Mobile Phones, Information and Economic Voting in Sub-Saharan Africa

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Abstract

In many low-income countries, politics takes place in uncertain political environments. This makes one's personal economic circumstances a stronger heuristic for government performance, such that economic voting is predominantly egotropic in nature. Yet as information about the macroeconomy and the inequality it embeds profilerates, we might expect voters to respond in a more sociotropic way, either directly rewarding incumbents for overseeing strong growth, or benchmarking their personal circumstances against national trends. To examine this mechanism, this paper studies the recent, rapid and homogenous expansion of mobile phone use across Sub-Saharan Africa. Mobile phones have a well-established informational function, and evidence from survey data and nighttime lights suggest that users make more accurate assessments of the national economy and use them when deciding how to vote. The argument is strengthened with an identified analysis in Ghana, exploiting the rollout of mobile coverage over time through a spatial difference-in-differences design. Overall, the paper shows that information proliferation can have important effects for the nature of performance voting in new democracies.

Introduction

In recent years mobile phone use has increased exponentially across all parts of Sub-Saharan Africa, with scholars seeing this as a marked structural shift akin to an "information revolution" (Kosec and Wantchekon 2020). Mobile phones have been shown to serve an informational function, increasing users' knowledge of the national political environment in which they are situated through their capacity to build social networks and connect users around a country. These effects are particularly significant where media markets are weak and where politics is uncertain. Most African countries fit this description (Bourgault 1995; Riedl and Lupu 2012), and mobile phones have been shown to affect protest, clientelistic engagement and political violence across the continent (Aker and Mbiti 2010; Pierskalla and Hollenbach

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2013; Keefer and Khemani 2014; Aker, Collier, and Vicente 2017; Gonzalez and Maffioli 2020; Manacorda and Tesei 2020). However, despite the fact that most African countries are nominally democratic, carrying out regular elections in which voters can hold politicians to account(Cheeseman 2015), the effects of mobile phones and political information on electoral behaviour have yet to be studied.

This paper closes the gap, offering a general theory of information and economic voting applied to Africa's large-scale information revolution. Much study of African electorates stresses the importance of local, *egotropic* economic evaluations in driving incumbent support. Yet while local economic performance is a fundamental part of one's lived experience that is inseperable from day-to-day life, the macroeconomy and one's relative position in it is a more abstract social phenomenon largely driven by proceedings elsewhere (Reeves and Gimpel 2012). As voters begin using mobile phones en masse, they obtain information about national economic performance to which they were previously not exposed. This makes *sociotropic* economic considerations more important in structuring vote choice, with voters using newfound knowledge to *directly* punish or reward macroeconomic conditions, or to *benchmark* their own personal circumstances. Both mechanisms have precedent in Europe, the US, Latin America and India, but have not been rigorously examined in Africa (Duch and Stevenson 2008).

The argument is tested with two empirical strategies. One links survey data with nighttime lights to validate the microfoundational assumptions of the theory, showing that mobile phone users do have more accurate economic perceptions and that these appear to condition their support for the incumbent. The other uses historical mobile coverage maps, special-access survey data and constituency-level election results in Ghana, employing a spatial difference-in-differences design to show that constituencies in coverage are more responsive to the state of the national and relative economy.

Overall the paper presents and tests a parsimonious theory of economic voting in low-information political environments, providing evidence that is qualitatively informed, descriptively representative and causally identified. It contributes to the broader literature by extending the study of economic voting to underrepresented contexts, and refines our understanding of how information shapes electoral outcomes in new democracies.

The Argument

Economic Performance and Incumbent Support

A long literature in comparative political science ties voters' perceptions of the economy to their electoral choices. In general, the national economy matters most to voters and is the strongest predictor of support for the incumbent government. The logic of economic voting arguments is inherently simple; voters hold the government responsible for the state of the economy, so retrospective economic evaluations are a significant predictor of incumbent support (Lewis-Beck and Stegmaier 2019).

We can distinguish the effects of *egotropic* and *sociotropic* economic evaluations, where

egotropic refers to one's personal economic circumstances, and sociotropic to those of the country as a whole (Fiorina 1981; Kinder and Kiewiet 1981). In general, sociotropic evaluations have greater explanatory power than egotropic ones (Duch and Stevenson 2008; Lewis-Beck and Stegmaier 2019), with consistent evidence from the US (Kramer 1971; Tufte 1978; Campbell et al. 1980; Lewis-Beck and Ratto 2013), Europe (Norpoth et al. 1991; Stubager, Lewis-Beck, and Nadeau 2013; Hobolt and Tilley 2014) and Latin America (Remmer 1991; Benton 2005; Lewis-Beck and Ratto 2013; Singer 2013).

Studies that trace the effects of the sociotropic economy propose a handful of causal mechanisms. For some authors, the national economy is itself important to voters and offers a general heuristic for government performance that is *directly* punished or rewarded (Kinder and Kiewiet 1981). For others the national economy allows voters to *benchmark*, by comparing the performance of their own country relative to similar counterparts (Kayser and Peress 2012; Arel-Bundock, Blais, and Dassonneville 2019; Aytaç 2020), or by subnationally comparing their region or group to national trends (Besley and Case 1995; Dash and Ferris 2020; Green, Hellwig, and Fieldhouse 2021). Finally, some question whether sociotropic judgements are actually *about* the national economy, arguing that voters' national perceptions are a reflection of performance in their local area (Reeves and Gimpel 2012) or the circumstances of people from a similar profession, age or class (Ansolabehere, Meredith, and Snowberg 2014), although some recent experimental work has pushed back against this (Damstra, Boukes, and Vliegenthart 2021).

In most African countries, however, sociotropic and relative judgements do not seem to be strong drivers of vote choice. Despite macroeconomic volatility being similar to that in other continents (Otchia and Asongu 2020), African Presidents have strong incumbency advantages (Cheeseman 2015; Bleck and Van de Walle 2018) and, at an aggregate level, electoral defeat seems unrelated to the state of the national economy.

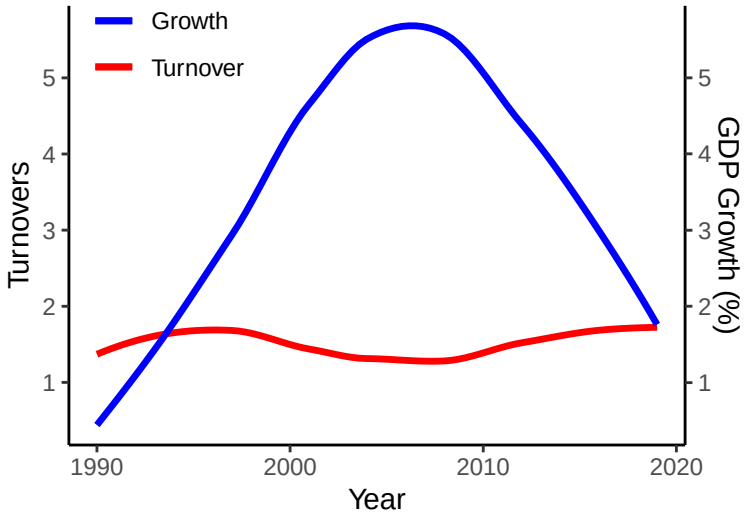

Figure 1: Turnover and Economic Growth in Sub-Saharan Africa, 1990-2019. Trend lines fitted with LOESS.

Instead, economic voting in African countries seems to be driven predominantly by local considerations. Scholars have shown that voters respond to egotropic evaluations (Eifert, Miguel, and Posner 2010; Bratton, Bhavnani, and Chen 2012), which themselves update in response to the quality of easily attributable public goods (Harding 2015, 2020; Kramon 2016; Carlson and Fidalgo 2016; Kadt and Lieberman 2020). Often such effects are studied in a context of ethnic polarisation and biased performance assessments (Adida et al. 2017). However, such polarisation is evident in only a handful of African countries (Elischer 2013; Harding and Michelitch 2019), and moreover does not seem theoretically distinct to existing work on partisan-biased evaluations in developed nations (Evans and Pickup 2010), at least in the narrow context of economic voting.

Despite this work, however, existing studies fail to explain why the national economy seems to matter less in elections across Africa than in other continents. One continental difference that could explain this effect is access to information about politics, with proliferation of mass media across Africa lagging the rest of the world (Bourgault 1995).[1] While most theories of economic voting assume that objective economic performance is strongly correlated with subjective perceptions (Rueda and Stegmueller 2019), this assumption is less likely to hold in African countries, where politics takes place in a deeply uncertain environment (Riedl and Lupu 2012).[2] Somewhat uniquely, then, rapid exposure to new information has the potential to exhibit significant effects on how African voters' perceive the economy.[3]

Mobile Phones as Information in Sub-Saharan Africa

While most African countries have had historically low access to information about politics, there is evidence that this is changing. In particular, mobile phone use has increased rapidly and homogeneously in the past twenty years, representing a structural shift in media use for most African electorates. Mobile phones exhibit national-level informational effects, such that their increased use should lead to increased information about the state of the national economy.

Firstly, there is a wealth of evidence that mobile phone use has rapidly increased across Africa and that this increase extends to all groups of society. At an aggregate level, World Bank data on mobile subscriptions and survey data on self-reported mobile use show a sharp increase over time. Comparatively, we can see in Figure 2 that African countries were late adopters of mobile phones when compared to their European and Latin American counterparts.

Digging into the individual-level determinants of mobile use with AfroBarometer survey data,

[1] With the exception of radio, although radio stations in Africa typically operate in local languages and focus on localised news stories, so do not offer the same access to national political information.

[2] There is convincing evidence to support this assumption in wealthy, developed nations (Fernández-Albertos and Kuo 2018; De Vries, Hobolt, and Tilley 2018), but it remains largely untested how far the assumption travels.

[3] While development economists and political scientists have struggled to find consistent informational effects in low-income countries (Dunning et al. 2019), these studies do not assess national-level outcomes. Instead, it is typically information about *local* performance or corruption that is randomised. This makes the mixed results less surprising; voters live and experience their local economic environment, so have information about it by definition.

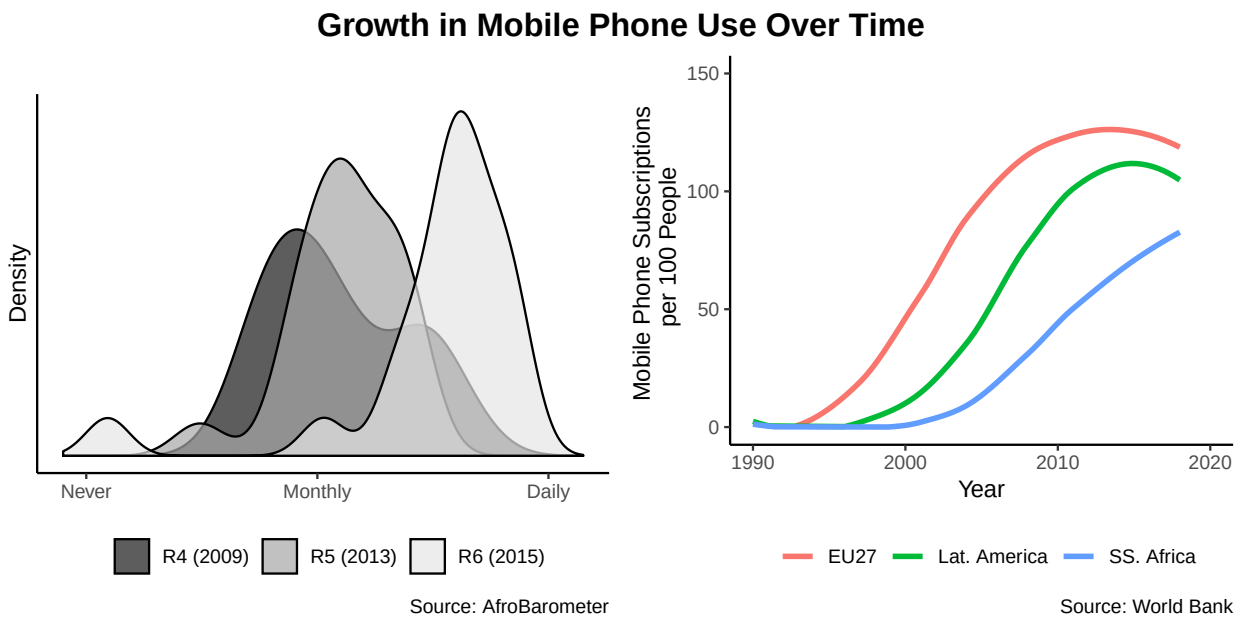

Figure 2: Mobile Phone Use, 1990-2018

we can see that demographic divides in use are diminishing over time and that this only applies to mobile phones. Using growth models that trace how the probability of using a mobile phone changes as a function of time, we can see that only mobile phone and internet use see significant increases. When a range of demographic covariates are included in the model and interacted with years, we can see a firmly negative trend for mobile phones that is not present for any other media source. In other words, biases toward urban, well educated respondents (panel A) are decreasing over time (panel B), suggesting that mobile use is growing in a balanced manner.[4]

Given that mobile phone use has increased dramatically across Sub-Saharan Africa, the question turns to whether we should expect this to impact voters' political information. Evidence from ethnographic and development economics literatures suggest that mobile use connects individuals to fellow users around the country, providing access to national-level information about the economy.

Mobile phones' primary informational function stems from their capacity to expand social networks. Phones are conceptually different to traditional mass media sources, in that they enable *two-way* communication, such that users can receive and create content (Kosec and Wantchekon 2020). As users join larger networks, they become exposed to content generated by others across the country, providing insight into events outside the user's local area. This represents an *informational* mechanism. Alternatively, mobile users can use their newfound social networks to create and mobilise others along national grievances, offering a mechanism

[4]Specifically, I estimate a mixed effects model of the following form, with country-round random intercepts:

$$media_{ik} = (\alpha_0 + u_k) + (\beta_0 + v_k)years_k + \gamma X_{ik} + \eta(X_{ik} * years_k) + \epsilon_{ik}$$

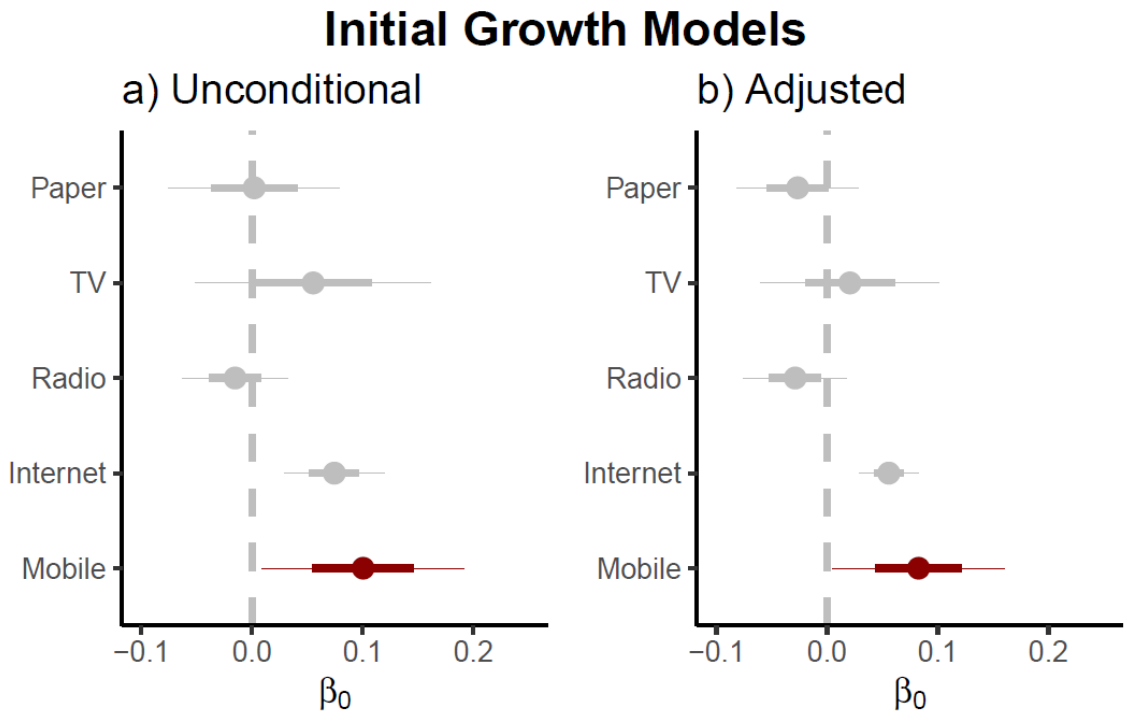

Figure 3: Unconditional Growth Models. The plotted coefficients represent the time fixed effect parameter, and can be interpreted as the average growth in use per year. There is significant growth for mobile and internet use, which panel (b) shows to be robust to covariate adjustment.

of *co-ordination* (Manacorda and Tesei 2020). In this way, mobile phone use becomes a source of national political information for users.

A selection of ethnographic studies points to mobile phones precipitating the expansion of social networks and enlarging the arena in which political discourse plays out (Gagliardone 2019). In Kenya, Nyabola (2018) frames mobile phone use and social media as representing new political spaces, which elites seek to control precisely because of their informational effect. In Senegal, Riley (2019) considers the use of digital spaces as a place for citizens to find new ways to "circulate information" (p. 131). In Nigeria, Orji (2019) shows how voters use mobile phones and social media in the 2011 and 2015 elections to connect and learn from people around the country with shared political interests. In Ghana, Dzisah (2018) demonstrates the positive role played by social media in recent election campaigns to promote nationwide information about government performance to voters.

By definition, most of this literature uses intensive case-studies and are cautious about generalising beyond them. Recent studies from the development economics literature offer accounts that are less case-specific, but which generalise further. In particular, scholars have highlighted the informational power of mobile phones across Sub-Saharan Africa, with outcomes ranging from clientelist engagement, participation in protest, incidence of political violence, and containment of Ebola (Aker and Mbiti 2010; Pierskalla and Hollenbach 2013; Keefer and Khemani 2014; Aker, Collier, and Vicente 2017; Gonzalez and Maffioli 2020; Manacorda and Tesei 2020). Some of these papers offer conclusions that, at least in a statistical sense, can be generalised to the entire continent and offer support for the microfoundational

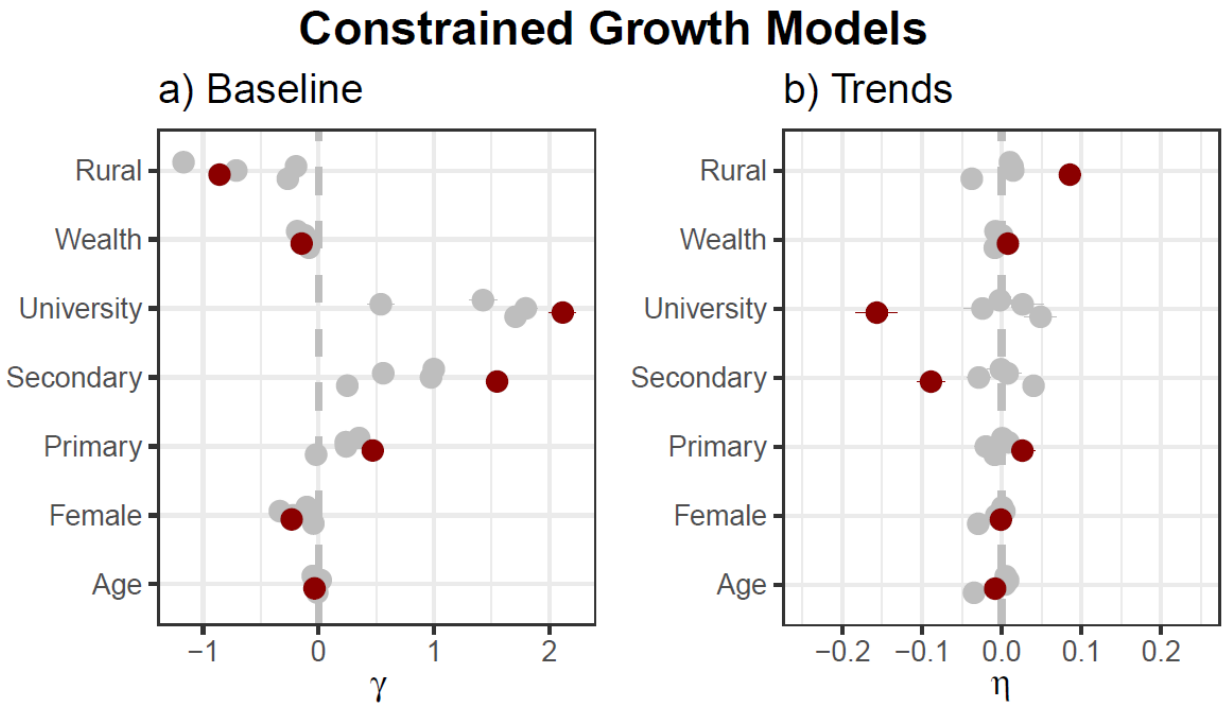

Figure 4: Constrained Growth Models. Red dots represent mobile phones. Panel (a) presents the fixed effects parameters for each demographic indicator, representing heterogeneity in the average level of use. Panel (b) presents the each covariate's interaction with time, representing demographic heterogeneity in the rate of change in use. The results suggest that mobile phone use amongst rural and lesser educated respondents increases at a faster rate than other media sources, implying that growth extends to these disadvantaged groups.

assumptions of this paper. To date, however, none have focused explicitly on electoral outcomes, despite the widespread prevalence of democracy in the region.

Collectively, the discussion thus far leads to the following *informational* hypotheses, to be tested empirically later in the paper. Mobile users should have more accurate information about the performance of the nationwide economy, and their own local circumstances in relation to it. However, mobile use should exhibit no effect on the accuracy with which voters assess their own local economic circumstances, as these are part of one's lived experience rather than an abstract social construction.

> **H1**: Mobile phone users will have more accurate assessments of national level economic performance, all else being equal.
>
> **H2**: Mobile phone users will have more accurate assessments of their relative economic position, all else being equal.
>
> **H3**: Mobile phone use will not affect the accuracy of local economic assessments, all else being equal.

From Mobile Use to Incumbent Support

Given these informational effects, we can consider how mobile phone users may use their knowledge of the national economy to punish or reward incumbent governments. The previous discussion touched upon two key mechanisms of interest here: direct and benchmarked economic voting.

Firstly, voters may see particularly strong or weak macroeconomic performance and wish to hold the incumbent directly accountable for it. Most African countries have strong executives with clearly demarcated responsibility for national economic governance, so it hence makes sense that voters hold them responsible for macroeconomic change.

However, an alternative is that voters use the general macroeconomic climate to contextualise their own personal circumstances. If personal circumstances stay constant but the economy as a whole grows, a voter might feel left out of the proceeds of growth and punish the President accordingly. Conversely, where personal situations improve in a context of macroeconomic decline, there is greater reason for a voter to reward the President for their relative prosperity.

These two mechanisms offer subtly different expected outcomes with respect to macroeconomic performance. To bring them together, I conceptualise two distinct types of economic growth. Where the macroeconomy grows or contracts *significantly*, a large and visible change from the previous year, voters will lean towards the direct mechanism. Extreme change in the national climate warrants direct reward or punishment to the executive, irrespective of local considerations. However, when macroeconomic change is only *moderate*, a smaller and less discernible shift from the previous year, voters are less likely to punish or reward it directly. Instead, voters will benchmark their personal economic (mis)fortunes, and use this when determining how to vote. This leads to the slightly counterintuitive outcome that, holding personal circumstances constant, moderate improvements in the macroeconomy will lead to a

relative decline in support for the incumbent among mobile phone users. These theoretical expectations are summarised in H4 and H5 below.

> **H4**: When the national economy performs significantly better (worse) than the local economy, mobile phone users will be more (less) likely to support the incumbent President.
>
> **H5**: When the national economy performs moderately better (worse), mobile phone users will be less (more) likely to support the incumbent President, all else being equal.

Microfoundations

The first empirical step of the paper is to use survey data to verify the microfoundational assumptions made in the theoretical argument. Namely, are mobile phone users more informed about the state of the national and relative economies, and does this condition their support for incumbent Presidents?

To do so, I deploy data from Rounds 4 and 5 of the AfroBarometer social survey, a series of nationally representative face-to-face surveys from around the continent. Round 4 is the first to ask about mobile phone use, and collectively the data covers the period from 2009-2013, during which mobile use expanded significantly.[5] To trace variation in economic performance at the subnational level I use nightlights data, aggregated at the first order administrative level, to proxy local economic performance.[6] Each AfroBarometer respondent is allocated to one such subnational unit, such that the datasets can be merged with relative ease.[7]

Do mobile phones increase political information?

Are mobile users better at assessing the state of the national and relative economy? To test this, I take respondent's subjective economic evaluations of the past 12 months, and compare them to the change in objective nightlights performance data for the same period.

To simplify measurement and interpretation, I code mobile use and economic performance as binary variables. Individuals who use a mobile phone several times a week or more are coded as 1, and 0 otherwise. Assessments of the economy as being "better" or "much better" are coded as 1, and "worse" or "much worse" as 0. Objectively positive changes to the economy in the last 12 months, at either level, are coded as 1, with negative changes set to 0. A region has a positive relative economy when its local economic change is larger than the average

[5]The analysis focuses on countries which are minimally democratic, such that elections take place and are seen as the main constitutive element of democracy, but making no assumptions about their freedom or fairness (Przeworski et al. 2000) nor about past incidence of turnover (Huntington 1991).

[6]There is also an argument that nightlights provide a more impartial measure of national economic performance than those reported by governments directly. For example, Martinez (2019) demonstrates that autocrats in Africa deliberately overestimate official GDP estimates.

[7]There are typically 10-20 such first order administrative units in each sample country. In total, the analysis leverages variation from 271 distinct units, containing around 50,000 individual AfroBarometer respondents.

local change across the country in that year.[8] Finally, economic assessments are coded as "correct" when they match the objective change, i.e. when both are equal to 0 or both equal to 1.

I then use linear mixed effects models to see how mobile use changes the probability of a correct assessment. I adjust for other media use and demographic covariates, and include country-round random intercepts. If mobile phone users make more accurate economic assessments, β_1 will be positive and statistically significant. This is expected to be the case for the national and relative economies, but not the local.

$$correct_{ijk} = (\alpha_0 + u_k) + \beta_1 mobile_{ik} + \xi media_{ik} + \gamma X_{ik} + \epsilon_{ik} \quad (1)$$

A concern with this specification is that the magnitude of economic change is not taken into account. Where changes to the economy are particularly large, they will be more visible to respondents, irrespective of media consumption. If mobile phones users happen to live in areas that face more pronounced change, this could confound the measurement of the informational function of mobile phones. To mitigate this possible selection bias, I run additional specifications that control for the absolute value of economic change (i.e. $|e_{t=2} - e_{t=1}|$). If β_1 retains its significance, it provides confidence that the results lend support to the informational mechanism, and are not spurious.

$$correct(e)_{ijcr} = (\alpha_0 + u_k) + \beta_1 mobile_{ik} + \beta_2 |\Delta e_{jk}| + \xi media_{ik} + \gamma X_{ik} + \epsilon_{ik} \quad (2)$$

The results, as shown Figure 5 below, provide strong support for H1-H3. Firstly, mobile phone use has a significant effect on correct assessments at the national and relative level, with users being around 1.3% more likely to form a correct assessment. Secondly, as expected under H3, there is no effect at the local level. This replicates the findings of existing work in the US; all voters share common information about local economic performance, and divergences arise only in relation to the national economy (Ansolabehere, Meredith, and Snowberg 2014). Thirdly, the results are robust when the magnitude of economic change is accounted for, with there being close to no change in the size or significance of the coefficients. This provides confidence that the effect is driven by information, rather than being a product of selection. I also note that the results are unchanged when an equivalent logistic mixed effects specification is used (not reported), insuring against model dependency.

Collectively, then, the analysis lends support to the idea that mobile phone users are systematically better at predicting the state of the national and relative economies. The next step of the argument is to connect information to vote choice, making the critical theoretical jump to incumbent support and economic voting.

[8] The average regional change, for country n and region j, is $\frac{\Sigma_{n=1}^{j} \Delta e_{jc}}{j_n}$, where a country has j_n administrative units.

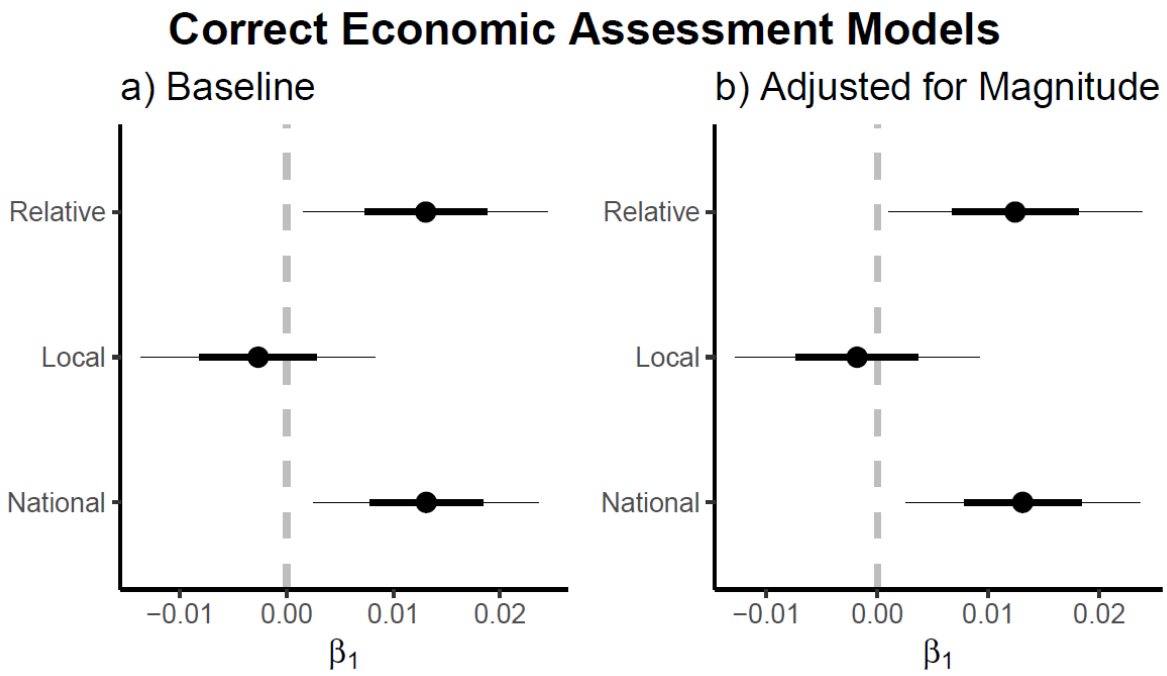

Figure 5: Mobile Phone Use and Correct Economic Perceptions. Each panel presents the marginal effect of mobile phone use on the probability of correctly assessing the economy. Panel (a) presents the baseline specification, whereas panel (b) presents the results when controlling the magnitude of economic change. The result imply that mobile phone users make systematically more accurate assessments of the national and relative economies, but are no better at assessing the local economy. This is firmly in line with theoretical expectations.

Is information used to hold politicians accountable?

Mobile phone users have more information about the national economy, but do they use it to hold the President accountable? I address this with two empirical analyses. The first focuses on general relationships, showing that mobile users condition their support on objective changes to the national and relative economy, in a way that non-users do not. The second distinguishes between moderate and significant changes to the economy, to provide specific evidence of direct and benchmarking effects.

General effects of the economy

To see whether mobile users lend more weight to national and relative economic evaluations, I specify mixed effects models that measure support for the incumbent President as a function of mobile use and the economy. Again I hold constant an array demographic characteristics and use of other media sources. The key coefficient of interest is the interaction between mobile use and the change in the economy. If this is positive and significant, it implies that changes in the economy have a larger effect on Presidential support for mobile phone users, in line with the theoretical argument. Presidential support is operationalised through a voting intention question, coded as one if the respondent intends to vote for the President's party and zero otherwise.

$$support_{ik} = (\alpha_0 + u_k) + \beta_1(mobile_{ik} * \Delta e_{ik}) + \xi media_{ik} + \gamma X_{ik} + \epsilon_{ik} \quad (3)$$

The results broadly support H4 and H5, showing that the objective economy matters more for informed voters. As can be seen in Figure 6, the national and relative economy exhibit a positive and statistically significant effect for mobile phone users, but there is no significant relationship for non-users. The results indicate that a standard deviation increase in the national or relative economy increases the probability that a mobile phone user will vote for the incumbent President by around 2%, relative to a non-user. Substantively, this effect could be large enough to change the outcome of a close election. Ghana's 2008 Presidential contest is one such election, and is discussed in the next section.

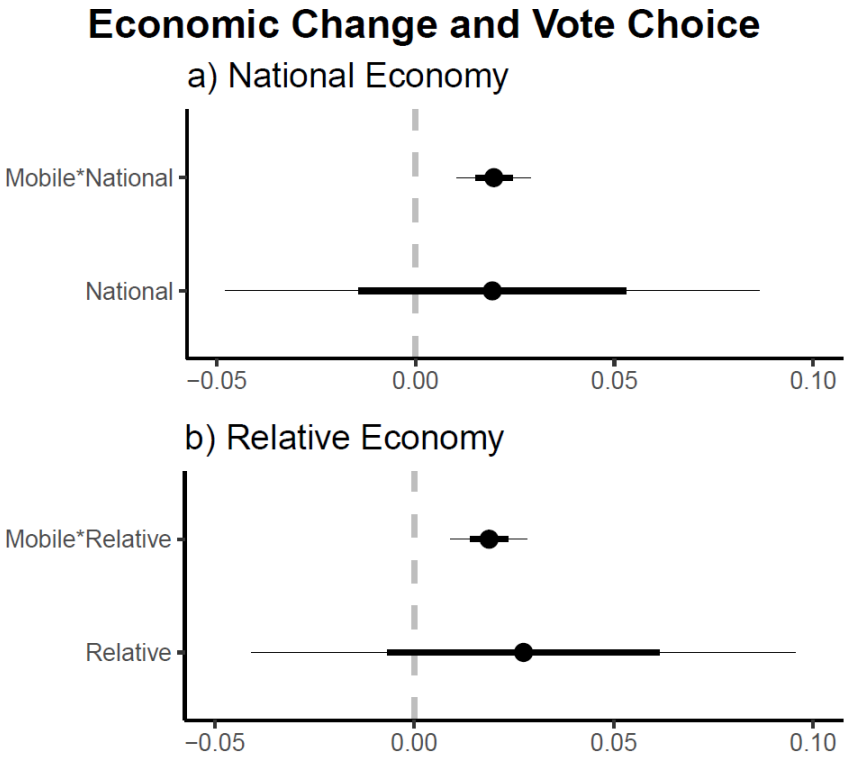

Figure 6: Objective Economic Change and Vote Choice. Panel (a) shows the effect of national economic change on vote choice, identifying a positive and statistically significant effect for mobile phone users, but no effect for non-users. Panel (b) shows the same results hold for the relative economy.

Benchmarking and Direct Effects

The theoretical argument outlined two channels by which the national economy affects incumbent support. Where the national economy undergoes significant change, this change is directly rewarded or punished by voters, leading to a positive direct effect and a negative relative effect. Where the national change is moderate its effects are instead benchmarked, mattering only in relation to changes at the local level. The direct effect of the national economy hence becomes negative, and benchmarking positive. These expectations are summarised in the table below.

Change to National Economy	Marginal Effect of National Economy (Direct)	Marginal Effect of Relative Economy (Benchmarking)
Moderate	Negative	Positive
Significant	Positive	Negative

To disaggregate moderate and significant change, I split the national economic performance variable into quartiles. The middle two quartiles are recoded as representing moderate change, with extreme high and low values representing significant shifts.

Empirically, I specify a saturated mixed effects model in which both the national and relative economy are interacted with mobile use, alongside a dummy variable indicating whether change is moderate or significant. The outcome of this three way interaction represents the change in the information effect as national economic change shifts from moderate to significant. By including both the relative and national economic interactions in the same specification, we can "partial out" the effect of one, allowing us see the marginal effect of the other (Wooldridge 2013).

$$\begin{aligned} support_{ik} =& (\alpha_0 + u_k) \\ &+ \beta_1(mobile_{ik} * \Delta e_k * significant_k) + \beta_2(mobile_{ik} * \Delta e_k * significant_{rel}) \\ &+ \xi media_{ik} + \gamma X_{ik} + \epsilon_{ik} \end{aligned} \tag{4}$$

The results provide specific support for H4 and H5. For the national economy, the information effect is more negative under moderate change, but more positive for significant change. This is in line with theoretical expectations, and implies that voters directly punish or reward significant changes to the national economy. The relationship is reversed for the relative economy, with more positive effects under moderate national change and more negative under significant change. This implies that voters benchmark when changes to the national economy are moderate, with the effect dropping away as national change becomes more extreme.

In aggregate, the results match theoretical expectations. Not only do the national and relative economies matter more for informed voters, they have heterogeneous effects that are consistent with direct and benchmarking logics of economic voting. We can credibly say that informed voters do hold the incumbent President accountable for the performance of the national and relative economy, as they come to learn about how the national economy has performed.

A few questions remain unexplored, however. Firstly, while comprehensive and representative, the analysis can only make descriptive claims. Without exogenising mobile use, we can only speak suggestively of its effects on information and vote choice. Secondly, the key measure of incumbent support has been a voter *intention* survey question. This could be tainted by social desirability bias among respondents, and respondents might legitimately change their mind on polling day as their electoral preferences crystallise (Andersen, Tilley, and Heath 2005). Finally, respondents could only be disaggregated at the regional level. While this is

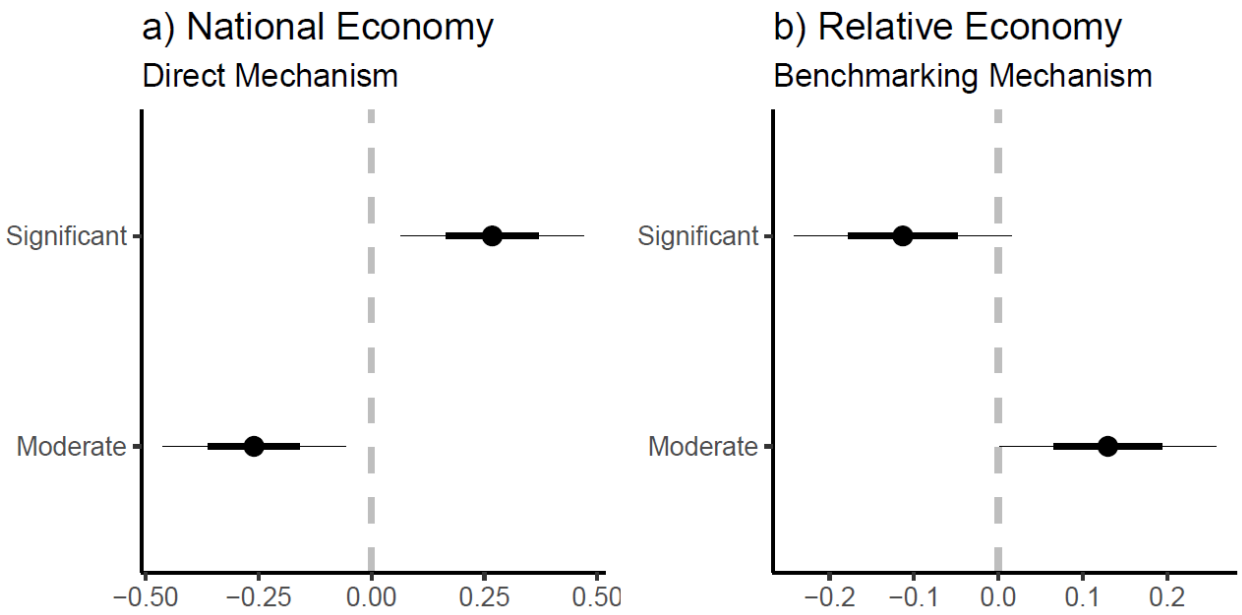

Figure 7: Direct and Benchmarking Effects as National Economic Performance Varies. Panel (a) presents the coefficients for the national economy, showing that informed voters directly reward national economic performance when the change is significant, but punish it otherwise. Panel (b) presents results for the relative economy, showing it to have a positive effect at smaller levels of national change. In aggregate, the results follow theoretical expectations and support the direct and benchmarking mechanisms.

an improvement on national-level analyses common in the literature, regions are still large units that could mask theoretically relevant internal heterogeneity. With this in mind I now turn to one particular election, for which higher quality data is available, and use a spatial difference-in-differences design to identify the effect of mobile phones on incumbent support with more causal flavour.

Mechanisms

Thus far, the paper has found descriptive support for the idea that mobile phone proliferation makes voters more responsive to sociotropic economic perceptions. To lend causal credibility to these findings, the paper now focuses on the rollout of mobile phone coverage in Ghana, using historical coverage maps and subnational electoral data to show that voters in coverage were more responsive to sociotropic and relative economic performance.

Context: The Ghanaian Elections of 2004 and 2008

Ghana has been heralded as one of the most consolidated democracies in Sub-Saharan Africa. The country has held multiparty elections every four years since 1992, with power changing hands regularly between the National Democratic Congress (NDC) and New Patriotic Party (NPP) in a highly institutionalised two party system (Riedl 2014). While there have been small episodes of violence at polling booths and some allegations of irregularities by the opposition (Ichino and Schündeln 2012; Brierley and Ofosu 2014; Ofosu 2019), election observers still heap praise on the country's political institutions and the efficacy of its democratic system

(Whitfield 2009).

The 2004 election saw incumbent NPP President John Kufour win re-election with ease, gaining 52.4% of the first round vote to the NDC candidate John Atta Mills' 44.6%. Kufour first won office in 2000, an election in which revolutionary leader Jerry Rawlings left office after two terms, having previously won two mandates in 1992 and 1996, Ghana's first elections since (re)democratisation. Kufour's victory was significant, as it marked the first peaceful transition of power from the NDC to the NPP. Kufour was generally seen to have performed well in his first term, and his 2004 victory was relatively unsurprising to analysts at the time (Kelly 2005).

In 2008 Kufour had reached the end of his second term, with then Foreign Minister Nana Akufo-Addo taking the NPP's Presidential nomination. The election was Ghana's closest to date, with Mills coming from behind to win the second round by just 50.2% to 49.8%. The NPP would not take power again until 2016, when Akufo-Addo found electoral success at the third attempt. The 2008 result was particularly dramatic, with both candidates oscillating in and out of the lead as the count went on, and with civil unrest in some parts of the country. Nonetheless, Ghana's electoral commission was praised for its independent and fair handling of a difficult election (EU Election Mission 2008; Carter Centre 2008).

Given the theoretical framework, the 2008 result might seem puzzling. In 2008 Ghana was in the midst of a period of strong macroeconomic growth, with GDP having more than tripled since the previous election. The country had recently discovered off-shore oil reserves and was debating how they would best be managed going forward (BBC 2008). The NPP sought to play up their economic competence in the election (Bleck and Van De Walle 2013), alongside highlighting their positive record on public service investment around the country (Harding 2015). On top of this, the NPP had won the 2004 election comfortably, and their eight years in power put them in pole position to secure the heavy incumbency advantages seen across African elections (Cheeseman 2015; Bleck and Van de Walle 2018). Yet, despite this, the NDC were able to gain more than half a million extra votes, with positive swing in all parts of the country, rather than simply mobilising core support in their Volta ethno-regional stronghold (Primus 2015).

A variety of explanations have been given to account for the NPP's loss. Some scholars highlight internal disputes within the NPP as playing a role, with seventeen candidates partaking in primaries to succeed Kufour. The party's spending of lavish sums of money on political theatre irritated voters more concerned about Ghana's, and their, circumstances (Whitfield 2009). Others have focused on the ethnic character of voting behaviour and potential electoral malpractice in party strongholds (Jockers, Kohnert, and Nugent 2010), or the gradual decline of clientelism as the goods demanded by voters became more expensive over time (Lindberg 2013). Others still have focused on performance related democratic accountability. In particular, Harding (2015) uses polling booth data to demonstrate voters' responsiveness to local road quality.

Whilst vote choice is always multicausal, and all of these explanations likely contain some truth, there is nonetheless an interesting omission. Between 2004 and 2008, it is estimated that mobile phone use in Ghana increased by a factor of six, with millions of citizens gaining access

for the first time. Despite this, no previous study has considered the electoral consequences of enhanced mobile connectivity, political information and economic voting that might stem from coverage. I now outline in more depth the growth of mobile phone coverage in Ghana, and use qualitative and quantitative evidence to show that coverage provision is plausibly independent to partisan interests.

Mobile Coverage in Ghana

Measurement and General Trends

Mobile phone use in Ghana increased significantly between 2004 and 2008. While this is confirmed using World Bank estimates and self-reported survey responses, these data do not allow us to disaggregate responses subnationally. An alternative is to use changes in mobile phone *coverage* in each electoral constituency as a proxy for subsequent use. Quantitative tests later in the paper confirm that living within mobile coverage is a strong predictor of individual level mobile use, holding an array of demographic characteristics constant.

To measure coverage, I use shapefiles from the Collins Bartholemew Mobile Coverage Explorer dataset.[9] The shapefiles represent a precise estimate of coverage within a country, representing an amalgamation of mobile network operators' data by the Global System for Mobile Communications Association (GSMA). The dataset has precedent for use in academic and policy work, particularly in development economics, and is generally considered to be of very high quality.[10]

For the current study, I use coverage maps from 2004 and 2008 in Ghana. Both maps date from March, with the election taking place 9 months later in December. While the coverage maps provide estimates of 3G (and, later, 4G) in some countries, 3G transmitters were not present at all in Ghana until 2008, with their commercial use only starting in subsequent years (GSMA 2015). I hence focus on changes to 2G GSM coverage, which can be used for sending SMS text messages and for limited access to mobile internet. This mode of coverage fits with the expected *informational* and *coordinative* effects of phone use (Manacorda and Tesei 2020).

Figure 8 shows the evolution of coverage between 2004 and 2008 in Ghana, mapped over electoral constituency boundaries. The total area of the country within coverage increased from approximately 45% to 75% across the four year period, an increase of two thirds. Whilst early coverage was mainly aimed at key urban centres, such as Accra, Kumasi or Tamale, coverage extended far beyond these to a range of rural areas across the country by 2008. When we compare the coverage maps to those of NPP and NDC vote shares in Figure 9, we see that there were large increases in coverage across the South Eastern Volta region, a stronghold of the opposition NDC. Indeed, at least from visual inspection, there appears to

[9] I am incredibly grateful to the Bodleian Social Science Library and the University of Oxford's e-resources procurement team for acquiring access to this dataset on my behalf. Information about the data is available at https://www.collinsbartholomew.com/mobile-coverage-maps/mobile-coverage-explorer/ (accessed 23.03.2021).

[10] Some recent papers that use the dataset, all published in highly ranked academic journals, include Pierskalla and Hollenbach (2013), Wantchekon and Riaz (2019) and Manacorda and Tesei (2020).

be no obvious spatial correlation between either party's electoral performance and coverage provision.

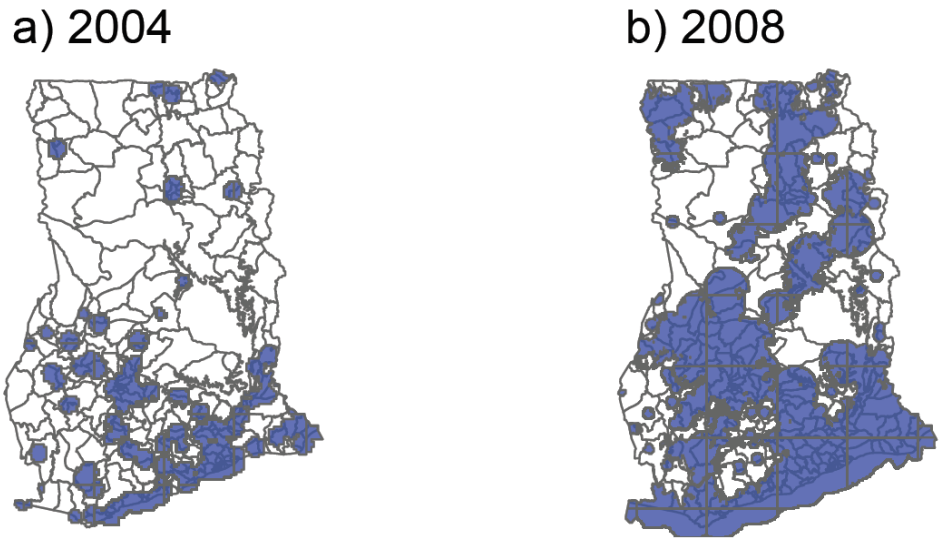

Figure 8: Mobile phone coverage in Ghana between 2004 and 2008

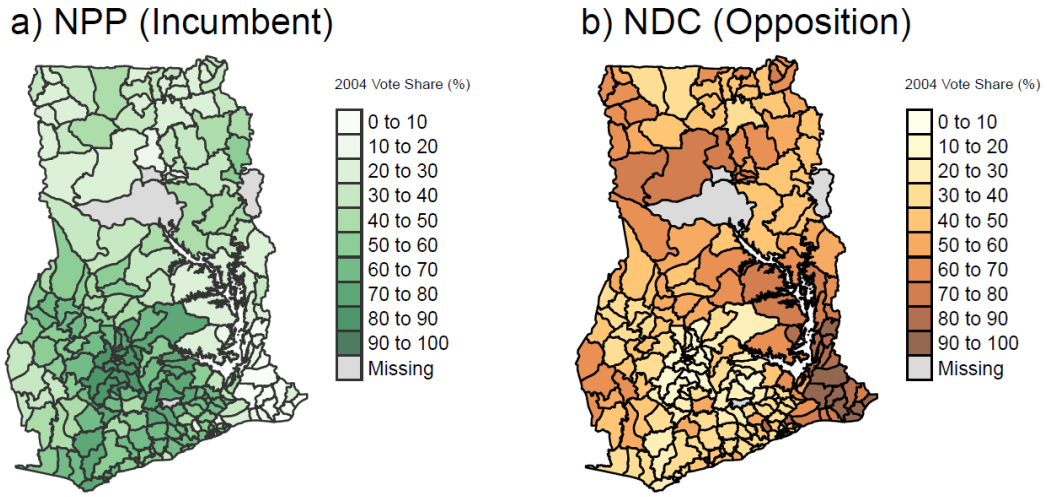

Figure 9: Constituency-Level Vote Shares in the 2004 Presidential Election

Who Receives Coverage and Why?

At this stage of the design, it is important to address concerns that the provision of mobile coverage could be biased.

Firstly, if mobile coverage followed party lines, it would pose two problems for the research design. On the one hand, it implies that "treated" constituencies would have fundamentally different electoral characteristics to those in the "control" group, such that any electoral treatment effect might be spurious (Angrist and Pischke 2009). On the other, there is a risk

that voters see mobile coverage as a quasi-public good to be rewarded at the ballot box. In such a case any electoral effect might stem from the allocation of coverage, rather than the theorised informational effects of mobile phone use in coverage zones.[11]

Secondly, it might be the case that coverage is allocated to more economically prosperous localities, as voters in such areas may become more effective at lobbying the government as they become more wealthy (Harding 2015). Were this to be the case, it implies that voters who receive coverage have disproportionate influence on the government, and are more likely to be electorally responsive to performance. This may confound any relationship between mobile coverage and increased democratic accountability.

Mobile coverage in Ghana does not appear to follow partisan or economic bias. While there is some evidence that other services have followed party lines in Ghana, such as the NDC skewing electrification projects to their own supporters (Briggs 2012) or both parties engaging in ethnic favouritism in some urban areas (Nathan 2016), bias does not apply universally. One prominent example is the provision of trunk roads, which is determined by an independent planning agency, exogenising road building from partisan demography (Harding 2015). Furthermore, coverage tends to be targeted to areas that are relatively *less* economically prosperous, undermining arguments about favouritism and lobbying.

I propose two tests to measure partisan and economic slants in coverage provision. Qualitatively, we can look at specific allocation rules and processes, alongside the interests of the political and economic actors involved. Quantitatively, we can see whether NPP support and relative economic performance in 2004 are significant predictors of 2008 coverage.

Qualitatively, while specific records of allocation decisions are difficult to come by, there is evidence to suggest that coverage provision is relatively independent of party politics. The expansion of Ghana's mobile network was facilitated by the Universal Services Fund, set up by the Ministry of Communications in 2004, and later the Ghana Investment Fund for Electronic Communications (GIFEC) (International Telocommunications Union 2005; GSMA 2014; GIFEC 2021). The fund's legal mandate is to "facilitate the provision of universal access to all persons through the use of afforable information communication technologies for socio-economic development" (Electronic Communications Act 2008). The fund is managed by a board of trustees that includes representatives from the bipartisan parliamentary select committee on communications and from each major telecom operator (GIFEC 2021). Given the diverse range of stakeholders involved in managing the fund, it seems unlikely that the governing party could target coverage towards their own supporters without sparking significant backlash. Moreover, given the fund's lack of politicisation, it is unlikely that voters see mobile coverage as a public good to be directly rewarded or punished. While protests about public good provision are common in Ghana, with voters proclaiming "no road no vote" and "no light no vote" in response to road quality and electrification (Harding 2015;

[11] This technically represents a SUTVA violation, as it implies that treatment assignment is not ignorable with respect to potential outcomes. Here the provision of mobile coverage is equivalent to treatment allocation $D_i = d$, and subsequent use of mobile phones is the treatment itself $Z_i = z$. If voters reward reception of coverage directly, then they are responding to treatment allocation rather than to treatment. SUTVA requires that assignment is ignorable, such that $Y_{(z=1,d)} = Y_{(z=0,d)}$ (Gerber and Green 2012). This condition would be violated in this particular case.

Sasse and Stäritz 2020), no such slogans have arisen in response to mobile phone coverage.

Quantitatively, we can test the extent to which support for the NPP government and relative economic performance predict mobile coverage at the individual and constituency level. Testing both levels of analysis provides confidence that the constituency-level data, used for the core analyses later in the chapter, do not fall foul to fallacies of ecological inference (King, Tanner, and Rosen 2004).

Firstly, at the individual level, I use AfroBarometer survey data to classify each respondent as in or outside of mobile coverage. In recent years AfroBarometer have begun to release geocoded data to academic researchers, subject to a successful research proposal, typically for only one country at a time. Using such data for Ghana allows me to trace the geographic location of the survey's enumeration areas (EAs) within which respondents are nested.[12] The EAs are significantly more spatially fine grained than the standard AfroBarometer data, which only provides information on a respondent's region. I code a respondent as inside coverage when their EA's centroid falls within a coverage polygon, defined by the GSMA dataset.

This allows us to investigate whether NPP supporters are disproportionately likely to receive coverage, conditional on a selection of demographic covariates (urban/rural, education, gender and a survey round dummy). To account for individual-level economic circumstances, I control for a respondent's score on the AfroBarometer lived poverty index. The model uses data from Round 3 (2005) and Round 4 (2008) of the survey, both of which are nationally representative. I estimate a linear probability model, estimating the probability that a respondent is in coverage (1) or not (0). OLS is used to facilitate easier interpretation of coefficients, but results are unchanged when an equivalent logistic specification is used.

$$inside_{it} = \beta_0 + \beta_1 NPP_{it} + \eta X_{it} + \epsilon_{it} \tag{5}$$

Secondly, at the constituency level, I run specifications to model 2008 constituency coverage as a function of 2004 NPP vote share or district-level economic performance.[13] In addition, I run specifications in which NPP share is interacted with economic performance, to see whether the lobbying argument carries better in constituencies with which the President shares partisanship. As covariates, I control for district-level variation in the percentage female population, area and population density (each taken from the Harding (2015) dataset). In Ghana districts are relatively fine grained, each containing an average of 1.35 electoral constituencies. Nonetheless, to counteract concerns that constituency residuals might correlate within districts I cluster standard errors at the district level (Abadie et al. 2017). The specifications for the political and economic models are outlined in the equations below.

$$coverage_{(c,2008)} = \beta_0 + \beta_1 NPP_{(c,2004)} + \eta X_d + \epsilon_{ct} \tag{6}$$

[12]The geocoding process itself is carried out by AidData, an independent organisation specialising in data-driven research in international development. AidData provide co-ordinates for the subnational emuneration areas within which AfroBarometer interviews take place. The coding procedure followed by AidData is outlined here: http://docs.aiddata.org/ad4/pdfs/geocodingafrobarometer.pdf (last accessed 17.03.2021)

[13]The constituency-level measure, and its assumptions, are outlined in greater detail in the next section.

$$coverage_{(c,2008)} = \beta_0 + \beta_1 economy_{(d,2004)} + \eta X_d + \epsilon_{ct} \quad (7)$$

The results, which can be seen in Table 2, show no evidence of NPP bias in coverage provision. Models (1) and (2) can be interpreted as the marginal change in probability that comes from a respondent's partisan support. With or without the inclusion of covariates, there is no significant effect. At the constituency level, the story is much the same. These models predict the marginal change in the proportion of a constituency within mobile coverage in 2008, as a function of incumbent vote share in 2004. In model (3), a 1% increase in NPP vote share actually has a small *negative* effect on coverage, decreasing it by 0.2%. Substantively, though, this effect is minimal in comparison to the mean coverage increase of 35%. Furthermore, when covariates are added in model (4), significance drops away. It is worth noting that the clustering of standard errors in model (4) does not change the significance level of any of the coefficients.

Table 3 shows the results for the economy, with constituency-level vote share the dependent variable. At the individual level, the wealth covariate (not displayed for brevity) has no significant effect on the probability of being inside coverage. At the constituency level, the results show that 2008 coverage tended to go to areas with *worse* relative economic performance, with the interactive terms showing this is not conditional on NPP support. On balance, these results ease concerns that local lobbying efforts are confounding outcomes.

Table 2: Partisan Bias in Coverage Allocation

	Dependent variable:			
	Individual Level		Constituency Level	
	(1)	(2)	(3)	(4)
NPP (Incumbent)	0.014	−0.008	−0.002**	−0.001
	(0.024)	(0.022)	(0.001)	(0.001)
Covariates	No	Yes	No	Yes
Adj. R Squared	-0.01	0.15	0.02	0.14
Observations	1806	1795	222	220
Note:				*p<0.1; **p<0.05; ***p<0.01
				Model (4) Standard Errors Clustered at the District Level

Applying the General Argument to Ghana

How should we expect informed voters to behave in the 2004 and 2008 elections in Ghana? Building on the previous theoretical and empirical sections, we should expect to see some evidence of direct and benchmarking effects. Firstly, and as already discussed, the national

Table 3: Economic Bias in Coverage Allocation

	Dependent variable:			
	2008 Constituency Coverage			
	(1)	(2)	(3)	(4)
Local Economy	−0.054***	−0.185***	−0.040	−0.167**
	(0.008)	(0.057)	(0.035)	(0.069)
NPP (Incumbent)			−0.001	−0.001
			(0.001)	(0.001)
NPP*Local Economy			−0.0002	−0.0003
			(0.001)	(0.001)
Covariates	No	Yes	No	Yes
Adj. R Squared	0.17	0.19	0.16	0.19
Observations	211	209	211	209

Note: *p<0.1; **p<0.05; ***p<0.01
Standard Errors Clustered at the District Level

economy was performing strongly in Ghana in 2008. Since the national economy refers to an abstract, countrywide amalgamation of economic performance, it is the same to all voters, regardless of their constituency. Ghana is just above the threshold for *significantly* positive growth, utilising the typology from before. As the national economy is the same across all constituencies, and information about it is proxied by mobile coverage, we might therefore expect mobile coverage to exhibit a positive effect on incumbent support.

> GH1: As mobile phone coverage increases in a constituency, NPP vote share will increase, all else being equal.

However, there is also stark economic inequality across Ghana. The fruits of the strong macroeconomic climate do not reach all citizens, a fact whose omission some authors have put down to diplomatic biases in how aid organisations interact with the country (Van de Walle 2001; Jockers, Kohnert, and Nugent 2010). Ghanaian politics has clear geographical sources of contestation, with political disputes over religion between the Muslim north and Christian south (Nathan 2019), over customary and legal authority for historically powerful traditional leaders, such as those in the Ashanti region (Ubink 2018), and between separatist groups and the state in Western Togoland (Ziaba 2020). Nonetheless, economic concerns often have a geographical flavour, and have been shown by multiple studies to shape vote choice (Lindberg 2013). Extending existing empirical findings about the importance of *egotropic* and *geotropic* economic concerns, we might expect to see benchmarking mechanisms take effect as voters use information about the national economy to relativise their own experiences. As a locality's economy performs *relatively* well, we might also expect to see incumbent support increase.

GH2: As mobile phone coverage increases in a constituency, NPP vote share will increase as the local economy performs relatively better, all else being equal.

Empirical Approach

To gauge the causal effect of mobile coverage on economic voting, I use a generalised difference-in-difference design with heterogeneous treatment effects. I first outline how I operationalise the treatment variable and the necessary assumptions necessary for inference, before detailing the model specification and precise hypotheses.

Operationalising Treatment

To understand how mobile phone use might shape constituency-level voting behaviour, we need a constituency-level proxy for mobile use. To do so, I calculate the percentage area of each constituency that overlaps mobile coverage.[14] This generates a constituency-level score between 0 and 1, with 1 indicating that 100% of the constituency is within range. This operationalisation captures the significant increase in coverage provision between 2004 and 2008, as demonstrated by the density plot in Figure 10.

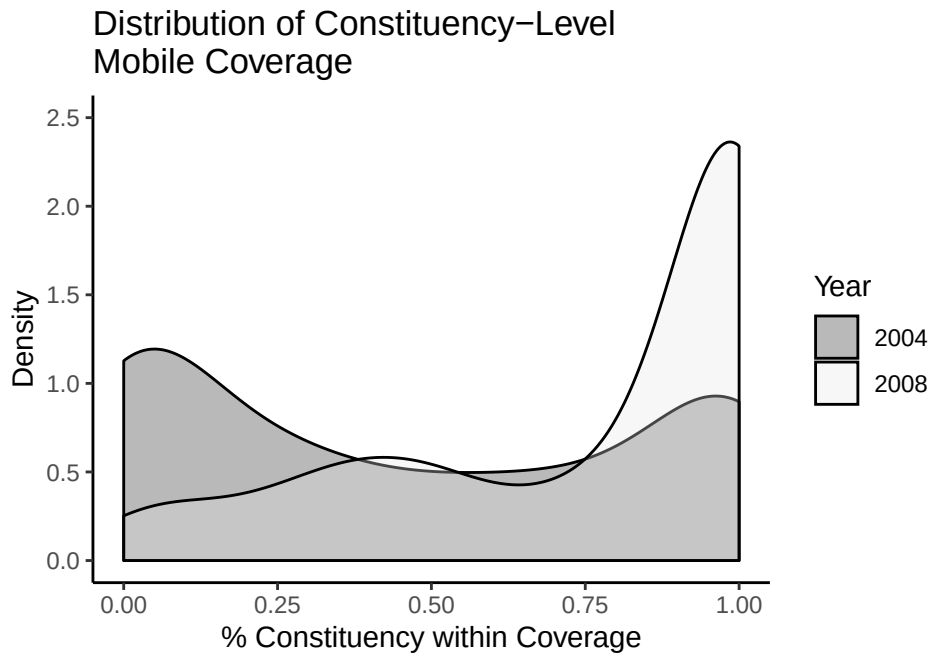

Figure 10: Distribution of the Constituency-Level Treatment Variable. The plot shows that the operationalisation successfully captures the large increase in coverage between 2004 and 2008.

This approach is useful because it allows us to compare constituencies across all of Ghana, giving the analysis greater external validity. However, making such comparisons entails a handful of empirical and theoretical assumptions, which I outline now.

[14] This calculation was conducted using the `sf` package in RStudio (Pebesma et al. 2021), using constituency shapefiles from Harding (2015) and coverage shapefiles from the Collins Bartholemew dataset.

From an empirical standpoint, I assume that voters are uniformly distributed within each constituency. While voter density can vary across constituencies (such as between a big city and peripheral rural area), it must be constant within them. This means that the areal proportion of a given constituency that is in coverage range always corresponds to the same proportion of that constituency's voters; if there is a 35% increase in coverage range, there is a 35% increase in the amount of voters in coverage range also. This enables us to pool constituencies together to estimate the average electoral effect of coverage.

Clearly voters are not uniformly distributed in the real world, with populations clustering in urban and rural settlements within and across constituencies. However capturing this quantitatively would require access to spatially disaggregated census data, which was not possible to obtain. It is worth noting that the uniform distribution assumption underpins many studies that use spatial overlaps to compute variables (Brunsdon and Comber 2019). While this does not directly imply that the assumption is valid, it does show that its adoption has precedent in the extant literature.

Theoretically, I assume that coverage is a reasonable proxy for mobile use. To facilitate comparison across the sample, I assume that the rate of mobile phone use increases by a constant amount relative to coverage across constituencies. The panel structure of the dataset helps here, since time invariant heterogeneity in the urbancy and wealth of a district (factors which might lead to a greater uptake in response to coverage) can be implicitly held constant, and mobile use benchmarked against 2004 levels.

Nonetheless, it is useful to provide some evidence that coverage is associated with mobile use. To do so, I return to the geocoded AfroBarometer dataset. Unfortunately Round 3 of the survey (2005) does not ask respondents a question about mobile use, but Round 4 (2008) does. This is helpful, as Round 4 provides a cross-sectional snapshot of mobile use in Ghana, for a nationally representative sample of respondents, just 9 months prior to the 2008 election.

To see if coverage is associated with phone use, I estimate a linear probability model, adjusting for urbancy, education, gender and lived poverty as before. Mobile phone use is modelled as a binary indicator, equaling one if a respondent uses a mobile phone at least once per month. In the equation below, we expect β_1 to be positive and statistically significant.

$$mobile_i = \beta_0 + \beta_1 inside_i + \eta X_i + \epsilon_i \tag{8}$$

The results in Table 4 suggest that coverage is indeed associated with mobile use. Model (1) shows that, on average, mobile use is 19% higher in the coverage zone. Model (2) shows that this finding persists when we hold a respondent's demographic characteristics constant. Whilst the level of statistical significance drops to the 10% level (p=0.09), the finding is still of substantive importance, implying that moving into coverage is associated with a 7.4% increase in mobile use. It is also worth noting that, since the models use only one round of the survey, they have fewer observations than previously, meaning the substantive effect needed for statistical significance is somewhat higher. Maintaining 10% significance, with a large substantive effect, hence represents a credible finding. Overall, the models provide confidence

in the theoretical assumption that mobile coverage is a reasonable proxy for use. With this in mind, I now turn to estimating the causal effects of coverage on voting behaviour.

Table 4: Coverage and Individual Level Mobile Use

	Dependent variable:	
	Mobile Phone Use	
	(1)	(2)
Inside Coverage Area	0.191***	0.074*
	(0.048)	(0.043)
Covariates	No	Yes
Adj. R Squared	0.02	0.24
Observations	876	873
Note:	*p<0.1; **p<0.05; ***p<0.01	

Specifying the Model

To model the effect of coverage on incumbent support, I estimate a generalised differences-in-differences model with two way fixed effects (TWFE). The specification identifies the effect of coverage while holding constant all unobserved time invariant heterogeneity at the election and constituency level, α_t and ϕ_c respectively. I assume that changes to mobile coverage between the elections took place at the same time. This alleviates concerns about differential treatment timing that could bias the TWFE estimator (Goodman-Bacon 2018; Imai and Kim 2020). Since the models use repeated observations of the same constituencies, I cluster standard errors at the constituency level, as is standard practice in the literature (Angrist and Pischke 2009; Abadie et al. 2017).

As previously discussed, changes to the national economy are by definition constant across all constituencies. This means that we can approximate the effect of the national economy on vote choice by seeing how coverage directly shapes approval. If coverage leads to increased NPP support, in the presence of constituency and election fixed effects, then it is consistent with the theoretical argument that informed voters directly reward the government for positive national economic performance. In such a case, β_1 in the equation below would be positive and statistically significant.

$$incumbent_{ct} = \beta_1 coverage_{ct} + \alpha_t + \phi_c + \epsilon_{ct} \tag{9}$$

An alternative account revolves around changes to the relative economy. If informed voters benchmark local economic performance against national trends, then we should expect positive relative economic performance to be associated with greater NPP vote share. Imitating the models used in the previous chapter, I model this relationship as a heterogeneous treatment

effect, interacting coverage with relative performance. If benchmarking is taking place, then β_1 in the below equation will be positive and significant.

$$incumbent_{ct} = \beta_1(coverage * economy)_{ct} + \alpha_t + \phi_c + \epsilon_{ct} \tag{10}$$

To measure subnational economic performance I again use nightlights data, calculating the change in the relative economy in the past twelve months. By holding this operationalisation constant, the results can be more directly compared to those in the previous chapter. Nonetheless, since this chapter focuses on just one country and uses spatially delimited subnational electoral data, it is possible to use more fine grained measures of performance. Specifically, I measure economic performance at the district level, providing estimates for small clusters of constituencies. In 2008 there were 170 districts in Ghana, each containing an average of 1.35 constituencies. This enhanced spatial resolution provides a harder test of the argument, and accounts for potential economic heterogeneity *within* regions that has hitherto not been measured.

Assumptions for Inference

For difference-in-differences specifications to yield causal interpretation, an identifying parallel trends assumption needs to be met. This requires that the *rate* of change in NPP vote share would remain constant if treatment had not been realised. This allows us to interpret control constituencies as approximating a counterfactual.

The parallel trends assumption is theoretical in nature, and cannot be directly observed. A common indication that the assumption has been met is to plot the coefficients of lagged and leading values of the treatment, with the implication that there should be no significant effect until *after* treatment has been received (Angrist and Pischke 2009). However, this is not possible in the current study. Empirically, Ghana's constituency boundaries changed significantly before and after the 2004 and 2008 elections, such that using election results from 2000 or 2012 would require a significant degree of aggregation.[15] Secondly, and more importantly, mobile coverage did exist in some areas in 2000, and continued between 2008 and 2012. For technical reasons, coverage tends to cluster around existing infrastructure, such that it is spatially autocorrelated over time (GSMA 2014). This means that treatment effects might well be visible in additional elections, but it would be unclear whether they were a function of mobile coverage or of a parallel trends violation.

Despite this, there is still reason to believe that the parallel trends assumption is valid in this context. The previous partisan and economic balance tests implied that there are no fundamental differences between areas that received coverage and those that did not. One potential concern is that coverage might itself cause economic growth, confounding the effect of information. I account for this possibility with a placebo outcome test, modelling economic performance as a function of coverage, and finding a null effect. Another concern is that coverage could interact with certain covariates, such as population density, and exhibit

[15] Harding (2015) faces the same problem in Ghana and opts for a first differences model, not testing for parallel trends.

differential effects that drive any headline findings. I address this concern with an analysis of treatment effect heterogeneity. Finally, a selection of spatial models are used to address the issue of spatial autocorrelation in coverage provision and its potential electoral effects. If coverage has an effect on NPP vote share and this effect holds across each of these robustness tests, it seems reasonable to conclude that the parallel trends assumption has been met.

Results

Main Findings

Table 5 presents the main results, showing the effects of mobile coverage at each level of economic growth. For each model, the mobile coverage variable falls between 0 and 1, while the vote share dependent variable is a percentage. This means that each coefficient represents the percentage point change in NPP vote share as a constituency moves from having no (0) to complete (1) coverage. The economic data has once again been standardised, so the coefficients correspond to a one standard deviation shift in performance.

Looking first at the national economy, model (1) shows that mobile coverage has a positive and significant effect on NPP vote share. As a given constituency moves to having full coverage, NPP vote share increases by around 5 percentage points, significant at the 5% level. For the average constituency, which saw a 35% increase in coverage, the equivalent effect would be an increase of around 1.7 percentage points. Substantively, this effect is more than four times larger than the narrow 0.4% margin by which the NDC won the election.

I next turn to the benchmarking models. The results are broadly similar between regions and districts, with the interactive term in models (3) and (5) showing that voters reward the NPP for relatively strong local performance, indicative of benchmarking. In line with the benchmarking thesis, we also see that the national economy has a weaker direct effect in these models, with no regional significance, and 10% significance at the district level. The interactive terms imply that a constituency moving to full mobile coverage, with a standard deviation increase in the relative economy, sees NPP vote share increase by around 2.5 percentage points. For a mean coverage increase, the equivalent effect size is around 0.9 percentage points, still more than twice that of the NDC's overall margin of victory.

On balance, these central models provide clear evidence that mobile coverage has a significant effect on electoral behaviour in Ghana. The effects match what we would expect to see under both the direct and benchmarked mechanisms of economic voting, and the magnitude of the effects carries substantive significance. Having established these baseline effects, I now turn to a battery of robustness tests, each designed to reaffirm the theoretical intuition that coverage and NPP vote share are connected through an informational mechanism.

Robustness I: Does Coverage Cause Economic Growth?

An initial concern with the design is that mobile coverage may itself exhibit a positive effect on local economic growth. Positive economic effects of mobile provision have been found around the world (Jensen 2007; Qureshi 2013; GSMA 2020), while recent work in Africa has found positive effects of internet rollouts too (Hjort and Poulsen 2019). This could create an

Table 5: Main Findings

	Dependent variable:		
	NPP Vote Share		
	National	Region (Relative)	District (Relative)
	(1)	(2)	(3)
Mobile Coverage	4.852**	3.007	4.300*
	(2.214)	(2.404)	(2.290)
Local Economy		−1.520	−2.574**
		(1.018)	(1.128)
Mobile Coverage*Local Economy		2.368**	2.596**
		(1.055)	(1.001)
Constituency FEs	Yes	Yes	Yes
Election FEs	Yes	Yes	Yes
Adj. R Squared	0.93	0.94	0.94
Observations	444	354	354

Note: *p<0.1; **p<0.05; ***p<0.01
Standard Errors Clustered at the Constituency Level

endogeneity problem in the current set up, whereby any association between coverage and NPP vote share reflects voters rewarding general economic improvement, rather than the effects of information.

There are two reasons to doubt this approach, however. Firstly, any economic effects of mobile coverage will be gradual, spanning every year for which a constituency is connected. By contrast, the analyses in this chapter use changes to the economy in the past twelve months. If connected constituencies saw their economies grow because of coverage, much of this growth would be netted out by the shorter term operationalisation used.

Secondly, the economic endogeneity argument can be evaluated empirically, with null effects ensuing. I measure the effect of coverage on local economic performance through the prism of a placebo outcome test, replicating the core analysis with a different dependent variable whose null effects give implied support to the causal mechanism (Eggers, Tuñón, and Dafoe 2021). I run a two way fixed effects specification as before, but modeling economic performance, rather than NPP vote share, as a function of mobile coverage. If coverage exhibits a significant effect on local growth, it should be picked up by β_1 the specification below. By contrast, a null result would lend further support to the notion that coverage shapes NPP support through information, as theorised.

$$economy_{ct} = \beta_1 coverage_{ct} + \alpha_t + \phi_c + \epsilon_{ct} \tag{11}$$

Table 6 presents the results of the analysis, for local economic change at both the regional and district level. As can be seen, coverage does not appear to have an effect on the performance of the local economy. The fact that coverage shapes NPP support while simultaneously *not* shaping economic performance makes it more likely that the informational mechanism is correct. The results hence provide additional validation to the causal mechanism.

Robustness II: Accounting for District Heterogeneity

A second alternative explanation is that the main findings are driven by district-level heterogeneity. While the direct effect of time-invariant differences between districts will be captured by fixed effects, their interactive effect is not and could potentially undermine the results.

Of particular concern is the role played by population density. While the analysis assumes density to be constant within each constituency (although allowing for different levels between constituencies), there are a few theoretical pathways by which density could shape the effects of mobile coverage. Firstly, we know that densely populated regions allow people to have more expansive social networks (Manacorda and Tesei 2020). This could amplify the co-ordinative effect of mobile phone use, leading to greater electoral variation. Secondly, we know that dense areas are likely to be targeted by turnout-maximising politicians and clientelist brokers (Stokes et al. 2013), which might distort electoral outcomes (Preuss 1981).

To test this empirically, I rerun the core models interacting mobile connectivity with district-level population density. In the relative and local economy models, this means specifying a three-way interaction. The theoretical quantities of interest here are the baseline coefficients.

Table 6: Coverage and Economic Growth (Placebo Outcome Test)

	Dependent variable:	
	Region	District
	(1)	(2)
Mobile Coverage	0.306	0.596
	(0.289)	(0.399)
Constituency FEs	Yes	Yes
Election FEs	Yes	Yes
Adj. R Squared	0.75	0.71
Observations	426	426
Note:		*p<0.1; **p<0.05; ***p<0.01
		Standard Errors Clustered at the Constituency Level

Even if there is a significant interactive effect with density, the central argument is undermined only if the baseline coefficients lose statistical significance. In other words, the aim of these models is to control for district-specific heterogeneity, and see if coverage exhibits an effect nonetheless.

The results are presented in Table 7. The direct effect of coverage in model (1) increases from five to eight percentage points, but loses significance in the relative models, implying that benchmarking offers a greater explanation of vote choice. The interactive effect of coverage and local economic performance remains positive, but only retains significance at the district level. This is not too problematic, however, since measuring benchmarking with more fine-grained performance data is a *harder* test of the argument. Whilst not displayed here for brevity, none of the density interaction coefficients reached statistical significance. A full table, including these coefficients, can be found in the Appendix.

Robustness III: Accounting for Spatial Autocorrelation

A third alternative explanation, and one for which panel data is less suited to explain by default, relates to the spatial distribution of party vote shares. While coverage was shown to be independent to partisan demography, visual inspection of the election results highlighted clear spatial clustering of party support, particularly for the NDC in the Volta region and for the NPP in the Ashanti Region.

Spatial autocorrelation in the data generating process could skew the effects of mobile coverage. One reason for this is that political mobilisation, be it through campaigning or clientelist redistribution, do not necessarily map onto constituency borders and might spillover into neighbouring areas. This would make sense in the Ghanaian case, since although Presidential votes are recorded by constituency, they are then amalgamated to

Table 7: Accounting for Population Density

	Dependent variable:		
	NPP Vote Share		
	National	Region (Relative)	District (Relative)
	(1)	(2)	(3)
Mobile Coverage	8.086***	5.968	5.469
	(2.834)	(3.674)	(3.420)
Local Economy		−1.188	−3.089**
		(1.524)	(1.538)
Mobile Coverage*Local Economy		2.279	3.352**
		(1.666)	(1.637)
Constituency FEs	Yes	Yes	Yes
Election FEs	Yes	Yes	Yes
Adj. R Squared	0.93	0.94	0.94
Observations	444	354	354

Note: *p<0.1; **p<0.05; ***p<0.01
Standard Errors Clustered at the Constituency Level

the national level to determine the winner. In other words, for Presidential candidates the absolute number of votes matters, rather than their voters' geographical concentration. For Presidential campaigns, there is hence minimal incentive for parties to demarcate campaigns along constituency lines, opening up potential spillover concerns.[16].

A second issue regards the spatial nature of social networks. Mobile phones matter because they increase the size and geographical scope of users' social interactions, providing information about economic performance outside their local area. Yet if a voter's neighbouring constituencies all become connected at once, it is possible that the voter's social network will disproportionately comprise people in these neighbouring constituencies, whose economic situations will probably not be too dissimilar. This could attenuate the informational effect of mobile phones, and in turn undercut the effects on NPP vote share.

To account for the spatial character of the data, I run spatial autoregressive (SARM) and spatial error models (SEM). SARMs control for a spatially lagged version of the dependent variable, with each neighbour adjusted by a matrix of spatial weights W. In this particular case, the spatial lag refers to NPP vote share in neighbouring constituencies, and is represented by $\eta W incumbent_{ct}$. SEMs decompose the error term of the model into that which is spatially correlated ($\lambda W \epsilon_{ct}$) and that which remains exogenous (γ_{ct}). For both models, the spatial weights matrix is generated using Queen's neighbours.

$$incumbent_{ct} = \eta W incumbent_{ct} + \beta_1 coverage_{ct} + \alpha_t + \phi_c + \epsilon_{ct} \tag{12}$$

$$\epsilon_{ct} = \lambda W \epsilon_{ct} + \gamma_{ct} \tag{13}$$

The results show no significant deviation from the headline findings. The direct effect of coverage in model (1) drops slightly in the SAR model from five to four percent, but unlike before coverage now exhibits a strongly significant direct effect across all three specifications. Furthermore, the interactive terms remain positive and significant, implying that voters continue to benchmark local economic performance.

In sum, this section has shown that mobile phone coverage is robustly associated with increased incumbent vote share in Ghana. The results provide evidence of both direct and benchmarking mechanisms, and, given the extremely close nature of the 2008 election, have high substantive significance. The results are robust to measures of district heterogeneity and spatial autocorrelation, and the difference-in-difference design allows us to hold constant unobserved time invariant heterogeneity. Coupled with the previous descriptive analyses, they provide confidence in the findings and the causal mechanism underpinning them.

[16]Note that in Ghana parliamentary elections, which operate under an SMDP electoral system, take place at the same time as Presidential elections. For MPs, there is strong incentive to delimit campaigns to constituency boundaries.

Table 8: Spatial Autoregressive Models

	Dependent variable:		
	NPP Vote Share		
	National	Region (Relative)	District (Relative)
	(1)	(2)	(3)
Mobile Coverage	4.120***	2.834**	3.898***
	(1.039)	(1.175)	(1.127)
Local Economy		−1.281***	−2.245***
		(0.496)	(0.582)
Mobile Coverage*Local Economy		2.086***	2.281***
		(0.605)	(0.486)
Constituency FEs	Yes	Yes	Yes
Election FEs	Yes	Yes	Yes
Observations	444	354	354
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 9: Spatial Error Models

	Dependent variable:		
	NPP Vote Share		
	National	Region (Relative)	District (Relative)
	(1)	(2)	(3)
Mobile Coverage	4.805***	3.482***	4.700***
	(1.160)	(1.324)	(1.276)
Local Economy		−1.398**	−2.533***
		(0.557)	(0.661)
Mobile Coverage*Local Economy		2.610***	2.636***
		(0.704)	(0.559)
Constituency FEs	Yes	Yes	Yes
Election FEs	Yes	Yes	Yes
Observations	444	354	354
Note:			*p<0.1; **p<0.05; ***p<0.01

Discussion and Conclusion

This paper has shown that Africa's information revolution matters, with consequences for the information voters have about politics and for the determinants of their support for the incumbent. Using cross-national survey data and nighttime lights, it was shown that mobile phone use is associated with more accurate assessments of the national and relative economy, and with these assessments playing a greater role in determining incumbent support. Exploiting the roll-out of mobile coverage in Ghana, this relationship held with subnational electoral data and was robust to a range of robustness tests. Taken together, therefore, the two empirical strategies allow us to speak with cautious generality about the effects of mobile phones on economic voting in Africa.

The paper makes an important contribution to the study of economic voting in comparative political science. The research design stretches the geographical contours of the existing literature to new contexts, showing that theoretical expectations designed for other parts of the world can hold elsewhere, subject to the right conditions. This is a particularly useful contribution, since we know that comparative politics as a discipline tends to neglect African country cases, to the detriment of collective theory building and empirical rigour (Song 2019; Wilson and Knutsen 2020).

The political effects of information provision are also of interest to a wide-ranging literature in development economics, in which the findings of randomised control trials (RCTs) have been frustratingly mixed (Pande 2011; Dunning et al. 2019). These studies tend to focus on hyper-local considerations, such as providing subjects with score-cards about the performance of their district councillor or MP (Grossman, Humphreys, and Sacramone-Lutz 2014; Carlson 2015; Grossman and Michelitch 2018; Dunning et al. 2019). To the best of my knowledge, no existing study has focused on the direct and relativising effects of the national economy in such a setting, and few measure its effect on electoral outcomes. The current investigation hence adds theoretical nuance to our understanding of political information, and suggests potential avenues for future experimental work going forward.

A handful of questions no doubt remain about the validity of the paper's findings and avenues for future research going forward. The case intensive focus on Ghana offers an invitation to pursue similar analyses in other African countries. While many dynamics *within* Ghana are representative of those across the continent (Nathan 2019; Harding 2020), it is no doubt true that Ghana is wealthier and its democracy more free and fair, when compared to many of its counterparts. A further issue relates to aggregation; while constituency-level data is a clear improvement on nationwide trends, future research could seek to examine changes at the polling booth level, perhaps in the context of a spatial discontinuity design. Polling-booth data from a variety of African countries has been used in the study of voting behaviour (Ichino and Nathan 2013; Harding 2015; Asunka et al. 2019; Adida et al. 2020), and could improve the precision with which the effects of mobile phone use are estimated.

Nonetheless, the paper offers a novel and robust empirical approach to the study of economic voting and information proliferation in developing countries, making a useful contribution to the literature on information, voting behaviour and politics in Sub-Saharan Africa. For the optimistic observer, information revolutions across Africa have made voters more responsive

to the macroeconomy and the inequality it embeds. Despite haphazard beginnings, therefore, the time might finally have come for democracy's dividends to be cashed in.

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