*Economic Dependency, Repression, and Deforestation: A Quantitative, Cross-National Analysis**

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This research builds upon previous cross-national studies of deforestation. In doing so, I examine how various world-systems indicators *interact* with political conditions within a nation. I test the hypothesis that repressive nations create a "good business climate" for multinational capital, which, in turn, affects deforestation. This "good business climate" consists of economic incentives (e.g., tax holidays), regulatory concessions (e.g., environmental law exemptions), and imposed political stability (e.g., outlawing strikes, protests, and unions). The results indicate that export partner concentration, commodity concentration, multinational corporate penetration, and International Monetary Fund conditionality increase deforestation more at higher rather than at lower levels of repression. I also confirm previous findings that gross domestic product per capita decreases deforestation, indicating that richer nations are able to externalize their environmental costs onto poorer nations. I conclude with the theoretical implications of this research, policy implications, and possible directions for future research.

Introduction

In recent years, a number of cross-national studies (Allen and Barnes 1985; Bilsborrow and Geores 1994; Burns, Kick, and Davis 2003; Burns et al. 1994; Capistrano 1994; Deacon 1994; Inman 1992; Ehrhardt-Martinez 1998; Ehrhardt-Martinez, Crenshaw, and Jenkins 2002; Jorgenson 2006a; Kahn and McDonald 1994; Kick et al. 1996; Rock 1996; Rudel 1989, 1998; Rudel and Roper 1997; Shandra 2007) on deforestation have been published. This volume is not surprising for several reasons. First, deforestation is associated with other environmental problems. Forests play an important role in preventing climate change in that trees remove large amounts of carbon dioxide from the atmosphere (Rock 1996). Further, forests are home to over 50 percent of all living organisms on the planet (Hurst 1990). The destruction of forests will greatly reduce the biodiversity of the planet. Trees also prevent soil erosion, flooding, and desertification (Ehrhardt-Martinez 1998). Second, deforestation may result in a number of social problems such as eradication of indigenous culture, spreading of disease, and an increase of rural violence (Homer-Dixon 1999). Third, deforestation is largely the result of human activities. Some of these activities include logging, mining, cattle ranching, and export agriculture (Bryant and

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Bailey 1997). Clearing of forests by growing populations and the building of infrastructure also impact deforestation (Rudel and Roper 1997).

Such factors have been examined in previous research. A number of these studies (Ehrhardt-Martinez 1998; Rock 1996; Rudel 1989) find support for indicators suggested by modernization theory (i.e., gross domestic product). Other studies (Allen and Barnes 1985; Inman 1993; Kahn and McDonald 1994; Rudel and Roper 1997) find support for world-systems hypotheses that exports and debt increase deforestation. Finally, a number of studies (Burns et al. 1994; Ehrhardt-Martinez et al. 2002; Kick et al. 1996) suggest aspects of both theoretical perspectives are related to deforestation.

A similar pattern of findings can be found in earlier cross-national research that examines a range of topics including economic growth (e.g., Bornschier and Chase-Dunn 1985), basic needs (e.g., Moon and Dixon 1985), and urbanization (e.g., London 1987). Such findings led Bradshaw (1987:235) to point out that researchers can avoid "current theoretical and ideological particularism" by including predictors from competing perspectives in the same model "without giving logical priority to either paradigm." Of course, this is a plausible research strategy that has been widely used in cross-national research. However, it provides little theoretical guidance for developing a more nuanced and complex understanding of the phenomenon under investigation. As Smith (1996:145) points out, "More critically, it represents a retreat to eclecticism. It sidesteps the real challenge, which is to construct a synthetic theoretical approach that melds the useful elements of competing approaches into coherent guiding principles and explanations." London and Smith (1988:41) continue, "It is necessary for social scientists to eliminate the sort of theoretical blinders that lead to the categorical analysis of either modernization or political-economy. This is because these allegedly antithetical approaches are related to each other in a specifiable and meaningful manner."

Consequently, recent efforts to understand deforestation can be criticized for being eclectic and for failing to pursue synthesis (but see Burns, Kick, and Davis 2003 and Burns et al. 1994 as notable exceptions). Therefore, the present study seeks to (1) construct theoretically informed models that build upon existing cross-national research on deforestation and (2) specify the contexts in which political factors that are "internal" to a nation *interact* with economic factors that are "external" to a nation.[1] Therefore, the major goal of this research relates not only to the importance of taking into account competing theoretical explanations (i.e., modernization and world-systems theories) in a study of deforestation, but also identifying the contexts in which the factors from these apparently divergent theoretical perspectives are related to each other in a meaningful way. In this regard, I examine how repressive nations create a "good business climate" for foreign investment through a variety of regulatory

concessions and economic incentives, which, in turn, affects deforestation. I conclude with some theoretical and methodological implications of this work, policy recommendations, and directions for future research.

Modernization Theory

The modernization perspective argues that a unique relationship exists between economic development and deforestation in which deforestation increases in early stages of development but levels off and declines as economies mature. This hypothesis is known as the environmental Kuznets curve, named for economist Simon Kuznets (1955) who demonstrated this type of relationship between economic growth and income inequality.

Ehrhardt-Martinez (1998) and Ehrhardt-Martinez, Crenshaw, and Jenkins (2002) hypothesize that this relationship exists mainly because of the shift of economic production activities away from natural resource extraction toward service-based activities. In terms of this sectoral change, very poor nations have limited production functions based on primitive technologies and spiritual attitudes toward the physical world. These factors place a ceiling on productivity and largely limit economies to subsistence agriculture. With economic activity limited predominantly to this form of agriculture, deforestation should be relatively low (Grossman and Kruger 1995). As countries begin to industrialize, the extraction of natural resources and the building of infrastructure play central roles in increasing economic development (Grossman and Kruger 1995). These practices often increase deforestation because they are highly dependent upon the extraction of minerals and other natural resources such as logs and other forest products (Ehrhardt-Martinez 1998). During this period, timber for construction and charcoal for household and industrial use are also in high demand (Ehrhardt-Martinez, Crenshaw, and Jenkins 2002). At high levels of economic development, however, there are improvements in energy efficiency and growing service-based economic activities. Further, high levels of development are also characterized by a complete infrastructure, a shift to new building materials, and more use of fossil fuels for energy, all of which may reduce pressure on forests (Selden and Song 1994).

Accordingly, deforestation would follow a general pattern of rapid growth during early development followed by a leveling off during higher development (Selden and Song 1994). A number of cross-national studies have found support for this theoretical perspective (Ehrhardt-Martinez 1998; Ehrhardt-Martinez et al. 2002; Rock 1996).

It has also been suggested by modernization theory that democracy may reduce deforestation (Li and Reuveny 2006). This is based on several factors. First, democratic nations have higher levels of activism than repressive nations because they provide their citizens with ways to engage in the public dialogue

(Crenshaw and Jenkins 1996; Paxton 2002). This occurs by granting the freedoms of speech, press, and assembly (Murphy 2000). Second, democratic nations must be more responsive to political activism because of electoral accountability (Ehrhardt-Martinez, Crenshaw, and Jenkins 2002). The responsiveness of leaders in a democracy is partially based upon the need for public officials to win popular elections to maintain their positions. The officials, who fail to address the needs of citizens or at least give the impression of concern, face the risk of losing their positions in subsequent elections. Third, greater freedom of the press leads to wider diffusion of information, which, in turn, raises public awareness, combats corruption, and encourages environmental reform (Payne 1999).

The findings involving democracy and deforestation are mixed. Li and Reuveny (2006), Mather, Needle, and Fairbairn (1999), and Didia (1997) find support for the hypothesis that democracy reduces deforestation. However, Ehrhardt-Martinez, Crenshaw, and Jenkins (2002) and Midlarsky (1998) find that democracy increases deforestation. Midlarsky (1998) argues that this relationship exists because democratic nations may experience policy inaction concerning the environment. This is the result of democratically elected leaders having to please competing interest groups in order to win as many votes as possible. Thus, additional research is needed to examine the link between democracy and deforestation.

World-Systems Theory

An important critique of the modernization perspective comes from scholars writing in the world-systems tradition. Bunker (1996, 1985) and Jorgenson (2003) note that rich nations externalize their consumption-based environmental impacts onto poor nations which increases various forms of environmental degradation in the latter. Jorgenson (2006a) finds support for this idea by finding poor nations with higher levels of exports sent to rich nations experience higher rates of deforestation.

Thus, it appears that deforestation is at least partly a result of an international hierarchy of unbalanced economic exchange relations. The economic exchange in this system is based upon the unequal appropriation of surplus in which development within the core countries is facilitated at the expense of the subordinate semiperipheral and peripheral nations of the world. It is possible for countries to move upward or downward within this economic structure. However, the gains of any one country dictate losses for other countries (Bornschier and Chase-Dunn 1985). According to this perspective, less developed countries become peripheralized in the world economy when they are penetrated by interests located in core countries, which are largely centered upon exports, multinational corporations, and structural adjustment loans (Wallerstein 1974).

Export dependency, also known as "vertical trade," consists of trade relationships between core and peripheral countries in which poor countries must import from rich nations high-priced, technologically advanced manufactured goods needed for the expansion of local production (Bunker 1996). In order to pay for these imports, poor countries exploit their natural resources. Exports from poor countries are often concentrated in logging, mining, oil drilling, and mono-crop agricultural production. Such a reliance on primary products typically results in deforestation. Further, the money needed to purchase manufactured goods from abroad reduces the amount of money available for government investment elsewhere (e.g., environmental protection). A number of cross-national studies have found that export dependency tends to increase deforestation (Allen and Barnes 1985; Burns et al. 1994; Jorgenson 2006a; Shandra 2007).

Within the world-systems literature, scholars have noted the changing nature of international economic exchanges between core and periphery that have taken place in the last 30 years. Some world-systems theory suggests foreign direct investment leads to increases in environmental degradation (Bunker 1985, 1996; Grimes and Kentor 2003). Often less developed countries are viewed as cheap factors of production for multinational corporations that are headquartered in the core (Ross and Trachte 1990). Peripheral countries, eager to attract foreign investment as a way to expand local production, employment, and technology and to generate foreign exchange to repay foreign debts, are in the position of competing with one another (Leonard 1988; London and Ross 1995). As a result, peripheral countries offer a variety of economic incentives (i.e., wage and tax reductions). One of the hypothesized consequences of increased multinational corporate penetration may be more deforestation, especially because multinational corporations are some of the investors in export-oriented industries such as logging, cattle ranching, mining, and oil drilling.

Finally, it is necessary to consider the links between debt and deforestation. Generally, there are three important connections that merit attention. First, structural adjustment programs usually require that states promote economic activities consonant with a given country's comparative advantage (Peet 2003). In other words, a handful of products assume a primary role as generators of foreign currency for developing countries to repay a loan. Borrowers agree to use funds to increase the production of primary products for export (Rich 1994). The production of primary products leads to immense deforestation because the vast majority of these exports come from cattle ranching, logging, drilling, and mining (Rich 1994).

Second, structural adjustment programs require governments to remove barriers to foreign investment by providing regulatory concessions (i.e., exemptions to environmental laws) and financial incentives (i.e., removal of minimum

wages, increases in labor mobility, and currency devaluation) (Walton and Ragin 1990). The removal of such regulations makes investment by foreign firms extremely profitable. However, deforestation often ensues because investment is concentrated in extractive industries.

Third, structural adjustment programs usually require deep cuts in government spending to correct for budgetary imbalances (Barbosa 2001). This often results in a reduction in the budgets and staffs of environment departments, which hampers enforcement of environmental regulations (Peet 2003). At the same time, land settlement schemes also become targets of mandatory government spending cuts. However, deforestation continues because governments still encourage agricultural expansion in frontier areas through tax policies and road building in lieu of cuts in government spending on land settlements (Rudel 2007). A number of cross-national studies have found support that economic dependency relationships centering upon international lending institutions increase deforestation (Kahn and McDonald 1994; Rudel and Roper 1997).

Considering Possible Interaction Effects

I note above that Bradshaw (1987) warns about "particularism" and London and Smith (1988) and Smith (1996) call for "synthesis" in cross-national research of this sort. Thus, I now turn to a discussion that begins to address such concerns and extends ideas from both modernization and world-systems theory in a novel way. An idea that has not received much attention in the cross-national literature is that repressive nations may intensify the harmful effect of exports, multinational corporations, and structural adjustment loans. This theoretical insight has been suggested by Ross and Trachte (1990), who argue that the mutually beneficial relationship rests upon the desire for development and personal economic gain by leaders of repressive governments along with the quest for profit by multinational corporations. This idea was later validated using cross-national data by London and Ross (1995). However, the implications of this relationship have not yet been applied to deforestation and empirically tested.

I draw upon the writing of these scholars to test the hypothesis that repression *interacts* with various world-systems measures so that exports, multinational corporations, and structural adjustment loans increase deforestation more at higher rather than at lower levels of repression. I hypothesize this occurs because repressive nations create a "good business climate" for foreign investment by providing them with a variety of economic incentives and regulatory concessions. In other words, this interaction hypothesis explicitly suggests that modernization factors that are internal to a nation are related to the sort of external variables suggested by world-systems theory. Consequently, the

interaction terms pursue the type of synthesis called for Bradshaw (1987), London and Smith (1987), and Smith (1996).

Repressive nations create a "good business climate" for multinational corporations through a variety of financial incentives and regulatory concessions that aim to lower costs for foreign investors (London and Ross 1995). The most notable financial incentives include "tax holidays" (Leonard 1988). Regulatory concessions include exemptions on log harvest quotas, clear cutting, logging protected species, and logging in protected areas (Hecht and Cockburn 1989). The purpose of the incentives and concessions is to increase investment by multinational corporations in activities including logging, mining, oil drilling, cash crop agriculture, and cattle ranching. However, deforestation often ensues.

A very good illustration of this point comes from Indonesia. President Suharto under the Foreign Capital Investment Law of 1967 provided Weyerhauser, Georgia Pacific, and C. Itoh with economic incentives. The most common were five- and six-year tax holidays (Hurst 1990). Some of these foreign companies were also able to extend the tax holidays for up to 15 years (Bryant and Bailey 1997).

There were also regulatory concessions instituted by the Indonesian government that benefited both multinational corporations and the government at the expense of the environment. First, the selective cutting policy was based on a 35-year regeneration cycle (Dauvergne 1994). However, concession leases given to foreign investors were usually only for 20 years so there was little incentive for managing a concession in a sustainable way (Dauvergne 1994). Second, royalties were based upon removal rather than on the volume of harvestable trees in a concession (Dauvergne 1994). Thus, companies tended to take only the most valuable trees and destroyed others in the process. Third, companies had to pay $10 per cubic meter of extracted wood under the reforestation policy, which would be collected after reforestation occurred (Dauvergne 1994). However, replanting was generally more expensive than the potential refund. Thus, most multinational corporations gave up their deposit (Dauvergne 1994). As a result of these economic incentives and regulatory concessions, Indonesia became a world leader in tropical timber exports while deforestation skyrocketed (Hurst 1990).

Repressive nations also create a "good business climate" for multinational corporations by not only providing economic incentives and regulatory concessions but also by promoting labor mobility and imposing political stability (London and Ross 1995). This involves the outlawing of strikes, protests, and unions. It also includes firing workers at will (Peet 2003). This aspect of a "good business climate" not only has the potential to minimize both the power and prevalence of workers but also social movements, non-governmental organizations, and concerned citizens (Shandra 2007). The inability to mobilize

in the pursuit of public interests often means that the malfeasances of multinational corporations continue unchecked (i.e., illegal logging and corruption) (Newell 2001).

For example, the Indonesian government under the Social Organization Laws of 1986 mandated that non-governmental organizations working in the country must register members and seek approval of funding for all projects (Bryant and Bailey 1997). The law also permitted the government to ban any non-governmental organization without explanation (Hurst 1990).

A similar example involves the struggle of the Penan with logging companies in Malaysia. Since the 1980s, the Penan have been engaged in protest activities (e.g., blockading of logging roads and sabotaging of logging equipment) to regain control over local forests (Hurst 1990). Bryant and Bailey (1997:182) write, "The response of the Malaysian government to these activities has been to repress the dissent, but this move only prompted the intervention of international non-governmental organizations including Sahabat Alam Malaysia and the World Rainforest Movement on the side of the Penan." These non-governmental organizations have supported the Penan by urging its members to raise awareness by writing letters to elected officials, providing financing for legal challenges in the Malaysian courts, and directly lobbying Malaysia's political leaders (Bryant and Bailey 1997). As a result of the intervention by the non-governmental organizations, however, Malaysian Prime Minister Mahathir ordered a crackdown on social movement activity (Hurst 1990). This effort included press censorship, crackdowns on protests, and the arrest of key Penan leaders (Bryant and Bailey 1997). At the same time, the government pushed for more logging in Sarawak (Hurst 1990).

In sum, I hypothesize that repression within a nation should interact with various world-systems measures, thereby increasing deforestation more at higher rather than at lower levels of repression. This is because repressive nations create a "good business climate" for foreign investment by boosting exports, reducing taxes, diminishing protections, and producing powerlessness.

Neo-Malthusian Theory

I have described how a variety of economic and political factors are hypothesized to contribute to deforestation. However, it has long been argued that demographic factors, especially population growth, are a prominent cause of environmental degradation. Such arguments, rooted in Malthus's (1983) well-known assertion that geometric growth in population would outstrip arithmetic growth in the means of subsistence, led to the pessimistic conclusion that carrying capacity problems would be inevitable if population size outpaced finite environmental resources such as land and food. This focus on environmental resource shortages has been extended in recent years to argue that

population size is also a major cause of environmental degradation (Ehrlich and Ehrlich 2004). The general argument holds that increases in population growth drive basic extraction, consumption, and production activities (Pimentel and Pimentel 1999).

All of these processes have the potential to generate deforestation. For example, Rudel and Roper (1997) describe how these processes play out in their immiserization and frontier models. Rudel and Roper (1997) see deforestation as the result of growing populations of peasants and shifting cultivators carving small farms out of forests. Economies of poor countries provide few livelihoods for poor peasants other than agriculture. Low levels of economic activity and the fiscal austerity associated with large foreign debts prevent the creation of jobs in sectors other than agriculture that otherwise might attract people to cities and relieve the human demand on forest resources (Burns et al. 2003). The absence of alternative economic opportunities and the increase in the number of people competing for these opportunities compel individuals to expand agricultural production to survive by clearing forests (Burns et al. 2003; Rudel 1998). This often occurs when an army of surplus laborers moves to obtain property by clearing land when road building opens up a region for development (Rudel 1993). Allen and Barnes (1985), Ehrhardt-Martinez (1998), Jorgenson (2006a), Rudel (1989), Rudel and Roper (1997), and Shandra (2007) have all found support for this theoretical perspective.

Methodology

Nations Included

The sample for this study is defined as all nations that are not categorized as high-income according to the World Bank's (2003) income quartile classification scheme. Countries formed following the collapse of the Soviet Union are not included in the analysis as there are little quality comparative data for these nations around 1990.[2] In particular, the sample consists of 67 nations for which measures are available for the dependent and all independent variables.[3] I restrict my sample to these nations because the effects of world-systems variables are anticipated to have a unique and different impact on poor nations compared to rich nations (Jorgenson 2006b).

Dependent Variable

Deforestation. The dependent variable for my analysis is the average annual percentage change in total forest area for the period 1990 to 2000. Data may be obtained from the Food and Agriculture Organization (2003). It is important to note that deforestation is signified by a positive value. I use data for this period because it is more expansive than previous years (e.g., 1980 to

1990). Further, data collected for this period are not comparable to earlier periods because of changes in collection methodology (Food and Agriculture Organization 2003). I provide descriptive statistics and bivariate correlations for all my variables in Appendix A.

Independent Variables

Gross Domestic Product. It is standard in such analyses to take into account a nation's level of development in order to make sure that any effects discovered are independent of a nation's level of wealth (London and Ross 1995). I employ a measure of gross domestic product per capita at parity purchasing power for 1990. These data may be obtained from the World Bank (2003). All else being held equal, modernization theory suggests there should be a non-monotonic relationship between this variable and deforestation. I test this hypothesis using a quadratic polynomial equation in which the level of development and its square are entered into the same model. If this relationship exists, the sign of the coefficient for the level of development should be positive and the sign of the coefficient for the squared term should be negative with this term being statistically significant. To reduce problems of multicollinearity, I begin by centering the linear term around its mean. I then square the centered term. Finally, I include the centered linear term and squared term in my models (York, Rosa, and Dietz 2003).

Government Expenditures. I also include a variable to determine the effect of government spending on deforestation. This variable is the total amount of central government expenditures as a percentage of gross domestic product for 1990. This data may be obtained from the World Bank (2003). Modernization theory suggests that government spending should increase deforestation because governments usually invest in activities (i.e., export agriculture and building of infrastructure) that cause deforestation (Deacon 1994).

Repression. This variable is the average of Freedom House's (1997) data on political rights and civil liberties for 1990. Political rights reflect whether a nation is governed by democratically elected representatives and has fair, open, and inclusive elections. Civil liberties reflect whether within a nation there is freedom of press, freedom of assembly, general personal freedom, freedom of private organizations, and freedom of private property. Each variable is a seven-point scale with the following codes: free (1–2), partially free (3–5), and not free (6–7). As a result, this variable may be interpreted as both a measure of repression and democracy with high scores equaling a high level of repression. Modernization theory suggests that repression should increase deforestation.

Domestic Investment. I also include a measure of domestic investment as percentage of gross domestic product for 1990. These data may be obtained from the World Bank (2003). It is standard to control for this variable when including variables such as foreign investment. Jorgenson (2006b) argues that domestic investors may experience greater pressure from social movements and non-governmental organizations to invest in less environmentally damaging processes and facilities.

Population Growth. In order to determine the impact of demographic factors on deforestation, I include the population growth rate from 1990 to 2000. These data may be obtained from the World Bank (2003). Neo-Malthusian theory suggests that total population growth should increase deforestation.

Total Forest Stocks. It is also necessary to include a control for forest stocks in a given country as the rate of deforestation may be influenced by either abundance or scarcity of forests (Rudel 1989). In doing so, I include the number of hectares of total forest area for a country in 1990. These data may be obtained from the World Resources Institute (2000). It is also logged to correct for its skewed distribution. It has been found that nations with large forests, for example, have a greater potential for deforestation in absolute terms than do countries with small forest covers (Rudel 1989). However, the rate of deforestation may be lower in nations with greater expanses of forests whereas higher rates are easily achieved in nations with minimal forest cover (Ehrhardt-Martinez 1998).

Data Quality. It is also imperative for researchers to account for the quality of the deforestation data. The Food and Agriculture Organization maintains records on how deforestation data are collected (2003). I use this information to classify forestry statistics as being highly reliable if they are based upon remote sensing survey or current national field sampling estimates. I classify forestry statistics as being of low reliability if they are based upon expert estimates, which often involves extrapolation from outdated national inventories. I include a dummy variable for high data quality (1 = high reliability). The reference category includes nations whose forestry estimates are based upon expert estimates. This approach has been used previously by Ehrhardt-Martinez, Crenshaw, and Jenkins (2002).

Geographical Location. It is also important in cross-national research to account for findings that may arise out of geographical and historical circumstances of nations that cannot be accounted for by the variables in each model (Firebaugh 1979). Therefore, I also include a series of dummy variables for the

region of the world in which a nation is located. I include a series of dummy variables for whether a nation is located in one of three different regions of the world such as Latin America, Asia, and Sub-Saharan Africa. The reference category includes nations in the rest of the world.

Export Partner Concentration. Export partner concentration is defined as the percentage of total exports to the single largest importing country. The data are for 1990. These data are taken from the United Nations (2000). World-systems theory suggests export partner concentration increases deforestation.

Commodity Concentration. Commodity concentration is the value of a nation's most important export commodity measured as a percentage of its total exports. This is measured for 1990 and indicates the degree to which poor nations rely on a single commodity and are vulnerable to market fluctuations for their export earnings. They are available from the United Nations (2000). World-systems theory predicts commodity concentration should also increase deforestation.

Foreign Investment. This variable is the end-of-year stocks of developed countries foreign direct investments in a given host country divided by gross national product for 1990.[4] These data may be obtained from the United Nations (2000). I log this variable to control for its skewed distribution. As with the other world-systems variables, the level of foreign investment is hypothesized to increase deforestation.

International Monetary Fund Conditionality. This index is the sum of four variables which include (1) the number of debt renegotiations between a country and an international financial body (private bank or multilateral lender); (2) the number of debt restructurings experienced by an indebted nation; (3) the number of times a country utilized the International Monetary Fund Extended Fund Facility; and (4) the total International Monetary Fund loans received by a country as a percentage of its allocated quota. This index was first used by Walton and Ragin (1990), who list the sources for each of the data. The variable is measured for the period of 1975 to 1990. The four components of the index are converted to Z-scores and summed. Based on world-systems theory, one would hypothesize that a high score on the International Monetary Fund conditionality index should increase deforestation.

Findings

In Table 1, I provide the ordinary least square (OLS) estimates of deforestation. In odd-numbered equations, I include gross domestic product per capita,

Table 1
Ordinary Least Square (OLS) Estimates for Additive Models of Deforestation, 1990–2000

	Equation 1.1	Equation 1.2	Equation 1.3	Equation 1.4	Equation 1.5	Equation 1.6	Equation 1.7	Equation 1.8
Modernization variables								
Gross domestic product, 1990	−.373**	−.361*	−.445**	−.305	−.394**	−.365*	−.380**	−.376*
	−.258	−.248	−.308	−.209	−.272	−.253	−.263	−.258
	(−1.940)	(−1.456)	(−2.290)	(−1.184)	(−2.029)	(−1.487)	(−1.980)	(−1.516)
Gross domestic product squared, 1990	−.325		−.219		−.326		−.338	
	−.223		−.150		−.224		−.232	
	(−1.243)		(−.874)		(−1.249)		(−1.296)	
Repression, 1990	.092	.047	.047	.011	.079	.037	.078	.032
	.120	.062	.062	.014	.103	.048	.102	.042
	(.733)	(.374)	(.377)	(.084)	(.626)	(.286)	(.614)	(.249)
Government expenditures, 1990	.024	.026	.023	.024	.022	.023	.023	.024
	.123	.132	.062	.121	.109	.116	.115	.120
	(1.033)	(1.083)	(.377)	(1.024)	(.941)	(.974)	(.991)	(1.006)
Neo-Malthusian variable								
Population growth rate, 1980–1990	−.063	−.169	−.039	−.160	−.042	−.155	−.059	−.163*
	−.063	−.168	−.039	−.159	−.042	−.154	−.059	−.162
	(−.477)	(−1.293)	(−.305)	(−1.217)	(−.319)	(−1.257)	(−.450)	(−1.322)

(*Continued*)

Table 1
(*Continued*)

	Equation 1.1	Equation 1.2	Equation 1.3	Equation 1.4	Equation 1.5	Equation 1.6	Equation 1.7	Equation 1.8
Control variables								
Domestic investment, 1990	−.019 −.108 (−.833)	−.017 −.103 (−.772)	−.019 −.109 (−.856)	−.019 −.102 (−.773)	−.015 −.032 (−.662)	−.016 −.096 (−.684)	−.020 −116 (−.883)	.019 −.110 (−.812)
Total forest stocks, 1990	−.458** −.273 (−2.376)	−.475*** −.284 (−2.406)	−.359** −.214 (−1.779)	−.417** −.249 (−2.002)	−.465*** −.278 (−2.411)	−.479*** −.286 (−2.413)	−.457** −.273 (−2.371)	−.475*** −.284 (−2.401)
High data quality (1 = Yes)	−.433 −.148 (−1.249)	−.553* −.189 (−1.578)	−.512* −.174 (−1.497)	−.629** −.214 (−1.790)	−.447* −.152 (−1.296)	−.577* −.197 (−1.657)	−.445 −.152 (−1.289)	−.573* −.195 (−1.646)
Latin America (1 = Yes)	.912** .472 (2.146)	.978*** .604 (2.812)	.999* .374 (1.640)	.984*** .570 (2.600)	.990** .500 (2.278)	.956*** .632 (2.928)	.988** .485 (2.228)	.999*** .625 (2.951)
Asia (1 = Yes)	.179 .053 (.269)	.608 .180 (.951)	.232 .069 (.353)	.298 .207 (1.074)	.192 .058 (.292)	.132 .187 (.971)	.166 .049 (.248)	.200 .180 (.937)
Sub-Saharan Africa (1 = Yes)	.638 .250 (1.057)	.950* .373 (1.591)	.628 .256 (1.058)	.893** .389 (1.672)	.708 .278 (1.153)	.700* .392 (1.627)	.641 .251 (1.061)	.765* .378 (1.615)

World-systems variables								
Export partner concentration, 1990	.003 .046 (.397)	.005 .062 (.525)						
Commodity concentration, 1990			.014* .198 (1.422)	.009 .122 (.869)				
Multinational corporate penetration, 1990					−.005 −.060 (−.505)	−.002 −.024 (−.197)		
International Monetary Fund conditionality, 1990							−.023 −.043 (−.373)	−.020 −.038 (−.327)
Adjusted R-squared	.295	.259	.320	.285	.297	.255	.295	.256
Number of cases	65	65	65	65	65	65	65	65
Mean variance inflation factor score	2.458	2.543	2.659	2.677	2.618	2.600	2.459	2.560
Highest variance inflation factor score	5.383	5.434	5.330	5.337	5.263	5.157	5.290	5.387

Notes: ***$P < .01$ (one-tailed); **$P < .05$ (one-tailed); *$P < .10$ (one-tailed).
The first number reported is the unstandardized regression coefficient, the second number is the standardized regression coefficient, and the third number in parentheses is the *t*-statistic.
Burundi and Oman are removed from each equation because they are influential cases.

gross domestic product per capita squared, repression, government spending, domestic investment, population growth, forest stocks, data quality dummy variable, geographical location dummy variables, and a world-systems measure. In even-numbered equations, I drop the gross domestic product squared term from the analysis. I include export partner concentration in equations 1.1 and 1.2, commodity concentration in equations 1.3 and 1.4, foreign investment in equations 1.5 and 1.6, and International Monetary Fund conditionality in equations 1.7 and 1.8.

I use these model specifications for two reasons. First, Shandra, London, and Williamson (2003) note the use of alternative model specifications is a useful tactic in conducting cross-national research. The sequential use of "cognate" but "distinct" indicators of one or more independent variables can shed considerable light on the complexity and dynamics of an issue under investigation. If the world-systems indicators exhibit similar effects on deforestation, for example, then the reliability of the findings is greatly enhanced. Second, I want to avoid problems with multicollinearity that may arise by including these indicators in a model simultaneously. In doing so, I report the highest and mean variance inflation factor scores for each model in order to determine if multicollinearity is problematic in the analysis. Stevens (2002) suggests that variance inflation factor scores over a value of 10 indicate problems with multicollinearity. There are no variance inflation factor scores over 10 for any model, indicating that multicollinearity is not a problem in this analysis.

Let me begin by focusing on statistically significant findings. There are several consistent findings in Table 1. First, I find that nations with high gross national product per capita have less deforestation. The coefficients for this variable are negative and significant in every even-numbered equation of Table 1 except equation 1.4. This finding replicates the findings of previous research conducted by Burns, Kick, and Davis (2003) and Jorgenson (2006a). This finding has been attributed the phenomenon of recursive exploitation (Burns et al. 2003). That is, richer nations are able to displace their environmental costs by importing resources (i.e., forest products) from the poorer nations of the world (Burns et al. 2003).

Second, several of the control variables also predict a significant amount of variation in deforestation. The coefficients for the forest stock variable are negative and significant in every equation. The coefficients for my data quality dummy variables are also negative and significant in equations 2.2, 2.3, 2.4, 2.5, 2.6, and 2.8. Third, the coefficients for two of my geographical dummy variables are also positive and significant. These findings indicate that nations located in Latin America and Sub-Saharan Africa have more deforestation than do nations in the rest of the world. There is no significant variation between nations in Asia and the rest of the world.

There are a number of other nonsignificant findings that should be mentioned too. First, I find no support for neo-Malthusian theory. The coefficients for population growth rate are not statistically significant.[5] Second, I find little or no support for aspects of modernization theory. In particular, I do not find evidence of an environmental Kuznets curve between economic development and deforestation. The coefficients for the squared term of gross domestic product per capita fail to reach statistical significance in all even-numbered equations.[6] Third, the coefficients for democracy and government expenditures are not statistically significant in any equation of Table 1. Fourth, I also observe no support for world-systems theory. The coefficients for export partner concentration, commodity concentration, foreign investment, and International Monetary Fund conditionality are not statistically significant.

To this point, I find limited support for both modernization and world-systems theory. Such an outcome is somewhat surprising. However, I have only considered the additive effects of the independent variables on deforestation. My previous discussion suggests it may be necessary to examine interactive relationships between my repression and the world-systems indicators. I test the hypothesis suggested by London and Ross (1995) and Ross and Trachte (1990) that repressive nations create a "good business climate" for multinational corporations by providing a variety of regulatory concessions and economic incentives. As a result, the world-systems measures should increase deforestation more at higher rather than at lower levels of repression.

I test this hypothesis by including an interaction term between each world-systems measure and repression in my models. I construct the interaction terms by centering the moderator variable (i.e., repression) and the focal variables (i.e., world-systems measure) around their means. I then multiply the centered version of each variable together (Jaccard and Turrisi 2001). I provide estimates of the effect of each world-systems variable at low (i.e., at one standard deviation below the mean), medium (i.e., at the mean), and high (i.e., at one standard deviation above the mean) levels of repression. By centering the moderator variable (i.e., repression), the effect of a world-systems variable on deforestation at mean levels of repression is equal to the unstandardized coefficient for that world-systems variable (Jaccard and Turrisi 2001). This procedure also reduces potential problems with multicollinearity.

Table 2, indicates substantial support for my hypotheses that repressive nations create a "good business climate" for foreign investors that contribute to deforestation. First, the interaction term between export partner concentration and repression is significant in equations 2.1 and 2.2 with the effect of export partner concentration on deforestation changing at different levels of repression. In equation 2.1, the effect of export partner concentration at high levels of repression is equal to .014. The effect on deforestation at mean levels of repression

Table 2
Ordinary Least Square (OLS) Estimates for Interactive Models of Deforestation, 1990–2000

	Equation 2.1	Equation 2.2	Equation 2.3	Equation 2.4	Equation 2.5	Equation 2.6	Equation 2.7	Equation 2.8
Modernization variables								
Gross domestic product, 1990	−.381**	−.375*	−.596***	−.229	−.371*	−.408**	−.392**	−.431**
	−.264	−.256	−.394	−.157	−.255	−.280	−.269	−.296
	(−1.996)	(1.515)	(−2.965)	(−.891)	(−1.622)	(−1.762)	(−1.914)	(−1.770)
Gross domestic product squared, 1990	−.328*		−.085		−.302		−.359	
	−.332		−.058		−.209		−.249	
	(−1.406)		(−.347)		(−1.220)		(−1.214)	
Repression, 1990	−.152	−.187	−.283*	−.223	−.140	−.195*	.119	.077
	−.199	−.244	−.370	−.291	−.182	−.255	.115	.101
	(−.693)	(−.830)	(−1.575)	(−1.165)	(−.968)	(−1.371)	(.938)	(.606)
Government expenditures, 1990	.022	.024	.023	.024	.027	.028	.030	.030
	.111	.121	.115	.120	.134	.142	.099	.103
	(.935)	(.991)	(1.061)	(1.033)	(1.221)	(1.275)	(.875)	(.885)
Neo-Malthusian variable								
Population growth rate, 1990–2000	−.039	−.146	−.032	−.178	−.038	−.121	−.063	−.161
	−.038	−.147	−.031	−.177	−.038	−.120	−.062	−.160
	(−.290)	(−1.185)	(−.258)	(−1.224)	(−.303)	(−1.109)	(−.490)	(−1.229)
Control variables								
Domestic investment, 1990	−.014	−.013	−.015	−.015	−.021	−.025	−.015	−.014
	−.080	−.076	−.087	−.177	−.135	−.145	−.062	−.081
	(−.617)	(−.568)	(−.710)	(−.655)	(−1.053)	(−1.108)	(−.490)	(−.608)

Total forest stocks, 1990	−.504***	−.540***	−.396**	−.453**	−.543***	−.562***	−.536**	−.663**
	−.301	−.310	−.236	−.270	−.324	−.335	−.246	−.255
	(−2.595)	(−2.603)	(−2.048)	(−2.198)	(−2.940)	(−3.001)	(−2.174)	(−2.195)
High data quality (1 = Yes)	−.429*	−.552*	−.448*	−.453**	−.484*	−.585**	−.526*	−.663**
	−.146	−.188	−.153	−.207	−.165	−.199	−.183	−.226
	(−1.247)	(−1.583)	(−1.368)	(−1.755)	(−1.484)	(−1.800)	(−1.575)	(−1.935)
Latin America (1 = Yes)	.948***	.815***	.999**	.939***	.934***	.911***	.911***	.985***
	.521	.653	.453	.662	.516	.616	.544	.679
	(2.355)	(3.008)	(2.060)	(2.968)	(2.487)	(3.058)	(2.531)	(3.260)
Asia (1 = Yes)	.131	.571	.366	.404*	.247	.577	.143	.557
	.039	.169	.109	.261	.073	.171	.043	.165
	(.197)	(.886)	(.582)	(1.355)	(.391)	(.951)	(.935)	(.882)
Sub-Saharan Africa	.668	.985**	.688	.765**	.746*	.767**	.554	.853*
(1 = Yes)	.262	.386	.270	.433	.292	.379	.217	.335
	(1.114)	(1.755)	(1.214)	(1.876)	(1.285)	(1.687)	(.935)	(1.459)
World-systems variables								
Export partner concentration,	.001	.001						
1990	.018	.001						
	(.145)	(.011)						
Commodity concentration,			.015*	.009				
1990			.212	.117				
			(1.595)	(.847)				
Multinational corporate					.016*	.020**		
penetration,1990					.214	.271		
					(1.414)	(1.812)		

(*Continued*)

Table 2
(*Continued*)

	Equation 2.1	Equation 2.2	Equation 2.3	Equation 2.4	Equation 2.5	Equation 2.6	Equation 2.7	Equation 2.8
International Monetary Fund conditionality, 1990							.035 .067 (.531)	.041 .077 (.599)
Interaction terms and calculated effects								
Corresponding world-systems	.008*	.008*	.015***	.009**	.018***	.020***	.076**	.081**
Measure × repression	.365 (1.348)	.348 (1.353)	.602 (2.475)	.413 (1.671)	.490 (2.692)	.543 (2.993)	.235 (1.882)	.249 (1.949)
Calculated world-systems effect at high repression	.014	.014	.040	.024	.046	.053	.134	.176
Calculated world-systems effect at low repression	−.012	−.012	−.010	−.006	−.014	−.013	−.091	−.094
Adjusted R-squared	.303	.300	.381	.379	.372	.353	.328	.299
Number of cases	65	65	65	65	65	65	65	65
Mean variance inflation factor score	2.636	2.550	2.562	2.578	2.559	2.613	2.590	2.562
Highest variance inflation factor score	5.235	5.277	5.236	5.300	5.224	5.307	5.273	5.277

Notes: ***P <.01 (one-tailed); **P < .05 (one-tailed); *P < .10 (one-tailed).
The first number reported is the unstandardized regression coefficient, the second number is the standardized regression coefficient, and the third number in parentheses is the t-statistic.
Burundi and Oman are removed from each equation because they are influential cases.

is equal to .001. The effect on deforestation at low levels of repression is equal to −.012. Second, the interaction term between commodity concentration and repression is significant in equations 2.3 and 2.4. A similar pattern to the export partner concentration equations can be observed with commodity concentration. Third, foreign investment tends to increase deforestation more in repressive nations than in democratic nations. The coefficients for the interaction term between foreign investment and repression are significant in equations 2.5 and 2.6. In equation 2.5, the effect of foreign investment on deforestation at high levels of repression is equal to .046. The effect on deforestation at mean levels of repression is equal to .016, and the effect at low levels of repression is equal to −.014. A similar pattern can be found in equation 2.6. Fourth, the coefficient for the interaction term between International Monetary Fund conditionality and repression are significant in equations 2.7 and 2.8. Again, the effect of International Monetary Fund conditionality on deforestation is more adverse in repressive nations than in democratic nations.[7]

It is important to note that other findings remain stable and consistent across the new model specification. First, I continue to find that economic development reduces deforestation. The coefficients for gross domestic product per capita are negative and significant in Table 2. Second, the coefficients for the forest stock, data quality, and geographical controls maintain their direction and level of statistical significance.[8]

A problem that commonly arises in cross-national research is that of missing data. Statistical procedures such as multivariate regression analysis generally assume that each country has complete data. However, for numerous reasons, countries may be missing values on one or more of the variables under investigation. When this is the case, questions emerge about the extent to which inferences about the parameters and tests of statistics are influenced by the presence of incomplete data. I deal with this limitation by using group mean substitution for a few of my variables (see above). However, mean substitution underestimates standard errors. Given that the imputed observations are themselves estimates, their values have corresponding random error. Despite this, imputed values are treated as actual observations in analyses. The extra source of error is ignored, resulting in too-small standard errors and too-small *P*-values (Kline 1998).

To overcome this limitation, I also estimate my models using listwise deletion. The results are remarkably similar to those presented here with all the interaction terms being statistically significant and calculations revealing that the various world-systems measures increase deforestation more at higher rather than at lower levels of repression. However, there are several potential drawbacks that may emerge from this approach. First, the effective sample size with listwise deletion only includes those countries with complete records, and,

consequently, this number can be substantially smaller than the original sample size if missing observations are scattered across many countries. Second, different models may be estimated with a different sample of countries in an attempt to maximize the use of data availability. In all these instances, listwise deletion may result in biased estimates (Kline 1998).

I attempt to determine if my estimates are biased by listwise deletion by using Arbuckle's (1996) full information maximum likelihood estimation routine to handle incomplete data. Jorgenson (2003), Paxton (2002), and Shandra (2007) use this approach in recent cross-national analyses. It works by creating a likelihood for the entire sample by summing the likelihoods of each case using whatever information is available for each case and yields more consistent and efficient estimates than listwise deletion (Arbuckle 1996).

The size and significance of the full information maximum likelihood coefficients are remarkably similar to both the mean substitution and listwise deletion coefficients. First, the coefficients for all the interaction terms are significant. Calculations revealed a pattern similar to the listwise deletion results in which the each of the world-systems variables increased deforestation more at higher levels of repression. Thus, there is little evidence that the listwise deletion results are biased, and, consequently, my confidence in these results is enhanced. I do not present these results here because of space, but they are available from the author upon request.

Discussion and Conclusion

The previous research on deforestation provides an important starting point for understanding this phenomenon, and I confirm several hypotheses of this earlier work. First, I find that economic development reduces deforestation. This has been documented previously by Burns et al. (1994), Jorgenson (2006a), and Shandra (2007). Second, I find that population growth also increases deforestation. This has been observed previously by Allen and Barnes (1985), Ehrhardt-Martinez (1998), Rudel (1989), Rudel and Roper (1997).

However, I note above that Bradshaw (1987) warns about "particularism" and London and Smith (1988) and Smith (1996) call for "synthesis" in cross-national research of this sort. My article begins to address such concerns by specifying the contexts in which political factors that are internal to a nation *interact* with economic factors that are external to a nation to influence deforestation. In doing so, I find that world-systems relationships such as export partner concentration, commodity concentration, foreign investment, and International Monetary Fund conditionality, increase deforestation more at higher levels of repression than at lower levels of repression. These findings support my hypothesis regarding the detrimental impact that "good business climates" created by repressive nations for multinational capital have on the

natural environment. It is apparent that the regulatory concessions (i.e., exemptions to environmental laws and labor mobility) and financial incentives (i.e., tax holidays) that repressive nations offer enhance the ability of foreign investors to pursue activities that result in deforestation.

Consequently, the main theoretical and methodological contributions of this research pertain to the importance of not only including factors from competing theoretical perspectives simultaneously in cross-national analyses but also specifying the contexts in which these factors interact with each other (see also Burns, Kick, and Davis 2003). Intranational–political and international–economic dynamics are so interwoven in the modern capitalist system that any analysis that does not specify how effects of both sets of factors interact to influence the environment is seriously deficient and offers at best a partial explanation (London and Williams 1990).

Some important policy implications correspond with my main findings. The results suggest that democracy mitigates the harmful effects of various world-systems measures on forests. Thus, there are certain policies that governments can promote that may lessen deforestation caused by exports, multinational corporations, and structural adjustment. Such policies include (1) popular participation in decision making; (2) public access to information; (3) recognition of labor unions; and (4) guarantees of free press, speech, and assembly (Rich 1994).

A great illustration of how such laws may reduce deforestation comes from Brazil. In 1986, Brazil passed an environmental impact assessment law that not only calls for environmental impact assessments for development projects but also requires that the assessments be written in publicly understandable languages and requires public hearings to review the studies (Rich 1994). The law was ignored by the government for the first four years it existed. However, approximately 500 people assembled for the first time in 1990 to discuss a cattle ranching proposal (Rich 1994). The cattle ranchers applied for a permit to convert a large amount of forest to pasture. The National Council of Rubber Tappers along with the help of international non-governmental organizations drafted a detailed refutation of the environmental impact report for the plan (Barbosa 2001). Following the meeting, the state environmental agency ruled against the deforestation proposal (Rich 1994).

I conclude with a discussion of possible directions for future research. This research highlights some broad patterns of deforestation on a global scale. However, this analysis surveys a short period of time and does not capture longer patterns in world-systems. Unfortunately, comparable data on deforestation are limited to the past 10 years. World-systems theory predicts macrostructural changes occurring over very long periods of time (Bornschier and Chase-Dunn 1985). Any efforts to gauge processes from the most recent period are bound to miss long-term cycles and secular trends. Therefore, researchers need more

longitudinal data on variables to understand the long-term effects of my independent variables on deforestation. Further, it would be possible to pool cross-sectional data so as to increase the number of degrees of freedom enabling researchers to include more than five or so independent variables included in these models when such data become available (Tabachnick and Fidell 2001). A pooled cross-sectional analysis would also allow researchers to conduct separate cross-national analyses for each region of the world. This would allow social scientists to shed some light on the dynamics that shape deforestation in these different locations.

ENDNOTES

*The author would like to thank Bruce London for helpful comments on an earlier draft. Thanks also to the anonymous reviewers for their insights and suggestions. Please direct all correspondence to John M. Shandra, Department of Sociology, Social and Behavior Sciences Building, State University of New York at Stony Brook, Stony Brook, New York, NY 11794 or via e-mail at jshandra@notes.cc.sunysb.edu.

[1]The discussion of the "internal" and "external" distinction used by cross-national researchers in sociology is similar to the "proximate" and "ultimate" distinction surrounding the causes of deforestation in the other disciplines. See Geist and Lambin (2002) for more on this latter distinction.

[2]The following nations are included in the analysis: Argentina, Bangladesh, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burundi, Cameroon, Central African Republic, Chad, Chile, China, Columbia, Costa Rica, Ecuador, El Salvador, Ethiopia, Gambia, Ghana, Guatemala, Guinea, Guinea Bissau, Haiti, Honduras, Hungary, India, Indonesia, Ivory Coast, Jamaica, Kenya, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Mongolia, Mozambique, Namibia, Nepal, Nicaragua, Niger, Nigeria, Oman, Pakistan, Panama, Paraguay, Peru, The Philippines, Poland, Peru, Romania, Rwanda, Senegal, South Africa, Sri Lanka, Tanzania, Thailand, Togo, Trinidad, Tunisia, Turkey, Uganda, Venezuela, Vietnam, and Zimbabwe.

[3]Three of my world-systems measures have data for less than 68 nations. Data are available on export partner concentration for 53 nations, data are available on commodity concentration for 51 nations, and data are available for International Monetary Fund conditionality for 59 nations. To allow for the maximum use of data available, I employ mean substitution for the missing values in these three variables to maintain a constant sample of 66 nations.

[4]I include total stocks of foreign direct investment rather than stocks in particular sectors (i.e., primary, secondary, or tertiary). It is possible that including total stocks underestimates the actual effect of multinational corporate investment on deforestation in poor nations. Jorgenson (2006a) takes a similar approach in examining flows of all exports rather than particular commodity types in his recent article on weighted export flows.

[5]York, Rosa, and Dietz (2003) argue that researchers should not only examine overall growth rates but also the impact of growth in different contexts. It has been argued that expanding urban centers create economic opportunities other than agricultural ones that attract people to cities, which relieve demands on forest resources (Rudel and Roper 1997). Therefore, I replace total population growth rate with rural and urban population growth rates in the analysis. The coefficients for each variable are in the expected direction but do not achieve statistical significance.

[6]Ehrhardt-Martinez (1998) finds that an inverted, U-shaped curve exists between urbanization and deforestation. I tested this hypothesis by replacing gross domestic product and its square with urbanization and its square. The coefficients for the squared term were negative but did not reach statistical significance.

[7]Bollen and Paxton (2000) argue that nonrandom measurement error arising from the subjective perceptions of judges affect all cross-national measures of democracy to some degree. This is true of the political rights and civil liberties scales published by Freedom House (1997). Such measurement error can bias coefficient estimators of effects and distort comparisons across nations, undermining the empirical results that ignore it. Thus, I attempt to overcome this limitation by also estimating my models using the level of democracy or autocracy in a nation using data from the Polity IV Project (2005). The use of multiple indicators can help overcome problems with validity and reliability that arise as a result of nonrandom measurement error (Kline 1998). This technique has been used previously by London and Ross (1995) and Paxton (2002). This measure ranges from a –10 (autocracy) to 10 (democracy). The results based upon this measure (not shown here for sake of space) are very similar to the results presented here. However, they are available from the author upon request.

[8]I would like to thank one of the reviewers for pointing out that the largest forest exporting nations may be "driving" the analysis. According to the World Resources Institute (2000), Brazil, Indonesia, and Malaysia were the largest forest exporting nations in 1990. Thus, I removed these nations from the analysis and re-run all of my models. This yielded a sample of 63 nations with Burundi and Oman again being removed because they are highly influential. The results excluding the largest forest product exporting nations were remarkably similar to the results presented. All of the variables maintained their expected sign and significance. Calculations involving the interaction term revealed that export partner concentration, commodity concentration, multinational corporate penetration, and conditionality increase deforestation more at higher rather than at lower levels of repression. I do not present these results for sake of space, but they are available from the author upon request.

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Appendix A

Descriptive Statistics and Bivariate Correlation Matrix for Variables Included in the Analysis

	Mean	Standard deviation	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Deforestation	.944	1.763	1.000															
(2) Gross domestic product	.000	2793.428	−.318	1.000														
(3) Gross domestic product squared	73690320	36800125	−.322	.049	1.000													
(4) Repression	4.44	1.793	.108	−.613	.236	1.000												
(5) Government expenditures	14.058	6.973	.125	.013	.013	−.016	1.000											
(6) Population growth	2.338	1.431	−.026	−.080	.401	.216	.125	1.000										
(7) Domestic investment	20.911	7.714	−.264	.245	−.091	−.175	.200	−.181	1.000									
(8) Forest stocks	5.351	.756	−.223	.046	−.093	−.042	−.112	−.127	.043	1.000								
(9) High data quality	.754	.434	−.236	.106	.168	−.231	−.236	.034	−.059	.083	1.000							
(10) Latin America	.279	.452	.148	.365	−.186	−.537	−.107	−.080	−.220	.243	.210	1.000						
(11) Asia	.177	.384	−.163	−.125	−.201	.093	−.089	−.094	.345	.164	−.123	−.290	1.000					
(12) Sub-Saharan Africa	.426	.498	.206	−.501	.138	.466	.158	.264	−.176	−.243	−.152	−.559	−.393	1.000				
(13) Export partner concentration	29.696	15.002	.132	−.008	−.095	−.107	−.207	.122	−.146	.043	−.004	.250	−.069	−.051	1.000			
(14) Commodity concentration	33.314	17.912	.330	−.345	.206	.242	−.083	.119	−.326	−.214	.144	.189	−.279	.142	.109	1.000		
(15) Multinational penetration	12.002	16.617	−.007	.127	−.164	−.238	.078	.095	.227	−.070	.016	.088	−.072	.073	.049	.027	1.000	
(16) International Monetary Fund concentration	.120	2.397	.029	.094	−.114	−.283	.007	−.156	−.159	.032	.100	.259	−.151	−.122	−.062	.062	.105	1.000