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Njangang, Henri and Asongu, Simplice and Mouchili, Eric

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Henri Njangang
Faculty of Economics and Management (LAREFA)
University of Dschang, Dschang, Cameroon
E-mail: ndieupahenri@gmail.com

Simplice Asongu
(Corresponding author)
African Governance and Development Institute,
P.O. Box 8413, Yaoundé, Cameroon
E-mails: asongusimplice@yahoo.com, asongus@afridev.org

Eric Mouchili
Faculty of Economics and Management (LAREFA)
University of Dschang, Dschang, Cameroon
E-mail: moumieeric@yahoo.com

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Abstract

Corruption remains a major challenge to sustainable economic growth, good governance, peace, and stability in both developed and developing countries. However, in developing countries, and particularly in Africa, hunger is another big challenge to inclusive economic development. To date, no empirical study has examined the effects of different types of corruption on hunger. Using three types of corruption (executive, legislative, and judicial corruption dynamics) and a panel of 45 African countries, this study contributes to the literature on the effects of corruption by examining, as a first attempt, the impact of types of corruption on hunger. We address the weak time-variance of our main regressors by using the most recent sequential linear panel dynamic estimator. The results show that countries with higher levels of executive, legislative, and judicial corruption are associated with a higher level of hunger. Moreover, the results show that executive corruption is the most disastrous for hunger in Africa, followed by legislative corruption. Our results remain valid even after using alternative measures of the key variables (hunger and corruption) and after controlling for the dynamic endogeneity using the generalized method of moments. Further analysis provides strong evidence that the political distribution of power across social groups mitigates the effect of corruption on hunger.

Keywords: Corruption; Hunger; Power distribution among social groups; Africa

***JEL Classification*:** P16; P35; O15; O55

1. Introduction

This paper investigates the effects of different types of political corruption (executive, legislative, and judicial) on hunger in Africa. In so doing, two strands of the contemporary economic literature are combined. While the first strand focuses on the determinants of hunger (see, for example, Gödecke et al., 2018; Mautau et al., 2018; Mary et al., 2020), the second strand is part of the vast literature on the effects of corruption (Mauro, 1995; Bardhan, 1997; Mauro, 1998; Asongu, 2014; Marakbi, 2020; Keneck-Massil et al., 2021; Asteriou et al., 2021). To the best of our knowledge, there is no study on the relationship between types of corruption and hunger. Hence, a major contribution of this paper is being the first empirical study to establish a link between types of corruption (i.e., executive, legislative, and judicial corruption dynamics) and hunger.

Eating, and especially eating well, is one of our most basic human needs, yet billions of people are not getting enough. This situation has led international organisations such as the World Bank to make the fight against hunger a global priority, including it at the top of the Millennium Development Goals (MDG 1). Through its goal of zero hunger by 2030, the Sustainable Development Goals (SDG 2) reaffirm the importance of fighting hunger as a necessity for sustainable and inclusive development. These programmes have achieved some remarkable progress in developing countries, reducing the prevalence of malnutrition from 23.4% to 13.5% between 1990 and 2014 (Mary et al., 2018). However, since 2015, the numbers have risen again, with over 821 million[1] (1 in 9 of the world's population) undernourished people worldwide in 2018, over 20% of whom are in Africa (WHO, 2018; Figure 1). Moreover, with the COVID-19 pandemic, the situation is likely to be more alarming, especially for low-income countries. By the end of 2019, 20% of Africa's population, or 250 million people, were suffering from famine. In Sub-Saharan Africa, as many as 234 million people were chronically undernourished[2].

This situation, described as a hunger crisis in several African countries, is causing insurmountable damage not only to human dignity, but also to peace and social order. According to UNICEF[3], the hunger crisis in Malawi is forcing adolescent girls into prostitution to feed their children. Beyond these observed cases, there is empirical evidence that hunger has both political consequences (such as recurrent riots, risk of conflict, and civil war) and socio-economic externalities (reduced growth, increased hardship and poverty, increased inequality, and child mortality) (Black et al., 2008; Asongu and Nwachukwu, 2016; Jepkemboi, 2018; Soffiantini, 2020; Ogunniyi et al., 2020).

In view of the increasing trends in the number of undernourished and food-insecure people, it seems more important than ever to identify the factors explaining undernourishment in order to propose adequate solutions to decision makers. Understanding the determinants of food security in general and

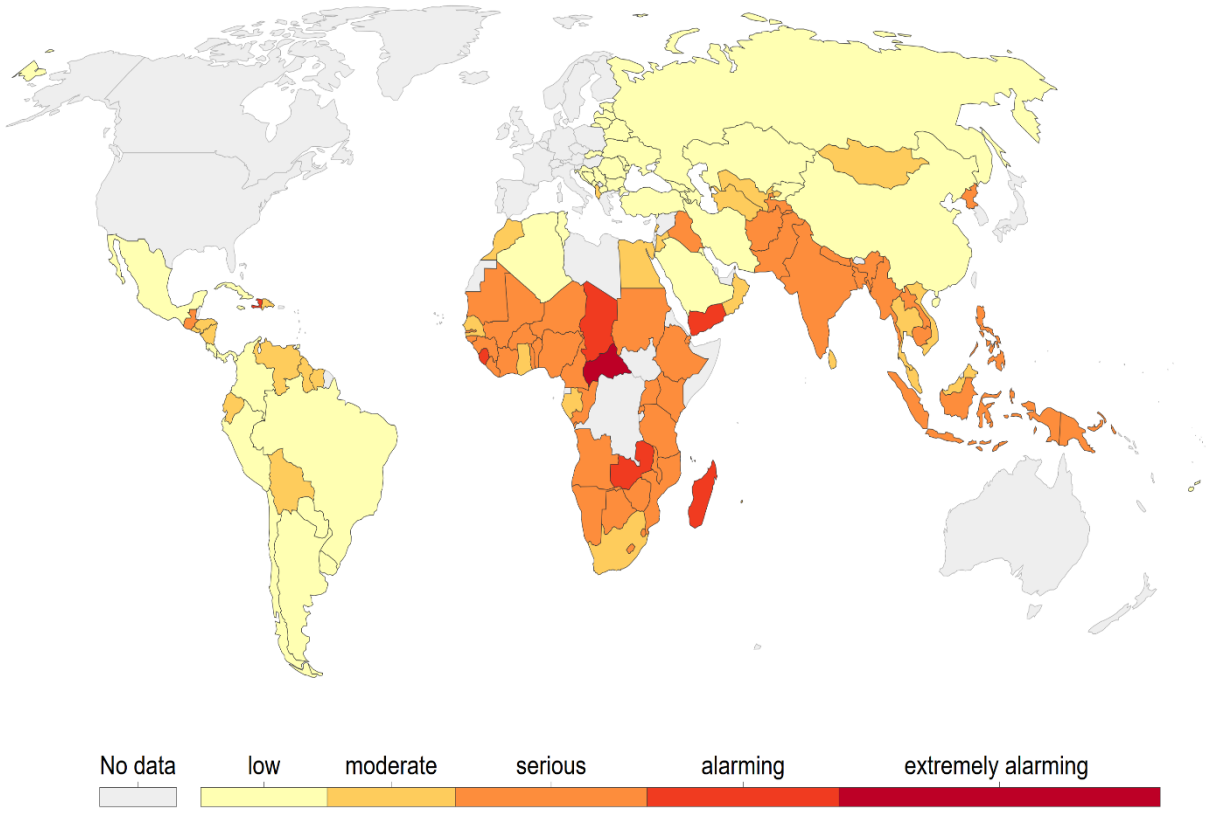
[1]This represents an increase of 191 million since 2014.
[2]https://www.worldvision.org/hunger-news-stories/africa-hunger-famine-facts
[3]https://www.unicef.org/stories/malawi-hunger-crisis-forces-teenage-girls-sell-sex

malnutrition in particular, is a matter of fundamental importance for governments and international agencies alike, particularly in Africa. Undernourishment has been found to be influenced by a number of fundamental geographical variables such as seasonal change, climate variability, natural disasters, and drought (Bohle et al., 1994; Downing, 1991).Several other socio-economic factors have a strong impact on hunger, *inter alia*, economic growth (Harttgen et al., 2013; Soriano and Garrido, 2016), poverty (Maitra and Rao, 2015), access to safe water and sanitation (Smith and Haddad, 2015), and remittances (Azizi, 2018; Mabrouk and Mekni, 2018). Other works highlight the role of food and agricultural aid (Mary et al., 2018; Mary et al., 2020), grain production (Mughal and FontanSers, 2020), investments in health and education (Headey, 2013), and the availability of agricultural land (Marselis et al., 2017). For Eini-Zinab et al. (2020), countries with higher literacy, a higher human development index (HDI), and low-income inequality are associated with lower undernourishment rates. Anríquez et al. (2013) consider that rising food prices worsen the nutritional status of populations. Other factors, this time political, have been identified as the main determinants of hunger in developing countries. For example, some authors (George et al., 2020; Koren and Bagozzi, 2016; Messer et al., 2001; Corley, 2021) show that political instability, the occurrence of conflicts and civil wars are associated with a high level of hunger. The case of Yemen is a perfect illustration. According to the World Food Programme (WFP), after more than 5 years of armed conflict, beyond the hundreds of deaths recorded, Yemen is facing the greatest food insecurity emergency in the world, with nearly 20 million people (66% of its population) in a situation of food insecurity and awaiting humanitarian aid. In the same vein, Sahley et al. (2005) and Pereira and Ruysenaar (2012), to name but two, highlight poor governance as a factor that can exacerbate food insecurity and, consequently,hunger.

Despite the growing number of empirical studies on the determinants of hunger, the effect of corruption has been less explored. Corruption, which is defined as the abuse of public power for private gain (see, Shleifer and Vishny, 1993), is a global phenomenon that seems to affect all countries, both developed and developing (see Figure 2), with more destructive effects on developing economies, particularly those in Africa. According to the World Economic Forum,developing countries have lost as much as $1.26 trillion to fraud, corruption and shady business deals every year (Fleming, 2019). These figures are even more alarming in Africa, as according to the Mo Ibrahim Foundation, Africa loses $128 billion a year to corruption, equivalent to 50% of its tax revenues and 25% of its GDP. Moreover, of the 179 countries that appear in the Transparency International ranking, only 6 out of 52 African countries have an above average score, and the last two countries are African (South Sudan and Somalia, with a score of 12/100 each) (Transparency International, 2020). These figures make it clear that corruption remains a major challenge to sustainable economic growth, good governance, peace and stability, which are requirements for tangible economic development in Africa.

Based on this observation, and since the seminal work of Mauro (1995) showing that corruption reduces economic growth, several studies (both macro and micro), have been undertaken to theoretically and empirically examine the effects of corruption. From this vast literature, there is a certain consensus that corruption, without being exhaustive, reduces investment (Barassi and Zhou, 2012; Wei, 2000; Campos et al., 1999), increases income inequality (Apergis et al., 2010), inhibits innovation (Dincer, 2019; Huang and Yuan, 2021), deteriorates people's health (Dincer and Teoman, 2019; Sharma et al., 2021), degrades the environment (Cole, 2007; Lv and Gao, 2021), reduces transparency of information (Dass et al., 2016), and increases public debt (Cooray et al., 2017; Benfratello et al., 2018).

Figure1: Global Hunger Map (2018)



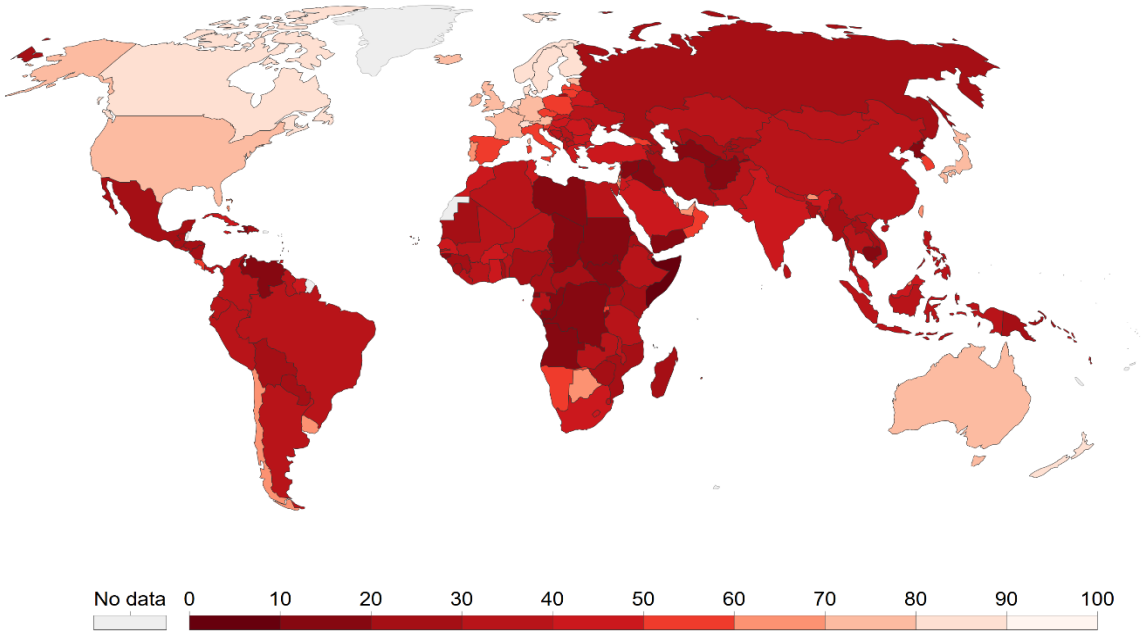
Source: International Food Policy Research Institute

Although recent research offers answers to some important questions related to the macroeconomic consequences of corruption and especially the factors explaining hunger, other questions remain unanswered. In particular, the question of whether or not different types of corruption have the same impact on socio-economic indicators is hardly addressed in the literature (Keneck-Massil et al., 2021). In this paper, we focus on this same research question by studying the effects of different types of corruption on hunger. In doing so, we contribute to the literature in at least three ways. **First**, to the best of our knowledge, no study has so far analysed the direct effect of types of corruption on hunger. Thus, this study uses for the first time three types of corruption, namely executive, legislative, and judicial

corruption dynamics, in an empirical analysis linking corruption and hunger. Examining this relationship is important, given that addressing hunger requires a better understanding of the factors affecting hunger, particularly in Africa.**Second**, given the very low variation of different types of corruption, we use for the first timean innovative econometric approach not yet used in the existing literature, namelythe sequential linear panel dynamic analysis proposed by Kripfganz and Schwarz (2019). This method proceeds in two steps. In the first step, only the coefficients of the time-varying regressors are estimated. In the second step, the coefficients of the time-invariant regressors are estimated. This method, unlike the classical estimators (OLS, FE, and RE), has the advantage of producing efficient estimators in the presence of time invariant variables. In addition, the two-step approach is more robust against misspecification than the generalised method of moment's estimators that obtain all parameter estimates simultaneously. Finally, this two-step approach exploits the advantages of transformation-based estimators to eliminate unit-specific heterogeneity. **Third**, this paper is one of the first attempts to study the influence of the distribution of political power across social groups on the relationship between types of corruption and hunger. To sum up, the results show that countries with higher levels of executive, legislative, and judicial corruption are associated with a higher level of hunger. Further analysis provides strong evidence that the political distribution of power across social groups mitigates the effect of corruption on hunger.

The rest of the paper is structured as follows. Section 2 discusses transmission channels linking corruption and hunger, while the data is covered in Section 3. Section 4 presents the methodology and empirical results, whereas Section 5 concludes with implications and future research directions.

Figure 2: Corruption Perception Index, 2018



Source: Transparency International

2. Corruption and hunger: transmission channels

We postulate that corruption increases hunger through its effects on income inequality, foreign aid, and education.

2.1. Income inequality

Studies on the effects of corruption on various economic indicators have attracted the interest of many researchers in recent years (Dutta et al., 2017; Policardo and Carrera, 2018; Fakir et al., 2018; Cooray and Dzhumashev, 2018). Among the selected indicators, several studies have shown that corruption increases inequality (Policardo and Carrera 2018; Fakir et al. 2018). It is argued by Fakir et al. (2018) that corruption undermines the effectiveness of redistributive policies, and by extension, creates a conducive environment for inequalityto increase. Shleifer and Vishny (1993), on the other hand, argue that corruption occurs because public officials engage in the sale of public assets for the prime purpose of improving their personal gains. This view of corruption implies that preferential arrangements between individuals in the public and private sectors provide strong incentives to derailfrom the legal institutional framework in existence; a derailment that is associated with opportunities of corruption. These authors go on to argue that such transaction of corrupt nature can fundamentally alter the legal distribution of public and private resources in their favour; and if this behaviour becomes commonplace, it can affect the composition of a country's income distribution. Policardo and Carrera (2018) argue that corruption can affect inequality in several ways. This view is also shared by several authors who show that corruption can affect inequality directly through biased tax systems that favour the rich and well-connected (Gupta et al., 2002; Ullah and Ahmad, 2016). Indirectly, corruption can foster inequality through other variables that in turn affect inequality, such as the level and efficiency of social spending (Suryadarma, 2012) and unequal access to education and public services, especially health services (Azfar and Gurgur, 2008).

Alongside this literature, other studies analyse the link between income inequality and hunger (Subramanian et al., 2007; Elmes and Derry, 2013). The main conclusion from this literature is that hunger tends to be worse in more unequal societies. Pickett and Wilkinson (2015) confirm this hypothesis by providing strong evidence that income inequality affects people's well-being. Palma et al. (2009) provide empirical support for this argument and show that countries characterised by widespread poverty and high income inequality are associated with a higher prevalence of hunger. Eini-Zinab et al. (2020) share this view and show that countries with lower levels of income inequality experience a faster decline in hunger. Therefore, we can argue that corruption, by fostering inequality, increases hunger.

2.2. Foreign aid

In the literature, it has been shown that aid received influences the nutritional status of local populations (Mary et al., 2020; Tusiime et al., 2013; Del Ninno et al., 2007; Gilligan and Hoddinott, 2007;

Quisumbing, 2003). Regarding the relationship between aid and hunger, foreign aid, and especially food aid,has been shown to significantly reduce malnutrition. For example, Mary et al. (2018) show that both food aid, and emergency food aid, are effective in reducing hunger. The argument that supports this claim is that food aid (i.e. by bringing food directly to the needy and increaseing their food consumption), positively affects the weight/height ratio in children, and increases their food security, all of which reduce the prevalence of malnutrition. However, Mary et al. (2018) argue that the effectiveness of aid in reducing hunger depends on food aid reaching those in need directly. However, there is evidence in the literature that corruption encourages the use of aid sent to developing countries for private purposes (Schudel, 2008; Asongu, 2016; Asongu and Tchamyou, 2019), all of which reduces its effectiveness in fighting hunger. Humanitarian aid, which can rightly be considered as post-conflict or post-disaster aid, is mostly provided to areas or countries where governance is weak and corruption in these countries leads to the diversion of funds for other purposes (Maxwell et al., 2012). As a result, funds allocated to support the food insecure population are diverted to other purposes, and such diversion increases the precariousness of the populations initially targeted by the aid, all of which increases hunger. It can therefore be argued that corruption increases the level of hunger through its negative effect on aid.

2.3. *Education*

The literature on the negative effects of corruption on education is extensive. The existing works seem to provide several arguments on the perverse effect of corruption on education. The main argument in favour of this stream is that corruption is unfriendly to the development of institutional and economic environments that enhance the expansion of education and the formation of high quality human capital (Dridi, 2014). Several studies supporting this argument posit that the desire to benefit from rents originating from the intervention of a government in an economy can possibly alter the decision by individuals to invest in human capital and by extension, provide less incentives for people to spend more time in education and, as a result, focus more on the accumulation of political capital that enables them to secure bureaucratic power and consolidate activities ofa rent-seeking nature (Ehrlich and Lui, 1999). Quality human capital is influenced by such activities and such influence could also motivate students to diverse from certain types of studies (e.g. engineering) to alternative disciplines (e.g. law), although the former are more likely to generate growth (Tanzi and Davoodi, 2001). In addition, there is work that argues that improved education levels help reduce malnutrition (Mutisya et al., 2016; Hickey et al., 2019). These studies show that education through its positive effects on improving living standards reduces malnutrition. Indeed, education policies are relevant for better nutrition as they improve knowledge about food production (Soriano and Garrido, 2016). They enable individuals to adopt healthier eating habits and make the best nutritional choices for their health and that of their children's (Smith and Haddad, 2015). Mutisya et al. (2016) illustrate some of the mechanisms by which education affects malnutrition and food

security and their contingency on the context, particularly concerning urban or rural spheres. In rural contexts, education affects food security via, sanitation, nutrition, and access to information on better agricultural production; hence better decision making (Bashir and Schilizzi, 2013). In urban areas, the incidence of education is via proxies through as household income, employment, and decision making that affect the access, utilisation and availability dimensions of food security (Mutisya et al., 2016). Increasing the number of years of schooling is linked to better employment opportunities, increased disposable income, work efficiency and better decision making (Bashir and Schilizzi, 2013). Given this, we can argue that corruption, by reducing educational attainment, contributes to increasing hunger.

3. Data

This study covers 45 African countries over the period 2000-2017 with data from various sources: World Bank: World Development Indicators (WDI); World Bank: World Governance Indicators (WGI); V-DEM (Varieties of Democracy), Version 11.1[4]; World Health Organisation (WHO);Food and Agriculture Organisation (FAO, FOASTAT), and Alesina et al. (2003). The periodicity under investigation is chosen according to data availability constraints. Table 1 presents the descriptive statistics, while Tables A1, A2, and A3in the appendix provide the correlation matrix of the basic model, the list of countries used, and the description of the variables, and data sources.

3.1 Dependent variable

The International Food Policy Research Institute (IFPRI) has constructed a unique indicator of hunger: the Global Hunger Index (GHI). This indicator has the advantage of capturing the multidimensional nature of hunger and, at the same time, allows for effective monitoring and understanding of the progress made in the world in the fight against hunger. Constructed by combining four sub-indicators (undernourishment, child mortality, child stunting, and child wasting), the Global Hunger Index has the shortcoming that it is only available for the years 1992; 2000; 2008; 2016; 2017, and 2018. To address this limitation of the global hunger index, we used some of its sub-indicators. Thus, our main dependent variable is hunger measured by the prevalence rate of undernourishment (Hunger 1). This variable denotes the percentage of the population for which food intake is not sufficient to meet dietary energy requirements on a continuous basis (World Bank, 2020). This indicator is widely used in the literature on undernourishment and food security (Soriano and Garrido, 2016; Mary et al., 2018; Mughal and FontanSers, 2020). For robustness, and especially to account for the multidimensional nature of hunger, we use the stunting prevalence rate (Hunger 2) as an alternative measure of hunger (see Smith and Haddad (2015)). Stunting prevalence represents the percentage of children who are under five and whose

[4] See Coppedge et al. (2021).

height for the attendant age is less than two standard deviations from the median of the WHO growth standards (WHO, 2020). Data for this indicator is available in the WHO database.

3.2 Independent variable

Our main independent variable constitutes the types of corruption obtained from the V-DEM, version 11.1. We distinguish three types of corruption, namely executive corruption, judicial corruption, and legislative corruption. Executive corruption is measured either by the frequency with which members of the executive grant favours in exchange for any kind of incentive (financial, material, or personal) or by the frequency with which they divert public funds for personal use. This indicator is coded in such a way that the lowest value represents the least corrupt activities and the highest value represents the most corrupt activities. Legislative corruption measures the frequency with which legislature members abuse their position for financial gain, which includes accepting bribes and/or facilitating government contracts for companies owned by the legislator (or his or her relatives). Finally, judicial corruption indicates the frequency with which officials make additional payments or undocumented bribes to delay or speed up the judicial process in order to obtain favourable decisions. The indices of legislative and judicial corruption are coded in such a way that their values range from the most corrupt to the least corrupt activities, meaning that an increase in these variables implies less corrupt activities. For ease of interpretation, we consider the opposite of the index of judicial and legislative corruption. With this new configuration, the judicial and executive corruption indexes range from the least corrupt activities to the most corrupt activities.

3.3 Control variables and exploratory statistics

To substantiate the nexus between types of corruption and hunger, as well as avoid variable omission bias, in the baseline analysis, we controlled for a number of the contemporaneous determinants that were found to be important for hunger (Smith and Haddad, 2015; Soriano and Garrido, 2016; Mary et al., 2018): (i) the log of GDP per capita, (ii) natural resources, (iii) voice and accountability, (iv) remittances, and (v) food price.

One of the major determinants of hunger is **income**, as both empirical and theoretical studies provide strong evidence linking income and food security (Ravallion, 1990; Subramanyam et al., 2011; Thi et al., 2018). Empirical studies such as Ruel et al. (2013) show that higher income is associated with poverty reduction and therefore represents an indicator of the capacity of households to buy food, drinkable water, sanitation, and medical care. We introduce per capita GDP to capture the general macroeconomic condition of an economy and expect a negative sign.

Remittances are another important determinant of food security. Empirical studies provide evidence that, international remittances received by increasing the disposable household's income will

increase their food security and therefore reduce undernourishment (Mabrouk and Mekni, 2018; Sulemana et al., 2019). We therefore introduce as control variables personal remittances received (%GDP) from the World Bank (WDI),and expect a positive sign.Several works, both theoretical and empirical, emphasize the **quality of institutions** as fundamental in promoting and sustaining progress in eradicating hunger, primarily by strengthening political commitment to food security and the right to food (Sen, 1981; D'Souza, 1994; Harris, 2014). Recently, Rossignoli and Balestri (2018) show that democratization processes are associated with improved food security. To capture the quality of institutions, we introduce voice and accountability (VA) as a control variable and we expect a negative sign.

Natural resources: since the influential work Sachs and Warner (1995) documenting the resource curse hypothesis, several empirical studies have extended the resource curse hypothesis to other socioeconomic variables (Tadadjeu et al., 2020; Wigley, 2017), including hunger (Bulte et al., 2005). Building on this emerging literature and consistent with Bulte et al. (2005), we control for natural resources measured by total natural resource rents (%GDP) and we expect an increasing effect of natural resources on hunger because it is recognized that resources reduce the quality of institutions and democracy (Isham et al., 2005) and increase inequality (Carmignani, 2013), which is likely to increase hunger, everything being equal.

Table 1: Summary statistics

	Variable	Obs	Mean	S.D	Min	Max
Hunger	Prevalence of undernourishment (Hunger 1)	798	22.542	13.662	3.400	71.500
	Prevalence of stunting (Hunger 2)	202	34.140	9.974	9.000	58.300
Corruption	Executive corruption	810	0.377	0.234	0.022	0.898
	Legislative corruption	783	-0.658	0.975	-3.165	2.029
	Judicial corruption	810	-0.784	1.054	-2.980	2.596
	Corruption control	765	-0.566	0.569	-1.562	1.217
	Public corruption	810	0.670	0.219	0.113	0.979
	Political corruption	810	0.671	0.215	0.132	0.977
Baseline controls	Per capita GDP	792	2009.036	2192.401	194.873	10199.48
	Natural resources	809	11.782	11.071	0.001	59.620
	Voice and accountability	765	-0.530	0.678	-1.830	0.986
	Remittances	722	3.772	5.989	0.000	53.826
	Food prices	748	8.156	10.042	-35.317	112.437
Additional controls	Ethnic fractionalisation	792	0.655	0.226	0.039	0.930
	Cereal production	780	13.442	2.706	2.197	17.286
	Water access	809	63.865	17.459	18.695	99.867
	Health expenditure	800	1.858	1.103	0.241	6.048
	Rainfall	702	81.459	54.482	1.569	260.313
Interactive model	Power distributed by social group	810	0.819	1.164	-2.167	3.176

The economics literature is replete with studies highlighting **food prices** as another important determinant of hunger, particularly in Africa (Hadley et al., 2012; Verpoorten et al., 2013; Amolegbe et al., 2021). The last global food crisis in 2007/2008 resulted in between 75 and 160 million more people suffering from hunger and poverty (de Hoyos and Medvedev, 2009; USDA, 2009). Consistent with Anríquez et al. (2013), we expect a positive effect of food prices on hunger.

For robustness, we use five additional control variables, including: ethnic fractionalisation, cereal production, water access, health expenditure, and rainfall. In line with the literature, on the one hand, we expect an increasing effect of ethnic fractionalisation, and rainfall (Hasegawa et al., 2016; Koomson and Churchill, 2021) on hunger. On the other hand, we expect cereal production, access to water, and health expenditure to be associated with lower hunger (Smith and Haddad 2015; Mary et al., 2018; Azizi, 2018; WHO, 2019; Mughal and FontanSers, 2020).

4. Methodology and empirical results

The aim of this paper is to investigate the impact of types of corruption on hunger in Africa. For this purpose, we hypothesize that countries with higher Judicial, legislative and executive corruption are associated with a higher level of hunger. Therefore, we investigate the following relationship in Equation (1):

$$Hunger = \text{f}(Corruption,\ X) \qquad (1)$$

Were X represents a set of control variables.

Two empirical strategies are employed to investigate the relationship described in Equation (1). First, as a baseline empirical strategy, we use a pooled OLS to estimate how types of corruption affect hunger, controlling for a number of potential determinants of hunger. Finally, as some variables (corruption indexes) are almost time-invariant, we implement the sequential linear panel data estimator to identify the coefficient of time-invariant regressors (see Kripfganz and Schwarz, 2019).

4.1. Baseline results: OLS estimates

We begin by estimating the following OLS model:

$$Hunger_{it} = \alpha + \beta Corruption_{it} + \gamma X_{it} + \varepsilon_{it} \quad \text{for } i = 1, \dots, N \text{ and } t = 1, \dots, T \qquad (2)$$

Where $Hunger_{it}$ is the level of hunger for country i in period t, $Corruption_{it}$ are the types of corruption considered in this study, X_{it} is a vector which includes a set of control variables, and ε_{it} is the error term. Table 2 reports the estimation results of Equation (2) with the prevalence of undernorishment used as the hunger index (Hunger1). In these estimations, we include a subsets of the contemporaneous determinants

of hunger:the log of per capita GDP, natural ressources, voice and accountability, remittances, and food prices. Columns (1) - (3) in Table 2 present a parsimonious specification in which other controls are excluded; in columns (4)- (6), correspondingcontrols variables are included in the regressions. A positive relationship is apparent in the results ofcolumns (1)- (3)as concerns therelationship between corruption and hunger. Moreover, regardless of the proxy of corruption, this impact is significant at the 1% level. Specifically, the magnitude suggests that a 1-unit increase in corruption leads to anincrease in hunger by 8.710, 1.937, and 0.820 units,respectively, for executive, legislative, and judicial corruption.Additionally the results show that the effect of executive corruption is more detrimental for hunger (+8.710) followed by legislative corruption (+1.937) and judicial corruption (+0.820).Therefore, our results show that the higher up the governmental hierarchy one goes, the more detrimental the effect of corruption is on hunger in Africa. Corruption at the executive level is most detrimental in terms of boosting hunger because compared to the legislature and the judiciary, it is the closest organ of power in the implementation of policies that deliver public commodities that address concerns related to hunger. Accordingly, relative to executive power, the legislature and the judiciary are less directly linked to concerns surrounding the management of funds allocated to the provision of public commodities. This result is consistent with the work of François and Méon (2021),who have shown that the level of corruption increases with the government hierarchy. The authors show that the president of the republic (i.e. the executive) is more corrupt than other levels of government.

In Columns (4) - (6),control variables are introduced. Such an introduction does not affect the sign of the coefficients of corruption proxies, although the slightly smaller magnitude of the coefficients is apparent. However, the results are consistent with those found in columns (1) - (3) that corruption worsens hunger in Africa and that executive corruption is more damaging than other types of corruption. Regarding the control variables, the results show that while per capita GDP, voice and accountability, and remittancesreduce hunger in Africa, natural resources and food prices increase hunger.

Table 2: Baseline OLS

	Dependent variable: Hunger1					
	(1)	(2)	(3)	(4)	(5)	(6)
Executive corruption	8.710***			17.16***		
	(1.940)			(2.197)		
Legislative corruption		1.937***			4.316***	
		(0.451)			(0.549)	
Judicial corruption			0.820*			0.384
			(0.496)			(0.422)
Per capita GDP (ln)				-4.983***	-6.106***	-12.22***
				(0.451)	(0.480)	(1.016)
Natural resources				0.345***	0.424***	0.0429
				(0.0457)	(0.0489)	(0.0283)
Voice accountability				-2.975***	-2.493***	-1.675**
				(0.781)	(0.754)	(0.799)
Remittances				-0.329***	-0.319***	-0.198***
				(0.0744)	(0.0743)	(0.0556)
Food prices				0.123**	0.0728	-0.0152
				(0.0481)	(0.0483)	(0.0180)
Constant	8.922***	19.08***	5.775***	44.65***	66.45***	109.2***
	(1.298)	(0.939)	(1.356)	(3.611)	(3.901)	(8.759)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	798	798	771	624	624	605
Adjusted R2	0.905	0.0214	0.876	0.294	0.295	0.935

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Robust standard errors reported in parenthesis.

4.2.Sequential Linear Panel dynamic estimator

The previous results obtained using the OLS estimator have established a rather robust and statistically significant increasing effect of corruption on hunger in Africa, regardless of the type of corruption. However, the possibility of reverse causality and unobserved heterogeneity (which are some dimensions of endogeneity) may bias the results and limit the relevance of our findings. To deal with these potential problems, the literature has relied on the Generalised Method of Moment (GMM) or the instrumental two stage least squares (IV-2SLS) estimators. However, given the fact that some regressors are time- invariant (types of corruption), these factors can influence the true effect of the types of corruption on hunger. We therefore, follow Kripfganz and Schwarz (2019) by using the Sequential Linear Panel Dynamic Model (SELPDM) to obtain all the coefficients of time-invariant variables. The SELPDM estimates a dynamic Hausman-Taylor model, in which the first stage estimates the coefficients of the time-varying regressors

and the second stage regresses the first-stage residuals on the time-invariant regressors. The SELPDM is most suitable as it avoids perfect collinearity between time-invariant regressors, and the unit-specific dummy variables present in fixed-effects models.

The issue raised by the presence of time-invariant regressors can be simply summarised as follows:

$$y_{it} = x'_{it}\beta + \mathrm{f}'_i\gamma + e_{it} \text{where} e_{it} = \alpha_i + u_{it} \quad (3)$$

Where x_{it} is a $(K_x, 1)$ vector of time-varying regressors in country i and in time t, $\mathrm{f_i}$ is a $(K_f, 1)$vector of time-invariant regressors that incorporate an intercept, and α_i is the unobserved unit-specific impact. This equation assumed that some regressors are correlated with the unobserved unit-specific impact. For the identification purpose, we rewrite Equation (4) as follows:

$$y_i = x'_i\beta + \mathrm{f}'_i\gamma + e_i \text{where} e_i = \alpha_i\iota_T + u_i \quad (4)$$

Where $y_i = (y_{i1}, y_{i2}, \dots, y_{iT})'$, ι_T is a $(T, 1)$ vector of ones. Given the following, two matrices are defined :$W_{yxi} = (X_i)$ the matrix of time-varying regressors where $\theta = \beta'$ are estimated in the first step, and $W_{yxfi} = (W_{yxi}, \mathrm{F}_i)$ is the full regressor matrix.

The results of the SELPDM estimates are reported in Table 3. Panel A in Table 3 presents the results of the first stage estimation, and Panel B displays the results of the second stage estimation. Consistent with the results reported in Table 2, we estimate a strong positive and statistically significant relationship between corruption and hunger, regardless of the types of corruption. Specifically, the magnitude suggest that a 1-unit increase in corruption leads to an increase in hunger by 11.61, 2.366 and 0.0269 units respectively, for executive, legislative, and judicial corruption dynamics (however the coeficient on judicial corruption is non signifcant). Additionally the results show that the effect of executive corruption is more detrimental for hunger (+11.61) followed by legislative corruption (+2.366). Therefore, our results show that the higher the governmental hierarchy, the more detrimental the effect of corruption is on hunger in Africa. As we have clarified earlier, compared to the judicial and legislative powers, the executive power is closest to the implementation of policies that deliver public commodities and by extension, executve coruption has the worst (or highest positive) impact on hunger. This result suggests that corruption, irrespective of type, is bad for hunger in Africa and that executive corruption engenders the worst effect compared to legislative corruption and judicial corruption. These results are in line with a large literature documenting a negative relationship between corruption and macroeconomic performance (Asongu, 2014; Keneck-Massil et al., 2021). Regarding the control variables, we have the expected signs. While per capita GDP, voice and accountability, and remittances are negatively correlated with hunger, natural resources and food prices are positively correlated with hunger.

Table 3: Sequential Linear Panel Dynamic Estimation

	Dependent variable: Hunger 1		
	(1)	(2)	(3)
Panel A : Time-variant/ First stage			
Per capita GDP (ln)	-4.806***	-4.806***	-4.806***
	(0.470)	(0.470)	(0.470)
Natural resources	0.265***	0.265***	0.265***
	(0.0464)	(0.0464)	(0.0464)
Voice accountability	-0.279	-0.279	-0.279
	(0.730)	(0.730)	(0.730)
Remittances	-0.324***	-0.324***	-0.324***
	(0.0775)	(0.0775)	(0.0775)
Food prices	0.108**	0.108**	0.108**
	(0.0501)	(0.0501)	(0.0501)
Panel B : Time-Invariant/ Second stage			
Executive corruption	11.61***		
	(2.117)		
Legislative corruption		2.366***	
		(0.502)	
Judicial corruption			0.0269
			(0.515)
Constant	-4.695***	3.893***	0.362
	(1.049)	(1.026)	(1.008)
Observations	624	624	624
Number of countries	43	43	43

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Kripfganz and Schwarz (2019) corrected standard errors are reported in parenthesis.

4.3 Robustness checks

To test the robustness of our main results, sensitivity analyses are conducted in this sub-section along several dimensions, using: additional control variables, alternative measures of hunger and corruption, alternative subsamples, and estimation strategy. Overall, in all robustness checks, the findings are broadly consistent with those established in Table 3.

4.3.1 Additional control variables

In Table **4**, we estimate our model with five additional control variables, including ethnic fractionalisation, cereal production, water access, health expenditure, and rainfall. We find that the coefficients associated with corruption types are positive and statistically significant ((except for judicial corruption, for which the coefficient is positive but non-significant), meaning that corruption increases hunger in Africa. Regarding the additional control variables, they are in line with the previous empirical studies.

Table 4: Robustness to additional controls

	Dependent variable : Hunger 1		
	(1)	(2)	(3)
Panel A : Time-variant/ First stage			
Baseline controls	Yes	Yes	Yes
Ethnic fractionalisation	7.269**	7.269**	7.269**
	(3.138)	(3.138)	(3.138)
Cereal production	-2.388***	-2.388***	-2.388***
	(0.247)	(0.247)	(0.247)
Water access	-20.16***	-20.16***	-20.16***
	(2.379)	(2.379)	(2.379)
Health expenditure	-1.972***	-1.972***	-1.972***
	(0.531)	(0.531)	(0.531)
Rainfall	0.0105	0.0105	0.0105
	(0.0117)	(0.0117)	(0.0117)
Panel B : Time-Invariant/ Second stage			
Executive corruption	8.737***		
	(2.043)		
Legislative corruption		1.647***	
		(0.475)	
Judicial corruption			0.0426
			(0.491)
Constant	-3.506***	144.9***	144.9***
	(0.985)	(9.101)	(9.101)
Observations	508	508	508
Number of countries	40	40	40

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Kripfganz and Schwarz (2019) corrected standard errors are reported in parenthesis.

4.3.2. Alternative measures of hunger

We now estimate our model using alternative measures of hunger, namely the stunting prevalence rate (Hunger 2) and the corresponding results are reported in Table **5**. From these results, we find once again that the coefficients on corruption types are positive and statistically significant at the conventional level (except for judicial corruption, for which the coefficient is positive but non-significant). This confirms that our hypothesis remains robust to the use of an alternative measure of hunger.

Table 5: Robustness to an alternative measure of hunger

	Dependent variable : Hunger 2		
	(1)	(2)	(3)
Panel A : Time-variant/ First stage			
Per capita GDP (ln)	-6.715***	-6.715***	-6.715***
	(0.731)	(0.731)	(0.731)
Natural resources	0.114*	0.114*	0.114*
	(0.0624)	(0.0624)	(0.0624)
Voice accountability	-1.164	-1.164	-1.164
	(1.025)	(1.025)	(1.025)
Remittances	-0.337***	-0.337***	-0.337***
	(0.116)	(0.116)	(0.116)
Food prices	0.239***	0.239***	0.239***
	(0.0701)	(0.0701)	(0.0701)
Panel B : Time-Invariant/ Second stage			
Executive corruption	6.242**		
	(2.922)		
Legislative corruption		1.953***	
		(0.699)	
Judicial corruption			0.273
			(0.776)
Constant	2.441*	-3.085**	0.479
	(1.403)	(5.360)	(1.593)
Observations	158	158	158
Number of countries	39	39	39

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Kripfganz and Schwarz (2019) corrected standard errors are reported in parenthesis.

4.3.3. Alternative measures of corruption

In this sub section, we use three alternative measures of corruption, namely public corruption and political corruption, from the V-DEM database, and corruption control from the World Bank: World Governance Indicators (WGI). The results of this exercise are reported in Table 6 and broadly corroborate our previous finding that corruption increases hunger in Africa.

Table 6: Robustness to alternative measures of corruption

	Dependent variable: Hunger 1		
	(1)	(2)	(3)
Panel A : Time-variant/ First stage			
Per capita GDP (ln)	-4.806***	-4.806***	-4.806***
	(0.470)	(0.470)	(0.470)
Natural resources	0.265***	0.265***	0.265***
	(0.0464)	(0.0464)	(0.0464)
Voice accountability	-0.279	-0.279	-0.279
	(0.730)	(0.730)	(0.730)
Remittances	-0.324***	-0.324***	-0.324***
	(0.0775)	(0.0775)	(0.0775)
Food prices	0.108**	0.108**	0.108**
	(0.0501)	(0.0501)	(0.0501)
Panel B : Time-Invariant/ Second stage			
Corruption_wgi	2.043**		
	(0.968)		
Public corruption		10.99***	
		(2.401)	
Political corruption			10.84***
			(2.397)
Constant	1.029	52.44***	52.44***
	(0.784)	(1.659)	(3.618)
Observations	624	624	624
Number of countries	43	43	43

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Kripfganz and Schwarz (2019) corrected standard errors are reported in parenthesis.

4.3.3 Alternative subsamples

The OLS and SLDPM results indicate that corruption (of any type) increases hunger in Africa and provide strong evidence to support our main hypothesis. Looking closely at our sample and according to the Global Hunger Index (2017), we observe that of the eight countries with alarming or extremely alarming levels of hunger, seven are in sub-Saharan Africa: Central African Republic, Liberia, Chad, Madagascar, Sudan, Sierra Leone, and Zambia. Moreover, of the 20 most corrupt countries in the world, 12 are African, and of these 12, four are in our sample (Chad, Republic of Congo, Guinea Bissau, and Sudan). One might therefore legitimately suspect that the effect of corruption on hunger is influenced by the level of corruption and hunger in these countries. To ensure that our results are not influenced by these outliers, we remove these countries from our initial sample and re-estimate our baseline model. The results of this exercise are presented in Table 7. We find that all coefficients associated with the corruption variable are positive and statistically significant (except for judicial corruption). These results confirm the detrimental effect of corruption on hunger in Africa.

Table 7: Robustness to outliers

	Dependent variable: Hunger 1					
	Excluding most corrupted countries			Excluding most undernourished countries		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A : Time-variant/ First stage						
Per capita GDP (ln)	-5.175***	-5.175***	-5.175***	-4.284***	-4.284***	-4.284***
	(0.485)	(0.485)	(0.485)	(0.461)	(0.461)	(0.461)
Natural resources	0.120**	0.120**	0.120**	0.166***	0.166***	0.166***
	(0.0563)	(0.0563)	(0.0563)	(0.0479)	(0.0479)	(0.0479)
Voice accountability	-0.273	-0.273	-0.273	-1.441**	-1.441**	-1.441**
	(0.761)	(0.761)	(0.761)	(0.728)	(0.728)	(0.728)
Remittances	-0.320***	-0.320***	-0.320***	-0.350***	-0.350***	-0.350***
	(0.0783)	(0.0783)	(0.0783)	(0.0767)	(0.0767)	(0.0767)
Food prices	0.146***	0.146***	0.146***	0.0576	0.0576	0.0576
	(0.0530)	(0.0530)	(0.0530)	(0.0493)	(0.0493)	(0.0493)
Panel B : Time-Invariant/ Second stage						
Executive corruption	13.49***			7.745***		
	(2.197)			(2.098)		
Legislative corruption		2.723***			2.166***	
		(0.519)			(0.486)	
Judicial corruption			0.0897			0.424
			(0.528)			(0.499)
Constant	-5.710***	55.97***	0.469	-3.107***	48.69***	-0.331
	(1.121)	(3.763)	(3.763)	(1.032)	(3.540)	(0.970)
Observations	587	587	587	573	573	573
Number of countries	40	40	40	39	39	39

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Kripfganz and Schwarz (2019) corrected standard errors are reported in parenthesis.

4.3.4. Robustness to endogeneity

To deal with the endogeneity that might result from reverse causality between the dependent variable and some of the control variables in the first stage of our model, we estimate the following dynamic equation (Equation 5) using conventional identification techniques, namely, the system generalized method of moments developed by Arellano and Bover (1995), and Blundell and Bond (1998).

$$Hunger_{it} = \alpha + \beta_1 Hunger_{it-1} + \beta_2 Corruption_{it} + \beta_3 X_{it} + \mu_i + v_t + \varepsilon_{i,t} \quad (5)$$

Where $Hunger_{it-1}$ is the lagged of hunger for country *i*in period *t*. $\mu_i$are the country's fixed effects that control for unobservable time-invariant and country-specific characteristics, $v_t$is time fixed effects, which account for global business cycles, and $\varepsilon_{i,t}$ is the error term.The results of the estimates are reported in Table 8, and the diagnostic tests show that our model is well specified. We reject the null hypothesis of no first-order residual serial correlation and accept the hypothesis of no second-order serial correlation.

Table 8: Corruption and hunger: system GMM

	Dependent variable: Hunger 1					
	(1)	(2)	(3)	(4)	(5)	(6)
Lag dependent	0.978***	1.010***	1.010***	1.025***	0.975***	0.990***
	(0.00512)	(0.00411)	(0.00446)	(0.0140)	(0.00372)	(0.00350)
Per capita GDP (ln)	-0.0589	-0.449***	-0.335***	-0.638***	-0.0630	-0.111
	(0.0892)	(0.0408)	(0.0718)	(0.217)	(0.118)	(0.0686)
Natural resources	0.0648***	0.00723	0.00107	0.0302**	0.0405***	0.0230***
	(0.00666)	(0.00686)	(0.00788)	(0.0127)	(0.00451)	(0.00712)
Voice accountability	-1.001***	0.943***	-0.0872	-1.471**	-0.918***	-0.631***
	(0.348)	(0.158)	(0.182)	(0.587)	(0.207)	(0.206)
Remittances	-0.000311	-0.116***	-0.138***	-0.120	-0.0276***	-0.0815***
	(0.00932)	(0.0179)	(0.0270)	(0.0844)	(0.00882)	(0.0156)
Food prices	0.0132**	0.000165	0.0113***	0.00646	0.00905***	0.00731*
	(0.00501)	(0.00135)	(0.00300)	(0.00899)	(0.00277)	(0.00383)
Executive corruption	2.671***					
	(0.507)					
Legislative corruption		0.692***				
		(0.131)				
Judicial corruption			0.327***			
			(0.103)			
Corruption_wgi				1.452**		
				(0.573)		
Public corruption					4.582***	
					(1.152)	
Political corruption						1.786***
						(0.607)
Constant	-0.287	-4.820***	-2.858***	-5.593***	3.415**	1.594*
	(0.613)	(0.357)	(0.537)	(2.002)	(1.528)	(0.817)
Observations	620	601	620	620	620	620
Number of countries	42	42	42	42	42	42
AR(1)	0.0004	0.0002	0.0001	0.0002	0.0014	0.0000
AR(2)	0.758	0.819	0.632	0.465	0.539	0.714
Instruments	38	38	31	38	38	38
Hansen OIR	0.529	0.182	0.161	0.254	0.322	0.459

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Robust standard errors are reported in parenthesis. The coefficients are based on the two-step GMM system estimation, using the finite sample correction of Windmeijer (2005). The size of the instrument matrix is reduced (collapsing instruments). All explanatory variables are treated as potentially endogenous. The lags of the explanatory variables are taken as an instrument for the difference equation, while the first differences of the explanatory variables are taken as an instrument for the level equation.

The Hansen test statistic of over-identifying restrictions is insignificant, which suggests that the set of instruments employed fulfills the exogeneity condition required to obtain consistent estimates. Too many instruments can severely weaken and bias Hansen's test of identification restrictions, and therefore, the rule of thumb is that the number of instruments should be less than the number of countries (Roodman, 2009). The results in Table 8 generate a maximum number of instruments (38) which is less

than the number of countries in each specification. Judging from these criteria, the estimated models and corresponding instruments are overwhelmingly valid. Looking at our principal results, the coefficients associated with all the corruption measures are positive and statistically significant at the conventional level, suggesting that corruption, regardless of the type, increases hunger in Africa.

4.4. Further analysis: Can the political distribution of power across social group matter?

Previous results have provided us with evidence that an increase in political corruption (executive, legislative, and judicial) leads to an increase in hunger in Africa. Therefore, any policy aimed at reducing political corruption could lead to a decrease in hunger. In this subsection, we examine the role of the distribution of political power among social groups. Separation of powers and the existence of checks and balances have been empirically demonstrated to be safeguards against government corruption (Alt and Lassen, 2008; de VíteriVázquez and Bjørnskov, 2020). Building on the recent work of Keneck-Massil et al. (2021), we formulate the following interactive model:

$$Hunger_{it} = \alpha + \beta_1 Hunger_{it-1} + \beta_2 Corruption_{it} + \beta_3 PDSG_{it} + \beta_4 Corruption_{it} * PDSG_{it} + \beta_5 X_{it} + \mu_i + v_t + \varepsilon_{i,t} \quad (6)$$

PDSG represents the distribution of political power among social groups and measures, within each country, the political power of social groups organized by caste, ethnicity, language, race, region, religion, or a combination of these. Low values indicate control of political power by a minority of the population, without frequent changes. Conversely, higher values show that social group identities are irrelevant to politics, since they have roughly the same political power. Corruption*PDSG is the interaction term between the types of corruption and PDSG, which allows us to examine the role of PDSG in the corruption-hunger relationship. The other components have the same meaning as before.

The results of the estimations of equation (5) are reported in Table 9, and the corresponding results show, on the one hand, that the coefficients associated with the types of corruption remain positive and statistically significant (except for judicial corruption, where the coefficient remains positive but not significant). On the other hand, the coefficients associated with the interaction variables between the types of corruption and the distributions of political power between social groups are negative and statistically significant. This last result confirms our hypothesis regarding the moderating role of the distribution of political power among social groups in attenuating the positive effects of corruption on hunger. In particular, the difference in hunger across countries is partly attributable to the way political power is distributed across social groups. Countries where political power is not concentrated in the hands of a minority may achieve a better distribution of political power among different social strata, which promotes the existence of checks and balances and a better separation of powers, all of which reduce

political corruption. African countries with little corruption will be able, for example, to make more effective use of the food aid they receive, invest effectively in education and ensure a stable political environment, all of which will increase their food security and reduce hunger. In the first column of Table 9, the net impact from the PDSG in modulating executive corruption to affect hunger is, for example, 11.01 ([-8.193× 0.819] + [17.81]). In this calculation, the average value of the political power distribution is 0.819; the unconditional effect of executive corruption is 17.81, while the conditional impact of the interaction between executive corruption and the political power distribution is -8.193.This computation of net effects is consistent with recent interactive regression literature (Asongu et al., 2017; Tchamyou and Asongu, 2017; Njangang et al., 2021).

Table 9: the role the political distribution of power across social group in corruption –hunger nexus

	Dependent variable : Hunger 1		
	(1)	(1)	(3)
Panel A : Time-variant/ First stage			
Per capita GDP (ln)	-4.806***	-4.892***	-4.806***
	(1.588)	(1.554)	(1.588)
Natural resources	0.265*	0.264*	0.265*
	(0.154)	(0.153)	(0.154)
Voice accountability	-0.279	-0.561	-0.279
	(2.517)	(2.488)	(2.517)
Remittances	-0.324*	-0.319*	-0.324*
	(0.173)	(0.168)	(0.173)
Food prices	0.108	0.119	0.108
	(0.0968)	(0.0931)	(0.0968)
Panel B : Time-Invariant/ Second stage			
Power distributed by social group	-3.179	-0.294	1.130
	(2.687)	(1.577)	(1.253)
Executive corruption	17.81**		
	(7.960)		
Executive corruption×Power distributed by social group	-8.193**		
	(4.108)		
Legislative corruption		5.272**	
		(2.382)	
Legislative corruption×Power distributed by social group		-1.694*	
		(0.987)	
Judicial corruption			2.753
			(2.521)
Judicial corruption×Power distributed by social group			-2.509*
			(1.419)
Constant	-8.677**	3.094	4.166
	(3.504)	(5.053)	(4.041)
Net effects	11.01	3.885	na
Observations	624	605	624

Number of countries	43	43	43

Notes: *, **, *** denote statistical significance at the 10%, 5% and 1% levels respectively. Kripfganz and Schwarz (2019) corrected standard errors are reported in parenthesis.na: not applicable because at least one estimated coefficient needed for the computation of the net effects and/or threshold is not significant.

5. Concluding implication and future research directions

Corruption remains a major challenge to sustainable economic growth, good governance, peace and stability in both developed and developing countries. However, in developing countries, and particularly in Africa, hunger is another big challenge to inclusive economic development. To date, no empirical study has examined the effect of types of corruption on hunger. Using three types of corruption (executive, legislative, and judicial corruption dynamics) and a panel of 45 African countries, this study contributes to the literature on the effects of corruption by examining, as a first attempt, the impact of types of corruption on hunger. We address the weak time-variance of our main regressors by using the most recent sequential linear panel dynamic estimator to examine the effect of corruption on hunger. The results show that countries with higher levels of legislative, judicial, and executive corruption are associated with higher levels of hunger. Moreover, the results show that executive corruption is the most disastrous for hunger in Africa, followed by legislative corruption. This result is robust to all robustness checks conducted, including additional covariates, alternative hunger measures, alternative corruption measures, alternative sub-samples, and alternative estimation strategies. Further analysis provides strong evidence that the distribution of political power across social groups mitigates the effect of corruption on hunger.

The main policy implication from this study is that corruption at the judicial, legislative, and executive levels (especially at the executive and legislative levels) has to be addressed in order to simultaneously address concerns pertaining to hunger and, by extension, food security in Africa. Accordingly, the findings clearly provide an empirical substantiation to policies based on the perspective that for Sustainable Development Goal 2 (SDG2) or zero hunger to be achieved, addressing concerns of corruption at all levels of power is worthwhile. We propose that one strategy to combat corruption is to improve the distribution of political power among social groups.

The results of this study obviously leave room for improvement, especially in assessing the impact of corruption on the other SDGs, particularly in poverty- and energy poverty-stricken regions of the world such as Africa. In addition, the results can also be considered in the context of interactive regressions, particularly when assessing how other policy measures can be used to modulate/mitigate the positive impact of types of corruption on hunger.

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Appendix

Table A1: Correlation matrix of baseline model

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
[1] Hunger 1	1.0000								
[2] Exe_Corup	0.0509	1.0000							
[3] Legis_Corup	0.1733	-0.7075	1.0000						
[4] Judi_Corup	0.0666	-0.6112	0.6854	1.0000					
[5] GDPP	-0.3876	0.1456	-0.2359	-0.3645	1.0000				
[6] NR	0.2691	-0.3667	0.3271	0.4928	-0.0537	1.0000			
[7] VA	-0.2042	0.5247	-0.4849	-0.5032	0.2121	-0.3589	1.0000		
[8] Remit	-0.1406	0.0602	-0.0333	-0.0243	-0.1187	-0.1386	0.0613	1.0000	
[9] Foodpr	0.1361	-0.0808	0.0573	-0.0185	-0.0998	0.0155	-0.0878	-0.0570	1.0000

Hunger 1: prevalence of undernourishment; Exe_Corup: executive corruption; Legis_Corup: legislative corruption; Judi_Corup: judicial corruption; GDPP: per capita GDP; NR: natural resources; VA: voice and accountability; Remit: remittances; Foodpr: food price.

Table A2: List of countries

Algeria	Gambia, The	Niger
Angola	Ghana	Nigeria
Benin	Guinea	Rwanda
Botswana	Guinea-Bissau	Sao Tome and Principe
Burkina Faso	Kenya	Senegal
Cabo Verde	Lesotho	Sierra Leone
Cameroon	Liberia	South Africa
Central African Republic	Madagascar	Sudan
Chad	Malawi	Swaziland
Congo, Rep	Mali	Tanzania
Cote d'Ivoire	Mauritania	Togo
Djibouti	Mauritius	Tunisia
Egypt, Arab Rep	Morocco	Uganda
Ethiopia	Mozambique	Zambia
Gabon	Namibia	Zimbabwe

Table A3: Variables definitions and data sources

Variables	Descriptions	Sources
Prevalence of undernourishment	Prevalence of undernourishment (% of population)	FAO
Prevalence of stunting	Prevalence of stunting, height for age (% of children under 5)	WHO
Executive corruption	The frequency with which members (or agents) of the executive branch grant favors in exchange for any type of incentive (financial, material, or personal), i.e. the frequency with which they divert public funds for personal use.	V-DEM, Version 11.1
Legislative corruption	The extent to which members of the legislature abuse their position for financial gain, including accepting bribes or facilitating government contracts for businesses owned by the legislator (or those close to the legislator)	V-DEM, Version 11.1
Judicial corruption	The frequency with which officers make additional undocumented payments or bribes to expedite or delay court proceedings in order to obtain favorable decisions.	V-DEM, Version 11.1
Corruption control	"Control of corruption (estimate): captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as 'capture' of the state by elites and private interests"	WGI
Public corruption	The extent to which public sector employees grant favors in exchange for bribes, kickbacks, or other material inducements, and the frequency with which they steal, divert public funds, or other government resources for their personal or family use	V-DEM, Version 11.1
Political corruption	The political corruption index is an average of (a) the public sector corruption index; (b) the executive corruption index; (c) the legislative corruption indicator; and (d) the judicial corruption indicator.	V-DEM, Version 11.1
Per capita GDP	GDP per capita (constant 2015 US$)	WDI
Natural resources	Total natural resources rents (% of GDP)	WDI
Voice and accountability	"Voice and accountability (estimate): measures the extent to which a country's citizens can participate in choosing their government and enjoy freedom of expression, freedom of association, and freedom of the media"	WGI
Remittances	Personal remittances, received (% of GDP)	WDI
Food price	The annual change in international prices of a basket of food commodities	FAO
Ethnic fractionalisation	The probability that two randomly selected individuals are from the same ethnic group	Alesina et al. (2003)
Cereal production	Cereal production (metric tons)	WDI
Water access	People using at least basic drinking water services (% of population)	WDI
Domestic credit to private sector	Domestic credit to private sector (% of GDP)	WDI
Rainfall	Precipitation in millimeters per year. Precipitation is defined as any kind of water that falls from clouds as a liquid ora solid.	FAO
Power distribution across social groups (PDSG)	PDSG measures, within each country, the political power of social groups organized by caste, ethnicity, language, race, region, religion, or some combination thereof.	V-DEM, Version 11.1

Notes: FOA: Food Agriculture Organization. WDI: World Development Indicators; WGI: World Governance Indicators; V-DEM: Varieties of Democracy. WHO: World Health Organisation.