

Public Investment in Rural Infrastructure

Some Political Economy Considerations

Moussa P. Blimpo
University of Oklahoma
moussa.blimpo@ou.edu

Robin Harding
New York University
robin.harding@nyu.edu

Leonard Wantchekon
Princeton University
lwantche@princeton.edu

August 2012¹

¹This background paper has been prepared for the UNDP's first African Human Development Report. We are grateful to Martin Heger and Marshall Burke for assistance with data. We would also like to thank Ricardo Fuentes and an anonymous reviewer for comments on an earlier draft. Thanks to the participants at the 36th plenary session of the African Economic Research Consortium's (AERC) Biannual Research Workshop in Arusha, Tanzania. Any mistakes are our own.

Abstract

We have constructed a unique dataset to study the extent of the relationship between political marginalization, public investment in transport infrastructure, and food security in Benin, Ghana, Mali, and Senegal. We first show a strong relation between food security and road infrastructures after controlling for other factors known to affect food security, including climate and land productivity. In order to trace a potential mechanism by which political marginalization impacts upon food security, we then look at its relation with the allocation of roads within countries. We find support for the argument that political factors affect the location of roads after controlling for the economic importance of the areas, as well as many other factors. This finding is robust to a number of alternative specifications. We conclude that politically marginalized areas have significantly fewer roads, thus supporting our claim that political marginalization indirectly affects food security, by undermining the quality and the allocation of transport infrastructures. Although we do not establish a causal effect here, this study is the first to empirically substantiate this relationship at the micro-level.

1. Introduction

According to Amartya Sen, political freedom has been one of the most effective remedies against famines. Yet there is evidence to suggest that democratic reforms have failed to prevent severe forms of food shortage and malnutrition in a wide range of countries, especially in Africa. Indeed, there is little indication of a correlation between the level of democracy and food security in Africa. For example, the food crisis in Niger in 2005-06 occurred at a time when that country was widely regarded as democratic, and the 2010 Sahel famine likewise affected democratic Mali and Nigeria, amongst others. Voting and political participation therefore seem to have scant relevance for the prevention of food crises. One potential cause of this may be the political marginalization of vulnerable voters; politicians and policy-makers ignore certain groups of citizens because they have little weight in determining political outcomes. Therefore in this paper we consider the possible impact of political marginalization on food security.

However, although marginalization may be linked to food security, this link may not be direct. Even if policy-makers focus their efforts away from marginal voters, this may not affect policies designed to reduce malnutrition directly, because if political effort in these policy areas is not visible then its electoral benefits will be limited. Instead, there may be an indirect effect whereby political action in more visible areas, like transport infrastructure, has implications for food security. It is widely accepted that investment in roads has a major impact on the development and maintenance of safe and reliable food supplies. Therefore we suggest that a possible mechanism linking political marginalization to food security may be that marginalization affects the distribution of investment in roads, which are crucial for food supplies. The data we present in this paper indicates that some of the most politically marginalized areas also contain fewer roads and suffer more food insecurity. These include well-known areas such as Timbuktu in northern Mali or Casamance in southern Senegal.

We investigate the validity of this mechanism in four West African countries. More specifically, we study the relationship between political marginalization, public investment in transport infrastructure, and food security in Benin, Ghana, Mali and Senegal, in order to trace the potential relationship between political marginalization and food security. First we investigate the determinants of food insecurity. Using data on stunted children, we show that the density of roads per square kilometer has a significant negative relationship to food insecurity. Moreover, this relationship holds when we control for other factors known to affect food security, including climate and land productivity. Following this, we then look at the factors that determine the presence of roads. Specifically, we find that politically marginalized areas have significantly fewer roads, even after controlling for the economic importance of the areas, and many other factors. These findings support our

claim that political marginalization indirectly affects food security, via its impact on the quality of transport infrastructure.

In the following section we discuss existing literature on the political economy of human development, in particular with regards to health and longevity. We then outline our argument for the indirect effect of political marginalization on food security in greater detail. In Section 3 we discuss our empirical strategy, describing the data that we use, and how we use it. We present the results in Section 4, and in Section 5 we conclude.

2. Literature and motivation

Although studies of human development have focused predominantly on income as a measure of welfare, this is only one dimension of the concept. Conceived more broadly, there are three essential elements of human life - longevity, knowledge, and decent living standards. With this in mind, it is clear that food security - or the condition where all people at all times have access to sufficient, safe, and nutritious food to maintain a healthy and active life - is a crucial aspect of human development. Where food security is threatened, not only do individuals' living standards fall, but also their life expectancy is reduced. This issue has been reprioritized within the global development debate in recent years, as rising food prices and the global economic downturn have reversed the steady reduction in the proportion of developing countries' populations who are undernourished. In this paper we offer some political economy considerations of this issue, by investigating a potential mechanism linking political marginalization with food security. As such, this research contributes to a broader literature on the impact of political institutions on health and longevity. In this section we present a brief review of this literature, before developing an argument about the impact of political marginalization on food security.

2.1 The political economy of human development: health and longevity

A number of studies have considered the relationship between political institutions and longevity, with the vast weight of evidence suggesting a positive impact of democracy. The United Nations Development Program's human development index incorporates data on life expectancy at birth as a measure of longevity, and a number of studies have used this indicator to show a positive effect of democracy (Lake and Baum 2001, Besley and Kudamatsu 2006, Tsai 2006, Vollmer and Ziegler 2009). For the most part these studies have taken a fairly straightforward approach to demonstrating the existence of a positive relationship between a country's political institutions and the average life expectancy of its citizens, although some do a better job than others of controlling for time trends and unobserved country-specific factors.

Democracy has also been shown to have a positive effect on other indicators of health – for example, compared to dictatorships democracies have lower mortality rates, and fewer women die in childbirth (Przeworski 2004). In addition, another popular health

indicator is infant mortality, which has been found to be significantly lower in democracies (Zweifel and Navia 2000, Shandra et al. 2004, Siegle, Weinstein and Halperin. 2004). Indeed, Lake and Baum (2001) find that a full transition to democracy reduces infant mortality by five deaths per thousand, and Przeworski (2004) finds that the positive effect of democracy on infant survival rates remains after controlling for selection effects.

This evidence strongly suggests that political institutions do matter for longevity, although the findings have been questioned on the basis that many of these studies have used biased samples (Ross 2006). One way to overcome these problems is to shift the analysis down from the national to the individual level. Doing just this, Masayuki Kudamatsu uses individual-level data from the Demographic and Health Surveys to analyze the “within-mother” effect of democratization on infant mortality across twenty-eight countries in sub-Saharan Africa (Kudamatsu 2010). By comparing the survival probabilities of infants born to the same mothers before and after a democratic transition, Kudamatsu identifies the effect of institutional change much more precisely, and in so doing he finds a positive and significant effect – infants are more likely to survive under democracy. Moving on from mortality rates, Blaydes and Kayser (2009) use data on average daily calorie consumption to investigate whether certain regime types are better at translating economic growth into consumption for the poorest citizens. With this data they provide evidence that democracies are indeed better than autocracies at converting economic growth into calorie consumption.

Moving from the question of whether to why electoral institutions should affect health and other aspects of human development has led to a focus on the role of accountability (Harding and Wantchekon 2010). The argument, most simply stated, is that electoral competition encourages an increase in the provision of public goods, because elections render politicians accountable to the electorate. As a result, politicians are required to distribute public goods to a wide segment of the population in order to stay in office (Bueno de Mesquita et al. 2001, Bates 1981, Lake and Baum (2001). In an interesting refinement on the accountability explanation, Mani and Mukand (2007) have argued that the incentives for elites to provide public goods vary across types of goods according to their “visibility”, where visibility refers to the likelihood that elites will gain credit from voters for the provision of the good. One example they offer is that reducing mortality through famine relief is much more visible than doing so by preventing malnutrition, even if the overall impact on mortality is much lower.²

The key point to note is that democratic political institutions alter incentives to provide different types of public goods, so not all public goods will be improved by democracy. For the question at hand, this highlights the fact that democracy may not necessarily lead directly to policies that are designed specifically to increase food security. Rather,

² See also Harding and Stasavage (2011), who highlight the abolition of user fees in primary education as an example of a verifiable education policy.

electoral institutions may impact upon food security indirectly, by altering the incentives for politicians to provide specific goods and services that they affect access to sufficient, safe, and nutritious food. In the following section we suggest that one such potential mechanism linking political considerations to food security in West Africa may be the provision of transport infrastructure.

2.2 Political marginalization, transport infrastructure, and food security

Electoral institutions create incentives for governments to provide public goods in order to win votes. As such, they give citizens power, in the sense that citizens can use their votes to hold politicians accountable for the goods and services they provide. However, this power is not distributed equally amongst all citizens. Instead, some citizens have little influence over political outcomes, and are thus marginal to the political process. Where citizens have less impact on electoral outcomes, they are likely to be ignored by politicians and policy-makers, and as a result they may be expected to receive lower levels of public goods and services.

Moreover, following the recognition that politicians' incentives may vary over different types of goods, we might also expect that the under provision of goods to politically marginalized citizens should be particularly severe with regards to more visible or attributable goods; since politicians gain credit for providing visible goods, they have an incentive to target them towards voters who have influence over electoral outcomes, rather than to politically marginalized citizens. In many African countries one such visible good is transport infrastructure, and in particular roads, the presence of which has an enormous impact on the daily lives of all citizens. Following Mani and Mukand (2007) then, we might expect that governments have stronger incentives to provide roads, relative to other less visible goods. However, they should have little incentive to provide roads to politically marginalized areas, where citizens have less influence over political outcomes.

It is worth noting here that the extent to which citizens are able to directly attribute roads to executive actions varies across countries. In Ghana the establishment of a road fund and a highly centralized road agency (the Ghana Highways Authority – GHA) not only implies a high level of state capacity with regards to the development and maintenance of the road network, but also makes it possible for citizens to attribute road outcomes directly to political action by the executive (Harding 2011). This capacity may not be as high in other countries. In Mali for example, while recent reforms have now led to the creation of a road authority and road fund, state capacity with regards to roads in Mali is somewhat short of that in Ghana (Briceno-Garmendia, Dominguez and Pushak 2011). That said, the visibility and importance of roads means there is good reason to think that their provision may be related to political marginalization everywhere, even if the intensity of this relationship varies across countries.

This matters for the issue at hand, because roads affect food security. A common conclusion from almost all studies of agricultural development in Africa is that a lack of

quality roads is a major constraint on agricultural markets (deGrassi 2005). As a result, it is widely accepted that roads encourage agricultural productivity and foster development of cereals production and marketing (Gladwin et al. 2001, Rosegrant and Cline 2003, Clover 2003). Moreover, detailed studies have shown that the quantity and quality of roads has a direct impact on the availability and accessibility of food. For example, transportation costs have been shown to explain most of the variation in food prices between producer regions in the former Zaire (Minten and Kyle 1999). Where transport infrastructure is limited, not only is agricultural development constrained, but also food prices are increased, further limiting access to food.

Taken together, this implies a link between political marginalization and food security. Moreover, it suggests that the mechanism underlying this link is the development of transport infrastructure; political marginalization should indirectly affect food security, because it has a negative impact on the provision of roads, which themselves are crucial for the availability of safe and reliable food supplies. In the following section we discuss the empirical strategy that we use to evaluate this link, describing first the data and then the estimation strategy that we employ.

Before we do so, however, it is important to acknowledge that political marginalization is by no means the only determinant of roads. Rather, factors such as external funding and the economic importance of a particular area (factors which themselves are inter-related) also play an important role. For instance, it is likely that economically important areas receive a greater share of infrastructure investment from the government. Moreover, the factors that make such areas important, such as the presence of minerals and other natural resources, are likely to drive external as well as internal investment. Therefore it is important to recognize the potential importance of such factors in any analysis of the determinants of roads in Africa.

It is also important to recognize that roads are not the only determinant of food security, nor is the mere presence of roads likely to be sufficient to ensure that all people have access to enough safe and nutritious food. Many factors affect food security, not least climate, and the productivity of the land, and as such it is important to control for as many of these factors as possible when analyzing the determinants of food security. Finally, it is also worth stating that our goal here is not to provide exhaustive explanations for food security and the distribution of roads in Africa, nor do we claim to provide estimates of causal effects. Instead, our expressed goal is much more modest; we aim to provide significant evidence of the existence of a relationship between political marginalization, roads, and food security, in order to support the validity of the argument outlined above. It is to this that we now turn.

3. Empirical Strategy

We employ a two-stage strategy in order to evaluate the claim that political marginalization affects food security indirectly, through its impact of transport infrastructure. We start by looking at the link between food security and roads in four West African countries (Benin, Ghana, Mali and Senegal). We then shift the analysis back, and look at the factors that determine roads. Our aim is to illuminate the link between political marginalization and food security by showing: (1) that roads matter for food security; and (2) that roads themselves are influenced by political marginalization. In this section we describe the data and estimation strategy in detail.

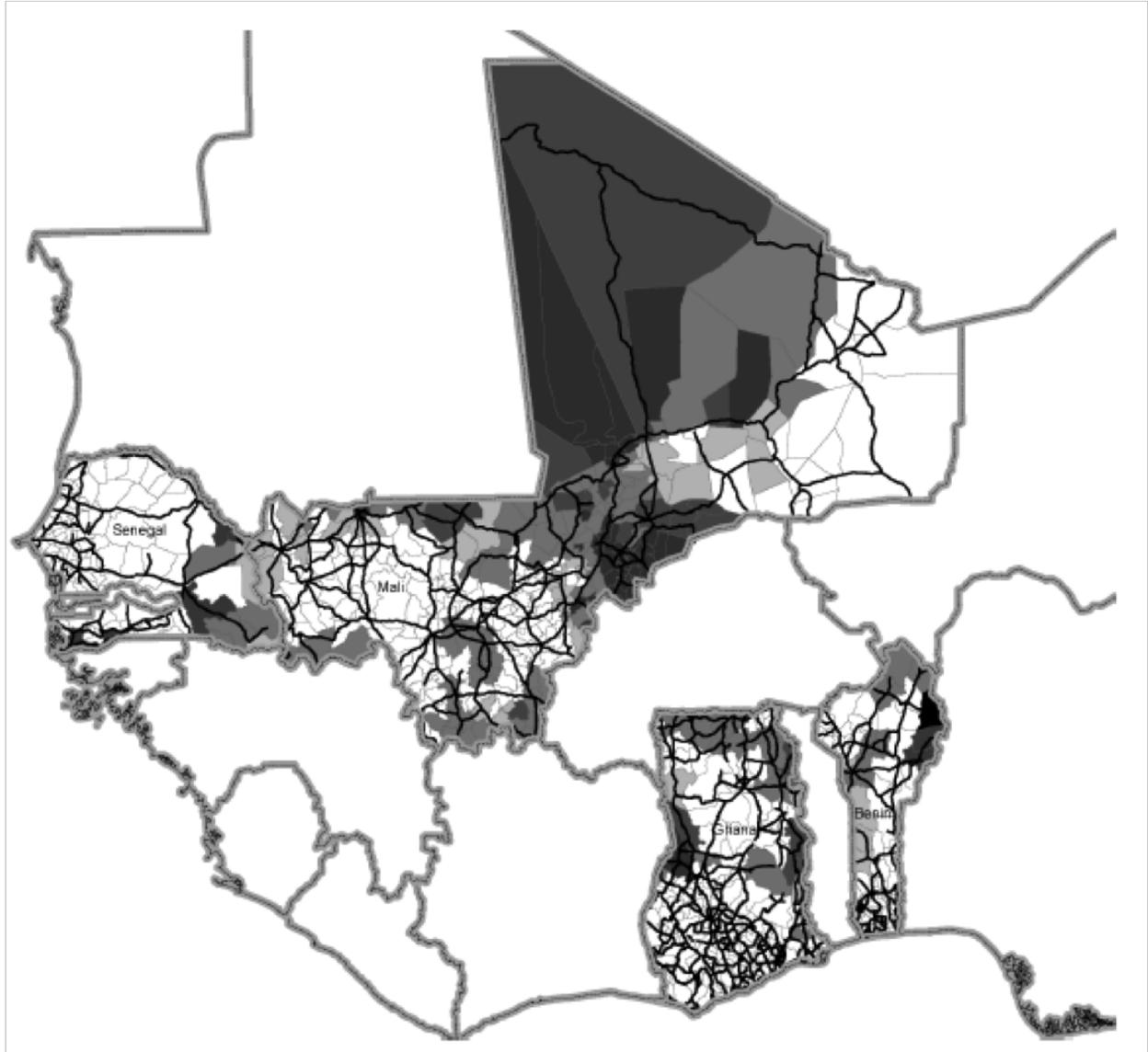
3.1 Data

We focus our analysis on four countries in West Africa – Benin, Ghana, Mali and Senegal. Limiting the study to countries within a single geographic region allows us to control for a great deal of variation that would otherwise be introduced if we were to broaden the study across the whole of Africa. At the same time, there are still important differences between these four countries, for example in terms of political history, economic status, and the nature of political competition, which allows for interesting comparisons across them. Although our sample contains four countries, our unit of observation is subnational. This is necessary because we are interested in variations in the distribution of transport infrastructure by national governments, within countries.

Therefore we have constructed a cross-sectional dataset, with our observations being the lowest level administrative units in each country (Communes in Benin, Districts in Ghana, and Arrondissements in Mali and Senegal). For each observation, our dataset contains measures of political marginalization, transport infrastructure, and food security, along with a number of relevant control variables, all of which are described below, and in even greater detail in the data appendix. In the analysis we include country fixed effects to control for any unobserved factors at the national level, as we discuss in Section 3.2. Maps of the sample are presented in Figures 1 and 2, which are shaded by political marginalization and food security, respectively.

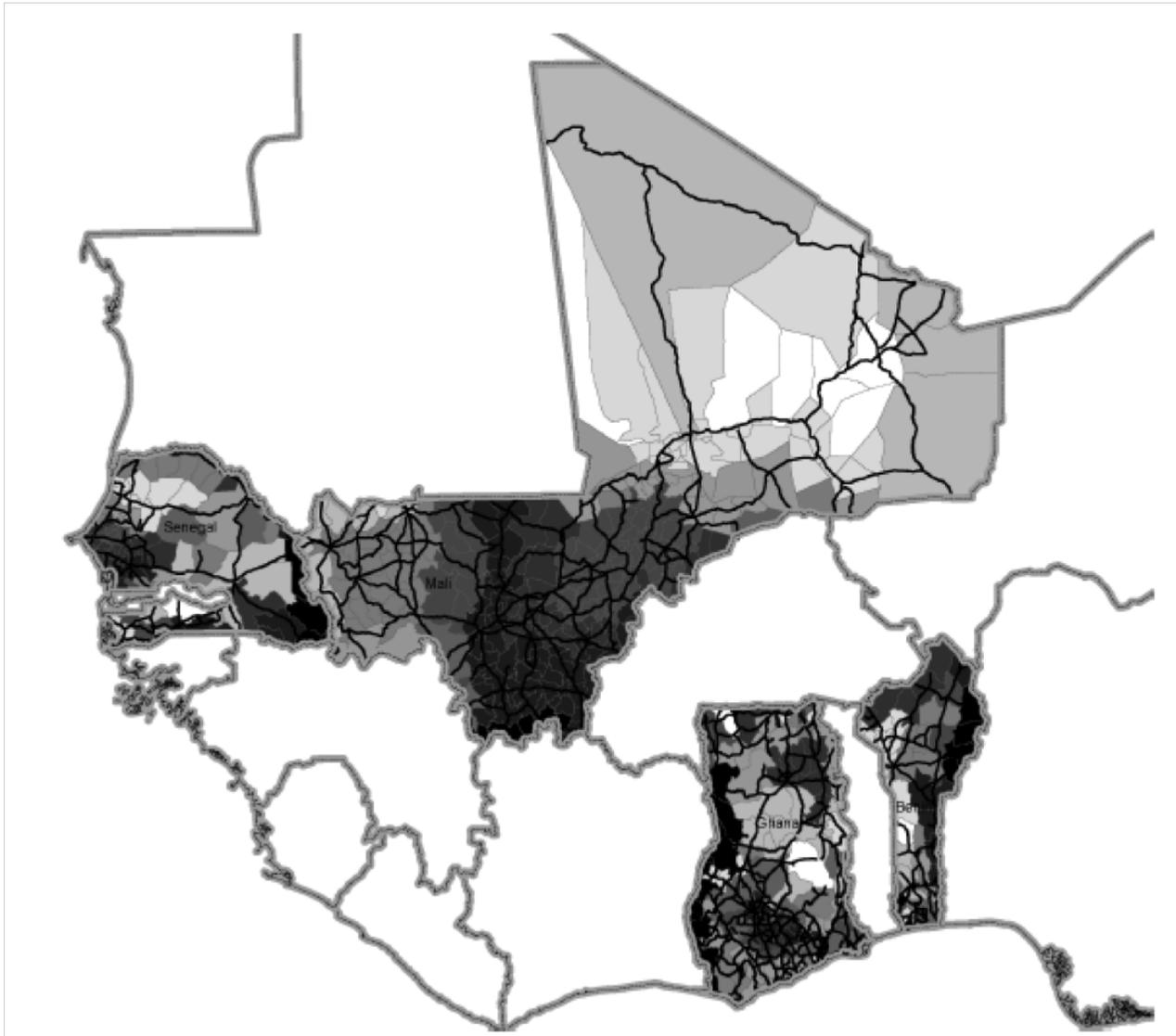
The first empirical issue that we face is defining political marginalization. There is a multitude of ways to conceptualize marginalization, but for our purposes we are interested in citizens who have little weight in determining political outcomes, and are thus essentially politically “ignorable.” We identify these citizens using a dataset of “ethnopolitical” groups constructed by Scarritt and Mozaffar (1999). This dataset identifies groups “having a base in ethnic identity but constantly moulded by political interaction with other groups and the state” (Scarritt and Mozaffar 1999: 83). As such, for each country in Africa the dataset lists all of the groups that are, have been, or have the potential to be politically relevant. This approach is biased towards inclusivity, which means we are less likely to spuriously code groups as being marginalized when in fact they are not. We

Figure 1: Map of sample distribution, by political marginalization



Note: Thick grey lines with dashed inner are national Black lines are national boundaries. Thin grey lines are sub-national administrative boundaries. Black lines are roads. Shading reflects marginalization, with darker areas being more marginalized

Figure 2: Map of sample distribution, by food security



Note: Thick grey lines with dashed inner are national boundaries. Black lines are national boundaries. Thin grey lines are sub-national administrative boundaries. Black lines are roads. Shading reflects food security, with darker areas having lower food security.

Take political irrelevance as a proxy for marginalization in Africa, because political competition therein is predominantly based on ethno-regional identities (Salih 2003, van de Walle 2003). Therefore where groups are not politically relevant, we take this as a sign that they are essentially ignorable in political terms.

For each of the four countries, we code all groups that are not listed in the index of ethnopolitical groups as being politically marginalized. We then locate these groups geographically using the Geo-Referencing of Ethnic Groups (GREG) database, which geo-references ethnic groups around the world using maps and data drawn from the

classical Soviet Atlas Narodov Mira (Weidmann, Rod and Cederman 2010). Because our observations are administrative units, which do not conform to the GREG boundaries, we then spatially join the GREG data to digital maps of the administrative boundaries, available from <http://www.gadm.org/country>. Doing so gives us a measure of average marginalization in each administrative unit (ranging from 0 to 1). Summary statistics are presented in Table 1.

As with the conceptualization, there are also many ways in which these ignorable citizens could be empirically identified. We could for instance try to use electoral outcomes to identify citizens whose votes make no difference to electoral outcomes. However, for presidential elections with direct popular voting systems, in which all votes count equally irrespective of geographic location, there is no obvious way to identify such citizens. Alternatively, we could attempt to identify areas where participation is low and take this as an indicator of marginalization, but such a measure would risk conflating marginalization with the many other possible determinants of political participation. Therefore given the alternatives, we feel that using the measure of political irrelevance, as a proxy for marginalization is the best option available.

The second empirical issue is measuring transport infrastructure. For this we use data on infrastructure in Benin, Mali and Senegal from the Africa Infrastructure Country Diagnostic (AICD) program implemented by the World Bank, which provides detailed economic and technical data on African infrastructure. This data includes digital maps of the road networks for these three countries, as well as for a number of other countries in Africa, which contain information on the

Table 1: Summary Statistics

Country	Admin. Unit	N	Mean Marginalization	Mean road km p/sqkm	Mean Stunted Children by population density (in 1000s)
Benin	Communes	76	.092	.113	3.124
Ghana	Districts	137	.105	.109	1.116
Mali	Arrondissements	287	.329	.059	6.639
Senegal	Arrondissements	93	.059	.054	1.255
Total	–	593	.204	.077	4.055

Note: Summary statistics for measures of political marginalization, road density, and food security, across administrative units in Benin, Ghana, Mali and Senegal.

Location, lengths, classification, surface type, and condition of these countries' road networks. Similar data for Ghana was collected from the GHA in Accra. Using these digital maps, we calculated the density of primary and secondary roads within each administrative unit in our sample (where the density is equal to kilometers of road per square kilometer of land).

The third empirical issue that we faced was obtaining a measure of food security for each of the administrative units in our sample. We did this using data on the number of stunted children under the age of five, contained in the Food Insecurity, Poverty and Environment

Global GIS Database (FGGD) constructed by the Food and Agriculture Organization.³ This provides a good measure of food security, because malnutrition resulting from limited access to sufficient nutritious food is a primary cause of stunted growth in children. Therefore we used this data to calculate the number of stunted children in each administrative unit, which we then weighted by each unit's population density using data from the Gridded Population of the World (GPW) dataset. Unfortunately, calculated in this way the measure is hard to interpret substantively, in terms of concrete numbers of stunted children. However, given the large variations in population density, and the absence of reliable data on population numbers by administrative units, this is the best way to specify the measure with the available data. Importantly, it is reasonable to assume that this measure is decreasing with greater food security.

We also required data on other potential determinants of food security and roads, in order to control for potentially confounding factors in our analysis. As noted in Section 2.2, food security is likely to be affected by climate and land productivity. To control for the former, we collected data on rainfall. Measures of rainfall are calculated either by using data from weather stations, or by blending weather station data with additional satellite data. We use various measures of both types, from the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA). Since we have cross-sectional data, we calculated measures of long-term monthly mean precipitation, for each of the administrative units in our sample.

In order to control for land productivity we use data on the amount of land used for crops and pasture, from the Socioeconomic Data and Applications Center (Ramankutty et al. 2010a,b). By joining this to our spatial database, we were able to construct measures of the extent of cropland and pasture in each of the administrative units across the four countries in our dataset. In addition, we also needed a measure of economic importance, because investment in transport infrastructure is likely to be affected by the economic importance of a given area. Therefore we used data on the location of mineral operations in Africa, created by the U.S. Geological Survey (Eros and Candelario-Quintana 2006). With this data we were able to construct a count variable of the number of mines and processing plants in each administrative unit in our sample.

Finally, we also include a measure of terrain slope. The nature of the terrain is likely to affect food security in a given area, because it is harder to produce and access food where the terrain is rougher. It is also possible that terrain slope affects the location of roads, because it is harder to build roads in areas where terrain is rough. Therefore we use data also contained in the FGGD database to construct a measure of terrain slope throughout our sample.⁴

³ We are grateful to Ricardo Fuentes for suggesting this data, which is available at <http://www.fao.org/geonetwork/srv/en/main.home>.

⁴ The data comes from the 'Terrain slope classes of the world' dataset, which is available at <http://www.fao.org/geonetwork/srv/en/main.home>.

Taken together then, we have a cross-sectional dataset containing 593 observations at the level of administrative units, across four countries in West Africa. For each unit, we have measures of political marginalization, transport infrastructure, and food security, as well as controls for climate, land productivity, economic importance, and terrain slope. We also include controls for the size of the administrative unit, and population density. This provides us with a powerful tool with which to evaluate the argument outlined in Section 2.2, that political marginalization indirectly affects food security because it has a negative impact on the provision of roads, which are necessary for the availability of food supplies.

3.2 Estimation Strategy

Using this dataset, we undertake a two-stage strategy to evaluate the argument. First, we investigate the relationship between food security and transport infrastructure, by estimating the OLS model

$$Y_{ij} = \beta_1 \text{marginalized}_{ij} + \beta_2 \text{roads}_{ij} + \lambda_j + \gamma X_{ij} + \varepsilon_{ij} \quad (1)$$

Where Y_{ij} is the number of stunted children under five in administrative unit i within country j , λ_j is a fixed effect that absorbs any unobservable factors for country j , and X_{ij} is a matrix of control variables for unit i that includes population density, area in square kilometers, terrain slope, usage of land for crops and pasture, and long-term mean monthly rainfall. What we are interested in then are β_1 and β_2 , which represent the coefficients for political marginalization and kilometers of road per square kilometer of land, respectively. If food insecurity were directly affected by marginalization, we would expect the β_1 coefficient to be negative and significant. Likewise, if food insecurity is moderated by the presence of transport infrastructure, we should expect the β_2 coefficient to be negative and significant.

Following this, the second step is to investigate the determinants of roads. The logic of our argument suggests that marginalized citizens should face lower levels of food security because food supplies are undermined by poor transport infrastructure, which itself is affected by political marginalization. We evaluate this logic by estimating the OLS model

$$Y_{ij} = \beta_1 \text{marginalized}_{ij} + \lambda_j + \gamma X_{ij} + \varepsilon_{ij} \quad (2)$$

Where this time Y_{ij} is kilometers of road per square kilometer of land in administrative unit i within country j , and marginalized_{ij} denotes the political marginalization score for unit

i. Again we include country fixed effects (λ_j) and the same matrix of control variables at the administrative unit level (X_{ij}), but this time we also include a control for the number of mineral mines and processing plants in unit i . What we are interested in then is β , which represents the coefficient on the political marginalization variable. If politically marginalized citizens are ignorable when it comes to the distribution of public goods, this coefficient should be negative and significant.

In Section 2.2 we argued that food security should be indirectly affected by political marginalization, because marginalized areas receive lower levels of investment in transport infrastructure, which in turn undermines food security. Therefore our expectation from estimating equation (1) is that the coefficient on roads will be negative and significant, but that the coefficient on marginalization should be insignificant, because marginalization has no direct effect on food security. Rather, the effect operates through roads. As such, we should expect the coefficient on marginalization in equation (2) to be negative and significant. In the following section we present the results.

4. Results

The results from estimates of equation (1) are presented in Table 2. From columns 1 and 2 it is clear that political marginalization has no direct effect on food insecurity. As we would expect, the coefficients are positive, suggesting that marginalized areas have higher numbers of stunted children under the age of five. However, these coefficients are not significant at standard levels. In contrast, from the results in columns 3 and 4, we can see that the density of roads is significantly related to food insecurity. The coefficient on roads per square kilometer is negative and significant at the 1% level, which implies that areas with more roads have significantly fewer stunted children. The results in columns 5 and 6 show that these findings hold when both the marginalization and roads measures are included at the same time.⁵ Moreover, when both variables are included simultaneously, the coefficient for political marginalization reduces substantially, and actually becomes negative when all of the control variables are included, although it is never significant. This suggests that roads may in fact mediate any relationship between political marginalization and food security.

The estimates presented in columns 2, 4 and 6 include the matrix of control variables. The coefficient on population density is always negative and significant, suggesting that more densely populated areas, which are likely to be urban areas, have lower levels of food insecurity. Similarly, the measures of land usage are both significantly related to food insecurity, suggesting that food insecurity is lower where land can be used productively, for either crops or pasture. The coefficient for rainfall is not significant, irrespective of which measure we use.

⁵ The correlation between these two variables is -0.1939.

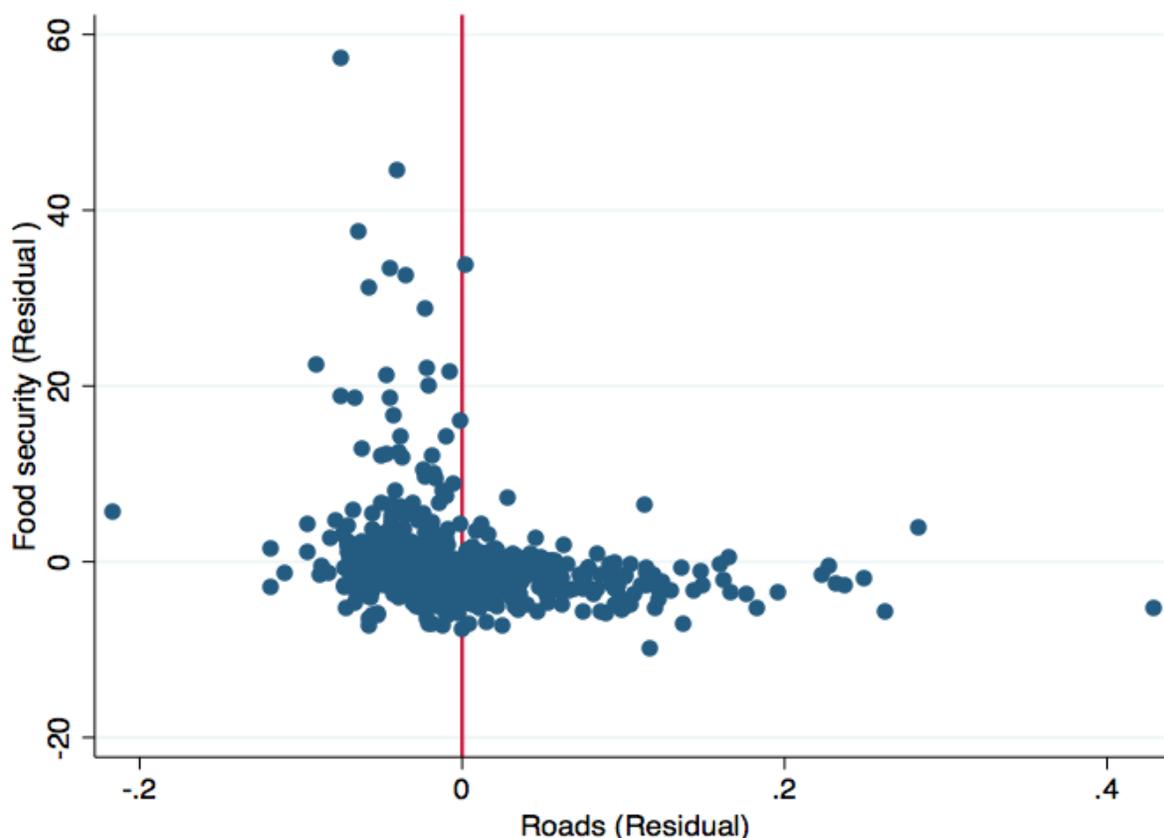
As expected then, while the presence of roads is significantly related to food security, there appears to be no direct relationship between political marginalization and food security. Moreover, the impact of roads is substantial – a one standard deviation increase in kilometers of road per square kilometer of land relates to a reduction in the number of stunted children that is roughly four times bigger than the reduction related to a one standard deviation increase in use of land for crops, and more than twice as large as that related to a one standard deviation increase in use of land for

Table 2: Estimates of Food Insecurity

	1	2	3	4	5	6
Marginalized	1.085 (0.989)	0.511 (1.168)			0.383 (0.941)	-0.150 (1.138)
Road per km			-24.430*** (3.814)	-24.218*** (3.765)	-24.206*** (3.849)	-23.298*** (3.845)
Cropland		-3.784** (1.464)		-2.587** (1.289)		-2.540* (1.406)
Pasture		-2.240* (1.282)		-2.649** (1.204)		-2.670** (1.226)
Rainfall (NASA)		-0.769 (0.543)		-0.763 (0.471)		-0.782 (0.532)
Population Density		-0.069*** (0.023)		-0.039*** (0.012)		-0.039*** (0.013)
Area (km2)		0.010 (0.034)		-0.004 (0.026)		-0.004 (0.026)
Terrain Slope		0.017 (0.295)		-0.027 (0.283)		-0.029 (0.286)
R-squared	0.148	0.167	0.199	0.212	0.199	0.213
N	590	590	590	590	590	590

*Note: Dependent variable is stunted children. All models include country fixed effects. Robust standard errors in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01.*

Figure 3: Partial scatter between food security and roads



Note: This figure of partial correlation controls for rainfall, cropland, pasture, population density, terrain slope, and the size of the area.

Pasture. Figure 3 presents a visual representation of this result. It shows that instances of extreme food insecurity, as proxied by the presence of high numbers of stunted children, occur only in areas where road infrastructure is lacking (to the left of the red vertical line).

Table 4 in the appendix presents the same results but with alternative measures of the key variables. Specifically, for the dependent variable we used the number of stunted children per (log) population. For the main explanatory variable of interest we used the length of roads per population density in model 1, per square kilometer in model 2, and the length alone in model 3. The results remained robust. Clearly then, roads matter for food security. The question that remains are, what determines roads?

Table 3 contains results from three different estimates of equation (2), where the dependent variable is road density. From these results it is clear that political marginalization is significantly related to roads. In all specifications, the coefficient for political marginalization is negative and significant, which implies that politically marginalized areas have significantly fewer kilometers of road per square kilometer of

land. This relationship is robust to the inclusion of the matrix of control variables used in the estimates of equation (1), plus a count variable for the number of mineral mines and plants combined, as a measure of economic importance (column 2). It remains significant when this combined minerals variable is broken up into two separate variables for the numbers of mines and plants (column 3).

Figure 4 presents a visual representation of this relationship, showing that higher levels of road density are clustered to the left hand side of the red vertical line, in correlation with lower levels of political marginalization. Although this relationship may not be quite as apparent as that between food security and road density, this visual representation highlights the existence of a clear correlation between political marginalization and road density.

One possible confounding factor that we considered is that the presence of just one or a few roads in a particular area might matter much more than the additional presence of subsequent roads. For example, one single road could open up a large area to outside markets. To check the robustness of our results to this possibility, we ran an alternative specification with the road variable replaced by a dummy variable indicating whether the defined road exists or not. Our findings remained robust to this specification, the results of which are presented in Table 5 in the appendixes

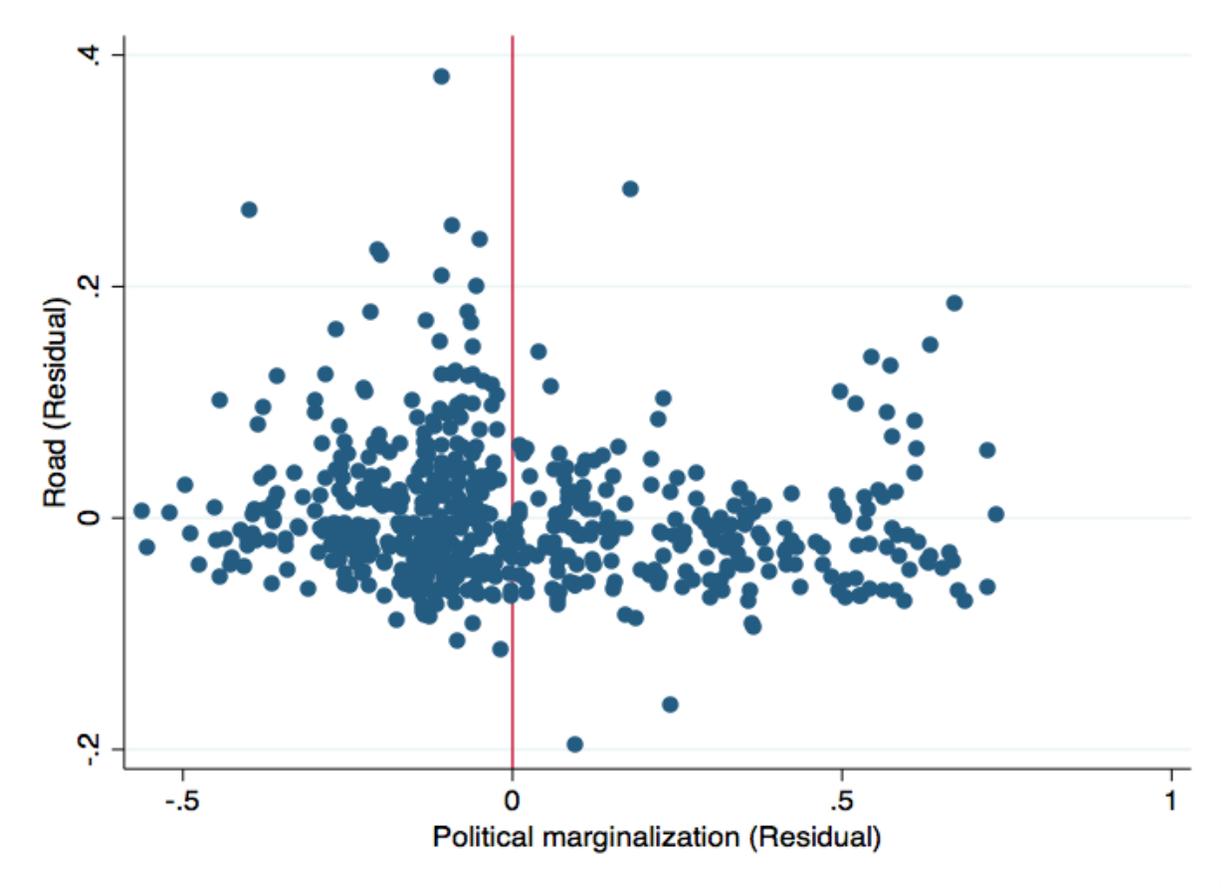
Table 3: Estimates of Road Density

	1	2	3
Political Marginalization	-0.028*** (0.009)	-0.024*** (0.009)	-0.025*** (0.009)
Cropland		0.057*** (0.018)	0.055*** (0.018)
Pasture		-0.012 (0.014)	-0.014 (0.014)
Rainfall (NASA)		-0.000 (0.003)	0.0002 (0.003)
Minerals		0.026** (0.011)	
Mines			0.016* (0.009)
Plants			0.036 (0.023)
Population Density		0.001 (0.001)	0.001 (0.001)
Terrain Slope		(0.0004) -0.001 (0.004)	(0.0004) -0.001 (0.004)
R-squared	0.186	0.217	0.219
N	593	593	593

Note: Dependent variable is length of road per square km. All models include country fixed effects. Robust standard errors in parentheses.

p < 0.1, **p < 0.05, *p < 0.0*

Figure 4: Partial scatter between political marginalization and roads



Note: This figure of partial correlation controls for minerals, mines, and plants in addition to rainfall, cropland, pasture, population density, terrain slope, and the size of the area.

As we might expect, the presence of mineral facilities is positively related to road density, as is the use of land for crop production. This supports the expectation that economically important areas receive higher levels of infrastructure investment. Yet, even controlling for these factors, politically marginalized areas have fewer roads. Again, the size of this relationship is substantial. A one standard deviation increase in the measure of political marginalization relates to a change in the density of roads that is only marginally smaller than the change related to one standard deviation increases in the minerals and cropland variables.

Taken together then, these findings support the argument that political marginalization indirectly affects food security, through its impact on transport infrastructure. In Table 2, the positive coefficient in column 1 implies that food security, as measured by the

prevalence of stunted children, is lower in marginalized areas, although this relationship is not significant. What is significant though is the relationship between transport infrastructure and food security; areas with more roads per square kilometer have significantly greater food security.

Interestingly, the fact that the coefficient on the marginalization variable drops so substantially when the road density variable is included suggests that roads may indeed be the mechanism linking marginalization to food security, because the relationship between marginalization and food security is mediated by the measure of transport infrastructure. The results presented in Table 3 provide further support for this claim – politically marginalized areas have significantly fewer roads. In sum then, these results support the claim that political marginalization indirectly affects food security, through its negative impact on transport infrastructure.

5. Conclusion

In this paper we have begun to investigate the political economy of food security in Africa. Despite the spread of democratic politics throughout the continent over the last two decades, crises of food security continue, and have worsened in recent years with the global economic downturn and rising food prices. In an effort to understand the political determinants of food security, we started by considering the incentives faced by politicians who are subject to the constraints of democratic electoral institutions. In so doing, we recognized that some citizens may be marginalized from the political process, because they have little weight in determining electoral outcomes. As a result, areas with higher concentrations of these marginalized citizens are likely to be ignored in the distribution of public goods, especially when it comes to visible and attributable goods, the provision of which has a greater impact on electoral outcomes.

In Africa, one such visible and attributable good is roads, and therefore we claim that politically marginalized areas should do worse in terms of transport infrastructure. This is important for food security, because it is widely accepted that roads have a major impact on the availability of, and access to, reliable sources of food. What this suggests therefore is that political marginalization should indirectly reduce food security, because marginalized areas should have poorer transport infrastructures, which in turn undermines the availability of food.

In order to evaluate this claim we have constructed an original spatial dataset at the level of administrative units across four countries in West Africa – Benin, Ghana, Mali and Senegal – which contains measures of political marginalization, transport infrastructure, and food security. Using this dataset, we have provided evidence that the density of roads is indeed related to food security – areas with fewer roads have higher numbers of stunted children. Moreover, we have shown that while political marginalization has no direct effect on food security, it is significantly related to

transport infrastructure --marginalized areas have significantly fewer roads per square kilometer. Therefore taken together, these results suggest that political marginalization indirectly affects food security, through its negative impact on transport infrastructure.

These findings have important implications for food security in Africa. First, they lend further support to the claim that transport infrastructure plays a crucial role in providing safe, nutritious and reliable food supplies. Even controlling for factors such as population density and terrain slope, the amount of road per square kilometer of land has a significant and substantial impact on the number of stunted children in an area. Second, they suggest that political marginalization affects the provision of public goods, at least in terms of a visible and verifiable good such as roads, which are crucial for the provision of reliable food supplies. As such, one way to improve food security for marginalized groups may be by helping them to help themselves, perhaps through efforts to encourage political efficacy and enable marginalized citizens to make their votes count. Finally, these findings suggest that, despite Sen's optimism, when it comes to preventing food crises electoral institutions alone may not be sufficient. Rather, it may be necessary to consider the incentives that these institutions create, and the consequences of these incentives for different types of citizens. By doing so we may be able to better understand the impact of electoral institutions on the vulnerable and marginalized, especially with regards to the provision of reliable sources of food.

Appendix 1: Robustness Checks

Table 4: Estimates of Food Insecurity (II)

	1	2	3
Marginalized	12.27** (5.63)	10.15* (5.3)	12.50** (5.6)
	(.01)	(18.78)	(.01)
Cropland	-11.58 (10.07)	-6.12 (9.93)	-11.56 (10.07)
Pasture	5.82 (4.08)	5.23 (4.06)	7.37* (4.16)
Rainfall (NASA)	6.15*** (1.82)	6.51*** (1.83)	6.33*** (1.81)
Population Density	-0.30 (0.15)	-.172* (.09)	-.31** (.14)
Area (km2)	.000 (0.06)	-.06** (.02)	.116 (.109)
Terrain Slope	.32 (1.56)	.31 (1.32)	.68 (1.35)
R-squared	0.20	0.24	0.27
N	590	590	590

*Note: Dependent variable is stunted children. All models include country fixed effects. Robust standard errors in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01. + The variable road is length of road per population density in model 1, per square kilometer in model 2, and the length only in model 3. The dependent variable is the number of stunted children per log population size of the area.*

Table 5: Estimates of Road Density (II)

	1	2	3
Political Marginalization	-0.10*** (0.04)	-0.10*** (0.04)	-.117*** (.04)
Cropland		0.24 (0.18)	.226 (.18)
Pasture		0.04 (0.06)	.029 (.06)
Rainfall (NASA)		-	-.015 (.019)
Minerals		-	
			()
Population Density		0.002 (0.001)	-.002 (.001)
Area (km2)		0.0004 (0.0004)	.0029 (.003)
Terrain Slope		0.03 (0.01)	.031 (.018)
Pseudo R-squared	0.07	0.09	0.09
N	590	590	590

*Note: Dependent variable is a dummy variable indicating the presence or not of the defined road regardless of its length. The specification is a marginal probit model. All models include country fixed effects. Robust standard errors in parentheses. *p < 0.1, **p < 0.05, ***p < 0.01. The variables mines, minerals and plants are dropped because they predict one of the outcomes on roads perfectly.*

Appendix 2: Data

Food Security

We measure food security using data on the number of stunted children under the age of five, contained in the Food Insecurity, Poverty and Environment Global GIS Database (FGGD) constructed by the Food and Agriculture Organization (FAO), which is available at <http://www.fao.org/geonetwork/srv/en/main.home>. The FGGD estimated number of stunted children map is a global raster datalayer with a resolution of 5 arc-minutes, and the number of stunted children is estimated according to the lowest available sub-national administrative units. We used this data to calculate the number of stunted children in each administrative unit, by joining the raster file of stunted children to the shapefiles of administrative units using ArcGIS software. We then weighted the number of stunted children by each unit's population density using data from the Gridded Population of the World (GPW) dataset, available from <http://sedac.ciesin.columbia.edu/gpw/>.

Political Marginalization

We define as politically marginalized those citizens who have historically been irrelevant to political competition. We identify these citizens using the dataset of “ethnopolitical” groups constructed by Scarritt and Mozaffar (1999). This dataset identifies groups “having a base in ethnic identity but constantly moulded by political interaction with other groups and the state” (Scarritt and Mozaffar 1999: 83). As such, for each country in Africa the dataset lists all of the groups that are, have been, or have the potential to be politically relevant. This approach is biased towards inclusivity, which means we are less likely to spuriously code groups as being marginalized when in fact they are not. We take political irrelevance as a proxy for marginalization in Africa, because political competition therein is predominantly based on ethno-regional identities (Salih 2003, van de Walle 2003). Therefore where groups are not politically relevant, we take this as a sign that they are essentially ignorable in political terms.

For each of the four countries, we code all groups that are not listed in the index of ethnopolitical groups as being politically marginalized. We then locate these groups geographically using the Geo-Referencing of Ethnic Groups (GREG) database, which geo-references ethnic groups around the world using maps and data drawn from the classical Soviet Atlas Narodov Mira (Weidmann, Rod and Cederman 2010). Because our observations are administrative units, which do not conform to the GREG boundaries, we then spatially join the GREG data to digital maps of the administrative boundaries, available from

<http://www.gadm.org/country>, using ArcGIS software. Doing so gives us a measure of average marginalization in each administrative unit (ranging from 0 to 1).

Transport infrastructure

To measure transport infrastructure we use data on the road networks in Benin, Mali and Senegal from the Africa Infrastructure Country Diagnostic (AICD) program implemented by the World Bank, which provides detailed economic and technical data on African infrastructure. The data is available from <http://www.infrastructureafrica.org/>. This data includes digital maps of the road networks for these three countries, as well as for a number of other countries in Africa, which contain information on the location, lengths, classification, surface type, and condition of these countries' road networks. Similar data for Ghana was collected from the Ghana Highways Authority in Accra. Using these digital maps, we calculated the density of primary and secondary roads within each administrative unit in our sample, where the density is equal to kilometers of road per square kilometer of land, using ArcGIS software. This measure includes all national and regional roads, but does not include local urban or rural roads.

Climate

We used data on rainfall to measure variations in climate across the units in our sample. Measures of rainfall are calculated either by using data from weather stations, or by blending weather station data with additional satellite data. We constructed measures of both types. For the former, we use data from the CRU TS 2.0 dataset, provided by the National Aeronautics and Space Administration (NASA) and available to download at http://data.giss.nasa.gov/precip_cru/maps.html. While the original CRU data is provided on a 0.5-degree grid, the maps provided by NASA are based on a copy of that data which was re-gridded to a coarser 2.0 degree resolution. We use long-term annual mean precipitation data calculated over the period 1901 to 2000.

In order to check that the results are not affected by the coarseness of the measure, we constructed a second measure using data from the University of Delaware Air Temperature and Precipitation dataset, which is also based solely on weather station data, and which we used to construct an annual long-term mean precipitation measure for the years 1951 to 1999. This dataset is provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their website at <http://www.esrl.noaa.gov/psd/>, and is derived from a 0.5 degree grid.

Finally, to construct a measure of rainfall calculated from a blend of both weather station data and additional satellite data, we used data from the Global Precipitation Climatology Project (GPCP), also provided by the NOAA/OAR/ESRL PSD, Boulder, Colorado, USA, from their website at <http://www.esrl.noaa.gov/psd/>. This data uses a 2.5 degree grid, and gives long-term monthly means for the period 1981-2010, which we used to construct an annual long-term mean precipitation measure. The results presented in the paper use the NASA variable, but are unaffected when this is replaced by either of the other two measures described here.

Terrain Slope

We measure terrain slope using data contained in the FGGD database. The data comes from the

'Terrain slope classes of the world' map, available at <http://www.fao.org/geonetwork/srv/en/main.home>, which is a global raster datalayer with a resolution of 5 arc-minutes. Each pixel of the map contains a terrain slope class value for the pixel area. The data are from the 1993 United States Geological Survey.

Land Productivity

In order to construct measures of land productivity we used data on the amount of land used for crops and pasture, from the Global Agricultural Lands in the Year 2000 dataset, provided by the Socioeconomic Data and Applications Center (SEDAC) and available at <http://sedac.ciesin.columbia.edu/es/aglands.html> (Ramankutty et al. 2010a,b). The dataset represents the proportion of land area used as cropland (land used for the cultivation of food) and pasture (land used for grazing) in the year 2000, and is based on satellite data combined with agricultural inventory data. By joining this to our spatial dataset using ArcGIS software, we were able to construct measures of the extent of cropland and pasture in each of the administrative units across the four countries in our dataset.

Economic Importance

We measure economic importance with data on the location of mineral operations in Africa, created by the United States Geological Survey (USGS) (Eros and Candelario-Quintana 2006). This dataset consists of records for over 1,500 mineral facilities in Africa and the Middle East. The mineral facilities include mines, plants, mills, or refineries of aluminum, cement, coal, copper, diamond, gold, iron and steel, nickel, platinum-group metals, salt, and silver, among others. The data were compiled from multiple sources, including the 2004 USGS Minerals Yearbook (Africa and Middle East volume), minerals statistics and information from the USGS minerals information website

(<http://minerals.usgs.gov/minerals/>), and data collected by USGS minerals information country specialists. The dataset contains the most recent published data available for each country at the time of its construction. With this data we were able to construct count variables of the numbers of mines and processing plants in each administrative unit in our sample, as well as a combined count of all facilities (both mines and plants together).

References

Bates, Robert. 1981. *Markets and States in Tropical Africa: The Political Basis of Agricultural Policies*. Berkeley: University of California Press.

Besley, T. and M. Kudamatsu. 2006. "Health and Democracy." *American Economic Review* 96(2):313–318.

Blaydes, Lisa and Mark Andreas Kayser. 2009. "Counting Calories: Democracy and Distribution in the Developing World." Working Paper.

Briceno-Garmendia, Cecilia, Carolina Dominguez and Nataliya Pushak. 2011. *Mali's Infrastructure: A Continental Perspective*. Technical report World Bank.

Bueno de Mesquita, B., J.D. Morrow, R. Siverson and A. Smith. 2001. "Political Competition and Economic Growth." *Journal of Democracy* 12(1):58–72.

Clover, Jenny. 2003. "Food Security in sub-Saharan Africa." *African Security Review* 12(1):5–15. deGrassi, Aaron. 2005. "Transport, Poverty and Agrarian Change in Africa: Models, Mechanisms and New Ways Forward." *Institute for Development Studies Bulletin* 36(2):52–57.

Eros, J.M. and L. Candelario-Quintana. 2006. *Mineral Operations of Africa and the Middle East*. Technical report U.S. Geological Survey. URL: <http://mrdata.usgs.gov/>

Gladwin, Christina H., Anne M. Thomson, Jennifer S. Peterson and Andrea S. Anderson. 2001. "Addressing food security in Africa via multiple livelihood strategies of women farmers." *Food Policy* 26:177–207.

Harding, Robin. 2011. "One for the Road: Voting for Public Goods in Ghana." Working Paper.

Harding, Robin and David Stasavage. 2011. "What Democracy Does (and Doesn't) do for Basic Services: School Fees, School Quality, and African Elections." Working Paper.

Harding, Robin and Leonard Wantchekon. 2010. "The Political Economy of Human Development." United Nations Development Programme Human Development Reports Research Papers 29.

Kudamatsu, M. 2010. "Has Democratization Reduced Infant Mortality in Sub-Saharan Africa? Evidence from Micro Data." Working Paper .

Lake, D.A. and M.A. Baum. 2001. "The Invisible Hand of Democracy: Political Control and the Provision of Public Services." *Comparative Political Studies* 34(6):587.

Mani, A and S Mukand. 2007. "Democracy, Visibility, and Public Good Provision." *Journal of Development Economics* 83:506–529.

Minten, Bart and Steven Kyle. 1999. "The effect of distance and road quality on food collection, marketing margins, and traders wages: evidence from the former Zaire." *Journal of Development Economics* 60:467–495.

Przeworski, Adam. 2004. *The Evolution of Political Knowledge*. Columbus: Ohio State University Press chapter Democracy and Economic Development.

Ramankutty, N., A.T. Evan, C. Monfreda and J.A. Foley. 2010a. *Global Agricultural Lands: Croplands, 2000*. Technical report Data distributed by the NASA Socioeconomic Data and Applications Center (SEDAC). [Downloaded November 2011]. URL: <http://sedac.ciesin.columbia.edu/es/aglands.html>.

Ramankutty, N., A.T. Evan, C. Monfreda and J.A. Foley. 2010b. *Global Agricultural Lands: Pastures, 2000*. Technical report Data distributed by the NASA Socioeconomic Data and Applications Center (SEDAC). [Downloaded November 2011]. URL: <http://sedac.ciesin.columbia.edu/es/aglands.html>.

Rosegrant, Mark W. and Sarah A. Cline. 2003. "Global Food Security: Challenges and Policies." *Science* 302:1917–1919.

Ross, Michael. 2006. "Is Democracy Good for the Poor?" *American Journal of Political Science* 50(4):860–874.

Salih, M. A. Mohamed, ed. 2003. *African Political Parties: Evolution, Institutionalization, and Governance*. London: Pluto Press.

Scarritt, James and Shaheen Mozaffar. 1999. "The Specification of Ethnic Cleavages and Ethnopolitical Groups for the Analysis of Democratic Competition in Contemporary Africa." *Nationalism and Ethnic Politics* 5(1).

Shandra, J.M., J. Nobles, B. London and J.B. Williamson. 2004. "Dependency, Democracy, and Infant Mortality: A Quantitative, Cross-National Analysis of Less Developed Countries." *Social Science and Medicine* 59(2):321–333.

Siegle, J.T., M.M. Weinstein and M.H. Halperin. 2004. "Why Democracies Excel." *Foreign Affairs* 83(5):57–71.

Tsai, M.C. 2006. "Does Political Democracy Enhance Human Development in Developing Countries?" *American Journal of Economics and Sociology* 65(2):233.

van de Walle, Nicholas. 2003. "Presidentialism and clientelism in Africa's emerging party systems." *The Journal of Modern African Studies* 41(02):297–321.

Vollmer, S. and M. Ziegler. 2009. "Political Institutions and Human Development: Does Democracy Fulfill its 'Constructive' and 'Instrumental' Role?" *Policy Research Working Paper* .

Weidmann, Nils B., Jan Ketil Rod and Lars-Erik Cederman. 2010. "Representing Ethnic Groups in Space: A New Dataset." *Journal of Peace Research* . in press.

Zweifel, T. D. and P. Navia. 2000. "Democracy, Dictatorship, and Infant Mortality." *Journal of Democracy* 11(2): 99–114.