DEBT, STRUCTURAL ADJUSTMENT, AND DEFORESTATON: A CROSS-NATIONAL STUDY[1]

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ABSTRACT

We present cross-national models that examine the determinants of deforestation from 1990 to 2005 for a sample of sixty-two poor nations. We test dependency theory hypotheses that both debt and structural adjustment affect forests. We find substantial support for this theoretical perspective. The results indicate that both factors increase deforestation. We also find support for world polity theory that international non-governmental organization density decreases deforestation. We conclude with a brief discussion of the findings, policy implications, and possible directions for future research.

INTRODUCTION

It is generally thought that high levels of debt in poor nations should lead to increases in deforestation (e.g., Barbosa 2001; George 1992; McMichael 2004; Rich 1994). The logic behind this assumption is that poor nations are under constant pressure to service their foreign debts. Thus, governments attempt to increase export earnings in order to finance interest and principal payments. This, in turn, may increase deforestation because the sectors targeted for export include forestry, agriculture, cattle ranching, and mining, all of which involve extensive tree removal. Nevertheless, cross-national research on this topic has yielded mixed results. For example, Kahn

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and MacDonald (1994) find that debt service increases tropical deforestation. Marquart-Pyatt (2004) finds no relationship between debt service and deforestation in a sample of both non-tropical and tropical nations. Capistrano (1994) observes that debt service decreases deforestation ostensibly by reducing capital available for investment for a sample of tropical and non-tropical nations.

These contradictory findings suggest a need for additional study of the relationship between debt and deforestation. Therefore, one goal of this research is to reevaluate this relationship within the framework of a cross-national model of deforestation. However, we expand upon previous research by considering the impact of structural adjustment lending. We do so because structural adjustment requires indebted nations to adopt certain macro-economic policy reforms to receive the loans. These policy reforms include boosting exports, liberalizing trade, and cutting government spending, which all may increase deforestation. The suggestion that structural adjustment increases deforestation is generally rooted in dependency theory. Thus, we now turn to a review of dependency theory and its prediction regarding deforestation. We also elaborate upon the reasons for including other relevant predictors in our cross-national models. We conclude with a discussion of the findings, brief policy suggestions, and possible directions for future research.

DEPENDENCY THEORY

The dependency perspective argues that international economic exchanges and unequal power relationships between rich and poor nations are detrimental to the poor nations of the world. In essence, rich nations become wealthy by exploiting the cheap labor and resources of poor nations (cf. Amin 1976; Evans 1979; Frank 1967).[2] In recent years, a substantial body of cross-national research has been produced in an attempt to provide empirical tests of propositions drawn from dependency theory. This research has noted the changing nature of economic exchange relationships among nations. The earliest studies tended to incorporate measures of "classical" trade dependence such as commodity concentration or export partner concentration. Research focusing on a later period – roughly the 1970s and early 1980s – tended to focus on multinational corporate penetration (i.e., Bornschier and Chase-Dunn 1985). Another strand of studies shifts the focus to various types of debt dependency generated by the "debt crisis" (i.e., Bradshaw and Huang 1991); Walton and Ragin 1990). Our study follows in this tradition.

The debt crisis highlighted the inability of many poor nations to generate enough revenue to make payments on their foreign debt. The International Monetary Fund and World Bank responded to the debt crisis by providing structural adjustment loans designed to resolve the balance-of-payment issues by rescheduling payments, renegotiating loan terms, and providing new loans (McMichael 2004). However, the new loans required indebted nations to institute a variety of economic policy reforms in return for the money (Rich 1994). These policy reforms include devaluing currency, reducing government spending, liberalizing trade, and privatizing government assets (Peet 2003). The underlying logic behind these reforms was an attempt to stimulate economic growth and generate hard currency for debt repayment by increasing exports

[2] There is a substantial literature in the tradition of dependency and world system theories. Given its familiarity, we do not present a detailed synthesis of this body of literature here for sake of space. Further, the emphasis of this research is on debt and structural adjustment. However, see Peet (1999) for a detailed overview of the origins and evolution of dependency theory.

and decreasing spending. While the "earn more" and "spend less" model may facilitate debt repayment, it also has the potential to increase deforestation (George 1992).

First, structural adjustment programs require that governments promote economic activity consonant with their "comparative advantage" (Peet 2003). This often involves the export of whatever available natural resources may be in demand on the world market. Put differently, nations attempt to increase export earnings in order to finance interest and principal payments (McMichael 2004). The most common way to achieve this is currency devaluation, which creates a demand for a nation's exports on the world market (Mohan 2001). Generally, poor nations meet increased demand by expanding production and extraction for export (Rich 1994). The sectors that may increase deforestation include logging, ranching, mining and agriculture (George 1992; McMichael 2004). In fact, most exports are destined for the rich nations of the world (Peet 2003). This idea corresponds with Jorgenson's (2006) insight regarding the theory of unequal ecological exchange (i.e., deforestation is higher in the poor nations of the world because they produce forest product for richer nations).

Second, structural adjustment loans usually require deep cuts in government spending to correct for budgetary imbalances (Barbosa 2001). The nature of the cuts has varied from nation to nation, but a common theme has been the reduction in the budgets and staffs of environment and conservation departments (Tockman 2001). These cuts often hamper enforcement of environmental regulations, impede efforts to prevent illegal logging, and hinder demarcation of protected area (Rich 1994). In other words, structural adjustment reduces the regulatory capacity of governments to deal with causes of forest loss. It is also important to note that budgetary cuts reduce or eliminate government subsidies and credit for agricultural inputs (Rudel 1993). These subsidy cuts often force small-scale farmers to expand production into marginal land areas, especially forests, in order to maintain crop yields (Rudel 2005).

Third, structural adjustment loans require governments to liberalize trade by removing barriers to foreign investment. This involves a variety of regulatory concessions and financial incentives as well as privatizing government assets (Walton and Ragin 1990). Regulatory concessions may include exemptions on logging harvest quotas, exporting raw logs, logging protected species, and logging in protected areas (Hurst 1990). The most notable financial incentives are "tax holidays" that involve exemptions of export duties, import duties, and corporate income taxes (Leonard 1988). The purpose of the regulatory concessions and financial incentives is to stimulate investment within a nation to generate currency to meet debt obligations (Clapp 1998). However, regulatory concessions and economic incentives often result in deforestation. Tax cuts and environmental law exemptions make cattle ranching, logging, and export agriculture more profitable. Thus, investment in these areas tends to increase and, consequently, deforestation increases as well (Mohan 2001). In addition, tax breaks and selling off of public enterprises often yield additional reductions in spending by eroding the tax base because there is little new revenue being collected by the government (George 1992). This hampers the regulatory capacity of governments to monitor forestry mandates and implement conservation projects, which are already limited by mandated cuts (Deacon 1994). Further, small-scale producers, who are thrown off the land when export agriculture is expanded by large corporations, may turn to logging for survival (Culas 2006).

Fourth, structural adjustment exacerbates poverty, which also may increase forest loss. In this regard, a focus on raw material exports prevents increases in the sort of value-added industries that employ the poor (i.e., manufacturing and services) (Mohan 2001). By slowing the creation of jobs in sectors other than agriculture, fewer jobs are available to urban workers who, lacking alternatives, put more pressure on forests (Ehrhardt-Martinez 1998). Finally, cuts on

social service expenditures for the poor also increase incursions into forests as people extract resources to supplement their incomes (George and Sabelli 1994).

As noted previously, cross-national research has not considered the impact of structural adjustment (e.g., Capistrano 1994; Kahn and MacDonald 1994; Marquart-Pyatt 2004; Rudel and Roper 1997). However, structural adjustment has been included as a predictor in cross-national research on a variety of other topics. For example, Walton and Ragin (1990) examined structural adjustment in models of political protest. Bradshaw and Schafer (2000) considered the impact of this variable on urbanization, economic growth, and access to safe drinking water. Schafer (1999) utilized this variable in cross-national models of education, while Buchman (1996) examined the relationship between structural adjustment and women's education. It is important to note that these studies also examined debt service at the same time. Thus, as suggested by dependency theory, we seek to test whether structural adjustment and debt service increase deforestation.

WORLD POLITY THEORY

Scholars writing in the world polity tradition hold that international organizations play an important role in constituting and reinforcing world cultural norms (e.g., Boli and Thomas 1999). In fact, Meyer and his colleagues (1997) describe the existence of the "world environmental regime" composed of international non-governmental organizations, inter-governmental organizations, and treaties that are part of this process. The role that international non-governmental organizations play is of particular interest here. First, international non-governmental organizations intervene in global political processes and help shape the language of international treaties dealing with the environment, thereby influencing the normative content of global institutions (Risse, Ropp, and Sikkink 1999; Smith 1995). In the absence of resources and formal mechanisms of enforcement, international non-governmental organizations monitor compliance by nations with environmental treaties (Clapp 1994; Frank 1999). Consequently, international non-governmental organizations are in a position of pointing out embarrassing failures and hypocrisies of nations, which puts pressure on governments to adapt their behaviors to international norms (Finnemore and Sikkink 1998; Hafner-Burton and Tsutsui 2005; Shor forthcoming).

Second, international non-governmental organizations also help mobilize support for problem-solving initiatives when national level avenues are either inadequate or blocked (Smith 1995). It has become increasingly common for these organizations to provide support for conservation efforts at sub-national levels (Schofer and Hironaka 2005). In doing so, international non-governmental organizations directly fund local environmental protection efforts. Furthermore, they often serve as intermediaries, bridging disparate community groups under the rubric of "grassroots" development (Schafer 1999). This involves facilitating conservation efforts by integrating financial, technical, and organizational resources from abroad with local knowledge and community participation (Bradshaw and Schafer 2000).

Third, international non-governmental organizations support social movement activity at the local level (Keck and Sikkink 1998). Frank, Hironaka, and Schofer (2000) found that nations strongly linked to world society (e.g., more international non-governmental organizations within a nation) experience a growth in domestic environmental social movements (e.g., more domestic non-governmental organizations within a nation). These ideas can be observed in practice when international non-governmental organizations (e.g., Greenpeace, Sierra Club, and Conservation International) employ frames and discourses that encourage domestic social movement activity and, in turn, environmentalism within a nation (Frank 1999). In such instances, governments are

"squeezed" from above and below to attend to environmental problems like deforestation (Schofer and Hironaka 2005). Keck and Sikkink (1998) refer to this process as a "boomerang effect." Recently, Shandra and colleagues (2008), Shandra (2007a, b), and Schofer and Hironaka (2005) found support for world polity theory. As such, we seek to further evaluate the hypothesis that international non-governmental organizations decrease deforestation in the context of a model that also takes into account both debt service and structural adjustment.

NEO-MALTHUSIAN THEORY

Neo-Malthusian theory argues that demographic factors, especially population growth, are prominent causes of environmental degradation. Such ideas, rooted in Malthus's (1983 [1826]) 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. Ehrlich and Ehrlich (2004) among others have extended this line of reasoning. Their general argument holds that increases in population growth drive extraction, consumption, and production.

These processes have the potential to increase deforestation—for a recent discussion of the literature on population dynamics and deforestation, see Carr, Suter, and Barbieri (2005). Rudel and Roper (1997) describe how deforestation comes about in their "immiserization" and "frontier" models of development. They see deforestation as the result of growing populations of peasants and shifting cultivators carving small farms out of forests. The economies of poor nations provide few livelihoods for poor peasants other than agriculture. Moreover, 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, Kick, and Davis 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 by clearing forests (Burns et al. 2003). 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). Jorgenson (2006), Ehrhardt-Martinez (1998), and Rudel (1989) among others find support for the hypothesis that population growth increases deforestation.

York, Rosa, and Dietz (2003) argue that it is important to "decompose" population in cross-national research. That is, researchers should examine not just overall growth rates per se, but also the impact of growth in different contexts. Accordingly, Jorgenson (2006) finds that rural population growth increases deforestation. Further, Jorgenson and Burns (2007) find that rural population growth should contribute to deforestation while urban population growth reduces it. They argue that expanding urban centers often create economic opportunities other than agricultural ones, which attract people to cities. This process relieves the demand on forest resources and reduces deforestation. Thus, we seek to examine the differential impact of rural and urban population growth on deforestation. However, we again would like to note that this will be in the context of a model that includes international non-governmental organizations, debt service, and structural adjustment.

We have provided the rationale for including these variables in our models. We also take into account several other factors. These variables include gross domestic product per capita, economic growth, domestic economy structure, democracy, government spending, forest stocks,

and data quality. We provide below a brief justification for including these variables in a model of deforestation.

NATIONS INCLUDED

We include nations located in Asia, Africa, Latin America, and the Caribbean that are not classified as high income according to the World Bank's (2003) income quartile classification scheme.[3] We exclude high income nations because they do not receive structural adjustment loans. We also do not include nations formed following the collapse of the Soviet Union because there are no data for them in 1990. This yields a sample of sixty-two nations for which complete data are available. We follow the standard practice to report and remove any influential cases from the analysis (Jorgenson 2003). In this analysis, we remove Indonesia because it is an influential case.

DEPENDENT VARIABLE

Deforestation

The dependent variable for our analysis is the average annual percentage change in natural forest area from 1990 to 2005. Please note that deforestation is signified by a positive value for interpretation purposes. The data may be obtained from the Food and Agriculture Organization (2005). This measure includes land greater than half a hectare in size with trees higher than five meters and a canopy cover of more than ten percent. A natural forest consists only of native forest species with the possible exception of small areas of natural regeneration or assisted natural regeneration. This measure excludes forest plantations, which are areas established through planting or seeding (Food and Agricultural Organization 2005). Most cross-national research (e.g., Burns, Kick, and Davis 2006; Jorgenson 2006; Shandra 2007a) examines the average annual percentage change in total forest area, which includes natural forest areas as well as forest plantations. A forest plantation often involves relative homogeneity in the types of species grown for commercial purposes (World Resources Institute 2005). We use natural forest area data because we are interested in the potential effects of debt and structural adjustment on land that is not already being intensively managed for commercial production. We provide descriptive statistics in Table 1 and bivariate correlations in Table 2.

[3] The following nations are included in the analysis: Albania, Algeria, Angola, Argentina, Bangladesh, Benin, Bolivia, Brazil, Bulgaria, Burkina Faso, Central African Republic, Chad, Chile, China, Columbia, Congo, El Salvador, Ethiopia, Gabon, Gambia, Ghana, Guatemala, Guinea, Guinea-Bissau, Honduras, Hungary, India, Jamaica, Kenya, Lesotho, Madagascar, Malawi, Malaysia, Mauritius, Mexico, Mongolia, Mozambique, Nepal, Nicaragua, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Romania, Rwanda, Senegal, Sierra Leone, South Africa, Sri Lanka, Swaziland, Tanzania, Thailand, Togo, Trinidad, Uganda, Uruguay, Zambia, and Zimbabwe.

Table 1. Descriptive Statistics (N=62)

	Mean	Standard Deviation	Skewness	Kurtosis
Deforestation, 1990-2005	0.656	1.034	.937	2.375
Gross Domestic Product, 1990 (ln)	7.627	.827	-.005	-1.105
Economic Growth Rate, 1990	2.207	4.491	-.674	.184
Service Activity, 1990	45.654	11.061	-.337	.626
Manufacturing Activity, 1990	16.033	8.249	.894	.816
Democracy, 1990	-4.234	1.580	-.138	-1.133
Government Expenditures, 1990	4.233	.414	-.063	1.443
Population Growth, 1990 (ln)	2.629	.083	-1.121	2.045
Rural Population Growth, 1990 (ln)	2.491	.145	-1.144	1.235
Urban Population Growth, 1990 (ln)	2.601	.136	-.596	.254
Natural Forest Stocks, 1990 (ln)	8.594	2.134	-1.061	2.372
Data Quality, 1990	.580	.497	.335	-1.952
Total Debt Service, 1990 (ln)	2.796	.817	-1.123	1.437
IMF-WB Debt Service, 1990 (ln)	2.697	.829	-1.110	1.362
Structural Adjustment, 1990 (ln)	2.355	.436	-.874	3.620
INGO Density, 1990 (ln)	.525	.465	1.346	1.968

Table 2. Bivariate Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) Deforestation, 1990-2005															
(2) Gross Domestic Product, 1990 (ln)	-.358														
(3) Economic Growth Rate, 1990	.144	-.166													
(4) Service Activity, 1990	-.047	.326	.178												
(5) Manufacturing Activity, 1990	-.287	.381	-.115	-.091											
(6) Democracy, 1990	-.117	.619	.074	.489	.081										
(7) Government Expenditures, 1990	-.072	-.062	-.176	-.164	.004	-.137									
(8) Population Growth, 1990 (ln)	.320	-.472	.346	.058	-.317	-.330	.088								
(9) Rural Population Growth, 1990 (ln)	.327	-.602	.329	-.091	-.139	-.396	.064	.653							
(10) Urban Population Growth, 1990 (ln)	.276	-.645	.406	-.016	-.459	-.402	.031	.786	.579						
(11) Natural Forest Stocks, 1990 (ln)	.026	-.051	-.137	-.074	.062	-.062	-.003	.123	-.012	.073					
(12) Data Quality, 1990	-.197	.122	.144	.152	-.018	.217	-.089	-.106	-.049	-.105	-.062				
(13) Total Debt Service, 1990 (ln)	.295	-.193	.216	-.051	-.160	.230	-.279	.120	-.043	.155	.279	.254			
(14) IMF-WB Debt Service, 1990 (ln)	.334	-.241	.242	-.052	-.187	.190	-.321	.123	-.011	.178	.226	.248	.981		
(15) Structural Adjustment, 1990 (ln)	.237	-.014	.082	.198	.031	.277	-.224	-.079	-.137	-.072	.176	.138	.310	.326	
(16) INGO Density, 1990 (ln)	-.130	.129	.285	.277	-.021	.348	.131	.024	.056	-.041	-.546	.176	.013	.014	.118

INDEPENDENT VARIABLES

Gross Domestic Product Per Capita

As is standard in such analyses, it is incumbent on us 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). In this regard, we 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). We log this variable to correct for its skewed distribution. Shandra (2007b, c) and Jorgenson (2006) find that economic development reduces deforestation. Burns and colleagues (2006) attribute this finding to wealthier nations externalizing their environmental costs by importing natural resources from poorer nations. Thus, we anticipate that gross domestic product per capita should decrease deforestation.

Economic Growth

We also include the average annual economic growth rate from 1980 to 1990. These data may be obtained from the World Bank (2003). It is generally thought that economic growth should increase deforestation. This is because there are large amounts of capital available for investment in activities that accelerate forest loss during periods of economic growth (Rudel 1989).

Service-Based Economic Activity

We also include the value added from service-based economic activity as a percentage of gross domestic product for 1990. These data may be obtained from the World Bank (2003). We include this variable because it has been suggested that the structure of the economy within a nation may be related to levels of deforestation (Ehrhardt-Martinez, Crenshaw, and Jenkins 2002). Jorgenson (2006) argues that poor nations largely rely on export markets to stimulate economic growth. In this regard, nations often export primary products and agricultural goods, which increase deforestation (Burns et al. 2003). However, forest loss may be mitigated to the extent that nations have something other than raw materials to export like services and manufactured goods. Thus, we hypothesize that nations with high levels of value added in services should have less deforestation.

Manufacturing-Based Economic Activity

We also include value added from the manufacturing sector as a percentage of gross domestic product in 1990. These data may be obtained from the World Bank (2003). We include this variable as another control for the structure of a domestic economy. As explained above, we hypothesize that nations with a larger amount of economic activity from manufacturing should have less deforestation.

Democracy

We use the average of Freedom House's (1997) political rights and civil liberties scales for 1990 as our measure of democracy. Political rights reflect the degree to which 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 (Freedom House 1997). These variables are measured on a seven-point scale with the following codes: free (1-2), partially free (3-5), and not free (6-7). We multiply our index by negative one so that high scores correspond with high levels of democracy. York and colleagues (2003) use these variables in a cross-national study of ecological footprints.

We anticipate that democracy should decrease deforestation because of political activism and electoral accountability (Li and Reuveny 2006). In general, democratic nations have higher levels of political activism than repressive nations because democracies guarantee certain rights including freedoms of speech, press, and assembly (Ehrhardt-Martinez et al. 2002). Leaders in a democracy must be responsive to such activism because of electoral accountability (Midlarsky 1998). Further, greater freedom of the press and assembly leads to wider diffusion of information, which, in turn, raises public awareness. Therefore, environmental groups are often more successful at informing people and organizing them to act in democratic rather than in repressive nations (Li and Reuveny 2006).

Government Expenditures

We also include a variable to assess the effect of state strength on deforestation. This variable is the total amount of central government expenditures as a percentage of gross domestic product for 1990. These data may be obtained from the World Bank (2003). Deacon (1994) argues that weak governments lack the ability to enforce forest protection and, consequently, forests tend to be treated as open access resources. This leads to increased deforestation. Thus, we hypothesize that government spending should reduce deforestation. However, it may well be that governments are spending money on projects that increase deforestation such as infrastructure and rural resettlement programs (Rich 1994).

Population Growth

The neo-Malthusian perspective suggests that demographic factors shape deforestation. Therefore, we include a measure of population growth from 1980 to 1990 in the analyses. These data may be obtained from the World Bank (2003). We log this variable to control for its skewed distribution. We hypothesize that population growth should increase deforestation.

Rural Population Growth

We note above that Jorgenson and Burns (2007) find that it is important to "decompose" demographic factors. That is, researchers should examine not just overall growth rates per se, but also the impact of population growth in different contexts (York et al. 2003). Therefore, we include the rural population growth rate from 1980 to 1990. This variable is logged to correct for its skewed distribution. These data may be obtained from the World Bank (2003). We hypothesize that rural population growth should increase deforestation.

Urban Population Growth

We also include the urban population growth rate from 1980 to 1990. These data may also be obtained from the World Bank (2003). We log this variable to deal with its skewed distribution. The discussion of neo-Malthusian theory suggests that urban population growth should reduce deforestation by removing excess population from rural areas and relieving pressure on forests (Jorgenson and Burns 2007).

Natural Forest Stocks

It is necessary to include a measure that controls for the potentially biasing effects of relative abundance or scarcity of forest resources (Rudel 1989). Therefore, we include natural forest area for 1990. We log this variable to control for its skewed distribution. These data may be obtained from the Food and Agricultural Organization (2005).

Data Quality

We also take into account data quality of the deforestation estimates.[4] These data may be obtained from the Food and Agriculture Organization (2005). We classify forestry statistics as being highly reliable if they are based upon remote sensing survey or current national field sampling estimates. We classify forestry statistics as having low reliability if they are based upon expert estimates, which often involve extrapolation from an outdated national inventory. As such, we include a dummy variable for reliability of deforestation measures, identifying those nations in which forest cover measures are based upon remote sensing surveys or current national field sampling estimates and should, therefore, be of higher quality (1 = high data quality). The reference category includes nations whose forestry estimates are based upon expert estimates or an outdated inventory (0 = low data quality). This coding has been used previously by Shandra (2007b, c).

International Non-Governmental Organization Density

We also include the number of international non-governmental organizations working on *environmental* and *animal rights* issues in a nation per capita for 1990. The data were collected by Smith (2004) from the *Yearbook of International Associations*. It is important to note that the data exclude labor unions, institutes, and foundations (Smith and Wiest 2005). Note, too, that a measure of international non-governmental organizations per capita is, in effect, a density measure. The population data (our denominator) may be obtained from the World Bank (2003). This variable has been used recently by Shandra (2007a). We feel this measure is an improvement over using the total number of international non-governmental organizations of all types because it specifically gauges the density of international non-governmental organizations concerned *only* with the natural environment. This is of particular importance because some organizations listed in the *Yearbook of International Associations* and included in the overall measure may not be concerned with the environment (e.g., labor unions). World polity theory hypothesizes that international non-governmental organization density should reduce deforestation.

[4] We would like to thank one of the reviewers for pointing out that the data quality variable may be a proxy for level of development. We do not think this is the case because the bivariate correlation between these two variables is .122. However, to be certain, we ran the analysis again removing the data quality dummy variable from the analysis. The results are similar to the ones presented in Table 2. Of particular note, gross domestic product per capita still does not explain any significant variation in deforestation. We do not present the results for sake of space, but they are available upon request.

Structural Adjustment

To capture the effects of structural adjustment, pressure, and conditionality required by the International Monetary Fund and other multilateral lenders, Walton and Ragin (1990) developed a conditionality index. It has been used previously by Shandra, London, and Williamson (2003), Bradshaw and Schafer (2000), Schafer (1999), and Buchman (1996) among others. This index is the sum of four variables which include (1) the number of debt renegotiations between a country and an international financial body, (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. The variables are measured in 1990. The four components of the index are converted to z-scores and summed. We log the variable to deal with its skewed distribution. The index effectively approximates structural adjustment because the International Monetary Fund imposes conditions in each of its negotiations and renegotiations with indebted nations (Walton and Ragin 1990). See Bradshaw and Wahl (1991) or Walton and Ragin (1990) for a more detailed discussion. Dependency theory hypothesizes that structural adjustment should increase deforestation.

Total Debt Service Ratio

In addition to the pressure to adjust their economies under structural adjustment, indebted nations must continually service their foreign debts. Therefore, it is also important to control for debt service as well as structural adjustment. This approach has been used previously by Bradshaw and Schafer (2000), Schafer (1999), and Buchman (1996). Thus, we also include the average sum of principal and interest payments in foreign currency, goods, or services on long-term public and publicly guaranteed private debt with maturity of one year or longer as a percentage of goods and services exports in 1990. These data come from the World Bank (2003). We log this variable to deal with its skewed distribution. According to dependency theory, total debt service should also increase deforestation.

International Monetary Fund and World Bank Debt Service Ratio

As an alternative measure of debt dependence, we also include the average debt service ratio that covers long-term public debt and repayments *only* to the International Monetary Fund and World Bank. These data are measured as a percentage of exports of goods and services for 1990, and may be obtained from the World Bank (2003). This variable is logged to control for its skewed distribution. Like total debt service, this variable should be associated with more forest loss.

FINDINGS

In Table 3, we present the ordinary least squares estimates of deforestation. In odd-numbered equations, we include the gross domestic product per capita, economic growth, service-based economic activity, manufacturing-based economic activity, government expenditures, measures of population growth, democracy, forest stocks, data quality, international non-governmental organization density, structural adjustment, and a measure of debt service.

Table 3. OLS Estimates of Deforestation (1990-2005) [N=62]

	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)	(2.8)
International Variables:								
Structural Adjustment,	.720**	.576*	.840**	.741**	.693**	.532*	.803**	.706**
1990 (ln)	.304	.243	.354	.33	.293	.224	.339	.298
	(2.322)	(1.945)	(2.805)	(2.779)	(2.243)	(1.798)	(2.693)	(2.625)
Total Debt Service,	.390*	.478***	.576***	.428***				
1990 (ln)	.308	.378	.455	.338				
	(1.981)	(2.907)	(2.997)	(2.863)				
International Monetary Fund and World					.414**	.494***	.579***	.421**
Bank Debt Service, 1990 (ln)					.332	.396	.464	.338
					(2.153)	(3.129)	(3.088)	(2.893)
Non-Governmental Organizations	-.753**	-.596*	-.861**	-.681**	-.741**	-.558*	-.833**	-.640**
Density, 1990 (ln)	-.338	-.268	-.387	-.306	-.333	-.251	-.375	-.288
	(-2.072)	(-1.850)	(-2.492)	(-2.358)	(-2.056)	(-1.757)	(-2.434)	(-2.233)
Intranational Variables:								
Gross Domestic Product,	-.103		.189		-.079		.211	
1990 (ln)	-.082		.151		-.063		.169	
	(-.442)		(.720)		(-.337)		(.802)	
Economic Growth Rate,	.010		.010		.008		.008	
1980-1990	.042		.043		.016		.034	
	(.317)		(.322)		(.261)		(.256)	
Service-Based Economic	.001		.006		.001		.006	
Activity, 1990	.016		.067		.016		.061	
	(.105)		(.486)		(.109)		(.451)	
Manufacturing-Based Economic	-.016		-.033**	-.023*	-.016		-.031*	-.021*
Activity, 1990	-.130		-.261	-.187	-.124		-.253	-.180
	(-.996)		(-1.989)	(-1.760)	(-.957)		(-1.936)	(-1.696)
Democracy, 1990	.013		-.063		.014		.054	
	.019		-.097		.022		.163	
	(.098)		(-.525)		(.113)		(.454)	
Government Expenditures,	.225		.362		.267		.406	
1990	.090		.145		.107		.163	
	(.691)		(1.174)		(.815)		(1.307)	
Population Growth Rate,	.901				.977			
1980-1990 (ln)	.232				.238			
	(1.546)				(1.601)			
Rural Population			.762***	.754***			.730***	.766***
Growth Rate, 1980-1990 (ln)			.486	.359			.482	.346
			(3.086)	(3.406)			(3.085)	(3.296)
Urban Population			-.976				-.979	
Growth Rate, 1980-1990 (ln)			-.155				-.143	
			(-.877)				(-.819)	
Control Variables:								
Natural Forest Stocks,	-.160**	-.139*	-.168**	-.141**	-.153**	-.125*	-.154**	-.127*
1990 (ln)	-.330	-.287	-.347	-.291	-.315	-.259	-.317	-.261
	(-2.096)	(-1.913)	(-2.339)	(-2.164)	(-2.057)	(-1.777)	(-2.202)	(-1.986)
Data Quality, 1990	.-.520**	-.617**	-.649**	-.573**	-.524**	-.619**	-.646**	-.568**
(1= High Reliability)	-.250	-.297	-.312	-.276	-.252	-.298	-.311	-.273
	(-2.059)	(-2.443)	(-2.709)	(-2.548)	(-2.096)	(-2.483)	(-2.716)	(-2.536)
Adjusted R-Square	.235	.188	.316	.358	.245	.205	.323	.360
Highest Variance Inflation Factor Score	3.073	1.689	3.934	1.721	2.983	1.625	3.987	1.650
Mean Variance Inflation Factor Score	1.995	1.053	2.227	1.126	1.872	1.101	2.276	1.092

Notes: * indicates p < .05, ** indicates p < .01, and *** p < .001 for a one-tailed test.
The first number is the unstandardized coefficient, the second number is the standardized coefficient,
and the third number is the t-statistic.

In equations (2.1) through (2.4), we include total debt service while in equations (2.5) through (2.8) we include debt service to only the International Monetary Fund and World Bank. We "decompose" population growth in equations (2.3), (2.4), (2.7), and (2.8). In even-numbered equations, we remove non-significant predictors from the previous equation in order to demonstrate the robustness of our findings.

We organize our analysis in this way for several important reasons. First, we want to avoid potential problems with multicollinearity. When we include both measures of debt service in the analysis at the same time, variance inflation factor scores are greater than ten. This is likely due to the high bivariate correlation between these variable (r = .980). However, the highest variance inflation factor score is less than four in models where we examine the effects of these variables separately. Second, the sequential use of "cognate" but "distinct" indicators of more than one independent variable should shed considerable light on the complexity of dynamics involving the issue under investigation (London and Ross 1995). If both debt service indicators maintain similar effects on deforestation, for example, then confidence in the general finding (i.e., debt increases deforestation) is enhanced. Third, multiple indicators help guard against potential problems associated with measurement error, because one indicator may be imperfect but several measures are less likely to have the same error (Paxton 2002).

Let us begin by considering the overall fit of our model to the data. The adjusted r-square values range from a low of .188 to a high of .360 in equations (2.2) and (2.8) respectively. The lowest of these values, especially equations (2.2) and (2.6), are problematic, even for cross-national research and, most likely, reflect the complexities of modeling deforestation. Note, however, that the lowest values are in the "trimmed" equations that do not decompose population growth—see equations (2.2) and (2.6). In other words, as should be expected, the equations without the significant rural population variable have the lowest adjusted r-square values. Moreover, all of the equations that include rural population, and, therefore, are more properly specified, have adjusted r-squares of .316 or higher. These r-square values are similar to those published by Shandra (2007a, b).

Now, let us turn our attention to statistically significant findings. First, we find substantial support for dependency theory in that *both* debt and structural adjustment increase deforestation. The coefficients for structural adjustment are positive and significant in every equation. The coefficients for the two debt service ratios are also positive and significant in every equation. Second, we find support that international non-governmental organization density reduces deforestation. The coefficients for this variable are negative and significant in every equation. Third, we find support for one particular aspect of neo-Malthusian theory. The coefficients for the rural population growth rate are positive and significant in every equation in which it is included. Fourth, we find some support for the claim that nations with a greater share of manufacturing have less deforestation. The coefficients for this variable are negative and significant in four of the eight equations. Fifth, the coefficients for both data quality and forest stocks are negative and significant in every equation.[5]

[5] 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 may emerge about the extent to which inferences about the parameters and tests of statistical significance are influenced by the presence of incomplete data. When using listwise deletion, for example, the effective sample size only includes those nations with complete records, and, consequently, this number can be substantially smaller than the original sample size if missing observations

There are some other non-significant findings that also should be mentioned. First, we find no support for the idea that democracy affects deforestation. The coefficients for this variable do not reach a level of statistical significance.[6] Second, we do not find that economic development decreases deforestation. The coefficients for gross domestic product per capita are not statistically significant.[7] Third, we do not find support for the hypothesis that economic growth increases deforestation. The coefficients for this variable are positive but do not reach a level of statistical significance. Fourth, no support was found for other aspects of the neo-Malthusian theory. We do not observe that urban population growth reduces deforestation by luring people to cities and lessening demands on forest resources. The coefficients for this variable are negative but not statistically significant. Likewise, the coefficients for total population growth are not significant. Fifth, we do not find that nations with a large service sector have less forest loss. The coefficients for service-based economic activity are not significant.[8] Sixth, we find no support for hypotheses that government spending affects forests.[9]

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are scattered across many nations. Further, nations that are excluded will often be the poorer countries that have fewer resources to allocate toward record keeping. Thus, the final sample may not be representative of the poorest nations. We attempt to determine if our estimates are biased by listwise deletion by using Arbuckle's (1997) full information maximum likelihood estimation routine to handle incomplete data. This approach has been used by Jorgenson (2003), Paxton (2002), and Kentor (2001). The size and significance of the full information maximum likelihood estimates are remarkably similar to the listwise deletion estimates, providing little evidence that the listwise deletion results are biased.

[6] Bollen and Paxton (2000) argue that non-random measurement error arising from the subjective perceptions of judges affect all cross-national measures of democracy to some degree. This bias may distort comparisons across nations, undermining the empirical results that ignore it. Therefore, we also estimate our models using the level of democracy or autocracy in a nation using data from the Polity IV Project (2005). This measure ranges from – 10 (autocracy) to 10 (democracy). The results using this measure are very similar to the results reported for the measurements of democracy in Table 1. We do not present these results for sake of space.

[7] Ehrhardt-Martinez et al. (2002) found that an environmental Kuznets curve exists between gross domestic product per capita and deforestation. We test this hypothesis using a quadratic polynomial equation in which the gross domestic product per capita 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, we begin by centering the linear term around its mean. We then square the centered term. Finally, we include the centered linear term and squared term in our models (York et al. 2003). The coefficients for the squared term are negative but fail to achieve statistical significance.

[8] Ehrhardt-Martinez (1998) tests for the presence of an inverted u–shaped curve between urbanization and deforestation. We use the same procedure described in the previous footnote to test this hypothesis. The squared urbanization term is negative but fails to predict any significant variation in deforestation, indicating no support for an environmental Kuznets curve between urbanization and deforestation.

DISCUSSION AND CONCLUSION

This study extends cross-national research on deforestation in a couple of novel ways. First, previous research that considers dependency theory hypotheses only examines how various forms of debt service impact deforestation. However, they do not consider the effect of structural adjustment on forest loss. We address this gap in the literature by examining the simultaneous impact of both factors on deforestation. In doing so, we find substantial support for dependency theory. The results indicate that both debt service and structural adjustment significantly increase forest loss. The reliability of these findings is demonstrated by their statistical significance across alternative model specifications and techniques for handling missing data as described in footnote five. Clearly, it is important to consider debt service and structural adjustment together when testing dependency theory hypotheses in a cross-national research design regarding the natural environment.

Second, we use a more nuanced indicator of deforestation as our dependent variable (i.e., average annual change in natural forest area) than previous studies. As noted above, this measure excludes forest plantations, areas established through planting or seeding, which are widely used to generate forest-related exports (Food and Agriculture Organization 2005). Using a deforestation measure that includes forest plantations may overestimate the impact of debt service and structural adjustment precisely because debt-related pressures and conditions are largely aimed at stimulating primary exports. Thus, this study provides a more conservative or precise test of the impact of debt service and structural adjustment on deforestation.

We also found that it is quite important to consider insights from other theories. In this regard, drawing on insights from neo-Malthusian theory, we found that rural population growth increases deforestation, while total population growth and urban population growth do not. This finding highlights contentions by Jorgenson and Burns (2007) and York and colleagues (2003) about the need to "decompose" demographic factors in cross-national research. It is clearly important to consider not just overall growth per se but also growth in different contexts. Furthermore, our analysis supports the hypothesis drawn from world polity theory that international non-governmental organization density decreases deforestation. This finding corresponds with research by Shandra (2007a), Schofer and Hironaka (2005), and Shandra et al. (2003).

Some important policy implications originate from the main findings. First, it may serve international non-governmental organizations well to focus their efforts on projects that decrease debt and deforestation. A "debt-for-nature" swap is a very good example. The procedure usually entails an international non-governmental organization paying off a portion of a nation's debt in return for that nation setting aside a certain amount of land for permanent protection (Cartwright 1989). Nevertheless, debt-for-nature swaps can be criticized for being "reformist" in that the swaps do not address the causes of increasing debt among poor nations (Newell 2000). Bryant and Bailey (1997) write, "If the argument is that fundamental change

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[9] Bradshaw and Schafer (2000) argue that it is not only important to examine overall government spending but also how governments allocate their resources. Therefore, we replaced total government spending with total government expenditures for health and total government expenditures for education. These variables are measured as a percentage of gross domestic product for 1990, and may be obtained from the World Bank (2003). The coefficients for both variables are negative but not statistically significant.

is the only way in which to solve the environmental crisis," then international non-governmental organizations "may be part of the problem and not part of the solution" (143). Accordingly, international non-governmental organizations should also focus their efforts on lobbying leaders of lending institutions for greater debt forgiveness and elimination of structural adjustment loans. This process could also involve lobbying leaders in rich nations to withhold funding to multilateral institutions until such changes occur (Rich 1994).

These policy suggestions also point to some promising avenues for future research. First, there has been no systematic research that examines the impact of debt-for-nature swaps on deforestation. Thus, one potential avenue for research includes conducting a study along these lines. Second, the International Monetary Fund and World Bank's Enhanced Highly Indebted Poor Countries (HIPC) Initiative offers debt forgiveness and low interest loans to reduce debt repayments to "sustainable" levels. However, governments must meet a range of economic management and performance targets to qualify for the aid (Peet 2003). The HIPC Initiative targets usually involve liberalization of trade and fiscal policy (e.g., tax holidays, firing workers at will, and weakening of government regulations), which are quite similar to structural adjustment loan conditions. Thus, future research could also consider if debt relief provided under the HIPC Initiative decreases pressure on forests or if the economic targets that must be met to qualify for the program promote it. Third, it may be helpful to use a series of structural equation models to test the pathways by which structural adjustment increases deforestation. This could involve examining the impact of structural adjustment on deforestation via government spending, forest exports, and poverty. Fourth, we note previously that the contradictory findings regarding debt service may be related to the forest type (i.e., tropical versus non-tropical). Future research could examine if the effects of structural adjustment are more pronounced in tropical than non-tropical nations.

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