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DOES DEMOCRACY PROMOTE FOOD SECURITY IN DEVELOPING COUNTRIES? AN EMPIRICAL ANALYSIS

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Abstract

Using a large sample of developing countries observed over the period 1990-2015, our econometrical estimations largely validate our theoretical assumption that the food situation is better in democratic countries. This result is both robust to estimation methods (OLS-FE, GMM system, IV-GMM, FE IV-GMM) and to different food security indicators (global hunger index, share of undernourished population, poverty incidence, prevalence of underweight in children under five, food availability in kilocalories per day per capita, and children below five mortality rate). Beyond its instrumental value highlighted by Sen, democracy, by promoting good governance, improves food security through its positive effect on the accumulation of agricultural capital and the growth of agricultural productivity.
Keywords: *Food security; Right to food; Democracy; Instrumental variables*
JEL Codes: *C01 ; C26 ; P48 ; Q18*

1. Introduction

Several factors are frequently used in the literature to explain the state of national-level food security. The role of economic performance has been the subject of numerous studies (Pritchett & Summers, 1996; Smith & Haddad, 2000; Wiesmann, 2006). Poor economic performance is a major cause of poverty. The role of economic growth as a factor in reducing poverty is well documented (Ravallion, 1995; Dollar & Kraay, 2002). Poverty influences food security through accessibility. Sustained growth also has a direct impact on food security by promoting agricultural production and therefore food supply (availability). In addition, good economic performance is likely to increase public spending on health and education and thus contribute to improving the health and social environments (Pritchett & Summers, 1996).

The influence of economic performance has often been related to population growth. The impact of population growth on development, food security and poverty is part of an ancient debate that has its roots in the work of Malthus (1798). The Malthusian thesis stipulates that population growth leads to an increase in pressure on agricultural resources, penalizing agricultural yields and food production. Food insecurity then occurs due to an imbalance between the population and productive capacities. The Malthusian thesis, however, has provoked considerable controversy, which has led to a change in its scope. On a theoretical level, the most famous criticism was provided by Boserup (1965). In her view, population growth creates creative pressure by promoting technological progress and productivity growth in the agricultural sector (Boserup, 1965). However, some criticisms are more factual in nature. For example, Birdsall and Sinding (2001) have shown that the effect of population growth, and specifically fertility, on poverty may differ according to the stage of

demographic transition. A high level of fertility before a demographic transition hinders poverty reduction, while a decline in fertility during the transition promotes poverty reduction by opening a window of opportunity. According to Merrick (2002), food security depends more on agricultural and trade policy. However, he admits that population growth can exacerbate the harmful effects of inappropriate policies.

Wealth inequalities affect food insecurity mainly indirectly through their impact on poverty. Indeed, while economic growth is a necessary condition for poverty reduction, it is by no means a sufficient condition because the fruits of growth must be equitably distributed. Many studies have shown that an increase in inequality could greatly attenuate the positive effect of growth on poverty reduction (Bourguignon, 2004; Ravallion, 2005; Easterly, 2007). In other words, because it promotes an increase in poverty, a high degree of inequality reflects the existence of food access constraints for some households.

The role of armed conflicts as determinants of malnutrition has also generated a relatively fertile literature (Messer et al., 1998; Sen, 2000; Messer et al., 2001; Teodosijević, 2003). Conflict seems to have a direct influence on food security by restricting both food availability (collapse of agricultural production) and accessibility (changes in relative prices, development of unemployment, decreased incomes and increased poverty). Conflicts are also the cause of deterioration in the health environment because they restrict the capacity for care (displacement, destruction of family cells and social networks, etc.) and contribute to the destruction of health systems.

There is an extensive literature on the adverse effects of rainfall shocks on household incomes in developing countries, especially the poorest households, which cannot afford to cover climate risks (Zidouemba, 2017). Alderman et al. (2001) describe the negative impact of rainfall shocks on human capital, especially on the schooling of children. They estimate that children affected by the civil war and drought during the 1970s and 1980s in rural Zimbabwe suffer from a 14% loss of income due to malnutrition. De Janvry et al. (2006) also observe a phenomenon of strong persistence of shocks on the schooling of children in Brazil.

Another factor that deserves important consideration is the effect of political will in achieving food security at the national level. The influence of the political context on the food situation is declining at several levels. First, the political context has a direct impact on food security. As Dreze and Sen (1989) and Sen (1999) have observed, there has never been a famine in a country that respects democratic rules. This reflects the view that political and civil rights contribute to the protection of economic and social rights, including the right to food. For Sen (1999), democracy has an important instrumental value in favoring the attention of rulers to the claims of citizens. This instrumental value is expressed at two levels. On the one hand, democratic rules act as incentive mechanisms. In a situation of potential famine, due to the existence of free elections and the possibility of penalties, democratic authorities are obliged to implement preventive policies to protect access to food for the most vulnerable of the population. On the other hand, democracy favors the dissemination of information due to the existence of political opposition and free media. This dissemination of information "plays a major role in prevention policies, for example by reporting on the onset of drought or flooding and the impact of these phenomena on employment" (Sen, 2000, p. 242).

It is by considering the multi-dimensionality of food security and the importance of the links between hunger, development and the welfare of a society that the importance of democracy becomes evident. Borrowing the ideas associated with the perspective of

"democratic peace", Scanlan (2004) demonstrated that authorities in democratic countries are more likely to demonstrate active concern for the well-being of their populations by making appropriate policies and programs that promote economic and social development. Thus, a high priority is given to social welfare through education, medical services, job security, and the satisfaction of the most basic human needs. Moreover, because they are essential to human existence, this approach aims to show that there are human rights that cannot be violated, including the right to food, access to income, and freedom of expression (Galtung, 1969). In other words, democrats, in their quest for "life, liberty and happiness," show more caring for their populations than despots or the authorities of a military regime. Following these ideas, D'Souza (1994) noted that it is not necessarily the democratic philosophy that is central but the processes of and controls on the quality and promises of democracy in making it "a remedy against starvation". Based on the ideas of Sen (1994), D'Souza (1994) underlined that the mechanisms of democratic governance, such as freedom of the press, are essential to ensure the government's responsibility for human suffering and needs. He argued that the absence of democracy, the lack of free media, and the prevalence of draconian censorship resulting in a culture of fear have played exacerbating roles in historical famines in China.

We argue that democratic regimes, by promoting the recognition of political and civil rights, contribute to the protection of economic and social rights, including the right to food. Democracy, the promotion and protection of human rights and fundamental freedoms, including the right to development, and the full participation of women and men are essential factors in achieving sustainable food security. Conversely, the food situation is not a fundamental concern for a dictator; what is important to him is the private interest of power. We therefore postulate in this paper that the food situation in democratic countries should be significantly better than in dictatorship countries.

The remainder of the paper is organized as follow: after describing our empirical strategy (section 2), we present the variables and data used (section 3) and results (section 4) before concluding (section 5).

2. Empirical Strategy

This section is devoted to empirical specification. We present the different econometric models of the relationship between democracy and food security. Two types of models are specified. We start with a simple model (naive approach) without taking into account the bias of endogeneity; then, we address the question of the identification strategy.

2.1. Ordinary Least Squares (OLS)

Our empirical model on the determinants of food security is specified as follow:

$$y_{i,t} = X'_{i,t}\beta + \theta d_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where $y_{i,t}$ is the dependent variable representing food security, i and t are indexes representing country and year, d is our variable of interest (democracy) and $X_{i,t}$ is a vector of control variables.

The ordinary least squares (OLS) applied to equation (1) do not take into account the country-specific effects and hence the heterogeneity between countries. The use of panel data has the advantage of taking into account unobserved heterogeneity and temporal and cross-sectional dimensions and increasing the number of observations, all of which contribute to obtaining more accurate estimates than cross-sections. Thus, taking advantage of the panel structure of our data, we estimate the following model:

$$y_{i,t} = X'_{i,t}\beta + \theta d_{i,t} + u_i + \varepsilon_{it} \qquad (2)$$

where u_i are country-specific effects. There are two ways to take this heterogeneity into account, either by assuming that the specific effects are deterministic in nature and therefore invariant over time (fixed effects model; FEM) or by assuming that they are stochastic, with the underlying assumption that there is no correlation between fixed effects and explanatory variables (Random Effects Model: REM). However, when we apply the Hausman specification test, whose null hypothesis is the absence of correlation between the specific effects and the explanatory variables, our results show that this null hypothesis is rejected since the probability of the test is less than 10%. Therefore, in the remainder of our study, we will estimate our models by controlling for fixed country effects (FEM).

Although the fixed country effects limit the bias induced by invariable non-observables, the disadvantage of non-controlling for variable non-observables remains. It is necessary to solve this problem using another approach. We use instrumental variable methods in the identification of $\hat{\theta}$.

2.2. Identification Strategy

The problem in the OLS estimation of models (1) and (2) is the endogeneity of the democracy variable. There are several reasons that this hypothesis of endogeneity can be advanced: first, it may have an inverse causality of the relationship between democracy and food insecurity. Food insecurity increases social tensions. The latter cost governments the confidence and support of the population. A country that enjoys a high degree of social cohesion can count on a relatively pacifist existence and political stability in which its citizens have confidence and are willing to work together for the common good. Studying the socio-economic determinants of democracy, Kunioka and Woller (1999) have shown that social capital, particularly the degree of citizens' confidence, is an important factor in the development of democracy. They found that social factors are more important in the explanation of democracy than economic factors. Moreover, when people do not have a sufficient daily diet to be healthy and active, it is very difficult for them to find the time and energy needed to have political influence. Second, endogeneity may arise from a bias of omitted variables. Although country fixed effects control for unobservable time-invariant variables, the bias of time-varying omitted variables persists if there are omitted variables that are simultaneously correlated with the dependent variable (food insecurity) and the variable of interest (democracy). Finally, measurement errors on explanatory variables, including subjective measures of democracy, can lead to a mitigation bias in the estimation of the relationship between democracy and food security.

To address the endogeneity problem encountered in the OLS estimates, we use the instrumental variable strategy. The selected instrumental variables should be correlated with

food insecurity indicators only through their impact on democracy or through the other variables for which we have already controlled. Three strategies of instrumental variables are retained in this paper, depending on the availability of instrumental variables.

2.2.1. The GMM-system Estimator

The previous model (2) can be specified as a dynamic panel model in which we control for the lagged value of the food security indicator. Thus, we specify the following dynamic model:

$$y_{i,t} = \rho y_{i,t-1} + X'_{i,t}\beta + \theta d_{i,t} + u_i + \varepsilon_{it} \qquad (3)$$

where the lagged value of the food security indicator is introduced to control for the persistence of the dynamics of food insecurity. Thus, the expected sign of ρ is positive.

A simple estimate of model (3) by OLS leads to a biased estimate of ρ due to the correlation between $y_{i,t-1}$ and u_i. The generalized method of moments (GMM) therefore seems the best way to consistently estimate the parameter ρ as well as the coefficients of predetermined and endogenous variables.

We have several reasons to use the GMM-system estimator in estimating our model: first, the food insecurity process is dynamic. Indeed, malnutrition affects the physical capacity of agricultural workers, which reduces their productivity and agricultural yield, leading to low production and consequently to an increase in the undernourished population in the following period. Then, many of our control variables are likely to be endogenous. The most obvious case is GDP per capita. To the extent that malnutrition reduces productivity (agricultural and non-agricultural), a situation of food insecurity is likely to reduce per capita income. Education is also endogenous. In a situation of food insecurity, the schooling of children becomes less of a priority, school performance is negatively affected, and drop-out rates increase, leading to a sharp reduction in the level of schooling in a country. The endogeneity of the conflict variable is also evident. Food insecurity can result in increased social tensions and insecurity (armed robbery, corruption, banditry, etc.), which can ultimately lead to social conflicts. The variable income inequality is also potentially endogenous. Indeed, some more privileged social groups (food traders) will profit from a situation of famine to become richer (by exorbitantly increasing prices of food products) at the expense of the most disadvantaged population, thus exacerbating the inequalities. Thus, the estimator of the GMM system solves the endogeneity problems of all the endogenous variables under the assumption that the variables lagged in level and in difference are good instruments for the endogenous variables. Finally, the panel structure of our data is well suited to the use of the GMM system. Indeed, as noted by Roodman (2009a, 2009b), the GMM system is adapted to the panel consisting of a relatively limited number of periods T and a sufficiently large sample N. When T is large, there are a multitude of instruments. This can lead to several problems when the sample is finished. On the one hand, since the number of elements in the moment variance matrix increases with T, a finite sample may lack adequate information to estimate such a matrix. On the other hand, Sargan (1958) showed that the error in his test (Sargan test) increases with the number of instruments. Our sample

consists of 111[1] developing countries observed over an eight-year period, which is a structure that is well suited for the GMM system.

This estimator consists of combining for each period the first difference equation with the level equation. In the first difference equation, the variables are instrumented by their lagged level values of at least one period. In contrast, for the level equation, the variables are instrumented by their first differences. The system of equations thus obtained is estimated simultaneously, using the method of generalized moments. Blundell and Bond (1998) tested this method using Monte Carlo simulations and found that the GMM-system estimator is more efficient than the GMM-difference estimator. To test the validity of lagged variables as instruments, Blundell and Bond (1998) suggest the Sargan over-identification test (later replaced by the Hansen test) and the second-order autocorrelation test.

Although the GMM-system estimator is relatively easy to implement – because researchers use internal instruments (lagged values of endogenous variables) – some disadvantages remain. First, lagged values may be weak instruments for endogenous variables if there is a high inertia of the instrumented variables or a weak correlation between the lagged values and the current values of the instrumented variables. Second, if the use of the lagged values of the variables reduces the problem of reverse causality, it does not solve the bias associated with measurement errors since lagged values of variables (especially democracy) are likely to suffer from the same problem. Therefore, we use estimates of instrumental variables (IV) with external instruments instead of internal instruments.

2.2.2. The Two-Stage Least Squares Procedure

Our technique of estimation is the procedure of the two-stage least squares in the following form:

$$d_{i,t} = Z'_{i,t}\,\gamma + X'_{i,t}\,\delta + u_i + v_{i,t} \tag{4}$$

$$y_{i,t} = X'_{i,t}\beta + \theta'\hat{d}_{it} + u_i + \varepsilon_{it} \tag{5}$$

where Z represents a set of instrumental variables and $\hat{d}$ is the predicted value of d estimated in the first-step equation (4). In section 3.3, we discuss the choice of instrumental variables.

3. Data

3.1. Metrics of Food Security

At the international level, food security and malnutrition are assessed by the percentage of the undernourished population, an indicator regularly computed by the Food and Agriculture Organization of the United Nations (FAO). While this measure has served as a reference for the formulation of the MDGs, it cannot account for the multiple faces of food

[1] See appendix C for the list.

insecurity: nutritional deficits, energy loss, apathy, disability, premature mortality, etc. Therefore, it seems relevant to use a composite indicator. This is the approach that the IFPRI has taken to build its Global Hunger Index (GHI). The GHI incorporates four components: (i) the percentage of undernourished people in the population; (ii) the percentage of wasting in children under five; (iii) the percentage of stunting in children under five; and (iv) the under-five mortality rate (Wiesmann, 2006; von Grebmer et al., 2016). The IFPRI has built a database for a few years (1990, 1992, 1996, 2000, 2001, 2008, 2012 and 2015) and more than 150 countries. After excluding the industrialized countries, and given the availability of data for the other explanatory variables, the remaining sample includes 111 developing countries. Nevertheless, throughout the article, we use the proportion of undernourished people in the total population (*Malnut)* in conjunction with the *GHI.* In a section devoted to robustness check, we use four other indicators of food insecurity: the dietary energy supply (*DES)* per day per capita, which is a measure of food availability; the incidence of poverty (*Pov),* which is an economic access measure of food insecurity; child malnutrition, which is the prevalence of underweight in children under five (*Defpond*); and the under-five mortality rate *(Mortinf).*

3.2. Explanatory Variables

We use two measures of democracy in our study. The first measure (*Polreg)* is a dichotomous variable taking the value 1 for countries with a democratic regime (presidential, parliamentary or mixed) and 0 for countries with a dictatorship regime. Data for this variable are taken from Golder (2005) and Bormann and Golder (2013). The second measure *(Polity2)* is a democracy score ranging from 0 for low-democracy countries to 10 for highly democratic countries. The score is obtained by calculating the average value of the following variables: state, political participation, rule of law, stability of democratic institutions and social and political integration.

The state variable measures the legitimacy of the state. It makes it possible to know to what extent the different groups in a society recognize themselves as citizens of the state and recognize the legitimacy of the nation-state. It also measures the existence of basic administrative structures.

The political participation variable determines whether governors are chosen by free and transparent general elections, whether democratically elected leaders have effective governance, whether there is freedom of formation of civil and political groups, and to what extent citizens, organizations and the press have freedom of expression.

The rule of law provides a basis for determining whether there is a separation of power, whether there is an independent judicial system, whether there are legal and political penalties for rulers abusing their positions and whether civil liberties are guaranteed and protected.

The stability of democratic institutions provides information on the extent to which democratic institutions, including judicial and administrative systems, are functional and to what extent democratic institutions are accepted and supported by all stakeholders.

Political and social integration makes it possible to determine whether there is a stable and socially rooted party system to articulate and aggregate societal interests and whether there is a network of cooperative associations or interest groups between society and the

political system. It also gives the level of social organization and the construction of social capital.

This variable (Polity2) was derived from The Economist Intelligence Unit (2016) and Freedom House[2]. The hypothesis tested in this paper is therefore $\hat{\theta} < 0$.

Following the literature on the determinants of food security, we control for the following variables:

GDP per capita (GDPPC) (in PPP dollars at 2010 prices): This variable captures the level of development of each country, and we hope for a negative sign for the coefficient of this variable. It has been extracted from the world development indicators of the World Bank.

Demographic pressure (Density): This variable is taken from the world development indicators of the World Bank. Its expected sign is positive; that is, according to the Malthusian thesis, high demographic pressure reduces the availability of arable land as well as agricultural productivity and consequently is food insecure.

Conflicts location (Conf_Loc): This variable was taken from the Uppsala Conflict Data Program (UCDP) database on armed conflict. It is set to 0 if the country is not a conflict zone, 1 if the conflict is weak and short-lived, 2 if the conflict is weak and long-lasting, and 3 if the conflict is severe and of long duration. According to the theory, a positive sign of the coefficient of this variable is expected: conflicts increase food insecurity.

Income inequality (GINI): Extracted from the world development indicators of the World Bank, this variable is measured by the Gini index. A high GINI value reflects strong income inequality. As argued earlier in the literature review, a positive effect of this variable on food insecurity is expected.

Education (Educ): This variable captures the effect of human capital and is measured by the secondary school enrollment rate. Education has a positive effect on food security through its positive effect on agricultural productivity. There is a general consensus among economists that human capital is a fundamental factor of agricultural productivity. Lio and Liu (2008) have shown a positive and robust effect of secondary education on agricultural production.

Investment (Invest): This variable is measured by the share of fixed capital (GFCF) in GDP. It is extracted from the WDI. We expect a negative sign of the coefficient of this variable; that is, investments, by increasing growth, can reduce food insecurity. We have also shown in the theoretical argument that public investment, particularly investment in agricultural infrastructure, roads, research and development, is favorable to agricultural productivity.

3.3. Instrumental Variables

Colonial heritage

Colonial heritage has been suggested in the literature of political science as an important determinant of democracy. It is measured by the inverse of the number of years of political independence of a country. Thus, the longer it has been since a country achieved

[2] https://freedomhouse.org

independence, the less that country has a colonial heritage and the higher its likelihood of being democratic. In other words, the probability of democracy increases with the time elapsed since political independence. Badawi and Makdisi (2007) found a negative and robust effect of colonial heritage on democracy. This result reflects the idea that colonialism was not "a school of democracy". Indeed, as Mamdani (1997) observed, most colonial regimes, especially in Africa, were Machiavellian dictatorships with no respect for the rules of good governance; the only concern of the foreign minority was to dominate an aboriginal majority. However, there is little chance that colonial heritage (in particular the number of years since independence) will have a direct influence on food insecurity other than through the current level of democracy.

$$Col_legacy_{i,t} = \frac{1}{\text{Number of years of independence}}$$

The legacy of democratic traditions: democracy lagged by one period

As in the case of the GMM system, the lagged value of democracy is probably a good instrument of the current level of democracy. However, beyond this serial correlation, the lagged value of the level of democracy is used in the literature on the determinants of democracy to capture the effect of democratic inheritance on the current democracy. Badawi and Makdisi (2007) showed that the democratic legacy was positively related to the level of democracy and that it takes time to establish democracy in a country.

Ethnic fragmentation

Badawi and Makdisi (2007) have shown an inverse U-shaped relationship between the index of ethnic fragmentation and the level of democracy. This means that when ethnic fragmentation is below a certain threshold (i.e., in more homogeneous societies), democracy and ethnic heterogeneity are positively correlated, whereas above this threshold (that is, in more heterogeneous societies), the relationship becomes negative. This evidence suggests that while everything else is equal, the advent of democracy is less likely in very heterogeneous societies. By exploiting the fact that social heterogeneity is a natural experience, we can stipulate the exogeneity of our instrument. The reader may well think that ethnic fragmentation can affect food security through its effect on the level of development highlighted by Easterly and Levine (1997). However, in all regressions, we will have to control for the level of development (GDP per capita), thereby eliminating this potential channel of endogeneity. This ethnic heterogeneity variable (*Eth_Frag*) is calculated as follows:

$$Eth_frag_j = 1 - \sum_{i=1}^{N} S_{i,j}$$

where $S_{i,j}$ is the share of ethnic group i ($i = 1, N$) in country j. This index gives the probability that two randomly selected individuals in a population belong to two different groups. A negative sign of the coefficient of this variable in the first-step equation is expected.

Dummy variable "Arab country"

There is a broad consensus in the literature on democracy that Arab countries are in a "deficit" of democracy (El-Mikawy et al., 2002). Hence, being an Arab country decreases the probability of being democratic. We therefore use a dichotomous variable taking the value 1 for the Arab countries in our sample and 0 for the non-Arab countries. Since this variable is a natural experiment, the expected sign of the coefficient of this variable in the first-step equation (4) is negative.

Appendix A provides a more detailed overview of these indicators and their respective original sources. Most of the chosen metrics have been featured in previous studies. In the next section, we discuss the results of the estimates of the econometric models specified above.

4. Results

4.1. Ordinary Least Squares Results

The results of the OLS estimation are presented in Table 1. There are two dependent variables, *GHI* and the proportion of undernourished people in the population *(Malnut)*, and two democracy variables *(Polreg* and *Polity2)*. Using OLS with country fixed effects, the results suggest that the impact of democracy on food security is positive and significant at least at 5%, regardless of the food security indicator used. This result seems to be in line with our basic assumption that democratic countries have better food security than dictatorship countries. Our control variables also show the expected signs and are for the most part statistically significant. Thus, conflicts and inequalities have negative and significant effects on food security, while per capita income, education, and public investment have a positive and significant impact on food security. More precisely, conflicts and income inequalities increase the proportion of the undernourished population, while an increase in per capita income, a high level of education and high public investment decrease the prevalence of undernourishment. However, these preliminary results do not support the Malthusian thesis that population pressure is a source of famine since the effect of the variable *Density* is not significantly different from zero. These results should, however, be interpreted with caution for the reasons of endogeneity raised in the previous section.

4.2. GMM-system Results

Here, we consider that democracy is endogenous and is therefore instrumented by its second-order delay. The results are shown in Table 2. We note that all tests designed to assess the validity of the GMM-system procedure are satisfactory. The consistency of the Arellano-Bond estimator is based on two assumptions: (i) the absence of second-order autocorrelation of the residuals and (ii) the validity of the selected instruments. To test the compliance of these two hypotheses, we report the Arellano-Bond second-order autocorrelation tests and the Sargan/Hansen overidentification test testing the validity of the instruments. Thus, the p-value of the Arellano-Bond test does not allow us to reject the null hypothesis of no second-order autocorrelation of the residuals. Additionally, the Hansen test

allows us to validate the null hypothesis of validity of instruments. Notably, there is also a strong inertia in the dynamics of food insecurity since the coefficients of the lagged variables are significant and positive, suggesting a vicious circle of food insecurity. Most control variables are significant and have the expected sign. However, the GINI variable that was significant in the OLS estimate is no longer valid when switching to the GMM system. The results of Table 2 also support our hypothesis that democratic regimes improve food security. Democratic countries have a GHI that is lower by 8.4 percentage points than that of dictatorship countries (column 1). An increase in the democracy score (Polity2) by one point makes it possible to reduce the GHI by 1.6 points (column 2). In columns 3 and 4, we find effects similar to those shown in columns 1 and 2. Moving from a dictatorship to a democratic regime decreases the proportion of the undernourished population by 8%, while an improvement in the democracy score reduces this proportion by 2%.

Table 1. Results of OLS Estimates with Country-Specific Effects

Variables	(1) GHI	(2) GHI	(3) Malnut	(4) Malnut
Polreg	-3.23*** (-11.14)		-0.0216** (-2.010)	
Polity2		-0.0481*** (-7.912)		-0.00832** (-2.288)
Conf_loc	0.071*** (2.626)	0.0521*** (3.078)	0.030*** (3.457)	0.042*** (3.161)
GDPPC	-0.0980** (-2.053)	-0.151*** (-2.726)	-0.101*** (-2.946)	-0.117* (-1.806)
Educ	-0.196*** (-4.092)	-0.173*** (-3.056)	-0.134** (-2.232)	-0.118*** (-3.082)
GINI	0.117*** (3.097)	0.158*** (3.525)	0.131 (1.503)	0.154* (1.770)
Invest	-0.139** (-2.456)	-0.216*** (-3.190)	-0.450*** (-3.504)	-0.493*** (-3.796)
Density	-0.0129 (-0.901)	-0.0226 (-1.347)	-0.00430 (-0.132)	-0.00428 (-0.133)
Constant	42.26*** (13.58)	46.89*** (12.93)	38.19*** (5.392)	40.18*** (5.733)
R^2	0.73	0.63	0.53	0.54
F test of fixed effects	7,41***	6,52***	5,19***	5,38***

Note : In brackets, the value of the student t corrected for heteroscedasticity. * Significant at 10%, ** Significant at 5%, *** Significant at 1%. The dependent variable in the first two regression is the Global Hunger Index. In columns (3) and (4) the dependent variable is the percentage of the population undernourished. Fixed country effects are included in the model.

Table 2. Results of two-step GMM System Estimation

Variables	(1) GHI	(2) GHI	(3) Malnut	(4) Malnut
GHI(-1)	0.085*** (2.719)	0.0318*** (3.393)		
Malnut(-1)			0.382** (2.420)	0.362*** (3.399)
Polreg	-8.37*** (-4.748)		-0.0795*** (-4.626)	
Polity2		-1.611*** (-5.266)		-0.0196*** (-3.317)
Conf_Loc	1.187** (2.429)	0.903*** (2.965)	0.177*** (3.110)	-0.826** (-2.333)
Density	0.012*** (2.713)	0.0128*** (3.190)	0.0162* (1.933)	0.0140** (2.420)
GDPPC	-0.156** (-2.213)	-0.159** (-2.570)	-0.275*** (-2.712)	-0.256*** (-2.942)
Educ	-0.16*** (-2.939)	-0.0953*** (-2.649)	-0.196** (-2.059)	-0.151* (-1.937)
GINI	0.0946 (0.854)	0.175 (1.570)	0.176 (0.915)	0.190 (0.839)
Invest	-0.255* (-1.691)	-0.316** (-2.474)	-0.656** (-2.281)	-0.626** (-2.389)
Constant	41.64*** (5.998)	39.50*** (4.878)	15.98 (0.884)	20.09 (1.341)
Hansen (P-Val) AR(2) (P-Val)	0,15 0.244	0,20 0.239	0,23 0.825	0,22 0.822

Note : In brackets, the value of the student t corrected for heteroscedasticity. * Significant at 10%, ** Significant at 5%, *** Significant at 1%. AR (2): probability of the second order autocorrelation test of Arellano and Bond. REGPOL, POLITY, GDPPC, EDUC are supposed to be endogenous. DENSITY, GINI, INVEST, CONF_LOC are assumed predetermined.

Although these results seem interesting and robust, it is clear that the use of "ready" instruments provided by the GMM system may nevertheless suffer from the problem of weak instruments. Moreover, as noted above, problems of measurement errors are not solved with the GMM-system estimator. The following section discusses the results obtained using external instruments.

4.3. The Two-stage Least Squares Results

Table 3 presents the first-stage estimates (columns 1 and 2) as well as estimates of the structural models. Columns 1 and 2 show that the external instruments are significant and have the expected signs. Thus, the coefficient of the ethnic fragmentation variable is positive and its square is negative, which corroborates the idea of Badawi and Makdisi (2007) of an

inverse U-shaped relationship between ethnic fragmentation and democracy. The coefficient of the variable Arab_count is also negative, again confirming the conclusion of Badawi and Makdisi (2007). Notably, the F-tests of our instrumentation equations are 45.65 and 65.79 for Polreg and Polity2, respectively. Thus, for a threshold of 9.08, we can stipulate the force of our instruments. In addition, the Shea R2 of the Polreg and Polity2 instrumentation equations is relatively high (0.292 and 0.380, respectively). For a conventional critical threshold of 20%, below which instruments are classified as weak, we conclude in favor of the relevance of our instruments. The hypothesis of exogeneity of the instruments is also illustrated by the p-value of the Hansen test. Let us first recall that the validity of this test is conditional to the relevance of at least one of our instruments; otherwise, the test would not be powerful enough to detect a possible correlation of the instruments with the residuals. According to our results, we can perform this test, since together, the three instruments significantly explain democracy. In all our estimates using the instrumental variable method, we cannot reject the null hypothesis of the absence of correlation between instruments and random deviations. Indeed, the probability in favor of this null hypothesis must be greater than 10%, which is true in our regression tables. Therefore, we conclude that our instruments satisfy the condition of orthogonality with respect to the random deviations.

The results suggest that the impact of democracy on food security is always positive and statistically significant. However, it appears that the effect of democracy on food security is slightly lower than that found in the GMM-system estimate. The control variables present the expected signs. Only GDP per capita and education are highly significant in all four regressions.

The use of time-invariant instruments does not allow controlling for all the invariant characteristics specific to each country through the introduction of fixed country effects. The literature on the colonial determinants of democracy provides us with a relevant instrument, namely, colonial heritage. As defined above, colonial heritage is the inverse of the number of years of independence. Badawi and Makdisi (2007) found a negative and robust relationship between colonial heritage and the level of democracy in a country. It means that a country with a large number of years of independence (and thus a weak colonial heritage) has a high probability of being democratic. On the other hand, considering the level of democracy lagged by a period as the legacy of democratic traditions, the same authors show a positive effect of democratic traditions on the current level of democracy. There would therefore be a virtuous spiral that makes democracy self-sustaining over time.

Table 4 presents the results of the first-stage estimates and those of the structural models. Based on the empirical results, it appears that the external instruments selected for causal identification are statistically significant, and this significance is supported by the high F-test values (greater than 9.08) and Shea R2 values (greater than 20%) of the endogenous variables in the first-step equations. Furthermore, the validity of the exclusion restrictions adopted is confirmed by the results of the Hansen overidentification test of each model.

In terms of control variables, per capita income, conflict, demographic pressure, education and investment have the expected signs and are significant at the usual thresholds. The most important results are the statistical and economic significance of the coefficients of the democratic variables. While the statistical effect remained robust to the new specification, the economic effect is greater than that found for the OLS-FE and the GMM system. This is not surprising because the identification strategy used here uses more precise

instruments than in the case of the GMM system. Thus, if we review the results in columns 3 and 5, we observe that a shift from a dictatorship to a democratic regime reduces the *GHI* by 9.3 percentage points and the share of the undernourished population by 7 percentage points. The results from columns 4 and 6 indicate that an increase in the democracy score by one point would reduce the *GHI* by 2.3 points and the proportion of the undernourished population by 3.6 percentage points.

Table 3. Results of Instrumental Variable Estimates (IV-GMM)

Variables	(1) Polreg	(2) Polity2	(3) GHI	(4) GHI	(5) Malnut	(6) Malnut
Polreg			-7.51*** (-3.652)		-0.053** (-2.325)	
Polity2				-1.235** (-2.138)		-0.0158* (-1.671)
Density	0.00108*** (4.033)	0.00509*** (4.146)	0.0127*** (2.826)	0.00706 (1.573)	0.0166* (1.818)	0.0101 (1.237)
GDPPC	0.081*** (2.909	0.0252*** (2.725)	-0.024*** (-8.511)	-0.025*** (-7.530)	-0.040*** (-7.199)	-0.039*** (-6.913)
Educ	0.00493** (2.509)	0.0329*** (3.587)	-0.089*** (-2.964)	-0.108*** (-3.197)	-0.077*** (-3.232)	-0.052*** (-3.842)
GINI	0.00905 (0.286)	0.0275 (1.444)	0.153** (2.340)	0.0823 (1.237)	0.333** (2.544)	0.258** (2.144)
Invest	-0.0116 (-1.395)	-0.0336 (-1.522)	-0.182** (-2.399)	-0.0975 (-1.269)	-0.678*** (-4.293)	-0.572*** (-4.040)
Arab_count	-0.0930* (-1.709)	-1.226** (-1.983)				
Eth_frag	1.518** (2.495)	8.066*** (2.820)				
Eth_gragsq	-1.505** (-2.352)	-7.161** (-2.402)				
Constant	-0.500* (-1.930)	-0.0486 (-0.0380)	37.83*** (13.23)	42.54*** (14.49)	33.48*** (5.784)	39.03*** (7.244)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Shea R2	0.292	0.380				
F-test	45,65	65,79				
Hansen (P-Val)			0.401	0,807	0,365	0,432

Notes : In brackets, the value of the student t corrected for heteroscedasticity. * Significant at 10%, ** Significant at 5%, *** Significant at 1%. The GMM estimator is preferred to the two-stage least square for estimating the parameters of our model. The external instruments used are invariant in time: dummy arab country, ethnic fragmentation and its square.

Table 4. Results of Estimates in Instrumental Variables (FE IV-GMM)

Variables	(1) Polreg	(2)Polity2	(3) GHI	(4) GHI	(5) Malnut	(6) Malnut
Polreg			-9.27*** (-3.975)		-0.070*** (-2.742)	
Polity2				-2.277*** (-3.416)		-0.0357** (-2.531)
Conf_Loc	-0.0416 (-0.638)	-0.610** (-2.545)	1.243*** (3.135)	0.540*** (3.361)	0.574*** (4.242)	2.074*** (4.691)
Density	0.00109*** (3.120)	0.00123 (0.992)	0.0262*** (3.027)	0.0212** (2.229)	0.0508*** (2.707)	0.0431** (2.261)
GDPPC	0.030** (2.483	0.108*** (3.030	-0.197*** (-4.119)	-0.128*** (-2.828)	-0.032*** (-3.046)	-0.0213** (-2.521)
Educ	0.0463*** (3.145)	0.0494** (2.412)	-0.0670* (-1.726)	-0.0877** (-2.296)	-0.104*** (-2.874)	-0.0724** (-2.534)
Gini	0.0154* (1.824)	0.00871 (0.320)	0.388** (2.133)	0.285 (1.392)	0.929** (2.357)	0.772* (1.879)
Invest	-0.00860 (-1.089)	0.0146 (0.527)	-0.326** (-2.190)	-0.00614 (-0.0366)	-0.921*** (-2.857)	-0.444 (-1.319)
Col_legacy	-0.26*** (-3.053)	-0.11*** (-3.013)				
Polreg(-1)	0.150** (2.234)					
Polity2(-1)		0.340*** (4.010)				
Constant	0.0545 (0.118)	4.452*** (2.671)	29.20*** (3.818)	42.09*** (5.075	9.302 (0.561)	28.58* (1.718)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Shea R2	0.475	0.485				
F-test :	27,34	16,22				
Hansen (P-Value)			0,192	0,201	0,343	0,374

Note : In brackets, the value of the student t corrected for heteroscedasticity. * Significant at 10%, ** Significant at 5%, *** Significant at 1%. The GMM estimator is preferred to the two-stage least squares for estimating the parameters of our model. The external instruments used vary over time: colonial heritage (col_legacy) and lagged democracy variables of two periods (polreg (-2) and Polity2 (-2)).

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Table 5. Robustness to food security indicators (IV-GMM FE)

Variables	(1) Polreg	(2) Pov	(3) Pov	(4) DES	(5) DES	(6) Defpond	(7) Defpond	(8) Mortinf	(9) Mortinf
Conf_Loc	-0.0743 (-0.939)	-1.886 (-1.055)	-1.709 (-0.882)	-27.87 (-1.287)	-23.19 (-1.012)	4.331*** (6.113)	4.289*** (6.097)	-1.015 (-0.299)	-1.971 (-0.607)
Density	0.000952** (2.269)	0.0261 (1.507)	0.0226 (1.398)	-0.147 (-1.109)	-0.0595 (-0.396)	0.0292*** (4.453)	0.0305*** (4.869)	-0.0559** (-2.453)	-0.0553** (-2.511)
GDPPC	0.33*** (2.692)	-0.00713*** (-7.056)	-0.00720*** (-7.242)	0.146*** (10.09)	0.158*** (9.180)	-0.00261*** (-5.258)	-0.00259*** (-5.276)	-0.0128*** (-6.081)	-0.0129*** (-6.257)
Educ	0.00267 (0.691)	-0.0288** (-2.236)	-0.00352** (-2.318)	-3.177*** (-2.662)	-3.237*** (-2.576)	-0.191*** (-4.077)	-0.182*** (-4.164)	-1.341*** (-6.829)	-1.296*** (-7.055)
GINI	0.0115 (1.119)	1.099*** (3.682)	1.099*** (3.373)	-7.183*** (-2.985)	-6.190** (-2.337)	0.109** (2.379)	0.120** (2.276)	0.895** (2.354)	0.852** (2.270)
Invest	-0.00628 (-0.659)	-0.385*** (-4.447)	-0.306*** (-3.291)	13.28*** (4.931)	12.66*** (4.336)	-0.0771*** (-2.688)	-0.0632** (-2.524)	-0.0796*** (-5.178)	-0.0652*** (-3.149)
Col_legacy	-0.071*** (-2.782)								
Polreg(-1)	0.0458*** (5.260)								
Polreg		-0.034*** (-3.549)	-0.048** (-2.280)	18.88 (1.249)	55.55** (2.072)	-0.06*** (-2.849)	-0.0859** (-2.534)	-.0145* (-1.834)	-0.0307** (-2.344)
Constant	0.306 (0.514)	8.131 (0.513)	9.846 (0.622)	2,303*** (19.34)	2,405*** (16.97)	29.07*** (6.851)	28.54*** (6.964)	221.9*** (11.60)	213.0*** (10.60)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2 de Shea F-test	0.484 30,32								

Note : In brackets, the value of the student t corrected for heteroscedasticity. * Significant at 10%, ** Significant at 5%, *** Significant at 1%. The GMM estimator is preferred to the DMC for estimating the parameters of our model. The external instruments used vary over time: colonial heritage (COL_LEGACY) and lagged democracy variables of two periods (POLREG (-2) and POLITY2 (-2)).

4.4. Robustness

For a robustness check, we estimate the model by instrumental variables (GMM option) with country fixed effects. The results are presented in Table 5. We used in this regression a single variable of democracy (Polreg). The first column presents the results of the instrumentation equation. The instruments are all significant, and the Shea F-test and R2 values are above the critical thresholds of 9.08 and 20%, respectively, which validates the strength of our instruments. These results are interesting because our variable of interest (Polreg) is significant at the thresholds of at least 10% except in column 4. The signs are also those expected. Democratic countries have a low incidence of poverty (POV), a low prevalence of underweight in children under five (Defpond), a low mortality rate among children under five (Mortinf) and greater food availability (DES). In particular, democracy reduces by 3 to 5 percentage points the proportion of people living with less than $1 a day, by 6 to 8 percentage points the prevalence of underweight in children under five, and by 1 to 3 percentage points the under-five mortality rate and increases food availability from 18 to 55 kcal per day per capita. These results broadly support our theoretical assumption that democracy actually promotes food security.

5. Conclusion

Achieving food security is one of the fundamental objectives of the international community. This implies a good understanding of the conditions for achieving this objective. While natural and man-made disasters (wars) are largely responsible for food insecurity, improving food security is also a matter of political will. In this study, we looked at this latter aspect by assuming that the form of the political regime has an influence on the food security of a country. In particular, democratic regimes is more favorable to food security than dictatorship ones. Using a large sample of developing countries observed over the period 1990-2015, our estimates of OLS and instrumental variables have validated fairly broadly our theoretical assumption that food security is better in democratic countries. This result is both robust to estimation methods (OLS-FE, GMM system, IV-GMM, FE IV-GMM) and various food safety indicators. In terms of economic policy implications of, a more sustained process of democratization is needed in developing countries, not only so that democratically elected governments become aware of their political and economic responsibility to the population but also to create an friendly agricultural productivity environment. In the absence of a strong political will, the multiplication of international food conferences and the multiplicity of strategic objectives to reduce food insecurity will inevitably lead to failure.

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Appendix A. Data Sources and Description

Variable	definition	sources
GDPPC	GDP per capita (log) converted to international dollars using purchasing power parity rates. Data are in constant 2010 international dollars.	World Bank (2017)
GINI	Gini index measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution. A Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality.	
Educ	Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more skill-oriented instruction using more specialized teachers.	
Invest	Share of gross fixed capital formation in GDP	
Density	Density of population: number of inhabitants per square kilometer	
Pov	Percentage of people living on less than $ 1 a day	
GHI	GHI scores are calculated using a three-step process. First, values for each of the four component indicators are determined from the available data for each country. The four indicators are undernourishment, child wasting, child stunting, and child mortality. Second, each of the four component indicators is given a standardized score. Third, standardized scores are aggregated to calculate the GHI score for each country. This calculation results in GHI scores on a 100-point scale, where 0 is the best score (no hunger) and 100 is the worst.	Wiesmann (2006) von Grebmer et al. (2016)
Malnut	Proportion of the undernourished population in the total population (%)	
Mortinf	Under-five mortality rate (%)	
Defpond	Prevalence of underweight in children under 5 (%)	
Arab_Count	Dummy taking the value 1 for Arab countries	Badawi and Makdisi (2007)
Eth_Frac	Index of ethnic fragmentation	Alesina et al. (2003)
Col_Legacy	Colonial heritage: inverse of the number of years of independence	Badawi and Makdisi (2007)

Polreg	Dummy taking value 1 for countries with a democratic regime	Golder (2005) Bormann and Golder (2013).
Polity2	score of democracy ranging from 0 (dictatorship) to 10 (perfect democracy)	https://freedomhouse.org/ The Economist Intelligence Unit (2016)
Conf_Loc	Conflict location area	Uppsala Conflict Data Program (http://www.ucdp.uu.se)

Appendix B. Summary statistics, by Variable

Variable	Mean	Std. Dev.	Min	Max
GHI	18.8616	10.88632	1.81	57.17
Malnut	23.62617	17.05524	0	74.7
Defpond	21.92525	13.78501	.7	70.1
Mortinf	110.0896	78.26766	5	330
GDPPC	3580.646	3355.618	491.1215	23661.82
Pov	19.57739	19.36432	2	77.88
Invest	21.39149	8.880198	2.420605	65.4332
DES	2401.27	428.6611	1500	3510
Educ	61.10573	27.54325	2.896945	99.23255
GINI	44.92985	8.874118	28.27	74.33
Conf_Loc	.5714286	1.028211	0	3
Polreg	.2918149	.4554087	0	1
Col_Legacy	.0311664	.0940377	-1	1
Arab_Count	.1118881	.3155047	0	1
Polity2	5.043291	3.257135	0	10

Appendix C. List of Countries in the Sample

1	Afghanistan	29	Djibouti	57	Lao	85	Saudi Arabia
2	Algeria	30	Dominican Rep	58	Lebanon	86	Senegal
3	Angola	31	Ecuador	59	Lesotho	87	Sierra Leone
4	Argentina	32	Egypt	60	Liberia	88	Somalia
5	Armenia	33	El Salvador	61	Libya	89	South Africa
6	Azerbaijan	34	Eritrea	62	Madagascar	90	Sri Lanka

7	Bangladesh	35	Ethiopia	63	Malawi	91	Sudan
8	Benin	36	Gabon	64	Malaysia	92	Suriname
9	Bhutan	37	Gambia	65	Mali	93	Swaziland
10	Bolivia	38	Georgia	66	Mauritania	94	Syrian Arab Rep
11	Bostwana	39	Ghana	67	Mauritius	95	Tajikistan
12	Brazil	40	Guatemala	68	Mexico	96	Tanzania
13	Burkina Faso	41	Guinea	69	Moldavia	97	Thailand
14	Burundi	42	Guinea-Bissau	70	Mongolia	98	Timor
15	Cambodia	43	Guyana	71	Morocco	99	Togo
16	Cameroon	44	Haiti	72	Mozambique	100	Trinidad an Tobago
17	Centrafric Rep	45	Honduras	73	Myanmar	101	Tunisia
18	Chad	46	India	74	Namibia	102	Turkey
19	Chile	47	Indonesia	75	Nepal	103	Turkmenistan
20	China	48	Iran	76	Nicaragua	104	Uganda
21	Colombia	49	Iraq	77	Niger	105	Uruguay
22	Comoros	50	Jamaica	78	Nigeria	106	Uzbekistan
23	Congo Rep	51	Jordan	79	Pakistan	107	Venezuela
24	Congo Rep Dem	52	Kazakhstan	80	Panama	108	Vietnam
25	Costa Rica	53	Kenya	81	Paraguay	109	Yemen Rep
26	Cote d'Ivoire	54	Korea,	82	Peru	110	Zambia
27	country	55	Kuwait	83	Philippines	111	Zimbabwe
28	Cuba	56	Kyrgyz Rep	84	Rwanda		