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For Everything There is a Season: Seasonality and Retrospective Voting in African Elections

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Abstract

Are African elections subject to seasonal effects? I argue that agricultural seasonality patterns election outcomes by influencing voters' retrospective performance evaluations. When countries hold elections after harvests, voters reward incumbents. As the year continues and conditions worsen, voters begin to sour on incumbents. I construct a measure of agricultural seasons using satellite imagery and pair it with an original dataset of 145 executive-election results from 32 countries, as well as with over 100,000 Afrobarometer survey responses. I first show a curvilinear relationship between the time from harvest and support for incumbent executives. Initially, voter support for incumbents increases following a harvest, but this relationship eventually reverses before the next harvest. To account for endogenous election timing, I also examine quasi-experimental evidence from two Zambian by-elections triggered by the deaths of incumbents. Finally, I analyze survey responses to probe for causal mechanisms and find evidence of sociotropic rather than pocketbook voting.

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> While the earth remaineth, seedtime and harvest, and cold and heat, and summer and winter, and day and night shall not cease. - Genesis 8:22

Do African incumbents benefit when countries hold elections after harvests? Rain-fed agriculture remains a central aspect of economic and social life in sub-Saharan African states. Nonetheless, we know little about how this reality shapes electoral outcomes across the continent. In this article, I make two claims. First, following harvests, incumbent executives do better at the polls. However, over the year, as households exhaust their savings and economic conditions worsen, voters begin to sour and increasingly punish incumbent governments. Second, I argue that this pattern is attributable to retrospective voting, changes in how individual voters evaluate the government's performance due to present economic conditions. I find support for this argument in analyses of election results and nationally representative surveys from across the continent using a measure of seasonality derived from satellite imagery.[1] For African voters, changes in agricultural conditions are a voting issue.

According to the World Bank, the agricultural sector employs over half of all African workers.[2] In most African countries, less than five percent of agricultural land is irrigated. These two facts suggest that in many countries, the modal household relies on rain-fed agriculture to provide its consumption needs. However, rainfall and other growing conditions are not constant throughout the year. Environmental constraints limit when households can plant and harvest crops. Work in development economics and public health shows seasonal patterns in household income, labor, disease environments, and many other outcomes.

I suggest that electoral outcomes similarly vary with agricultural seasons. After harvests, when households enjoy a sudden yet predictable earnings windfall, voters reward incumbent executives with their votes. As the year progresses and households increasingly draw from savings, loans, and local support networks to meet consumption needs, attitudes toward the government worsen, and voters increasingly punish incumbents at the polls.

What explains this seasonal pattern? Analyses of African voting behavior frequently emphasize either an economic logic (e.g., Rhee, 2021), in which

voters reward or punish incumbents based on personal economic evaluations, or a patronage model (e.g., Kasara, 2007), in which political elites mobilize voters through patron-client networks, to explain vote choices. In line with retrospective models of economic voting, I argue that this trend in election outcomes is attributable to shifting performance evaluations. Additionally, I find no evidence of seasonal variation in the strength of potential patron-client networks.

Retrospective voting may result from changes in a voter's personal living conditions, so-called pocketbook or egotropic voting, or due to changes in the economic conditions of their community or country, sociotropic voting (Lewis-Beck & Stegmaier, 2000, 2018). This distinction features more prominently in studies of advanced industrial democracies (Lewis-Beck & Stegmaier, 2008), which tend to find stronger support for sociotropic models. Like these studies, I find that seasonal variation in performance evaluations is more consistent with a sociotropic view of economic voting than with a pocketbook-based one.

To consider my argument, I create a measure of agricultural seasons using remote-sensed data from Landsat satellites. I calculate the commonly used Normalized Difference Vegetation Index (NDVI) for every first-order subnational unit in sub-Saharan Africa at 8-day intervals. For every year, I find the average date of maximum-NDVI, a proxy for harvests. Next, I pair this measure with an original panel dataset of 145 executive-election results from 32 countries, broken down by subnational unit, creating a measure of time from harvest. I then estimate a series of two-way fixed-effects regressions, regressing the incumbent's vote share and margin of victory or defeat on this measure of time since harvest.

One challenge with this approach is the non-random timing of elections. If incumbents can manipulate electoral calendars, vulnerable executives might manipulate election dates to their benefit. Manipulations can happen even in countries with nominally fixed election dates if institutions cannot prevent incumbent machinations. To eliminate this concern, I extend my analysis with quasi-experimental data from Zambia following the untimely deaths of Levy Mwanawasa and Michael Sata. These deaths triggered by-elections, with election timing exogenous to agricultural seasons.

My results consistently illustrate a relationship between agricultural seasons and election outcomes. In the Africa-wide and Zambian analyses, there is an inverted-U-shaped, curvilinear relationship between the time from harvest and elections. Initially, as time from harvest increases, so does the expected incumbent vote share and margin of victory, with an incumbent's predicted electoral results peaking between eight and ten months following a harvest. Then, as the following harvest approaches, this relationship reverses

and additional time from harvest is associated with worse election outcomes for the incumbent.

To consider the mechanisms linking seasonality to individual voter behavior, I pair my harvest measure with survey responses from rounds 5, 6, and 7 of the Afrobarometer. I use three performance measures to examine whether an individual's evaluation of government performance varies by season: respondents' approval of their government's economic performance, performance in improving living conditions, and performance in keeping down prices. The results again illustrate an inverted-U-shaped relationship between time from harvest and performance evaluations, mirroring election results.

However, these measures cannot distinguish between pocketbook and sociotropic understandings of retrospective voting. To gain additional theoretical insight, I estimate two models using measures of respondents' evaluations of their personal living conditions and the country's economic conditions. In line with sociotropic theories, evaluations of the country's economic conditions also show an inverted-U-shaped relationship with time from harvest. However, a respondent's evaluation of their personal living conditions shows no relationship with time from harvest.

I find less evidence for two alternative mechanisms. First, in line with patronage models of voter behavior, I examine whether the strength of patron-client networks varies across seasons. Neither a respondent's view of traditional leaders nor the relative salience of ethnic versus national identities varies across seasons. Second, there is no discernible relationship between turnout and time from harvest, which augurs against seasonal changes in the voter pool due to migration or the opportunity cost of forgoing a day's labor to vote.

This empirical strategy has several benefits. First, by using actual election results, it considers real-world outcomes in which we are genuinely interested. Second, it combines an analysis of diverse cases from across Africa with exogenously timed elections in Zambia. The Zambian elections allow for a more rigorous test in which the unique nature of the elections can rule out potential confounds. At the same time, the Africa-wide analysis situates results in a richer context, allowing for consideration of external validity and scope conditions. Finally, my analysis moves beyond aggregate measures of election outcomes and explicitly considers which mechanisms may be present by using theoretically appropriate individual-level survey responses.

This article makes several theoretical and empirical contributions to our understanding of African politics and voter behavior more broadly. First, it extends conventional theories of retrospective voting in a new substantive context. In doing so, it illustrates how changes in agricultural conditions

inform a voter's choice of candidate, an often untested assumption in accounts linking food security and accountability (e.g., Sen, 1999). Additionally, by exploiting an exogenous source of performance evaluations, it provides clear evidence not only of retrospective voting in African elections, but also of the relative strength of sociotropic rather than pocketbook understandings of it. Empirically, it develops a measure of agricultural seasons using remote-sensed data and exploits an original dataset of executive elections disaggregated by subnational region that improves on previous data collection efforts. Finally, it demonstrates seasonality's potential influence on political behaviors and outcomes. Researchers should be mindful of potential seasonal effects as a source of confounding when conducting analyses or collecting data.

Agriculture, Economics, and African Voters

Many accounts of voter behavior rest on an economic rationale. This includes both economic voting, in which a voter's evaluation of economic conditions shapes their voting decision, and patronage models, in which an individual's voting behavior is reduced to a commodity to be bought and sold.

Theories of economic voting differ along two dimensions: their time orientation and their target (Lewis-Beck & Stegmaier, 2000, 2018). Voters can be retrospective, making their decisions based on past economic performance, or prospective, relying on a candidate's promises of future economic performance. Additionally, voters might rely on changes in their personal living conditions as the basis of their evaluations, termed pocketbook or egotropic voting, or they may rely on changes in the economic conditions of some broader reference community, such as a country or nation, referred to as sociotropic voting (Kinder & Kiewiet, 1979, 1981).

Traditionally, retrospective accounts of economic voting appear more frequently than prospective ones (Lewis-Beck & Stegmaier, 2008). According to these models, voters react to poor economic conditions by updating their beliefs of an incumbent's performance and sanctioning incumbent politicians accordingly (Barro, 1973; Ferejohn, 1986). Voters might even engage in "blind retrospection," in which they reward or punish incumbents for events outside of the politician's control (Achen & Bartels, 2002; Campello & Zucco, 2015; Healy et al., 2010).

A growing literature applies these insights into retrospective voting developed in Western democracies to the African context (Lynge & Martinez i Coma, 2022; Rhee, 2021; Wimpy & Whitten, 2017). However, aside from Bratton et al. (2012), few distinguish between pocketbook and sociotropic forms of economic voting. Additionally, this literature remains unsettled,

with different studies finding conflicting amounts of support for performance-based arguments. One reason for this might be due to the endogeneity of performance evaluations to various forms of identity, most notably ethnicity. The economy and related performance evaluations become an electoral Rorschach test in which voters base their evaluations on the relative ethnicity of an incumbent politician. Studies highlight how a voter's evaluations interact with a candidate's ethnicity (Carlson, 2015; Gutiérrez-Romero, 2024), are subject to ethnicity-based motivated reasoning (Adida et al., 2017), and how they rely on ethnic cues when evaluating mixed records (Ferree et al., 2021).

Accounts of African politics also frequently cite a patronage- or clientelism-based understanding of electoral behavior (Kramon & Posner, 2013; Lemarchand, 1972; van de Walle, 2003). According to this logic, an individual's vote is a commodity, exchanged for a particularistic or selective benefit. Voters are typically embedded in patron-client networks, with a broker or political intermediary mediating any exchanges (Stokes et al., 2013). Voting behavior is a function of their real or anticipated receipt of benefits through these patron-client networks. According to many patronage-based accounts, poorer or more vulnerable voters are more likely to sell their votes because the marginal utility of any selective benefit is higher (Dixit & Londregan, 1996; Nathan, 2016).

The Political Economy of African Agriculture

For many African households and communities, agricultural production and economic conditions are inseparable. Given the importance of agriculture to many African economies, it stands to reason that agricultural conditions and economic conditions are tightly intertwined for many voters.

Accounts of African politics often depict agricultural producers as marginal actors. Bates and Rogerson (1980), for instance, develop a formal model illustrating how governments have incentives to cater to urban consumers at the expense of rural producers. This argument helped spark a literature arguing for an "urban bias" in African policymaking. Because urban populations pose a greater threat to political stability, regimes attempt to suppress food prices and extract surpluses from the countryside to buy off urban populations, while also funneling selective benefits to politically advantageous farmers (Bates, 1981).

Politicians can provide a variety of goods and services to support agricultural communities. For instance, after their near-total eradication in the 1990s, agricultural input subsidies are increasingly common across sub-Saharan Africa (Holden, 2019; Jayne et al., 2018). Among other policies,

politicians have manipulated producer prices for decades (Bates, 1981; Kasara, 2007), provided extension agents, and funded irrigation projects. These benefits have sparked interest both in how politicians distribute them (Dorward & Chirwa, 2011; Mason et al., 2013; Pan & Christiaensen, 2012) and in the political effects they have (Dionne & Horowitz, 2016).

For politicians, retrospective and patronage-based accounts of African voting behavior create distinct policymaking incentives. According to a patronage logic, politicians should prioritize selective benefits, such as subsidized inputs or land, through patron-client networks to buy support. Historically, many accounts of agrarian political economy in Africa implicitly or explicitly adopt this view. Some emphasize the role of organized interests in representing the agrarian sector and pressing for state benefits. For example, the agricultural sector's structure incentivizes politicians to provide different goods (Bratton, 1987; Widner, 1993, 1994). Other studies focus on the implementation of specific policies, most notably subsidized inputs, with conflicting results on voting behavior (Brazys et al., 2015; Dionne & Horowitz, 2016; Mason et al., 2017).

One implication of retrospective models is that politicians have incentives to provide constituents with good policies to avoid sanctioning at the polls. According to this logic, politicians should pursue policies that broadly improve the conditions of agrarian communities to win their support in upcoming elections. Bates and Block (2013) is consistent with this view, arguing that as democracy takes hold across the continent and with median voters more likely to work in agriculture, politicians have electoral incentives to favor large groups such as agricultural producers.

Environmental Influences on Political Life

Scholars increasingly emphasize the connection between environmental and political outcomes (e.g. Obradovich, 2017; Remmer, 2014). Many of these works narrowly consider how short-run weather anomalies or shocks (most notably in rainfall) are associated with economic, social, and political outcomes. For example, a rich literature links periods of drought or poor rainfall with higher levels of conflict (Linke et al., 2017; Miguel et al., 2004).[3] Weather events also influence electoral outcomes (Bassi, 2019; Fraga & Hersh, 2011), with election day weather affecting both voters' decisions to vote and for whom they vote.

Although this literature makes many important contributions, it overemphasizes weather as a source of exogenous variation at the expense of long-run seasonal patterns. While short-run anomalies may create attractive empirical opportunities, they overlook structural patterns that condition the

political field. Additionally, these accounts often implicitly reduce seasonal or environmental forces to meteorological conditions while postulating variation in agricultural conditions as a mechanism. While a correlation between meteorological and agricultural seasons may exist, these are distinct concepts. Separating these concepts and other forms of seasonal variation will allow researchers to disentangle complex causal processes linking the environment to political outcomes.

Conceptualizing Seasonality and Theoretical Mechanisms

I focus on a specific aspect of agricultural production: seasonality. In agrarian communities, households can divide the year into distinct, discrete seasons in which households plant their crops, their crops grow, households harvest their crops, and a fallow period until the next planting season begins.[4]

Agricultural Seasonality

Because much of sub-Saharan Africa remains rural and reliant on agriculture, seasonality plays a vital role in patterning economic and social life. The widespread reliance on rain-fed agriculture means farmers depend on rainfall to meet their crops' water needs. Additionally, air temperature and sunlight are also biological constraints on agricultural production, limiting when crops can be grown. As rainfall, temperature, and sunlight are subject to seasonal patterns, so is agricultural production. Much of the continent is tied to distinct wet and dry seasons when the Intertropical Convergence Zone shifts north or south of the equator with the Earth's orbit. During the wet season, rainfall is consistent, enabling agricultural production, while during the dry season, rainfall is rare and inconsistent, preventing many forms of agricultural production.

These seasonal patterns mean rural communities plant and harvest crops around the same time every year. Because agricultural production remains an important economic activity, and opportunities for non-farm employment are limited (de Janvry et al., 2022), harvests represent a sudden, significant increase in household incomes and well-being. If households grow food crops for household consumption, the food produced in one season must last until the next harvest. If households grow cash crops or sell their product on the market, their harvest proceeds must fund consumption and household expenses until the next harvest.

Across much of the continent, there is only one harvest per year. However, in some communities there are two distinct rainy seasons and two harvests,

with one harvest typically being larger than the other. Additionally, farmers may harvest certain crops outside of the main harvest season. For example, certain mango cultivars only fruit after rains have finished, meaning they are harvested after the principal harvest. Some crops require on-farm processing which can result in a lag between harvest and sale dates. Finally, during fallow periods, farming households could seek other wage-paying work, for instance, as tailors or carpenters.[5]

Prior research links seasonality to several related economic and social outcomes, notably changes in the relative price of food, food insecurity, and poverty. When analyzed over the course of a year, many foods exhibit distinct seasonal patterns in price, with prices sometimes almost doubling between peaks and troughs (Gilbert et al., 2017; Kaminski et al., 2014). Following harvests, supplies are at their peak and deplete throughout the year. Meanwhile, demand for food remains constant. Notably, trends in food prices are frequently non-linear (See, for instance, Devereux, 2010; Gilbert et al., 2017), with prices lowest a few months after harvests and then rapidly increasing. Interconnected markets should help smooth these price differences, but many local markets in Africa remain poorly integrated into national and global food markets (Baffes et al., 2017). Similarly, spoilage and limits in food storage may contribute to this non-linear trend (Brander et al., 2020).

These trends are not limited to seasonal fluctuations in food prices. Food insecurity and malnutrition often follow similar seasonal patterns (Sibhatu and Qaim 2017; Bonuedi et al., 2022; Egata et al., 2013), with both the amount and diversity of foods consumed varying by season (Hirvonen et al., 2016). During lean seasons, households rely more on purchased foods, which become increasingly expensive, exacerbating household welfare. Often masked by annual national statistics, seasonal patterns temporarily push millions of households into poverty throughout the year (Dercon & Krishnan, 2000; Dostie et al., 2002).

According to conventional economic theories, households should recognize these patterns and attempt to smooth their consumption, maintaining a consistent level of consumption regardless of the season. However, prior research highlights how many households struggle to smooth their consumption (Augenblick et al., 2023; Fafchamps et al., 1998; Kazianga & Udry, 2006). Scholars attribute consumption smoothing failures to problems with information retrieval, social pressures to share, and missing markets. For many households, consumption patterns during lean times are non-linear, often decaying exponentially, with the most challenging times of the year occurring immediately before the next harvest.

Still, households could rely on several strategies to cope with these seasonal patterns. People might look for alternative sources of income, either

in their community or through seasonal migration to urban centers (Hampshire, 2006; Hampshire & Randall, 1999). However, seasonal patterns can extend to labor demand, with underemployment more pronounced during lean times (de Janvry et al., 2022), while wages themselves might be lower (Goldberg, 2016). Households may seek loans to bridge consumption gaps, but rural communities often have poorly developed financial sectors that limit access to traditional financial services (Janzen & Carter, 2019). Worse still, opportunistic elites may act as loan sharks during lean times. These elites may even take advantage of low food prices after harvests to buy surplus crops, and then sell them back to households at higher prices later in the year (Fink et al., 2020; Hill, 1970). In theory, governments could provide social safety nets, yet few do so adequately (Devereux, 2010), highlighting how these seasonal patterns are in part attributable to policy failures. Instead, households often skip meals, sell assets, and seek the help of family, neighbors, and other local institutions to meet consumption needs (Hill, 1970).

Many scholars agree that economics and elections go hand in hand. Additionally, seasonality has clear economic impacts. Therefore, I argue that after harvests, when food prices, poverty, and food insecurity are at seasonal lows, voters will be more likely to support incumbents. As the year progresses and economic conditions worsen with the seasons, voters will shift their support towards challengers. This shift towards challengers will be most pronounced as the following harvest approaches, when food prices, food insecurity, and poverty are at their seasonal peaks.

But is this seasonal effect linear or non-linear? I argue it is non-linear for two reasons. First, many households have difficulty smoothing their consumption. For many households, declines in spending and consumption accelerate as the year progresses. Therefore, if electoral outcomes are connected to changes in a household's living conditions, they should similarly accelerate. Second, prior research broadly suggests that seasonal variation in food prices is non-linear, so if households are responding to broader economic patterns, we might similarly expect a non-linear relationship.[6]

This discussion leads to my main hypothesis:

H1: A curvilinear, inverted-U-shaped relationship exists between the time from harvest and support for incumbent politicians.

Mechanisms. This article considers several potential mechanisms linking agricultural seasons to election outcomes. First, consistent with theories of retrospective voting, agricultural seasonality could induce systematic patterns in how voters evaluate their government's performance.

H2: A curvilinear, inverted-U-shaped relationship exists between the time from harvest and positive evaluations of the incumbent's economic performance.

In addition to considering retrospective voting more broadly, I also examine whether seasonal patterns are more consistent with pocketbook or sociotropic approaches. Specifically, I examine whether evaluations of an individual's personal living conditions or of the country's economic conditions vary by season.

H3: A curvilinear, inverted-U-shaped relationship exists between the time from harvest and positive evaluations of the incumbent's economic performance.

H4: A curvilinear, inverted-U-shaped relationship exists between the time from harvest and positive evaluations of the incumbent's economic performance.

Second, I consider whether seasonal electoral patterns are consistent with patronage models of voter behavior. There are two reasons why we might expect a patronage mechanism. First, during lean times of the year, individuals might be more willing to treat their votes as a sellable asset as part of a consumption-smoothing strategy.[7] Second, if households rely on local support networks to smooth their consumption, patron-client ties may be stronger if those ties overlap with support networks.

I consider two possible patron-client links relevant to African politics. First, in some parts of Africa, traditional leaders act as vote brokers (e.g., de Kadt & Larreguy, 2018; Koter, 2013). During lean times, households may rely on traditional leaders for support, leading to more favorable opinions of them. Second, many accounts suggest that patronage works through ethnicity-based networks (e.g., Kasara, 2007). Consistent with this view, we might see seasonal variation in how attached individuals feel to their ethnic group. This is admittedly an imperfect measure of the relative strength of ethnic patronage, and so any null effect should interpreted carefully as the absence of evidence rather than evidence of absence.

H5: A curvilinear, U-shaped relationship exists between the time from harvest and positive evaluations of traditional leaders.

H6: A curvilinear, U-shaped relationship exists between the time from harvest and identification as a member of a nation instead of a member of an ethnic group.

Finally, seasonality could create costs to voting that certain voters are unwilling to bear. Farmers may be reluctant to sacrifice a day of labor to vote during specific periods of the agricultural calendar. Similarly, seasonality can induce seasonal migration into urban centers as a coping strategy; these potential voters may be unwilling to pay the costs associated with returning home to vote or re-registering in a new town. These hypothetical costs could alter the voter pool, influencing election outcomes through changes in who is voting. Again this is likely an imperfect test of this mechanism, as a full consideration of the pool of voters for any election would likely require exit polls or some other individual-level measures of electoral participation. Again, any null effect should be interpreted carefully and not interpreted as disproving any hypothesized mechanism.

H7: Voter turnout varies with time from harvest.

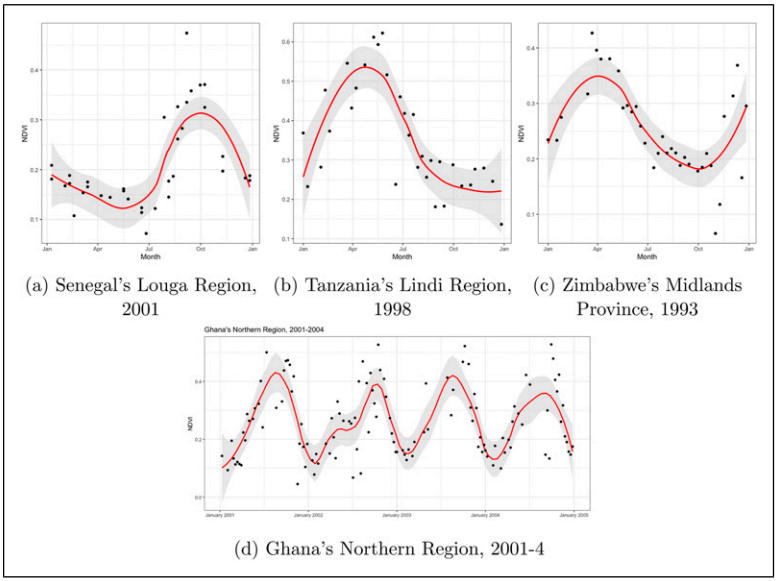
Empirical Analysis

This article first considers the relationship between agricultural seasons and aggregate election outcomes. To do this, I use Landsat satellite data to model agricultural seasons, calculate the time between harvest and an election, and assemble an original dataset of election results by subnational unit. I begin by considering my first hypothesis with all available data across Africa. I then focus on quasi-experimental evidence from two Zambian elections that rule out confounds due to incumbents' opportunistic timing of elections. Finally, I probe for mechanisms using survey responses from three rounds of the Afrobarometer.

Measuring Seasons

To measure agricultural seasons, I use satellite data from Landsats 5, 7, and 8 to calculate a normalized difference vegetation index (NDVI) time series for every African subnational unit from 1984 to 2014. The NDVI measures the amount of vegetation in a geographic area. It takes advantage of the fact that plant matter absorbs wavelengths on the visible spectrum but reflects near-infrared wavelengths. Other surfaces, such as soil, rocks, or water, absorb or reflect visual and near-infrared wavelengths.[8] This objectively measures how much vegetation exists in a given region.

This article is not the first to use NDVI estimates to measure agricultural production. Researchers have used NDVI estimates to calculate both agricultural productivity (Dempewolf et al., 2014; Milesi et al., 2010; Tottrup & Rasmussen, 2004) as well as seasonal variation in crop cover (Bellón et al.,



(a) Senegal's Louga Region, 2001 (b) Tanzania's Lindi Region, 1998 (c) Zimbabwe's Midlands Province, 1993

(d) Ghana's Northern Region, 2001-4

Figure 1. Examples of NDVI Yearly Trends (a) Senegal's Louga Region, 2001; (b) Tanzania's Lindi Region, 1998; (c) Zimbabwe's Midlands Province, 1993; (d) Ghana's Northern Region, 2001-4

2017; Eastman et al., 2013; Kouadio et al., 2014). Similarly, the Food and Agriculture Organization's Global Information and Early Warning System on Food and Agriculture uses NDVI estimates to define crop-growing seasons.[9]

I use Google Earth Engine to calculate the average NDVI level every eight days with sufficient data between 1984 and 2014 for every African subnational unit. Data may be missing if there is cloud coverage or if the atmosphere is too dusty or sandy. To improve reliability, I drop all years with fewer than ten observations and calculate the date of maximum NDVI for each year. Figure 1 shows four examples from across Africa, with observations and a LOESS line of best fit. I join this estimate with election results and count the days between the maximum NDVI date and the following election day. For ease of interpretation, I divide this number by 30, creating a measure of "Months from Harvest."

This measure has several benefits compared to the main alternative: crop calendars. My Months from Harvest measure varies over time based on a year's specific conditions, whereas crop calendars are largely static. Similarly, crop calendars typically denote harvests as occurring during a wider

time range, as opposed to a single point, which is more easily operationalized for analyses. One downside is that it reduces harvests to a single day, when the actual process of harvesting, processing, and selling any agricultural product may occur over a longer time period.

To validate my NDVI-derived measure of harvests, I randomly selected 20% of observations and compared my calculated harvest date with crop calendars produced by the U.S. Department of Agriculture's International Production Assessment Division.[10] In just over 75% of cases my calculated harvest date corresponds with a harvest period as described on the calendars. An additional eight percent of cases were within one month, and a further eight percent of cases were within two months. This concordance suggests my measure is largely in line with available alternatives.[11]

Seasonality and African Elections

I begin by considering the relationship between agricultural seasons and election results across Africa using an original dataset of executive election results by first-order subnational unit from 1990 to 2020.[12] This dataset includes information from 145 elections in 32 African countries, broken down by subnational unit.[13] This dataset was made by combining official election results, media reports, and secondary sources. Although it does not contain results from every possible election (See Fridy (2009) for the difficulty in collecting subnational election results in Africa), it expands on previous data collection efforts.

I estimate a series of OLS regressions using two-way fixed effects to consider the relationship between agricultural seasons and electoral outcomes. Two-way fixed effects models are a generalization of the difference-in-differences estimator, controlling for potential unit- and time-invariant confounds. This includes controlling for unit-specific differences, such as ethnic composition, local festivals, and underlying agricultural conditions, and any year-specific exogenous shocks, such as weather shocks or fluctuations in international commodity prices.

I start with a base model:

$$Y_{imc} = \alpha_i + \beta_1 Months_i + \beta_2 Months_i^2 + \beta_3 X_c + \delta_m \quad (1)$$

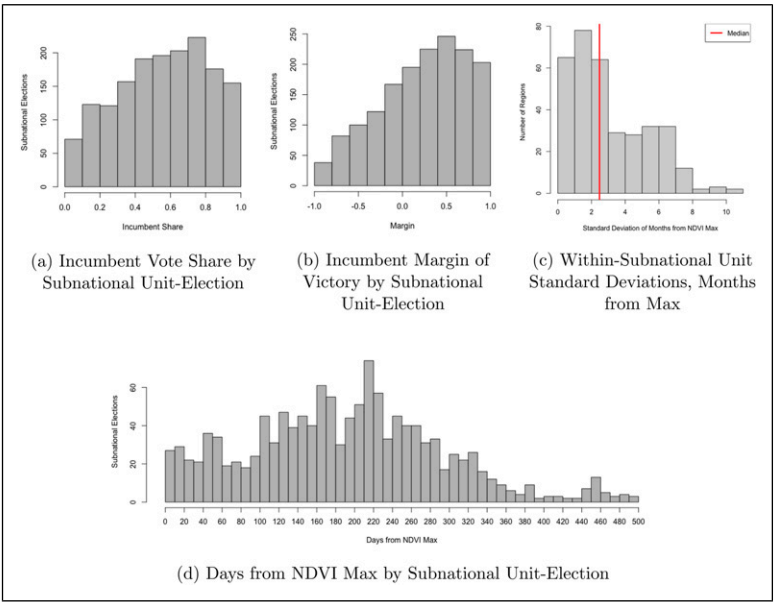
where Y_{imy} is either the share of the vote won by the incumbent executive's political party or the margin between the incumbent party candidate and the leading challenger. $Months_i$ is a measure of the time between a harvest and the election date for each subnational unit i, while $Months^2$ is a quadratic term to test for a curvilinear relationship between seasons and election

outcomes. α_i and δ_m are sub-national unit and year fixed effects meant to control for time-invariant unobserved confounds, such as other non-agricultural seasonal effects and time-specific exogenous shocks. Finally, X_c is a vector of controls, including a country's GDP per capita, its Polity score, the percentage of the country's workforce employed in agriculture, the percentage of a country's GDP from agriculture, and the NDVI value for the region's most recent harvest. I include these controls to account for situations in which an incumbent may attempt to manipulate the electoral calendar.

One potential problem with using subnational-unit fixed effects is that it may produce unreliable estimates if there is little within-unit variation.[14] For my measure of Months from Harvest, within-unit variation happens when either election dates or harvest dates vary over time. In some African countries, elections typically occur at a similar time every year. However, even then, most have at least one aberrant election, such as Ghana's 1992 election, which occurred a month earlier than usual, or Tanzania's 2005 election, which they held in December instead of the usual October. In other countries, election dates vary considerably. Sierra Leone's elections have been held in six months, ranging from February to November. In Guinea-Bissau, they have held elections in five different months between January and November. Harvest dates vary over time, both for as-if-random reasons such as the occurrence of El Niño, as well as for climate-change related reasons (Kotir, 2011; Vrieling et al., 2013). In Figure 2, for each subnational unit, I calculate the standard deviation of my Months from Harvest measure, which shows that there is within-unit variation for this measure.[15]

Figure 2 also plots election results and an election's time from harvest by subnational unit. African incumbents win, on average, about 55% of the vote in a subnational unit, with a margin of victory of about 20%. However, there is significant variation in both of these measures. African elections are held, on average, roughly 206 days, or seven months, after harvests, but there is, again, meaningful variation in the timing of elections.

Empirical Results. Table 1 shows the results from the Africa-wide analysis. A statistically significant, curvilinear relationship exists between agricultural seasons and election outcomes (see Figure 3[16]). Initially, as time from harvest increases, there is a positive relationship between time from harvest and support for the incumbent. Over time, this relationship weakens and after eight months reverses. In an election held eight months after a region's harvest, the incumbent can expect to win 6.4 percentage points more of the vote and have a margin of victory nearly 14 percentage points greater than if



(a) Incumbent Vote Share by Subnational Unit-Election

(b) Incumbent Margin of Victory by Subnational Unit-Election

(c) Within-Subnational Unit Standard Deviations, Months from Max

(d) Days from NDVI Max by Subnational Unit-Election

Figure 2. Distributions of Key Variables - Sub-Saharan Africa (a) Incumbent Vote Share by Subnational Unit-Election; (b) Incumbent Margin of Victory by Subnational Unit-Election; (c) Within-Subnational Unit Standard Deviations, Months from Max; (d) Days from NDVI Max by Subnational Unit-Election

the election were held on the same day as the region's harvest. However, given the large confidence intervals on these predicted values, estimate sizes should be interpreted cautiously.

My main hypothesis argues for an inverted U-shape relationship between the time from harvest and incumbent political support, but it does not make a prediction of when peak incumbent support should occur. One reason peak incumbent support occurs at eight months and not sooner might be due to the existence of multiple harvests and counter-seasonal crops in some locations. In these communities alternative sources of income might delay or otherwise counteract a seasonal effect, which in aggregate models might produce a delayed peak.

Another reason peak incumbent support may be delayed is that my measure of harvests is ultimately reduced to a single day. Any harvest income may be delayed from this date due to processing, the transaction costs of locating and negotiating with buyers, and opportunistic delays in sales to take advantage of higher prices. For instance, after harvest, cocoa beans are typically fermented on site for up to a week, then left to dry before being sold

Table 1. African Elections by Subnational Unit

	Incumbent share		Margin	
	Reduced	Controls	Reduced	Controls
Months from harvest	0.015*	0.016**	0.031*	0.034**
	(0.007)	(0.006)	(0.012)	(0.012)
Months from harvest^2	−0.001+	−0.001*	−0.001*	−0.002*
	(0.000)	(0.000)	(0.001)	(0.001)
Harvest NDVI		−0.066		−0.135
		(0.131)		(0.248)
Polity		0.003		0.003
		(0.009)		(0.019)
GDP PC PPP		0.000		0.000
		(0.000)		(0.000)
Pct. Employed ag.		−0.001		0.000
		(0.003)		(0.006)
Pct. GDP from ag.		−0.010*		−0.014+
		(0.004)		(0.008)
Num.Obs.	1159	1150	1152	1143
Subnat. Unit FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes

Standard errors clustered by subnational unit.
+ $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

and transported. Maize farmers similarly dry their crops post-harvest to reduce moisture and improve storability. The time associated with these post-harvest processing activities vary by local conditions and the exact technique used, but often improve a farmer's ability to store their crops. This, in turn, potentially allows some farmers to opportunistically withhold sales in anticipation of better prices later in the year.

One way to assess the robustness of these results is to estimate the probability of observing a relationship as strong or stronger than the observed one if harvests are randomly assigned.[17] As a robustness check, I randomly generate harvest dates for each subnational unit, calculate months from harvest, and re-estimate models on the new, simulated data. In Figure 4 I repeat this process 10,000 times, plotting simulated T-Values for "Months from Max" and "Months from Max^2."[18] As expected, the results from this procedure suggest that if harvest dates were randomly assigned, there would be no relationship between agricultural seasons and election outcomes on average. Additionally, based on simulated results, there is less than a five

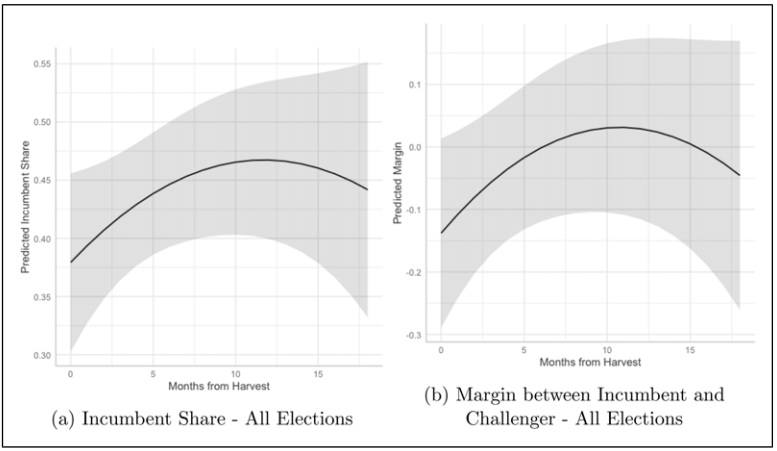


Figure 3. Sub-Saharan Africa Predicted Values (a) Incumbent Share - All Elections; (b) Margin Between Incumbent and Challenger - All Elections

percent chance of observing results as strong or stronger in either direction due to random chance alone.

Additional Models. In the supplementary materials, I report results from several additional models that either vary modeling assumptions or estimate interaction effects. First, I repeat my analysis, omitting the quadratic term, estimating a linear relationship between Months from Harvest and incumbent share and margin. I find no evidence of a linear relationship. Next, I estimate a model replacing subnational-unit fixed effects with country fixed effects. A similar relationship exists to what is reported in Table 1, although the quadratic term fails to reach statistical significance.[19] Finally, I estimate models interacting Months from Harvest with measures of urbanization, political competition, harvest size as measured by the prior harvest's NDVI, agricultural employment, and the percent of GDP from agriculture. These models suggest that seasonal effects are greater in rural areas, in more competitive political systems, in regions with larger harvests, and in countries with larger agricultural sectors as measured by either employment or contribution to GDP.[20]

Quasi-Experimental Evidence From Zambia

One difficulty in analyzing the relationship between seasonality and electoral outcomes is the non-random timing of elections. Although most African

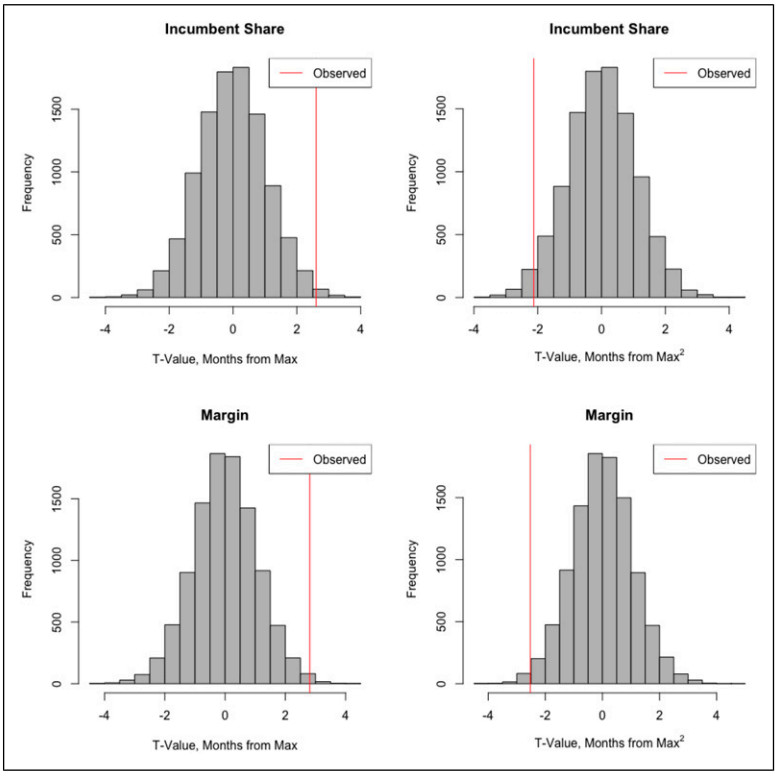


Figure 4. Randomization Inference - Sub-Saharan Africa

states have presidential systems, election timing is often malleable and subject to manipulation by incumbent politicians. Among the 145 national elections for which I have data, 27 were either delayed or held before their regularly scheduled date (Hyde & Marinov, 2012). Additionally, 22 elections were either the first competitive election or held after an extra-constitutional change, situations in which the incumbent government may have discretion over election timing.[21]

If national leaders can manipulate electoral calendars, they may delay elections to more favorable dates [22] The ability and incentive to manipulate election timing likely correlates with election outcomes. According to Hyde and Marinov (2012), of the 145 elections for which I have data, there was reliable pre-election polling in 57. Election dates changed in 33.3% of elections with polling data unfavorable to the incumbent, whereas they changed in only 15.6% of elections with polling data favorable to the

Table 2. Zambian Presidential By-Elections

President	Date of death	By-election date	Cause of death
Levy Mwanawasa	19 August 2008	30 October 2008	Stroke
Michael Sata	28 October 2014	20 January 2015	Illness

incumbent. The malleability of election timing in African elections makes it difficult to disentangle the effect of agricultural seasons from an incumbent's anticipated vulnerability. I attempt to remedy this potential problem by focusing on two elections in which we know with certainty that the timing was exogenously determined: Zambia's 2008 and 2015 presidential by-elections.

Untimely Incumbent Deaths and Early Elections. In the event of the current president's death, the Zambian constitution requires a special by-election within 90 days. By-elections have happened twice in Zambian political history (see Table 2). These deaths create exogenous variation in election timing, eliminating confounds due to the strategic nature of election timing (Bernhard & Leblang, 1999; McClean, 2021; Smith, 2009). Vibrant, multiparty competition marks contemporary Zambian politics, in which three incumbent presidents have lost re-election since 1990.

Following decades of one-party rule, Frederick Chiluba defeated longtime president Kenneth Kaunda in Zambia's first multi-party elections in 1991. After two terms in office, Chiluba was succeeded in 2001 by his vice-president, Levy Mwanawasa. Mwanawasa suffered a mild stroke in April 2006, shortly before his successful 2006 re-election campaign. In June 2008, while attending an African Union meeting, Mwanawasa suffered another stroke and was hospitalized. Two days later, he was medically evacuated to France for treatment. On August 18th, Vice President Rupiah Banda announced that Mwanawasa's condition was worsening. He passed away the next day at the age of 59. On October 30th, 72 days after Mwanawasa's death, Zambian voters elected Banda to finish Mwanawasa's term.

Banda defeated Michael Sata of the Patriotic Front but would lose a rematch to Sata in Zambia's 2011 election. Sata was an experienced politician, holding political appointments during the Kaunda years and several Ministry-level appointments during Chiluba's presidency. Throughout 2014, rumors swirled that Sata's health was deteriorating, as the ordinarily extroverted politician shied away from public appearances. Then, on October 19th, days before Zambia's 50th anniversary of

independence, Sata left for London in what his office described as a medical check-up. He passed away on October 28th from an undisclosed illness at 77.

On January 20th, 2015, 84 days following Sata's death, Zambian voters went to the polls to choose who would finish Sata's term. Sata's political party, the Patriotic Front, nominated Edgar Lungu, Sata's Defense Minister, who eventually prevailed over Hakainde Hichilema of the United Party for National Development.[23]

To Consider the Relationship Between Agricultural Seasons and Election Outcomes in Zambia, I Again Estimate a Series of OLS Regressions With two-way Fixed Effects, Including Constituency and Year Fixed Effects

$$Y_{cy} = \alpha_c + \beta_1 Months_c + \beta_2 Months_c^2 + \delta_y \quad (2)$$

where Y_{cpy} is an electoral outcome, either the share of the vote won by the nominee of the previous president's political party or the margin between the incumbent party's nominee and the leading challenger, for each of Zambia's 150 electoral constituencies.[24] $Months_c$ measures months from harvest, measured by months from the maximum NDVI date, and $Months_c^2$ is a quadratic term to test for a curvilinear relationship. α_c are constituency fixed-effects, and δ_y are year fixed-effects. Including constituency and year fixed effects means that coefficient estimates can be interpreted as difference-in-differences estimates.

I also estimate models that include both fixed effects and a lagged dependent variable. However, we should interpret these models carefully, as constituency fixed effects correlate with lagged dependent variables, leading to inconsistent estimates. All models include standard errors clustered by constituency.

Figure 5 plots the frequency of my dependent variables and time from harvest by constituency. In the election results, we see two peaks, corresponding to constituencies where the incumbent party won between 60 and 80% of the vote and those where it won between 10 and 20%. Most elections occur between six and ten months after a constituency's harvest.

Empirical Results. Table 3 shows coefficient estimates from OLS regression models probing the relationship between agricultural seasons and election results. As expected, these estimates show a clear, curvilinear relationship between months from harvest and the share of the vote won by the incumbent party's candidate, as well as the margin between the incumbent party's candidate and the leading challenger. As the time from harvest increases, incumbents can first expect to see more favorable results. However, after ten months, this effect reverses, and additional time between harvest and an election is associated with poorer election outcomes. Figure 6 plots the predicted share of the vote and margin, graphically illustrating this result.[25]

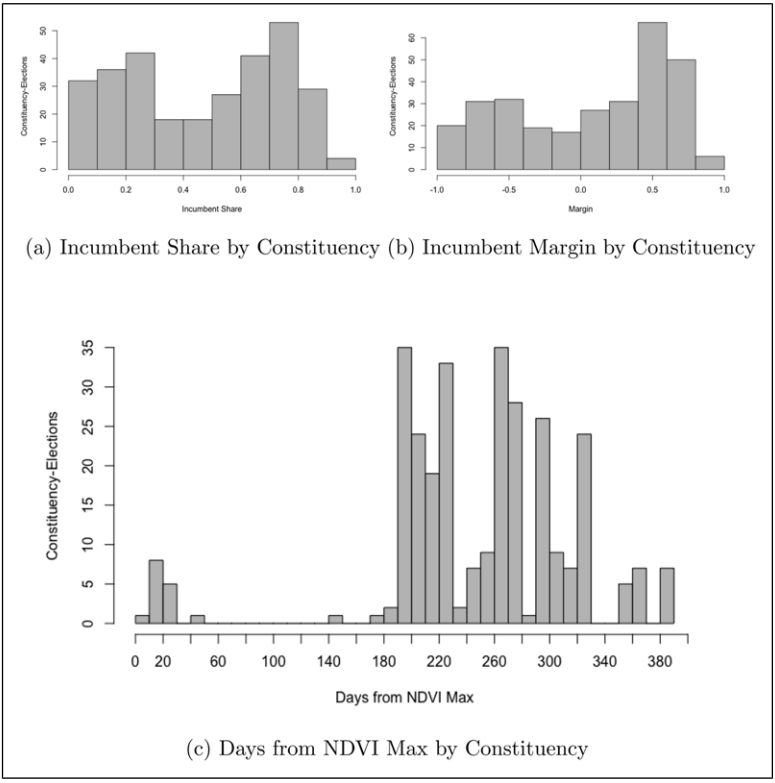


Figure 5. Distributions of Key Variables - Zambia (a) Incumbent Share by Constituency; (b) Incumbent Margin by Constituency; (c) Days from NDVI Max by Constituency

Holding everything else constant, an incumbent party candidate can expect to win 37 percentage points more of the vote if the election is held 10 months after a constituency's harvest than if the election were held on the constituency's harvest date. However, effect sizes should be interpreted cautiously given the sizable confidence intervals seen on these predicted values.

As a robustness check, I re-estimate these results using randomly generated harvest dates. I calculate the time between these randomly generated harvest dates and elections and re-estimate my main results. I run 10,000 simulations, plot associated T-Values, and compare them with the observed results (see Figure 7). As expected, simulated results show, on average, no relationship between agricultural seasons and election outcomes. Moreover, there is a less than 10% chance of observing a relationship as

Table 3. Zambian Presidential Elections by Constituency

	Incumbent	Margin	Incumbent	Margin
Months from harvest	0.067*	0.142*	0.062**	0.159***
	(0.028)	(0.060)	(0.017)	(0.040)
Months from harvest^2	−0.003**	−0.007**	−0.003***	−0.008***
	(0.001)	(0.002)	(0.001)	(0.001)
Harvest NDVI	1.129	3.022	1.175	2.786
	(1.001)	(2.298)	(1.010)	(2.242)
Lagged DV			0.120	−0.390
			(0.565)	(0.760)
Num.Obs.	300	300	300	300
Constituency FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes

Standard errors clustered by province-year.
+ $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

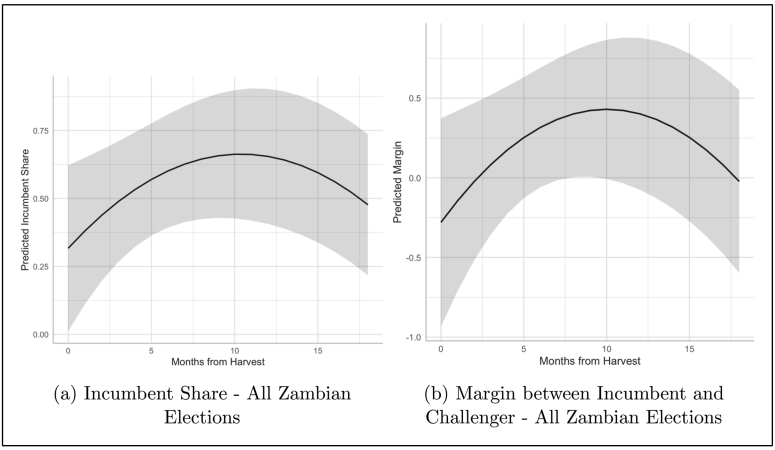
strong or stronger between Months from Harvest and either incumbent vote share or margin if harvest dates were randomly assigned.

One potential challenge to these results is that voters might be responding to the death of the incumbent president by voting for the incumbent party's candidate out of sympathy. However, there are two reasons to discount this potential threat. First, every voter is exposed to this possible effect, making it unlikely to explain variation in election results. Second, suppose we assume that some voters, for example, those of the incumbent's party or home region, are particularly prone to this effect. In that case, any sympathy effect from the incumbent's death should be soaked up by constituency-fixed effects.

In the supplementary materials I report estimates from several additional models. First, I estimate models omitting the quadratic term to estimate a linear relationship between Months from Harvest and either incumbent share or margin of victory. I find no evidence of a linear relationship. Second, I re-estimate my main results, replacing constituency fixed effects with province fixed effects, finding similar results. Third, I estimate a model interacting Months from Harvest with a binary variable indicating whether a constituency is urban or rural. These models suggest the seasonal effect is mainly found in rural constituencies.

Mechanisms Linking Seasonality and Elections

What explains this association between agricultural seasons and election outcomes? I briefly consider three potential mechanisms: 1.) Seasonal



(a) Incumbent Share - All Zambian Elections

(b) Margin between Incumbent and Challenger - All Zambian Elections

Figure 6. Zambia Predicted Values; (a) Incumbent Share - All Zambian Elections; (b) Margin Between Incumbent and Challenger - All Zambian Elections

variation in retrospective evaluations of incumbent government performance, personal living conditions, and a country's economic conditions, 2.) Seasonal fluctuations in the strength of patron-client networks, and 3.) Changes in the pool of voters.

Retrospective Voting. I first consider the possibility that changes in election outcomes result from changes in performance evaluations tied to agricultural seasons. I use individual-level survey responses from rounds 5, 6, and 7 of the Afrobarometer to assess this possibility. Altogether, there are over 120,000 responses from 30 countries in these rounds.[26] Using the enumerator recorded interview date, I pair Afrobarometer responses with my measure of maximum NDVI date to create a "Months from Harvest" variable. Figure 8 shows survey responses by days from harvest and date of the year (where 0 equals January 1st). These plots show substantial variation in the timing of Afrobarometer surveys across the year and across the agricultural season in which they are conducted.

During different times of the agricultural calendar, farming households may be more or less willing to reward or sanction incumbent politicians at the ballot box. This willingness could be due to pocketbook or egotropic voting, resulting from changes in their personal living conditions, or due to sociotropic voting, resulting from changes in their community or country's economic conditions. According to either logic, politicians should receive more

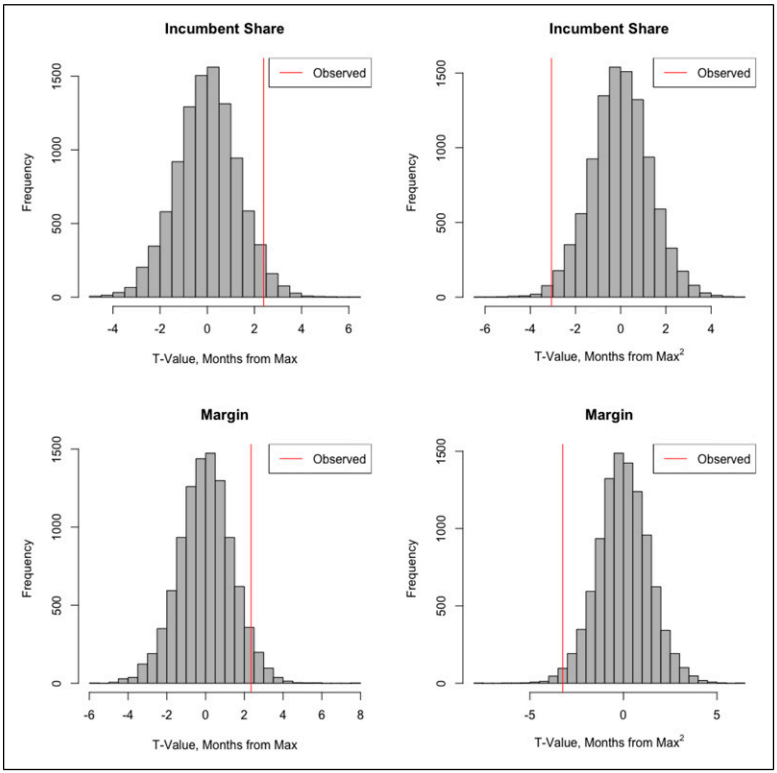
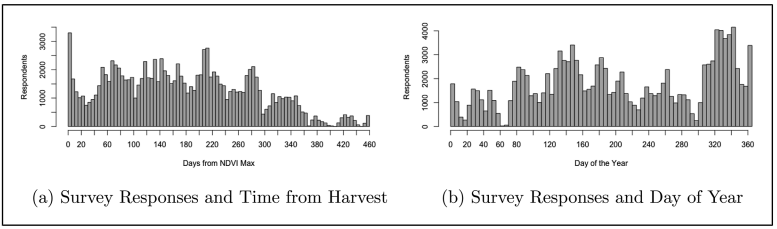


Figure 7. Randomization Inference - Zambian Elections

favorable performance evaluations after harvests, with evaluations worsening as the agricultural calendar progresses.

To substantiate a retrospective voting mechanism, I rely on three measures of incumbent economic performance from the Afrobarometer. The first is a 4-point ordinal measure of the extent to which the respondent believes the government handles the economy well. Second, a similar measure of how well the respondent thinks the government is doing in improving the living standards of the poor. Third, a measure of how well the respondent believes the government is doing at keeping prices down. In my main results, I treat each variable as an ordinal measure, but in the supplementary materials, I repeat the analysis with binary dependent variables.[27] I control for respondents' urban/rural location, age, employment status, gender, and whether they discuss politics. Each model includes sub-national unit, month, year, and



(a) Survey Responses and Time from Harvest (b) Survey Responses and Day of Year

Figure 8. Afrobarometer Timing, Rounds 5, 6, and 7 Pooled (a) Survey Responses and Time From Harvest; (b) Survey Responses and Day of Year

month-in-year (e.g., April 2014, October 2009) fixed effects. Finally, I cluster standard errors by the primary sampling unit.

Table 4 shows coefficient estimates from this analysis. There is an apparent relationship between agricultural seasons and performance evaluations related to the economy, improving the living standards of the poor, and keeping prices down. These results resemble the inverted U-shape seen earlier, where performance evaluations initially increase with Months from Harvest before reversing later in the calendar (See Figure 9).

While these results provide evidence of retrospective voting, they are consistent with both pocketbook and sociotropic forms of voting. To assess whether one or the other form is present, I estimate two additional models that regress ordinal measures of a respondent's assessment of their personal living conditions or their country's economic conditions on Months from Harvest. There is no relationship between the time from harvest and a respondent's assessment of their personal living conditions. The relationship between Months from Harvest and their evaluation of the country's economic conditions, however, resembles the curvilinear relationship seen with a respondent's performance evaluations. These results suggest that African voters are more likely to follow a sociotropic logic than a pocketbook one.

Patronage Politics and Patron-Client Networks. Next, I consider whether seasonality affects the strength of patron-client networks. Households may be more willing to sell their votes during lean periods. Alternatively, households may be more reliant on family, friends, coethnics, and local elites for support during lean times, strengthening patron-client networks.

I test for this possibility by again using two questions from the Afrobarometer. The first asks respondents their opinion of their traditional leader's performance.[28] If seasonality induces a greater attachment to these figures, respondents should report more favorable opinions of them. The second asks respondents whether they identify more as a member of an ethnic group or a

Table 4. Seasonality and the Afrobarometer - OLS

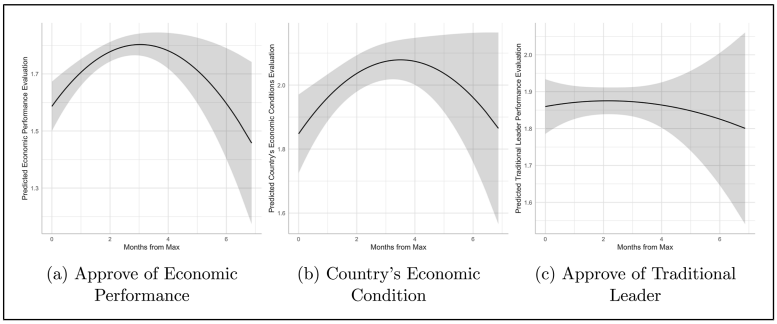
	Economic Performance	Poverty Performance	Price Performance	Living Performance	Economic Performance	Trad. Leader Performance	Ethnic ID
Months from harvest	0.143***	0.076**	0.060*	0.040	0.132***	0.015	0.012
	(0.031)	(0.028)	(0.026)	(0.033)	(0.040)	(0.025)	(0.013)
Months from harvest^2	−0.023***	−0.013*	−0.009+	−0.007	−0.019*	−0.003	−0.002
	(0.006)	(0.005)	(0.005)	(0.006)	(0.008)	(0.006)	(0.003)
Harvest NDVI	0.266*	0.311**	0.546***	0.286*	0.218	0.023	0.076
	(0.128)	(0.113)	(0.114)	(0.142)	(0.165)	(0.160)	(0.059)
Female	−0.033***	−0.013*	−0.014**	0.023**	−0.018*	−0.011	0.020***
	(0.006)	(0.006)	(0.006)	(0.008)	(0.008)	(0.008)	(0.003)
Rural	0.004	−0.008	0.008	−0.056***	0.032+	0.104***	0.014*
	(0.015)	(0.013)	(0.013)	(0.015)	(0.017)	(0.014)	(0.007)
Age	0.000	−0.000	−0.001*	−0.004***	−0.002***	0.002***	−0.000+
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Employed	−0.004	0.006	−0.017+	0.069***	−0.006	0.001	−0.016***
	(0.011)	(0.010)	(0.009)	(0.011)	(0.012)	(0.011)	(0.005)
Education	0.000	0.005*	0.002	0.065***	0.016***	−0.025***	−0.007***
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)	(0.001)
Party membership	0.053***	0.057***	0.051***	0.003	0.070***	0.072***	−0.016***
	(0.009)	(0.008)	(0.008)	(0.010)	(0.010)	(0.010)	(0.004)
Constant	0.284	0.271+	0.262+	1.685***	0.420*	1.178***	1.008***
	(0.179)	(0.153)	(0.139)	(0.179)	(0.212)	(0.127)	(0.064)
Num.Obs.	101763	103502	103039	106977	106020	56776	100915
Unit FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

(continued)

Table 4. (continued)

	Economic Performance	Poverty Performance	Price Performance	Living Performance	Economic Performance	Trad. Leader Performance	Ethnic ID
Year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month and year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Weights and survey design included.
Standard errors clustered by PSU.
+ $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.



(a) Approve of Economic Performance (b) Country's Economic Condition (c) Approve of Traditional Leader

Figure 9. Afrobarometer Predicted Values (a) Approve of Economic Performance; (b) Evaluate Country's Economic Condition; (c) Approve of Traditional Leader

nation (e.g., as a Kikuyu or a Kenyan). While an imperfect test of this mechanism, seasonal variation in this measure could indicate that ethnic salience varies by season.

The estimates in Table 4 show no evidence supporting either supposition. Months from Harvest shows no relationship with either a respondent's evaluation of their traditional leader or the relative strength of their ethnic identity compared to a national one. This suggests that the strength of these potential patron-client ties do not vary by season.

Migration, Labor and the Costs of Voting. Finally, I consider the possibility that changes in election outcomes result from changes in the voter pool. Voting is not a costless endeavor; the costs associated with voting may vary by agricultural season. This could be due to the opportunity costs associated with voting. Labor may be critical at certain times in the agricultural calendar (e.g., planting, weeding, harvesting), and forgoing a day's labor to queue at the polls is more costly than during other periods. These costs may fall unevenly. For instance, workers of a particular gender may be expected to perform certain types of labor, or younger workers may be more likely to migrate to urban centers. In this way, agricultural seasons might indirectly affect election outcomes by influencing who participates in an election.

To consider this possibility, I examine the relationship between Months from Harvest and turnout. If there are changes in the pool of voters, this could be reflected in different turnout rates. However, as seen in Table 5, there is no relationship between seasonality and turnout in the Africa-wide or Zambia samples.

Table 5. Seasonality and Election Turnout

	All Africa	Zambia
Months from harvest	−0.006	−0.007
	(0.004)	(0.004)
Months from harvest^2	0.000	−0.000
	(0.000)	(0.000)
Harvest NDVI	−0.002	−0.055
	(0.082)	(0.115)
Num.Obs.	846	300
Region FEs	Yes	Yes
Year FEs	Yes	Yes

Zambia models SEs clustered by constituency.
Africa model SEs clustered by subnational unit.
+ $p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Additional Models. In the supplementary materials, I estimate several additional models that either vary the modeling assumptions or extend the models presented in the text. First, I re-estimate my models with binary dependent variables, finding consistent results. Next, I estimate models that include an interaction between Months from Harvest and whether a respondent is rural. These models suggest the curvilinear relationships shown in my main models tend to be more pronounced with rural respondents. Finally, I estimate an instrumental variable regression predicting whether a respondent intends to vote for the incumbent party, using Months from Harvest as an exogenous predictor of a respondent's performance evaluation.

Conclusion

Despite significant research in other fields, political science has largely overlooked potential seasonal effects on political outcomes. This article begins to fill this gap by considering whether African incumbents do better in elections held after harvests and, if so, why. In doing so, it provides new insights into retrospective voting in sub-Saharan Africa and how environmental factors influence electoral behavior.

Starting with an analysis of election outcomes across Africa, this article shows a curvilinear relationship between time from harvest and support for incumbent politicians. Initially, time from harvest is associated with better results for the incumbent. Eventually, this relationship reverses, and more time from the harvest is associated with poorer electoral outcomes for the incumbent. I replicate these results using quasi-experimental evidence from

two Zambian by-elections triggered by the untimely death of incumbent presidents. A subsequent analysis of Afrobarometer survey responses indicates a potential mechanism explaining this result: retrospective voting. Not only do aggregate election outcomes vary by season, but so do individual evaluations of government performance. Furthermore, these results provide some evidence that, like voters in more established democracies, African voters prioritize sociotropic evaluations when evaluating incumbent performance.

These results offer insights for several audiences. First, African policymakers should craft policies to counter seasonality's harmful effects, particularly those seeking re-election. Similarly, researchers of African politics should account for potential seasonal effects in their research, particularly when collecting data. When researchers conduct a survey or field experiment, it may interact with agricultural seasonality in unexpected ways, shaping results.

Finally, these results improve our understanding of the relationship between the environment and political outcomes. Researchers are increasingly interested in how the environment influences political outcomes and vice versa. This interest is only growing with the threat of climate change. While climate scientists acknowledge the growing risk of disruptions to agricultural seasons related to climate change, we know little about how agricultural seasons influence political outcomes in the absence of such changes.

Future research could extend these results in several ways. First, researchers could more precisely estimate the relationship between harvests and electoral outcomes, perhaps by more explicitly accounting for different environmental or political contexts, or by restricting their analysis to specific food systems. Additionally, while this article focuses on voter behavior and electoral outcomes, these insights could be extended to other types of political behavior.

Critics often contend that governments should be responsive to popular demands for food security and improved agricultural conditions. However, this criticism is predicated on the idea that African voters are willing to cast their ballots based on these issues. This article provides evidence that agricultural conditions are a voting issue for many Africans.

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Declaration of Conflicting Interests

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Data Availability Statement

Replication materials, including data and code, can be found at Engelsma (2026).

Supplemental Material

Supplemental material for this article is available online.

Notes

1. See Engelsma (2026) for replication materials including all necessary data and code.
2. The actual number of Africans working in agriculture may be higher due to informal employment and family labor, as well as people farming plots of land as a secondary income source.
3. See also Schultz and Mankin (2019) for why measured weather anomalies may not be as exogenous as some authors think.
4. This is not necessarily exhaustive. For example, there may be a weeding season following planting. Additionally, in select cases, multiple harvests or continuous, year-round production is possible, reducing or eliminating fallow periods.
5. In general, the existence of alternative income sources would bias against finding any seasonal effects.
6. As the distinction between a linear and non-linear relationship is potentially an empirical question, in the supplementary materials I repeat my analyses as linear models, finding no relationship.
7. Alternatively, consistent with canonical models of vote buying, if households' living conditions worsen during lean times, the marginal utility of selling should be greater.

8. Specifically, NDVI is calculated using the following formula: NDVI = *(NIR - Red)/(NIR + Red)*, where NIR equals measurements from the near-infrared region, and Red the red visual region.
9. See https://www.fao.org/giews/earthobservation/asis/index_1.jsp.
10. See https://ipad.fas.usda.gov/ogamaps/cropcalendar.aspx for crop calendars. A spreadsheet comparing my observations with their crop calendars is available in the replication materials.
11. Additionally, since crop calendars are largely static, they may be slow to react to climate change-related changes to growing seasons.
12. For example, provinces, regions, states, etc., are first-order subnational units. The exact naming convention varies by country.
13. See the supplementary materials for the list of elections. This dataset primarily consists of presidential election results, including first and second-round results in majoritarian systems, with legislative election results for parliamentary systems.
14. This would be an issue if, for instance, elections and harvests always occurred at the same time every year.
15. In the supplementary materials, I plot a region's standard deviation of Months from Harvest against a region's mean Months from Harvest. A weak positive correlation exists between these measures.
16. Predicted values are based on the Reduced models, with the region assumed to be Sierra Leone's Northern Province and the year 2007.
17. This procedure is analogous to Fisher's Randomization Inference procedure.
18. T-Values are calculated by dividing the coefficient estimate by the standard error. Estimated models are identical to the "Controls" models in Table 1.
19. Both likelihood-ratio tests and F-tests suggest that models with subnational-unit fixed effects are a better fit than models with country fixed effects.
20. The estimated interaction effects are largely insignificant statistically, however.
21. Countries with delayed elections include Angola, Benin, Burundi, Central African Republic, Chad, Côte d'Ivoire, Djibouti, D.R. Congo, Gabon, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Malawi, Niger, Nigeria, Sierra Leone, South Africa, Sudan, Tanzania, Togo, and Zimbabwe.
22. Opposition politicians often make similar accusations during delays (e.g. Africa Confidential, 2019).
23. Sata's Vice President, Guy Scott, served as interim president but did not stand in the election.
24. Election results are taken from the Electoral Commission of Zambia's website.
25. To generate predicted values, I specify that the constituency is Chipangali and the year is 2008.
26. See the supplementary materials for a complete list of country-rounds, sample sizes, and survey dates for included rounds.

27. In the supplementary materials I report the correlations among these measures, which range from .47 to .63. Although these measures are correlated, some variation still exists distinguishing each substantive evaluation.
28. This question is only available for rounds 6 and 7 of the Afrobarometer.

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