

The Effects of Liberalism on the Terrestrial Environment

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In recent decades, many countries have adopted, to various degrees, the ideologies of commercial and republican liberalism. One salient aspect of the spread of commercial liberalism in the world has been the growth in international trade. The spread of republican liberalism has manifested itself by the rise in the level of democracy in countries over time. What are the implications of trade and democracy for the terrestrial environment? Two bodies of literature are relevant to this question: one studies the effect of trade on the environment, while a second body focuses on the effect of democracy on the environment. The effects of both forces on the environment are debated theoretically and empirically. The two bodies of literature have generally developed separately, and the effects of trade and democracy have not been evaluated in the same model. This paper discusses the theoretical effects of trade and democracy on the environment, and develops a statistical model to study these effects on the terrestrial environment in the areas of deforestation and land degradation. The results indicate that a rise in trade openness reduces deforestation in autocracy and increases deforestation in democracy, and the effect is similar for the less developed countries (LDCs) and the developed countries (DCs). A rise in trade openness reduces land degradation, but the effect is not robust and does not depend on regime type. A rise in democracy increases deforestation and reduces land degradation, but these effects are weaker in LDCs than in DCs. In addition, the effect of democracy on deforestation is stronger when trade openness is high. The effect of democracy on land degradation does not depend on trade openness. The paper concludes with an examination of the implications of these results for public policy.

Keywords liberalism, democracy, trade, deforestation, land degradation

Introduction

A large body of literature in the social sciences studies the effects of the ideology of liberalism on various aspects of human life. This literature can be categorized in two main categories: republican liberalism and commercial liberalism. In broad terms, the body of

literature on republican liberalism focuses on the effect of democracy on international relations, income distribution, and economic performance. The body of literature on commercial liberalism emphasizes the virtues of capitalist free markets in promoting economic prosperity, egalitarianism, and international and intranational peace.

This paper studies the effects of commercial and republican liberalism on the terrestrial environment. Specifically, we focus on the effects of national democracy and international trade on land degradation and the rate of deforestation within countries. These two environmental attributes are very important for life on Earth: land quality is a crucial force in the ability of land to produce food for people and animals, while deforestation plays a major role in the mechanisms that influence climate change and the decline in air quality in general.¹

The effects of trade and democracy on environmental degradation are studied in two separate bodies of literature: the trade-environment literature, and the democracy-environment literature. Both these bodies of literature contain competing theoretical expectations. In one view, international trade is good for the environment. In another, trade can harm the environment. Similarly, in one view, a rise in democracy reduces the level of environmental degradation in a country. In a second view, a rise in democracy may not reduce the level of environmental degradation in a country and may even lead to further degradation.²

So far, these two bodies of literature have remained largely on separate courses. We argue that the effects of international trade and national democracy on environmental degradation need to be studied together. While both forces are said to affect the environment, scholars also find that international trade flows and democracy affect each other.³ Empirical studies that exclude either trade or democracy as a right-hand-side variable in models of environmental degradation can incorrectly attribute the effect of one force to the other.

Existing empirical evidence on the effect of international trade on environmental degradation is mixed. Some studies find that trade improves the environment in some areas, whereas other studies find that trade degrades the environment in the same or other areas, or has no effect on the environment at all. Research on the effect of democracy on environmental degradation also has produced conflicting arguments and mixed findings. But relatively little has been done in the democracy-environment literature to sort out the complex relationships using large-N statistical analysis.⁴

We seek to contribute to the bodies of literature on the effects of trade and democracy on environmental degradation in a country. After discussing the theoretical expectations in the two bodies of literature on the effect of each of our two variables on the environment, we test the effects of trade and democracy on the terrestrial environment statistically, across a large number of countries. We focus on two important aspects of the terrestrial environment: the rate of deforestation and the level of land degradation.

Summarizing our key results, a rise in trade openness reduces deforestation in autocracy and increases deforestation in democracy, and the effect is similar for the less developed countries (LDCs) and the developed countries (DCs). A rise in trade openness reduces land degradation, but the effect is not robust and does not depend on regime type. A rise

¹For a review on the various strands of liberalism, see Zacher and Matthew (1995). Other categories of liberalism, which are not directly studied here, stress the importance of international institutions, epistemic communities, the ideology of social contacts between people, countries, and cultures in promoting economic prosperity, and international and intranational peace.

²Theoretical channels through which these two forces are said to operate and affect the environment are discussed in the next section.

³For example, Gasiorowski (1995) and Li and Reuveny (2003) find that trade affects the level of democracy in a country, whereas Dixon and Moon (1993) and Bliss and Russett (1998) find that joint democracy increases bilateral trade flows, an issue to which we will return.

⁴Citations of are provided in the next two sections.

in democracy increases deforestation and reduces land degradation, but these effects are weaker in the LDCs than in the DCs. In addition, the effect of democracy on deforestation is stronger when trade openness is high. The effect of democracy on land degradation does not depend on trade openness.

The remainder of this paper proceeds as follows. Section 2 discusses theories on the effects of international trade and democracy on environmental degradation, and theories on the effects of democracy and trade on each other. Section 3 discusses empirical studies pertaining to the theories discussed in Section 2. Section 4 presents our empirical research design, and describes the data and indicators to be used in the empirical analysis. Section 5 presents the results from the statistical analysis. Section 6 concludes the paper, discusses its implications for formulating public policies that aim to reduce terrestrial environmental degradation, and suggests directions for future research.

Theoretical Literature

Four types of theoretical arguments are important for our purpose: (1) The effect of commercial liberalism on the environment; (2) The effect of republican liberalism on the environment; (3) the Environmental Kuznets Curve hypothesis; and (4) The trade-democracy nexus. Our primary interest lies with the first and second arguments. The third and the fourth arguments will assist us in putting together our empirical model, but studying them in and of themselves is not our main goal. Furthermore, as we shall see, trade and democracy are said to affect the environment through several channels that operate in parallel. We do not seek to investigate the relative importance of these channels, but rather to study their net effect that results from their combined operation.

Commercial Liberalism and the Environment

There are two types of broadly defined theoretical channels through which commercial liberalism or international trade is expected to affect the level of environmental degradation. One channel works directly by influencing microlevel economic activities that affect the environment, regardless of whether the economy is growing. A second channel works indirectly, through the positive effect of international trade on the rate of economic growth of a country. Economic growth, or rising income per capita, in turn, is expected to affect the environment.⁵ The positive effect of international trade on the rate of economic growth is established in many studies and will be taken here as a given.⁶

The direct effects of international trade on the environment can promote or reduce environmental degradation. These effects are brought about by trade changing the profitability of producing some products, as with trade it is also possible to purchase them abroad. The *structural effect* of trade on the environment involves changes in patterns of domestic production, consumption, and investment due to trade, as well as changes in location of agricultural activities. The structural effect of trade can involve, for example, reducing production of chemical-intensive crops, which promotes environmental quality. This effect, however, also could promote activities such as increased drainage of wetlands in order to satisfy demands for greater production for a larger international market, hurting the environment.

⁵For reviews of the literature on the effect of trade on the environment see, e.g., the discussions in OECD (1994), Panayoto (2000b), Harris (2002), and Pugel (2003). Our discussion builds on and synthesizes these sources.

⁶For recent reviews of the body of literature on international trade and economic growth, see Pugel (2003) and Salvatore (2004).

The *composition effect* of trade can damage the environment by changing the composition of the goods produced at home, as countries follow their comparative advantages when they open their economies for international trade competition. For example, consider a country that produces a labor-intensive good that does not affect the environment and a timber-intensive good by harvesting forests. According to neoclassical trade theory, if the country is timber abundant, or is highly forested, for example, it will have comparative advantage in the timber-intensive good. Therefore, international trade in our example will increase the production of the timber good and promote deforestation, which degrades the environment. If the country is labor abundant, on the other hand, international trade will increase production of the labor-intensive good, and reduce the production of the timber goods, which will reduce deforestation.

The *technology effect* of trade can reduce environmental degradation by shifting domestic production to methods that are environmentally less damaging due to requirements brought about by international trade, such as rising foreign demand for goods produced using farming methods that require the use of fewer fertilizers. By promoting contacts and technological diffusion, trade also could spread new, environmentally cleaner technologies and innovations, which can improve the environment. However, trade could also spread the use of "dirtier technologies," whose use damages the environment. Such technologies could be cheaper to employ and make exporters more competitive in international markets, while remaining within the bounds of existing domestic environmental laws. This will result in a fall in environmental quality.

The *regulatory effect* of trade is expected to promote pro-environment government policies. Some trade agreements require countries to limit environmental damage. Trade openness also may lead to more stringent environmental regulation across the board, if an influential country that sets the pace for others is pro-environment. The approach of this country could influence other countries which seek to sell their products in that nation. Yet this effect also may work in the opposite direction; the influential country may be anti-environment in some areas. In addition, parochial trade interests may push for a relaxation of existing regulation in order to raise competitiveness and shift to cheaper production methods that may damage the environment. Since many nations may follow this course of action, the result could be a race to the bottom, increasing damage to the environment.

The existing multilateral trade accords are virtually all sector-specific. The Convention on International Trade on Endangered Species (CITES), for example, has regulated trade in endangered species since 1973. The Montreal Protocol on Substances that Deplete the Ozone has regulated and phased-out production and trade of most chlorofluorocarbons.⁷ Wider setups are either bilateral or regional. Regional and bilateral trade agreements (e.g., the European Union, Australia-New Zealand Closer Economic Relationship, North American Free Trade Agreement) have required members to harmonize environmental standards and regulate environmental damage due to trade-related activities.⁸ Environmental activists have tried to bring their concerns into the World Trade Organization (WTO), but so far have failed. The United Nations Environmental Program (UNEP), which is currently the only truly, across-the-board multilateral environmental organization, has so far not focused on trade.⁹

⁷On CITES and the UNEP, see, e.g., Frankel (2003). On the Montreal Protocol, see Brack (1996) and Parson (2002).

⁸See, e.g., Hufbauer et al. (2000), Crutsinger (2001), Frankel (2003).

⁹See Harris (2002). On WTO, see also Bhagwati (2000) and Charnovitz (2002, 2001).

Republican Liberalism and the Environment

Studies have debated the effect of republican liberalism, or democracy, on the environment.¹⁰ Beginning with the view that democracy may not reduce environmental degradation, *the market argument* is offered by Dryzek (1987). Observing that democracies also are market economies, he notes that business interests in market economies have considerable clout. "Environmental groups have a hard time getting a foot in the door" (Dryzek, 1987: 121) in many market economies, as their particular democracy tends to be skewed in the direction of business. "Polyarchy will normally yield to the imperatives of the market, if not always to the interests of large corporations. . . . At their corporatist worst, polyarchies degenerate into caricatures of the ideal, with some dire consequences for ecological rationality" (Dryzek, 1987: 125). Since business circles normally seek to maximize profits, not environmental quality, democratic governments in market economies may not pursue environmental quality as a goal.

According to the *policy inaction argument*, facing environmental degradation, democracy can often exhibit policy inaction for several reasons (Midlarsky, 1998: 159). First, democracy seeks to please competing interest groups. As such, it may be reluctant to alleviate environmental degradation because some groups are expected to benefit (or lose) from environmental policies more than others. Second, "corporation and environmental groups can fight each other to a standstill, leaving a decision making vacuum instead of a direct impact of democracy on the environment." Third, when budgets are tight democracies may ignore environmental problems, perceiving economic issues to be more pressing.

The global-commons thesis notes that, while the characters of the economy and the environment are global, "democracy functions on only national and local decision levels" (Paehlke, 1996: 28). It follows that national democracy may not be able to alleviate global environmental problems. Hardin (1968) warns that global environmental resources such as clean air, oceans, and forests, which are often referred to as the commons, typically do not have well-developed property rights. In such situations, free actors that seek to maximize their own interest often tend to ignore the damage that their actions inflict on the environment. The link of this argument to democracy is provided by Gleditsch and Sverdlap (2003). Hardin's logic, they argue, implies that political and economic freedoms may not benefit the environment. Using Hardin's (1968: 1244) words, "freedom in the commons brings ruin to all."

The *fertility-choice* channel comes from Heilbrunner (1974). Population growth is expected to promote environmental degradation since it raises pressures on renewable and nonrenewable resources and the absorptive capacities of the environment. Democracies respect free individual choice, including the choice to procreate without imposed limits on the number of children. In contrast, autocracies can and do at times curtail the rate of population growth by decree (e.g., the one-child policy of China). It follows that democracy may indirectly promote environmental degradation by enabling a higher global population growth rate.

Moving to the view that democracy reduces the level of environmental degradation, one set of considerations focuses on the institutional qualities of democracy. The *responsiveness argument* is that democracies are more responsive to the environmental needs of the public than are autocracies due to their very nature of taking public interests into account (Kotov and Nikitina, 1995). It is also argued that democracies comply with environmental agreements well, since they respect, and respond to, the rule of law (Weiss and Jacobsen, 1999). *The freedom of information channel* is offered by Schultz and Crockett (1990) and Payne (1995). They theorize that political rights and greater freedom for information flows

¹⁰For reviews, see, e.g., Midlarsky (1998), and Gleditsch and Sverdlap (2003).

help to promote the cause of environmental groups, raise public awareness of problems and potential solutions, and encourage environmental legislation to curtail environmental degradation. Democracies also tend to have market economies, which further promotes the flow of information as economic efficiency and profits requires full information. Hence, unlike the above argument, this channel expects that profit-maximizing markets will promote environmental quality (Berger, 1994).

A second set of considerations on the positive role of democracy on environmental quality focuses on the effects of democracy on human life and crisis situations. *The famines argument* (Sen, 1994) observes that famines tend to promote environmental degradation because they divert attention away from longer-term environmental concerns. Since famines typically do not occur in democracies, argues Sen, environmental quality is expected to be higher in democracies than in autocracies. *The human life argument* (Gleditsch & Sverdløp, 2003) suggests that since democracies respect human life more than autocracies, they are more responsive to life-threatening environmental degradation. A related argument, *the war channel*, reasons that to the extent that democracies engage in fewer wars, they should also have a higher level of environmental quality (Gleditsch & Sverdløp, 2003), since war often destroys the environment of the warring parties (Lietzmann & Vest, 1999).

Auxiliary Theories: The Environmental Kuznets Curve, and Trade and Democracy

This subsection discusses two relevant auxiliary theories. The Environmental Kuznets Curve Theory investigates the effect of economic growth on environmental degradation. A second theory focuses on the trade-democracy nexus.

The Environmental Kuznets Curve (EKC) Theory

This theory argues that trade may affect the environment through the effect it has on economic growth. The argument that trade is the engine of growth can be traced to British economists Adam Smith and David Ricardo. Since then, it became one of the hallmarks of economics. But what is the effect of growth on the environment?

The *economic growth effect* of trade on the environment falls under the title of the EKC theory. Trade promotes growth, which, in turn, affects environmental degradation. The theory argues that up to some threshold of income per capita, environmental damage rises as the economy grows in scale. As income per capita grows above this level, the damage is expected to decline. The plot of environmental degradation as a function of income per capita is denoted as EKC, taking the shape of an inverted U. The name EKC is given by analogy with the original Kuznets curve, which plots income inequality as a function of income per capita and also takes the shape of an inverted U.¹¹

What drives the U shape of the EKC? The EKC theory discusses two forces: the *scale effect* and the *income effect*. Beginning with the *scale effect*, as the economy grows, it produces and consumes more goods and services. With the current energy sources, technologies and methods of production, and means of transportation, higher levels of production and consumption generate more pollution and waste. The effect of the growth of production and consumption on the environment is referred to as the *scale effect of economic growth*, the impact of which on environmental degradation is expected to be positive.

However, as income per capita rises, human preferences are expected to shift toward consuming goods that generate less environmental damage in consumption, as well as goods whose production techniques generate less environmental damage. This gives rise to the

¹¹For recent reviews and discussions of the principles of the EKC see, e.g., Panayoto (2000a) and Dinda (2004).

income effect of economic growth. Richer people, with a higher income per capita, also are said to be more willing to pay for cleaner goods, which are produced using cleaner technologies of production and generate lower levels of pollution. They are also said to be more willing to pay for and cover the consequences of more environmental protection. Moreover, they also are more able to afford these additional costs. The sign of the *income effect* of economic growth therefore is expected to be negative.

Putting the two effects together, the EKC argument hypothesizes that as income per capita rises above some threshold—the level of which is not known based on theoretical reasoning, but can be estimated empirically—the income effect of economic growth comes to dominate the scale effect of growth, generating the inverted U shape of the EKC

Trade and Democracy

We investigate the effect of commercial and republican liberalism on environmental degradation, but trade and democracy are expected to affect each other. Political scientists acknowledge that trade is determined by economic forces, but argue that political forces also can be important. Scholars have long been aware that trade can be used at times as a tool of foreign policy and instrument of power (see, e.g. Hirschman, 1980; Hufbauer, 2005). Stating this argument succinctly, Diaz-Alejandro (1975; 214) writes: “which markets are allowed to operate and how, which are encouraged and which are repressed—these are political decisions, both nationally and internationally.”

If trade can be used as a tool of power, who will trade with whom? Grieco (1988), Gowa (1994), and Gowa and Mansfield (1993), among others, expect that states will avoid trade with states they consider to be their actual or potential adversaries. In such situations, the concern for relative gains—who gains more from trade—may reduce trade flows to trickles, as the side that gains less will worry that the side that gains more may translate the gain to military power. During the Cold War, for example, the U.S. regulated its trade with the Soviet bloc based on this logic. Since democracies are expected not to engage in wars against each other, they feel more secure in their bilateral trade and may be content with trade regardless of who gains more. Democracy, then, should promote trade (e.g., Russett & Oneal, 2001; Morrow, 1997; Snidal, 1991). Moreover, since democracy is associated with the rule of law and respect for property rights, agents will feel more secure to trade as the level of democracy rises, as it is more likely they will be able to enjoy the fruits of their investments (e.g., Olson, 1993; Clauge et al., 1996).

At the same time, the literature in comparative politics has argued that international trade openness of a country itself can affect the level of democracy of that country. This is the essence of several theories discussed in Li and Reuveny (2003). This study paints a picture of controversy. On one side, some observers expect that a rise in international trade will promote democracy in a country since, for example, trade leads to gains, economic growth, and technological diffusion. Prospering business people, in turn, are more educated. They push for democracy, which serves them best with its transparency and preference for the rule of law and stable property rights. On the other side, scholars expect that a rise in international trade will have a negative effect on democracy by creating winners and losers in a country, intensifying income inequality, weakening the state's ability to govern autonomously facing external economic forces, and pushing the local governments to serve the interests of international traders, instead of those of their own people.¹²

¹²Li and Reuveny (2003) cite many sources supporting each view. See also Held et al. (1999), Diamond (1999), Martin and Schuman (1997), Im (1996), Schmitter (1996), and Bhagwati (1994).

TABLE 1 Summary of causal mechanisms

Channel	Expected Effect on Environmental Quality
A: Commercial Liberalism	
Structural	Positive or Negative
Composition	Positive or Negative
Technology	Positive or Negative
Regulatory	Positive or Negative
B: Republic Liberalism	
Market	Negative
Policy Inaction	Negative
Global Commons	Negative
Fertility choice	Negative
Responsiveness	Positive
Freedom of Information	Positive
Famines	Positive
Human Life	Positive
War	Positive
C: Environmental Kuznets Curve	
Scale	Negative
Income	Positive

Summary of Forces Affecting the Environment

We discussed a number of trade and democracy-related forces affecting the environment. The causal mechanisms through which these forces are expected to work are complex. Table 1 lists these causal mechanisms, and denotes the signs of their expected effects on the environment. Panel A in Table 1 is devoted to commercial liberalism, panel B to republican liberalism, and Panel C to the EKC. In each case, a negative sign of an expected effect implies less environmental quality, or increasing degradation, while a positive sign implies increasing quality, or reducing degradation.

Empirical Literature

The previous section discussed four groups of theoretical arguments. These arguments received various degrees of empirical attention in the literature. Beginning with commercial liberalism, the number of statistical studies that investigate the effect of trade on environmental degradation in a large sample is relatively small. Lucas and colleagues (1992) studied the toxic intensity of output produced in 80 countries between 1960 and 1988. They concluded that the growth rate of this toxic intensity is lower for economies that are open and grow rapidly, relative to comparatively closed economies. Grossman and Krueger (1993) employed city data from 1977, 1982, and 1988 for emissions of sulfur dioxide, SO₂, (for 42 countries), fine smoke (for 19 countries), and suspended particulate matter, SPM, (for 29 countries). They found that trade openness (measured as ratio of export plus import to gross domestic product, GDP) reduces SO₂ emissions. The effect of trade openness on smoke and SPM is not significant.

Suri and Chapman (1998) studied the effect of the ratio of import over GDP on energy consumption per capita (used as a proxy for air pollution) for 33 industrialized countries between 1971 and 1990. They reported that the effect is negative. Antweiler and colleagues (2001) employed city data of SO₂ for 40 nations in the 1970s and 1980s. They found that trade liberalization reduces SO₂, but that the effect is small. Barbier (2001) studied the effect of trade on agricultural land expansion for tropical countries from 1961 to 1994. He found that agricultural export promotes agricultural land expansion, concluding that trade intensifies pressure on the environment. Dean (2002) employed data on Chinese water pollution from 1987 to 1995. She found that trade liberalization, which is measured from reductions in black market premiums, promotes water pollution. The mixed results and relatively small number of studies suggest, as summarized by Panayoto (2000a), that there is room for more empirical analysis of the effect of trade on environmental degradation.

Moving to studies on democracy and the environment, the number of statistical tests also is relatively small, and the statistical results reported have been mixed. Congleton (1992) reported that a rise in democracy increases the levels of methane and chlorofluorocarbon emissions per capita. Midlarsky (1998) reported that a rise in democracy increases Carbon dioxide (CO₂) emissions per capita, soil erosion by water, and the rate of deforestation, and reduces biodiversity. Scruggs (1998) concluded that democracy does not affect particulate emissions and water pollution, while Torras and Boyce (1998) investigated the effect on SO₂, smoke, particulate emissions, and water pollution, and found mixed results. Barrett and Graddy (2000) found that a rise in democracy lowers the levels of per capita SO₂ and particulate emissions, and does not affect water pollution. Gleditsch and Sverdløp (2003) found that a rise in democracy reduces the level of CO₂ emission per capita. Li and Reuveny (2006) found that democracy reduces CO₂ and NO_x emissions per capita, land degradation, and water pollution, and raises deforestation.

The body of empirical literature investigating the presence of the EKC is considerably larger than the bodies of literature on the effects of trade and democracy on the environment. Since the seminal study of Grossman and Krueger (1993), many studies have attempted to verify the presence of the EKC. For recent extensive reviews of these studies, see Panayoto (2000b) and Dinda (2004). The empirical studies use data from various sources for national cross-sections, panel data, and pooled data, depending largely on the availability of data. Most studies focus on air pollution (particularly SO₂, but also carbon monoxide and dioxide, nitrous oxides, and suspended particle matters). Some studies investigate water quality (organic and nonorganic pollution), a few studies investigate deforestation and, as far as we can see, virtually no study investigates land degradation. In general, some studies find that EKCs exist for local air pollutants, primarily SO₂, and considerably less so for water quality and other types of air pollution. Global direct indicators such as carbon dioxide and municipal waste, and indirect indicators such as traffic volume and energy consumption, generally do not exhibit an inverted U. EKC results for deforestation are mixed and debated (e.g., Bhattarai & Hamming, 2001; Bulte & van Soest, 2001). Finally, EKC studies typically do not include trade or democracy on the right-hand side. When they do, they do not include both trade and democracy, despite empirical evidence showing that the two forces affect each other, to which we turn next.¹³

Several studies have found that democracy promotes trade. Morrow et al. (1998) found that democracy promotes trade among great powers, and Remmer (1998) found that in South America, democracies signed more trade agreements with each other. Dixon and Moon (1993) reported that the U.S. exports more to democracies than to nondemocracies,

¹³For other reviews and assessments of the empirical literature on EKC, see Stern (1998), Harris (2002), Harbaugh et al. (2002), and Pugel (2003).

while Bliss and Russett (1998) and Russett and Oneal (2001) found that this result holds for a larger sample. Turning to the other causal direction, treating trade as a control variable Gasiowrowksi (1995) found that trade openness does not promote democratization. Focusing on trade as one of the independent variables, Li and Reuveny (2003) found that the effect of trade openness on the level of democracy in a country is negative. Taken together, these studies suggest that trade and democracy affect each other, and we should therefore include both in our empirical models.

Empirical Research Design

This section presents our empirical research design. We seek to investigate the effect of commercial and republican liberalism—trade and democracy—on land degradation and deforestation, both of which are important environmental forces. Land degradation affects the ability of land to provide food, reducing its productivity. Facing growing populations, food security already is a problem in parts of the developing world. The Intergovernmental Panel on Climate Change Deforestation identifies deforestation as one of the key drivers of global warming. Forests are among the key absorbers of carbon emissions, the accumulation and trapping of which in the atmosphere is the most significant cause of global warming.

The theoretical arguments discussed suggest that liberalism affects environmental degradation through multiple channels. In this paper, our goal is not to study the relative importance of these channels, but rather to measure their overall or net effect on the terrestrial environment. This is important for four reasons: (1) From a long-term perspective, the net effect counts, i.e. are democracy and trade good or bad overall for the environment? (2) Extant studies do not include both democracy and trade in the model, which we will do here. (3) The effect of liberalism on deforestation is debated based on a relatively small number of studies. (4) As far as we can see, the effect of liberalism on land degradation has not been studied so far.

We argue that the effects of democracy and trade on the environment need to be studied together, as they both influence the environment and each other. Economically open democracies may differ qualitatively from economically open autocracies in their approach to environmental degradation. For example, in democratic trading states, leaders are held accountable to the electorate and their trade-related environmental concerns. In autocracies, the ruling elite of an open economy may be less responsive to trade-related environmental concerns that affect the public.

The first dependent variable, deforestation, is measured in terms of permanent man-made conversion of natural forests into other uses, such as building settlements, mining, ranching, or agriculture. Forest areas that are logged with the intent of regeneration of trees and forest areas degraded by people gathering wood for fuel, by acid rain, and by forest fires are not included in the measure. Data on average annual deforestation rates are available for the decade 1980 to 1990 from World Resources (1999) and for the decade 1990 to 2000 from State of the World Forest (2001). Our dataset combines these two sources. A positive value of the deforestation variable indicates a rise in forest area over time (afforestation), and a negative value implies a fall in forest area over time (deforestation).

Data on land degradation come from the Food and Agriculture Organization (FAO) of the United Nations (FAO, 2002), which provides the only currently available uniform global source of data on land degradation across nations (FAO, 2000). The data measure land degradation in the late 1980s, from the following sources: (1) water erosion, which degrades land by causing loss of topsoil, terrain deformation, and reservoir sedimentation; (2) wind erosion, which causes loss of topsoil, terrain deforming, and over-blowing; (3) chemical deterioration, which degrades land by causing loss of nutrients, salinization, and acidification;

and (4) physical deterioration, which degrades land by causing compaction, crusting, and lowered water table.

The data are reported as shares of degraded land out of total land. There are five degrees of degradation: (1) not degraded; (2) lightly degraded, with reduced agricultural suitability; (3) moderately degraded, with greatly reduced productivity; (4) severely degraded, where the land is largely destroyed, and is unreclaimable at farm level; and (5) very severely degraded—the land has fully destroyed biotic functions, and is therefore unreclaimable for agricultural activity. In this analysis, we focus on the severely and very severely degraded land. The dependent variable for land degradation is the logged share of severely and very severely degraded land.

Next we discuss our empirical measures of the two aspects of liberalism: commercial (or trade) and republican (or democracy). We define a country as a democracy if the widely used composite indicator of regime type from POLITY IV (Marshall & Jaggers, 2000), computed as the difference between the 10-point democracy index (DEMOC) and the 10-point autocracy index (AUTOC), is greater than or equal to 6 (see, e.g., Dixon, 1994; Neumayer 2002). The democracy variable to be used in the statistical model is coded as 1 if a country is democratic, and is coded as 0 otherwise. We measure the effect of trade on the environment by the sum of the values of export and import of a country divided by the country's GDP, which measures the importance of trade in the national economy. Data are from the Penn World Table 6.1 (Heston et al., 2002). We also construct an interactive term between democracy and openness to test their conditional effect on the dependent variables. We center the trade variable for ease of interpretation.

The levels of these terrestrial environmental indicators are not only determined by democracy or trade. The literature on environmental degradation indicates the need to use control variables in our empirical models. First, we control for the indirect effect of trade on the environment through its effect on income per capita and the EKC hypothesis. To that effect, we include, on the right-hand side, the GDP per capita of a country, and the square of the GDP per capita. If the EKC holds, the coefficient of GDP per capita should be positive, and the coefficient of GDP per capita squared should be negative. Data on real GDP per capita expressed in purchasing power parity (PPP) adjusted, constant 1996 international dollars come from Penn World Table 6.1 (Heston et al., 2002).

It is generally argued that the size of population affects environmental degradation. To capture this effect we use population density (total population divided by land area). Previous studies (see Panayoto, 2000b, for examples) have shown that population density generally increases the level of environmental degradation. These data come from the World Development Indicators (2002).

Terrestrial environmental degradation may vary across continents. A country in Africa, for example, may be exposed to conditions different from those in America, and may exhibit different rates of development and urbanization (although this variation is controlled for by GDP per capita). To control for regional variations, we will include regional dummy variables in the model, set to 1 when a country is in Asia, South America, North Africa and Middle East, rest of Africa, Europe, and Oceania, respectively, with North America being the reference category. It is worth noting that these dummies are not theoretical, and often tend to absorb much of the variations in the dependent variable that can be otherwise attributed to substantive variables. Hence, results from models including these dummies need to be interpreted with caution.

Another design issue we need to consider is the risk for heteroscedasticity, which may exist in our cross-sectional analysis.¹⁴ With heteroscedasticity in the error term, the

¹⁴Serial correlation is not a concern in our case, as we do not have time series data.

estimated coefficients are consistent, but their standard errors are inefficient and biased. To defend against the risk for heteroscedasticity, we will estimate Huber-White robust standard errors, which are consistent in the presence of heteroscedasticity (White, 1980).

Finally, there is the issue of the sample of countries to be used in the empirical analysis. For almost all of the DCs, the level of democracy has reached the highest value in the polity data score during the years for which we have environmental terrestrial data. In the developing countries, in contrast, the level of democracy is considerably lower than in the DCs, and the level of democracy itself is less stable and more prone to reversals. Stylized observation also suggests that the developing countries in general tend to be relatively less open to international trade than the DCs. At the same time, the Kuznets hypothesis, as well as stylized facts, lead us to expect that the developing countries will have a weaker institutional and regulatory framework to monitor the status of the terrestrial environment and promote its preservation. All these considerations lead us to conduct our analysis in two empirical samples, one for all the DCs, and one for the developing countries alone. We identify DCs as such if they are members in the Organization for Economic Cooperation and Development (OECD). Non-OECD members are taken to be developing countries.

Empirical Results

For the statistical analysis of the effect of trade and democracy on deforestation, the sample covers 134 countries for which data were available. For each country, there are two average annual deforestation rates: one for the 1980–1990 decade, and the other for the decade 1990 to 2000. Accordingly, all of the right-hand-side variables take on their respective decade-average values.

The results are presented in Table 2. We estimate eight models using ordinary least squares (OLS). Going from left to right in Table 2, the first four models are for a sample that includes all the countries. The next four models are for a sample that includes only the LDCs. For each sample, Model 1 represents a baseline setup, testing the separate effects of democracy and trade. Model 2 adds a democracy-trade interaction term to Model 1. Model 3 adds regional dummy variables to Model 1, and Model 4 adds regional dummy variables to Model 2.

For the all-countries sample, the effect of democracy on deforestation in Model 1 is negative and statistically significant, suggesting that a rise in democracy from 0 to 1 increases the rate of deforestation. With the regional dummies in Model 3, the effect of democracy also is negative, but is statistically insignificant. This result may well reflect the fact that the average level of democracy varies across regions: it is highest in Europe and lowest in Africa, in the Middle East and in North Africa, absorbing the variance to be explained by democracy. Our interpretation also is reflected by the smaller coefficients of democracy in Models 3 and 4, compared with the coefficients in Models 1 and 2.

The effects of trade openness on deforestation in Models 1 and 3 are positive and statistically significant. Hence, a rise in trade openness in the all country sample reduces the rate of deforestation. This effect is robust even when we control for regional differences.

Before considering the interactive Models 2 and 4, it is useful to first discuss the interpretation of the relevant terms. Recall that the trade openness variable is centered around its mean. The coefficient of democracy measures the effect of a rise in democracy from 0 to 1, holding trade at its mean (for which the interaction term equals 0). The coefficient of trade openness measures the effect of raising trade openness by one unit in autocracies (when the democracy variable and the interaction term equal 0). Hence, the coefficient of the interaction term indicates the additional effect in a democracy of raising trade openness

TABLE 2 Effects of democracy and trade openness on deforestation

	(1) All	(2) All	(3) All	(4) All	(1) LDC	(2) LDC	(3) LDC	(4) LDC
Democracy	-0.9327** (0.4415)	-0.8698** (0.4205)	-0.2732 (0.3095)	-0.2131 (0.2896)	-0.6185* (0.3810)	-0.5207* (0.3512)	-0.2405 (0.3025)	-0.1517 (0.2810)
Trade Openness	0.0130** (0.0070)	0.0189** (0.0094)	0.0119** (0.0070)	0.0177** (0.0091)	0.0123** (0.0071)	0.0189** (0.0093)	0.0107* (0.0075)	0.0170** (0.0091)
Democracy*Openness		-0.0206** (0.0109)		-0.0234** (0.0109)		-0.0262** (0.0112)		-0.0310*** (0.0114)
GDPPC	0.0004*** (0.0001)	0.0004*** (0.0001)	0.0003*** (0.0001)	0.0004*** (0.0001)	0.0001 (0.0001)	0.0001 (0.0001)	0.00020* (0.00015)	0.00021* (0.00015)
GDPPC ²	-8.55e-09** (3.58e-09)	-9.04e-09** (3.58e-09)	-8.27e-09** (3.48e-09)	-9.48e-09*** (3.41e-09)	9.31e-09 (9.77e-09)	9.52e-09 (1.01e-08)	3.15e-09 (9.99e-09)	2.73e-09 (1.02e-08)
Population	-0.0009* (0.0006)	-0.0013** (0.0007)	-0.0010* (0.0006)	-0.0013** (0.0007)	-0.0011** (0.0006)	-0.0015** (0.0007)	-0.0010** (0.0006)	-0.0014** (0.0007)
Asia			1.6408*** (0.4275)	1.4892*** (0.4427)			1.6251*** (0.4332)	1.3964*** (0.4586)
South America			0.7692** (0.4550)	0.5005 (0.4790)			0.8168** (0.4579)	0.4135 (0.4952)
Europe			1.0592*** (0.4420)	1.2931*** (0.4231)			1.4495*** (0.4762)	1.8372*** (0.4537)
Africa			1.4341*** (0.3551)	1.4223*** (0.3658)			1.3477*** (0.3793)	1.3159*** (0.3997)
Middle East & North Africa			3.5943*** (0.8068)	3.5403*** (0.8096)			3.1479*** (0.8480)	2.9772*** (0.8350)
Oceania			0.8443* (0.4617)	0.7290* (0.5539)			1.3831*** (0.4691)	1.3570** (0.5898)
Constant	-1.2740*** (0.3464)	-1.2346*** (0.3507)	-2.7703*** (0.4267)	-2.6785*** (0.4381)	-0.9598** (0.3987)	-0.9026** (0.4041)	-2.5099*** (0.5580)	-2.3765*** (0.5719)
Observations	204	204	204	204	187	187	187	187
R-squared	0.21	0.23	0.31	0.33	0.24	0.27	0.30	0.34

Robust standard errors in parentheses.

* $p < 0.10$

** $p < 0.05$

*** $p < 0.01$

(for autocracy, the interaction term equals 0), or the additional effect of raising democracy from 0 to 1 when trade openness is not at its mean (making the interaction term nonzero).

In Model 2 for the all country sample, recall that a negative value for the deforestation variable means deforestation while a positive value indicates afforestation. Holding trade openness at its mean, the effect of a rise in democracy on deforestation is negative and significant. The coefficient of the democracy-trade interaction term is negative and significant. The coefficient of trade openness is positive and significant. Thus, a rise in democracy from 0 to 1 increases the rate of deforestation when trade openness is at its sample mean, based on the democracy term. In addition, this effect of democracy gets stronger as trade openness rises above its sample mean, based on the interaction term. In contrast, autocracies have lower deforestation rates than democracies, as the democracy variable is zero. A rise in trade openness in autocracies reduces the rate of deforestation, based on the trade openness term. In addition, this effect of trade openness gets weaker in a democracy according to the interaction term. In Model 4 for the all country sample, which controls for the regional differences, the results are essentially the same as in Model 2 with one exception. In this case, the effect of democracy on deforestation, holding trade at its mean, is negative but statistically insignificant.

In Models 1 and 3 for the LDC sample, the results for democracy and openness are similar in terms of signs and significance to the results obtained for the all country sample. The net effect of democracy on deforestation is negative and statistically significant in Model 1, and statistically not significant when controlling for regional variations in Model 3. The effect of democracy is weaker in size in the LDCs than in the full sample, reflecting the smaller relative share of democracies among the LDCs. The effect of trade openness in Models 1 and 3 is positive and significant, as in the full sample. The effect is similar in size across the samples, suggesting that it largely originates from the LDCs. The results for Models 2 and 4 (with the interaction term) are similar to those from the all-countries sample, and will not be discussed here.

Moving to the control variables, in the all-countries sample, the coefficient of GDP per capita is positive and statistically significant, and the coefficient of GDP per capita squared is negative and significant. The rate of deforestation falls (becomes less negative) as GDP per capita rises, and then rises (becomes more negative) as GDP per capita rises above some level. Hence, we do not find evidence supporting the EKC hypothesis in the full sample. The nonlinear effect found in the all-countries sample largely disappears in the LDC sample. Next, the effect of population density on deforestation is negative and statistically significant for both samples. High population density is associated with more deforestation, as such countries tend to exhibit larger pressures to clear forest, needing more agricultural and urban areas, *ceteris paribus*. The regional dummy variables suggest that the rate of deforestation is relatively more intense in North America (the U.S., Canada, Mexico, and Central America, the reference group), than in other regions.

For the analysis of land degradation, the sample includes one cross section of 105 countries, and the independent variables take on their 1985 values. We estimate eight OLS models reported in Table 3. The first four models in Table 3 are for a sample including all of the countries. The next four models are for a sample including only the LDCs.

The effect of democracy on land degradation is negative and statistically significant in Models 1 and 3 for the all-countries sample, and in Model 1 for the LDCs. The sign of the effect in Model 3 for the LDCs, which includes the regional dummy variables, is negative but is not statistically significant. Models 2 and 4 for the all-countries sample show that democracy significantly reduces land degradation when trade is held at its mean, but further trade openness does not add to this effect. Similar results hold for the LDCs, but

TABLE 3 Effects of democracy and trade openness on land degradation

Variable	(1) All	(2) All	(3) All	(4) All	(1) LDC	(2) LDC	(3) LDC	(4) LDC
Democracy	-0.6834** (0.3427)	-0.7539** (0.3707)	-0.7830** (0.3417)	-0.8557*** (0.3584)	-0.5807* (0.3549)	-0.6824** (0.4095)	-0.3595 (0.3732)	-0.3829 (0.4230)
Trade Openness	-0.0068* (0.0051)	-0.0025 (0.0058)	-0.0033 (0.0053)	0.0012 (0.0065)	-0.0033 (0.0053)	0.0004 (0.0057)	0.0025 (0.0052)	0.0032 (0.0062)
Democracy*Openness		-0.0094 (0.0111)		-0.0105 (0.0104)		-0.0118 (0.0117)		-0.0027 (0.0100)
GDPPC	6.1067*** (2.3417)	5.8017*** (2.4452)	4.7759* (3.0145)	4.7158* (3.0702)	1.4095 (3.5583)	1.2757 (3.6868)	0.7217 (4.7716)	0.7665 (4.7993)
GDPPC ²	-0.3652*** (0.1440)	-0.3476** (0.1501)	-0.3069** (0.1819)	-0.3070** (0.1842)	-0.0591 (0.2217)	-0.0526 (0.2295)	-0.0419 (0.2946)	-0.0452 (0.2960)
Population	0.2798*** (0.0969)	0.3082*** (0.1076)	0.1490 (0.1236)	0.1775* (0.1308)	0.4358*** (0.1046)	0.4609*** (0.1078)	0.3033*** (0.1203)	0.3101*** (0.1207)
Asia			-0.8948** (0.4064)	-0.9758*** (0.4002)			-0.7592*** (0.2603)	-0.7784*** (0.2688)
South America			-0.5313* (0.3657)	-0.6179** (0.3599)			-0.7377*** (0.2508)	-0.7578*** (0.2497)
Europe			-0.1790 (0.4980)	-0.0769 (0.4565)			-0.4155 (0.4172)	-0.3938 (0.4182)
Africa			-1.6576*** (0.5754)	-1.7181*** (0.5868)			-1.5231*** (0.5260)	-1.5260*** (0.5324)
Middle East & North Africa			-1.4416*** (0.4879)	-1.4338*** (0.4528)			-1.0329*** (0.3600)	-1.0389*** (0.3660)
Oceania			-2.1813*** (0.8356)	-2.0820*** (0.8152)			-3.8804*** (0.4677)	-3.8190*** (0.5646)
Constant	-22.9935** (9.4540)	-21.7429** (9.8598)	-14.5444 (12.5896)	-14.0756 (12.8749)	-5.6673 (14.1314)	-5.0725 (14.6453)	0.2205 (19.4282)	0.0659 (19.5502)
Observations	105	105	105	105	84	84	84	84
R-squared	0.20	0.21	0.31	0.32	0.25	0.26	0.40	0.40

Robust standard errors in parentheses.

* $p < 0.10$

** $p < 0.05$

*** $p < 0.01$

in Model 4 the negative effect of democracy is not significant. The interaction term is not statistically significant across the board, suggesting that the effect of democracy does not become stronger when trade openness is above the mean, and the effect of trade openness does not depend on regime type.

The effect of trade openness on land degradation in Model 1 for the all-countries sample is negative and statistically significant. In other models, the effect is not statistically significant. Given this outcome, the result in Model 1 for the all-countries sample seems driven by the DCs, which also is suggested by the fact that the effect of trade for the LDCs is not significant. This is to be expected if we recall that trade in the DCs tends to be intra-industry, which generally does not degrade land. In contrast, LDCs tend to export primary commodities, minerals, and mined resources, the production of which tend to degrade land. The sign of the effect of trade on land degradation in three out of four models for the LDCs is indeed positive; however, the effect is not large due to the relatively smaller size of trade in LDCs to begin with.

Moving to the control variables in the land degradation models, the EKC is statistically significant for the all-countries sample, but not for the LDC sample. As before, this result is to be expected, because the DCs, which tend to exhibit the EKC in our results, are not included in the LDC sample. A rise in population density leads to more land degradation in both the all-countries and in the LDC samples, which makes intuitive sense. A more dense country is expected to exert a larger pressure on land due to more intense agriculture and waste-dump, *ceteris paribus*. Finally, the regional dummy variables in this set of statistical models suggest that the land in the continent of North America is statistically significantly more degraded than land in Asia, South America, Africa, the Middle East and North Africa, and Oceania, and as degraded as the land found in Europe.

Conclusion

This paper studies statistically the effects of trade openness and democracy on the rate of deforestation and the level of land degradation. Summarizing our primary results, a rise in trade openness reduces deforestation in autocracy and increases deforestation in democracy, and the effect is similar for the LDCs and the DCs. A rise in trade openness reduces land degradation, but the effect is not robust and does not depend on regime type. A rise in democracy increases deforestation and reduces land degradation, but these effects are weaker in the LDCs than in the DCs. In addition, the effect of democracy on deforestation is stronger when trade openness is high. The effect of democracy on land degradation does not depend on trade openness.

Our results suggest that progress in political liberalism has a mixed effect on the terrestrial environment: it is good for land degradation, and bad for deforestation. The evidence for land degradation is consistent with the notion that democratic governments have to care for the physical environment in which their citizens reside, and that institutional checks and balances in democracy empower a broad range of public interests, including pro-environment groups. The evidence for deforestation, in contrast, is consistent with the notion that democratic regimes may ignore negative effects on the environment if strong constituencies can gain from it. In the case of deforestation, these interests often include logging firms, farms gaining cleared land, urbanized areas facing population pressures alleviated by clearing forested land, and landless people seeking to gain land by clearing forests.

The effect of economic liberalism on the terrestrial environment also is mixed. It appears that trade produces some beneficial effect on the quality of land, but the effect is generally

weak. Trade, however, reduces the rate of deforestation in both the all country and the LDC sample, but the beneficial effect tends to occur in autocracies, not in democracies, in line with the tendency for democracy to promote deforestation in our results. The problem is potentially serious for the LDCs, as they face pressures from within and outside to both democratize and liberalize their economies. Facing these pressures, the LDCs are neither well equipped in terms of regulatory expertise, nor have the capabilities and incentives to deal with the negative externalities of these policies.

These findings suggest the need for additional investigations. Future research may study the relative importance of the different mechanisms through which democracy affects the degradation of land and forest, focusing particularly on the important dichotomy suggested by our results for the two types of terrestrial environmental degradations. Future research may also examine how different types of traded goods influence the terrestrial environment. This could potentially provide more informative lessons for improving the quality of the terrestrial environment throughout the world.

When all is said and done, we cannot ignore the fact that global population has been rising and will continue to do so for the foreseeable future. It also becomes increasingly clear that global warming and climate change are generally expected to continue in the coming decades. In light of these expected developments, improving the quality of the terrestrial environment seems all the more important, particularly in the midst of the spread and intensification of commercial and political liberalism.

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