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Democratization, Elections, and Public Goods: The Evidence from Deforestation

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Abstract: *This article shows that over the last three decades, competitive elections were associated with increased deforestation. Protection of forested areas provides long-term public goods, while their destruction provides short-term private goods for particular voters. Politicians facing a competitive election offer voters access to forested areas mainly for small-scale farming or commercial use of timber in exchange for electoral support. I test this theory of political deforestation using satellite generated global forest cover data and the results of over 1,000 national-level elections between 1982 and 2016. I find that countries that undergo a democratic transition lose an additional 0.8 percentage points of their forest cover each year, that years with close elections have over 1 percentage point per year higher forest cover loss compared to nonelection years, and that as the margin of victory in an election decreases by 10 points, the amount of deforestation increases by 0.7 percentage points per year. These increases are on the order of 5–10 times the average rate of forest loss globally. This suggests democratization is associated with underprovision of environmental public goods and contested elections are partially responsible for this underprovision.*

Verification Materials: The data and materials required to verify the computational reproducibility of the results, procedures and analyses in this article are available on the *American Journal of Political Science* Dataverse within the Harvard Dataverse Network, at: https://doi.org/10.7910/DVN/EF7R0Z.

> If an election were held every year, there would be no forest left.
> –High-level Kenyan official, December 1998[1]

Leading up to Kenya's first competitive election in 1992, President Moi signed a series of excisions granting key voters access to protected forested areas (Morjaria 2012). The World Resource Institute noted, "Recent forest loss has resulted from government approved, politically motivated, and dubiously legal excisions of forest land from protected areas, reserves, and plantations" (Seymour and Hutter 2000). Decades earlier, Bates (1979) wrote "securing the backing of the Mourides became more urgent with the advent of self-government in Senegal… the government of Senegal curried favor with the Marabouts by giving them privileged access to publicly subsidized inputs: fertilizers, mechanical equipment, *land carved out from forest reserves…*" (emphasis added). Deforestation rates increase 8–10% in mayoral election years in Brazil (Pailler 2016, 2018). How widespread is political deforestation, and what are the common mechanisms that underlie these electoral deforestation cycles?

Deforestation is one of the most important environmental issues of our time. When forests are cleared, most of the carbon in their biomass is released into the atmosphere, accounting for over one third of all greenhouse gas emissions (Alkama and Cescatti 2016). Preventing deforestation is one of the most cost-effective climate change mitigation measures (Gibbs et al. 2010). Deforestation is also the leading cause of habitat loss and

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[1]The original quote appears in Seymour and Hutter (2000) and later appears in Klopp (2012).

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species extinction and is associated with higher aridity, increased soil erosion, and lower water quality. Globally, only 6.2 million square kilometers of the preindustrial 16 million square kilometers of forest remain (Malhi et al. 2008), nearly 90% of which is on publicly owned land. Recent estimates point to a slowing rate of deforestation but continued tropical deforestation remains an important problem (Song et al. 2018). Because nearly 90% of remaining forests are publicly owned, deforestation is a political problem.

Some argue that democratic governments tend to provide more public goods than autocratic governments, the provision of which improves the lives of those who democracies enfranchise (Lakeand Baum 2001; de Mesquita 2005). Others suggest that competitive elections in weakly institutionalized democracies incentivize politicians to forgo public goods provision and instead target electorally influential people with private goods (e.g., Gottlieb and Kosec 2019; Pierskalla and Sacks 2019). This article adds nuance to the research on democratic governance and environmental protection (Buitenzorgy and Mol 2011; Li and Reuveny 2006) by considering the effects of competitive elections on the provision of environmental public goods through forest protection.

I demonstrate that democratic transitions and closely contested elections in weakly institutionalized democracies result in deforestation. I start with a tradeoff politicians face: provide short-term private goods offered by cutting down forests or provide long-term public goods offered by forest preservation. When a politician faces a more competitive election, the short-term electoral advantage they gain from giving key voters access to forested land outweighs the long-term support a politician gains by preserving forests. This results in increased rates of deforestation during competitive elections—as observed in Kenya (Morjaria 2012) or Brazil (Pailler 2018). I test this theory globally using satellite derived data on deforestation from 1982 to 2016 (Hansen 2018). I combine this with national-level electoral data, and economic and demographic covariates. Across all countries with any forest from 1982 to 2016, forests in countries that undergo a democratic transition have higher rates of forest loss after the transition than before, controlling for changes in population and economic growth. Election years have higher rates of forest loss than nonelection years in weakly institutionalized democracies. Elections with smaller margins of victory are associated with a higher rate of forest cover loss compared to elections with larger margins of victory in these countries. These tests eliminate many alternative mechanisms including economic growth, population changes, time-invariant characteristics of a location (such as topography or agricultural suitability), and year-to-year changes that affect all cells similarly (such as global commodity prices).

In generalizing across such a wide array of countries over such a long time, this article is limited in its ability to isolate specific causal mechanisms. Increased deforestation in an election year can occur as a result of agricultural expansion, logging, mining, infrastructure expansion, or others. However, the decision to allow destruction of forests so that other land uses can occur is one which is most likely to occur in weak democracies in an election year—something that is both important and merits further investigation.

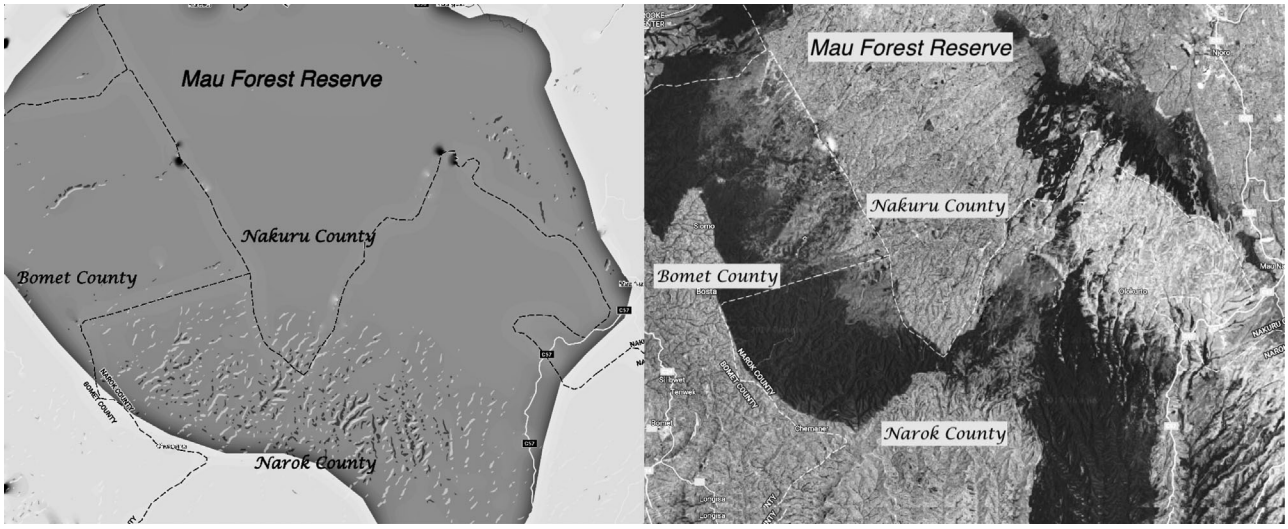
This article provides the first cross-national, longitudinal study of the link between elections and deforestation using data generated from satellite imagery. I show that forests are a resource politicians can use for political gain, and that electoral competition may lead politicians to prioritize short-term gain at the expense of longer term environmental public goods provision. This means that competitive elections themselves, a foundational component of democracy, provide perverse incentives to cause long-term environmental damage. This runs counter to the common conception of democracy as protective of natural capital.

Democracy and Deforestation

It is a stylized fact that democratic governments improve public goods provision resulting in welfare gains for the majority of the population (de Mesquita 2005; Lakeand Baum 2001), and that the mechanism that drives this relationship is competitive elections (Besley 2007). This line of reasoning extends into the research on democracy and the environment. Developed democracies tend to have higher levels of environmental protection and lower levels of pollution than nondemocracies (Dasgupta and De Cian 2018) because of their tendencies to provide public goods (Ehrhardt-Martinez, Crenshaw, and Jenkins 2002; Buitenzorgy and Mol 2011; Bernauer and Koubi 2009) and reduce corruption (Didia 1997; Gibbs et al. 2010).

Other research clarifies when democracy reduces public goods provision and environmental protection. Often in young or developing democracies an introduction or increase in political competition can decrease the availability of public goods (Gottlieb and Kosec 2019; Keefer 2007), increase patronage politics (Driscoll 2018; Pierskalla and Sacks 2019), and hurt

FIGURE 1 Deforestation in the Mau Forest Reserve



Note: Left panel shows the extent of the forest preserve in gray. The right is a satellite image from 2008, showing extent of cropland (light) and forest (dark)

the poor (Harding and Stasavage 2014). Others have found that democracies are associated with worse environmental outcomes (Midlarsky 1998) and specifically deforestation (Marquart-Pyatt 2004; Ehrhardt-Martinez, Crenshaw, and Jenkins 2002) though these findings lack theoretical motivation.

Several case studies examine the link between electoral incentives and deforestation. Klopp (2012) argues that the destruction of several forest reserves in Kenya can be attributed to increased demand for patronage in pre-election periods. Also set in Kenya, Morjaria (2012) argues that the introduction of multiparty elections in 1991 led to targeted excisions of protected forested land in areas pivotal for the election and deforestation rates increased thereafter. Pailler (2018) finds that in Brazilian municipalities where mayors run for reelection deforestation rates are 8–10% higher than in nonelection years. Burgess et al. (2011) discover "political logging cycles" in Indonesia, where deforestation rates increase during competitive elections. These studies join brief observations by other authors that in competitive elections, politicians use protected forested areas as a bargaining chip to win the support of key voters (Bates 1979; Boone 2003, 2014).

Natural sciences research identifies the mechanisms by which most deforestation occurs. The most common land use transition over the last 50 years has been from forest to agricultural land and pasture. Over the last 30 years, more than 80% of new agricultural land was previously forest (Gibbs et al. 2010). Economic growth causes deforestation through logging as well as infrastructure expansion and mining (Chupezi 2009; Mertens and Lambin 1997).

Drawing on theories of electoral competition and public goods provision, case studies, and the natural sciences literature on causes of deforestation, this article systematically develops and tests a theory of the link between deforestation and elections across countries. It contributes a general theoretical model for when and where electoral deforestation cycles should be strongest. Methodologically and empirically, this study adds higher quality data and panel methods to the debate on democracy and environment, and performs the first cross-national tests of electoral deforestation cycles.

Trading the Forest for the Trees?

Kenya: A Motivating Case

Figure 1 shows the Mau Forest Reserve, an area of government-owned protected forest, more than half of which has been converted into small-holder farms. The map on the left shows that the formally protected (darker) area falls into three counties: Nakuru, Narok, and Bomet. The satellite image on the right shows (light colored) cropland areas and (dark colored) forested areas. Nakuru county is an electorally competitive county

with a population of over one million divided among the major Kenyan tribes. Narok county is a primarily Maasai county that consistently voted for the opposition to the incumbent Kenya African National Union (KANU) party by a large margin in the 1990s and early 2000s. Bomet county has consistently voted for KANU by a wide margin. Most of the forest preserve in Nakuru county has been converted from forest to cropland (with the largest losses occurring around elections), while the majority of the preserve in Narok and Bomet county remains standing. In the Mau Forest Reserve the important difference was political: Nakuru was pivotal for control of the national legislature, while Narok and Bomet's representatives were but guaranteed to represent the opposition and incumbent parties, respectively. President Moi and the KANU party distributed patronage in the form of explicit and de jure land grants to voters in pivotal counties to maintain political control. Klopp (2012) describes two possible benefits the ruling party obtained through these land grants: sell the timber to finance reelection campaigns or distribute the land to potential supporters in exchange for their electoral support.

This and other anecdotes describe how deforestation can result from electoral competition at the district level. If this is generally true then years with competitive elections should have higher rates of deforestation at the national level, even if that deforestation is concentrated in competitive districts. I generalize the theoretical mechanism for how and when politicians exchange trees for votes and then consider the implications on a *cross-national level* using the overall competitiveness of national-level elections rather than district-level competitiveness. This allows observation of global patterns across the many countries and years for which subnational electoral returns are not available.

The Value of Forests

Protected[2] forests are valuable to voters for several reasons. First, when left undisturbed, forests provide ecosystem services to surrounding areas (Newell 2016). They host pollinators that are essential to seed production and predators that control pest populations. Additionally, forests reduce air pollution, decreasing respiratory and cardiac illnesses. They act as natural filters that purify water and help to recharge groundwater basins that are important for agriculture. Forests mitigate floods and droughts by preventing large fluctuations in the flow of rivers while preventing erosion and sediment loading that can make water more difficult to consume and shortens the lifespan of dams (Boelee 2011). Finally, they attract tourists and bring foreign spending. Most of these benefits accrue to populations beyond those that are adjacent to the forest, and fall somewhere on the spectrum of positive externalities (sediment reduction) to pure public goods (CO_2 emissions reduction) (Chazdon 2008). These benefits accrue slowly, for example, flood mitigation would not be apparent except in high-runoff events, and the effects of air quality on health can be latent for tens of years. However, there is growing evidence that negative environmental effects on voters' livelihoods can reduce support for an incumbent politician (Obradovich 2017). As a result, politicians who protect forests may receive some additional electoral support from those who benefit from the public goods that forests provide.

Forested land is also valuable through the sale of timber or the potential to use the land for crops or other commercial purposes. The timber itself has value for firms which benefit from decreased protections for forests (Pailler 2016; Burgess et al. 2011; Ross 2001). More commonly or in conjunction with the above is commodity driven deforestation where the value of removing forests comes from what replaces the trees (Morjaria 2012). Forested land is high in nutrients such as nitrogen and phosphorous and is extremely productive when converted to agriculture (Rudel 2013). Rather than providing value over time, the value associated with cutting down forests is immediately realized and clearly attributable to the politician who provided it. Furthermore, the stored value of forested land accrues directly to the firm who is able to log the region or to the people who gain access to agricultural land. This choice over the distribution of value from forests mirrors the choice faced by politicians in electoral business cycles where politicians are more likely to increase spending in competitive districts and on projects for which politicians can easily claim credit (Drazen 2000; Mayhew 2004; Rogoff 1987).

The mechanism of granting access to forests generally takes one of two forms: use permits or property rights. Both these mechanisms vary in their formality—they range from being transparent and formal to hidden and informal. Use permits grant firms the right to log or mine an area of land, as in Brazil and Indonesia (Burgess et al. 2011; Pailler 2016). The politician can target a firm, which can provide jobs or economic growth to a particular area, or can contribute additional money to the politician either through higher tax revenue or political donations. Politicians can achieve a similar outcome by reducing protections or even reducing enforcement of protections for forests; this strategy has

[2]Protected means requiring government authorization for use.

lower target-ability but is less visible to the general public. In either situation, continued use is often contingent on the reelection of the politician who provided permits or reduced protection (Albertus 2013). Property rights grant farmers the ability to clear forests and plant crops or graze livestock with the understanding that those who benefit will vote for the politician who provided those rights. The Kenya case is instructive for how this transaction occurs. Politicians can either target a particular forested with reduced protection, benefiting the people who live nearby and can expand onto the deprotected land or by granting property rights to a group of people whose votes the politician wants to secure. Property rights may be reversible should the incumbent who provided the property lose the subsequent election.

Forests differ from other classes of goods governments provide such as roads, clinics, and schools (Harding 2011; Harding and Stasavage 2014). Forests take decades to regenerate and are thus a one-off opportunity in a political lifetime. Additionally, the allocation of forested areas does not require government spending that trades off with other projects. The exploitation of forests in the present only trades off with either their future exploitation or the future public goods that they could provide. Even if the government absolutely discounted the diffuse public goods that forested areas provide, it might choose to preserve some forested areas for future use and smooth its consumption of forested areas (Ostrom et al. 1999). The implication is that even if officials place little or no value on the public goods forests provide, they should tend to preserve forested areas until the present need for the goods exploitation of forests provides is greater than the expected future need for those goods. In other words, politicians should only grant access when they need to provide short-term benefits to an important group of constituents or when they are afraid they might lose the ability to grant access.

Political Incentives

Seeking to stay in power, politicians possess two strategies with respect to forested areas: one is to allocate some access to publicly owned forests to the constituents on whose support they rely. The other is to protect forests and rely on the public goods protected forests provide to convince constituents that they will be better off if the politician stays in power. A politician must distribute benefits in such a way that they generate enough support to stay in power.

How will a politician use limited forest resources to maximize their chances of staying in power? Most research focuses on how politicians supply goods to potential supporters. In an autocracy where a politician must please a small winning coalition, providing private goods tends to be more efficient than providing public goods (de Mesquita 2005), and we expect politicians to allocate more access to public forests (Didia 1997; Buitenzorgy and Mol 2011; Li and Reuveny 2006). In a democracy where the winning coalition is large, providing public goods is more efficient at generating support, and politicians can be expected to preserve forest at a higher rate (Deacon 2009; Lakeand Baum 2001; Olson 1965).

However, there are two demand-side reasons deforestation rates increase when a country transitions from autocracy to democracy: the relative political empowerment of those who demand land and the shortened political time horizons that come with regular elections. In a new democracy, the selectorate includes recently enfranchised small-holder farmers (or others who may benefit from deforestation) for whom forested land is an extremely valuable resource (Boone 2003; Morjaria 2012). In an autocracy, the selectorate tends to consist of a small wealthy group of industrialists who do not have incentives to quickly deforest[3] (Anderson 2010; Bates and Block 2013; Kasara 2007; Swinnen 2010). Note that this can occur in countries where agriculture plays a small role in the economy—all that is required is the combination of newly enfranchised forest consumers. When a democratic transition occurs, the political value of removing protections for forested land increases.

Weakly institutionalized democracies are more clientelistic because parties are weaker and their promises are less credible in the mind of voters (Keefer and Vlaicu 2008) and lower public goods provision (Gottlieb and Kosec 2019). The introduction of additional electoral competition can exacerbate clientelism (Pierskalla and Sacks 2019) by increasing the stakes of clientelist relationships or by increasing the demand for clientelist goods (Driscoll 2018). Thus, after democratic transitions and during close elections targeted forest allocation should be more likely, especially in weakly institutionalized democracies.

I focus first on countries that experience a democratic transition. This allows me to isolate the relationship between political incentives and deforestation rates in the two different systems while holding other conditions relatively constant. Based on the empowerment of

[3]This is for two reasons. The value for industrialists tends to come from selling timber products rather than planting crops meaning that they would smooth their consumption of forest over time. Second, as the number of plausible consumers of forest increases, the incentive to deforest now becomes stronger (Ostrom et al. 1999).

farmers who demand cropland and the introduction of elections which emphasize short-term political gains, I hypothesize that

Hypothesis 1. Countries that transition regime type have higher rates of deforestation under democratic government.

There are further observable implications for election and nonelection years. Politicians have a shortened time horizon ahead of a competitive election because they may not be reelected. Short horizons reduce the value of the long-run goods forests provide and make the short-run benefits of granting access to the land more appealing. Should the politicians lose reelection, the long-term goods protected forests provide are worthless to them, rendering the immediate increase in political support from immediate allocation even more valuable in comparison. Additionally, if the politician is able to identify pivotal voters, the efficiency of granting access to those voters likely exceeds the efficiency of providing public goods. However, this comes at the expense of the increase in support generated by protecting forested lands until they are allocated at some point in the future and the benefit the politician might get in a future election by allocating those goods. Because of this, a politician should generally only choose to allocate forested land when they feel truly threatened, and only if institutions are weak enough that the politician will face minimal backlash for these allocations. Given that autocracies rarely, if ever, have competitive and meaningful elections and institutionalized democracies have mechanisms to punish politicians for clientelist behavior, the following two hypotheses apply primarily to weakly institutionalized democracies.

Hypothesis 2. Election years will have higher rates of deforestation than nonelection years.

Hypothesis 3. Years with competitive elections will have higher rates of deforestation than years with noncompetitive elections.

Finally, all of the hypotheses should be strongest in places where politicians can observe and target key constituents. In a single-district proportional representation system policies, which by their nature target certain geographic areas, are less likely to be useful than in majoritarian systems with low district magnitude (like Kenya) where politicians can identify pivotal districts (Park and Jensen 2007; Rogowski 1987).

Hypothesis 4. Majoritarian systems will amplify the effects of democratic transitions and elections on deforestation compared to nonmajoritarian systems.

Empirical Strategies

Data

The dependent variable for this study is the percentage point change in primary forest cover in a $0.05^\circ \times 0.05^\circ$ cell of land in one year. The total area of a cell is $30.25\,km^2$ near the equator, but as small as $8.90\,km^2$ near the poles. Forest is characterized by the presence of vegetation with a canopy over 5 meters tall. The data used to construct this measure are from Hansen (2018) who uses data from advanced very high resolution radiometer instruments to measure vegetation cover over the globe on an annual basis. This type of data are remarkable for a few reasons: the coverage is global, the method is accurate, and the data are not susceptible to interference from parties that seek to conceal or misrepresent information. I use data from 1982 to 2016, the full extent of the available data (Song et al. 2018).

I extract the percentage of forest land-cover of each cell in each year, resulting in 34 years of global forest cover data, and calculate the year-on-year differences for the dependent variable. The dependent variable exhibits a unit root in levels, which suggests taking a first difference will produce more consistent results than including a lagged dependent variable. Alternately, the dependent variable of interest is the rate of forest cover change rather than the level of forest cover. A value of -1 for a cell indicates a 1 percentage point loss of forest.

I merge national boundaries with these data, so each observation contains a unit-level measure of forest cover and a set of national-level independent variables. I exclude all observations that never have forest cover from 1982 to 2016 because such places are never eligible to lose forest. Many areas gain forest, particularly in China, Russia, and Canada where large scale tree planting or climatic changes have resulted in more forests. Forest increases are included in the data but are difficult to link to a political event because the different growth rates of various species of trees mean that new trees may take many years to appear in the data. However, a slower than normal rate of gain in a particular year could indicate forest loss in some parts of the cell.

Right-hand side variables come from several sources and are merged with forest cover data by country-year. This analysis uses a dichotomous indicator of democracy from Boix, Miller, and Rosato (2013) for the democratic transition test. They define a minimum threshold for both contestation and participation to determine whether a country is a democracy in a given year. Data on election years and votes come from the Database of Political Institutions (DPI) (Beck et al. 2001) and the V-Dem

project (Coppedge et al. 2020). The variable *election year* takes a value of 1 if a national-level legislative election occurred in that country in a given year, and 0 otherwise.[4]

Kayser and Lindstädt (2015) note that ideally researchers should use past vote swings and seats–votes elasticities to calculate electoral risk, but even this is complicated by implicit assumptions about how effort maps to votes (Cox, Fiva, and Smith 2020). This is further complicated by two features of this study: seat–vote elasticities are not available for most of the countries considered, and using previous vote swings requires six previous elections with relatively stable parties. Because the focus of this article is young democracies, previous elections both are not available and do not provide good information on which to base an expectation of the competitiveness of the current election. Instead, in the spirit of Kayser and Lindstädt (2015) I use the percentage of seat difference between the two largest parties. This most clearly captures the margin by which the largest party holds the prime minister position in a parliamentary system or the presidency in a two-party democracy as measured by Coppedge et al. (2020). Alternately, I use two measures derived from Beck et al. (2001): the difference between the incumbent coalition's vote proportion and 0.5; and the difference between the incumbent coalition's seat proportion and 0.5. For interpretability, I transform these variables so that a value of 100 represents a tie election and a value of 0 represents one-party garnering 100% of the vote or seats.[5] I use the Polity IV data to divide countries into "autocracies" (polityIV < -5), "anocracies" (polityIV ≤ 5 and ≥ 5) and "democracies" (polityIV > 5) (Marshall 2019). Anocracies are the weakly institutionalized democracies for which I expect electoral deforestation cycles to be most pronounced.

I create a variable which is 1 if proportional representation is used in national legislative elections, and 0 otherwise (Beck et al. 2001). This allows a test of Hypothesis 4 by isolating majoritarian systems where geographic targeting is more feasible.

In each regression, I include the following controls from the World Bank World Development Indicators: per capita GDP (thousands of US dollars), change in per capita GDP (% change), and change in population (% change) (WDI 2017). Each is lagged by one year to prevent the inclusion of posttreatment controls. This means that a variable such as per capita GDP is included from time $t-1$ and change in per capita GDP is included as the change from time $t-2$ to time $t-1$. I also include a control for the amount of forest remaining in a cell at the start of the year because I expect deforestation rates might be higher in places that are partially forested than places that have 100% forest cover. Supporting Information Tables A.1 and A.3 and Figure A.1 (pp. 3–8) present specifications that include percentage of the population employed in agriculture and agriculture as a percentage of the GDP.

TABLE 1 Observations in Different Levels of Aggregation

Number of Forested Cell-Years	158,423,948
Number of forested cells	4,633,413
Number of countries with forested area	164
Number of country-years	5,735
Number of elections	1,244

I include unit and year fixed effects. The unit fixed effect absorbs any time-invariant characteristics at the unit level, including location, country, elevation, average climate, soil type, etc. It also demeans the forest cover loss variable, considering only deviations from the average forest cover loss in each cell. Year fixed effects absorb global-level changes specific to a single year, such as food, lumber, or fuel prices. The remaining variation is composed of deviations from each observation's average forest cover loss that are also deviations from the global average forest cover loss in that year. Because election shocks should appear only in cell-years that experience an election, this specification should control for most variables that are associated with both election years and deforestation. It should also control for most of the nonpolitical drivers of deforestation including economic and population growth. Simply, the variation I explain is: changes in forest cover that are not associated with development, economic growth, population growth, size of the agricultural sector, growth in the agricultural sector, and changes idiosyncratic to a particular location or year.

I cluster standard errors at the country and year levels to account for correlation in residuals between cells in the same country, possibly over many years, and to account for correlation in residuals between distant cells in the same year. This reduces the effective number of observations to a number much closer to the number of country-years (thousands) instead of cell-years (tens of millions) (Table 1). The second set of regressions reported next aggregates forested cells to the country level, generating a dependent variable that is the average change in forest cover among forested cells in a country in a year. Supporting Information Tables B.1– B.3 (pp.

[4]I use the V-Dem measure in the article but the results are robust to DPI.

[5]Formally, margin $= 100 - |\%\text{votes}_i - \%\text{votes}_j|$, where i and j are the two parties with the most seats, or margin $= |50 - \%\text{votes or seats}_i| \times 2$, where i is the incumbent coalition.

TABLE 2 Elections by Regime and Electoral Type

Regime Type	System	Elections	Margin < 20	Margin < 10
Anocracy	PR	92	15	5
Anocracy	Majoritarian	105	24	17
Autocracy	PR	28	2	2
Autocracy	Majoritarian	67	12	5
Democracy	PR	544	340	220
Democracy	Majoritarian	144	64	36

8–10) aggregate to cells which are 100 times larger than those described above, and levels 1 and 2 subnational administrative units. The country-level specification targets the question "for a country experiencing a democratic transition or election, what is the national expected rate of forest loss for forested areas" while the cell-level specification targets the question "for a patch of forest, what is the expected rate of forest loss during a transition or election." The cell level has a fixed geographic area as the unit of analysis, so it tends to upweight countries with lots of forest. The country level tends to upweight the effects on forests in countries without much forest.

Summary Statistics

There are approximately 4.4 million cells that ever have forest, 136 countries that have some forest and appear in them sample, and 1,146 elections. Those elections predominantly occur in strong democracies, but 197 of them are in anocracies and 95 in autocracies. Only 22 elections in anocracies have a margin of victory of less than 10 percentage points (Table 2).

Test 1: Democratic Transitions

First, I test whether cells in democratic countries that experience regime-type transitions have higher rates of deforestation than cells in nondemocratic countries that experience such a transition. The main independent variable is whether a country is a democracy, where democracies are coded 1 and nondemocracies coded 0. The dependent variable is percentage point change in forest cover for a cell in a year. The main specification uses unit and year fixed effects that project out time-invariant characteristics of each cell (and thus country):

$$\text{ForestChange}_{i,c,t} = \alpha_i + \gamma_t + \beta_1 \times \text{Democracy}_{c,t} + \lambda \times X_{c,t} + \delta \times X_{i,t} + u_{i,c,t}. \quad (1)$$

β_1 represents the within-country difference between years when a country was a democracy (according to Boix, Miller, and Rosato 2013) and years when that country was not. α and γ are cell and year fixed effects, $X_{c,t}$ is a vector of country-level controls, $X_{i,t}$ is a vector of cell-level controls, and $u_{i,c,t}$ is the unexplained variation, clustered at the country and year levels.

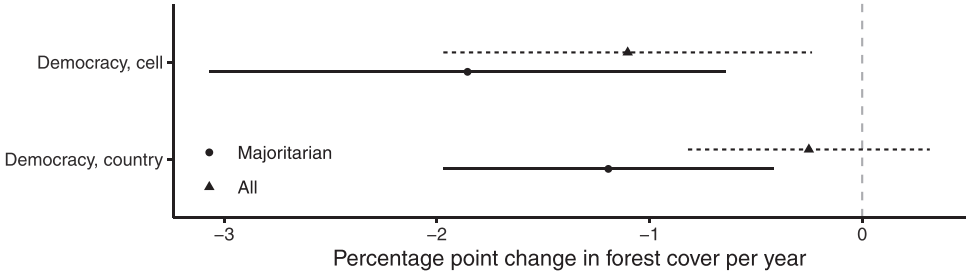
This regression targets whether a patch of forest was more likely to lose forest under a democratic or nondemocratic regime. It gives each equal-sized area the same weight, focusing on the total amount of deforestation. I focus on these cell-level regressions, however, I also present the country-level results in Figure 2 and in Supporting Information Figures A.1– A.3 (pp. 3–7).

Hypothesis 1 is countries that transition regime type have higher rates of deforestation under democratic government.

Table 3 shows that among countries that experience at least some years as a democracy and a nondemocracy, forested areas have about 1 percentage point greater forest cover loss during democratic years compared to the nondemocratic years. Columns 2 and 4 show that without including fixed effects this relationship is not detectable because it compares deforestation rates *between* fundamentally different countries rather than within a single country. This change in forest cover is estimated to be negative at a $\alpha = .05$ confidence level in the cell-level specification. The rate of forest cover loss associated with democracy is higher than the global average has been in any year since 1982. Democratization is responsible for approximately nine million square kilometers of forest loss, or an area roughly the size of Brazil. This represents approximately 9% of the total forest cover as measured in 1982 lost in countries that have experienced years as a democracy and nondemocracy. Furthermore, this estimate is *after* the main structural economic and demographic drivers of forest cover loss have been taken into account.

Hypothesis 4 posits that the effect of democratization will be stronger in majoritarian systems. To test this,

FIGURE 2 Forest Cover Change across Electoral Systems



Coefficients for the regression in Table 3. Dashed triangles correspond to columns 1 and 3, black circles are the same regressions for transitions to democracies with majoritarian systems

I run the following regression:

$$\begin{aligned}\text{ForestChange}_{i,c,t} = \alpha_i + \gamma_t + \beta_1 \times \text{Democracy}_{c,t} \\ + \beta_2 \times PR_{c,t} + \beta_3 \times (\text{Democracy}_{c,t} \\ \times \text{PR}_{c,t}) + \lambda \times X_{c,t} + \delta \times X_{i,t} + u_{i,c,t}. \quad (2)\end{aligned}$$

The β_1 coefficient can be interpreted as the relationship between a democratic transition and forest cover change for majoritarian systems. Figure 2 shows the democracy coefficient from the original specification and the coefficient from this specification. When a country transitions to a majoritarian system the forest cover loss associated with this transition is consistently large, negative, and significant across aggregation levels.

When the data are aggregated to a national level, the effect size is smaller and not statistically distinguishable from 0. This points to the possibility that the effect is more pronounced in countries with more forested cells or that the effects are localized to hot spots, which carry little weight in the national-level regressions. To further investigate, I run geographically weighted regressions and regressions at different levels of spatial aggregation, including aggregating cells to 55 km × 55 km, and aggregating to first and second-level subnational units. As Lee and Rogers (2019) point out, identifying the "correct" unit of analysis can be difficult and lead to different results, so results from various levels of aggregation can be found in Supporting Information Tables B.1– B.3 (pp. 8–10). When focusing on majoritarian systems the effect of a regime-type transition is larger and significant for all levels of aggregation, suggesting that geographic targeting is for the political and ecological versions of this question.

Where previous results attempt to answer the question of whether democracies deforest more than nondemocracies, this article poses a more tractable question: how do rates of forest cover loss change when a country switches between being a nondemocracy to being a democracy? This refrains from comparisons between vastly different countries and instead relies on variation within countries over time. Second, by including data at the cell area, it allows me to ask a modified

TABLE 3 Regressions of Forest Change on Democracy

	Cell	Cell	National	National
Democracy	−1.10* (0.44)	−0.35 (0.39)	−0.25 (0.29)	0.04 (0.10)
Forest	−0.77*** (0.03)	−0.05*** (0.01)	−0.56*** (0.06)	−0.01 (0.01)
PCGDP	0.08 (0.05)	0.00 (0.01)	0.11** (0.03)	0.00 (0.01)
Δ PCGDP	−7.86 (20.33)	10.26 (28.39)	−9.33 (10.40)	26.70 (16.96)
Population growth	−0.13 (0.27)	−0.01 (0.12)	−0.08 (0.08)	−0.06 (0.06)
Constant		1.78*** (0.31)		0.46 (0.27)
Fixed effects	Cell + Year	None	Country + Year	None
No. of obs.	136,743,524	136,743,524	4,375	4,375
Adj. R^2 (full model)	0.38	0.02	0.34	0.01
Adj. R^2 (project model)	0.37	0.02	0.26	0.01

Note: Sixty-one countries experienced a regime-type transition. Columns 2 and 4 replicate the nonfixed effects specifications used in the previous work. *** $p < .001$; ** $p < .01$; * $p < .05$.

version of the question—for an area of forested land, what is the likely result of having the country in which it is located change regime types. This focuses on an effect that is substantively important: in the large countries where most of the remaining forest in the world resides, what were the consequences of democratic transitions? The evidence shown here is that democratic transitions are associated with higher rates of deforestation, especially when the transition is to an electoral system with geographic targeting.

Test 2: Election Years

Competitive elections create a unique set of incentives for politicians to allocate more forested land to voters than they do in nonelection years. I expect this to be the strongest in weakly institutionalized democracies and weak in both autocracies (where leaders' positions of power are not contingent on elections) and strong democracies (where institutions can prevent clientelism). A blunt test of Hypothesis 2 considers forest cover loss in all national-level election years across the government-type trichotomy and compares it to forest cover loss in nonelection years. Because business cycles are known to be connected with elections and could drive deforestation, I control for change in per capita GDP from $t-2$ to $t-1$. While this estimation strategy cannot rule out the possibility of some unobserved confounder, such a confounder would have to cause elections and increase forest loss in many countries over the course of multiple elections. Unit and year fixed effects prevent unit, country, or year-specific characteristics from confounding the estimates:

$$\begin{aligned}\text{ForestChange}_{i,c,t} = {} & \alpha_i + \gamma_t + \beta_1 \times \text{Election}_{c,t} \\ & + \beta_2 \times \text{GovType}_{c,t} + \beta_3(\text{Election}_{c,t} \\ & \times \text{GovType}_{c,t}) + \lambda \times X_{c,t} + \delta \times X_{i,t} + u_{i,c,t}. \quad (3)\end{aligned}$$

β_1 represents the within-country difference between election years and nonelection years for anocracies. β_2 represents the within-country difference between regime types. β_3 represents the difference between election-year effects for anocracies versus democracies or autocracies. The second and third panels only include elections within the specified margin of victory. α and γ are unit and year fixed effects, $X_{c,t}$ is a vector of country-level controls, $X_{i,t}$ is a vector of cell-level controls, and $u_{i,c,t}$ is the unexplained variation, clustered at the country and year level. The goal is to isolate deviations from each cell or country's average rate of deforestation that cannot be explained by economic or demographic characteristics, and test whether those deviations align with election years and close elections.

In an average election there is no more deforestation than usual. However, as the competitiveness of the election increases so does the expected rate of deforestation, culminating in a 2 percentage point increase in the rate of deforestation (over 10 times the average rate of forest loss in the Brazilian Amazon). Columns 1–3 of Table 4 show results at the cell level. Election years themselves are not significantly associated with forest change, but elections with less than a 20-point and less than a 10-point margin of victory are increasingly associated with deforestation. Columns 4–6 show that when aggregated to a national level these results at not significant. At the cell level, rows 4–6 show that in democracies the effect of elections are counteracted, but row 7 supports the above conclusion that being in a democracy is a net negative for forest cover.

Figure 3 shows this relationship across levels of aggregation and electoral system types. Refer to Table 1 for the number of elections in each category. The top of Figure 3 shows the coefficients from the first three rows of Table 4. The bottom half of the figure shows the results from the electoral system regressions—at the cell level, the point estimates are smaller but still significant. At the national level, focusing on majoritarian systems increases the precision of the estimates where competitive and close elections both have higher rates of deforestation than nonelection years. When aggregated over elections in anocracies, I find that close elections are responsible for around *additional* 500,000 square kilometers of deforestation, or larger than the size of the state of California.

In many countries we should expect subnational variation in effect sizes due to variation in importance or competitiveness across districts. This or specific locations of key constituencies should lead us to expect only some parts of countries to exhibit higher rates of deforestation in election years. This should bias against finding results because it averages across areas where no change in forest cover should be expected.

Supporting Information Figures C.1– C.4 (pp. 11–12) show results of geographically weighted regressions. Notably, the subequatorial region that has experienced the most intense deforestation in the last 40 years also has the strongest relationship between elections and forest cover loss, stretching across Brazil, Argentina, Uruguay, DRC, Congo, Angola, Indonesia, and up into South Asia. This analysis also shows heterogeneity within countries–something which merits analysis in future work.

TABLE 4 Regressions of Forest Change on Election Year

	Cell	Cell	Cell	National	National	National
Election year	−0.10			−0.12		
	(0.38)			(0.23)		
Margin < 20		−1.38			−0.39	
		(0.69)			(0.38)	
Margin < 10			−2.17**			−0.37
			(0.70)			(0.35)
Election: Democracy	0.06			0.07		
	(0.37)			(0.22)		
Margin < 20: Democracy		1.22			0.19	
		(0.76)			(0.42)	
Margin<10: Democracy			2.08**			0.16
			(0.65)			(0.41)
Democracy	−0.91*	−0.87*	−0.96*	−0.33	−0.38	−0.35
	(0.37)	(0.35)	(0.37)	(0.23)	(0.23)	(0.25)
Autocracy	−0.50	−0.54	−0.56	0.11	0.21	0.21
	(0.60)	(0.63)	(0.63)	(0.38)	(0.37)	(0.37)
Forest	−0.77***	−0.77***	−0.77***	−0.55***	−0.56***	−0.56***
	(0.03)	(0.03)	(0.03)	(0.06)	(0.06)	(0.06)
PCGDP	0.07	0.08	0.09	0.11**	0.11**	0.11**
	(0.06)	(0.05)	(0.05)	(0.03)	(0.03)	(0.03)
Δ PCGDP	35.20	7.91	13.68	−1.48	1.93	3.14
	(37.62)	(29.47)	(31.86)	(10.02)	(10.10)	(10.21)
Population growth	−0.14	−0.23	−0.18	−0.06	−0.08	−0.07
	(0.27)	(0.26)	(0.27)	(0.07)	(0.06)	(0.06)
Country + Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	13,280,1614	118,463,788	110,285,677	4,081	3,701	3,517
Adj. R^2	0.38	0.38	0.38	0.34	0.35	0.35
No. of groups: Country	136	136	136	136	136	136
No. of groups: Year	33	33	33	33	33	33

Note: Election years are subset by how competitive they were: columns 1 is all election years, 2 is years with a margin of victory less than 20 points, 3 is years with a margin of victory less than 10 points. Election year is interacted with regime type with anocracy as the base case.*** $p < .001$; ** $p < .01$; * $p < .05$.

Test 3: Competitiveness

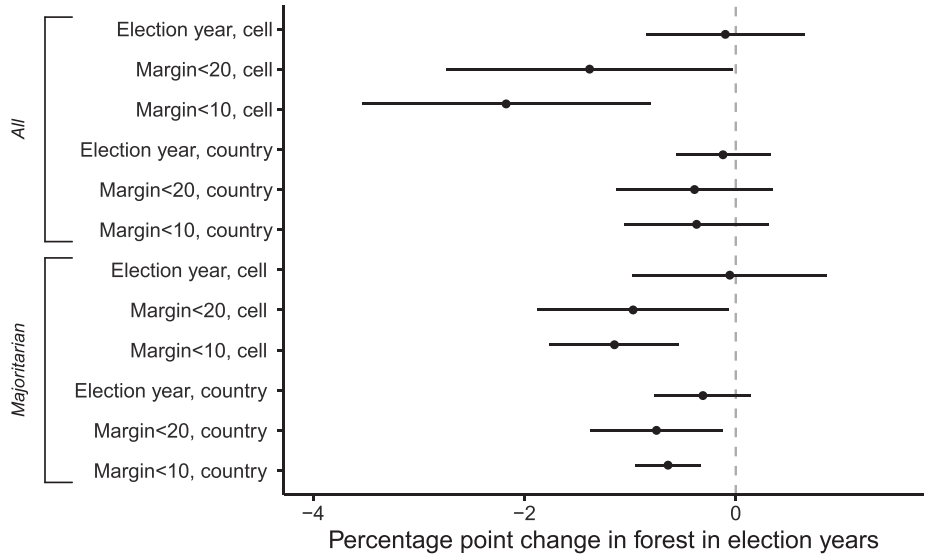
In this section, the sample is restricted to years in which elections occurred, and close elections (in which the margin of victory is low) are compared to elections where one party got a preponderance of the votes. The independent variable measures the competitiveness of an election where 100 corresponds to a tie vote between the two largest parties and 0 corresponds to an election in which one party got 100% of the votes cast. This simplifies the interpretation of the coefficient—as elections get more competitive rates of forest cover loss increase. Once again the main independent variable is interacted with the trichotomized polity variable to isolate the effects in weakly institutionalized democracies. The main test includes unit fixed effects,[6] and the same controls:

$$\begin{aligned}\text{ForestChange}_{i,c,t} = \alpha_i + \beta_1 \times \text{Competition}_{c,t} \\ + \beta_2 \times \text{GovType}_{c,t} + \beta_3(\text{Competition}_{c,t} \times \text{GovType}_{c,t}) \\ + \lambda \times X_{c,t} + \delta \times X_{i,t} + u_{i,c,t}. \quad (4)\end{aligned}$$

β_1 represents the within-country difference between election years and nonelection years for anocracies. β_2 represents the differences between rates of deforestation in election years across regime type estimated at a competitiveness of 0. β_3 represents the difference

[6]But not year fixed effect because demeaning forest cover change only in cells that have an election by year does not make sense and loses several years in which there was only one election.

FIGURE 3 Forest Cover Change across Levels of Electoral Competitiveness, Regime Type, and Electoral System



between margin-of-victory effects for anocracies versus democracies or autocracies. α is unit fixed effects, $X_{c,t}$ is a vector of country-level controls, $X_{i,t}$ is a vector of cell-level controls, and $u_{i,c,t}$ is the unexplained variation, clustered at the country and year levels.

Table 5 shows that at the cell level a 1 percentage point increase in competitiveness is associated with a 0.06 percentage point decrease in forest cover among election years in anocracies. While the previous set of regressions compared election years to nonelection years, this regression compares competitive to uncompetitive elections. However, the results are consistent with a 10 percentage point increase in competitiveness linked to a 0.6 percentage point decrease in forest cover, or the difference between a 20-point margin and a 10-point margin. While the coefficient on the interaction between democracy and competitiveness is not significant, it exactly cancels out the size of the anocracy competitiveness coefficient, suggesting that the relationship between electoral competitiveness and deforestation is mitigated there. At the national level, the effect is not distinguishable from zero, likely for the same reasons cited above—that elections in countries with large forested areas are driving the effect.

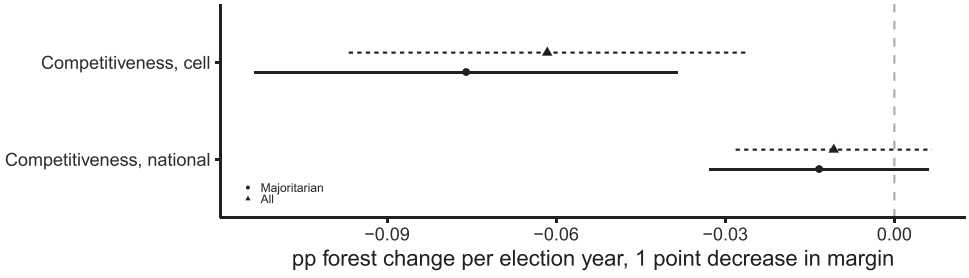
Figure 4 shows this relationship across cell and national levels of aggregation, and across electoral systems. Here, like the above subsetting to majoritarian countries only marginally changes the estimate of the effect size, and the two estimates are not significantly different. This test demonstrates that the degree of competitiveness can have a large effect on the deforestation rate. Brazil's average rate of deforestation between 1982 and 2016 was −0.13 percentage points per year. Applying the global average effect of elections to a cell in Brazil, the expected rate of deforestation would be expected to increase by 90% if the margin of victory shrinks by only 2 percentage points.

TABLE 5 Regressions of Forest Change on Electoral Competitiveness

	Cell	National
Competitiveness	−0.06**	−0.01
	(0.02)	(0.01)
Competitiveness: Democracy	0.06*	0.00
	(0.03)	(0.01)
Democracy	−4.53	0.16
	(2.36)	(0.89)
Forest	−0.71***	−0.43***
	(0.03)	(0.06)
PCGDP	0.07	0.14**
	(0.08)	(0.05)
Δ PCGDP	43.02	12.29
	(26.81)	(32.50)
Population growth	−0.03	−0.34
	(0.44)	(0.24)
Fixed effects	cell	country
No. of obs.	35,346,878	864
Adj. R^2	0.35	0.22
No. of groups: Country	128	128

Note: Competitiveness is interacted with government type with anocracy as the base case. *** $p < .001$; ** $p < .01$; * $p < .05$.

FIGURE 4 Forest Cover Change across Electoral Competitiveness, Regime Type, and Electoral System



A variety of other mechanism and robustness tests can be found in the Supporting Information: Tests of heterogeneous treatment effects by forest type and agricultural influence in (A), different levels of spatial aggregation results (B), geographically weighted regressions for the other tests (C), different measures of electoral competitiveness (D), including neighboring and lagged forest as controls (E), and examining the timing of deforestation with respect to elections (F).

Implications and Limitations

Implications

A number of influential papers argue that democratic governments are more likely to provide public goods than nondemocratic governments. Lake and Baum (2001) and Olson (1993) argue that more contestable political markets decrease the monopoly rents the state can extract from its provision of public goods, implying that the more competitive the election, the more public goods politicians are likely to provide. This article demonstrates that in young or weakly institutionalized democracies this relationship does not hold; rather than politicians choosing between state rents and public goods, politicians choose between strategies that maximize their chances of victory, sacrificing long-term provision of public goods for short-term transfers of private goods. As a result, we should not expect political competition to increase state production of *environmental public goods*. Instead, political competition may fuel exploitation of natural resources in a way that is more consistent with Ostrom's (1990) description of common pool resources (CPRs). Keefer and Vlaicu (2008) and Keefer (2007) argue that young democracies are more prone to clientelism and corruption, which reinforces the effect observed in this article.

Deacon (2009) and de Mesquita (2005) argue that because democratic politicians rely on the support of a larger subset of the population to stay in power, providing public goods is a more efficient way to generate public support than providing private goods. My findings run contrary to Deacon and Mesquita's theses. First, they do not consider differences in demand for different types of goods across different selectorates. When the newly enfranchised population is largely agrarian, politicians may choose to distribute private goods with a higher marginal utility to that population rather than providing public goods. Second, selectorate models do not incorporate changes in the marginal utility of public or private goods leading up to an election. As the time of an election grows nearer or if geographic targeting is easy, politicians can exercise a price-discriminating strategy where they distribute just enough goods to secure pivotal districts. When a politician can do this, the efficiency of providing public goods decreases (because it essentially offers a single price for the vote of a selectorate member) and politicians will choose to offer private goods (forest access) to low-price members of the winning coalition even if doing so reduces the well-being of other constituents. This effect may be amplified in places where the distribution of private goods is highly attributable but the utility provided by ecosystem services is not easily attributable. Klopp (2012) notes that as the attributability of environmental destruction increased in Kenya, forest for votes exchanges became less common.

In addition to the question of democratic provision of public goods, the findings have implications for how we categorize the goods natural systems such as forests provide when they are preserved. The default framework for natural resources in political science work is CPRs as in Ostrom (1990). These resources are notoriously hard to preserve because consumers face an N-player prisoners dilemma game where defection from preservation is a strictly dominant strategy for each player (Hardin 1968; Ostrom et al. 1999). This article characterizes

forests differently: rather than only considering the value forests provide when they are cut down or "consumed," it evaluates the value these forests provide when they are preserved. The ecosystem services outlined above are public goods (nonrival, nonexcludable), which changes the way we might think about their preservation. In nonelection years, government control of the resources produces an efficient outcome (contrary to what one might expect with a CPR). However, in election years, CPR problems begin to crop up. Perhaps forested areas are a class of goods that are best described as "public goods with common pool resource problems."

With this categorization, the CPR literature can offer some insight into why election years have such an effect on forest change. Ostrom (1990) argues that rapid changes in the value of a CPR can reduce the ability of any governance system to prevent overuse, but does not consider when political systems themselves might induce this change. As elections approach the value protected forests provide politicians (through the political support they help to generate) undergoes rapid changes. The value to a politician of removing protections and granting access increases relative to the value of preserving that resource, triggering a situation where the governance system (democratic governance) fails.

Limitations

A few limitations exist for these findings. These include the vast heterogeneity among countries and years in the sample, and potential measurement issues for independent variables across such a heterogeneous sample. These limitations generate possibilities for future work including testing the hypotheses here with higher resolution data, exploiting surprise elections, and examining the factors that might mediate the effect including political institutions, the demand for forested land, and the type of forest. The results for democracy only apply to countries that switch regime type, not stable democracies. The other effects are often estimated based on relatively few elections and as a result are more likely to be idiosyncratic to the sample, but this is a fundamental limitation of the data and our political history.

Second, because the vote totals are an outcome of the level of deforestation, there may be some reverse causality. However, the rate of deforestation likely only explains a very small part of the variation in electoral competitiveness (compared to vote-buying, Boone 2014; constructing roads and clinics, Harding 2011; and agricultural taxation and subsidation, Kasara 2007), limiting the size of the potential reverse causality bias. Future work could use preelection polling results to directly measure the effect that deforestation has on voting behavior (Morjaria 2012 uses a similar strategy).

This article is limited in how it can address specific mechanisms. Using national election returns means that I cannot assess whether politicians target core or swing voters, or whether the effect is driven by particular sectors. It also means that deforestation as a result of electoral business cycles is observationally equivalent to targeted allocation of protected forested land. I also cannot rule out the possibility that firms try to extract timber faster when there is political uncertainty. While I expect these effects to be relatively small compared to agriculturally and pastorally driven electoral deforestation cycles, they are potentially important mechanisms.

Conclusion

To summarize, I argue that democratic transitions are associated with higher rates of deforestation, competitive election years have higher rates of deforestation than nonelection years, and the more competitive an election the higher the rate of forest loss. Politicians choose to allow, induce, or even subsidize deforestation to garner political support when they fear they might not be reelected. Doing this is costly for the politicians—they give up both the additional support the public goods provided by forests might provide them and the ability to allocate that land in the future.

These findings are a first step toward demonstrating that natural resources might not fit neatly into the democracy and public goods provision literature. This is in part because natural resources differ from the "normal" public or private goods politicians offer their constituents in exchange for political support. However, this is also because an electoral mechanism leads to changes in demand for particular types of goods, leading politicians to take actions that do not seem efficient if one only considers the supply of public and private goods. Finally, it shows natural resources that provide environmental services might not fit neatly into a CPR framework, opening possibilities for new lines of research into environmental preservation.

The policy implications of this work are twofold. First, international institutions should note that democratic transitions and especially closely contested elections during a transition pose a threat to forests. Preventing forest cover loss is one of the most cost-effective methods to combat global warming, and politically motivated deforestation is something a process that

international environmental institutions might be uniquely suited to address. Second, this research illuminates behavior by politicians that is inefficient in the long term as a contributor to deforestation. Recognizing the situations in which democratic elections do not promote public goods provision but rather the provision of goods to a small politically important subset of the population is an important first step toward understanding when democracy fails to live up to its promise.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix A: Heterogeneous Treatment Effects: agriculture and election type
Appendix B: Levels of aggregation
Appendix C: Geographically weighted regressions
Appendix D: Measures of competitiveness
Appendix E: Neighboring forest and lagged forest
Appendix F: Timing of Deforestation