

Does democracy guarantee (de)forestation? An empirical analysis

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**Anders Rydning Gaarder**

Norwegian University of Science and Technology, Trondheim, Norway

Krishna C Vadlamannati

School of Politics & International Relations, University College Dublin, Ireland

Abstract

It is a commonly held view that democracy is better at safeguarding environment while autocracy is predatory in nature, and is thus insensitive towards environment. However, others argue that democracy leads to environmental degradation. We revisit this contentious relationship between regime type and environment degradation in the context of deforestation. Using panel data on 139 countries during the 1990–2012 period, we find that democracy is associated with lower levels of forest coverage. Although our results appear counter-intuitive, further analyses reveal the positive effect of democracy on forest area coverage is conditional upon the level of economic development. Roughly, at per capita income of about US\$8200, the impact of democracy on forest coverage becomes positive. Our results suggest that a democratic government's priority to tackle environmental problems depends on its level of economic development. These results also highlight the fundamental reason as to why there is a lack of coordinated effort between developing and developed countries in addressing environmental issues.

Keywords

Afforestation, democracy, economic development.

Almost wherever people at the grass-roots level are deprived of a voice in the decisions that affect their lives, they and the environment suffer. I have come to believe that an essential prerequisite for saving the environment is the spread of democratic government.¹

– 2007 Nobel laureate Albert Gore

Corresponding author:

Krishna Chaitanya Vadlamannati, School of Politics & International Relations, University College Dublin, Dublin, Ireland.

Email: krishna.vadlamannati@ucd.ie

Introduction

Is democracy vis-à-vis autocracy better at safeguarding the environment? If so, can the level of economic development explain the variation among democracies in protecting environment? The relationship between regime type and environment protection is controversial and has been pondered by policy makers, scholars, academics over several decades. Both theoretical arguments and empirical evidence on this question remain contentious. The dominant view is that democracy is benign in nature, and thus protects the environment better in terms of outcomes (Barrett and Graddy 2000; Bättig and Bernauer, 2009; Payne, 1995; Torras and Boyce, 1998). This also holds true for international environmental commitments (Neumayer, 2002). Prominent studies including Fredriksson and Neumayer (2013), Buitenzorgy and Mol (2011), Shandra (2007), Li and Reuveny (2006), Neumayer (2002), Didia (1997), among others, find that democracy has a positive impact in reducing pollution (air, land and water) and deforestation. Particularly Buitenzorgy and Mol (2011), Shandra (2007), Li and Reuveny (2006) find that democracy is associated with lower levels of deforestation. These studies argue that the virtues of democracy, namely, civil and political liberties, free flow of information, civil society activism, free media, exchanging ideas with foreigners, lead to greater awareness on environmental issues, forcing the democratically elected governments to address environmental concerns. On the other hand, others argue that democracy is no better in safeguarding environment. For instance, Midlarsky (1998) finds no uniform results in the effects of democracy, and actually finds some indication of a negative effect on environmental protection in some areas. He also finds that democracies are associated with an increase in deforestation. Likewise, Roberts and Parks (2007) and Scruggs (1998) find no support for the fact that democracy has any effect on various environmental indicators in the realm of air, water and land pollution.

Why is empirical literature on this topic ambiguous? We argue that this literature is incomplete and misses potentially important effects of the role of economic development. While most studies examining the relationship between economic development and environment in an Environment Kuznets Curve (EKC hereafter)² framework ignore the role of political institutions, studies exploring the effects of regime type on environment overlook the role of economic development. To the best of our knowledge, no study has factored in the role of economic development. We fill this gap in the literature by focusing on the role of economic development in explaining the impact of democracy on deforestation. Our central argument is that the impact of democracy on environment protection (i.e. deforestation) is conditional upon level of economic development of a country. We argue that at a lower level of economic development the democratic regimes are under pressure from the electorate to generate jobs via boosting investments and kick starting the process of industrialization thereby increasing economic growth and development. In many poor countries where large sections of the population live below the poverty line, job opportunities are seen as a means to escape from poverty. Thus, the median voter prefers those governments which increase job opportunities. Moreover, at lower levels of economic development the general environmental awareness and consciousness among the masses is expected to be lower. On the other hand, higher on the economic developmental ladder, the governments often face a different sort of pressure from their electorate. That is, the pressure to preserve environment by embarking upon policies that focus on sustainable economic development in which environmental protection is given an equal importance. Thus, we argue that the positive effect of regime type (especially democracy) on protecting environment is highly conditional upon the state of economic development.

We put these theoretical propositions to an empirical test in a panel data setting covering 139 countries during the 1990–2012 period. We use forest coverage (i.e. the percentage area of land covered by forests) as a proxy for deforestation. We use forest area coverage for three specific purposes. First, in studying this topic, previous works have excessively focused on pollution related

variables like smoke, heavy particles, organic water pollution such as fouling of fresh water supplies, soil degradation, faecal coliform, arsenic, lead, dissolved oxygen, sulphur dioxide, nitrogen oxide, carbon dioxide emissions, other emissions like greenhouse gas, among others, or commitment to international environmental treaties. Little attention is focused on understanding how political institutions affect deforestation specifically.³ Second, focusing on an environmental outcome rather than environmental commitments, such as ratification of environmental treaties, is advantageous. It allows us to test the effect of regime type on the environment outcome – there is after all no guarantee that commitment to protect environment (like forests) will actually lead to positive outcomes. Finally, forest coverage is not just a proxy, but vital in its own right. Studies in environmental literature highlight the importance of forests and problems associated with deforestation. Arvin and Lew (2011) show that deforestation is a major contributor to climate change. Likewise, Walsh (2007) estimates that deforestation accounts for about 20% of all carbon emissions in the world – which is more than what is being emitted by motor transportation. Furthermore, deforestation causes loss in biodiversity and is also linked to soil erosion (Erhardt-Martinez, 1998; Rudel, 2013).

Using Feasible Generalized Least Squares two-way fixed effects estimator we find that democracy (autocracy) had a negative (positive) effect on forest coverage during the 1992–2012 period. However, when interacting our democracy variable with the level of economic development (proxied by per capita income), we find a positive effect of democracy on forest coverage at a higher level of per capita income, while a negative effect is found at lower levels of per capita income. More precisely, we find that at per capita income of over US\$8200, the impact of democracy on forest coverage becomes positive. Our results suggest that a democratic government's priority to tackle environmental problems depends on its level of economic development. These results are robust to a variety of robustness checks. These results lend support to our argument that the impact of regime type in explaining the variation in forest area coverage is conditional upon level of economic development of a country.

The rest of the paper is structured as follows: in the next section, we review the previous literature (both theoretical and empirical) on the relationship between regime type and deforestation. We use the previous literature to build our central arguments leading to some testable hypotheses. In the third section we provide a description of the data and estimation methods that we apply in this paper. The fourth section presents our results along with analysis. The fifth section concludes the study.

Literature review and hypotheses

In this section, we review the existing literature on the impact of regime type on the environment in general and also on deforestation. The previous theoretical as well as empirical literature on this topic remains contentious. While some scholars argue that democracy is associated with improvement in environmental protection, others find that democracy has no positive effect. Some even argue that autocracies are much better at protecting against environmental degradation. We begin with reviewing the existing theoretical and empirical literature from both these two camps to arrive at a testable hypothesis on this topic. Next, we will then examine the role economic development plays, while examining the impact of regime type on environment to derive our second hypothesis.

Democracy as the guarantor of environmental commitment

As previous literature on the relationship between regime types and environment is contentious, we divide the arguments into two opposing camps. The conventional wisdom in comparative politics is that democracy is benign in nature and generally acts in a manner that serves the greater

interest of the people. Since protecting the environment undoubtedly is good for society as a whole, it is expected that democracy will behave in the best interest of the people and ensure environmental protection. At least it would do so to a larger degree than an autocracy would – considering it represents a smaller segment of the population with often-dubious goals.

Examining the importance of democracy in environmental debate, Payne (1995) and Farzin and Bond (2006) conducted a comprehensive treatise on the impact of democracy on environment degradation. They highlight five central arguments as to why democracies are better at protecting the environment. First, democracies create a climate for the free flow of information. In fact, Hollyer et al. (2011) find that democracy is a key prerequisite in explaining the variation in government transparency among countries.⁴ Extending the analysis on transparency further, Hollyer et al. (2015) find that transparency destabilizes autocratic regimes through mass protests and demonstrations. Schultz and Crockett (1990) argue that the free flow of information in democracies significantly increases public awareness on environmental issues through the activities of various environmental groups. Thus, coupled with strong individual rights, democracy allows citizens to influence their government, especially collectively in the form of Non-Governmental Organizations (NGOs hereafter) and also through free media (Barrett and Graddy, 2000). In this climate, ideas compete in a ‘free market’, where the most beneficial ones pull through. In the case of the environment, the protection of the environment should do just that since it is in people’s collective interest. The presence of NGOs has previously been found to reduce strain on the environment (Binder and Neumayer, 2005) and the stringency of policies (Fredriksson et al., 2005). Second, in a democratic setting governments are more responsive and accountable to public opinion. If the first argument holds true, it would be natural to assume that voters will punish governing parties that do not deliver in the realm of environmental protection (Li and Reuveny, 2006). This will in turn put pressure on the government to consider seriously the environmental concerns of the majority. Third, Payne (1995) claims that both political parties and the electorate in democracies are more likely to draw lessons from the experiences of their autocratic counterparts. This derives from the freedom of information that autocracies do not have. Payne (1995), building on Godwin’s (1992) argument, also points to the fact that autocracies lack flexibility and ability to innovate as they are more interested in maintaining status quo bias in favour of economic and political elite. The fourth argument focuses on international cooperation. Democracies, according to Payne (1995) and Farzin and Bond (2006), are more likely to participate in international organizations and treaties. Furthermore, they are more likely to meet environmental standards (Neumayer, 2002). It is expected that this in turn will lead to better environmental outcomes in the form of lower levels of pollution and deforestation. In fact, a world development report by Gates et al. (2003) empirically confirms that democracies are more likely to ratify multilateral environmental agreements, and put a greater percentage of their land area under protection status. Eichengreen and Leblang (2008) describe this integration through the relationship between democracy and globalization. They find bidirectional causality between the two. The last argument of Payne (1995) is that democracies are open market economies. In fact, Eichengreen and Leblang (2008) find that democratic countries are more open to trade and foreign investments than autocracies. Similar such findings are echoed by Jensen (2003, 2004, 2006) and Jakobsen and de Soysa (2006). This gives governments a wide array of opportunities to direct market forces in the desired direction (Tamazian and Rao, 2012). Regulations can be imposed on the markets, which in turn provide incentives for corporations to act in a more environmentally friendly way.

Fredriksson and Neumayer (2013) take a new angle in evaluating democracy’s effect on the environment. Instead of looking at the current state of democracy, they examine the impact of accumulated democratic experience. Particularly, a long history of executive constraints, they find, has a large positive effect in explaining variation in climate protection among countries. From this,

it is concluded that young democracies are not expected to commit heavily to environmental policies (Buitenzorgy and Mol, 2011). These findings are in line with Gerring et al. (2005), who stress the importance of strong institutions, which are key in protecting the environment. Strong institutions develop over a period of time, thus long standing democracies hold an edge over new democracies in protecting environment. Focusing on environmental commitment instead of outcomes has its disadvantages. It does not necessarily lead to better outcomes. Still, Fredriksson and Neumayer (2013) posit that democracy will show improvement in outcomes as well, if given enough time. In other words, the effects, they argue, are not contemporaneous and there is a substantial lag effect. In fact, their findings are in line with Congleton (1992), who theorizes that autocratic regimes often have shorter time horizons than their democratic counterparts. Consequently, they set weaker environmental policies and instead plunder the riches for themselves and their close support groups. Furthermore, Nobel laureate Amartya Sen (1994) argues that famine is the major cause of environmental degradation. Theisen (2008, 2012) finds that factors related to climate change and environmental degradation influence the risk of conflicts and violent events.⁵ Sen (1994) contends that the frequency of occurrence of famines is less in democracies because democratic governments, according to Gleditsch and Sverdrup (2003), are more responsive to the life threatening concerns of the people.

The contradictory view

Empirical results that go against the dominant paradigm have also been documented in the literature. As already indicated there are contrarian views which argue that democracy has no significant impact on environment protection. The most prominent among such studies is Midlarsky (1998), who uses regime type data on 156 countries in examining the effects of democracy on six different environmental variables. Surprisingly, he finds a positive correlation between democracy and soil erosion, carbon dioxide emissions and deforestation in his regression analysis. He points to the contradiction this poses to the commonly held view on democracy as consistently benign for the environment. Several plausible explanations are given in the literature by various scholars to support this finding. First, Midlarsky (1998) theorizes that the negative effect of democracy on environmental health has been due to a cause overlooked by the earlier research on this subject. The economic needs of the population, particularly in the poorer countries, trump environmental protection. He finds that the derived evidence is largely from the fact that when controlling for (usually wealthy) European countries, democracy has a negative effect on the environment. This indicates the possibility of a deeper relationship between level of development and democracy. Desai (1998) takes Midlarsky's argument one step further. He argues that democracies do not necessarily have a uniform and positive influence on the environment. According to Desai (1998), democracies are highly accountable to the people and are pressured to deliver in terms of economic growth and development, which can have negative consequences for environment and forests. Thus, rulers in a democratic setting might see environmental degradation as a necessary byproduct of development. Notice how this argument uses the exact same logic as Payne's (1995) second argument, but is taken to the opposite conclusion. They diverge at the issue of whether people will prioritize the environment first, or sacrifice it in favour of expanding the economy.

The second argument is the extension of the first, in which democracies on one hand are accountable to the electorate to deliver economic development and prosperity and on the other hand they are more open to markets, as discussed earlier. This allows various competing interest and lobby groups in the industry with vast resources to influence government to favour industrial policies over environmental concerns (Dryzek, 1987). The political class in democracies is willing to invest their political capital to favour industry over environment with the hope that their

policies will generate industrialization and thereby contribute to economic prosperity in the medium to long term. Obviously, the main focus of industries is to seek profits in order to maximize the value of shareholders but need not necessarily stand for the betterment of environmental protection. The third argument presented by some scholars is that autocracies are actually better equipped to tackle problems associated with population pressures which tend to put enormous strain on the environment and natural resources like forests (Heilbrunner, 1974). Neumayer (2002) argues that without much political constraint, it is easier for the autocracies vis-à-vis democracies to curtail the problem of excess birth rates. If indeed this is true then autocracies are better positioned to handle the problem of conflict over resource scarcity as hypothesized by Homer-Dixon (1994).⁶

Summing up so far, based on the discussion presented above, the literature on this topic is divided into two opposing camps – one that sees democracy as benign for the environment and one that is more sceptical. We thus test for our first hypothesis that *democracies are more likely to increase forest coverage than autocracies*.

The empirical literature on this topic is also divided. For instance, Roberts and Parks (2007) and Scruggs (1998) find no significant effect of democracy on various measures of environment. On the other hand, Congleton (1992) and Midlarsky (1998) find that democracies actually worsen the environmental situation. However, several other studies, including Torras and Boyce (1998), Barrett and Graddy (2000), Harbaugh et al. (2002) and Neumayer (2002), found that their measures of democracy variables were statistically significant and associated with an improvement in various aspects measuring environmental protection. With specific focus on deforestation, Midlarsky (1998) and Erhardt-Martinez et al. (2002) find that democracy actually increases the pace of deforestation. However, an empirical analysis of deforestation rates by Didia (1997) found a positive correlation between democracies and lower deforestation rates. This helps strengthen the argument of democracy's benignity. Didia's (1997) weakness was that only a univariate regression was utilized in the study. Overcoming these concerns, Li and Reuveny (2006) and Shandra (2007) conducted a panel data study covering a large number of countries that found that democracy has a positive effect on reducing deforestation rates. In a more recent study, Buitenzorgy and Mol (2011) examine the relationship between democracy and deforestation. They find evidence in favour of an inverted U-shaped relationship between democracy and deforestation. More specifically, they find that democratic countries experiencing a transition have higher rates of deforestation compared with matured democracies. Similar such findings of an inverted U-shape in the context of deforestation and economic development are documented by Cropper and Griffiths (1994). For almost all the geographic regions in the world (with the exception of Asia), they find a strong inverted U-shaped relationship between deforestation and other air and water pollution variables and economic development. This inverted U-shaped relationship is in line with the EKC theory, which argues that environment deteriorates in early stages of economic development and subsequently improves as the economy matures after a certain critical point. Panayotou (1993) and Bhattarai and Hammig (2001) also find similar evidence of EKC relationship for deforestation and other pollution related variables with economic development. A recent empirical paper by Arvin and Lew (2011) also examines the impact of democracy on the environment, albeit on carbon dioxide emissions, water pollution and deforestation damage as measurements of environmental protection. They find that difference in the effect of democracy on pollution is based on the developmental stage of a country. They believe that this variation signifies that the relationship between democracy and the environment is multi-faceted in nature, so that prescribing the same pill (of promoting democracy) to cure environmental problems in all countries might not be feasible. In fact, most of the studies focusing on the EKC relationship with reference to environment and deforestation concede the importance of the role of regime type and institutions in general. In the

following section, the role of economic development in the context of regime type and deforestation will be further discussed.

The role of economic development

As already highlighted, Midlarsky (1998) argues that regime type alone may not fully explain the variation in environmental outcomes. There exists a wide range of literature that focuses on this relationship between economic development and environmental outcomes. The EKC is an empirically based model for which a lot of empirical support has been found in the literature (see Buitenzorgy and Mol, 2011; Copeland and Taylor, 2004; Panayotou 1993; Stern et al., 1996; Tamazian and Rao, 2010). The EKC explains the relationship between economic development and pollution, which takes the form of an inverted U-shaped curve. Accordingly, as an undeveloped country starts developing, the levels of pollution start to rise. At some point in time, a turning point is reached and the trend shifts (Van Alstine and Neumayer, 2009). From there on, the added levels of development are accompanied by lower levels of pollution. This effect can be attributed to several factors. Van Alstine and Neumayer (2009) work through previous theoretical cases for what might invoke the presence of an EKC. One argument is that of environmental awareness. As a country develops, its citizens will have access to better education and information. This will create a fertile ground for environmental activism to grow on. The effect could also be spurious because countries that develop have been known to experience slowing population growth rates. Larger populations are linked to greater pollution, and if this growth is slowed, it could put less strain on the environment. Developed countries have traditionally switched to a greater number of less-polluting sectors as they grow. They have embraced the knowledge-based economy, while the traditional manufacturing has been outsourced to countries with cheaper factor inputs in what could be described as a 'race to the bottom'. This would entail effectively exporting pollution to less developed countries – the 'pollution haven hypothesis' (Dinda, 2004; Van Alstine and Neumayer, 2009). The export of pollution could be a big part of why the curve is often observed. On the downside, this could indicate that the world's net pollution is not decreased. Rather, it is simply shuffled to poorer countries. Van Alstine and Neumayer (2009) highlight this as the biggest challenge to the EKC model's relevance in the future. However, there are forces that can mitigate the pollution, one of which is technological diffusion. Access to more efficient and environment friendly technology will allow developing countries to produce at lower rates of pollution per output. This might be furthered by the development of economies of scale, which allow production with minimal waste levels (Dinda, 2004).

We hypothesize that economic development plays a significant role in explaining democracy's effect on the environment. We build on Desai's (1998) and Midlarsky's (1998) theory on the pressures democratic leaders face, which force them to sacrifice environmental protection for the sake of economic development and job creation in the short term. People at the lower end of the economic development ladder quite naturally want to acquire decent jobs to improve their standard of living. Acquiring a decent job in many poor countries is often seen as a ticket to move the household out of poverty. There is a vast literature which shows that the chances of reelection of democratically elected leaders is strongly correlated with their economic performance in terms of generating higher economic growth and lowering the level of unemployment (see for instance: Blount, 2002; Brender and Drazen, 2008; Ferguson et al., 2013; Kayser, 2005). Thus, leaders will try to accommodate this by embarking on attracting investments, which fuels rapid industrialization that in turn generates job opportunities. This obviously will likely take a heavy toll on the environment (Cole and Neumayer, 2004; Dinda, 2004; Van Alstine and Neumayer, 2009), particularly on forest area coverage. Industrialization process requires large swathes of land, which is in

short supply in many of the poor countries, thus resulting in deforestation. Industrial corridors, Special Economic Zones, Export Processing Zones, industrial parks, special manufacturing hubs all require land on a large scale if the industrialization process has to be unleashed (Haeuber, 1993). This puts tremendous pressure on forest area for land (Kaimowitz and Angelsen, 1998). Moreover, it is noteworthy that deforestation lowers transportation costs. Lower transport costs in turn open the possibility for more trade and investments. Evidence shows that transport costs measured as the distances to be covered between different markets is one of the significant determinates of industrialization and trade. The empirical literature supporting the fact that transportation costs are lowered due to deforestation is abundant (see Angelsen, 1996; Pichon, 1997; Southgate et al., 1991). Lower transportation costs coupled with an increase in returns to scale might further fuel more industrialization and agglomeration of industrial activities closer to different markets.

Our line of argument actually contradicts Payne's (1995) argument that the electorate in democracies will apply pressure on their leaders to protect the environment. Our bone of contention with this line of argument by Payne (1995) is that he presumes that this is a universal attitude, present across all democracies irrespective of their level of economic development. We argue that the wealthier democracies will protect environment better as basic needs are largely covered, thus shifting the focus towards a long-term sustainable economic development model in which environment protection is given equal importance. Fredriksson and Wollscheid (2014), Ringquist (1993) and Khator (1993) lend support to our argument. They find that level of income is the most important predictor of environmental protection. Specifically, they find that wealthier American states witness an increase in environmental protection compared with poor states.⁷ This is precisely in line with the EKC theory on pollution in which the levels of pollution will dramatically come down as the economic development increases. In other words, popular pressure will be of paramount importance in democracies at all levels of development, albeit with different goals and priorities. But as the democratic countries grow wealthier, the preferences of electorate and governments will shift from 'development at all cost' to 'sustainable model of development'. Thus, they are expected to grow more economically sustainable (de Soysa et al., 2009), and this in turn will relieve some of the environmental pressures. In addition, the increase in literacy rates that often accompanies higher economic development levels should help raise public awareness on environmental issues. Under such conditions democracy facilitates the mobilization to fight for environmental cause. These effects should be possible to observe in terms of environmental outcomes such as forest area coverage. Therefore, we expect that *democracy's effect on forest coverage is conditional upon the level of economic development*.

Data and methods

Model specification

We use panel data covering 139 countries (see appendix 1) during 1990–2012 period (23 years) to examine the impact of regime type on forest coverage. Note that the forest coverage data is made available only from 1990 onwards. Hence, the study period begins from 1990. We specify the regression equation as follows:

$$Y_{it} = \varphi_i + \beta_1 X_{it} + \beta_2 Z_{it} + v_i + \lambda_t + \omega_{it}$$

wherein Y_{it} is the dependent variable, which is the forest coverage defined as the percentage of land area covered by forests in country i in year t . The data is sourced from the World Development Indicators (WDI), 2014 version, compiled by the World Bank. The WDI defines deforestation as 'the permanent conversion of natural forest area to other uses, including agriculture, ranching,

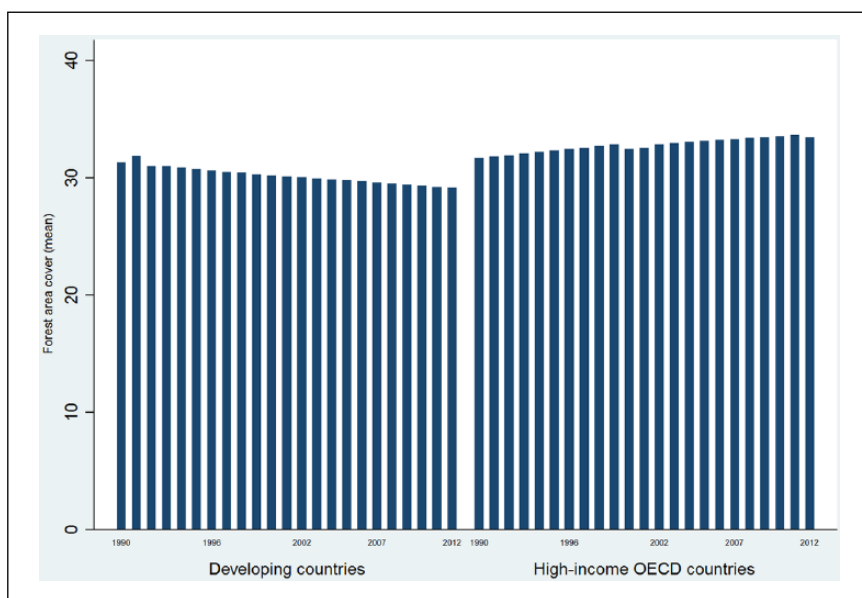


Figure 1. Forest area cover by group of countries during the 1990–2012 period.
OECD: Organization for Economic Cooperation and Development.

settlements, and infrastructure. Deforested areas do not include areas logged but intended for regeneration or areas degraded by fuelwood gathering, acid precipitation, or forest fires.’ (World Bank, 2015). We use the level of forest coverage area and not net forest depletion because the former captures the permanent change in the land use, while the latter covers only loss in the value of timber which is extracted. While computing the forest coverage area, the World Bank does include the area which is logged out or was affected by natural calamity but is clearly intended for regeneration. The forest depletion on the other hand covers only the timber values and ignores the losses from non-timber benefits and other non-use benefits. Figure 1 provides a descriptive overview on the forest coverage in our sample of countries during the 1990–2012 period.

As seen, on average the forest coverage has declined steadily throughout the study period for global sample. Although a decrease of two percentage points on average might seem minuscule, it could have an impact on the environment. However, when we split our sample into two different groups, namely, developing countries and high-income OECD (Organization for Economic Cooperation and Development) countries, we see a clear difference in the pattern of afforestation rate. While in the sample of developing countries a mix of democracies and autocracies does witness a steady declining trend, it is quite the opposite for high-income OECD countries that are all democracies. In a way, Figure 1 tends to provide some support for our hypothesis 2.

In equation (1) X_{it} represents our main independent variable, democracy. We create a *democracy dummy* measure based on the Marshall and Jagers (2002) polity IV index⁸ which is recoded as 1 if the Polity IV index is above +5 on the scale of –10 to +10, in which higher values represent full democracy, and 0 otherwise.⁹ Likewise, we also create the *autocracy dummy* variable, which is coded 1 if the Polity IV index is below –5 and 0 otherwise. Figure 2 provides a descriptive view of the evolution of democracies during our study period.

As seen, Figure 2 shows a rising trend in the number of democracies. As of 1990, roughly 40% of the countries in our sample were democracies. This number increases to roughly 50% by 2012.

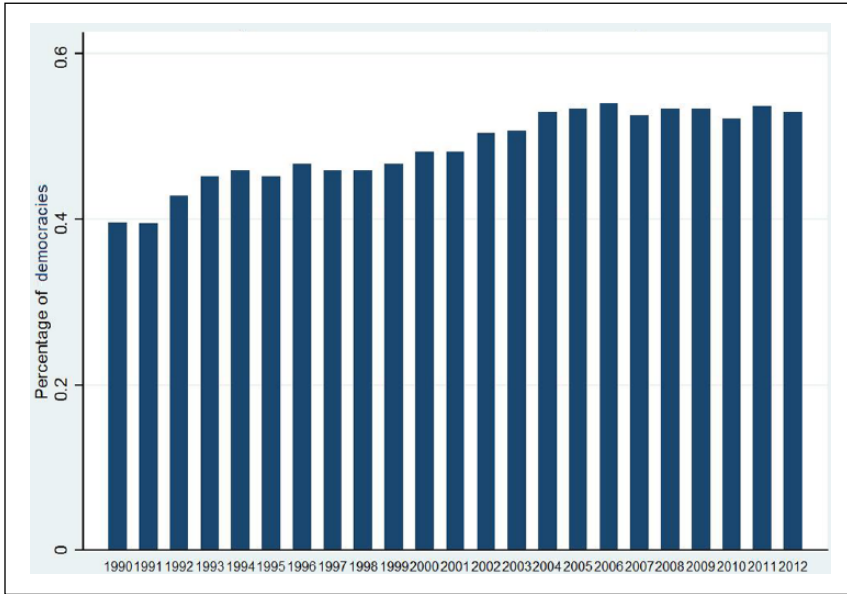


Figure 2. Evolution of democracies during the 1990–2012 period.

These numbers are broadly in line with the third wave of democratization process during the 1990s period (Papaioannou and Gregerios, 2004; Strand et al., 2012).

The vector Z_{it} includes other potential determinants on forest coverage. We select the control variables based on a handful of previous studies on determinants of forest coverage (e.g. Erhardt-Martinez, 1998; Htun et al., 2013; Kaimowitz and Angelsen, 1998; Rudel, 2013). Following these studies, we include a measure of level of income using per capita gross domestic product (GDP; logged), measured in constant 2005 US dollar prices. The data is sourced from the United Nations Conference on Trade and Development statistics (UNCTAD statistics (2015) hereafter). GDP per capita captures the effect that level of development has on the environment (see Arvin and Lew, 2011). Cole and Neumayer (2004) control for population as they find larger populations are significantly linked to greater environmental degradation. We thus include the population (log) sourced from the UNCTAD statistics (2015). Countries with higher trade openness promote environmental cooperation (e.g. Neumayer, 2002). We therefore add a measure of trade openness measured as total trade (exports and imports) as a share of GDP. The data is also sourced from the UNCTAD statistics (2015). The NGO activities have previously been found to be correlated with environmental commitments (Binder and Neumayer, 2005). In turn, this could also lead to better environmental outcomes in terms of forest coverage. We thus add a count measure of all active NGOs (logged) present in country i in year t . The data is sourced from the Union of International Associations' *Yearbook of International Organizations* (Union of International Associations, 2015). States with high mineral rents can be expected to put greater strain on forest coverage. Open pit mining operations have been suggested to cause deforestation (Angelsen and Kaimowitz, 1999). We add the measure of mining using total mineral rents as a share of GDP, sourced from the World Bank's WDI (World Bank, 2015). Accordingly, the World Bank defines resource rents as unit price minus the cost of production multiplied by the quantity produced. Finally, we include a law and order index sourced from the International Country Risk Guide (ICRG), which is coded on the scale of 0–6 wherein higher value denotes good law and order conditions in the country. The

ICRG law and order index captures two sub-components, namely, ‘law’, which takes into account the strength and independence of the legal system, and ‘order’, which considers compliance to the law.

Note that we do not include a lagged dependent variable as inclusion of a lagged dependent variable, according to Achen (2000), can drastically reduce the explanatory power of the independent variables. Including a lagged dependent variable in a short panel (23 years) with fixed effects causes inconsistent estimations, resulting in a downward bias of the coefficient, known as the ‘Nickell bias’ (Nickell, 1981). Thus, we estimate all our models without the inclusion of a lagged dependent variable.¹⁰ Following Dreher and Rupprecht (2007) we estimate all our regressions using the Ordinary Least Squares (OLS henceforth) method. Note that when estimating OLS estimators we control for both time and country fixed effects in all our models. The descriptive statistics on all the afore-mentioned variables are reported in Appendix 2 and the details on definitions and data sources are provided in Appendix 3.

Interactions

To examine our hypothesis 2, we estimate interaction models in which we introduce interaction between our measure of democracy and per capita income (log) as under the following:

$$Y_{it} = \varphi_i + \beta_1 X_{it} + \beta_2 (X \times iv)_{it} + \beta_3 iv_{it} + \beta_4 Z_{it} + v_i + \lambda_t + \omega_{it}$$

wherein $(X \times iv)_{it}$ captures the interaction between our democracy measure (X_{it}) and per capita income (log), as described above, which is our interaction variable (iv_{it}). Note that all the interaction effect models for global sample and a sample of developing countries are estimated using OLS estimator controlling for both country and time fixed effects.

Empirical results

Tables 1–3 present the main results. Table 1 presents results for regime type with controls, which are added stepwise. Table 2 reports the same results for the sample of developing countries alone. Finally, Table 3 reports the results on interactions between democracy and level of income for both global sample and a sample of developing countries alone. Before examining the regression results, a simple ‘back of the envelope’ calculation provides a first descriptive look at the relationship between regime type and afforestation. Among the developing countries sample, democracies have forest area coverage of about 31% while autocracies are associated with 28%. The gap between the two is minimal. Further disaggregation of forest coverage data shows that autocracies have about 15% coverage area, while anocracies have roughly 35% and democracies 31%. Interestingly, among high-income OECD nations, the forest coverage is 36%. These simple stylized facts show that democracies are not always associated with a higher proportion of forest cover, although with the exception of high-income OECD nations. These simple bivariate statistics, however, may lead to spurious conclusions without controls, such as income or population pressures, rather than regime type differences, to explain the differences. We thus move next to examine the statistical relationship in greater detail and precision in multivariate models.

Table 1 reports the impact of regime type on afforestation rate. As seen in column 1, democracy is associated with a decline in the rate of afforestation. The point estimates suggest that a democratic country is associated with a 0.74% decline in forest area coverage rate, which is significantly different from zero at the 1% level. This finding negates our first hypothesis, that democracies are better at environmental protection in the form of forest protection. These results also contradict the

Table 1. Afforestation rates and regime type during the 1990–2012 period (global sample).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Afforestation	Afforestation	Afforestation	Afforestation	Afforestation	Afforestation	Afforestation
Democracy dummy ($t-1$)	-0.736*** (0.133)	-0.789*** (0.132)	-0.894*** (0.128)	-0.905*** (0.129)	-0.951*** (0.128)	-0.968*** (0.127)	-1.333*** (0.135)
Autocracy dummy ($t-1$)	1.473*** (0.158)	1.233*** (0.160)	1.019*** (0.156)	1.037*** (0.157)	0.899*** (0.157)	0.864*** (0.157)	0.991*** (0.169)
Per capita income (log) ($t-1$)		1.477*** (0.205)	0.654*** (0.207)	0.664*** (0.211)	0.356* (0.214)	0.907*** (0.223)	0.626** (0.245)
Population (log) ($t-1$)			-5.014*** (0.358)	-5.115*** (0.367)	-4.435*** (0.377)	-4.349*** (0.374)	-4.210*** (0.389)
Trade/GDP ($t-1$)				-0.00175 (0.00108)	-0.00284*** (0.00108)	-0.00193* (0.00109)	-0.00312*** (0.00111)
NGOs (log) ($t-1$)					1.304*** (0.185)	1.218*** (0.184)	3.818*** (0.330)
Mineral rents/GDP ($t-1$)						-0.0316* (0.0171)	-0.0309* (0.0174)
Rule of law ($t-1$)							0.137*** (0.0534)
Constant	28.18*** (0.384)	16.63*** (1.650)	64.51*** (3.778)	65.37*** (3.907)	54.16*** (4.189)	49.69*** (4.192)	34.63*** (4.524)
R-squared	0.0998	0.1186	0.1773	0.1792	0.1936	0.2044	0.2457
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	136	136	136	136	136	135	129
Total observations	2933	2923	2921	2913	2913	2870	2689

Country fixed effects and year dummies are included and robust standard errors are in parentheses.

*** $p < 0.01$.** $p < 0.05$.* $p < 0.1$.

GDP: gross domestic product; NGO: Non-Governmental Organization.

Table 2. Afforestation rates and regime type during the 1990–2012 period (non-OECD sample).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Afforestation	Afforestation	Afforestation	Afforestation	Afforestation	Afforestation	Afforestation
Democracy dummy ($t-1$)	-0.602*** (0.135)	-0.652*** (0.133)	-0.749*** (0.132)	-0.757*** (0.133)	0.802*** (0.131)	-0.820*** (0.129)	-1.188*** (0.138)
Autocracy dummy ($t-1$)	1.254*** (0.161)	0.935*** (0.162)	0.844*** (0.160)	0.850*** (0.162)	0.648*** (0.160)	0.601*** (0.160)	0.691*** (0.173)
Per capita income (log) ($t-1$)		1.857*** (0.212)	1.189*** (0.223)	1.241*** (0.228)	0.883*** (0.228)	1.473*** (0.238)	1.184*** (0.263)
Population (log) ($t-1$)			-3.447*** (0.393)	-3.433*** (0.406)	2.332*** (0.417)	-2.246*** (0.413)	-2.022*** (0.433)
Trade/GDP ($t-1$)				-0.000946 (0.00112)	-0.00236** (0.00111)	-0.00160 (0.00111)	-0.00280** (0.00114)
NGOs (log) ($t-1$)					1.746*** (0.193)	1.651*** (0.192)	4.145*** (0.346)
Mineral rents/GDP ($t-1$)						-0.0152 (0.0176)	-0.0139 (0.0179)
Rule of law ($t-1$)							0.175*** (0.0575)
Constant	27.83*** (0.394)	13.26*** (1.709)	47.06*** (4.221)	46.59*** (4.394)	29.55*** (4.712)	24.80*** (4.704)	9.641* (5.055)
R-squared	0.1552	0.1864	0.2129	0.215	0.2418	0.254	0.2964
Time fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of countries	115	115	115	115	115	114	108
Total observations	2480	2470	2468	2460	2460	2417	2236

Country fixed effects and year dummies are included and robust standard errors are in parentheses. *** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

OECD: Organization for Economic Cooperation and Development; GDP: gross domestic product; NGO: Non-Governmental Organization.

Table 3. Afforestation rates and regime type during the 1990–2012 period, interactions with income level.

	(1)	(2)	(3)	(4)
	Afforestation	Afforestation	Afforestation	Afforestation
Democracy dummy (t-1) × per capita income (log) (t-1)	0.840*** (0.0992)	0.376*** (0.102)	0.756*** (0.100)	0.371*** (0.104)
Democracy dummy (t-1)	-6.913*** (0.735)	-4.038*** (0.743)	-6.166*** (0.742)	-3.856*** (0.758)
Per capita income (log) (t-1)	1.150*** (0.206)	0.529** (0.246)	1.562*** (0.213)	1.104*** (0.263)
Autocracy dummy (t-1)	1.130*** (0.158)	0.948*** (0.169)	0.849*** (0.161)	0.647*** (0.173)
Population (log) (t-1)		-4.013*** (0.391)		-1.816*** (0.435)
Trade/GDP (t-1)		-0.00274** (0.00111)		-0.00241** (0.00115)
NGOs (log) (t-1)		3.685*** (0.331)		4.004*** (0.347)
Mineral rents/GDP (t-1)		-0.0320* (0.0173)		-0.0150 (0.0178)
Rule of law (t-1)		0.132** (0.0533)		0.171*** (0.0573)
Constant	18.84*** (1.650)	34.40*** (4.513)	15.26*** (1.709)	9.255* (5.042)
R-squared	0.1409	0.2498	0.2058	0.3007
Sample of countries	Global	Global	Non-OECD	Non-OECD
Time fixed effects	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes
Number of countries	136	129	115	108
Total observations	2923	2689	2470	2236

Country fixed effects and year dummies are included and robust standard errors are in parentheses. *** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

GDP: gross domestic product; NGO: Non-Governmental Organization; OECD: Organization for Economic Cooperation and Development.

findings of Payne (1995) and raise questions about the universality of his treatise on why democracies are better at protecting the environment. In addition, Neumayer (2002) found that democracies sign more environmental commitments than autocracies. While this may be true, our results indicate that environmental commitment need not necessarily lead to positive environmental outcomes. Interestingly, we find that autocratic countries are associated with an increase in forest area coverage rate of 1.4%, which is also significantly different from zero at the 1% level. In other words, they tend to leave more of their forests untouched. In column 2, when income level as an additional control is included, the effect of democracy remains negative, while autocracy is positive, and is significantly different from zero at the 1% level. After controlling for the income levels, the point estimate suggests that a democratic country is associated with a 0.79% decrease in forest area coverage. Notice that the impact of income levels itself on forest area coverage is positive and significantly different from zero at the 1% level. The substantial effects suggest that a standard deviation

above mean in per capita income (log) is associated with a 2.5% increase in forest area coverage rate, which is 12% of the standard deviation of afforestation rate. In column 3 we add the population variable, which has a negative effect on forest coverage, which is statistically significant at the 1% level. Hardly a surprising result, as a bigger population puts more pressure on natural resources like forests. These results fall in line with the results of Cole and Neumayer (2004). Democracy's effect has actually increased after controlling for population and development, while autocracies have fallen slightly. The introduction of the trade openness variable in column 4 does little to change the results on the democracy variable. Our measure of democracy is still negative and statistically significant at the 1% level. The trade openness effect on afforestation itself is weak and insignificant by itself. Our results contradict the findings of Neumayer (2002), who finds that trade openness leads to better environmental protection.

Next, the presence of more NGOs is linked to greater forest coverage and we add this variable in column 5. Our results on the impact of NGOs on afforestation are in line with Fredriksson et al. (2005), whose evidence links the number of NGOs and stringency of environmental policies. A standard deviation above mean in number of NGOs (log) is associated with a 1.2% increase in forest area coverage rate, which is 6% of the standard deviation of afforestation rate. Notice that adding the NGOs variable into the model does not change the results on the impact of democracy. In column 6, we add the mineral rents variable. Having a greater ratio of minerals to GDP has a negative effect on forest coverage. A standard deviation above mean in mineral rents to GDP is associated with a 0.11% decrease in forest area coverage rate, which is significantly different from zero at the 10% level. This result is on expected lines as mining operations eat up a lot of forest land. Lastly, column 7 shows that having a better rule of law is associated with an increase in forest coverage area. A point increase in ICRG's rule of law index is associated with 0.13% increase in forest cover, which is significantly different from zero at the 5% level. Notice that the substantive effect of democracy, after controlling for all the potential factors, jumps to 1.33% decrease in forest coverage. The results on regime type remain robust to the inclusion of these controls.

In Table 2 we replicate the estimations reported in Table 1 with a restricted sample.

We exclude high-income OECD countries, which are all democratic countries and are equipped with well-developed and sophisticated institutional mechanisms to ensure protection from deforestation. These include: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK and USA. It is quite plausible that our results might be driven by these countries, which are democracies, and there exists no significant variation in democratic scores during our study period in this group of countries. As seen from Table 2, in line with our findings in Table 1, democracies are negatively associated with forest area coverage, while the opposite effects are found for autocracies. On average, democratic (autocratic) countries, excluding high income OECD countries, are associated with a 0.6% (1.25%) decrease (increase) in forest coverage, which is significantly different from zero at the 1% level (see column 1). As seen from column 2, these results are robust to including income variable. Also, note that the level of income is positive and statistically significant at the 1% level. A standard deviation above mean in per capita income (log) is associated with a 3.1% increase in forest area coverage rate, which is 14% of the standard deviation of afforestation rate of non-OECD nations. Thus, the net effect of democracy (net of income level) in developing countries on afforestation rate is negative. Finally, in columns 3–7, additional control variables do not change our results very much. Controlling for other plausible explanatory factors, democracy in developing countries is associated with a 1.19% decrease in the forest area cover (see column 7, Table 2), which is statistically significant at the 1% level. By and large, these results suggest that even among developing countries alone, the impact of democracy is actually negative. Notice that the results on control variables remain largely the same in Table 2. As our results for this restrictive

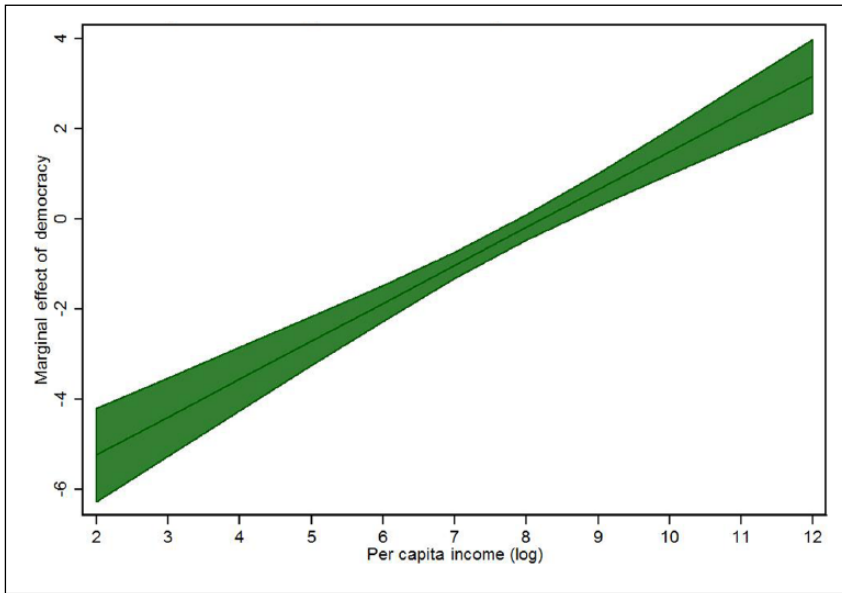


Figure 3. Democracy, level of income and marginal effect on afforestation.

sample group of developing countries are comparable to those with the full sample, we believe that our results are not driven by the inclusion of the high-income OECD countries in the sample, whose democratic polity is relatively high.

Conditional effects

Next, we examine whether the effect of democracy on afforestation rate is conditional on the level of per capita income.

We introduce interaction terms between democracy and per capita income level in Table 3. Note that columns 1 and 2 capture these interaction effects for global sample, while the result for the sample of developing countries alone is reported in columns 3 and 4. As seen from column 1, the conditional effect between democracy and level of per capita income (log) is positive on the afforestation rate, a result which supports the argument that the effect of democracy on environment protection is conditional upon the level of economic development of a country. Importantly, democracy on its own, in other words, when level of per capita income is set equal to zero, has a strong negative effect on afforestation rate. Also noteworthy is that level of per capita income on its own, that is, when the democracy variable is set equal to zero, has a strong positive effect on afforestation rate, both of which are significantly different from zero at the 1% level. Thus, without income, the effect of democracy on afforestation is bound to be negative.

It is important to note that the interpretation of the interaction term even in a linear model is not straightforward. Consequently, a simple *t*-test on the coefficient of the interaction term is not sufficient to see whether the interaction is statistically significant (Ai and Norton, 2003). We thus rely on the conditional plot as shown in Figure 3, which depicts the magnitude of the interaction effect.

To calculate the marginal effect of a country being a democracy, we take into account both the conditioning variable (democracy) and the interaction term, and show the total marginal effect conditional on level of per capita income graphically. The y-axis of Figure 3 displays the marginal

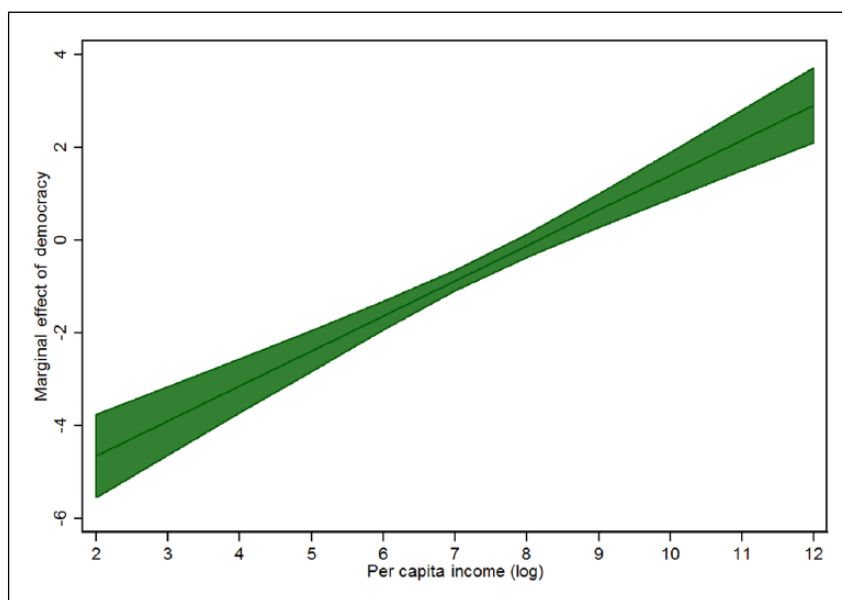


Figure 4. Democracy, level of income and marginal effect on afforestation (non-OECD sample).
OECD: Organization for Economic Cooperation and Development.

effect of democratic countries, and the x-axis the level of per capita income (logged) at which the marginal effect is evaluated. In addition, we include the 90% confidence interval in the figure. As seen there, and in line with the results shown in Table 3, democratic countries witness an increase in afforestation rate (at the 90% confidence level at least) if the level of per capita income (log) is greater than log eight, which is roughly US\$8200. For instance, a democratic country with a per capita income level of roughly US\$8200 witnesses about 0.65% increase in forest area coverage, which is significantly different from zero at the 1% level (see Figure 3). Likewise, if the per capita income level is at its maximum value (US\$71,354), the impact of democracy on forest area cover increases by 3.2%, which is significantly different from zero at the 1% level. Figure 3 also shows that there is a negative effect of democracy on afforestation rate when the level of per capita income is less than US\$8200. Thus, the marginal effects are significant albeit negative when the lower bound of the confidence interval is below zero. By and large, these results support hypothesis 2, which states that democracy's effect on forest coverage is conditional upon the level of development. Note that these effects are similar when estimating the interaction model after controlling for other control variables reported in column 2.

In columns 3 and 4 the results on the interaction between democracy and per capita income for the sample of developing countries alone are captured. As seen, the conditional effect between democracy and income level is positive on the afforestation, which is significantly different from zero at the 1% level. Once again, democratic countries on their own have a strong negative effect on afforestation, which is significantly different from zero at the 1% level, while the level of income, when democracy is set equal to zero, has a positive effect on afforestation rate which is statistically significant at the 1% level. Once again, we resort to a conditional plot to explain these results. Figure 4 displays the conditional effects. The y-axis of Figure 4 is the marginal effect of democratic countries, and the x-axis the performance criteria level of per capita income of developing countries at which the marginal effect is evaluated at the 90% confidence interval.

As seen there, democratic countries witness an increase in afforestation rate (at the 90% confidence level at least) if the level of per capita income is greater than US\$8200. For instance, a democratic developing country with a per capita income level of roughly US\$8200 witnesses about 0.63% increase in forest area coverage, which is significantly different from zero at the 1% level (see Figure 3). Likewise, if the per capita income level of developing countries is at its maximum value (US\$60,258), the impact of democracy on forest area cover increases by 2.9%, which is significantly different from zero at the 1% level. Figure 4 also shows that there is a negative effect of democracy on afforestation rate when the level of per capita income is less than US\$8200. Thus, the marginal effects are significant albeit negative when the lower bound of the confidence interval is below zero. These results once again lend support to hypothesis 2, even among developing countries, that the positive effects of democracy on afforestation are conditional upon the level of economic development. Once again, the effects are similar when estimating the interaction model after controlling for other variables reported in column 4.

Further checks on robustness

We examine the robustness of the main findings in the following ways. First, as additional tests for robustness, we replace the democracy and autocracy dummies with Polity IV index, which measures the regime type on a -10 to +10 scale, in which higher value denotes full democracy and vice-versa. Next, we replace the democracy measure which is based on Polity with the Freedom House measure of democracy. We include a new democracy variable which is measured by Freedom House's civil and political liberties average score on a scale of 1 (full liberties) to 7 (no liberties). The Freedom House computes civil liberties and political freedom indices each measured on a 1–7 scale. We take the average of both these indices to formulate one measure of democracy. For easy interpretation, we reverse code this measure wherein higher value (i.e. the score of 7) now denotes full liberties and vice-versa. When estimating our models with this new measure of democracy, our results basically remain robust for both the global sample and also the sample of developing countries alone. Note that the results on interaction term too remain positive and significantly different from zero at the conventional levels of statistical significance.

Second, we include additional explanatory variables, namely, *global conventions affecting deforestation* and *investment activities*, which might be influenced by regime type and could be a key determinant in explaining variation in afforestation rates in turn. To measure *global conventions affecting deforestation* we rely on three major such international conventions namely: (i) climate change convention initiated in 1992; (ii) convention on biological diversity initiated in 1992; (iii) desertification convention initiated in 1994. Following Neumayer (2002), we first dummy code for each of these conventions if country i has ratified each of these conventions and 0 otherwise. Then we sum the ratification count on all these conventions together for country i in year t . Neumayer (2002) finds in his study on 122 countries that democracies are more likely to sign and ratify international conventions related to environment protection. Thus, if democracies are more inclined to ratify these conventions it can possibly affect the afforestation rates in those countries. On *investment activities* we use World Bank's WDI (2014) measure on Gross Fixed Capital Formation as a share of GDP, which is a proxy for both domestic and foreign investment activities in country i in year t . Previous studies find that democratic regimes are more likely than autocracies to attract investments (see Jakobsen and de Soysa, 2006; Jensen, 2003, 2004, 2006; Li and Resnick, 2003). Thus, if democracies indeed attract more investments, then it can possibly affect the afforestation rates in democratic countries vis-à-vis in autocratic states. Including these measures into our afforestation models closes possible transmission channels of an impact of democracy via environmental conventions and investments. The results from these models show

that the coefficients on these two variables are not significant at conventional levels whereas the effect of democracy remains negative and significantly different from zero at the 1% level respectively. Note that these results are consistent in both global sample and a sample of developing countries. These results suggest that this effect of democracy does not depend on international treaty conventions on environment and investments.

Finally, we remove some suspicious cases where there was an upward reporting bias in favour of a sudden increase in forest area coverage by around 8% points or more during the 1990–2012 period. These include: Bulgaria, Cuba, Italy, Norway, Spain, Sweden and Vietnam. Re-estimating all our models (including the interactions) without these outliers does not change our results much on our main variables of interest, suggesting that the results are not driven by extreme values. The robustness check results are not shown here due to brevity but are available upon request. In summary, the results taken together seem robust to using alternative data, sample and testing procedure.

Conclusion

The theoretical and empirical literature on the impact of regime type on deforestation remains contentious. Some studies argue that democracy is better at protecting environmental degradation and thereby halting the process of deforestation. However, other studies show that democracy has no significant impact on protecting environment. Moreover, some argue that autocracy is better at protecting environment. In this paper, we argue that the divergent results in the literature could be due to neglecting the role of the level of economic development. Theoretically speaking, while democracies might have a positive effect on afforestation, these effects, we argue, are mitigated by the level of economic development. More precisely, we argue that those democracies which are at the lower end of economic development face pressure from the bottom (i.e. electorates) to generate job opportunities through industrialization, investments and economic growth, thus hampering forests. On the other hand, high-income, well developed democracies' focus is on sustainable economic development models in which environment protection is a key component. We empirically test these arguments by relying on the forest area coverage dataset compiled by the World Bank's WDI. Using panel data on 139 countries during the 1990–2012 period (23 years), we find that democracies are associated with lower levels of forest coverage. Further analyses reveal that the positive effect of democracy on forest area coverage is conditional upon the level of economic development. Our findings show that at per capita income of over US\$8200, the impact of democracy on forest coverage becomes positive. These results survive a wide variety of robustness checks including alternative data, sample and testing methods.

Our results highlight two key policy implications. First, our findings are in stark contrast to those who argue that democracy on its own can mitigate the problems associated with deforestation. Our results show that the positive effects of democracy are conditional upon the level of economic development. This suggests that a democratic government's priority to tackle environmental problems depends on its level of economic development. Second, these results could also throw light on the main reason as to why there is a lack of coordinated effort between developing and developed countries in addressing environmental issues. While the priority of poor countries is development at any cost to uplift large numbers of people from poverty through industrialization and increasing income levels, the focus of developed countries on the other hand is more on a balanced and sustainable form of economic development. Finally, our results imply that to reduce deforestation the sole emphasis need not be on democracy alone but also on economic development. Of course, this does not mean that poor democracies should be allowed to pollute freely in order to develop quickly. This 'pollute now, clean up later' strategy has some serious limitations. Rather, our results show that democratization is not in itself enough to solve the environmental

problems and that it cannot be viewed as unquestionably benign in a deterministic fashion, as argued by some in the literature. Indeed, economic development can be a part of the solution to the environmental issues, rather than just a cause of the problem.

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Notes

1. See Gore (1992): <http://www.routledge.com/books/details/9781844074846/>.
2. The EKC theory in environment is actually named after Kuznets (1955), who found that the relationship between income inequality and economic development is in an inverted U-shape. That is, the inequality first rises and then falls as economic development increases.
3. For a comprehensive overview on determinants of deforestation, see Kaimowitz and Angelsen (1998).
4. Similar such findings are echoed by Vadlamannati and de Soysa (2015), Vadlamannati and Cooray (2014) and Berliner (2014).
5. However, Gleditsch (2012) reviews a large body of literature linking environmental degradation and conflict and finds that most of the empirical results from previous studies on this subject vary and a firm conclusion cannot be drawn.
6. While some argue that democratic governments are more responsive in addressing environmental concerns which might lead to scarcity and conflict (Gleditsch and Sverdrup, 2003), it is also plausible to assume the opposite. Autocrats would like to avoid unnecessary conflicts which threaten the very existence of the regime and hence it could be argued that they would be more considerate towards environmental problems.
7. See Gleditsch (1997) for an excellent review on how economic prosperity leads to environmental protection and mitigates resource scarcity problems thereby avoiding serious conflict.
8. Though the Polity IV index has faced some criticism (see Potrafke, 2012), it captures three important elements of democracy, namely, presence of institutions, existence of effective constraints on executive and participation in political process, which are found to be key for economic openness (de Soysa and Vadlamannati, 2011).
9. Note that estimating the models directly with the Polity IV index does not alter our results much.
10. Moreover, there is no theoretical reasoning in our setup which warrants adding a lagged dependent variable.

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Appendix 1. Countries under study.

Albania	Colombia	Guatemala	Liberia	Panama	Tajikistan
Algeria	Congo	Guinea	Libya	Papua New Guinea	Tanzania
Angola	Congo, Democratic Republic	Guinea-Bissau	Lithuania	Paraguay	Thailand
Antigua	Costa Rica	Guyana	Macedonia	Peru	Togo
Argentina	Cote de Ivoire	Haiti	Madagascar	Philippines	Trinidad and Tobago
Armenia	Croatia	Honduras	Malawi	Poland	Tunisia
Australia	Cuba	Hungary	Malaysia	Portugal	Turkey
Austria	Cyprus	India	Mali	Qatar	Uganda
Azerbaijan	Czech Republic	Indonesia	Mexico	Romania	Ukraine
Bahrain	Denmark	Iran	Moldova	Russia	United Arab Emirates
Bangladesh	Dominican Republic	Iraq	Mongolia	Saudi Arabia	United Kingdom
Belarus	Ecuador	Ireland	Morocco	Senegal	USA
Belgium	Egypt	Israel	Mozambique	Sierra Leone	Uruguay
Belize	El Salvador	Italy	Myanmar	Singapore	Uzbekistan
Bolivia	Estonia	Jamaica	Namibia	Slovakia	Venezuela
Botswana	Ethiopia	Japan	Nepal	Slovenia	Vietnam
Brazil	Finland	Jordan	Netherlands	South Africa	Yemen
Brunei	France	Kazakhstan	New Zealand	Spain	Zambia
Bulgaria	Gabon	Kenya	Nicaragua	Sri Lanka	Zimbabwe
Burkina Faso	Gambia	Korea, Republic	Niger	Sudan	
Cameroon	Georgia	Kuwait	Nigeria	Suriname	
Canada	Germany	Kyrgyzstan	Norway	Sweden	
Chile	Ghana	Latvia	Oman	Switzerland	
China	Greece	Lebanon	Pakistan	Syria	

Appendix 2. Descriptive statistics.

Variables	Mean	Standard deviation	Minimum	Maximum	Observations
Share of forest coverage area	30.580	22.320	0.000	94.720	3165
Democracy dummy	0.490	0.500	0.000	1.000	3079
Autocracy dummy	0.170	0.380	0.000	1.000	3079
Per capita income (log)	7.990	1.680	3.300	11.170	3168
Population (log)	9.320	1.580	4.120	14.130	3162
Trade/GDP	76.000	99.280	5.000	1349.620	3152
NGOs (log)	6.620	0.920	0.000	8.500	3177
Mineral rents/GDP	1.080	3.280	0.000	35.340	3149
Rule of law	3.750	1.400	0.000	6.000	2917

Appendix 3. Data definition and sources.

Variables	Data definition and sources
Forest coverage	Percentage of total land area covered by forests. Data sourced from the WDI (2015), World Bank.
Democracy dummy	Based on Polity IV index (−10 to +10) takes the value 1 if the Polity IV index is +5 and above and 0 otherwise.
Autocracy dummy	Based on Polity IV index (−10 to +10) takes the value 1 if the Polity IV index is −5 and below and 0 otherwise.
Per capita GDP (log)	GDP per head in 2000 US dollars constant prices sourced from UNCTAD statistics (2015).
Population (log)	Total population in each country (logged), sourced from UNCTAD statistics (2015).
Trade openness	Sum of total exports and imports divided by GDP, sourced from UNCTAD statistics (2015).
NGOs (log)	Count of total number of NGOs present in each country during that year (logged). The data on NGOs is sourced from the <i>Yearbook of the Union of International Associations</i> .
Mineral rents/GDP	Rents defined as the unit price minus the cost of production multiplied by the quantity produced from various minerals and is divided by GDP. Sourced from WDI 2015, World Bank.
Rule of law	ICRG law and order index coded on the scale of 0–6 in which higher value denotes effective law and order situation.