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# Spatial analysis of bureaucrats' attempts to resist political capture in a developing democracy: The distribution of solar panels in Ghana

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## ABSTRACT

Can civil servants in a developing democracy successfully resist political capture in the distribution of public goods? Existing research tends to highlight political patronage logics of distribution, and scholarship focuses primarily on politicians' motivations. But service decisions are often made by bureaucrats, who sometimes explicitly try to avoid capture and allocate on the basis of need. Using qualitative interviews and spatial regressions with geo-coded data from a solar panel program in Ghana, we examine such a situation. We show that, despite considerable efforts to thwart it, national-level civil servants were unable to fully resist political capture. While solar panel distribution partially corresponded to need for electricity, we find that panels also went to areas where voter turnout was historically inconsistent, likely to motivate voter turnout. The direction of these relationships was consistent across subnational space, but the magnitudes varied considerably and were strongest in districts adjacent to Lake Volta. Qualitative data analysis reveals that this subnational variation reflects the logistics of space and the historical politics of place. The article contributes to theories of distributive politics and of voting behavior, and highlights the need for subnational disaggregation across space.

## 1. Introduction

Political scientists have studied distributive politics – who gets public goods, where, and when – in industrialized democracies for decades.<sup>1</sup> A newer literature has begun to address these issues in emerging democracies.<sup>2</sup> These studies generally focus on whether politicians distribute public goods according to a particular electoral logic – for example, to reward party loyalists, target swing voters, or mobilize supporters to vote. But much of the existing literature sidelines the role of public administrators as decision makers,<sup>3</sup> even though career civil servants and donor staff are often given discretion to make practical decisions about how to distribute scarce resources in aid-dependent

countries.<sup>4</sup> While theories of political capture suggest that bureaucrats act on behalf of the ruling political party, some civil servants are protected from political interference, and others eschew electoral politicking, seeing themselves as falling on the more technocratic side of the “politics-administration divide.”<sup>5</sup> Bureaucrats' decisions, moreover, are shaped by the logistics of space – they may need to decide whether to allocate goods in geographic clusters that streamline service delivery or to maximize the number of geographic locations that receive services. But they are also shaped by the politics of place, with goods distribution guided at least partially by historic relationships between citizens, politicians, donors, and civil servants. This paper explores these dynamics by examining, first, whether civil servants are able to avoid political

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<sup>1</sup> Cox & McCubbins, 1986; Dixit & Londregan, 1996; Dahlberg & Johansson, 2002; Hirano, 2011; Weingast, Shepsle, & Johnsen, 1981; Rich, 1989; Martin, 2003.

<sup>2</sup> Brass, 2012; Calvo & Murillo, 2007; Ejedemyr, Kramon, & Robinson, 2018; Franck & Rainer, 2012; Gottlieb, Grossman, Larreguy, & Marx, 2019; Grzymala-Busse, 2008; Habyarimana, Humphreys, Posner, & Weinstein, 2007; Harris & Posner, 2019; Keefer, 2005; Kramon & Posner, 2013; Wibbels, 2006.

<sup>3</sup> Some recent studies have focused on bureaucrats and service provision and/or political capture, such as Brierley, 2020, Oliveros & Schuster, 2018; Boräng, Cornell, Grimes, & Schuster, 2018; and Gulzar & Pasquale, 2017.

<sup>4</sup> See Gailmard & Patty, 2007 for the theory behind this statement.

<sup>5</sup> For seminal work, see Wilson, 1887 and Waldo, 1948. A recent empirical example in this line is Dahlstrom & Lapuente, 2017. There is no clear reason that either the political capture model or the “politics-administration divide” model should be universally dominant.

capture; and second, whether these patterns vary across sub-national units, suggesting that civil servants' behavior may be shaped by space and place.

We analyze a solar panel distribution program in Ghana in which program implementers recognized the risk of political influence and took explicit steps to avoid political capture. In the program, officials from Ghana's Ministry of Energy and Petroleum (MOEP) collaborated with representatives from a donor-funded European multinational company (MNC) to install 1242 solar panels between 2009 and 2012. The program's stated aim was to provide solar photovoltaic panels in un-electrified areas of the country for schools, clinics, police stations, streetlights, community halls, and entertainment spaces, starting with remote and under-developed communities around Lake Volta and then moving on to other areas with poor electricity access.<sup>6</sup> Knowing that distribution would occur during an election period, both the MOEP bureaucrats and the company representatives strove to avoid political capture by using data and analysis – rather than local politicians' input – to determine where panels would be installed. This study seeks to empirically assess whether program officials were successful at keeping electoral politics out of distribution, and to assess the subnational political geography of the effort.

As a young but stable democracy, Ghana provides a useful context for studying the logic of public goods distribution. Since 1992, Ghana has had peaceful elections and has witnessed several transfers of power between the National Democratic Congress (NDC) and New Patriotic Party (NPP), revealing that Ghanaian voters can and do react to political strategies and policies. Ghana also has enough subnational administrative units to facilitate quantitative analysis of meaningful variation across the geographic space.

Additionally, Ghana has a rapidly expanding economy and a goal of universal access to electricity by 2020 (with 10% from renewable sources). Ghana has successfully doubled access in the past decade, reaching 82.5% access in 2016,<sup>7</sup> illustrating that the country's civil service is capable of responding to citizens' need for basic services. Nonetheless, Ghana's MOEP has limited resources to meet its ambitious electrification goals, and it is unlikely that the MOEP will be able to extend the country's national grid to all of the remote communities that need electricity in the medium term, due to the high costs and low predicted revenues from difficult to reach and impoverished areas. MOEP officials therefore worked with donors to distribute solar panels and provide electricity access to some communities, but not others.

Our study takes a mixed-methods approach that combines statistical spatial analysis to test hypotheses and qualitative analysis based on fieldwork to generate hypotheses and explore how distributional logics vary by space and place. Our choice of methods speaks directly to long-standing debates in this journal and others about how to conduct studies that bridge perspectives from political science and geography. We intentionally employ some methods to explain "average effects" across all of Ghana's districts and other methods to theorize subnational variation within the country.

To unpack the "black box" of program implementation, we draw on qualitative interviews with donors, subcontractors, politicians, bureaucrats, and citizens conducted in four regions of Ghana during seven one-month trips between 2014 and 2019. This fieldwork helped to generate hypotheses about how Ministry officials selected districts to receive panels. To test our hypotheses, we first use spatially-lagged dependent variable (SLDV) models in order to isolate the direct effects of a district's political and need-based characteristics on public goods distribution. Then, to determine whether these effects apply uniformly across Ghana's 170 districts, we analyze subnational spatial variation using geographically-weighted regression (GWR). Finally, we employ

qualitative evidence to explore how political history in specific places and the logistics of infrastructure across space shape panel distribution within regions.

Although our results show that districts with more infrastructure were significantly less likely to receive panels, suggesting that MOEP officials were somewhat successful at distributing panels to the remote districts that needed them, results also show that civil servants failed to completely avoid political capture. Panels were allocated to districts where voter turnout has varied. Following Cammett and Issar, we interpret this as suggestive evidence that public goods could be used to *mobilize* potential voters to turn out. Specifically, panels may have been distributed in hopes of inducing voters to turn out and support the incumbent in the upcoming election. Our results show that political capture does not always involve straightforward dyadic exchanges of private goods such as cash or jobs from patrons for loyalty from constituents. We also find that although the basic logic of results holds throughout Ghana, the *magnitude* of the relationship varies subnationally, reflecting differing histories of space and place.

This analysis contributes to distributive politics research by bridging insights from geography, political science, and public administration. Our analysis also suggests that more social scientists should pay attention to decisions made by unelected bureaucrats, in addition to those of politicians.<sup>8</sup> Public administrators often possess both authority and discretion to make allocative decisions,<sup>9</sup> and these actors sometimes grapple with concerns about how to use scarce resources to maximize citizen benefit from public goods amidst political interference. Drawing attention to civil servants allows us to see how a variety of actors with agency – and potentially with different preferences and access to information – shape decision-making. Finally, we implement the recommendation from O'Loughlin's (2018) article in this journal to seriously consider "space and place" in our analysis. We use analytical methods that address spatial dependencies and allow us to examine sub-national variation in hypothesized relationships, as well as qualitative interviews and historical subnational analysis to understand how political geographic context can shape goods allocation.<sup>10</sup>

## 2. The solar program: implementers' efforts to achieve need-based goals

Before outlining possible logics shaping how services are distributed, we begin with an overview of the project, noting the emphasis multiple project implementers placed on the deliberate steps the MOEP and the MNC took to avoid political capture. In interviews, implementers expressed confidence that these careful steps had been successful, which presented an intriguing empirical puzzle.<sup>11</sup>

Through a €300,000 grant from a European government, the MOEP jointly implemented a solar panel distribution program with a donor subcontractor, a private European MNC.<sup>12</sup> The program aimed to provide solar photovoltaic panels in unelectrified areas for schools, clinics, police stations, streetlights, community halls, and entertainment spaces. The panels ranged in size from 100 to 250 W, producing sufficient electricity to power lights, charge mobile phones, and run small

<sup>6</sup> Solar systems were small, ranging from 100 to 250w with 150 to 400wh of batteries.

<sup>7</sup> Kumi, 2017.

<sup>8</sup> Focus on bureaucrats by mainstream political scientists has become more common recently (e.g., Ang, 2016; Brierley, 2020; Oliveros & Schuster, 2018; Boräng et al., 2018; and; Gulzar & Pasquale, 2017), but often *assumes* political control of bureaucrats.

<sup>9</sup> Gailmard & Patty, 2007.

<sup>10</sup> Fotheringham, Brunson, & Charlton, 2002.

<sup>11</sup> Several implementers independently explained their efforts to avoid political capture without prompting by the interviewer, and they did so with apparent pride. This presented a set of questions that motivated our analysis.

<sup>12</sup> Interview GH170209. Interview codes are used to protect human subjects. The code represents the country, year, month, and day. An FGD prefix indicates a focus group discussion.

appliances like laptops and radios. While Ghana has one of the highest rates of electric grid access in sub-Saharan Africa, solar arrays improve electricity access in areas that lack access to the grid, as well as areas where the grid is subject to frequent power outages, which were common in Ghana during the study period.<sup>13</sup> Solar panels are generally considered inferior to the grid<sup>14</sup>; once people sense the possibility of grid access, they no longer want solar as an alternative.<sup>15</sup>

The program targeted areas that were unlikely to gain national electric grid access within five years, starting with tiny, remote island communities within Lake Volta, which were deemed cost-inefficient for future grid expansion.<sup>16</sup> When the Memorandum of Understanding between the Ghanaian government and the company was signed, Minister of Energy Joe Oteng-Adjei emphasized that the facilities were installed at public institutions such as security outposts, clinics, schools and public gathering places, “so as to improve on the general wellbeing of our people.”<sup>17</sup> Implementers also asserted that providing electricity services in remote communities would help those places attract or retain high-quality teachers and healthcare providers, and that later in the program, border areas were targeted to enhance security in those areas.<sup>18</sup>

The program’s 1242 solar panels were distributed by unelected bureaucrats within the MOEP renewable energy office, working closely with a MNC representative stationed in the country. Officials knew at the program onset that they did not have sufficient resources to distribute panels everywhere that they were needed. To select placement sites, implementers began with internal documentation and MOEP Rural Electrification Program maps of existing and planned grid extension, which tends to follow major roadways.<sup>19</sup> Based on these maps, they selected districts that contained areas away from planned grid extension who would need medium-term alternatives to the grid if citizens were to receive basic access to electricity (See Fig. 1). After selecting districts based on current and planned electric grid maps, MOEP and MNC staff traveled to the districts to consult with District Planning Engineers, Solar Project Officers, local bureaucrats from the Ministries of Health and Education, area police, and local-level traditional chiefs.<sup>20</sup> Following Ghanaian policy, these district-level civil servants had already prepared district development plans that assessed and documented the needs of communities within each district.<sup>21</sup> MOEP and MNC staff asked these local officials to help them identify communities to receive solar panels, based on the following criteria: 1) the population size of the community; 2) the number of public facilities such as schools or clinics in the community; and 3) the existence of rural industry.<sup>22</sup>

From these conversations, the MOEP and MNC administrators created lists of all possible recipient communities. The Solar Project Officers then conducted socio-economic impact studies on a short list of communities, narrowing their assessments to public institutions in places that would be able to serve 10 to 30 nearby micro-villages, which were clusters of several families. These communities were then compared to the MOEP data and grid extension master plan before final sites were chosen. MNC and MOEP officials based in Accra traveled to approximately 80 percent of implementation sites to confirm firsthand the absence of electricity in the site, to geocode the precise installation

of the solar panels, and then later to participate in the opening ceremony.

Both Ghanaian and European program personnel were emphatic that selection of recipient districts was apolitical and need-based. Officials were aware that their three-year contract spanned an election cycle, and avoided engaging MPs in the selection process, as MPs were known to encourage distribution to their personal strongholds because “your uncle is living in that place or you want votes for the next election.”<sup>23</sup> When asked whether he worked with local politicians to select recipient districts, one MOEP official reported that “[w]e want to make it free from politics. ... We target the district and it is always free from politics.” However, other civil servants interviewed did acknowledge that MPs had attempted to shape the selection by directly contacting MOEP officials while in Accra and highlighting certain communities on their list, but insisted that final lists of recipient communities were vetted multiple times and cross-checked at the local level to avoid political influence.<sup>24</sup>

### 3. Possible logics of public goods distribution and why they might vary subnationally

This solar distribution project in Ghana therefore represents an extreme case, in that it allows us to test whether bureaucrats who explicitly attempted to distribute goods apolitically were successful, and how it may have varied subnationally. Here, we explore these possibilities theoretically.

#### 3.1. Political distribution

Much of the work in political science on the distribution of public goods, both in the US and elsewhere, has focused on the role of politicians in shaping the distribution of resources for electoral gain. Scholars have suggested that goods are provided by local party officials,<sup>25</sup> by members of Congress or Parliament,<sup>26</sup> or by public officials acting on behalf of incumbent party officials.<sup>27</sup> A growing literature also suggests that within-country aid is distributed largely for political reasons, and may not target the poor.<sup>28</sup> Jablonski, for example, finds that donor-funded programs in Kenya followed the same patronage logic as state-distributed programs, because Kenyan officials took advantage of donors’ lack of information about the distribution of real need to steer aid toward areas where voters were most likely to help them win elections; Briggs echoes these findings.<sup>29</sup> Other scholars have argued ethnic favoritism affects goods distribution, but this remains open for debate.<sup>30</sup>

Many studies thus argue that goods are distributed primarily to affect electoral outcomes by rewarding loyal voters or by gaining the support of swing voters.<sup>31</sup> For example, Dixit and Londregan posit that voters have fixed partisan preferences, but can be induced to vote for the rival party with sufficient material inducement.<sup>32</sup> This suggests that parties can distribute goods strategically to reward and retain loyal supporters, or alternatively, to induce the support of swing voters. The swing voter hypothesis in particular requires an electoral system in which two or more parties actively compete for voters, and also suggests that politicians or parties need a way to identify swing voters or jurisdictions who

<sup>13</sup> MacLean et al. 2016.

<sup>14</sup> GH1405298.

<sup>15</sup> Dugoua & Urpelainen, 2014.

<sup>16</sup> GH170225; GH180312A.

<sup>17</sup> Government of Ghana ND.

<sup>18</sup> GH170209.

<sup>19</sup> GH170209; GH180312A.

<sup>20</sup> In most communities in Ghana, precolonial chieftancy institutions continue to be recognized as legitimate traditional authorities guaranteed in the Constitution, as they oversee use of customary lands and mediate local disputes. They remain separate from the central government structure.

<sup>21</sup> GH180312B.

<sup>22</sup> GH180312A.

<sup>23</sup> GH170209.

<sup>24</sup> GH180312A.

<sup>25</sup> e.g., Dixit & Londregan, 1996.

<sup>26</sup> e.g., Weingast et al., 1981; Weghorst & Lindberg, 2013.

<sup>27</sup> Dahlberg & Johansson, 2002.

<sup>28</sup> Briggs, 2017; Masaki, 2018; Öhler & Nunnenkamp, 2014; Zhang, 2004.

<sup>29</sup> Jablonski, 2014; Briggs, 2014.

<sup>30</sup> e.g., Fearon, 1999; Habyarimana et al., 2007; but see Kramon & Posner, 2013 and Burgess, Jedwab, Miguel, & Morjaria, 2015 for counterarguments.

<sup>31</sup> e.g., Golden & Min, 2013.

<sup>32</sup> Dixit & Londregan, 1996.

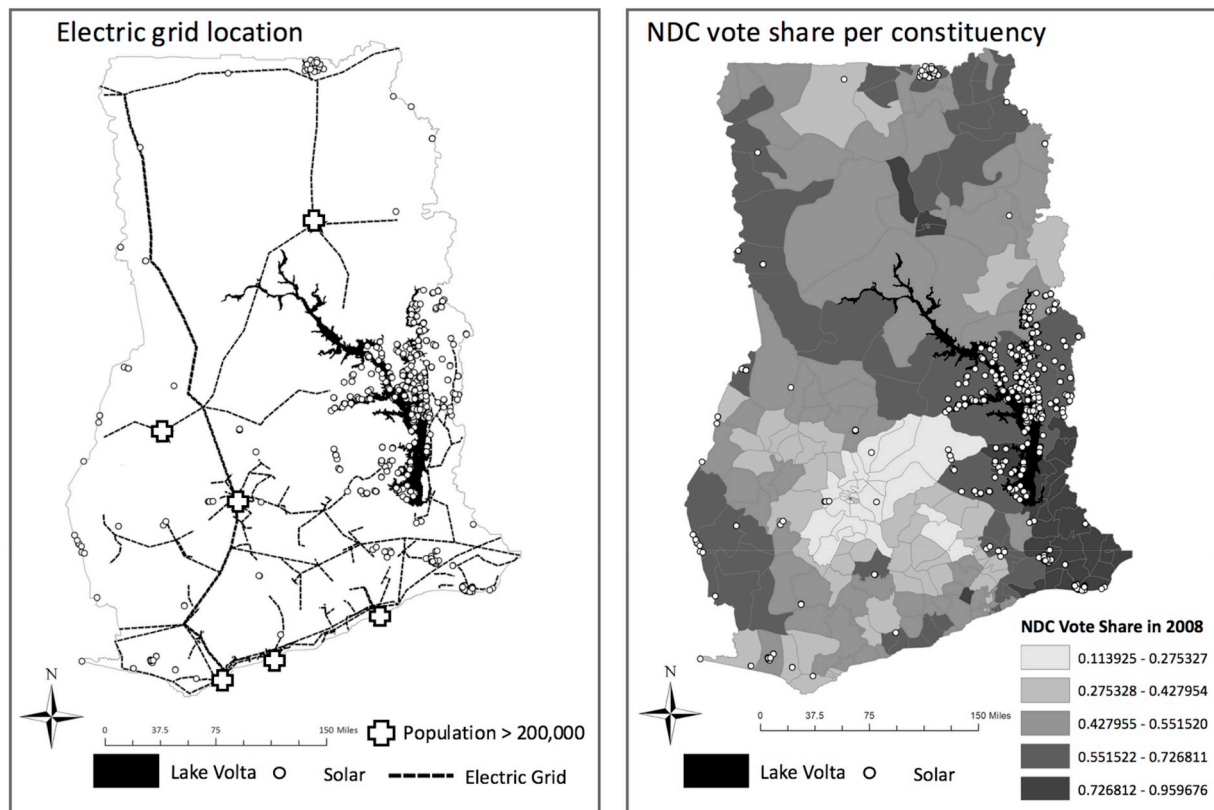


Fig. 1. Maps of solar project locations shown with other key variables.

might be persuaded to shift their support.<sup>33,34</sup>

These competing hypotheses, however, tend to overlook an additional way that voters can express their preferences: by choosing whether or not to vote on election day. Nichter hypothesizes that parties target resources toward “unmobilized strong supporters,” not to gain their vote but to ensure turnout among their base.<sup>35</sup> And incumbent governments sometimes work to provide services to non-supporters in an attempt to mobilize new potential groups of voters.<sup>36</sup> This suggests that politicians might seek to mobilize not only known supporters, but also to mobilize voters who have not consistently participated in elections in the hope that they might support an incumbent who has brought goods to their area.

While scholars often test the loyalist, swing voter, and voter mobilization hypotheses as mutually exclusive rivals, evidence suggests that all are used in sub-Saharan Africa. Many studies find that incumbent parties use goods to reward loyalists.<sup>37</sup> In a recent study of Ghanaian voters, however, Weghorst and Lindberg find evidence that incumbents can effectively gain support of swing voters by providing local public

goods,<sup>38</sup> and Baldwin provides support for the notion that national actors may cede allocation decision-making to local leaders in order to entice the local leaders to mobilize their supporters in the future.<sup>39</sup> While it is clear that politics can affect distribution in emerging democracies like Ghana, no systematic evidence exists in favor of – or opposed to – any of the hypotheses highlighting political drivers.

Moreover, in our particular context, the goods in question were provided by donors, rather than Ghanaian politicians, and were distributed by MOEP bureaucrats. While our interview respondents insisted that they had insulated distribution from political considerations, the implementation process does suggest some opportunity for political capture, particularly if local political officials sought out informal opportunities to advise and influence MOEP officials’ distribution decisions.<sup>40</sup> Based on the above, our first hypothesis, H1, posits that *panels were distributed to districts for purposes of electoral gain*, using one of three political logics:

**H1A.** Officials *reward loyalists* by directing solar panels to districts with historically high support for the incumbent political party.

**H1B.** Officials *induce swing voters* by directing solar panels to districts with historically variable support for the incumbent political party.

**H1C.** Officials *mobilize potential supporters* by directing solar panels to districts with variable participation in elections.

<sup>33</sup> Dixit & Londregan, 1996; Golden & Min, 2013; Dahlberg & Johansson, 2002; Stokes, 2005; 2009; Golden & Picci, 2008.

<sup>34</sup> Strictly speaking, these theories focus on the distribution of patronage goods – such as jobs or favors – to individuals. Nonetheless, the logic of their model is sometimes scaled to the community level, where politicians or public officials acting on behalf of the incumbent party may strategically distribute goods for political gain (Dahlberg & Johansson, 2002; Dellmuth & Stoffel, 2012; Fried, 2012).

<sup>35</sup> Nichter, 2008.

<sup>36</sup> Cammett & Issar, 2010.

<sup>37</sup> Riedl, 2014; LeBas, 2011; Briggs, 2012.

<sup>38</sup> Nuancing these findings, Harding (2015) shows that elections allow voters to hold politicians accountable for service provision when citizens can correctly attribute public goods to them, suggesting that patronage politics can give way to issue-based politics.

<sup>39</sup> Weghorst & Lindberg, 2013; Baldwin, 2014.

<sup>40</sup> Politicians can also use indirect means of control, such as threats of employee reassignment (Brierley, 2020).



### 3.2. Need based distribution

Despite the electoral focus of most distributive politics research, the fact is that career civil servants, not politicians, often make the final decisions about where goods should go. Because these individuals do not face the electoral pressures of politicians, they may be able to avoid political capture, particularly in countries like Ghana that are striving to establish a professional civil service with the capacity to meet ambitious policy goals like providing universal electricity access to all citizens by 2020.<sup>41</sup> To the degree that bureaucrats in countries like Ghana seek to avoid political capture, they adhere to a Weberian model of bureaucracy, where officials are appointed on the basis of their qualifications, are expected to treat citizens equally, are rewarded for their ability to meet policy goals, and are kept relatively insulated from political pressures.<sup>42</sup> Empirical evidence suggests that the Weberian model – rather than the complete political capture model – tends to predominate in industrialized countries, but some studies have also shown that bureaucracies in developing countries with greater Weberian characteristics produce positive outcomes.<sup>43</sup> A literature on “pockets of effectiveness” or “islands of excellence” in developing countries also highlights that bureaucrats given autonomy – expressly shielded from political patronage pressures – are more able to achieve development goals.<sup>44</sup>

While political scientists have focused on politics as the predominant logic behind goods distribution, many non-elected decision-makers claim to act based on citizen need, whether or not they succeed at doing so. At least one study has shown that aid that by-passes government entirely is *not* subject to patrimonial distribution.<sup>45</sup> There are several different ways that bureaucrats might think about citizens’ need for electricity. If bureaucrats are primarily concerned with meeting citizens’ current need for electricity, we might expect them to simply target solar panel distribution in places that currently lack electric grid access.

But solar panels are considered inferior to access to the national grid in countries like Ghana. And since Ghana is rapidly expanding the electricity grid, bureaucrats might have a forward-looking orientation where they provide panels in areas that are also unlikely to receive grid access in the near future. Here, we draw on interviews in five sub-Saharan African countries to acknowledge that there is a particularly strong relationship between road infrastructure and the likelihood of getting grid access. The link between grid expansion and roads may not be initially obvious, but grid extension requires road infrastructure to transport the required materials (poles, transformers). Moreover, energy ministries often prioritize grid extension along major roads, because this strategy allows the government to provide electricity to hospitals, schools, and population centers to maximize social benefits. Fig. 2 shows a 2009 map of planned grid extension (left), with a map of trunk roads (right). Thus, if bureaucrats have a more future-oriented conceptualization of citizens’ need for electricity, we might expect to see panels allocated to roadless areas where grid expansion is unlikely.

Our second hypothesis, H2, posits that *panels were distributed to districts to meet citizens’ need for electricity*, using one of two need-based logics:

**H2A.** *Officials meet citizens’ current needs by directing panels to districts with limited grid access.*

**H2B.** *Officials meet citizens’ expected future needs by directing solar panels to districts with limited road networks, which make future grid expansion unlikely.*

### 3.3. Spatial variation and spatial dependence in the logics of distribution

In addition to the political and need-based logics proffered above, there are reasons to think that space and place might affect officials’ decisions about where to distribute goods in ways that are rarely examined in empirical analyses. Solar panels, for example, are not a good that is simply distributed among citizens; panels must be installed in a particular place, connected to lighting or other appliances, and care must be taken to maintain panels over time. Previous literature suggests that solar panels in particular should be installed in places where there are qualified engineers who can ensure that panels are installed and maintained correctly,<sup>46</sup> or alternatively, that solar panel programs should be clustered in areas that facilitate program implementers’ ability to conduct routine maintenance. There is thus an element of spatial dependence in solar panel distribution, where panels are distributed in proximity to one another, or in proximity to existing resources that can support installation, operation, and long-term panel maintenance.

Moreover, while we hypothesize that both political and need-based logics may play a role in panel distribution, it is not clear that these logics will be uniform across all of Ghana’s districts. The area around Lake Volta (which is not the same territory as the “Volta Region” administrative unit; see Fig. 3), for example, has a unique history in Ghana, where the area was flooded when Akosombo Dam was created in the 1960s to create the country’s first large-scale hydroelectric dam. While the dam’s electricity improved communications and services in Ghana’s large cities, flooding made the communities around Lake Volta more isolated, turning some communities into islands and forcing others to rely on bridges and ferries or to construct new roads that would connect them with the country’s cities and industrial hubs. The Lake Volta area was also seen as an area where grid extension might never be feasible and where need-based logics seemed particularly likely to prevail. Given this historical legacy of place and contemporary reality of space, civil servants might be particularly attuned to the needs of citizens in the Lake Volta area. In the next section, we discuss how we empirically test these hypotheses.

## 4. Research design, methods, and data

At the time of project site selection, there were 170 administrative districts in the country.<sup>47</sup> Although there are some political appointees at the district level, such as the District Chief Executive, districts are the primary public administration unit around which public agencies, including ministries, organize their work.<sup>48</sup> For example, statistical data is almost always collected and presented at this administrative level.

To determine whether bureaucrats were able to avoid political capture in solar panel distribution, we analyze whether the number of panels allocated to a particular district is significantly correlated with that district’s historic voting patterns or characteristics that represent the district’s need for electricity services. We test this correlation using both OLS and SLDV models, which provide us estimates for the country as a whole. We then use geographically-weighted regression (GWR) to examine how our findings vary spatially across Ghana’s districts. Finally, we provide qualitative analysis of interviews, focus groups, and primary and secondary source materials that helps to make sense of our findings. We purposively selected participants for over 65 in-depth interviews and 19 focus group discussions in a variety of rural and urban communities.

<sup>41</sup> Per the Ghana Vision 2020 plan.

<sup>42</sup> Walton, 2005; Olsen, 2006.

<sup>43</sup> Evans & Rauch, 1999; Rauch & Evans, 2000; Oliveros & Schuster, 2018.

<sup>44</sup> Geddes, 1994; Leonard, 2010; Bersch, Praca, & Taylor, 2017; Dahlstrom & Lapuente, 2017.

<sup>45</sup> Dietrich, 2013.

<sup>46</sup> Brass, Carley, MacLean & Baldwin, 2012.

<sup>47</sup> Districts make up Ghana’s second-level administrative unit, after region.

<sup>48</sup> District Chief Executives are directly appointed by the president, but districts do not have national political meaning in the way that parliamentary constituencies do.

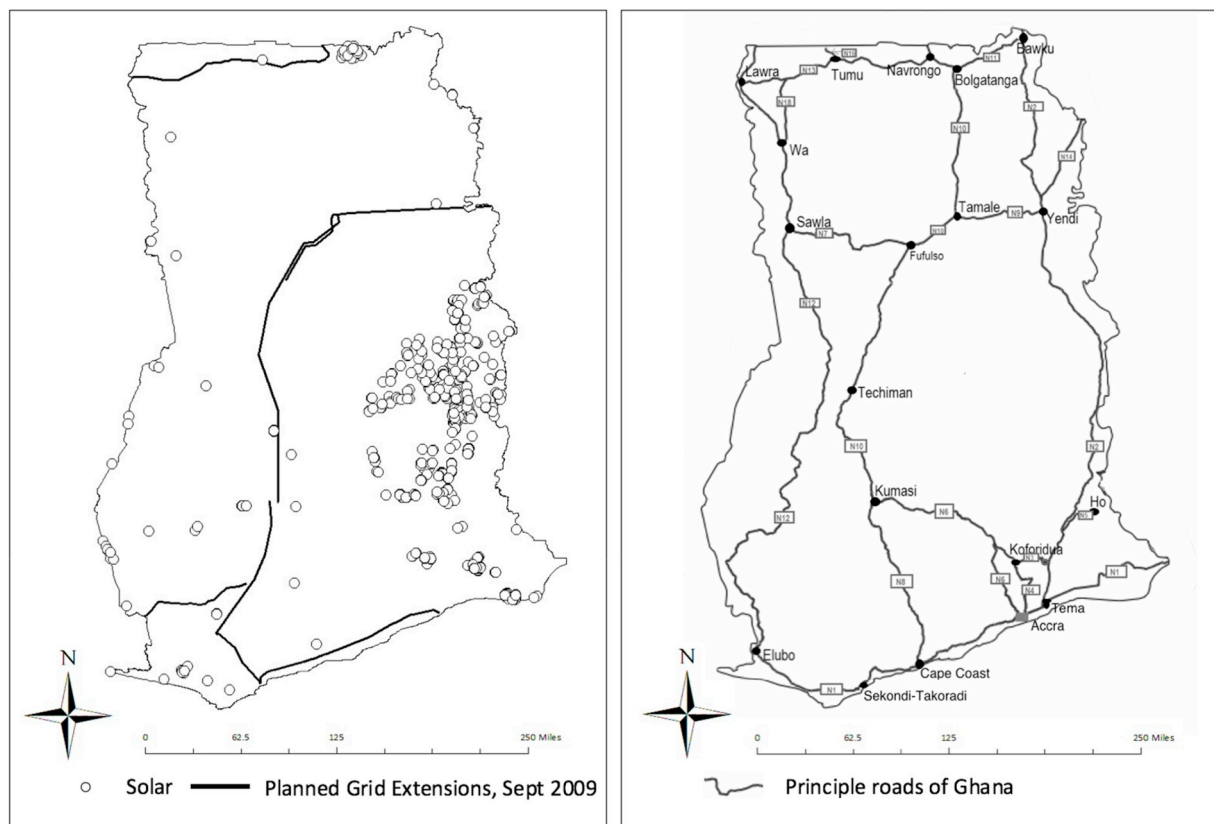


Fig. 2. 2009 MOEP planned grid extension (left) and trunk roads of Ghana (right).

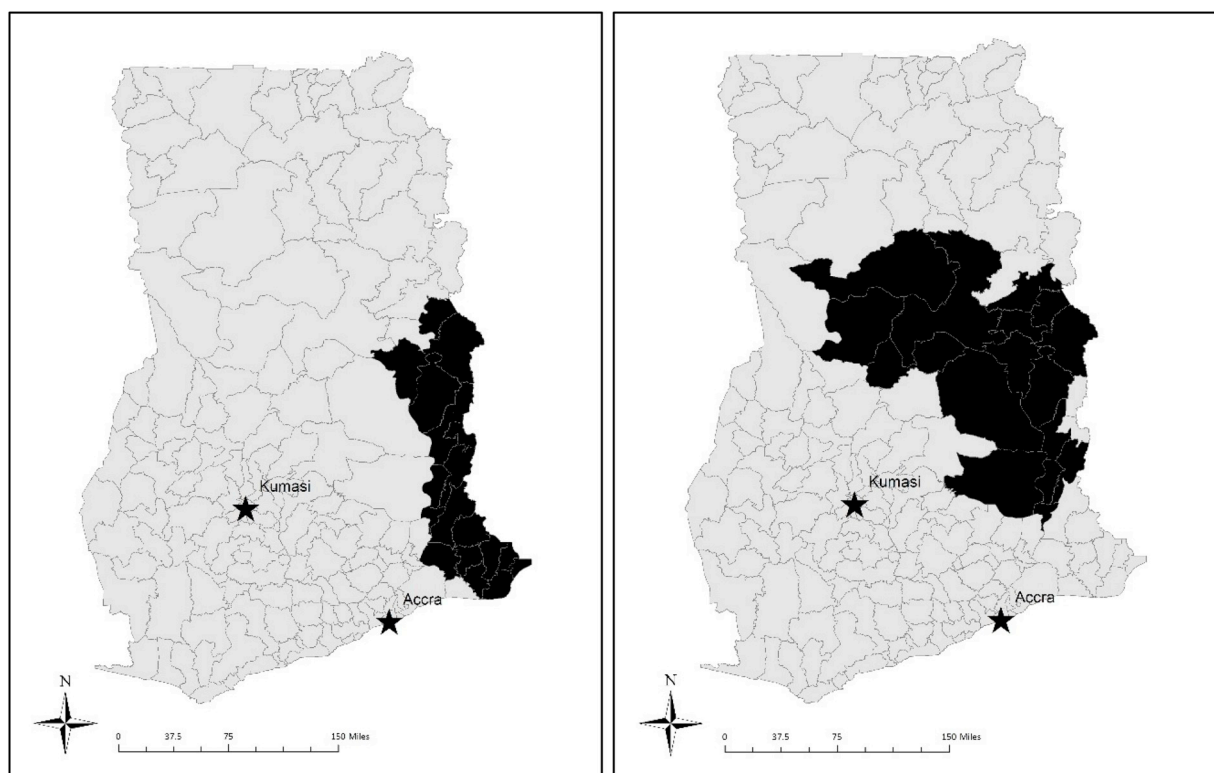


Fig. 3. Distinction between the Volta region, an administrative unit (left) and “the area around Lake Volta” referred to in this paper (right).



#### 4.1. Spatially lagged dependent variable models and geographically weighted regression

As the above section suggests, we have theoretical reasons to expect that our dependent variable, the number of panels allocated to a given district, may exhibit spatial clustering. Since such clustering violates the normal OLS assumption that observations are independent, we use spatially-lagged dependent variable (SLDV) models, which account for the possibility that the values of the dependent variable in one location are influenced by the values in nearby locations. SLDV models allow us to isolate the effect of explanatory variables on solar panel installations by controlling for the prevalence of other solar panels in nearby districts.<sup>49</sup> The model used in these analyses is:

$$y = (\rho)Wy + X(\beta) + \varepsilon,$$

where  $y$  is the number of solar panels distributed to a district,  $X$  is a matrix of district characteristics,  $\varepsilon$  is a vector of error terms, and  $\rho$  and  $\beta$  are parameters.  $Wy$  is a spatially lagged dependent variable for weights matrix  $W$ , representing a geographically weighted measure of other districts' solar panel distributions as a function of  $X$  characteristics. In the model,  $\rho$  represents the indirect effects of other districts' characteristics on  $y$  as a function of spatial dependence, and  $\beta$  represents the primary coefficient of interest in this analysis, the direct effects of a districts' own characteristics on  $y$ , controlling for spatial autocorrelation.<sup>50</sup>

We also use geographically weighted regression (GWR) to probe for localized patterns of behavior in Ghana's subnational political geography.<sup>51</sup> GWR allows us to examine whether the distributional logics that are significant in our primary SLDV models reflect trends that are consistent throughout Ghana, or whether these effects hold only in some areas of the country, such as those bordering Lake Volta where the program initiated. Whereas global models produce a single coefficient representing the average marginal effect across all units for an independent variable, GWR produces individual coefficient estimates for each unit of the data.<sup>52</sup> Our GWR analysis thus estimates a coefficient for each district in Ghana for each variable of interest, which allows us to examine subnational variation.

#### 4.2. Variables and data

Data for the dependent variable, "solar projects" come from the MOEP and represent 1242 individual solar panel installations during the 2009–2012 time period.<sup>53</sup> The dataset provides geographic coordinates for each solar project installed, which allowed us to convert the point data into district-level counts using ArcGIS. Because the projects were designed to meet community – rather than individual – needs, a single additional solar installation has the potential to reach multiple households, and places with many installations provide benefits to many people.

Our independent variables of interest focus on our hypothesized logics of distribution. Starting with political logics of distribution, we operationalize our hypotheses by exploiting changes in the ruling party in the 2004 and 2008 elections. The NDC party, in power since 1992, lost to the rival NPP party in 2000 and again in 2004, but regained the

presidency in 2008, just before the panels were distributed. To operationalize the "reward NDC loyalists" hypothesis, we measure district level vote share for the NDC party in the 2008 election. If politicians sought to use solar panels to reward supportive districts, we would expect them to direct panels to areas where NDC support was high in 2008. To operationalize the "induce swing voters" hypothesis, in contrast, we use the absolute value of the difference between the 2004 and 2008 NDC vote share to indicate the amount of support that is potentially "up for grabs."

We also create two measures that operationalize the hypothesis about mobilizing potential supporters. First, we create a variable, "Mobilize nonvoting incumbent supporters," that multiplies the percentage of 2008 nonvoters in a district by the percentage of incumbent supporters. High scores on this measure suggest that a district's voters are likely to support the incumbent but that they did not turn out in the last election, giving politicians a potential opportunity to use public goods to mobilize potential supporters. To operationalize the hypothesis that politicians may target goods in districts where voting is historically variable, we measure the absolute value of difference in turnout between the 2004 and 2008 elections. We use the absolute value for this measure because whether turnout increased or decreased is not relevant to our hypothesis. An increase in turnout between 2004 and 2008 suggests that voters were more motivated to go to the polls in 2008 than 2004, and a decrease in turnout suggests that voters were more motivated to vote in 2004 than in 2008. In either case, what is critical for our hypothesis is that voters' turnout varies, suggesting that voters' motivation to engage in politics is inconsistent and could therefore change in response to politicians' public goods distribution strategies. In districts where this value is low, voters are consistent in their decisions to go to the polls or stay home, and there is little opportunity for politicians to use public goods to mobilize them.

All political variables are created using replication data from [Ichino and Nathan \(2013\)](#), which provides measures of NDC support and voter turnout for Ghana's political constituencies.<sup>54</sup> 133 of Ghana's 170 districts comprise a single constituency, allowing us to use Ichino and Nathan's constituency-level measure. For the 37 districts that contain multiple constituencies, we create district level variables by combining constituency levels and then weighting the results by sub-district constituency population.

Turning next to our need-based logics of distribution, we create two variables that measure the *need* for electricity in different ways. To operationalize our hypothesis that panels are distributed where current grid access is limited, we calculate the amount of electricity grid in each district on a per capita basis.<sup>55</sup> To operationalize our hypothesis that panels are distributed to areas unlikely to receive grid access in the future, we create a road density measure.<sup>56</sup> Districts with limited road infrastructure are unlikely targets for future grid expansion (see [Fig. 2](#)), suggesting high need for solar panels.<sup>57</sup>

In addition to the independent variables of interest, we also include a number of control variables that might affect goods distribution, including ethnic fractionalization, population density, poverty rates, inequality, and literacy, the ratio of females to males, and the number of World Bank-funded projects and health care facilities.<sup>58</sup> We also include the percentage of 2008 nonvoters, which is used in our interaction term. All variables are measured at the district level using data from several

<sup>49</sup> Diagnostic tests revealed that SLDV models were a better fit for our data than an alternative, spatial error models; see the Appendix for more information.

<sup>50</sup> Results are estimated using a package called "spdep" in R, including the "impacts" function for post-estimation. Direct effect coefficients can be interpreted like OLS coefficients. See [Bivand et al., 2005](#).

<sup>51</sup> [Darmofal, 2008](#), p. 944.

<sup>52</sup> [Fotheringham, Charlton, & Brunson, 1998](#); [Calvo & Escobar, 2003](#); [Darmofal, 2008](#), pp. 944–945.

<sup>53</sup> [Government of Ghana ND](#).

<sup>54</sup> [Ichino & Nathan, 2013](#).

<sup>55</sup> As an alternative variable specification, we examined electric grid density.

<sup>56</sup> Two datasets for roads in Ghana exist: CIESIN's data and a dataset used by [Harding \(2015\)](#) that focuses on trunk roads. We use the CIESIN data because it includes urban roads and feeder roads, which connect rural areas to each other, and which provide a better proxy for local-level infrastructure.

<sup>57</sup> [Foley, 1992](#).

<sup>58</sup> [Ichino and Nathan \(2013\)](#) have more detailed ethnic data for the Brong Ahafo region, but it was not available for the country as a whole.

sources (see Table 1). Details on variable creation and descriptive statistics are in the Appendix.<sup>59</sup>

## 5. Model results

Results are presented in Table 2.<sup>60</sup> Model 3, which presents an SLDV model, is our primary model since it accounts for spatial autocorrelation. We also present Models 1 and 2, OLS models with standard errors clustered by region, for specific reasons: Model 1 allows us to show how results of SLDV compare to those using OLS. It also shows the results of a basic model without an interaction term in it. Model 2 then includes the interaction between NDC vote share and the percent of nonvoters in a district, in order to test the hypothesis that solar panels are intended to mobilize supporters of the incumbent political party. We present this

**Table 1**  
Description of variables.

Variable	Description	Source
<i>Dependent Variable</i>		
Solar projects	Number of total solar projects at district level	Ghana– Ministry of Energy, 2009–2012
<i>Political Variables</i>		
Reward NDC loyalists (2008 NDC vote share)	2008 NDC vote share	Ichino and Nathan (2013), data from 2008
Induce swing voters (NDC vote share volatility)	Absolute value of the difference in NDC vote share from 2004 to 2008	Ichino and Nathan (2013), data from 2008
Mobilize nonvoting incumbent supporters (nonvoters * NDC vote share)	Interaction between the percentage of nonvoters and NDC vote share in 2008	Ichino and Nathan (2013), data from 2008
Mobilize voters where turnout level varies (turnout volatility)	Absolute value of the difference in turnout from 2004 to 2008	Ichino and Nathan (2013), data from 2008
<i>Need Variables</i>		
Electric grid per capita	Electric grid length in km divided by population	Harvard World Map Project, data from 2000
Road network density	Measure of future need for grid extension; Road density (km/km <sup>2</sup> )	Center for International Earth Science Information Network (CIESIN)/Columbia University, and Information Technology Outreach Services (ITOS)/University of Georgia, 2013
<i>Control Variables</i>		
Ethnic fractionalization	Measure of ethnic diversity	Ichino and Nathan (2013), data from 2008
Population Density	Population divided by district area	Ghana Statistical Service–2010 Census
World Bank projects	Measure of convenience; count of World Bank projects	AidData database of project locations from 2000 to 2011
Percent nonvoters 2008	1 minus 2008 turnout rate	Ichino and Nathan (2013), data from 2008
Poverty rate	Percent of people in poverty	Ghana Statistical Service–2010 Census
Inequality level (Gini)	Gini Index of inequality	Ghana Statistical Service–2010 Census
Number of health facilities	Count of health facilities	Ghana– Ministry of Health, released 2016
Literacy	Literacy rate	Ghana Statistical Service–2010 Census
Female ratio	Ratio of the population that is female	RS/GIS Lab at the University of Ghana, Legon, data from 2014

<sup>59</sup> The number of districts in Ghana grew from 170 to 216 during the life of this program's implementation (Resnick, 2017). We use the 2008 boundaries for consistency.

<sup>60</sup> See Appendix for a variety of robustness checks.

**Table 2**  
Results of two modeling strategies for total solar projects.

	OLS Model 1	OLS Model 2	SLDV Model 3
<i>Political Variables</i>			
H1A: Reward NDC loyalists (2008 NDC vote share)	19.69 (12.47)	–56.75 (70.11)	14.69 (1.21)
H1B: Induce swing voters (NDC vote share volatility)	48.68 (73.04)	60.39 (76.22)	49.23 (1.05)
H1C: Mobilize nonvoting incumbent supporters (nonvoters * NDC vote share)		262.97 (253.41)	
H1C: Mobilize voters where turnout level varies (turnout volatility)	145.22* (59.38)	128.93* (55.95)	119.35* (2.19)
<i>Need Variables</i>			
H2A: Electric grid per capita	–5059.93+ (2669.37)	–4939.84+ (2613.32)	–4545 (–1.08)
H2B: Road network density	–171.33* (72.61)	–162.41* (69.07)	–141.97** (–2.62)
<i>Control Variables</i>			
Ethnic fractionalization	7.00 (12.24)	9.27 (12.25)	2.61 (0.25)
Population density	0.004+ (0.002)	0.004+ (0.002)	0.003 (1.39)
World Bank projects	–0.22 (0.25)	–0.28 (0.27)	–0.28 (–0.70)
Percent nonvoters 2008	36.97 (50.49)	–88.89 (106.52)	42.72 (0.97)
Poverty rate	–0.06 (0.12)	–0.07 (0.12)	–0.09 (–0.73)
Inequality level (Gini)	0.14 (0.30)	0.17 (0.29)	0.08 (0.27)
Number of health facilities	–0.04 (0.05)	–0.04 (0.05)	–0.03 (–0.33)
Literacy	–8.70 (18.24)	–10.49 (18.02)	–13.59 (–0.84)
Female ratio	–377.37 (237.45)	–372.23 (231.38)	–363.85** (–2.58)
N	170	170	170

+ p < 0.10; \*p < 0.05; \*\*p < 0.01; \*\*\*p < 0.001.

OLS estimates are mean effects and standard errors clustered by region in parentheses.

SLDV estimates are mean direct effects and simulated z-statistics in parentheses.

model using OLS analysis, since it is unclear how to interpret an interaction term in an SLDV model.

Turning first to the political variables, results show no support for the reward loyalists or induce swing voters hypotheses. However, there is mixed support for the voter mobilization hypothesis. While Model 2 suggests that panels are not directed at districts with potential to mobilize non-voting incumbent supporters, model results show a statistically significant relationship between turnout volatility and solar panels: a one standard deviation increase in district turnout volatility is associated with almost five additional solar panels, holding all other factors constant. These results suggest that while the program was not used as a vote-buying exercise, efforts to avoid political influence were not fully effective, and politicians may have used solar projects in an attempt to mobilize future turnout.<sup>61</sup> Interview responses support this interpretation.<sup>62</sup> Although MOEP and MNC implementers explained all of the measures they took to avoid such political capture, another civil servant associated with the program at the MOEP in Accra reported that some politicians tried to exert control over constituency-level solar

<sup>61</sup> We also examined a binary indicator of whether turnout increased or decreased from 2004 to 2008, rather than the absolute value. Results, available in the Appendix, remained consistent.

<sup>62</sup> Akee, CopelandCostello, Holbein, & Simeonova, 2018 and Baicker & Finckelstein, 2018 also found politicians using goods to mobilize voter turnout.

panel allocations. This official said that MPs and other politicians believed that if they distributed solar devices, recipient constituents would come out and vote for them in future elections.<sup>63</sup>

Turning next to the need-based hypotheses, the OLS models show a negative and statistically significant correlation between electricity grid per capita and solar panel allocations, providing modest support for Hypothesis 2A. In the SLDV Model 3, which accounts for spatial clustering, the electricity grid per capita variable is not significant, suggesting that spatial considerations – such as geographic proximity of panels and ease of providing maintenance – may combine with need-based considerations to shape bureaucrats' allocation decisions. Across all models, there is a significant and negative correlation between panel allocation and road density. A one standard deviation increase in road density is associated with roughly seven fewer panels, suggesting that panels are significantly less likely to be allocated to road-dense areas where grid expansion is likely.

While these results suggest that civil servants were not able to fully avoid political capture, they also suggest that distribution is shaped by infrastructural need and the capacity to organize the logistics of space. Even after controlling for political factors, solar panels were distributed to remote areas with limited transportation infrastructure – the very areas that are least likely to receive grid access in the foreseeable future, and where citizens are likely to receive long-term benefits from their solar panels.

### 5.1. Analysis of distributional logics at the local level using geographically weighted regression

While the results of OLS and SLDV models are informative, their presentation of “global” average marginal effects across all districts may mask local variation that is of interest to political geography scholars. To examine local variation, we employ geographically weighted regression (GWR), which estimates distinct model coefficients for each district. These estimates allow us to examine whether relationships between variables are similar throughout Ghana; whether they are positive or negative in different parts of the country; and whether the magnitudes of the relationships vary. Identifying which of these scenarios are occurring adds valuable nuance. We focus interpretation on the hypothesized drivers of panel distribution that were significant in SLDV models: road density and turnout volatility. Maps facilitate the assessment of variation in coefficients across these subunits, which we present in Figs. 4 and 5. Statistical results and technical details are available in the appendix.

Fig. 4 shows GWR coefficient ranges, including their clustering, for road density and turnout volatility at the district level. The maps reveal that there are clear subnational geographic patterns for how these variables affect solar panel placements, a dynamic that gets hidden in the global models. But the GWR results also suggest that the basic logic of distributing projects where infrastructure is limited is fairly consistent countrywide. The relationship between road density and solar panel receipt is almost universally negative, save for the northeast corner of the country, an area with high road density that received a cluster of panels. The magnitude of the relationship is strongest in the districts surrounding Lake Volta. Likewise, results from GWR show that turnout volatility is positively associated with panel distribution in most of Ghana, with a particularly strong relationship in the subset of the districts that border Lake Volta. GWR results thus suggest that the underlying logic of distribution is consistent countrywide, but that the strong magnitude of effects in the area bordering Lake Volta may be driving the statistically significant results reported in our global SLDV models.

Additional context is needed to understand these local patterns.<sup>64</sup> The clustering around Lake Volta might suggest that solar projects were directed towards areas that suffered from displacement from the new

Volta Lake when the Akosombo Dam was constructed in the mid-1960s. While we cannot rule out the possibility that historic injustice was a factor behind project implementers' decision to target the region, our results indicate that the logic of distribution cannot be explained by dam-related displacement alone. Although displacement was most acute along the eastern edge of Lake Volta, we see clusters of solar panels on the east, west and south of the lake, as well as elsewhere in Ghana.

The maps thus tend to suggest that projects went to areas where both need and turnout volatility were high, even within the areas near the lake. Fig. 5 shows maps of solar power projects with road density and voter turnout volatility, respectively, at the district level. These maps reveal that the area around Lake Volta is the *only* area that combines high values of voter turnout volatility with low values of road density.<sup>65</sup> This yields a combined motivation to place solar power projects in this area: high need and high voter mobilization potential.

### 5.2. Qualitative analysis theorizing subnational variation: politics of place and logistics of space

Our SLDV models suggest that both a political logic and a need-based logic shaped the distribution of solar panels. The GWR then revealed that the magnitude of the relationships varied across space within Ghana. We turn now to qualitative evidence from fieldwork to theorize two different spatial dynamics at the subnational level – the politics of place and the logistics of space. This qualitative analysis suggests that it is not simply access to service provision that matters, but also the history and quality of how that service is delivered in different regions of Ghana.

First, we examine the politics of place. In the southeast corner of Ghana, MOEP officials initially targeted Dangme East as one of the districts to receive solar panel distribution. Dangme East received a total of 68 panels, far higher than the nationwide district average of 7. The district is known to be a political stronghold for the NDC party, with 80% of voters in the district supporting the NDC in the 2008 elections, and posters promoting local NDC candidates pasted on every corner. But, politics was not the only factor driving distribution in the district. Dangme East is also a rural district with limited grid infrastructure and unmet needs for electricity. A former District Chief Executive lamented that many of the communities “were not hooked to the national grid.”<sup>66</sup> Local and central government politicians and civil servants agreed that the communities around what is now Lake Volta were particularly deserving of some kind of electricity, precisely because so many people had been displaced from their homes or had their livelihoods in fishing or agriculture negatively impacted by the construction of the Akosombo Dam in the 1960s.

While the greatest number of solar panels were distributed around Lake Volta, two other notable clusters could be found in the border towns on the northern frontier with Burkina Faso and the western boundary with Cote d'Ivoire. One central ministry official explained that the government was targeting solar panels for public facilities such as clinics, schools, and security outposts in communities that were not likely to get the grid.<sup>67</sup> Hence, these border areas had greater political importance for the security of the country than other similar places without access to the grid.

Qualitative interviews also revealed how the logistics of space differed across regions. In the areas bordering Lake Volta, it was too expensive to extend the central grid to “hard to reach” communities with low population density living on small islands in the lake or in the estuary.<sup>68</sup> One District Assembly civil servant in Dangme East explained that island communities were selected to receive solar panels “because

<sup>65</sup> See the Appendix for a robustness check including an indicator for a district containing Lake Volta. Results remain consistent.

<sup>66</sup> GH180308.

<sup>67</sup> GH140529.

<sup>68</sup> GH180312; GH180308; GH181019; FGD2-181017.

<sup>63</sup> 2GH952914.

<sup>64</sup> Cho & Gimpel, 2010, p. 87.

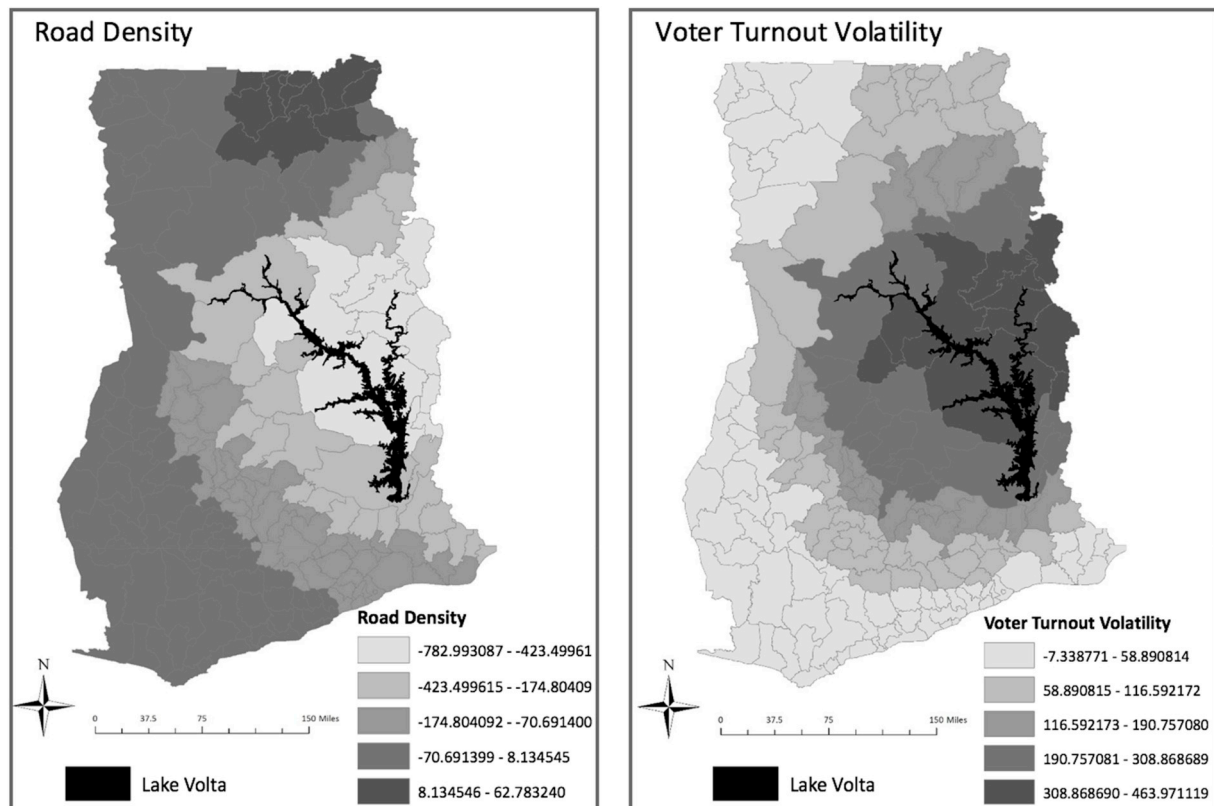


Fig. 4. GWR district coefficient maps for key variables (DV = total solar panels).

the grid will never go there – it is so difficult to reach, and there is so much cost involved in trying to get there.<sup>69</sup> A central government official echoed this point when he explained how the MOEP targeted certain remote areas with solar panels: “In some places, by virtue of their location, it is just impossible to extend the national grid, now or ever.”<sup>70</sup>

Meanwhile, in the northern border area, the logistics of space differed in important ways. Low road density and low population density made grid extension even more expensive than further south. One NGO official working in the Northern region justified the use of small-scale solar: “There are certain areas that electricity cannot go [in the Northern regions]. The roads are bad or don’t exist. You cannot even cross the area with the trucks carrying the poles.”<sup>71</sup> One official from the distribution company in the northern regions known as NEDCO explained how lower population density further affected the finances: “In the South, you can take one pole and connect six houses. Up here, you can take ten poles to connect just one house! And that house will use only 3 bulbs. No fridge, or TV, or anything. The cost of operation is so huge!”<sup>72</sup>

These logistics problems were aggravated by the technical challenges of transmitting electricity across long distances. By the time electricity was transmitted from the dams and thermal plants in the southern regions of Ghana over 700 km to the border town of Paga, the current was notoriously low and unreliable. According to a civil servant from Ghana’s transmission company, “By the time the power reaches all the way to Tamale [still four hours south of the northern border], then there is some loss because it is a long way; the power is less strong.”<sup>73</sup> One NGO representative from Bolgatanga stated: “The service provided is not

good. The quality is very poor.”<sup>74</sup> A district assembly representative concurred: “Our power is not stable. Power will drop (low current) and then go off and then come back on again.”<sup>75</sup> The fundamental problem was not basic access to the central grid, but, instead, the quality of the electricity delivered across space given the distance from the power generation source.

## 6. Discussion and conclusions

Our results offer new insights about distributive politics in emerging democracies. One of the motivations of this paper was to understand whether political capture is inevitable in them, or whether it can be avoided in certain contexts – such as here, where a relatively capable bureaucracy, working with donor implementers, explicitly sought to avoid political influence in their public goods distribution. Our results suggest that MOEP officials were not fully successful in their efforts to keep politics out of distribution. Although panels went to places whose lack of road infrastructure pointed to long-term need for non-grid approaches to electric service provision, they also went to places with political meaning. Here, though, our results provide very limited support for distributional logics that center on politicians buying votes from either supporters or swing voters. Instead, our results suggest that politicians may be aware of and try to incentivize people to go to the polls in areas with inconsistent turnout. And while the use of public goods to mobilize voters is usually designed to work to the advantage of the incumbent, these results suggest a nuanced political calculation. Rather than straightforward vote-buying, it appears that political actors could strategically use welfare-enhancing goods to attract the support of previously un-mobilized voters.

Our finding that panels may be used to mobilize turnout also suggests

<sup>69</sup> GH180312.

<sup>70</sup> GH140529.

<sup>71</sup> GH190314.

<sup>72</sup> GH190313A.

<sup>73</sup> GH190312.

<sup>74</sup> GH190316.

<sup>75</sup> GH190313B.



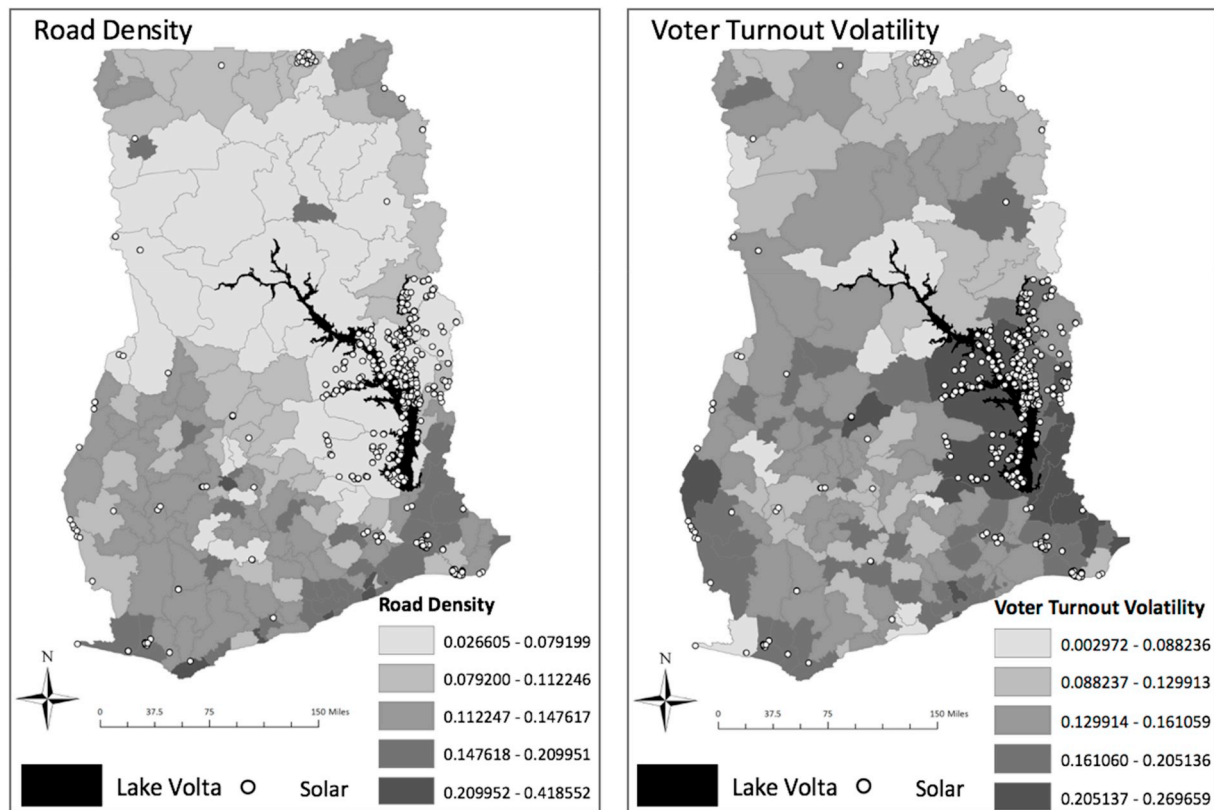


Fig. 5. Solar projects overlaid with road density and voter turnout volatility.

that scholars may have paid short shrift to how the nature of the good shapes the logic of distribution. Whereas our findings suggest that distribution of panels was used to *mobilize* voters, Briggs finds that political parties use the extension of the central electricity grid to either *reward* supporters or gain *swing* voters in Ghana during the same time period.<sup>76</sup> One possible explanation for these divergent findings is that solar panels and grid extension are a fundamentally different type of public good.<sup>77</sup> Much of the existing literature implicitly assumes that different types of public goods are, in principle, equivalent – that is, if political strategy or ethnic favoritism is the dominant strategy for one public good, those findings can be generalized to other types of public goods. Kramon and Posner, however, demonstrate the limits of this assumption by showing that distributional logics may vary by type of good.<sup>78</sup> In a study of multiple goods and services across three countries in Africa, they find evidence that public officials favor some ethnic groups with one type of public good, but favor another group with a different good.

Here, we extend Kramon and Posner's logic to argue that public officials may use short-term and long-term goods in fundamentally different ways, and that these strategies vary by space and place. The electricity grid is a long-term good: it is an expensive and durable investment in welfare-enhancing infrastructure that facilitates long-term access to transportation and communication. Grid extension benefits not only the local community, but also provides benefits to others who travel to or trade with that community. Having access to the electric grid, moreover, has been a core feature of the collective national identity of Ghana ever since the first president, Kwame Nkrumah, vowed to dam the Volta River to provide power for West Africa, and Ghanaian politicians often make electricity access a key campaign promise.<sup>79</sup> Politicians

may thus invest in grid extensions to ensure continued support and gain support of swing voters in subsequent elections. Solar panels, however, represent no major infrastructure investment or long-term commitment on the part of the state, and are widely seen by citizens as a stopgap measure until the state brings the electric grid to a community.<sup>80</sup> Although they have significant potential to enhance community welfare, they are fundamentally different than the national grid, and citizens are unlikely to see panels as fulfilling political promises to provide citizens with electricity access. They may, however, be easily deployed to areas that are unsuitable for grid extension; and they could be used to buy votes or induce turnout. Our analysis thus highlights that short- and long-term goods could have different logics of distribution.

At the same time, this study's generalizability is limited by the specific context of a single country case study. Here, Ghana is a fairly well-consolidated democracy with strong economic growth, but that is highly dependent on foreign aid. Additional studies are needed to test this relationship in other contexts. Meanwhile, given its high degree of aid dependence, the study's findings that bureaucrats and local actors have some autonomy and influence over project implementation, particularly at the local level, are significant.<sup>81</sup>

This study therefore suggests that scholars of distributive politics in developing countries may need to continue to widen the lens beyond elected politicians and donors to consider the possibility of an emerging democratic politics within the bureaucracy. Although some studies do this, we argue that scholars still need to pay more attention to the attitudes and behaviors of bureaucrats, and how they may shape goods distribution. Our interview evidence counters negative stereotypes

<sup>76</sup> Briggs, 2012.

<sup>77</sup> See also Min (2015) regarding electricity as a public good.

<sup>78</sup> Kramon & Posner, 2013.

<sup>79</sup> MacLean et al., 2016; Gore, Brass, Baldwin, & MacLean, 2019.

<sup>80</sup> GH1405298.

<sup>81</sup> Although not a core feature of the paper, our analysis highlights the importance of examining the role of donors within aid-recipient countries on subnational distributional politics (see e.g. Gibson, Andersson, Ostrom, & Shivakumar, 2005).



about developing country bureaucrats, showing that in some cases – for example, in countries with relatively high levels of wealth and administrative capacity – civil servants can be committed to improving citizens' welfare and capable of deploying sophisticated strategies to improve it. In Ghana, civil servants took strategic advantage of donor funds and engaged in a planning process that used data and analysis to identify priority areas that most needed solar panels. They were aware that their efforts might be undermined by election-year politics and took steps to reduce political influence. While they were not fully successful at insulating goods distribution from politics – and it is even possible their efforts even represent the upper bound of bureaucratic prevention of political capture – they nonetheless distributed public goods to areas with significant long-term need. Our case thus highlights civil servants as important decision makers who may exercise discretion in ways that improve citizens' welfare.

Finally, in addition to examining the overall logics that shape goods distribution, this study analyzed subnational variation in the direction and magnitude of these logics. Our study highlights that spatial factors – like proximity of roads, availability of skilled technicians, or potential to streamline distribution by clustering goods – may play an important but overlooked role in distribution decisions. The difference between our OLS and SLDV models illustrate the importance of spatial factors, as well as the potential errors that might be made if they are ignored.

Beyond simply showing the utility of accounting for spatial clustering, however, this study also suggests the need for more careful analytical disaggregation of subnational units, including more careful analysis of subnational space and place. Results from GWR analysis show considerable spatial variation in the strength of the effects of need and politics across Ghana, with effects most pronounced in the area around Lake Volta. Our qualitative interviews with project implementers, moreover, suggests that perceptions of historic need shape these observed patterns; and that logistical concerns about how to most efficiently deliver public goods across physical space also shapes implementation strategies. Statistically significant patterns across an entire country can easily mask divergent causal processes in individual locations.<sup>82</sup> In cases where there is a particularly strong relationship between variables in one area, average marginal effects for the country could lead researchers to mistakenly draw conclusions that do not apply throughout that country.

Our paper thus illustrates how more careful use of mixed methods can help bring the perspectives of geography to bear on questions of importance to political science. Political scientists and geographers often have divergent ideas about what questions are important and how they should be approached methodologically. Like many political scientists, we are interested in testing generalizable hypotheses about the factors that drive goods distribution. Here, to isolate the causal relationship of interest, we must control for relevant spatial factors in our models. But we are also interested in understanding whether these drivers are stronger in some places than others, and why these patterns might vary across Ghana. To do so, we need to examine spatial patterns and engage in qualitative analysis to understand whether and why the drivers of distribution might vary. Our study thus highlights that synthesizing across these perspectives – and including mixed methods that analyze subnational variation qualitatively – can produce a more complete answer to important questions about distributional politics than would otherwise be possible.

## Data statement

Data is available from the authors upon request.

<sup>82</sup> Clemons et al. (2015) make a similar argument about variation in distributional logics used by different members of Congress; GWR can allow analysts to examine this variation.

## Declaration of competing interest

None.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.polgeo.2019.102087>.

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