the main challenge of estimating Equation 1 is the potential endogeneity problem, due to the possibility of a reverse causality between the food insecurity indicator and domestic food production. The failure to control for endogeneity could lead to biased and inconsistent estimates of the coefficients. To circumvent this challenge, the study estimated the system of (1) and (2) using the fixed effects-2SLS method. The 2SLS framework not only addresses the endogeneity problem, but also enables us to examine the indirect effect of governance and institutions variables, trade, food aid and other explanatory variables on food insecurity through food production (Sala-i-Martin and Subramanian, 2013). The fixed effects approach helps account for unobserved heterogeneities, given the plausible concern that country-specific characteristics may be correlated with several of the regressors. An interaction term was also introduced in the baseline model to capture the effect of governance on the extent to which domestic food production translates into food insecurity reduction.

For the naive model estimated in Equation 1, the Hausman (1978) endogeneity test was used to confirm the presence of endogeneity related to food production. For identification purposes, the number of instrumental variables should be at least equal to the number of endogenous variables in the equation.

Instruments, by definition, should be strongly related to domestic food production, but uncorrelated with the error term. However, finding truly exogenous instruments is a difficult task. In this study, we jointly used three sets of instruments: the log of arable land size, the share of agricultural labour in total employment and a rainfall dummy to identify the treatment effect. These variables are key determinants of food

production in a developing region that is still trying to catch up with technology-driven agriculture. Rainfed food production persists in Africa coupled with demand for arable land so long as local labour is available (Cooper et al, 2008; Xu et al, 2020). However, arable land size, agricultural labour and rainfall are unlikely to be correlated with the outcomes of interest: calories per capita required per day to avert undernourishment and prevalence of undernourishment. While one could still argue by intuition that an increase in arable land size and agricultural labour, and high precipitation may influence food insecurity by increasing the production of non-food crops, such effects could only operate through income and trade, which are already captured in the model.

The validity of the instruments was tested using the Hansen test and the presence of weak identification was checked using the Cragg–Donald Wald F-statistics. While the 2SLS estimator leads to consistency, an important condition for an efficient estimator is homoscedasticity and no serial correlation. Hence, the study reported heteroscedasticity-robust standard errors. Furthermore, model (1) is estimated using alternative methods, namely the two-step system GMM and the limited-information maximum likelihood (LIML) techniques, to ensure the robustness of the estimates (see Section 8).

Another challenge that arises when estimating Equations 1 and 2 is multicollinearity. Indeed, some of the exogenous variables included in the model may be correlated with each other, leading to lower precision of the estimates. This is particularly the case for the governance and institutional quality variables, and political stability variables, but also between the other explanatory variables and governance variables (for example, access to basic sanitation and government effectiveness), and among explanatory variables. Consequently, the correlation coefficients between explanatory variables were computed and used to decide on the simultaneous inclusion of variables in the regression (see Table 4). Furthermore, the values of the variance inflation factor (VIF) were examined, with a rule of thumb of greater than 10 for multicollinearity. The estimated VIF for the various models are reported in the results tables.

As shown in Table 4, there was a moderate/high correlation between institution and governance variables, as expected, except between economic freedom and the political stability and absence of violence index. These variables were therefore included one after the other (separately) in the estimated models. In addition, composite indexes based on PCA computation were used as explanatory variables. The economic freedom and transport infrastructure indices seemed to be moderately correlated. Meanwhile, the correlation between other variables and governance and institutions indicators were weak. Furthermore, the indicators of food aid and inequality in dietary energy consumption appeared to be moderately correlated with the lagged value of per capita GDP and the share of the population employed in agriculture (Table 4).

Table 4: Correlation matrix for explanatory variables (Spearman's correlation)

	Trade openness	Log of initial GDP per capita	Log of food aid	Log of CV in caloric cons.	EF	GE	CC	RL	VA	PS	Victims of natural disasters	Transport infras.	Log of total arable land	Agric. labour
Trade openness	1													
Log of initial GDP per capita	0.44	1												
Log of food aid	-0.19	-0.60	1											
Log of CV in caloric cons.	-0.13	-0.56	0.49	1										
Economic freedom (EF)	0.12	0.42	-0.36	-0.25	1									
Government effectiveness (GE)	0.15	0.42	-0.20	-0.46	0.67	1								
Control of corruption (CC)	0.28	0.30	-0.15	-0.27	0.61	0.84	1							
Rule of law (RL)	0.25	0.39	-0.23	-0.38	0.66	0.88	0.88	1						
Voice and Accountability (VA)	0.28	0.39	-0.31	-0.37	0.58	0.72	0.73	0.81	1					
Political stability (PS)	0.36	0.38	-0.29	-0.26	0.40	0.64	0.71	0.77	0.73	1				
Victims of natural disasters	-0.15	-0.23	0.20	0.02	-0.04	0.02	0.00	-0.01	0.01	-0.10	1			
Transport infras.	0.23	0.53	-0.41	-0.20	0.55	0.49	0.46	0.47	0.36	0.43	-0.22	1		
Log of total arable land	-0.49	-0.24	0.29	0.11	-0.06	-0.08	-0.26	-0.17	-0.15	-0.40	0.29	-0.39	1	
Agric. labour	-0.49	-0.75	0.56	0.54	-0.43	-0.45	-0.44	-0.52	-0.55	-0.46	0.21	-0.59	0.34	1
High rainfall dummy	-0.06	-0.03	0.01	0.05	-0.03	-0.09	-0.07	-0.07	-0.07	-0.02	0.06	-0.04	0.01	0.02

7. Results and discussions

Tables 5 and 6 report the first stage (Panel B) and the second stage (Panel A) IV regression results, with the depth of food deficit (expressed in logarithm) and the prevalence of undernourishment (in percentages) as dependent variables respectively. Indeed, the endogeneity test statistics support the presence of endogeneity, meaning that food production cannot safely be treated as an exogenous variable in the model. In addition, the Cragg–Donald Wald F-statistics — which exclude the presence of weak identification — and the Hansen J test of over-identifying restrictions confirm the validity of the instruments used in the estimation, namely the log of arable land size, employment in agriculture (% of total employment) and high precipitation dummy.

Tables 5 and 6 present the regression results with the depth of food deficit and the prevalence of undernourishment as dependent variables respectively. For model (1), all the explanatory variables are included except the governance variables. In model (2), regional dummies are introduced, and the governance variables are included in models (3) to (8). Panels A and B report the second stage and the first stage regression results with food insecurity indicators and domestic food production as dependent variables respectively. While the second stage results provide evidence on the factors explaining depth of food deficit and the prevalence of undernourishment, the first stage analysis provides evidence on the (indirect) effects of the covariates through the food production channel (Sala-i-Martin and Subramanian, 2013; Bonuedi et al, 2020).

Focusing on model (1), in Panel A, an increase in domestic food production leads to a significant fall in the depth of food deficit and the prevalence of undernourishment in SSA, on average. This finding is consistent with the conclusion reported by other authors (Sacks and Levi, 2010; Sassi. 2015; Kaur and Kaur, 2016) who also showed that food produced locally is more accessible to the population, and greater domestic food production would help promote food access and reduce food insecurity in SSA. The negative effect of domestic food production on food insecurity was consistently observed in all estimation results[13] (see Tables 5 to 12).

13 The magnitude of the effect of domestic food production seems much higher once one accounts for endogeneity (about twice the magnitude of the random effects estimation) compared to the fixed and random effects results, reflecting a larger effect of domestic food production on food insecurity in SSA.

Furthermore, the coefficient of variation of habitual caloric consumption distribution had a positive and significant effect on the depth of food deficit and the prevalence of undernourishment, suggesting that the more unequal the distribution of dietary energy consumption the greater the proportion of the undernourished and the deeper the level of food deficit (Tables 5 and 6). In contrast to the findings of Dithmer and Abdulai (2017), however, the coefficient on trade ratio was negative but not statistically significant. This finding was consistent across the two measures of food insecurity. The absence of a direct effect of trade openness on food security is presumably attributable to the relatively greater prevalence of food insecurity in rural areas of SSA. Since rural communities tend to benefit less from the imports of food items than urban dwellers, the direct effect of trade openness on food insecurity would be negligible. Similarly, the results show no direct statistically significant effect of both transport infrastructure and food aid on the outcome variables of interest: depth of food deficit and the prevalence of undernourishment (see model (1) of Tables 5 and 6). The insignificant effect of food aid on food insecurity is in line with the findings of Sacks and Levi (2010).

Also, the coefficient of lagged income, although statistically insignificant in the baseline model, had a negative statistically significant effect on food insecurity once we accounted for the role of governance (in Table 5, see models (4), (6) and (8), and model (6) in Table 6). In other words, as income increases, citizens have greater access to food and are less food insecure. These findings are consistent with the conclusion of Sassi (2015) and Kaur and Kaur (2016) who also showed that income plays an important role in nutrition, and the higher the income of a household the greater their access to food. The sign of the coefficient on the indicator of negative external shocks (the share of victims of natural disasters in total population) was, however, contrary to expectations, as it suggests that a greater incidence of natural disasters would lead to a fall in food insecurity in SSA. This finding is likely attributable, however, to the support received by affected populations which may not be adequately captured in the measure of food aid.

Regional differences in food insecurity were also observed. Specifically, compared with the West Africa region, the depth of food deficit and the prevalence of undernourishment were significantly higher in Eastern Africa and in Southern Africa (see model (2) in Tables 5 and 6). The finding is presumably driven by the high level of food insecurity of most Eastern and Southern African countries considered, such as Madagascar, Rwanda, Zambia and Zimbabwe (see Table A3).

The first stage regression results, reported in Panel A show the effects of the explanatory variables on food production, thereby providing insights on the indirect effects of the various covariates on food insecurity through domestic food production. Again, focusing on the baseline model, the results showed that higher trade openness positively affects domestic food production, implying an indirect effect of trade on

The fixed and random effects estimates are available and will be provided upon request.

food security through domestic food production. The indirect effect of openness on food production can be attributed to the role of trade in promoting competitiveness, thereby enhancing innovation among domestic farmers, and technological inflows to the region — access to fertilizer, improved seeds and other imported yield-enhancing technologies (Armstrong and Read, 1998; Wacziarg and Welch, 2008).

The results also showed that improvements in transport infrastructure are beneficial for food production while negative external shocks, measured by the proportion of victims of natural disasters, lead to significant declines in domestic food production. Hence, the effects of both variables are mainly indirect via domestic food production, as natural disasters hinder food access by curtailing local production of food while poor transport infrastructure limits farmers' access to inputs and markets for greater agricultural production. Furthermore, food production in Southern and Eastern Africa were significantly lower than in West Africa, on average. The reverse, however, was observed for Central Africa. This finding is in line with existing evidence that agricultural productivity and food production have considerably increased in West Africa over the last decades, with the sub-region accounting for the largest share of total agricultural production in SSA (NEPAD, 2014). The geographical location and the climatic conditions in West and Central Africa also tend to be generally more favourable for agricultural production (NEPAD, 2014).

External assistance in the form of food aid had a positive rather than negative effect on domestic food production. Since evidence shows that food insecurity in SSA is much more prevalent in rural communities, which are mainly based on agriculture, this finding may be reflecting the role of food aid in enabling households to meet their dietary needs, thereby increasing their productivity. As expected, the availability.

Table 5: Food insecurity and governance quality: Results based on 2SLS estimation; Dependent variable: Log of depth of food deficit .

Panel A: Depth of food deficit (kcal/caput/day)

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	(8)
Log of food production index	-1.593***	-1.59***	-1.547***	8.403**	-1.524***	-4.151**	-1.588***	-1.465***
	(-7.017)	(-6.96)	(-6.543)	(2.532)	(-6.639)	(-2.507)	(-6.422)	(-5.328)
Trade openness	-0.009	-0.009	0.018	0.079	0.016	-0.081	0.045	0.037
	(-0.256)	(-0.16)	(0.168)	(0.795)	(0.155)	(-1.200)	(0.414)	(0.343)
Lagged log of GDP per capita	-0.064	-0.064	0.065	-0.244*	0.049	-0.327**	0.012	-0.308**
	(-0.547)	(-0.60)	(0.506)	(-1.822)	(0.386)	(-2.061)	(0.094)	(-2.042)
Log of food aid	0.008	0.008	0.007	-0.009	0.007	-0.003	0.008	-0.008
	(1.240)	(1.34)	(1.120)	(-1.214)	(1.068)	(-0.265)	(1.118)	(-0.854)
Log of coefficient of variation in caloric consumption	1.439***	1.44***	1.299***	2.730***	1.244**	2.144***	1.489***	2.712***
	(3.770)	(3.12)	(2.684)	(4.161)	(2.563)	(3.583)	(3.176)	(3.881)
External shocks (Victims of natural disasters)	-0.330**	-0.33**	-0.344**	-0.359**	-0.337**	-0.750**	-0.331**	-0.549***
	(-2.353)	(-2.09)	(-2.438)	(-2.574)	(-2.478)	(-2.503)	(-2.325)	(-3.205)
Transport infrastructure	0.004	0.003	-0.001		-0.002		0.001	
	(0.464)	(0.56)	(-0.175)		(-0.307)		(0.162)	
Economic freedom (EF)			-0.099***	7.276***	-0.104***			
			(-2.837)	(2.819)	(-3.104)			
Government effectiveness (GE)					0.109	17.354*		
					(1.462)	(1.669)		
Governance Index (GI)							-0.036	5.337**
							(-1.022)	(2.254)
Log of food production index * EF				-1.594***				
				(-2.861)				

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; VIF = variance inflation factor; SEE = Standard error of estimates.

Log of food production index * GE						-3.728*		
						(-1.650)		
Log of food production index * GI								-1.150**
								(-2.255)
Regional dummies (Ref.= West Africa)								
Central Africa		-0.132						
		(-0.47)						
Southern Africa		0.720***						
		(5.48)						
East Africa		0.248***						
		(2.36)						
Observations	430	430	398	476	398	493	398	450
Number of countries	34	34	34	34	34	34	34	34
R-squared	0.0334		0.0802	-0.201	0.0985	-0.653	0.0440	-0.229
Hansen J	4.078	4.273	2.853	1.058	2.515	2.409	3.042	2.059
Hansen J P-value	0.130	0.1181	0.240	0.304	0.284	0.121	0.218	0.151
Cragg–Donald Wald (F-stat)	24.54	23.629	20.86	3.622	21.36	0.853	20.42	1.836
Hausman (Endogeneity) test	29.25	-	23.36	24.08	23.78	25.15	24.06	22.02
Prob>chi2	0.00	-	0.00	0.00	0.00	0.00	0.00	0.00
VIF	1.73	1.80	1.81	-	2.32	-	1.65	-
SEE	0.180	0.18	0.180	0.239	0.179	0.267	0.184	0.235

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; VIF = variance inflation factor; SEE = Standard error of estimates.

Table 5 continued

Panel B: Log of per capita food production index

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	(8)
Trade openness	0.052***	0.052***	0.081*	0.052	0.081*	0.047***	0.092**	0.073*
	(2.817)	(2.05)	(1.771)	(1.201)	(1.752)	(2.755)	(1.982)	(1.663)
Lagged log of GDP per capita	0.039	0.039	0.068	0.086	0.055	0.072	0.039	0.073
	(0.682)	(0.76)	(1.084)	(1.447)	(0.879)	(1.467)	(0.612)	(1.192)
Log of food aid	0.007***	0.01***	0.006**	0.006**	0.006**	0.010***	0.006**	0.009***
	(2.780)	(2.61)	(2.287)	(2.370)	(2.194)	(3.911)	(2.219)	(3.295)
Log of coefficient of variation in caloric consumption	-0.352	-0.35	-0.320	-0.168	-0.356	-0.327	-0.238	-0.153
	(-1.352)	(-1.58)	(-0.970)	(-0.637)	(-1.096)	(-1.541)	(-0.730)	(-0.529)
External shocks (victims of natural disasters)	-0.208**	-0.21**	-0.225***	-0.172*	-0.224***	-0.231***	-0.215***	-0.253***
	(-2.554)	(-2.87)	(-2.766)	(-1.844)	(-2.835)	(-3.262)	(-2.693)	(-3.552)
Transport infrastructure	0.010***	0.01***	0.008**		0.007**		0.008***	
	(3.226)	(3.34)	(2.450)		(2.305)		(2.592)	
Economic freedom (EF)			-0.028	-0.017	-0.032*			
			(-1.605)	(-0.931)	(-1.914)			
Government effectiveness (GE)					0.074***	0.089***		
					(2.621)	(4.227)		
Governance index (GI)							0.002	0.015
							(0.135)	(0.977)
Regional dummies (Ref.= West Africa)								
Central Africa		0.558**						
		(2.58)						
Southern Africa		-0.361***						
		(-5.64)						
East Africa		0.510***						
		(-6.33)						
Log of total arable land	0.385***	0.385***	0.381***	0.440***	0.388***	0.433***	0.370***	0.423***
	(6.084)	(6.44)	(5.611)	(7.391)	(5.821)	(7.763)	(5.479)	(6.895)
Agricultural labour	-0.006***	-0.006***	-0.007***	-0.008***	-0.007***	-0.005***	-0.007***	-0.007***
	(-2.681)	(-4.09)	(-2.942)	(-3.255)	(-3.021)	(-2.636)	(-2.958)	(-2.974)
Three or more months high rainfall dummy	0.021**	(0.021)	0.022**	0.026***	0.021**	0.022**	0.023**	0.024**
	(2.379)	(2.32)	(2.325)	(2.638)	(2.225)	(2.362)	(2.359)	(2.385)
Observations	430	430	398	476	398	493	398	450
Number of countries	34	34	34	34	34	34	34	34

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 6: Food insecurity and governance quality: Results based on 2SLS estimation; Dependent variable: Prevalence of Undernourishment

	Panel A: Prevalence of undernourishment (%)							
Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	(8)
Log of food production index	-28.442***	-28.44***	-25.886***	85.294*	-21.267***	-56.376***	-26.616***	-24.808***
	(-6.513)	(-7.16)	(-5.929)	(1.875)	(-4.804)	(-2.596)	(-5.894)	(-6.468)
Trade openness	-0.428	-0.428	-1.139	-1.469	-1.628	-1.689*	-0.881	-1.593
	(-0.649)	(-0.45)	(-0.599)	(-0.927)	(-0.929)	(-1.861)	(-0.457)	(-0.933)
Lagged log of GDP per capita	-3.842	-3.84	-1.995	-4.196*	-3.036	-5.726**	-2.180	-4.925**
	(-1.311)	(-2.07)	(-0.624)	(-1.870)	(-1.251)	(-2.531)	(-0.717)	(-2.018)
Log of food aid	0.017	0.017	-0.016	-0.223*	-0.120	-0.074	-0.010	-0.179
	(0.130)	(0.16)	(-0.128)	(-1.837)	(-1.087)	(-0.498)	(-0.080)	(-1.313)
Log of coefficient of variation in caloric consumption	17.773***	17.77***	17.499**	34.243***	21.826***	26.106***	19.835**	33.435***
	(2.600)	(2.22)	(2.093)	(3.571)	(3.149)	(3.079)	(2.516)	(3.215)
External shocks (victims of natural disasters)	-4.602*	-4.60*	-4.564*	-4.129*	-4.733**	-9.532**	-4.576*	-7.358***
	(-1.797)	(-1.68)	(-1.870)	(-1.781)	(-2.094)	(-2.199)	(-1.837)	(-2.719)
Transport infrastructure	0.165	0.16	0.055				0.089	
	(1.034)	(1.48)	(0.384)				(0.565)	
Economic freedom (EF)			-1.979***	79.898**	-2.014***			
			(-2.786)	(2.248)	(-3.187)			
Government effectiveness (GE)					1.018 (0.888)	187.435 (1.491)		
Governance							-1.551**	57.957*
							(-2.502)	(1.903)
Log of food production index * EF				-17.722** (-2.311)				

Log of food production index * GE						-40.393		
						(-1.482)		
Log of food production index * Governance index								-12.683*
Regional dummies (Ref.= West Africa)								
Central Africa		4.48						
		(0.91)						
Southern Africa		16.00***						
		(7.02)						
East Africa		5.18***						
		(2.85)						
Observations	430	430	398	476	450	493	398	450
Number of countries	34	34	34	34	34	34	34	34
R-sq	0.171	2.303	0.246	0.257	0.347	0.00280	0.229	0.223
Hansen J	2.065	0.3162	1.304	2.303	5.327	3.916	1.628	2.987
Hansen J P-value	0.356	-	0.521	0.129	0.0697	0.0478	0.443	0.0839
Cragg–Donald Wald (F-stat)	24.54	-	20.86	3.622	31.06	0.853	20.42	1.836
Hausman (Endogeneity) test	15.68	-	11.07	12.83	6.619	14	11.83	11.49
Prob>chi2	0.000		0.000	0.000	0.000	0.000	0.001	0.001
VIF	1.73	1.80	1.81	-	2.32	-	1.91	-
SEE	3.131		3.068	3.461	3.177	3.846	3.104	3.465

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; VIF = variance inflation factor; SEE = Standard error of estimates

Table 6 continued

Panel B: Log of per capita food production index

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Trade openness	0.052***	0.052***	0.081*	0.052	0.067	0.047***	0.092**	0.073*
	(2.817)	(2.05)	(1.771)	(1.201)	(1.546)	(2.755)	(1.982)	(1.663)
Lagged log of GDP per capita	0.039	0.04	0.068	0.086	0.080	0.072	0.039	0.073
	(0.682)	(0.70)	(1.084)	(1.447)	(1.328)	(1.467)	(0.612)	(1.192)
Log of food aid	0.007***	0.01***	0.006**	0.006**	0.008***	0.010***	0.006**	0.009***
	(2.780)	(2.61)	(2.287)	(2.370)	(3.164)	(3.911)	(2.219)	(3.295)
Log of coefficient of variation in caloric consumption	-0.352	0.35	-0.320	-0.168	-0.173	-0.327	-0.238	-0.153
	(-1.352)	(-1.58)	(-0.970)	(-0.637)	(-0.617)	(-1.541)	(-0.730)	(-0.529)
External shocks (victims of natural disasters)	-0.208**	-0.21**	-0.225***	-0.172*	-0.256***	-0.231***	-0.215***	-0.253***
	(-2.554)	(-2.87)	(-2.766)	(-1.844)	(-3.585)	(-3.262)	(-2.693)	(-3.552)
Transport infrastructure	0.010***	0.01***	0.008**				0.008***	
	(3.226)	(3.34)	(2.450)				(2.592)	
Economic freedom (EF)			-0.028	-0.017	-0.020			
			(-1.605)	(-0.931)	(-1.147)			
Government effectiveness (GE)					0.080***	0.089***		
					(2.991)	(4.227)		
Governance							0.002	0.015
							(0.135)	(0.977)
Regional dummies (Ref.= West Africa)								
Central Africa		0.558***						
		(2.82)						
Southern Africa		-3.61***						
		(-5.68)						
East Africa		-0.51****						
		(-6.33)						
Log of total arable land	0.385***	0.38***	0.381***	0.440***	0.445***	0.433***	0.370***	0.423***
	(6.084)	6.44	(5.611)	(7.391)	(7.465)	(7.763)	(5.479)	(6.895)
Agricultural labour	-0.006***	-0.01***	-0.007***	-0.008***	-0.007***	-0.005***	-0.007***	-0.007***
	(-2.681)	(-4.09)	(-2.942)	(-3.255)	(-3.099)	(-2.636)	(-2.958)	(-2.974)
Three or more months high rainfall dummy	0.021**	0.02**	0.022**	0.026***	0.022**	0.022**	0.023**	0.024**
	(2.379)	2.32	(2.325)	(2.638)	(2.234)	(2.362)	(2.359)	(2.385)
Observations	430	430	398	476	450	493	398	450
Number of countries	34	34	34	34	34	34	34	34

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; VIF = variance inflation factor; SEE = Standard error of estimates

In models (3) to (8), the governance variables were included in the regression analysis. The interaction of governance and domestic food production were introduced in models (4), (6), and (8) to test the hypothesis of a greater "food insecurity-reducing" effects of economic freedom, government effectiveness and the composite governance index. The results from model (3), where only economic freedom was introduced as a covariate, suggest that an improvement in economic governance, measured by economic freedom, would lead to a fall in the depth of food deficit and the prevalence of undernourishment in SSA (Tables 5 and 6). These findings suggest that promoting a free business environment, market competition, openness and property rights enforcement would lead to reductions in food insecurity in SSA. This result therefore supports the arguments of the proponents of neoliberalism, who posited that such market-oriented reforms have generally contributed to improvements in welfare in the region (Ndulu et al, 2008; Fosu and Gafa, 2020).

In model (4), the coefficient on the interaction term is negative and significant, and the coefficient on the food production index is positive and significant. These results reveal a non-linear relationship between domestic food production and food insecurity, with economic freedom influencing the food insecurity-reducing effect of domestic food production. Specifically, there is a minimum level of economic freedom above which domestic food production would promote food security. In other words, under strict State interventionism an increase in food production would rather have a deleterious effect on food insecurity in SSA. This finding suggests that market-oriented economic policies increase the extent to which improvements in local food production are translated into food security, by presumably creating a more efficient supply chain for farmers and improving access for consumers. This conclusion further supports the argument leading the implementation of the SAPs in SSA. For example, the total effect of food production on the depth of food deficit can be written as:

$$\partial FoodInsecurity / \partial FoodProduc = 8.40 - 1.59 * Economic\ Freedom$$

The average estimated threshold value of economic freedom is 5.28 when the depth of food deficit is considered and 4.81 for the prevalence of undernourishment. These levels are below the SSA average (6 points). Countries that fall below the highest economic freedom threshold are Chad and Zimbabwe. Furthermore, the sign of the coefficient on economic freedom is also positive and statistically significant with the inclusion of the interaction term (model (4) in Tables 5 and 6). This finding shows that a non-linear relationship also exists between economic freedom and the depth of undernourishment. Hence, at very low levels of domestic food production, additional free-market reforms would exacerbate rather than reduce the depth of food deficit, on average. However, once domestic food production exceeds a certain threshold, neoliberal reforms would be beneficial, on average. For example, the overall effect of economic governance on the depth of undernourishment is therefore given as:

$$\partial FoodInsecurity / \partial Economic\ Freedom = 7.28 - 1.59 * FoodProduc$$

The estimated thresholds of the food production index were 97.38 for the depth of food deficit and 90.74 for the prevalence of undernourishment. These values are again lower than the SSA average of 102.84 (see Table 3). Hence, on average, countries in the region would start reaping the positive effects of economic freedom on calorie shortfall only when the food production index exceeds this threshold. These findings are attributable to the fact that food insecurity in SSA is largely prevalent among rural households who are mostly poor with little ability to afford and access or purchase imported food (because of low income and weak infrastructure), and thus are heavily dependent on subsistence food production for their calorie intake. Consequently, for such households, failure to maintain a minimum level of domestic food production would lead to a greater calorie shortfall and undernourishment, especially with a reduction in the size of government — that is when government interventions in the agriculture sector such as extension services, agricultural and farmer support programmes, and public expenditure on research and development are suppressed.

Government effectiveness seemed to have no direct effect on the depth of food deficit and the prevalence of undernourishment. The coefficient on the variable was statistically insignificant when included in the equation (see Tables 5 and 6, model (5)). However, by introducing the interaction term, the coefficient on government effectiveness was positive while that of the interaction term was negative. When the depth of food deficit was considered as the dependent variable, both coefficients were significant at 1% level. Again, these results show that without a minimum level of domestic production, improving the quality of public services and civil service alone would fail to promote food security. Rather, people would experience a greater shortfall in their calorie intake. Among other possible causes, this finding is likely attributable to the fact that public resources would have to be diverted from agricultural support in order to increase the provision of social services like health care or education.

Improvements in government effectiveness increase the food insecurity-reducing effect of domestic food production. Indeed, the adequate provision of social services such as sanitation, education and health, and the effective implementation of social programmes would not only improve productivity and strengthen the food supply chain, but also raise the incomes of various actors, enabling them to improve their calorie intake. For example, existing studies show that policy interventions in the form of rural development programmes improving access to markets, and safety nets and cash transfer programmes have positive effects on access to food (Miller et al, 2011; Tiwari et al, 2016). These findings are further confirmed by the results of models (7) and (8), where the governance composite index and its interaction with domestic food production are used (Table 5 and 6). Hence, the findings support the hypothesis that governance plays an important role in shaping the extent to which domestic food production is translated into food security in SSA.

Focusing on the effect of governance on food production — that is the indirect effect on food insecurity via domestic food production (Tables 5 and 6, Panel A) — results show that government effectiveness positively affected domestic food production in SSA. Although this result is contrary to the findings for economic freedom, which had a more direct effect of food insecurity, it seems to reflect an important difference between these two governance variables. Indeed, unlike the economic freedom index, government effectiveness measures the quality of social services provided by governments. These public services (health care, education and other social interventions) are essential for productivity increases and thus positively affect food production, rather than food distribution or access *per se*.

While the effect of economic freedom, which is a summary index, seems to be mainly direct rather than indirect through food production (Panel A versus Panel B), a disaggregation of the index shows different effects across components (see Tables 7 and 8). Overall, the main contributors to depth of food deficit (direct effect) were legal system and property rights, freedom to trade internationally and regulation (Table 7). Meanwhile, when the dependent variable is the prevalence of undernourishment, improvements in the legal system and property rights and freedom to trade internationally significantly promoted food security (Table 8). Comparing Panel A to Panel B, the findings suggest that an efficient judiciary system improves food security directly rather than indirectly through food production (Tables 5 and 6). In other words, reliable justice system and property rights enforcement promote better food distribution. However, policies of open markets and trade with minimum restrictions promote food security directly but tend to discourage food production. The significant direct effect of freedom of international trade may be attributable to the rise in competitiveness, which helps maintain the price of food at a low level for greater affordability of food in the region. Meanwhile, these policies also tend to discourage domestic food production presumably because of the fall in the demand for locally produced food.

Focusing on the role of institutional quality, Tables 9 and 10 present the results based on the fixed effects-2SLS regressions, with depth of food deficit and prevalence of undernourishment as the dependent variables respectively. Overall, the results reported in Panel A (second stage results) show that the effects (direct effects) of rule of law, control of corruption, and voice and accountability, and their interaction with food production on depth of food deficit and prevalence of undernourishment were statistically insignificant, suggesting no direct and mediating effects of these variables on food insecurity. However, the coefficient of control of corruption is positive and statistically significant in the first stage equation, meaning that improving institutions by adequately control corruption is essential to boost domestic food production in SSA. These results indicate a positive indirect effect of control of corruption on food security through domestic food production in the region. This finding supports the argument that corruption hinders equal opportunities in the access of inputs for agricultural production, thereby having adverse effects on food security in the region (Ogunniyi et al, 2020).

Table 7: Food insecurity and the dimensions of economic freedom: Results based on 2SLS estimation; Dependent variable: Log of depth of food deficit

	Panel A: Depth of food deficit (kcal/caput/day)						*Panel B: Per capita food production*					
Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Log of food production index	- 1.593***	- 1.605***	- 1.537***	- 1.461***	- 1.598***	- 1.461***						
	(-6.449)	(-6.405)	(-6.743)	(-5.877)	(-6.427)	(-6.327)						
Trade openness	0.060	0.013	0.026	0.055	0.053	0.031	0.091**	0.088*	0.081*	0.089*	0.095**	0.104**
	(0.564)	(0.117)	(0.255)	(0.519)	(0.484)	(0.290)	(1.969)	(1.846)	(1.795)	(1.914)	(2.081)	(2.183)
Lagged log of GDP per capita	0.037	0.014	0.022	0.013	-0.031	0.049	0.038	0.044	0.064	0.030	0.047	0.033
	(0.296)	(0.111)	(0.185)	(0.104)	(-0.243)	(0.424)	(0.606)	(0.687)	(1.055)	(0.492)	(0.765)	(0.521)
Log of food aid	0.007	0.006	0.006	0.009	0.007	0.005	0.006**	0.006**	0.006**	0.006**	0.007**	0.006**
	(1.050)	(0.903)	(0.787)	(1.362)	(0.916)	(0.711)	(2.225)	(2.173)	(2.085)	(2.013)	(2.430)	(2.131)
Log of coefficient of variation in caloric consumption	1.466***	1.468***	1.418***	1.386***	1.609***	1.392***	-0.236	-0.248	-0.306	-0.188	-0.291	-0.238
	(3.179)	(3.143)	(3.168)	(3.113)	(3.486)	(3.046)	(-0.733)	(-0.761)	(-0.942)	(-0.591)	(-0.888)	(-0.723)
External shocks (victims of natural disasters)	-0.334**	-0.331**	-0.348**	-0.311**	-0.315**	-0.338**	- 0.214***	- 0.216***	- 0.230***	- -0.210**	- 0.220***	- 0.225***
	(-2.379)	(-2.230)	(-2.442)	(-2.380)	(-2.164)	(-2.553)	(-2.650)	(-2.683)	(-2.777)	(-2.587)	(-2.758)	(-2.837)
Transport infrastructure	0.004	-0.000	-0.003	-0.000	0.002	-0.002	0.008**	0.008**	0.007**	0.009***	0.008**	0.008**
	(0.442)	(-0.018)	(-0.393)	(-0.013)	(0.291)	(-0.288)	(2.544)	(2.507)	(2.229)	(2.682)	(2.575)	(2.470)
Legal system & property rights	-0.048**					-0.021	0.003					0.003
	(-2.114)					(-0.867)	(0.329)					(0.304)
Sound money		-0.022				0.007		-0.002				0.013
		(-1.540)				(0.420)		(-0.178)				(1.419)
Freedom to trade internationally			- 0.104***			- 0.104***			- 0.039***			- 0.050***
			(-3.837)			(-2.978)			(-3.863)			(-3.978)

Table 7 Continued

Panel A: Depth of food deficit (kcal/caput/day)							Panel B: Per capita food production					
Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Regulation					-0.057**		-0.032				0.015		0.019
					(-2.235)		(-1.196)				(1.121)		(1.271)
Size of government						0.019	0.027					-0.016**	-0.011
						(0.977)	(1.515)					(-2.110)	(-1.581)
Log of total arable land								0.370***	0.371***	0.379***	0.355***	0.376***	0.363***
								(5.507)	(5.509)	(5.800)	(5.321)	(5.636)	(5.718)
								-	-	-	-	-	-
Agricultural labour								0.007***	0.007***	0.007***	0.007***	0.007***	0.007***
								(-2.976)	(-2.941)	(-3.007)	(-2.831)	(-2.965)	(-2.949)
Three or more months high rainfall dummy								0.023**	0.022**	0.024***	0.023**	0.022**	0.025***
								(2.371)	(2.340)	(2.593)	(2.359)	(2.320)	(2.657)
Observations		398	398	398	398	398	398	398	398	398	398	398	398
Number of countries		34	34	34	34	34	34	34	34	34	34	34	34
R-squared		0.0497	0.0386	0.113	0.112	0.0393	0.162						
Hansen J		2.808	2.806	3.696	2.916	2.980	3.868						
Hansen J P-value		0.246	0.246	0.158	0.233	0.225	0.145						
Cragg–Donald Wald (F-stat)		20.60	20.41	22.53	17.73	20.97	20.49						
Hausman (Endogeneity) test		23.77	24.17	22.68	20.01	24.90	21.20						
Prob>chi^2		0.000	0.000	0.000	0.000	0.000	0.000						
VIF		1.92	1.76	1.75	1.77	1.71	2.13						
SEE		0.183	0.184	0.177	0.177	0.184	0.173						

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; VIF = variance inflation factor; SEE = Standard error of estimates

Table 8: Food insecurity and the dimensions of economic freedom: Results based on 2SLS estimation; Dependent variable: Prevalence of undernourishment

	Panel A: Prevalence of undernourishment (%)						*Panel B: Log of per capita food production index*					
VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Log of food production index	-26.79***	-27.02***	-25.92***	-25.37***	-26.82***	-26.16***						
	(-5.94)	(-5.90)	(-6.13)	(-5.43)	(-5.89)	(-6.09)						
Trade openness	-0.27	-1.22	-0.84	-0.38	-0.37	-0.80	0.09**	0.09*	0.08*	0.09*	0.09**	0.10**
	(-0.14)	(-0.60)	(-0.45)	(-0.20)	(-0.19)	(-0.41)	(1.97)	(1.85)	(1.80)	(1.91)	(2.08)	(2.18)
Lagged log of GDP per capita	-2.21	-3.03	-3.03	-3.43	-3.86	-1.95	0.04	0.04	0.06	0.03	0.05	0.03
	(-0.72)	(-0.96)	(-0.96)	(-1.05)	(-1.18)	(-0.68)	(0.61)	(0.69)	(1.06)	(0.49)	(0.76)	(0.52)
Log of food aid	-0.03	-0.04	-0.05	-0.00	-0.02	-0.07	0.01**	0.01**	0.01**	0.01**	0.01**	0.01**
	(-0.20)	(-0.29)	(-0.36)	(-0.01)	(-0.16)	(-0.51)	(2.23)	(2.17)	(2.08)	(2.01)	(2.43)	(2.13)
Log of coefficient of variation in caloric consumption	20.34**	20.91***	20.38***	20.89***	23.01***	19.72**	-0.24	-0.25	-0.31	-0.19	-0.29	-0.24
	(2.58)	(2.64)	(2.62)	(2.61)	(2.85)	(2.37)	(-0.73)	(-0.76)	(-0.94)	(-0.59)	(-0.89)	(-0.72)
External shocks (victims of natural disasters)	-4.43*	-4.30*	-4.53*	-3.97*	-4.04	-4.74**	-0.21***	-0.22***	-0.23***	-0.21**	-0.22***	-0.22***
	(-1.85)	(-1.66)	(-1.84)	(-1.68)	(-1.61)	(-1.99)	(-2.65)	(-2.68)	(-2.78)	(-2.59)	(-2.76)	(-2.84)
Transport infrastructure	0.16	0.08	0.04	0.10	0.12	0.09	0.01**	0.01**	0.01**	0.01***	0.01**	0.01**
	(0.97)	(0.50)	(0.32)	(0.58)	(0.73)	(0.62)	(2.54)	(2.51)	(2.23)	(2.68)	(2.57)	(2.47)
Legal system & property rights	-1.23***					-1.01**	0.00					0.00
	(-2.83)					(-2.14)	(0.33)					(0.30)
Sound money		-0.44				0.01		-0.00				0.01

Table 8 continued

	Panel A: Prevalence of undernourishment (%)						*Panel B: Log of per capita food production index*					
VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)
Freedom to trade internationally				-1.69***			-1.59***			-0.04***		-0.05***
				(-3.47)			(-2.62)			(-3.86)		(-3.98)
Regulation					-0.59		0.10				0.02	0.02
					(-1.36)		(0.21)				(1.12)	(1.27)
Size of government						0.14	0.23				-0.02**	-0.01
						(0.41)	(0.77)				(-2.11)	(-1.58)
Log of total arable land								0.37***	0.37***	0.38***	0.35***	0.38***	0.36***
								(5.51)	(5.51)	(5.80)	(5.32)	(5.64)	(5.72)
Agricultural labour								-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
								(-2.98)	(-2.94)	(-3.01)	(-2.83)	(-2.97)	(-2.95)
Three or more months high rainfall dummy								0.02**	0.02**	0.02***	0.02**	0.02**	0.03***
								(2.37)	(2.34)	(2.59)	(2.36)	(2.32)	(2.66)
Observations		398	398	398	398	398	398	398	398	398	398	398	398
Number of countries		34	34	34	34	34	34	34	34	34	34	34	34
R-squared		0.228	0.209	0.259	0.236	0.207	0.270						
Hansen J		1.405	1.517	2.102	1.551	1.745	2.027						
Hansen J P-value		0.495	0.468	0.350	0.460	0.418	0.363						
Cragg–Donald Wald (F-stat)		20.60	20.41	22.53	17.73	20.97	20.49						
Hausman (Endogeneity) test		11.88	12.12	10.90	9.830	12.37	11.66						
Prob>chi^2		0.00	0.00	0.00	0.00	0.00	0.00						
VIF		1.92	1.76	1.75	1.77	1.71	2.13						

Table 9: Food insecurity and institutional quality: Results based on 2SLS estimation; Dependent variable: Log of depth of food deficit

Panel A: Depth of food deficit (kcal/caput/day)

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)	Model (11)
	-	-	-	-	-	-	-	-	-	-	
Log of food production index	1.577***	1.557***	1.600***	2.203***	1.595***	1.631***	1.591***	1.510***	1.540***	2.609***	-1.58***
	(-7.130)	(-2.874)	(-6.988)	(-3.903)	(-6.979)	(-6.201)	(-7.007)	(-5.172)	(-7.207)	(-2.885)	(-7.141)
Trade openness	-0.002	-0.002	-0.004	-0.036	-0.009	-0.010	-0.005	-0.012	0.020	0.051	0.002
	(-0.067)	(-0.056)	(-0.108)	(-0.725)	(-0.252)	(-0.286)	(-0.139)	(-0.300)	(0.528)	(0.728)	(0.058)
Lagged log of GDP per capita	-0.077	-0.078	-0.077	-0.186	-0.063	-0.074	-0.075	-0.093	-0.086	0.007	-0.080
	(-0.668)	(-0.672)	(-0.649)	(-1.291)	(-0.535)	(-0.571)	(-0.645)	(-0.774)	(-0.742)	(0.041)	(-0.683)
Log of food aid	0.009	0.009	0.009	0.008	0.008	0.008	0.009	0.009	0.008	0.010	0.009
	(1.381)	(1.380)	(1.408)	(0.946)	(1.210)	(1.187)	(1.389)	(1.287)	(1.306)	(0.996)	(1.358)
Log of coefficient of variation in caloric consumption	1.330***	1.331***	1.366***	1.612***	1.452***	1.450***	1.335***	1.369***	1.000**	1.122**	1.411***
	(3.411)	(3.401)	(3.359)	(3.477)	(3.580)	(3.644)	(3.273)	(3.431)	(2.469)	(2.008)	(3.482)
External shocks (victims of natural disasters)	-0.329**	-0.327**	-0.325**	-0.419**	-0.331**	-0.332**	-0.325**	-0.345**	-0.258*	-0.627*	-0.332**
	(-2.361)	(-2.254)	(-2.261)	(-2.172)	(-2.355)	(-2.389)	(-2.323)	(-2.388)	(-1.918)	(-1.923)	(-2.260)
Transport infrastructure	0.003	0.002	0.003	0.003	0.004	0.003	0.003	0.004	0.005		0.002
	(0.333)	(0.298)	(0.428)	(0.440)	(0.458)	(0.463)	(0.428)	(0.520)	(0.709)		(0.246)
Control of corruption (CC)	0.095*	-0.086									0.091
	(1.708)	(-0.018)									(1.189)
Rule of law (RL)			0.082	7.460							0.076
			(1.174)	(1.212)							(0.731)
Voice and accountability (VA)					-0.008	0.753					-0.085
					(-0.153)	(0.214)					(-1.368)
Institution index (II)							0.031	0.868			

Table 9 continued 2

Panel B: Log of Per Capita Food Production index

VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)	Model (11)
Trade openness	0.058***	0.058***	0.051***	0.051***	0.054***	0.054***	0.052***	0.052***	0.053***	0.053***	0.058***
	(3.315)	(3.315)	(2.791)	(2.791)	(3.007)	(3.007)	(2.743)	(2.743)	(2.813)	(2.813)	(3.360)
Lagged log of GDP per capita	0.026	0.026	0.039	0.039	0.035	0.035	0.039	0.039	0.037	0.037	0.030
	(0.474)	(0.474)	(0.699)	(0.699)	(0.614)	(0.614)	(0.683)	(0.683)	(0.667)	(0.667)	(0.547)
Log of food aid	0.008***	0.008***	0.007***	0.007***	0.008***	0.008***	0.007***	0.007***	0.007***	0.007***	0.007***
	(3.015)	(3.015)	(2.708)	(2.708)	(2.893)	(2.893)	(2.641)	(2.641)	(2.801)	(2.801)	(2.594)
Log of Coefficient of variation in caloric consumption	-0.462*	-0.462*	-0.349	-0.349	-0.406	-0.406	-0.325	-0.325	-0.366	-0.366	-0.393
	(-1.794)	(-1.794)	(-1.304)	(-1.304)	(-1.494)	(-1.494)	(-1.172)	(-1.172)	(-1.332)	(-1.332)	(-1.505)
External shocks (Victims of natural disasters)	-0.210***	-0.210***	-0.209**	-0.209**	-0.206**	-0.206**	-0.210**	-0.210**	-0.206**	-0.206**	-0.223***
	(-2.631)	(-2.631)	(-2.551)	(-2.551)	(-2.536)	(-2.536)	(-2.578)	(-2.578)	(-2.500)	(-2.500)	(-2.824)
Transport infrastructure	0.009***	0.009***	0.010***	0.010***	0.010***	0.010***	0.010***	0.010***	0.010***	0.010***	0.009***
	(3.020)	(3.020)	(3.238)	(3.238)	(3.145)	(3.145)	(3.216)	(3.216)	(3.251)	(3.251)	(3.144)
Control of Corruption (CC)	0.090***	0.090***									0.149***
	(3.667)	(3.667)									(4.329)
Rule of Law (RL)			-0.004	-0.004							-0.081*
			(-0.144)	(-0.144)							(-1.901)
Voice and Accountability (VA)							-0.016	-0.016			-0.039
							(-0.656)	(-0.656)			(-1.347)

Table 9 continued 3

Panel B: Log of Per Capita Food Production index

VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)	Model (11)
Institution Index (II)						0.015	0.015				
						(1.439)	(1.439)				
Political Stability (PS)										0.005	0.005
										(0.431)	(0.431)
Log of total arable land		0.393***	0.393***	0.385***	0.385***	0.384***	0.384***	0.386***	0.386***	0.383***	0.383***	0.406***
		(6.311)	(6.311)	(6.084)	(6.084)	(6.094)	(6.094)	(6.080)	(6.080)	(6.076)	(6.076)	(6.589)
Agricultural labour		-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***	-0.006***
		(-2.866)	(-2.866)	(-2.672)	(-2.672)	(-2.688)	(-2.688)	(-2.691)	(-2.691)	(-2.764)	(-2.764)	(-3.013)
Three or more months high rainfall dummy		0.021**	0.021**	0.021**	0.021**	0.022**	0.022**	0.021**	0.021**	0.022**	0.022**	0.019**
		(2.375)	(2.375)	(2.374)	(2.374)	(2.450)	(2.450)	(2.326)	(2.326)	(2.382)	(2.382)	(2.117)
Observations		430	430	430	430	430	430	430	430	430	430	430
Number of Countries		34	34	34	34	34	34	34	34	34	34	34

Robust t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10: Food insecurity and institutional quality: Results based on 2SLS estimation; Dependent variable: Prevalence of undernourishment

Panel A: Prevalence of undernourishment (%)

VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)	Model (11)
Log of food production index	- 28.496***	- 35.361***	- 28.339***	- 38.908***	- 28.249***	- 30.642***	- 28.366***	- 25.602***	- 28.151***	- 32.680***	- 28.212***
	(-6.651)	(-3.391)	(-6.496)	(-4.047)	(-6.458)	(-6.218)	(-6.489)	(-4.626)	(-6.510)	(-5.594)	(-6.727)
Trade openness	-0.435	-0.539	-0.502	-1.072	-0.439	-0.547	-0.487	-0.728	-0.269	0.036	-0.441
	(-0.647)	(-0.750)	(-0.786)	(-1.204)	(-0.697)	(-0.840)	(-0.756)	(-1.008)	(-0.392)	(0.040)	(-0.691)
Lagged log of GDP per capita	-3.815	-3.600	-3.647	-5.553*	-3.776	-4.520	-3.717	-4.318	-3.964	-3.812	-3.668
	(-1.323)	(-1.277)	(-1.259)	(-1.779)	(-1.294)	(-1.430)	(-1.289)	(-1.465)	(-1.352)	(-1.296)	(-1.271)
Log of food aid	0.016	0.031	-0.003	-0.032	-0.003	-0.004	-0.001	-0.006	0.018	-0.019	-0.007
	(0.116)	(0.216)	(-0.025)	(-0.204)	(-0.024)	(-0.029)	(-0.007)	(-0.039)	(0.137)	(-0.122)	(-0.054)
Log of coefficient of variation in caloric consumption	17.923**	17.632**	18.885***	23.198***	19.784***	19.615***	19.218***	20.368***	15.382**	6.558	19.388***
	(2.540)	(2.472)	(2.756)	(2.868)	(2.815)	(2.867)	(2.714)	(2.847)	(2.148)	(0.541)	(2.776)
External shocks (victims of natural disasters)	-4.611*	-5.192**	-4.687*	-6.341*	-4.681*	-4.750*	-4.648*	-5.318**	-4.207	-5.226	-4.768*
	(-1.799)	(-1.993)	(-1.861)	(-1.879)	(-1.802)	(-1.845)	(-1.822)	(-1.986)	(-1.647)	(-1.643)	(-1.860)
Transport infrastructure	0.166	0.195	0.167	0.158	0.156	0.148	0.167	0.177	0.174	0.202	0.153
	(1.036)	(1.305)	(1.071)	(1.302)	(0.984)	(1.067)	(1.053)	(1.347)	(1.101)	(1.591)	(0.975)
Control of corruption (CC)	-0.137	62.626									0.864
	(-0.141)	(0.670)									(0.648)
Rule of law (RL)			-1.249	128.085							-1.260
			(-1.101)	(1.226)							(-0.744)
Voice and accountability (VA)					-1.169	49.847					-0.890
					(-1.382)	(0.767)					(-0.842)

Table 10 continued

Panel A: Prevalence of undernourishment (%)											
VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)	Model (11)
Institution index (II)						-0.418	28.168				
						(-1.003)	(0.926)				
Political stability (PS)								0.728*	132.127		
								(1.699)	(1.211)		
Log of food production index * CC		-13.503									
		(-0.671)									
Log of food production index *RL				-27.922							
				(-1.238)							
Log of food production index *VA						-11.047					
						(-0.785)					
Log of food production index *II							-6.200				
							(-0.938)				
Log of food production index *PS									-28.184		
									(-1.205)		
Observations	430	430	430	430	430	430	430	430	430	430	430
Number of countries	34	34	34	34	34	34	34	34	34	34	34
R-squared	0.170	0.152	0.176	0.119	0.179	0.183	0.175	0.171	0.183	-0.0637	0.181
Hansen J	2.071	1.441	1.912	0.467	1.736	1.078	1.939	1.020	2.086	0.322	1.620
Hansen J P-value	0.355	0.230	0.384	0.494	0.420	0.299	0.379	0.313	0.352	0.571	0.445
Cragg–Donald Wald (F-stat)	26.56	1.896	24.41	1.910	24.37	3.660	24.72	2.840	24.69	1.393	27.86
Hausman (Endogeneity) test	17.85	5.095	15.68	3.227	15.17	6.279	15.98	5.453	15.53	1.917	18.08
Prob>chi^2	0.000	0.0240	0.000	0.0724	0.000	0.0122	0.000	0.0195	0.000	0.166	0.000
VIF	1.93	-	1.88	-	1.76	-	1.89	-	1.77	412.81	3.14
SEE	3.137	3.176	3.126	3.237	3.121	3.118	3.128	3.141	3.114	3.557	3.125

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; VIF = variance inflation factor; SEE = Standard error of estimates

Table 10 continued 2

Panel B: Log of per capita food production index

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)	Model (11)
Trade openness	0.058***	0.058***	0.051***	0.051***	0.052***	0.052***	0.054***	0.054***	0.053***	0.053***	0.058***
	(3.315)	(3.315)	(2.791)	(2.791)	(2.743)	(2.743)	(3.007)	(3.007)	(2.813)	(2.813)	(3.360)
Lagged log of GDP per capita	0.026	0.026	0.039	0.039	0.039	0.039	0.035	0.035	0.037	0.037	0.030
	(0.474)	(0.474)	(0.699)	(0.699)	(0.683)	(0.683)	(0.614)	(0.614)	(0.667)	(0.667)	(0.547)
Log of food aid	0.008***	0.008***	0.007***	0.007***	0.007***	0.007***	0.008***	0.008***	0.007***	0.007***	0.007***
	(3.015)	(3.015)	(2.708)	(2.708)	(2.641)	(2.641)	(2.893)	(2.893)	(2.801)	(2.801)	(2.594)
Log of coefficient of variation in caloric consumption	-0.462*	-0.462*	-0.349	-0.349	-0.325	-0.325	-0.406	-0.406	-0.366	-0.366	-0.393
	(-1.794)	(-1.794)	(-1.304)	(-1.304)	(-1.172)	(-1.172)	(-1.494)	(-1.494)	(-1.332)	(-1.332)	(-1.505)
External shocks (victims of natural disasters)	-0.210***	-0.210***	-0.209**	-0.209**	-0.210**	-0.210**	-0.206**	-0.206**	-0.206**	-0.206**	-0.223***
	(-2.631)	(-2.631)	(-2.551)	(-2.551)	(-2.578)	(-2.578)	(-2.536)	(-2.536)	(-2.500)	(-2.500)	(-2.824)
Transport infrastructure	0.009***	0.009***	0.010***	0.010***	0.010***	0.010***	0.010***	0.010***	0.010***	0.010***	0.009***
	(3.020)	(3.020)	(3.238)	(3.238)	(3.216)	(3.216)	(3.145)	(3.145)	(3.251)	(3.251)	(3.144)
Control of corruption (CC)	0.090***	0.090***									0.149***
	(3.667)	(3.667)									(4.329)
Rule of law (RL)			-0.004	-0.004							-0.081*
			(-0.144)	(-0.144)							(-1.901)

Table 10 continued 3

	Panel A: Prevalence of undernourishment (%)										
VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)	Model (9)	Model (10)	Model (11)
Voice and accountability (VA)					-0.016	-0.016					-0.039
					(-0.656)	(-0.656)					(-1.347)
Institution index (II)							0.015	0.015			
							(1.439)	(1.439)			
Political stability (PS)									0.005	0.005	
									(0.431)	(0.431)	
Log of total arable land	0.393***	0.393***	0.385***	0.385***	0.386***	0.386***	0.384***	0.384***	0.383***	0.383***	0.406***
	(6.311)	(6.311)	(6.084)	(6.084)	(6.080)	(6.080)	(6.094)	(6.094)	(6.076)	(6.076)	(6.589)
Agricultural labour	- 0.006***	- 0.006***	- 0.006***	- 0.006***	- 0.006***	- 0.006***	- 0.006***	- 0.006***	- 0.006***	- 0.006***	- 0.006***
	(-2.866)	(-2.866)	(-2.672)	(-2.672)	(-2.691)	(-2.691)	(-2.688)	(-2.688)	(-2.764)	(-2.764)	(-3.013)
Three or more months high rainfall dummy	0.021**	0.021**	0.021**	0.021**	0.021**	0.021**	0.022**	0.022**	0.022**	0.022**	0.019**
	(2.375)	(2.375)	(2.374)	(2.374)	(2.326)	(2.326)	(2.450)	(2.450)	(2.382)	(2.382)	(2.117)
Observations	430	430	430	430	430	430	430	430	430	430	430
Number of countries	34	34	34	34	34	34	34	34	34	34	34

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; VIF = variance inflation factor; SEE = Standard error of estimates

8. Robustness checks

To investigate the robustness of our findings, alternative estimation techniques were used. Specifically, we performed the analysis using the two-step system GMM and the LIML estimators. The two-step system GMM estimator, not only accounts for unobserved heterogeneity but also tends to be more efficient as it relaxes the "independent and identically distributed (i.i.d)" assumption by addressing problems of heteroscedasticity and autocorrelation through the use of optimal weighting matrix for moment conditions. In addition to the external instruments, internal instruments are introduced to strengthen the over-identifying restrictions of the model. Furthermore, the plausible endogeneity of the political stability and absence of violence variable is addressed. The LIML performs better than the fixed effects-2SLS in situations of weak instruments, which are likely to generate biased and inconsistent results. This method, thus, allows us to check the robustness of the results by minimizing the problem of weak instruments, particularly in the specifications that include the interaction terms.

The results using the two-step system GMM and the LIML approaches considering the depth of food deficit and the prevalence of undernourishment as dependent variables are presented in Tables B1 to B8. Overall, the findings with respect to the effects of food production, governance and institutional quality variables obtained from these alternative estimators supported the results from the fixed effects-2SLS model. Furthermore, once the endogeneity concern regarding the political stability variable was addressed in the GMM estimation, the counter-intuitive positive effect of political stability on food insecurity was insignificant, suggesting that the observed significance in earlier results stems from the endogeneity of political stability in the model (see Tables B5 and B6).

9. Conclusion

Reducing the incidence of hunger and malnutrition remain undoubtedly important in Africa, particularly if the continent is to achieve the SDGs by 2030 and the AU Agenda by 2063. Using data on 34 SSA countries, this study investigated the factors explaining food insecurity measured by two indicators, namely the depth of food deficit and the prevalence of undernourishment. The study focused on the role of domestic food production, governance (measured by economic freedom and government effectiveness) and institutions (measured by control of corruption, rule of law, voice and accountability). It also investigated the role of governance and institutions in moderating the effect of domestic food production on food insecurity. Lastly, this paper provides some evidence on the role of domestic food production as a channel through which the quality of governance and institutions affect food insecurity in the region.

The study found that an increase in domestic food production and a more equal distribution of habitual calorie consumption are essential in promoting food security in SSA. It also confirmed the existence of a bi-directional relationship between food production and food security in SSA, and observed a greater effect of food production on food security, once endogeneity is accounted for. Furthermore, the results suggest that trade, transport infrastructure development, and external assistance play an important role in promoting food production, thereby indirectly influencing food insecurity in the region. Moreover, natural disasters such as floods and droughts represent negative external shocks, which adversely affect food production.

The analysis of the effect of governance and institutional quality on food security showed important variations. Specifically, the results showed that improvements in governance would contribute to reductions in food insecurity. However, its effect was non-linear. Specifically, we found that in the absence of adequate domestic food production, improving governance, economic freedom and government effectiveness would be impotent in reducing the depth of food deficit and the prevalence of undernourishment. Furthermore, the results support the hypothesis that "good" governance would enable countries to better translate domestic food production into reductions in food insecurity. This finding is attributable to the potential role of governance in strengthening the food supply chain and improving the income of the various actors, including farmers. With respect to economic freedom, however, the study revealed that increasing food production would lead to increases in calorie shortfall and undernourishment under strict State interventionism. However, beyond

a given threshold (of roughly 5, on average), countries would start experiencing a fall in food insecurity as domestic food production increases. Given that economic freedom had no significant effect on food production, the findings show the need for governments in SSA to find the *right balance* between strict State interventionism and pure market economy (Fosu, 2013; Stiglitz, 2016).

Furthermore, the study showed that the positive (direct) effect of economic freedom on food security is mainly driven by the positive effect of a well-functioning judiciary system and property rights enforcement on food distribution, which are key for land administration and food distribution on the continent. In addition, the existence of minimum trade restrictions contributes both directly and indirectly to food security. Furthermore, government effectiveness in the provision of public services is crucial for productivity, and thus, for food production. However, rule of law appeared to have no significant influence on food insecurity, whereas the control of corruption is greatly beneficial to productivity and food production, with positive consequences on food security in the region.

As revealed by the results, achieving food security would require, among other things, a greater investment in transport infrastructure and adaptation strategies to mitigate the impact of natural disasters on the production of food. Additionally, food aid remains an important solution for food security in times of crisis because it is "productivity-enhancing" within food insecure localities in SSA, and hence would likely promote food production in the region. Furthermore, corruption remains a hindering factor in the food production sector. Aside from addressing the corruption issues affecting the agriculture sector, government should also continue to improve the effectiveness of public services delivery, as the study found that the variable is important in supporting domestic food production in SSA. On whether trade is good or bad for food security on the continent, the findings are in favour of the hypothesis that trade has been beneficial to food production on the continent. However, the effects of trade openness policies have been mixed. Our results seem to suggest that while minimizing trade restrictions would help alleviate food insecurity, presumably, through decreases in food prices, it could also hamper food production. Finally, promoting a business-friendly environment by improving the judiciary system and property rights enforcement and ensuring adequate regulatory systems appear to be important in addressing hunger and malnutrition in SSA.

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Appendix A: List of countries, PCA results and summary statistics

Table A1: List of countries

No	Country name	No	Country name
1	Benin	18	Malawi
2	Botswana	19	Mali
3	Burkina Faso	20	Mauritania
4	Cape Verde	21	Mauritius
5	Cameroon	22	Mozambique
6	CAR	23	Namibia
7	Chad	24	Niger
8	Cote d'Ivoire	25	Nigeria
9	Ethiopia	26	Rwanda
10	Gabon	27	Senegal
11	Ghana	28	Sierra Leone
12	Guinea	29	South Africa
13	Guinea-Bissau	30	Tanzania
14	Kenya	31	Togo
15	Lesotho	32	Uganda
16	Liberia	33	Zambia
17	Madagascar	34	Zimbabwe

Note: The number and the choice of countries were determined by the availability of data.

Table A2: PCA computation: Aggregate indexes

Governance index		
Component	Eigenvalue	Proportion
1	1.69	0.85
2	0.31	0.15
Institution index		
Component	Eigenvalue	Proportion
1	2.61	0.87
2	0.29	0.10
3	0.09	0.03

Table A3: Mean values of variables by country (continued)

	Prevalence of undernourishment (in %)	depth of food deficit (kcal/caput/day)	Gross Per Capita Food Production Index	trade openness (x+M/GDP)	Initial GDP per capita (constant 2010 US$)	Food aid in tonnes	CoV of habitual caloric consumption distribution	victims of natural disasters (share of population)	Arable land (unit: 1000ha)	Employment in agriculture (% total employment)
Benin	13	84	109	55	757	10235	0.28	0.010	2589	44
Botswana	29	218	106	99	6203	0	0.24	0.002	265	23
Burkina Faso	22	173	100	45	568	24918	0.41	0.040	5645	48
Cape Verde	15	108	90	99	3364	4522	0.26	0.001	52	15
Cameroon	14	91	115	53	1303	12725	0.24	0.001	6072	56
CAR	41	318	105	38	413	13223	0.29	0.002	1870	79
Chad	38	292	106	82	807	75031	0.35	0.031	4288	79
Côte d'Ivoire	16	118	100	86	1235	19072	0.38	0.000	3015	47
Ethiopia	30	206	124	43	395	439017	0.27	0.033	15465	71
Gabon	9	60	95	85	9249	0	0.25	0.005	325	38
Ghana	7	49	108	79	1271	32195	0.28	0.002	4456	50
Guinea	17	118	108	77	690	7625	0.31	0.001	3100	65
Guinea-Bissau	25	173	107	49	534	7457	0.28	0.007	288	71
Lesotho	13	91	99	140	1163	5360	0.27	0.067	297	11
Liberia	42	358	95	131	587	666	0.42	0.002	500	44
Madagascar	35	244	100	72	413	32804	0.29	0.024	2992	74
Malawi	24	161	123	60	419	49776	0.31	0.079	3396	49
Mali	8	51	112	58	677	25792	0.30	0.027	6097	69
Mauritania	8	55	94	111	1210	32936	0.28	0.043	404	57
Mauritius	5	37	96	115	7384	0	0.26	0.000	80	9
Mozambique	32	235	109	87	390	96667	0.35	0.018	5308	77
Namibia	31	221	88	102	4941	1839	0.24	0.086	804	29
Niger	13	78	107	56	345	70274	0.29	0.085	15243	77
Nigeria	7	41	93	38	2089	2523	0.25	0.004	34754	42
Rwanda	39	299	114	42	514	19116	0.33	0.009	1126	79
Senegal	16	103	105	61	1226	24556	0.24	0.013	3245	39
Sierra Leone	31	230	116	59	406	23451	0.34	0.001	1493	64
South Africa	4	28	107	60	7001	6020	0.23	0.029	12562	6
Tanzania	34	249	112	47	667	46753	0.36	0.014	11405	72
Togo	21	144	108	91	521	5303	0.29	0.004	2419	44
Uganda	30	211	82	46	552	73619	0.31	0.009	6488	69
Zambia	50	416	123	69	1304	26056	0.39	0.022	3317	65
Zimbabwe	38	295	86	75	950	120875	0.31	0.050	4000	66

Table A3: continued

	Economic Freedom summary index	Government effectiveness	Control of corruption index	Rule of law index	Political stability index	Transport composite Index	N
Benin	6.0	-0.5	-0.6	-0.6	0.3	5.8	13.0
Botswana	7.1	0.5	1.0	0.7	1.0	23.5	13.0
Burkina Faso	5.9	-0.6	-0.4	-0.4	-0.3	12.8	11.0
Cape Verde	6.5	0.1	0.9	0.5	0.7	27.0	6.0
Cameroon	5.9	-0.8	-1.1	-1.1	-0.5	3.6	13.0
CAR	5.4	-1.5	-1.1	-1.5	-1.9	2.4	13.0
Chad	4.9	-1.4	-1.4	-1.4	-1.5	1.1	13.0
Côte d'Ivoire	5.7	-1.1	-1.0	-1.2	-1.6	6.9	13.0
Ethiopia	5.5	-0.5	-0.5	-0.6	-1.5	1.7	5.0
Gabon	5.7	-0.8	-0.8	-0.5	0.3	4.1	13.0
Ghana	6.7	-0.1	-0.1	0.0	0.0	8.9	13.0
Guinea	5.7	-1.2	-1.0	-1.3	-0.9	6.1	3.0
Guinea-Bissau	5.3	-1.2	-1.2	-1.3	-0.6	5.0	13.0
Lesotho	6.3	-0.4	0.1	-0.2	0.1	8.6	9.0
Liberia	7.0	-1.4	-0.7	-0.8	-0.7	3.0	2.0
Madagascar	6.1	-0.8	-0.4	-0.6	-0.3	3.2	13.0
Malawi	6.0	-0.6	-0.6	-0.2	0.0	5.5	13.0
Mali	5.8	-0.8	-0.6	-0.4	-0.5	1.9	13.0
Mauritania	5.8	-0.9	-0.7	-0.9	-0.7	5.1	11.0
Mauritius	7.8	0.8	0.4	0.9	0.9	36.0	13.0
Mozambique	5.7	-0.6	-0.6	-0.7	0.2	2.0	13.0
Namibia	6.7	0.1	0.3	0.2	0.8	22.7	13.0
Niger	5.4	-0.7	-0.7	-0.6	-0.8	2.1	13.0
Nigeria	6.2	-1.0	-1.1	-1.2	-1.9	5.2	13.0
Rwanda	6.9	-0.2	0.1	-0.4	-0.5	12.8	13.0
Senegal	5.9	-0.4	-0.3	-0.2	-0.2	3.4	13.0
Sierra Leone	5.9	-1.2	-0.9	-1.0	-0.3	4.5	13.0
South Africa	6.9	0.5	0.2	0.1	-0.1	13.3	13.0
Tanzania	6.6	-0.5	-0.6	-0.4	-0.3	3.0	13.0
Togo	5.6	-1.4	-1.0	-0.9	-0.4	6.3	13.0
Uganda	7.2	-0.5	-0.9	-0.4	-1.0	9.4	13.0
Zambia	6.9	-0.7	-0.4	-0.4	0.4	8.4	13.0
Zimbabwe	4.4	-1.3	-1.4	-1.7	-1.0	14.6	13.0

Notes: In addition to the external instruments, the GMM estimation considered the lagged values of domestic food production as internal instruments.

Appendix B: Robustness check results from the two-step system GMM

Table B1: Food insecurity and governance quality: Results based on Two-step system GMM estimation; Dependent variable: Log of depth of food deficit

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(8)
Log of food production index	-1.59**	-1.60**	7.36*	-1.65**	-5.02**	-1.65***	-2.06***
	(-2.10)	(-2.59)	(1.82)	(-2.11)	(-2.48)	(-3.06)	(-2.82)
Trade openness	-0.22	-0.71	-0.11	-0.44	-0.25	-0.12	-0.54
	(-1.05)	(-1.00)	(-0.21)	(-1.46)	(-0.48)	(-0.30)	(-0.89)
Lagged log of GDP per capita	-0.43*	-0.30	-0.32**	-0.30*	-0.32	-0.43**	-0.29
	(-1.79)	(-1.34)	(-2.18)	(-1.70)	(-1.23)	(-2.10)	(-1.56)
Log of food aid	0.00	-0.02	-0.01	0.00	-0.01	-0.01	-0.02
	(0.01)	(-0.43)	(-0.26)	(0.18)	(-0.30)	(-0.35)	(-0.77)
Log of Coefficient of variation in caloric consumption	1.55	1.57	1.87	1.42	1.62	1.33	2.07*
	(1.14)	(1.13)	(1.49)	(1.21)	(1.36)	(0.90)	(1.84)
External shocks (Victims of natural disasters)	-0.23	-0.07	-0.14	-0.24	-0.68**	-0.46	-0.17
	(-0.66)	(-0.14)	(-0.39)	(-0.74)	(-2.16)	(-0.88)	(-0.39)
Economic freedom (EF)		-0.14	6.84**				
		(-0.90)	(2.13)				
Government effectiveness (GE)				-0.16	19.67*		
				(-0.61)	(1.85)		

Table B1 Contd.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(8)
Governance						-0.02	8.30*
						(-0.14)	(2.01)
Log of food production index * EF			-1.51**				
			(-2.12)				
Log of food production index * GE					-4.28*		
					(-1.82)		
Log of food production index * Governance index							-1.81**
							(-2.04)
Constant	17.21***	17.72***	-23.64	16.50***	32.59***	17.27***	19.53***
	(4.34)	(5.59)	(-1.24)	(4.39)	(3.52)	(6.32)	(5.65)
Observations	430	476	476	493	493	450	450
Number of countries	34	34	34	34	34	34	34
Number of instruments	15	19	29	17	31	22	31
AR(2)	1.649	1.637	0.917	1.487	0.296	1.248	1.434
AR(2) — P-value	0.100	0.102	0.359	0.137	0.767	0.212	0.152
Hansen J	9.784	14.82	20.54	9.045	23.36	18.46	18.05
Hansen J P-value	0.201	0.191	0.425	0.433	0.382	0.187	0.703

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Notes: In addition to the external instruments, the GMM estimation considered the lagged values of domestic food production as internal instruments.

Table B2: Food insecurity and governance quality: Results based on Two-step system GMM estimation; Dependent variable: Prevalence of Undernourishment

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log of food production index	-21.49**	134.62*	-25.66**	-82.86**	-29.28**	-25.76**
	(-2.18)	(1.85)	(-2.14)	(-2.51)	(-2.66)	(-2.08)
Trade openness	-21.00*	-12.55	-11.27	-2.97	-18.41*	-13.30
	(-1.69)	(-1.04)	(-1.06)	(-0.39)	(-1.74)	(-0.83)
Lagged log of GDP per capita	-4.43	-4.55	-5.27	-5.84	-5.84	-2.83
	(-1.00)	(-1.04)	(-1.43)	(-1.38)	(-1.44)	(-0.82)
Log of food aid	-0.48	-0.54	-0.18	-0.32	-0.25	-0.28
	(-0.92)	(-1.05)	(-0.38)	(-0.83)	(-0.55)	(-0.49)
Log of Coefficient of variation in caloric consumption	38.92	31.23	27.05	24.59	26.86	40.03
	(1.08)	(0.96)	(0.94)	(0.86)	(0.84)	(1.30)
External shocks (Victims of natural disasters)	3.18	-5.39	3.08	-8.15	-2.23	-2.51
	(0.28)	(-0.83)	(0.36)	(-1.25)	(-0.32)	(-0.33)
Transport infrastructure	0.42		0.39		0.41	
	(1.41)		(1.28)		(1.05)	
Economic freedom (EF)	-3.44**	125.95**				
	(-2.15)	(2.26)				
Government effectiveness (GE)			-4.69	312.62**		
			(-1.31)	(2.05)		

Table B2 continued

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Governance index (GI)					-1.07	76.50*
					(-0.61)	(1.96)
Log of food production index * EF		-27.70**				
		(-2.31)				
Log of food production index * GE				-68.09**		
				(-2.05)		
Log of food production index * GI						-16.85*
						(-1.95)
Constant	237.09***	-502.06	213.85***	480.12***	244.13***	222.59***
	(3.99)	(-1.50)	(4.63)	(3.19)	(4.34)	(2.94)
Observations	398	476	430	493	398	450
Number of countries	34	34	34	34	34	34
Number of Instruments	14	27	18	25	18	22
AR (2)	1.635	1.141	1.534	0.472	1.562	1.504
AR (2) — P-value	0.102	0.254	0.125	0.637	0.118	0.132
Hansen J	8.777	20.12	11.03	14.70	13.03	17.73
Hansen J P-value	0.118	0.326	0.274	0.546	0.161	0.168

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1 Notes: See Table B1.

Table B3: Food insecurity and governance quality: Results based on Limited Information Maximum Likelihood (LIML); Dependent variable: Log of depth of food deficit

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log of food production index	-1.661***	-1.595***	8.797**	-1.563***	-5.197*	-1.643***	-1.503***
	(-6.766)	(-6.371)	(2.483)	(-6.490)	(-1.725)	(-6.242)	(-4.839)
Trade openness	-0.004	0.027	0.081	0.024	-0.096	0.056	0.037
	(-0.107)	(0.247)	(0.807)	(0.221)	(-0.957)	(0.500)	(0.324)
Lagged log of GDP per capita	-0.046	0.079	-0.247*	0.060	-0.351	0.027	-0.321*
	(-0.376)	(0.601)	(-1.788)	(0.467)	(-1.519)	(0.202)	(-1.870)
Log of food aid	0.009	0.008	-0.010	0.007	-0.004	0.008	-0.009
	(1.295)	(1.154)	(-1.211)	(1.096)	(-0.261)	(1.155)	(-0.856)
Log of Coefficient of variation in caloric consumption	1.422***	1.287***	2.777***	1.233**	2.338***	1.478***	2.827***
	(3.612)	(2.605)	(4.088)	(2.498)	(2.704)	(3.081)	(3.610)
External shocks (Victims of natural disasters)	-0.344**	-0.355**	-0.367**	-0.346**	-0.910*	-0.343**	-0.577***
	(-2.366)	(-2.447)	(-2.568)	(-2.487)	(-1.871)	(-2.337)	(-3.085)
Transport infrastructure	0.004	-0.001		-0.002		0.002	
	(0.521)	(-0.124)		(-0.264)		(0.213)	
Economic freedom (EF)		-0.100***	7.584***	-0.105***			
		(-2.814)	(2.755)	(-3.086)			
Government effectiveness (GE)				0.112	23.310		
				(1.477)	(1.220)		

Table B3 continued

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Governance						-0.036	5.969**
						(-0.998)	(2.038)
Log of food production index * EF			-1.661***				
			(-2.795)				
Log of food production index * GE					-5.022		
					(-1.209)		
Log of food production index * Governance index							-1.286**
							(-2.039)
Observations	430	398	476	398	493	398	450
Number of countries	34	34	34	34	34	34	34
R-squared	-0.00270	0.0573	-0.245	0.0806	-1.451	0.0160	-0.359
Hansen J	3.960	2.800	1.023	2.475	1.646	2.973	1.855
Hansen J P-value	0.138	0.247	0.312	0.290	0.199	0.226	0.173
Cragg–Donald Wald (F-stat)	24.54	20.86	3.622	21.36	0.853	20.42	1.836
SEE	0.184	0.182	0.243	0.180	0.325	0.186	0.247

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; SEE= Standard error of estimates. Notes: See Table B1.

Table B4: Food insecurity and governance quality: Results based on Limited Information Maximum Likelihood (LIML) estimation; Dependent variable: Prevalence of Undernourishment

Variables	(1)	(2)	(3)	(4)	(5)
Log of food production index	-26.127***	92.942*	-77.578	-26.957***	-25.401***
	(-5.870)	(1.834)	(-1.505)	(-5.819)	(-6.013)
Trade openness	-1.094	-1.414	-1.993	-0.815	-1.568
	(-0.572)	(-0.885)	(-1.322)	(-0.419)	(-0.889)
Lagged log of GDP per capita	-1.925	-4.239*	-6.179*	-2.088	-5.057*
	(-0.598)	(-1.851)	(-1.834)	(-0.682)	(-1.952)
Log of food aid	-0.015	-0.225*	-0.088	-0.008	-0.188
	(-0.115)	(-1.825)	(-0.439)	(-0.061)	(-1.297)
Log of Coefficient of variation in caloric consumption	17.439**	35.153***	30.018**	19.767**	34.940***
	(2.079)	(3.478)	(2.134)	(2.494)	(3.034)
External shocks (Victims of natural disasters)	-4.619*	-4.310*	-12.786	-4.651*	-7.753***
	(-1.877)	(-1.822)	(-1.524)	(-1.847)	(-2.659)
Transport infrastructure	0.057			0.092	
	(0.395)			(0.579)	
Economic freedom (EF)	-1.984***	85.948**			
	(-2.787)	(2.172)			
Government effectiveness (GE)			307.594		
			(0.981)		

Table B4 continued

Variables	(1)	(2)	(3)	(4)	(5)
Governance				-1.550**	66.233*
				(-2.490)	(1.734)
Log of food production index * EF		-19.028**			
		(-2.228)			
Log of food production index * GE			-66.497		
			(-0.976)		
Log of food production index * Governance index					-14.463*
					(-1.764)
Observations	398	476	493	398	450
Number of countries	34	34	34	34	34
R-squared	0.242	0.233	-0.561	0.222	0.175
Hansen J	1.297	2.245	2.554	1.614	2.828
Hansen J P-value	0.523	0.134	0.110	0.446	0.0926
Cragg–Donald Wald (F-stat)	20.86	3.622	0.853	20.42	1.836
SEE	3.077	3.516	4.812	3.117	3.570

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; SEE= Standard error of estimates
Notes: See Table B1.

Table B5: Food insecurity and institutional quality: Results based on Two-step system GMM estimation; Dependent variable: Log of depth of food deficit

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log of food production index	-1.94**	-1.75*	-1.86**	-1.94*	-1.98**	-1.80*	-1.67**	-2.24**	-2.37*	-2.20**
	(-2.73)	(-1.83)	(-2.09)	(-1.80)	(-2.30)	(-1.72)	(-2.61)	(-2.27)	(-1.97)	(-2.25)
Trade openness	-0.32	-0.21	-0.35	-0.20	-0.32	-0.34	-0.34	-0.19	-0.71	-0.51
	(-1.17)	(-0.90)	(-1.24)	(-1.03)	(-1.24)	(-1.26)	(-1.58)	(-0.89)	(-1.15)	(-1.46)
Lagged log of GDP per capita	-0.40	-0.39*	-0.39	-0.31	-0.41*	-0.25	-0.37*	-0.32**	-0.50**	-0.33
	(-1.69)	(-1.74)	(-1.65)	(-1.55)	(-1.95)	(-1.67)	(-2.02)	(-2.22)	(-2.13)	(-1.69)
Log of food aid	-0.01	-0.01	-0.01	0.00	-0.01	-0.00	-0.00	-0.01	-0.01	-0.02
	(-0.17)	(-0.39)	(-0.23)	(0.14)	(-0.31)	(-0.15)	(-0.19)	(-0.26)	(-0.42)	(-0.67)
Log of Coefficient of variation in caloric consumption	1.94	2.11*	1.67	2.19*	1.62	2.56**	1.81	2.54**	2.04	2.61**
	(1.34)	(1.87)	(1.18)	(1.98)	(1.14)	(2.45)	(1.45)	(2.20)	(1.34)	(2.72)
External shocks (Victims of natural disasters)	-0.21	-0.32	-0.21	-0.04	-0.15	0.16	-0.18	-0.18	-0.24	-0.20
	(-0.49)	(-1.04)	(-0.51)	(-0.16)	(-0.32)	(0.60)	(-0.52)	(-0.56)	(-0.47)	(-0.62)
Transport infrastructure	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.00	-0.01
	(0.29)	(0.40)	(0.63)	(1.16)	(0.66)	(0.93)	(0.70)	(0.70)	(0.07)	(-0.30)
Control of Corruption (CC)	-0.00	5.83								
	(-0.00)	(1.23)								
Rule of Law (RL)			-0.18	10.62						
			(-0.92)	(1.00)						
Voice and Accountability (VA)					-0.22*	12.16				
					(-1.74)	(1.25)				
Institution Index (II)							-0.07	4.80		

Table B5 continued

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
							(-0.96)	(1.04)		
Political Stability (PS)									0.37	11.19
									(1.55)	(1.53)
Log of food production index * CC		-1.26								
		(-1.21)								
Log of food production index *RL				-2.35						
				(-1.02)						
Log of food production index *VA						-2.68				
						(-1.28)				
Log of food production index *II								-1.06		
								(-1.06)		
Log of food production index *PS										-2.34
										(-1.48)
Constant	19.21***	18.32***	18.32***	18.41***	18.95***	18.08***	17.59***	20.61***	22.58***	21.30***
	(6.74)	(3.84)	(4.24)	(3.36)	(4.87)	(3.47)	(5.75)	(4.91)	(3.88)	(4.11)
Observations	430	430	430	430	430	430	430	430	430	430
Number of countries	34	34	34	34	34	34	34	34	34	34
Number of Instruments	17	27	15	20	15	26	17	19	14	30
AR (2)	1.394	1.037	1.460	0.856	1.600	0.585	1.619	-0.279	0.828	0.0594
AR (2) — P-value	0.163	0.300	0.144	0.392	0.110	0.559	0.106	0.780	0.408	0.953
Hansen J	10.08	19.62	6.581	9.252	6.188	12.28	7.907	5.726	9.062	21.46
Hansen J P-value	0.259	0.294	0.361	0.508	0.402	0.725	0.443	0.767	0.107	0.371

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; SEE= Standard error of estimates.

Notes: In models 9 and 10, political stability and absence of violence is endogenised and instrumented using its lagged values. For other details, see Table B1.

Table B6: Food insecurity and institutional quality: Results based on Two-step system GMM estimation; Dependent variable: Prevalence of Undernourishment

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log of food production index	-26.86**	-31.09**	-27.43**	-38.19*	-37.17*	-41.06**	-35.02***	-31.69***	-24.14***	-42.09*
	(-2.36)	(-2.17)	(-2.31)	(-1.91)	(-1.93)	(-2.13)	(-3.32)	(-3.81)	(-2.78)	(-1.73)
Trade openness	-9.83	-7.46*	-8.93	-10.45*	-8.70	-12.42	-8.57	-4.74	-8.99	-19.92
	(-0.96)	(-1.78)	(-1.09)	(-1.77)	(-1.16)	(-1.05)	(-1.26)	(-1.14)	(-1.37)	(-1.50)
Lagged log of GDP per capita	-5.32	-4.88	-5.99	-3.87	-5.64	-2.04	-5.49	-5.93	-7.06*	-8.27*
	(-1.38)	(-1.32)	(-1.49)	(-1.21)	(-1.40)	(-0.51)	(-1.50)	(-1.46)	(-1.80)	(-1.97)
Log of food aid	-0.21	-0.20	-0.26	-0.14	-0.31	-0.05	-0.28	-0.34	-0.40	-0.66
	(-0.39)	(-0.46)	(-0.68)	(-0.31)	(-0.62)	(-0.09)	(-0.56)	(-0.77)	(-0.92)	(-1.26)
Log of Coefficient of variation in caloric consumption	36.18	40.77*	30.44	45.49	33.69	36.65	35.51	43.20	47.13*	46.58*
	(1.18)	(1.80)	(1.03)	(1.63)	(0.98)	(1.20)	(1.21)	(1.57)	(1.80)	(1.86)
External shocks (Victims of natural disasters)	1.46	-2.29	-1.13	3.52	-2.54	3.98	-1.31	-3.07	-1.43	-2.39
	(0.16)	(-0.34)	(-0.19)	(0.66)	(-0.27)	(0.44)	(-0.17)	(-0.42)	(-0.17)	(-0.16)
Transport infrastructure	0.33	0.29	0.38	0.38	0.30	0.17	0.34	0.46	0.12	0.03
	(0.92)	(0.92)	(1.55)	(1.38)	(1.03)	(0.52)	(1.15)	(1.03)	(0.30)	(0.06)
Control of Corruption (CC)	-1.77	26.82								
	(-0.39)	(0.29)								
Rule of Law (RL)			-3.97	172.53						
			(-1.34)	(1.29)						
Voice and Accountability (VA)					-3.96	323.55				
					(-1.52)	(1.44)				
Institution Index (II)							-1.51	52.52		
							(-1.38)	(0.63)		

Table B6 continued

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Political Stability (PS)									4.80	170.49
									(1.58)	(0.94)
Log of food production index * CC		-5.60								
		(-0.28)								
Log of food production index *RL				-38.17						
				(-1.32)						
Log of food production index *VA						-70.39				
						(-1.46)				
Log of food production index *II								-11.57		
								(-0.64)		
Log of food production index *PS										-35.03
										(-0.89)
Constant	232.77***	254.73***	231.16***	284.47***	279.98***	278.50***	272.29***	266.27***	252.34***	355.71***
	(4.86)	(3.39)	(4.46)	(2.77)	(3.69)	(3.10)	(6.56)	(5.82)	(5.79)	(3.11)
Observations	430	430	430	430	430	430	430	430	430	430
Number of countries	34	34	34	34	34	34	34	34	34	34
Number of Instruments	16	26	16	24	13	29	17	22	22	23
AR (2)	1.588	1.320	1.616	0.653	1.547	0.455	1.465	0.288	1.561	-0.324
AR (2) — P-value	0.112	0.187	0.106	0.514	0.122	0.649	0.143	0.773	0.118	0.746
Hansen J	11.14	14.39	7.698	11.56	4.552	23.20	6.682	11.22	12.82	11.21
Hansen J P-value	0.133	0.570	0.360	0.641	0.336	0.229	0.571	0.511	0.462	0.593

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; SEE= Standard error of estimates.
Notes: See Tables B1 and B5.

Table B7: Food insecurity and institutional quality: Results based on Limited Information Maximum Likelihood (LIML) estimation; Dependent variable: Log of depth of food deficit

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log of food production index	-1.640***	-1.425	-1.673***	-2.627**	-1.664***	-1.572***	-1.663***	-1.652***	-1.588***	-3.033**
	(-6.892)	(-0.999)	(-6.721)	(-2.262)	(-6.737)	(-3.455)	(-6.734)	(-5.152)	(-7.018)	(-2.128)
Trade openness	0.003	0.006	0.002	-0.056	0.001	-0.007	-0.004	-0.003	0.024	0.072
	(0.072)	(0.131)	(0.044)	(-0.691)	(0.014)	(-0.146)	(-0.103)	(-0.078)	(0.613)	(0.797)
Lagged log of GDP per capita	-0.060	-0.066	-0.057	-0.250	-0.056	-0.076	-0.044	-0.041	-0.074	0.078
	(-0.507)	(-0.536)	(-0.465)	(-1.041)	(-0.462)	(-0.528)	(-0.366)	(-0.261)	(-0.617)	(0.304)
Log of food aid	0.010	0.009	0.010	0.007	0.010	0.010	0.008	0.008	0.009	0.012
	(1.435)	(1.339)	(1.462)	(0.681)	(1.447)	(1.318)	(1.263)	(1.263)	(1.345)	(0.970)
Log of Coefficient of variation in caloric consumption	1.308***	1.316***	1.347***	1.767**	1.312***	1.349***	1.435***	1.436***	0.988**	1.067
	(3.259)	(3.108)	(3.210)	(2.578)	(3.112)	(3.132)	(3.431)	(3.410)	(2.394)	(1.508)
External shocks (Victims of natural disasters)	-0.342**	-0.324*	-0.340**	-0.487*	-0.340**	-0.359**	-0.346**	-0.345**	-0.268*	-0.739
	(-2.376)	(-1.735)	(-2.277)	(-1.712)	(-2.338)	(-2.214)	(-2.368)	(-2.353)	(-1.938)	(-1.593)
Transport infrastructure	0.003	0.002	0.004	0.003	0.004	0.004	0.004	0.004	0.006	
	(0.384)	(0.187)	(0.489)	(0.329)	(0.489)	(0.580)	(0.516)	(0.515)	(0.748)	
Control of Corruption (CC)	0.100*	-1.899								
	(1.759)	(-0.141)								
Rule of Law (RL)			0.083	12.326						
			(1.163)	(0.886)						
Voice and Accountability (VA)							-0.008	-0.240		
							(-0.155)	(-0.042)		
Institution Index (II)					0.032	0.906				

Table B7 continued

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
					(1.231)	(0.270)				
Political Stability (PS)									0.133***	14.081
									(4.537)	(0.985)
Log of food production index * CC		0.430								
		(0.148)								
Log of food production index *RL				-2.643						
				(-0.881)						
Log of food production index *VA								0.050		
								(0.040)		
Log of food production index *II						-0.190				
						(-0.260)				
Log of food production index *PS										-3.012
										(-0.976)
Observations	430	430	430	430	430	430	430	430	430	493
Number of countries	34	34	34	34	34	34	34	34	34	34
R-squared	0.0166	-0.019	-0.005	-0.342	-0.0003	0.022	-0.004	-0.010	0.0934	-1.372
Hansen J	3.957	3.950	4.125	2.216	4.150	3.957	3.857	3.845	3.113	0.932
Hansen J P-value	0.138	0.0469	0.127	0.137	0.126	0.0467	0.145	0.0499	0.211	0.334
Cragg–DonaldWald (F-stat)	26.56	1.896	24.41	1.910	24.72	2.840	24.37	3.660	24.69	0.854
SEE	0.182	0.186	0.184	0.213	0.184	0.182	0.184	0.185	0.175	0.319

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; SEE = Standard error of estimates.
Notes: See Tables B1 and B5.

Table AB8: Food insecurity and institutional quality: Results based on Limited Information Maximum Likelihood (LIML) estimation; Dependent variable: Prevalence of Undernourishment

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log of food production index	-28.946***	-37.024***	-28.761***	-39.624***	-28.625***	-30.979***	-28.796***	-25.607***	-28.599***	-33.071***
	(-6.553)	(-2.780)	(-6.401)	(-3.822)	(-6.373)	(-6.072)	(-6.394)	(-4.308)	(-6.408)	(-5.380)
Trade openness	-0.398	-0.536	-0.471	-1.101	-0.411	-0.535	-0.454	-0.730	-0.236	0.062
	(-0.590)	(-0.718)	(-0.734)	(-1.187)	(-0.649)	(-0.812)	(-0.701)	(-0.980)	(-0.343)	(0.067)
Lagged log of GDP per capita	-3.695	-3.478	-3.533	-5.648*	-3.673	-4.494	-3.603	-4.307	-3.843	-3.788
	(-1.269)	(-1.227)	(-1.208)	(-1.757)	(-1.248)	(-1.389)	(-1.237)	(-1.434)	(-1.298)	(-1.276)
Log of food aid	0.020	0.037	-0.000	-0.034	-0.000	-0.002	0.003	-0.004	0.021	-0.021
	(0.145)	(0.251)	(-0.001)	(-0.208)	(-0.001)	(-0.016)	(0.020)	(-0.029)	(0.164)	(-0.135)
Log of Coefficient of variation in caloric consumption	17.763**	17.468**	18.774***	23.439***	19.688***	19.550***	19.083***	20.387***	15.267**	5.874
	(2.495)	(2.402)	(2.718)	(2.804)	(2.782)	(2.848)	(2.672)	(2.811)	(2.116)	(0.456)
External shocks (Victims of natural disasters)	-4.706*	-5.370**	-4.775*	-6.456*	-4.759*	-4.801*	-4.737*	-5.412**	-4.301*	-5.313
	(-1.812)	(-1.978)	(-1.872)	(-1.850)	(-1.812)	(-1.851)	(-1.833)	(-1.982)	(-1.662)	(-1.618)
Transport infrastructure	0.169	0.202	0.171	0.158	0.159	0.150	0.170	0.179	0.178	0.204
	(1.051)	(1.336)	(1.087)	(1.297)	(0.998)	(1.079)	(1.069)	(1.374)	(1.117)	(1.612)
Control of Corruption (CC)	-0.102	75.126								
	(-0.103)	(0.612)								
Rule of Law (RL)			-1.248	135.909						
			(-1.096)	(1.182)						
Voice and Accountability (VA)					-1.170	52.247				
					(-1.377)	(0.725)				
Institution Index (II)							-0.411	30.303		

Table AB8 continued

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
							(-0.981)	(0.870)		
Political Stability (PS)									0.727*	142.125
									(1.691)	(1.175)
Log of food production index * CC		-16.187								
		(-0.612)								
Log of food production index *RL				-29.611						
				(-1.193)						
Log of food production index *VA						-11.567				
						(-0.741)				
Log of food production index *II								-6.662		
								(-0.881)		
Log of food production index *PS										-30.329
										(-1.169)
Observations	430	430	430	430	430	430	430	430	430	430
Number of countries	34	34	34	34	34	34	34	34	34	34
R-squared	0.160	0.130	0.167	0.102	0.170	0.177	0.165	0.161	0.173	-0.109
Hansen J	2.048	1.400	1.892	0.459	1.719	1.071	1.918	1.007	2.063	0.308
Hansen J P-value	0.359	0.237	0.388	0.498	0.423	0.301	0.383	0.316	0.356	0.579
Cragg–Donald Wald (F-stat)	26.56	1.896	24.41	1.910	24.37	3.660	24.72	2.840	24.69	1.393
SEE	3.157	3.216	3.143	3.268	3.137	3.129	3.147	3.159	3.133	3.633

Robust t-statistics in parentheses; *** p<0.01, ** p<0.05, * p<0.1; SEE = Standard error of estimates.
Notes: See Tables B1 and B5.

Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

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