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

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**Abstract**

This paper offers a political explanation for increases in deforestation: competitive elections. The protection of forested areas provides long-term, public goods while their destruction provides short-term, private goods for local voters. Politicians facing a competitive election offer voters access to forested areas for commercial use of timber and small-scale farming in exchange for electoral support. I test this theory of political deforestation using satellite-verified global forest cover data and the results of over 500 national-level elections between 1975 and 2005. The findings suggest that the transition to democracy is associated with higher rates of deforestation, that election years may have slightly higher rates of deforestation than non-election years, and that close elections have 25% higher deforestation rates than elections in which one side won by a wide margin. This suggests that democratization is associated with underprovision of environmental public goods and that contested elections are partially responsible for this underprovision.

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# 1 Introduction

*"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 (Seymour and Hutter, 2000) noted, "Recent forest loss has resulted from government approved, politically motivated, and dubiously legal excisions of forest land from protected areas, reserves, and plantations." Over 30 years earlier, Robert Bates (1979) wrote about a similar process: "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). Similarly, deforestation rates have been shown to increase 8-10% in mayoral election years in Brazil (Pailler, 2016, 2018). How widespread is political deforestation, and what are the mechanisms that underlie these electoral deforestation cycles? To my knowledge this paper provides the first cross-national, longitudinal study of the link between elections and deforestation using novel, remotely-sensed data.

Deforestation accounts for over one third of all greenhouse gas emissions, and preventing it 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 extinction of species and is associated with higher aridity, increased soil erosion, and lower water quality. Globally, only 6.2 million square kilometers of the pre-industrial 16 million square kilometers of forest remain (Malhi et al., 2008), nearly 90% of which is on publicly owned land.

Conventional wisdom holds that deforestation is primarily the result of demographic and economic factors: larger populations require more food and more space

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

to live, both of which entail a loss of forested area. Additionally, economic growth is fueled by natural resource extraction including logging, mining, and cropland expansion, all of which lead to higher rates of deforestation (Rudel, 2013). Political scientists have found that democratic regimes are more likely to protect the environment (Li and Reuveny, 2006), that corruption is associated with environmental destruction (Pailler, 2016), and that actors with long time horizons can build institutions to prevent the tragedy of the commons (Ostrom, 1990).

In this paper I offer a theory of political deforestation. I start with a trade-off politicians face: when choosing whether or not to protect (or maintain protection for) a forested area, a politician must choose between providing the short-term, private goods offered by cutting down forests (logging, cropland expansion) and providing the long-term, public goods offered by forest preserves (ecosystem services, tourism revenue). When a politician thinks she might not be re-elected, the short-term electoral advantage that she gets from giving key voters access to forested land outweighs the long-term support that a politician gains by preserving forests. This results in increased rates of deforestation during competitive elections–as in Kenya (Morjaria, 2012) or Brazil (Pailler, 2018).

To test this theory, I leverage new sources of data that allow us to study deforestation at a granular level on a global scale. Using a remote sensing validated dataset of global land cover from 1975 to 2005 (Meiyappan and Jain, 2012) I extract primary[2] forest cover for each $0.5^\circ \times 0.5^\circ$ (approximately 55km x 55km near the equator) cell of land. The dependent variable is the percentage point change in primary forest cover in one of these cells. I combine this with national level electoral data, and economic and demographic covariates to test: (1) whether a democratic transition is associated with higher rates of deforestation, (2) whether a national election year is associated with a higher rate of deforestation, and (3) whether competitive national elections are associated with higher rates of deforestation than elections in

[2]Primary denotes "original" forests that have not been re-planted. For this reason primary forest cover almost never increases in contemporary data at this scale of measurement

which one side won easily.[3]

The results show that in 148 countries with 523 unique elections from 1975-2005 there is a significant association between democratic transitions and deforestation. Election years have about 10% higher rates of forest loss, and as the margin of victory decreases the impact of election years grows (up to 30% higher than non-election years for close elections). Finally, a smaller margin of victory in an election is associated with a higher rate of forest cover loss compared to election years with larger margins of victory (about 20% higher forest loss for every 10 percentage point decrease in the margin of victory). While the tests presented in this paper do not provide perfect causal identification, they do eliminate most of the alternative mechanisms that could be responsible for a link between elections and deforestation. This includes economic growth, population changes, time-invariant characteristics of a cell (such as geography), and year-to-year changes that affect all cells similarly (including commodity prices).

This is contrary to the established claims that leaders in democracies preserve more forest because public goods are more efficient at mobilizing a large franchise (Alston, Libecap and Schneider, 1996; Amacher, Ollikainen and Koskela, 2012; Buitenzorgy and P. J. Mol, 2011; Li and Reuveny, 2006; You et al., 2015) and contradicts more general findings that electoral competition promotes public goods provision (Lake and Baum, 2001; Mesquita, 2005). Contrary to this finding, this paper demonstrates that electoral competition itself may lead politicians to prefer the short-term benefits that exploiting natural resources provide instead of their long-term value. This paper shows that *elections themselves* may provide an altogether different set of incentives than those assumed to come with democracy.

[3]I focus on national elections because the data are not high enough resolution to distinguish sub-national districts in most countries, sub-national tests on higher resolution data are the subject of on-going research.

## 2 Existing explanations of deforestation

The current literature explaining the causes of deforestation comes mainly from the natural sciences, and examines the social, economic, and natural drivers of deforestation. The largest global driver of deforestation is population growth (Megevand, 2013; Allen and Barnes, 1985) which acts through a variety of mechanisms including the increased demand for living space, infrastructure, and most importantly, agricultural area. By far the most common land use transition over the last fifty years has been from forest to agricultural land (Meiyappan and Jain, 2012) followed by the transition from forest to pasture. Over the last thirty years, more than 80% of new agricultural land came from land that was previously forest (Gibbs et al., 2010). The other main mechanism by which population growth causes deforestation is in the energy sector, where much of the rural population relies on biomass for cooking. In Sub-Saharan Africa, 93% of rural energy use comes from wood and charcoal, both of which are derived from cutting down forests (Megevand, 2013; Zhang et al., 2006).

The second main driver of deforestation is economic growth which growth causes deforestation through logging, infrastructure expansion, and the mining sector. Logging is a cheap source of capital for those who have access, and is often broken into formal (permitted) and informal (black market) sectors. Infrastructure expansion, especially the construction of new roads, has both a direct and an indirect effect on deforestation. Roads often requires the removal of forest to build, and allow easier access to untapped forest resources (Mertens and Lambin, 1997). Finally, mining sites have greater deforestation in surrounding areas because they induce infrastructure and population growth in the areas near the mine, and are often directly responsible for forest removal (Chupezi, 2009; Megevand, 2013).

In addition to demographic and economic explanations of deforestation, corruption leads to higher rates of natural resource exploitation (Wilson and Damania, 2005), and in particular, deforestation (Didia, 1997; Gibbs et al., 2010) because

politicians can exchange public forests for personal gain. A major implication of this literature is that if democratization and competitive elections can reduce corruption, they will reduce the exploitation of natural resources. A second political economy argument that explains deforestation is that a higher number of political districts increases the rate of deforestation (Burgess et al., 2012) because politicians sell access to forested areas for bribes, and a larger number of districts means more sellers, lower prices, and more sales. The literature that examines the relationship between democratization and environmental protection is moving towards a consensus that developed democracies tend to have higher levels of environmental protection and lower levels of pollution than non-democracies (Dasgupta and De Cian, 2018), though there is some disagreement about whether democracies are better at preventing deforestation because of their demand for public goods (Ehrhardt-Martinez, Crenshaw and Jenkins, 2002; Buitenzorgy and P. J. Mol, 2011; Bernauer and Koubi, 2009), or whether they are worse at preventing deforestation because of their sensitivity to popular demands (Midlarsky, 1998; Marquart-Pyatt, 2004; Ehrhardt-Martinez, Crenshaw and Jenkins, 2002). A new meta-analysis of the 'governance hypothesis' of whether good governance decreases deforestation, (Wehkamp et al., 2018) find that stronger environmental governance is associated with lower rates of deforestation, but that other types of governance are not related to deforestation.

When scholars have studied the link between deforestation and democracy they have focused on a single country over a short time period. Klopp (2012) argues that the destruction of several forest reserves in Kenya can be attributed to increased demand for patronage in the period before elections. Klopp argues that government ownership of forested land, high demand for additional cropland, and the potential for timber to generate additional funds led to bursts of legal and under the table excisions of the Nandi, Karura, and Mau forest reserves. Morjaria (2012) argues that in Kenya, the introduction of multiparty elections in 1991 led to targeted excisions of protected forested land in provinces that were pivotal for the election. He finds

that deforestation rates increased after the introduction of multi-party elections in 1991, and that deforestation was most concentrated in loyal and swing districts, and not in opposition districts. Pailler (2018) finds that in Brazilian municipalities where mayors run for re-election deforestation rates are 8-10% higher than in non-election years. In a working paper Burgess et al. (2011) also 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). Yet no work has been done to study the link more systematically across countries and develop a general theory that links elections to deforestation.

# 3 Theory: When do politicians trade the forest for the trees?

## Kenya: A motivating case

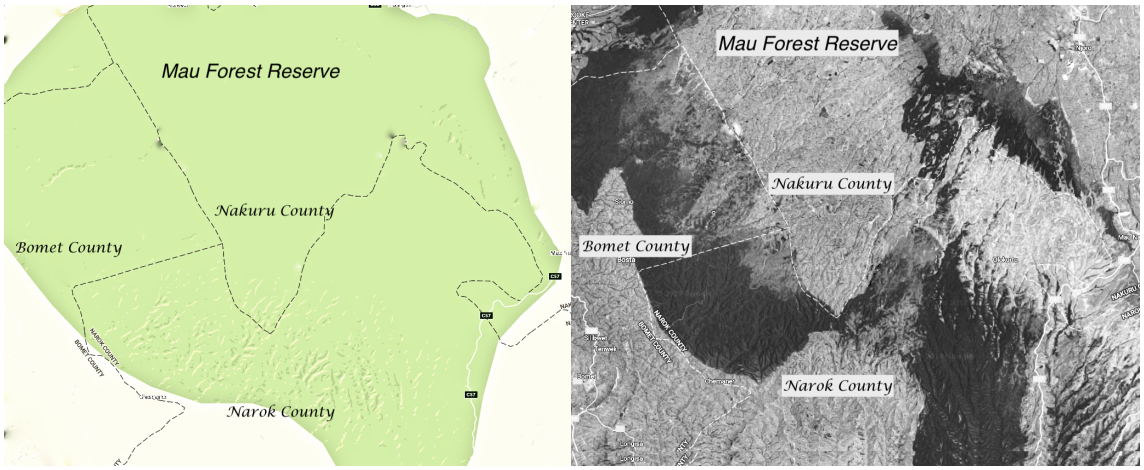


Figure 1: Deforestation in the Mau Forest Reserve

Figure 1 shows the Mau Forest Reserve, an area of government-owned protected forest, more than half of which has been converted into smallholder farms. The map in the left shows that the formally protected area (darker) 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 while the majority of the preserve in Narok and Bomet county remains standing. In the case of 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 all but guaranteed to represent the opposition and incumbent parties respectively. As part of a strategy to maintain control of the government, president Moi and the KANU party distributed patronage in the form of explicit and de-jure land grants to voters in pivotal counties. Klopp (2012) describes two possible benefits that the ruling party obtained through these land-grants: when land was granted to a politician facing re-election he could sell the timber to finance his campaign, or he could distribute the land to potential supporters in exchange for their support in the upcoming election.

The value that politicians derive from preserving or allocating land comes from whether doing so improves their chances of re-election. Because the benefit of preserving forests to voters is long-term and diffuse, preserving forests is an efficient way to use forested areas to generate political support in the long-run. However, for a politician with a short time horizon, the immediate increase in attributable well-being associated with receiving access to forested land is more efficient at generating support. As a result, politicians who fear that they might lose re-election will choose to sacrifice some of the long-term benefit that they get from protecting forest for the short-term benefits they get from allocating that land to voters. As a politicians fears of losing re-election grow, so do their appetite for raiding forests.

## The value of forests

The worlds forests occupy about 3.4 billion hectares of land, or about the area of the North American and European continents combined, but have decreased in area by about 50% since 1980 (Turner, 1990). Of remaining forested land, about 86% are publicly owned (Gibbs et al., 2010). This means that governments have the power to control what activities take place in the vast majority of the world's forests. Here allocation is defined as granting access to publicly owned land, which includes the allocation of informal access, use permits or of property rights. The most common types of allocation of forested lands are logging or mining permits (Pailler, 2016; Burgess et al., 2012) and the granting of some form of property rights to farmers (Morjaria, 2012; Klopp, 2012; Pailler, 2018).

Protected[4] forests are valuable to voters for several reasons. First, when left undisturbed, forests provide ecosystem services to surrounding areas (Newell, 2016). They host pollinators like bees and birds that are essential to pollinating crops so that they can produce seeds. They also host predators that control the populations of pests. Additionally, forests reduce the levels of pollution in the air, decreasing the amount of respiratory and cardiac illnesses in people who live nearby (Nelson et al., 2009). They act as natural filters that purify water, and help to recharge groundwater basins that are important for agriculture that relies on wells. Forests also mitigate floods and droughts by storing water and preventing large fluctuations in the flow of rivers. They also prevent erosion and sediment loading that can make water more difficult to consume and shorten the lifespan of dams (Boelee, 2011). Finally, they often serve as tourist attractions that bring infusions of foreign spending to the country as a whole. 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 (air quality) (Chazdon,

[4]Protected means government owned and not available for farming or timber harvesting. High levels of protection include national parks, lower levels of protection include government owned land for which there are currently few or no use permits.

2008). These benefits also accrue slowly, for example flood mitigation would not be apparent except in high-runoff events, and the effects of air quality on health are often hidden for tens of years. Depending on how much of this benefit voters attribute to politicians, those voters might be more willing to vote for the re-election of the politician who provided protection of forests.

The other way forested land is valuable is through the value created by removing the forest and using the land for crops or other commercial purposes. The timber itself is often valuable, especially for old-growth hardwood forests like those near the equator. However, more of the value of removing forests comes from what replaces the trees. Forested land tends to be high in nutrients like nitrogen and phosphorous and as a result is extremely productive when converted to agriculture. Finally, removal of forest allows people to build infrastructure or develop land, in which case the land itself has value based on its location. 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 value accrues directly to a designated person or a group of people rather than to the public. This difference in attributability and targetability has been noted in the case of electoral business cycles where the literature suggests that politicians are more likely to increase spending in competitive districts and on projects for which politicians can easily claim credit (Rogoff, 1987; Drazen, 2000; Aidt, Veiga and Veiga, 2011; Mayhew, 2004).

While the mechanism of granting access to forests seems to vary between countries, it generally takes one of two forms. One form is that the politician removes protection of a piece of land and grants the use of that land to a particular group of people, like Moi did in Kenya in 1991 (Morjaria, 2012; Klopp, 2012). The targeted allocation can take place either through the location of the land that loses protection[5] or through the granting of a property right. In either case, the politician can target

[5]in many African countries location is highly correlated with ethnicity, and ethnic groups often have homogeneous and known voting preferences

the benefit at a particular group of voters. Furthermore, granting access can occur either through a public, legal act or through a less-visible relaxation of enforcement. These grants are not easily reversible–after access has been granted, removing the right to access that land can be politically and logistically difficult. However, should an incumbent who just provided a land grant lose an election, the likelihood of that grant being reversed drastically increases, especially if the access was granted under the table (Albertus, 2013). A second form of land access is through use permits, which could grant firms the right to log or mine an area of land, as in Brazil and Indonesia (Pailler, 2016; Burgess et al., 2011). Here, the politician can target a firm, which might provide jobs or economic growth to a particular area, or might contribute additional money to the politician either through higher tax revenue or political donations. Similarly, reducing enforcement is a non-explicit way of permitting use. In either case, continued use is often contingent on the re-election of the politician who provided access (Albertus, 2013).

Forests differ from other classes of goods that governments provide such as roads, clinics, and schools (Harding, 2011; Harding and Stasavage, 2014; Burgess et al., 2013). Forests are limited with little prospect for renewal within the lifetime of an individual and the allocation of forested areas does not require government spending that trades off with other projects. Whereas funding roads might trade off with funding schools, the exploitation of forests in the present only trades off with either their future exploitation or the future public goods that they could provide. This means that 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, or to smooth its "consumption" of forested areas (Ostrom et al., 1999). The implication is that even if governments place a low value on the public goods that forests provide, they should tend to preserve forested areas until the present need for the goods that exploitation of forests provides is greater than the expected future need for those goods. In other words, politicians should only grant access when they really need to provide short-term benefits to an important group

of constituents, or when they are afraid they might lose an election.

## Political incentives

Facing re-election, politicians possess two strategies with respect to forested areas: one is to allocate some access to publicly owned forests to the constituents that she believes to be pivotal in an election. The other is to protect forests and rely on the public goods that protected forests provide to convince constituents that they will be better off if she is elected. Knowing that voters reward politicians who provide benefits, a politician must distribute benefits in such a way that she generates enough support to be re-elected.

With this in mind, it becomes possible to understand how a politician who controls ownership or access to public (possibly protected) forests could efficiently use those limited resources to maximize her chances of staying in power. The conventional wisdom on public goods and democracy is as follows. In an autocracy where a politician must please a small winning coalition, providing private goods tends to be more efficient than providing public goods (Mesquita, 2005), and we expect politicians to allocate more access to public forests (Li and Reuveny, 2006; Didia, 1997; Buitenzorgy and P. J. Mol, 2011). 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 (Olson, 1965; Lake and Baum, 2001; Deacon, 2009).

However, this reasoning focuses only on the logic of efficiency of vote buying ignores the demand-side characteristics of forested land as a good. There are two demand-side reasons that deforestation rates increase when a country transitions from autocracy to democracy: the political empowerment of farmers who demand land and the shortened political time horizons that come with regular elections. In a new democracy the selectorate often includes a large number of farmers for whom forested land is an extremely valuable resource (Ceddia et al., 2014). In an autocracy,

the selectorate tends to consist of wealthy industrialists for whom forested land is less valuable[6] (Anderson, 2010; Swinnen, 2010; Bates and Block, 2013; Kasara, 2007). When an agricultural country transitions towards democracy, the political value of removing protections for forested land suddenly increases. A second reason that the transition to democracy might lead to higher rates of allocation of forested land is that politicians in democracies face regular electoral challenges that shorten their time horizons and make short-term increases in support more valuable than the slow, long-term accrual of support.

It is difficult to estimate the effect of government type on deforestation because of the many factors linked to government type that might cause deforestation (e.g. factor endowment, level of economic development, etc.). However, the comparison of a country before and after a democratic transition should allow us to reasonably consider the relationship between political incentives and deforestation rates in the two different systems while holding other conditions relatively constant. Both because of the empowerment of farmers who demand cropland and the introduction of elections which emphasize short-term political gains, I hypothesize that:

**Hypothesis 1:** *Countries have higher rates of deforestation during and after a democratic transition than under authoritarian rule.*

This theory also provides observable implications for election and non-election years. During an election year, and especially a closely contested (hereafter: competitive) election, politicians have a shortened time horizon because they may not be reelected. This reduces the value of the long-run goods that forests provide and make the short-run benefits of granting access to the land more appealing. Should the politician lose re-election, the long-term goods that protected forests provide are worthless to her, rendering the immediate increase in political support from immediate allocation even more valuable in comparison. Additionally, if the politician is

[6] Also, the value for industrialists tends to come from selling timber products rather than planting crops. This means that even if autocracies and democracies allocated forested land at the same rate, the autocracy would have lower rates of deforestation because industrialists would smooth their consumption of forest, while smallholder farmers would clear forest immediately to plant crops

able to identify pivotal voters, the efficiency of targeting those voters likely exceeds the efficiency of providing public goods, meaning that the politician has an additional incentive to prefer granting access over preservation. Because the politician might lose the election and knows she can improve her chances by targeting a few voters, she is more likely to permit pivotal voters to deforest protected public lands and reap the concentrated benefits associated with removing forests. However, this comes at the expense of the increase in support generated by the forested lands until they are allocated at some point in the future and the benefit that 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 she feels truly threatened. Because autocracies rarely if ever have competitive and meaningful elections, the following two hypotheses apply primarily to democracies:

**Hypothesis 2:** *Election years will have higher rates of deforestation than non-election years.*

**Hypothesis 3:** *Years with competitive elections will have higher rates of deforestation than years with non-competitive elections.*

The following chart lays out the hypotheses as a set of subgroup analyses:

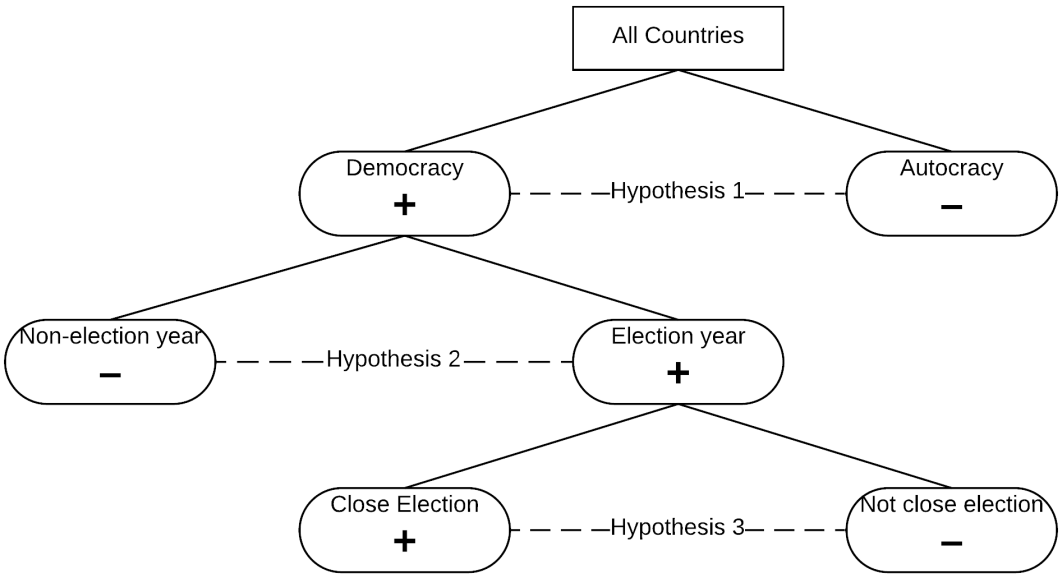


Figure 2: Hypotheses

# 4 Empirical Strategies

I use remote-sensing validated historical land cover data, data on democratic transitions, and the results of over 550 elections over 35 years to test the above hypotheses. I find that democratic transitions are associated with large and significant increases in forest cover loss, that election years have about 5% higher forest cover loss, competitive elections have even higher rates of deforestation than either non-competitive elections or non-election years. Tests include a full set of controls, geographic unit and year fixed effects, and errors are clustered at the country-year level to account for spatial and temporal autocorrelation.

## Data

The dependent variable for this study is the percentage point change in primary forest cover in a $.5^{\circ} \times .5^{\circ}$ ($55 \times 55$ km near the equator, smaller near the poles) cell of land in one year. Primary forest is characterized by the presence of naturally occurring, mature trees. The original dataset used to construct this measure is from Meiyappan and Jain (2012) that measures global land use conversions by matching data from satellite images with historical cropland extent and wood harvest data. This type of data is 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 beginning in 1970 in order to ensure the greatest accuracy of vegetation type estimation from the satellite data and ending in 2005, the most recent year included in the dataset. Meiyappan and Jain (2012) present the results of three models designed to maximize accuracy for different land-cover types. I use the measure developed in Houghton (2005) (called HH in Meiyappan 2012), which is specifically calibrated to changes in forest cover.

I extract the percent landcover of primary forest[7] of each cell in each year,

[7]primary forest consists of: tropical evergreen broadleaf forest, tropical deciduous broadleaf forest, temperate evergreen broadleaf forest, temperate evergreen needleleaf forest, temperate de-

resulting in 36 years of global forest cover data, and the year-on-year differences of this compose the dependent variable. I spatially merge national boundaries with this data so that each observation contains a unit level measure of forest cover and a set of national-level independent variables.

While there are some increases in primary forest cover in the data, the hypotheses tested in this paper do not generate predictions for positive forest cover change. Furthermore, forest cover increases only make up about 0.15% of the total changes in forest cover, and are observed in about 0.5% of the cells. On the other hand, 67% of total cells have 0% forest cover over the course of the dataset, generating a large number of structural zeroes in the first differenced data (places with no forest can't lose any more forest) and resulting in a bias towards 0 in any coefficients. To account for this I remove any cells that begin with 0% forest cover in 1970 from the data. Then, I generate an indicator variable that is 1 in time $t$ for each point that has some forest in time $t$. All right hand side variables are interacted with this indicator. In the supporting information I perform the same analysis with listwise deletion of these observations and find similar results.

Because the dependent variable is change in primary forest cover, I first-difference the forest cover variable, generating a variable that is the difference between forest cover in time t and forest cover in time t-1. The dependent variable exhibits a unit root in levels, which suggests that taking a first difference will produce more consistent results than including a lagged dependent variable. Formally,
$forest.diff_{i,t} = forest_{i,t} - forest_{i,t-1}$.

A few notes on how we might interpret this dependent variable: The total area of a $.5^\circ \times .5^\circ$ or $\approx 55km \times 55km$ cell of land is $\approx 3025km^2$ near the equator, but as small as $890km^2$ in forested areas near the poles. A value of -1 for a cell indicates a one percentage point loss meaning an average loss of about $22.2km^2$ of primary forest per cell. The average change in forest cover is $-0.24$ percentage points, or about $5km^2$ per forested cell per year (globally).

ciduous broadleaf forest, boreal evergreen needleleaf forest, boreal deciduous needleleaf forest

Right-hand side variables come from several sources and merged with forest cover data by country-year. Data on whether a country is a democracy comes from Boix, Miller and Rosato (2013) who provide a dichotomous coding that is widely used in the literature. They define a minimum threshold for both contestation and participation to determine whether a country is a democracy or not in a given year. In this paper **democracy** takes a value of 1 if the country is a democracy and 0 otherwise. Results are robust to the other common measure of democracy provided by Cheibub, Gandhi and Vreeland (2010). Data on election years comes from the Database of Political Institutions (DPI) (Beck et al., 2001). The variable **election year** takes a value of 1 if a national-level election occurred in that country in a given year and 0 otherwise. The margin of victory in an election is generated by taking the difference between the party with the most votes and the party with the second most votes in an election. Here measures of votes are provided by DPI. For interpretability I transform this variable so that a value of 100 represents a tie election and a value of 0 represents one party garnering 100% of the vote[8].

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 (thousands of USD), change in population (% change), population employed in agriculture (% of total population), and change in percent of population employed in agriculture (WDI, 2017). Each of these is lagged by one year to prevent the inclusion of post-treatment controls. Both of the population in agriculture variables are scaled so that the regression coefficient corresponds to a 10% change to make coefficients and confidence intervals comparable across figures. This means that a variable like per capita GPD 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 always include a control for the amount of forest remaining in a cell at the start of the year–we expect that deforestation rates might be higher in places that are partially forested than places that have 100% forest cover. An alternate specification (in the

[8]Formally: $margin = 100 - |pct\_votes_i - pct\_votes_j|$ where $i$ and $j$ are the two parties receiving the most votes.

appendix) controls for the average forest cover of neighboring cells in addition to lagged forest cover.

I also 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 de-means the forest cover loss variable, essentially considering only deviations from the average forest cover loss in each cell. An alternate specification uses unit specific time trends to account for places where the rate of deforestation is increasing or decreasing. Year fixed-effects absorb global-level changes specific to a single year, like 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. Because election shocks should appear only in cell-years that experience an election, this specification should control for the majority of variables that are associated with both election years and deforestation. It should also control for most of the non-political drivers of deforestation including economic and population growth. Put more simply, the variation that 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. Some summary statistics are presented below:

- 40.2% of cells have forest cover in 1970
- 34.0% of cells have forest cover in 2005
- 148 countries have forested land in 1970
- 2,145,000 cell-years from 1975-2005
- 5328 unique country-years
- 523 unique elections

## Test 1: Democratic transitions

I begin with a test of whether countries that experience democratic transitions have higher rates of deforestation than countries that do not experience such a transition. The main independent variable is whether a country is a democracy, where

democracies are coded 1 and non-democracies 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 which project out time-invariant characteristics of each country (completely eliminating any variation for all countries that do not transition to/from democracy). As a result, the coefficient on democracy represents the within-country difference between years when a country was a democracy and years when that country was not. Hypothesis 1 was that countries that experience democratic transitions will have higher rates of deforestation after the transition. Figure 3 presents point estimates and 90/95% confidence intervals of the coefficients corresponding to the main independent variable (in bold) and the control variables in the model. The variables are arranged on the x-axis, and the expected percentage point changes in forest cover are on the y-axis, with a negative value corresponding to forest cover *loss*. Regression tables for each of the tests in this paper can be found in Supporting Information Section 1.

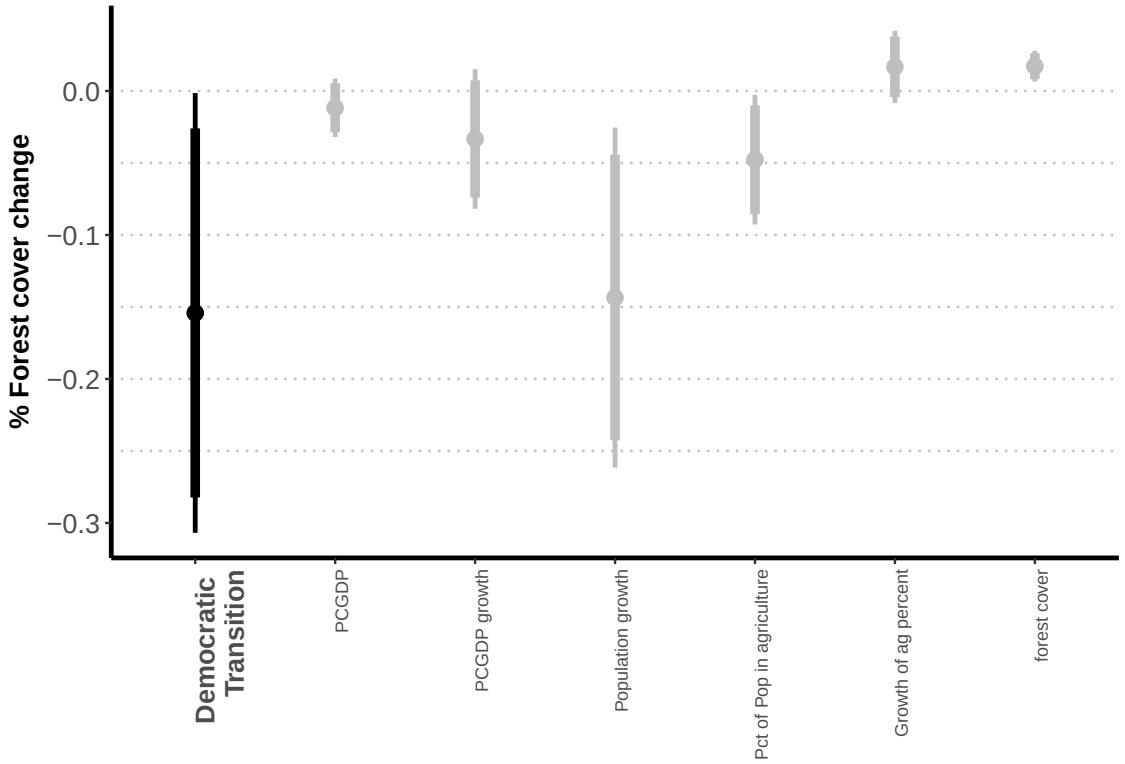


Figure 3: Democratic transitions and forest cover loss
Controls include unit and year fixed effects, standard errors are clustered at the country and year level. 423,172 observations, adjusted $R^2$: 0.251

Figure 3 shows that among countries that experience at least some years as a democracy and a non-democracy, the democratic years have about 0.16 percentage points greater forest cover loss compared to the nondemocratic years. This change in forest cover is estimated to be negative at a $\alpha = 0.05$ confidence level. Among the controls, both population growth and percentage of the population employed in agriculture are associated with higher rates of forest cover loss and cells with a lower initial level of forest cover have a higher rate of forest loss. The rate of forest cover loss associated with democracy is 67% higher than the global average (-0.24), meaning that after democratization deforestation continues at 1.5 to 2 times the rate of their predecessors even *after* the main structural economic and demographic drivers of forest cover loss have been taken into account. On average, every 100km$^2$ of forest could be expected to lose about 1 km$^2$ every four years. However, when a country transitions to a democratic governance system, its rate of forest loss increases so that every 100 km$^2$ could be expected to lose 1 km$^2$ every two to three years.The large standard errors indicate a large amount of heterogeneity in the effect size. The primary difference between a pre-democratic transition country and its post-democratic transition successor is the presence of elections. To explore the electoral mechanism more carefully, I next consider the relationship between election years and forest cover loss.

## 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 non-election years. A blunt test of this hypothesis considers forest cover loss in all election years and compares it to forest cover loss in non-election years (Hypothesis 2). Based on the current literature on deforestation, the timing of elections is not correllated with the known drivers of forest loss. One exception might be that business cycles are known to be connected with elections and could drive deforestation, so I control for change in per capita

GPD from $t-2$ to $t-1$. While this estimation strategy cannot rule out the possibility of an unobserved confounder, such a coufounder would have to cause both elections and increases in 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. The goal is to isolate deviations from each cell's average rate of deforestation that cannot be explained by economic or demographic characteristics, and test whether those deviations align with election years. This is achieved by including the controls described above, unit and year fixed effects, and standard errors clustered at the country and year level.

The three panels in 4 correspond to the results of three models: the first compares all election years to all non-election years, the second compares election years where the margin of victory is less than 20% to all non-election years, and the third compares elections with a margin of victory of less than 10% to non-election years. These three tests focus on elections in which an incumbent politician's expected time horizon is shortened by the prospect of losing an election. The first test posits that any election is threatening, the second that elections in which a challenger are threatening, and the third that elections in which the incumbent is unsure of the outcome are threatening. Remember that for a politician to decide to allocate forested land to potential voters, they must be willing to trade some of their ability to win future elections in exchange for a higher probability of victory in the current election.

Among the 131 countries that had at least one election, election years have about a 0.02 percentage point higher rate of forest cover loss than a non-election year (about a 1/12 increase over the average). While a substantially smaller effect than that of a democratic transition, an 8% higher deforestation rate is still substantively important, especially considering that this includes all known national-level elections between 1975 and 2005. About 1/5 of elections in this sample had a margin of victory that was above 20 points, meaning that there was low uncertainty about the outcome. Excluding these elections generates a coefficient of -0.046 (significant

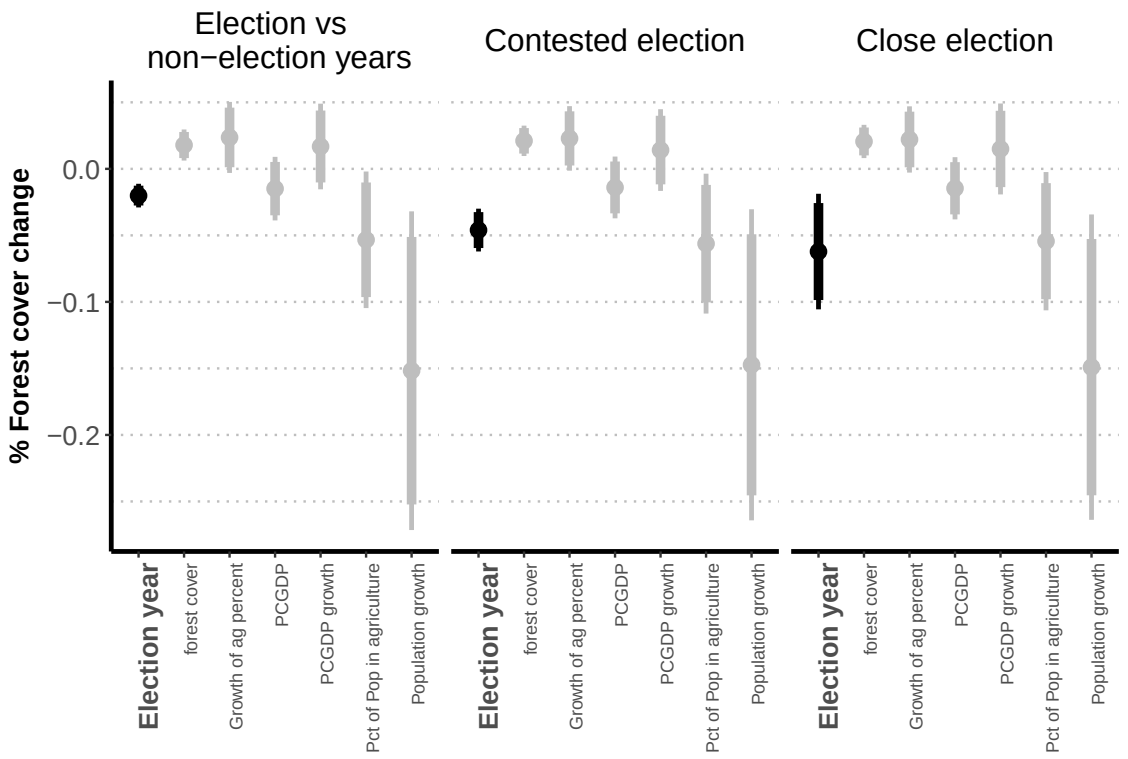


Figure 4: Election years vs non-election years

The three panels from left to right are: all election years vs non-election years, all election years with a margin of victory less than 20% vs non-election years, and all election years with a margin of victory of less than 10% vs non-election years. Controls include unit and year fixed effects and linear unit trends, standard errors are clustered at the country and year level. 425,965; 414,244; 389,875 observations respectively, adjusted $R^2$: 0.244; 0.252; 0.245. Control coefficients and standard errors are identical across models.

at $\alpha = 0.01$). Furthermore, if we compare only close elections where the margin of victory was less than 10%, the difference between election years and non-election years grows to -0.062 (also significant at $\alpha = 0.01$).

Figure 4 shows that deforestation rates are higher during competitive election years than non-election years by as much as 1/4 the global average rate of deforestation. It also provides some evidence that the stakes of an election matter, and that the closer the election is, the more politicians are willing to allocate forested land to help them gain a competitive edge.

## 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 dependent variable measures the margin of victory, for which 100 corresponds to a maximally competitive election resulting in a tie, 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. The main test includes unit and year fixed effects, and the same controls. Standard errors are clustered at the country and year level.

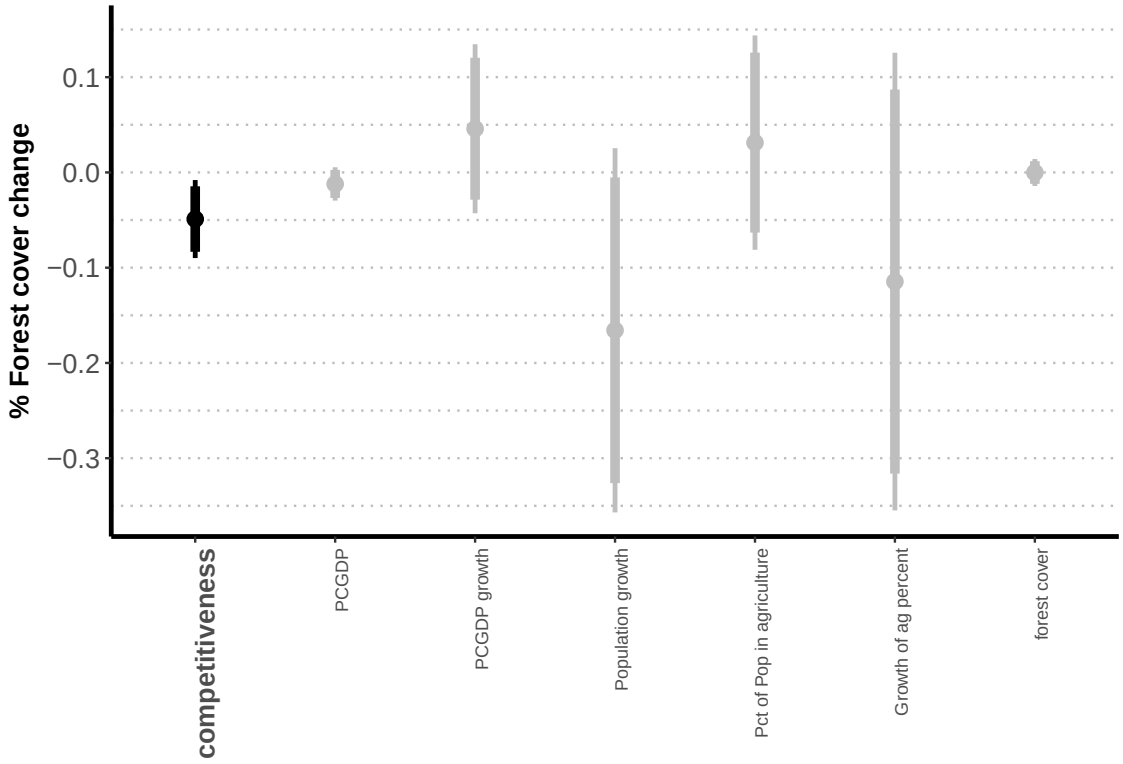


Figure 5: Competitiveness of election
Controls include unit and year fixed effects and linear unit trends, standard errors are clustered at the country and year level. 6,012 observations, adjusted $R^2$: 0.143.

A 10% increase in electoral competitiveness is associated with a 0.04 percentage point increase in forest cover loss, with the coefficient estimated to be less than 0 at $\alpha = 0.05$ confidence. The average difference between a 55-45 win and a 50-50

tie is about a 30% increase over the average deforestation rate in the more competitive election. Because DPI measures the percentage of votes earned by all government parties, the absolute different from 50% appears to be a good way to measure competitiveness. Supporting Information Section 3 provides some non-parametric evidence that deforestation rates are highest around a 50-50 split. It also suggests that the effect is largely driven by close incumbent victories rather than challenger victories. This provides additional support for Hypothesis 3, that more competitive elections have higher rates of forest loss than non-competitive elections.

## Timing of Deforestation and other Mechanism Tests

The final test presented here is of the timing of the forest loss with respect to an election. I expect deforestation rates to be highest in the year before and the year of an election. The rate at which politicians will choose to allocate forested land will peak just before the election takes place for two reasons: the ability of a politician to efficiently allocate resources increases as the election approaches, and voters exhibit recency bias. First, as an election approaches a politician's expected probability of winning that election becomes more precise, so she can choose how much land to allocate to ensure victory without wasting too much of the resource. Second, voters tend to exhibit some myopia and give more weight to recent events than less-recent events. Simply, a politician wants the benefit that a voter received from that politician to be in the front of his mind when he goes to the ballot box (Keefer, 2007; Keefer and Khemani, 2005).

While one might expect deforestation to be a slow process and thus expect higher rates of deforestation for several years after an election, I expect deforestation associated with elections to happen quickly for two reasons: opportunity costs of waiting and political uncertainty. Consider the two mechanisms highlighted above: smallholder farmers converting forest to cropland and logging firms extracting timber. Smallholder farmers have an incentive to clear forests quickly so that they can

plant crops during the next growing season. Failure to do so would be to sacrifice a year's worth of additional income. Furthermore, if farmers have to relocate to obtain this additional land like they did in the case of the Mau forest reserve in Kenya, their main priority is to clear the land and start growing crops. Alternatively, logging firms have different incentives to exploit forested resources quickly: their access might be contingent on the incumbent winning the upcoming election. Should a challenger win it would make sense for the challenger to revoke access to a firm that supported their opponent. Knowing this, logging firms should extract as much as possible very quickly.

Table 1:

| | *Dependent variable:* |
|---|---|
| | Forest Cover Change |
| 1 yr before | $-0.048^{**}$ |
| | (0.019) |
| Competitive election year | $-0.087^{***}$ |
| | (0.028) |
| 1 yr after | $-0.036^{**}$ |
| | (0.018) |
| Unit-year effects? | Yes |
| Observations | 303,014 |
| Adjusted $R^2$ | 0.291 |
| Residual Std. Error | 0.523 (df = 283989) |
| *Note:* | $^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01 |

I test this by creating a lead and a lag of the **competitive election** variable ($t-$ to $t+1$) to identify the timing of deforestation. Table 1 lends strong support to this story that the highest level of deforestation occurs *during* the year of a competitive election. Because the temporal resolution of the dependent variable is annual it is difficult to distinguish the exact timing of deforestation. Elections could happen at any point in an election year, so on average we would expect the highest rate of deforestation to occur in that year. Table 1 shows that the years before, during,

and after competitive elections (less than 10% margin of victory) have significantly higher rates of deforestation than the average. If politicians begin using forested land to build support in the run up to an election this is precisely what we would expect to find. The year after an election also has a higher rate of forest cover loss. This also reflects the timing described above–deforestation usually happens very quickly after access is granted, but if an election is near the end of a year some of the forest loss might occur into the following year. Supporting Information Section 9 attempts to exploit the month of an election to further test this mechanism, but it likely underpowered and fails to reject the null hypothesis.

A variety of other mechanism and robbustness tests can be found in the Supporting Information: Differential effects between legislative and executive elections (Section 2), Differential effects when the incumbent parties win or lose (Section 3), Adding neighboring cells' level of forest as a control (Section 4), Differentiating by tropical, temperate, or boreal forests (Section 5), Differentiating by democracy, anocracy, and autocracy per Polity IV (Section 6), Deleting cells as they lose all forest cover (Section 7), Differentiating by number of elections observed in each cell (Section 8), Differentiating by month of election (Section 9), Weighting observations by the inverse forested area of each country (Section 10), Aggregating the results to the country level (Section 11), and using the level of political competition in the previous election to instrument for or proxy for political competition in the current election.

# 5 Discussion

The finding that politicians allocate forest resources in exchange for electoral support during the lead up to an election has two broader implications: first, characteristics specific to natural resources change the familiar dynamic between democratic government and increased public goods provision; and second, ecosystem services and other public goods supplied by the preservation of natural resources

can change how states address common pool resource problems. While providing evidence of a general relationship between deforestation and both democratic transitions and elections, I discuss a few limitations exist that might temper the robustness of the finding. These include the vast heterogeneity among countries and years in the sample, the spatial and temporal resolution of the data, possible remaining endogeneity, and potential issues with the measure of competitiveness used here. Finally, these limitations as well as a few of the implications above lay out possibilities for future work including testing the hypotheses here with higher resolution data, using surprise elections, exploiting incumbent wins vs incumbent losses, and examining the factors that might mediate the effect including political institutions, the demand for forested land, and the type of forest.

## Implications

A number of influential papers argue that democratic governments are more likely to provide public goods than non-democratic governments. Lake and Baum (2001) and Olson (1993) argue that more contestable political markets decrease the monopoly rents that 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 paper demonstrates a situation where 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 competiton to increase state production of *environmental public goods*. Instead, political competiton may fuel exploitation of natural resources in a way that is more consistent with Ostrom (1990)'s description of common pool resources. Keefer and Vlaicu (2008) and Keefer (2007) argue that young democracies are more prone to clientelism and corruption, which re-enforces the effect observed in this paper.

Deacon (2009) and 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. The finding that democratic transitions reduce the provision of environmental public goods in the form of deforestation and the finding that competitive elections lead politicians to choose to provide private goods (access to forested land) rather than public goods (preservation of that land) run contrary to Deacon's and Mesquita's theses. There are two main reasons for this disagreement. First, Deacon and Bueno de Mesquita's argument does not consider differences in demand for different types of goods across different selectorates. The transition to democracy empowers a larger portion of the population, but also increases demand for agricultural land. Because politicians have to choose between highly demanded private goods and less demanded public goods, it is not always efficient to provide public goods even if politicians aim to satisfy a large constituency. 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. Ross (2006)'s argument that the public goods that democracies provide benefit the middle class is in line with this argument–that the demand for different kinds of public goods drives which goods are provided.

Second, selectorate models do not incorporate changes in the marginal utility of providing private vs public goods leading up to an election. As the time of an election grows nearer, the subset of the voters who might be pivotal comes into focus for a politician seeking re-election. With knowledge of who these constituents are and where they are located, politicians might be able to exercise a price-discriminating strategy where they distribute just enough goods to secure the vote of each member of the winning coalition. 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 to high-price members of the winning coalition. This means offering pivotal voters access

to protected forested areas even though 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. In places without a strong rule of law or low freedom of the press, voters might not know that a politician is giving away public land in a way that will hurt the voters in the long run (Kenya in the 1990's for example (Klopp, 2012)).

In addition to the question of democratic provision of public goods, the findings have implications for how we categorize the goods that natural systems like forests provide when they are preserved. The default framework for natural resources in political science work is Common Pool Resources (CPRs) as in Ostrom (1990). These resources are notoriously hard to preserve because consumers face an n-player prisoners dilemma game where defection from perservation is a strictly dominant strategy for every player (Hardin, 1968; Ostrom et al., 1999). This paper characterizes forests differently: rather than only considering the value that forests provide when they are cut down or "consumed," it evaluates the value that these forests provide when they are preserved. The ecosystem services outlined above are public goods (non-rival, non-excludable), which changes the way that we might think about their preservation. In non-election 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 common pool resource can reduce the ability of any governance system to prevent overuse. As elections approach the value that protected forests provide politicians (through the political support that 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 current governance system (democratic governance) fails.

## Limitations and future work

The result presented here has three main limitations: the generality of the theory prevents a more in-depth analysis of the specific processes that occur in particular places at varying times, the resolution of the data doesn't allow for the analysis of sub-annual and sub-national implications, and there is a possibility that some endogeneity remains in the result. The first limitation is a natural part of trying to fit a general theory to a variety of cases that span the globe over a long time period: a number of examples exist in which the specifics are under-explained by the theory. We know that allowing farming and logging on protected forested land are two ways in which politicians can generate political support (through votes and money), but there are likely many other ways in which this happens that are not explored in this paper. Another example is the concept of political competition. I use two measures of how close an election was: the difference between the percent of votes obtained by the top two parties, and the difference between the top vote-getter and 50%. While many close elections fall into one or both of these categories, many others do not and are thus incorrectly measured above. The problem that this presents is an attenuation of the result. That a substantive effect appears despite this should demonstrate that the magnitude shown in this paper is closer to a lower bound on the effect size than an upper bound.

A second limitation is in the spatial and temporal resolution of the data used here. With annual forest cover change data we lose the ability to determine precisely when the deforestation occurs–whether it is before or after the election occurs. With $.5^\circ \times .5^\circ$ spatial resolution we lose the ability to extract meaningful sub-national variation in the many countries in which electoral units are relatively small. Future work will move to solve both of these problems with higher spatial and temporal

resolution remote sensing products and sub-national electoral data (Kollman et al., 2017).

A third limitation is that there may be unobserved confounding in the analysis, though for this to be a problem it would have to be associated with the timing of elections and the rate of deforestation, but not captured by economic or population size or growth or by the size or changes in the agricultural sector. Future research with more granular data will move towards solving this problem by holding national characteristics constant and identifying off of sub-national data.

Reverse causality might be a larger problem, especially because the theory is that politicians can gain an advantage in elections by increasing the deforestation rate. This directly suggests reverse causality, that deforestation influences the outcome of elections. However, deforestation is one item on a long menu of strategies available to politicians in the lead-up to an election. A few of the other strategies available include vote-buying (Stokes et al., 2013; Boone, 2014), constructing roads and clinics (Burgess et al., 2013; Harding, 2011), and agricultural taxation and subsidation (Kasara, 2007). In fact, Posner and Kramon (2011) points out that politicians choose among a set of many strategies. This means that the rate of deforestation likely only explains a very small part of the variation in electoral competitiveness, limiting the size of the reverse causality bias. Future work will take advantage of pre-election polling results where they are available and the amount of deforestation leading up to an election to try to directly measure the effect that deforestation has on voting behavior (Morjaria (2012) uses a similar strategy).

Besides those described above, there are a few heterogeneous treatment effects that merit attention in future work. One is the structure of political institutions in a country. The effect might be more pronounced in smaller districts (Rogowski, 1987), in first past the post systems, or in central (as opposed to federal) systems. A second type of heterogeneous treatment effect might be in the demand for forested land, as measured by strength of agricultural sector in a country. In places where demand

for forested land is higher, we might expect a larger treatment effect. Finally, the type of forest might be a source of differential treatment effects. Tropical forest is much more valuable as a source for cropland and timber than temperate forest, so we might expect a larger treatment effect there.

There are also a few mechanism tests suggested by the theory described above. First, because we know that rule of law is important for how seriously people take their property rights, there may be reasons to believe it also plays a role here. There is already some evidence that stronger property rights reduce the incentives for landowners to quickly deforest (Mendelsohn, 1994; Araujo et al., 2009). Perhaps the strength of property rights mediates the relationship between elections and deforestation.

Second, the theory presented above partially rests on the assumption that a politician does not experience much of a reduction in support from those who will ultimately be negatively affected by the forest loss for which she is responsible. This assumption appears to be largely correct in Kenya and Brazil but might not always hold. For example, in countries with strong green parties, many NGOs and a free media one could imagine that giving away nationally owned land to key voters would be the subject of media coverage and result in enough of a general decrease in political support that doing so would not longer be a viable strategy. Future research might test whether political openness and media freedoms could explain some of the variation in the relationship between elections and deforestation.

Third, the mechanisms described above naturally generate some predictions for within country geographic variation in election-year deforestation. Strategic politicians should distribute to pivotal districts rather than safe districts if seats or support are counted by geographic region. Alternatively, politicians might choose to distribute to their core supporters in order boost their enthusiasm just before an election and improve voter turnout (Stokes et al., 2013). Future research using higher spatial resolution data on elections (with geo-referenced districts) and higher

spatial resolution deforestation data could determine where forest cover loss happens in election years.

# 6 Conclusion

To summarize, I test whether democratic transitions and competitive elections are associated with higher rates of deforestation. I find that deforestation rates are 67% higher after a democratic transition has occurred, that years in which close elections are held have 25% higher deforestation rates than non-election years, and that a decrease of 10% in the margin of victory in an election is associated with roughly 20% higher rate of forest loss. This is because politicians choose to exchange access to forested land for political support when they fear that they might not be re-elected. Doing this is costly for the politicians–they give up both the additional support that the public goods provided by forests might provide them as well as the ability to allocate that land in the future.

These findings are a first step towards 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 that 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 that 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 towards understanding when democracy fails to live up to its promise.

# References


Aidt, Toke S., Francisco José Veiga and Linda Gonçalves Veiga. 2011. "Election results and opportunistic policies: A new test of the rational political business cycle model." *Public Choice* 148(1-2):21–44.
**URL:** *https://link.springer.com/article/10.1007/s11127-010-9644-3*

Albertus, Michael. 2013. "Vote Buying With Multiple Distributive Goods." *Comparative Political Studies* 46(9):1082–1111.
**URL:** *https://doi.org/10.1177/0010414012463897*

Allen, Julia C and Douglas F Barnes. 1985. "The causes of deforestation in developing countries." *Annals of the association of American Geographers* 75(2):163–184.

Alston, Lee J., Gary D. Libecap and Robert Schneider. 1996. The Determinants and Impact of Property Rights: Land Titles on the Brazilian Frontier. Working Paper 5405 National Bureau of Economic Research.
**URL:** *http://www.nber.org/papers/w5405*

Amacher, Gregory S., Markku Ollikainen and Erkki Koskela. 2012. "Corruption and forest concessions." *Journal of Environmental Economics and Management* 63(1):92–104.
**URL:** *http://linkinghub.elsevier.com/retrieve/pii/S0095069611000994*

Anderson, Kym. 2010. *The political economy of agricultural price distortions.* Cambridge University Press.

Araujo, Claudio, Catherine Araujo Bonjean, Jean-Louis Combes, Pascale Combes Motel and Eustaquio J Reis. 2009. "Property rights and deforestation in the Brazilian Amazon." *Ecological economics* 68(8-9):2461–2468.

Bates, Robert H. 1979. *Markets and States in Tropical Africa.* U. of California Press.

Bates, Robert H. and Steven A. Block. 2013. "Revisiting African Agriculture: Institutional Change and Productivity Growth." *The Journal of Politics* 75(2):372–384.

**URL:** *http://www.journals.uchicago.edu/doi/10.1017/S0022381613000078*

Beck, Thorsten, George Clarke, Alberto Groff, Philip Keefer and Patrick Walsh. 2001. "New Tools in Comparative Political Economy: The Database of Political Institutions." *The World Bank Economic Review* 15(1):165–176.

**URL:** *https://academic.oup.com/wber/article/15/1/165/1682021*

Bernauer, Thomas and Vally Koubi. 2009. "Effects of political institutions on air quality." *Ecological Economics* 68(5):1355–1365.

**URL:** *http://linkinghub.elsevier.com/retrieve/pii/S0921800908004345*

Boelee, Eline. 2011. *Ecosystems for water and food security. [Background paper].* United Nations Environment Programme (UNEP); International Water Management Institute (IWMI).

**URL:** *https://cgspace.cgiar.org/handle/10568/36532*

Boix, Carles, Michael Miller and Sebastian Rosato. 2013. "A Complete Data Set of Political Regimes, 1800–2007." *Comparative Political Studies* 46(12):1523–1554.

**URL:** *https://doi.org/10.1177/0010414012463905*

Boone, Catherine. 2003. *Political topographies of the African state: territorial authority and institutional choice.* Cambridge studies in comparative politics Cambridge, UK ; New York: Cambridge University Press.

Boone, Catherine. 2014. *Property and political order in Africa: land rights and the*

*structure of politics*. Cambridge studies in comparative politics New York: Cambridge University Press.

Buitenzorgy, Meilanie and Arthur P. J. Mol. 2011. "Does Democracy Lead to a Better Environment? Deforestation and the Democratic Transition Peak." *Environmental and Resource Economics* 48(1):59–70.
**URL:** *http://link.springer.com/10.1007/s10640-010-9397-y*

Burgess, Robin, Matthew Hansen, Benjamin A. Olken, Peter Potapov and Stefanie Sieber. 2011. The Political Economy of Deforestation in the Tropics. Working Paper 17417 National Bureau of Economic Research.
**URL:** *http://www.nber.org/papers/w17417*

Burgess, Robin, Matthew Hansen, Benjamin A. Olken, Peter Potapov and Stefanie Sieber. 2012. "The Political Economy of Deforestation in the Tropics*." *The Quarterly Journal of Economics* 127(4):1707–1754.
**URL:** *https://academic.oup.com/qje/article-lookup/doi/10.1093/qje/qjs034*

Burgess, Robin, Remi Jedwab, Edward Miguel, Ameet Morjaria and Gerard Padró i Miquel. 2013. The Value of Democracy: Evidence from Road Building in Kenya. Working Paper 19398 National Bureau of Economic Research.
**URL:** *http://www.nber.org/papers/w19398*

Ceddia, Michele Graziano, Nicholas Oliver Bardsley, Sergio Gomez-y Paloma and Sabine Sedlacek. 2014. "Governance, agricultural intensification, and land sparing in tropical South America." *Proceedings of the National Academy of Sciences* 111(20):7242–7247.
**URL:** *http://www.pnas.org/content/111/20/7242*

Chazdon, Robin L. 2008. "Beyond Deforestation: Restoring Forests and Ecosystem Services on Degraded Lands." *Science* 320(5882):1458–1460.
**URL:** *http://science.sciencemag.org/content/320/5882/1458*

Cheibub, José Antonio, Jennifer Gandhi and James Raymond Vreeland. 2010. "Democracy and dictatorship revisited." *Public Choice* 143(1-2):67–101.
**URL:** *https://link.springer.com/article/10.1007/s11127-009-9491-2*

Chupezi, Tieguhong Julius. 2009. "Sustainable forest management in Cameroon." *In Search of Common Ground* p. 411.

Dasgupta, Shouro and Enrica De Cian. 2018. "The influence of institutions, governance, and public opinion on the environment: Synthesized findings from applied econometrics studies." *Energy Research & Social Science* .
**URL:** *http://www.sciencedirect.com/science/article/pii/S2214629618305164*

Deacon, Robert T. 2009. "Public good provision under dictatorship and democracy." *Public Choice* 139(1-2):241–262.
**URL:** *https://link.springer.com/article/10.1007/s11127-008-9391-x*

Didia, Dal O. 1997. "Democracy, political instability and tropical deforestation." *Global Environmental Change* 7(1):63–76.
**URL:** *http://www.sciencedirect.com/science/article/pii/S0959378096000246*

Drazen, Allan. 2000. "The Political Business Cycle after 25 Years." *NBER Macroeconomics Annual* 15:75–117.
**URL:** *http://www.journals.uchicago.edu/doi/abs/10.1086/654407*

Ehrhardt-Martinez, Karen, Edward M. Crenshaw and J. Craig Jenkins. 2002. "Deforestation and the Environmental Kuznets Curve: A Cross-National Investigation of Intervening Mechanisms." *Social Science Quarterly* 83(1):226–243.
**URL:** *http://onlinelibrary.wiley.com/doi/10.1111/1540-6237.00080/full*

Gibbs, H. K., A. S. Ruesch, F. Achard, M. K. Clayton, P. Holmgren, N. Ramankutty and J. A. Foley. 2010. "Tropical forests were the primary sources of new agricultural land in the 1980s and 1990s." *Proceedings of the National Academy of Sciences* 107(38):16732–16737.
**URL:** *http://www.pnas.org/content/107/38/16732*

Hardin, Garrett. 1968. "The Tragedy of the Commons." *Science* 162(3859):1243–1248.
**URL:** *http://science.sciencemag.org/content/162/3859/1243*

Harding, Robin. 2011. One for the road: Voting for public goods in ghana.

Technical report Working Paper, New York University.

Harding, Robin and David Stasavage. 2014. "What Democracy Does (and Doesn't Do) for Basic Services: School Fees, School Inputs, and African Elections." *The Journal of Politics* 76(1):229–245.

**URL:** *http://www.journals.uchicago.edu/doi/10.1017/S0022381613001254*

Houghton, R. A. 2005. "Aboveground Forest Biomass and the Global Carbon Balance." *Global Change Biology* 11(6):945–958.

**URL:**

*http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2486.2005.00955.x/abstract*

Kasara, Kimuli. 2007. "Tax Me If You Can: Ethnic Geography, Democracy, and the Taxation of Agriculture in Africa." *American Political Science Review* 101(1):159–172.

Keefer, Philip. 2007. "Clientelism, Credibility, and the Policy Choices of Young Democracies." *American Journal of Political Science* 51(4):804–821.

**URL:**

*http://onlinelibrary.wiley.com/doi/10.1111/j.1540-5907.2007.00282.x/abstract*

Keefer, Philip and Razvan Vlaicu. 2008. "Democracy, Credibility, and Clientelism." *The Journal of Law, Economics, and Organization* 24(2):371–406.

**URL:** *https://academic.oup.com/jleo/article/24/2/371/832316*

Keefer, Philip and Stuti Khemani. 2005. "Democracy, Public Expenditures, and the Poor: Understanding Political Incentives for Providing Public Services." *The World Bank Research Observer* 20(1):1–27.

**URL:** *http://www.jstor.org/stable/41261407*

Klopp, Jacqueline M. 2012. "Deforestation and democratization: patronage, politics and forests in Kenya." *Journal of Eastern African Studies* 6(2):351–370.

Kollman, Ken, Allen Hicken, Daniele Caramani, David Backer, David Lublin, Joel Selway and Fabricio Vasselai. 2017. "GeoReferenced Electoral Districts Datasets (Beta 2)." *Ann Arbor, MI: University of Michigan Center for Political Studies* . bibtex: kollman_georeferenced_2017.

Lake, David A. and Matthew A. Baum. 2001. "The invisible hand of democracy: political control and the provision of public services." *Comparative political studies* 34(6):587–621.

**URL:** *https://doi.org/10.1177/0010414001034006001*

Li, Quan and Rafael Reuveny. 2006. "Democracy and environmental degradation." *International studies quarterly* 50(4):935–956.

**URL:** *http://onlinelibrary.wiley.com/doi/10.1111/j.1468-2478.2006.00432.x/full*

Malhi, Yadvinder, J Timmons Roberts, Richard A Betts, Timothy J Killeen, Wenhong Li and Carlos A Nobre. 2008. "Climate change, deforestation, and the fate of the Amazon." *science* 319(5860):169–172.

Marquart-Pyatt, Sandra. 2004. "A Cross-National Investigation of Deforestation, Debt, State Fiscal Capacity, and the Environmental Kuznets Curve." *International Journal of Sociology* 34(1):33–51.

**URL:** *http://www.tandfonline.com/doi/abs/10.1080/00207659.2004.11043128*

Mayhew, David R. 2004. *Congress: The Electoral Connection, Second Edition.* 2 edition ed. New Haven: Yale University Press.

Megevand, Aline Hourticq, Joël Sanders Klas Doetinchem Nina Streck Charlotte Carole Mosnier. 2013. What Will Drive Deforestation in the Congo Basin? A Multisectoral Analysis. In *Deforestation Trends in the Congo Basin.* Directions in Development - Environment and Sustainable Development The World Bank pp. 57–118.

**URL:** *http://elibrary.worldbank.org/doi/abs/10.1596/9780821397428_CH02*

Meiyappan, Prasanth and Atul K. Jain. 2012. "Three distinct global estimates of historical land-cover change and land-use conversions for over 200 years." *Frontiers of Earth Science* 6(2):122–139.

**URL:** *http://link.springer.com/10.1007/s11707-012-0314-2*

Mendelsohn, Robert. 1994. "Property rights and tropical deforestation." *Oxford economic papers* pp. 750–756.

Mertens, Benoît and Eric F. Lambin. 1997. "Spatial modelling of deforestation in

southern Cameroon." *Applied Geography* 17(2):143–162.

**URL:** *http://www.sciencedirect.com/science/article/pii/S0143622897000325*

Mesquita, Bruce Bueno de. 2005. *The Logic of Political Survival*. MIT Press. Google-Books-ID: 1PlRlcgQdpMC.

Midlarsky, Manus I. 1998. "Democracy and the Environment: An Empirical Assessment." *Journal of Peace Research* 35(3):341–361.

**URL:** *https://doi.org/10.1177/0022343398035003005*

Morjaria, Ameet. 2012. Electoral Competition and Deforestation: Evidence From Kenya. In *Paper for the World Bank's 2012 Annual Bank Conference on Development Economics*.

Nelson, Erik, Guillermo Mendoza, James Regetz, Stephen Polasky, Heather Tallis, DRichard Cameron, Kai MA Chan, Gretchen C Daily, Joshua Goldstein, Peter M Kareiva, Eric Lonsdorf, Robin Naidoo, Taylor H Ricketts and MRebecca Shaw. 2009. "Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales." *Frontiers in Ecology and the Environment* 7(1):4–11.

**URL:** *http://onlinelibrary.wiley.com/doi/10.1890/080023/abstract*

Newell, Peter. 2016. *The Globalization and Environment Reader*. John Wiley & Sons. Google-Books-ID: E0ZICgAAQBAJ.

Olson, Mancur. 1965. *The Logic of Collective Action*. Harvard University Press.

**URL:** *http://www.hup.harvard.edu/catalog.php?isbn=9780674537514*

Olson, Mancur. 1993. "Dictatorship, Democracy, and Development." *The American Political Science Review* 87(3):567–576.

**URL:** *http://www.jstor.org/stable/2938736*

Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge University Press. Google-Books-ID: 4xg6oUobMz4C.

Ostrom, Elinor, Joanna Burger, Christopher B. Field, Richard B. Norgaard and David Policansky. 1999. "Revisiting the Commons: Local Lessons, Global

Challenges." *Science* 284(5412):278–282.

**URL:** *http://science.sciencemag.org/content/284/5412/278*

Pailler, Sharon. 2016. Local politics and deforestation in the Brazilian Amazon PhD thesis CLARK UNIVERSITY.

Pailler, Sharon. 2018. "Re-election incentives and deforestation cycles in the Brazilian Amazon." *Journal of Environmental Economics and Management* 88:345–365.

**URL:** *https://www.sciencedirect.com/science/article/pii/S0095069616301577*

Posner, Daniel N. and Eric Kramon. 2011. Who Benefits from Distributive Politics? How the Outcome One Studies Affects the Answer One Gets. SSRN Scholarly Paper ID 1802623 Social Science Research Network Rochester, NY: .

**URL:** *https://papers.ssrn.com/abstract=1802623*

Rogoff, Kenneth. 1987. Equilibrium Political Budget Cycles. Working Paper 2428 National Bureau of Economic Research.

**URL:** *http://www.nber.org/papers/w2428*

Rogowski, Ronald. 1987. "Trade and the Variety of Democratic Institutions." *International Organization* 41(2):203–223.

**URL:** *http://www.jstor.org/stable/2706660*

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

**URL:**

*http://onlinelibrary.wiley.com/doi/10.1111/j.1540-5907.2006.00220.x/abstract*

Rudel, Thomas K. 2013. "The national determinants of deforestation in sub-Saharan Africa." *Phil. Trans. R. Soc. B* 368(1625):20120405.

**URL:** *http://rstb.royalsocietypublishing.org/content/368/1625/20120405*

Seymour, Frances J. and Carollyne Hutter, eds. 2000. *The right conditions: the World Bank, structural adjustment, and forest policy reform.* Washington, D.C: World Resources Institute.

Stokes, Susan C, Thad Dunning, Marcelo Nazareno and Valeria Brusco. 2013.

*Brokers, voters, and clientelism: The puzzle of distributive politics*. Cambridge University Press.

Swinnen, Johan FM. 2010. "The political economy of agricultural distortions: The literature to date." *The Political Economy of Agricultural Price Distortions* pp. 81–104.

Turner, B. L., ed. 1990. *The Earth as transformed by human action: global and regional changes in the biosphere over the past 300 years*. Cambridge ; New York: Cambridge University Press with Clark University.

WDI. 2017. "World Development Indicators | DataBank.".
**URL:** *http://databank.worldbank.org/data/*

Wehkamp, Johanna, Nicolas Koch, Sebastian Lübbers and Sabine Fuss. 2018. "Governance and deforestation — a meta-analysis in economics." *Ecological Economics* 144(Supplement C):214–227.
**URL:** *http://www.sciencedirect.com/science/article/pii/S0921800916315427*

Wilson, John K. and Richard Damania. 2005. "Corruption, political competition and environmental policy." *Journal of Environmental Economics and Management* 49(3):516–535.
**URL:** *http://linkinghub.elsevier.com/retrieve/pii/S0095069604001159*

You, Wan-Hai, Hui-Ming Zhu, Keming Yu and Cheng Peng. 2015. "Democracy, Financial Openness, and Global Carbon Dioxide Emissions: Heterogeneity Across Existing Emission Levels." *World Development* 66:189–207.
**URL:** *http://linkinghub.elsevier.com/retrieve/pii/S0305750X14002514*

Zhang, Quanfa, Christopher O. Justice, Mingxi Jiang, Jake Brunner and David S. Wilkie. 2006. "A gis-based assessment on the vulnerability and future extent of the tropical forests of the congo basin." *Environmental Monitoring and Assessment* 114(1-3):107–121.
**URL:** *https://link.springer.com/article/10.1007/s10661-006-2015-3*