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The United States Agency for International Development and forest loss: A cross-national analysis of environmental aid☆

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ABSTRACT

Among scholars of international development, there is a debate regarding the effectiveness of bilateral aid to improve the natural environment. Here we focus on evaluating whether United States Agency for International Development's (USAID) aid in the environmental sector reduces forest loss. Little empirical evidence exists on this question, partly because of the challenge of modeling such a relationship, given the problem of endogeneity whereby the same social, political, or economic processes that affect forest loss may also be correlated with a nation receiving aid from international donors. We contribute to this debate by utilizing a two-stage instrumental variable regression model to analyze cross-national data for a sample of 74 low and middle income nations. After controlling for potential endogeneity, we find that higher levels of USAID's aid for environmental protection correspond with lower rates of forest loss. We also find that a forest's proximity to infrastructure, agricultural and forestry exports, agricultural land area, and tropical climate are related to increased forest loss.

1. Introduction

The United States Agency for International Development (USAID) has provided low and middle income countries bilateral aid in the environmental sector over the past twenty years. In 1990, when it first institutionalized such aid, it supported approximately $125 million of projects in the environmental sector (AidData, 2016). By 2000, its aid for environmental protection doubled and, in 2010, it was approximately $380 million (AidData, 2016). The aid supports projects and efforts that improve the natural environment, like limiting forest loss. This aid in the environmental sector can take on a number of forms. In some instances, projects involve "strict" conservation efforts with the intention of completely protecting areas of forest and enforcing such efforts with patrols and boundaries (Miller, 2014). In other instances, however, projects involve "mixed" conservation efforts that integrate livelihood concerns of local people while protecting forests (Miller, 2014). Mixed conservation efforts entail creation of buffer zones that allow limited extractive activities like farming or fuelwood collection. There is also attention given to clearly defining property rights and land tenure systems (Bryant & Bailey, 1997). Given the variety of types of projects and approaches to conservation, it is incumbent upon scholars to better understand what factors drive forest loss or reduce it by bringing empirical evidence to bear on this question.

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However, to our knowledge, there is no cross-national research that evaluates the effectiveness of USAID aid concerning forests. This is somewhat surprising for a number of reasons. First, social scientists have long called for research that evaluates how international organizations impact the natural environment. For instance, Young (1992) calls for efforts to determine if international organizations are able to achieve their intended goals and, if so, elaborate on why that does occur. Similarly, Buttel (1996) questions whether international organizations that support environmental projects and programs are effective or simply "window dressing."

Second, there is a nascent but growing literature that examines how bilateral aid in the environmental sector impacts forests. For example, Arvin and Lew (2009) find that higher levels of bilateral aid in the environmental sector correspond with increased forest loss. Bare, Kaufman, and Miller (2015) reports a similar finding for in Sub-Saharan African nations and contributes it to programs creating protected areas that displace local people, who go on to clear forests elsewhere. However, Bare et al. (2015) argues that the empirical findings may arise as a result of not addressing donor selection bias, examining only one geographical region, or using a measure that includes aid from several bilateral donors, which may have differing effects on the environment. Hermanrud and de Soysa (2017) begin to address such issues in their study by using a two stage model to control for potential donor selection bias. Using this approach, the authors find that Norwegian bilateral aid in the forestry sector has no impact on forest loss.

Third, it is now possible to obtain data on USAID's aid (AidData, 2016). The information available includes recipient nation, amount, sector, and approval date (AidData, 2016). There is also a brief project description available in many instances (AidData, 2016). By utilizing this information, more detailed analyses are possible to perform, yielding greater specificity in our empirical assessments of different aid projects.

These three points provide the justification and starting point for our study in which we extend the research frontier in novel ways. First, we focus *solely* on the USAID and how its bilateral aid in the environmental sector affects forest loss. We do so in an attempt to isolate the impact of this one donor's aid for the environment on forests, seeing as bilateral aid institutions may pursue differing policies guided by their own institutional mandates. Second, we do not restrict our analysis to only one region, but rather include all low and middle income nations according to the World Bank's (2016) classification for which data are available. We expand the population of interest because forest loss is not concentrated in only one geographical region of the world. Third, to address the potential impacts of donor selection bias when evaluating the effects of bilateral aid on forest loss, we use a two stage instrumental variable regression model (Easterly, 2005).

We now turn to a discussion of USAID and why its aid in the environmental sector may be associated with less forest loss. We then go on to discuss the variables and methodology that allows us to address potential problems with selection bias. We conclude by discussing the findings along with the theoretical, methodological, and policy implications.

1.1. The United States Agency for International Development and forest loss

USAID has been financing projects that support environmental protection to some extent since the 1970s (Brockington & Duffy, 2011). However, the projects it funded were relatively small scale and ad hoc in nature (Bower Kux, 1991). By the late 1980s, however, it began taking environmental issues seriously (Corson, 2010). This change came in part as the result of a number of factors. First, the institution responded to a highly publicized campaign in the United States Senate by non-governmental organizations, who critiqued and raised awareness against the World Bank for its role in causing forest loss in Brazil (Rich, 1994). There was concern USAID's funding might be compromised because it also supported projects in the region, leading it to develop its focus on environmental protection (Goldman, 2005). Second, the United Nations World Commission on Environment and Development's publication, *Our Common Future*, renewed concern about environmental issues and their potential impact on economic growth (Bryant & Bailey, 1997). In response, the United States Congress passed an appropriation bill requiring USAID to fund $4 million worth of biodiversity and conservation projects annually (Bower Kux, 1991). By 1990, the agency was providing $125 million of bilateral aid to support the natural environment. At the turn of the century, this figure doubled to $250 million worth of aid in the sector (AidData, 2016).

Its earliest efforts often involved establishing forest borders as a first step in conservation and environmental protection (Adams & Hutton, 2007). The money would be spent to demarcate protected areas and monitor them for illegal logging (Miller, 2014). In many instances, this bilateral aid greatly increased the recipient government's spending on the environment (AidData, 2016). For example, USAID provided a $5 million grant to Sri Lanka during the 1980s to create a system of wildlife parks (United States Agency for International Development, 1995). The program declared certain activities – including grazing, logging, and hunting – illegal in the protected areas. The guards who were trained as part of the grant enforced the ban (United States Agency for International Development, 1995). There were similar programs put in place in Costa Rica, Jamaica, Madagascar, Nepal, and Thailand (United States Agency for International Development, 1995). In the end, these programs relied on the tactics of "guns, fences, and fines" to promote forest conservation (Kangalawe & Noe, 2012).

However, such programs were soon criticized because local people were excluded from protected areas by armed patrols (Bryant & Bailey, 1997). While "environment-first" rather than "people-first" projects remain a staple of USAID's conservation efforts, the agency now seeks to reduce pressure of forests by providing alternative sources of income to local people (Adams & Hutton, 2007). This idea follows from recommendations from the study, "People and Parks: Linking Protected Areas with Local Communities," carried out by USAID along with the World Bank and World Wildlife Fund. The study argues that environmental protection can only be successful if a government is capable of putting forestry and agricultural management plans into place that address the needs of all stakeholders (World Bank, 2001). In many rural settings, people are dependent on forests for various resources, like fuelwood and fodder, to support their livelihoods. Thus, improving the management of forest resources can be imperative for the welfare of a large portion of a country's population (Miller, 2014).

To accomplish this task, USAID worked to reform laws and financial incentives in the forestry and agricultural sectors along with enhancing a government's capacity to implement and monitor such reforms (United States Agency for International Development, 2015). There is often attention given to changing land tenure systems in an effort to better define ownership rights (Pinckney & Kimuyu, 1994). This includes governments revising their forestry codes to define areas in the public commons, clarifying definitions of customary rights held by local populations, and introducing artisanal permits for the legal extraction of some forestry products (United States Agency for International Development, 2013). Such reforms should provide governments with a better understanding of what area is under various forms of cultivation and what areas are protected. With such limits in place operating under a clarified legal system, projects are predicated on limited extraction of agricultural and forestry products, which would be obtained through intensified productive processes. For agriculture, intensification entails greater use and reliance on fertilizers, pesticides, and irrigation, in order to increase yields (United States Agency for International Development, 2013). For forestry, intensified practices include using implementation of technologies that limit waste during harvesting and processing (United States Agency for International Development, 2013).

To accomplish these goals, projects often integrate other sectors including education, health, family planning, or micro-finance (United States Agency for International Development, 2015). Many projects also include a gender component, focusing on improving the lives of women and girls, because they tend to be uniquely and disproportionately affected by forest loss (Norgaard & York, 2005). This is because women often bear the responsibility for collecting wood and water for the household and thus are seen as playing a key role in preserving natural resources (Shandra, Shandra, & London, 2008).

A feature of many USAID projects is their emphasis on working in collaboration with other organizations (Corson, 2010). The first way that this occurs involves donor harmonization, which seeks to eliminate the fragmentary nature of multiple donors funding ad hoc and duplicate projects within a nation in favor of greater coordination among several donors (Gottret & Schieber, 2006). Donor harmonization allows financing of projects across an entire sector or a larger geographical region and is representative of USAID's commitment to protecting "landscapes," "ecoregions," and "hotspots," as a result of working closely with non-governmental organizations (Chapin, 2004). While donors give up the right to select specific projects, they gain a voice in setting broader national policy and priorities. Donors can become more involved in decision making around how governmental resources are allocated for conservation (Corson, 2010).

USAID works with non-governmental organizations concerned with the environment. This is not surprising because stipulations from an appropriations bill in the 1980s requires USAID to spend $4 million annually on biodiversity, and mandates that these projects are implemented via the not-for-profit sector (Corson, 2010). By the end of the 1990s, USAID had funded more than $300 million worth of projects in the environmental sector with 70 percent directed toward the five largest non-governmental organizations from the United States (Dowie, 2005).

Requirements that funds be implemented in the not-for-profit sector often translates into a non-governmental organization providing technical support or implementing the project altogether (Chapin, 2004). For example, USAID has supported bilateral debt-for-nature swaps in several nations, in which it provides funds to pay off a portion of a country's bilateral debt. In turn, the recipient country uses the money that would have been spent on debt repayment to fund conservation programs that are run by non-governmental organizations like the Nature Conservancy or World Wildlife Fund (Chapin, 2004).

This discussion leads us to our main hypothesis—we expect that higher levels of USAID aid in the environmental sector should correspond with less forest loss. We note above that the limited existing cross-national research does not support this hypothesis. Thus, we now turn to a discussion of the factors that have been put forth to explain why this may be the case.

1.2. Limitations of aid

There are numerous reasons what bilateral aid may be ineffective in decreasing forest loss or be considered "window dressing." We review the five most common reasons put forth. First, USAID's environmental aid may not impact forest loss because it is small scale (Livernash, 1992). For instance, we note above that USAID funds approximately $380 million worth of environmental projects in 2010 (AidData, 2016). However, it disbursed just under $1 billion for fossil fuel and transport sectors (AidData, 2016). Similarly, Bryant and Bailey (1997) argue that "mixed" conservation projects funded by USAID do not assist enough people in a large enough geographical area to have a meaningful impact on forest loss.

Second, USAID's aid may be limited in geographical scope (Jakobeit, 1996). In particular, it tends to invest in nations with which it already has existing ties. These ties may include geography, a commitment by a recipient government to aggressively deal with terrorism, or the willingness to create a "good business climate" for United States businesses (Corson, 2010). This issue is often exacerbated because conservation funding tends to be unbalanced within a nation. USAID often channels money into locations where non-governmental organizations and scientists are already working (Chapin, 2004). In the end, a few areas within a country may receive the majority of funds, while other locations, which have large amounts of forest that are no less threatened, are ignored (Miller, Agrawal, & Roberts, 2013).

Third, Easterly (2005) argues that bilateral aid exacerbates corruption and poverty. This situation occurs for a couple of reasons including government officials in recipient nations putting "rent seeking" policies into place that allow themselves to benefit from aid and lack of accountability because projects are not externally evaluated (Easterly, 2005). Because of a lack of external evaluation, Maren (1997) argues that implementing partners often mismanage funds or undertake projects that do not reach local populations. Stewart (1997) argues, when small organizations "scale up" their activities as a result of an influx of funding, perhaps from bilateral aid, they often do not retain certain characteristics (e.g., flexibility, lack of bureaucracy, and closeness to target groups) that make them most suitable for implementing conservation projects.

Fourth, USAID's environmental aid may be affected by the government of a recipient nation. Lewis (2003) argues that USAID supported projects tend to be more effective in democratic rather than repressive nations. This is because repressive nations tend to tolerate non-governmental organizations, who implement projects on behalf of USAID, only if they meet the approval of government officials (Bryant & Bailey, 1997). In this regard, repressive nations can use law-making powers to "dull the sharp edge of non-governmental organization criticism" by passing laws that require non-governmental organizations to register is members or seek approval for funding of its projects (Clark, 1991: 179). A government may also ban any non-governmental organization without explanation and jail members for not complying with these rules (Hurst, 1990).

Fifth, USAID may fund projects that are conducted without due regard for the livelihood needs of local people (Chapin, 2004). It has partially addressed this issue by making "mixed" conservation a cornerstone of its aid. However, USAID does still fund "strict" conservation efforts that may well translate into increased forest loss (Corson, 2010). Since many of its projects result in completely protected areas, people whose survival is dependent on natural resources within areas to be protected are often adversely affected (Chapin, 2004). In these situations, its projects can actually lead to more forest loss. Bryant and Bailey (1997: 142) note in regard to a debt-for-nature swap carried out in Ecuador, "Farmers, shifting cultivators, or other grassroots actors are denied access as part of the terms of the swap and resort, thereafter, to illegal forest extraction or land uses (e.g., grazing)."

The above discussion highlights five of common reasons why USAID aid may not be effective in decreasing forest loss. These reasons include aid being too small-scale, limited in geographical scope, or not adequately involve local people in planning, design, implementation, and evaluation. The aid Aid may also exacerbate governance issues and poverty within a nation, or be hindered by a recipient country's laws. From our discussion of USAID bilateral aid and these limitations, we arrive at the following summary.

1.3. Summary

Because of a refocused aid policy spurred on by pressure and partnerships with the not-for-profit sector, we expect that bilateral aid provided to countries by USAID will be associated with less forest loss. However, this may not be the case for the reasons we review above. Thus, we carry out the first cross-national analysis to our knowledge that evaluates the effectiveness of USAID's bilateral aid in the environmental sector on forests. Prior to discussing our findings, we review the sources of the data for our empirical analysis and consider how to overcome one of the main methodological challenges therein.

2. Methodology

2.1. Data

The country-level data for this study was obtained from a number of sources, described below. We employ listwise deletion if a country is missing data for any of our key independent variables, yielding a sample of 74 nations defined by the World Bank (2016) as low to middle income nations.[1] We now turn to a description of the source of each indicator and a theoretical justification for its inclusion in our models.

2.2. Dependent variable

2.2.1. Forest loss

Until recently, cross-national research on forest loss relied on data form the Food and Agriculture Organization's *Global Forest Resources Assessment* (e.g., Shandra, Rademacher, & Coburn, 2016). However, the reliability of the data has been called into question because the data are gathered utilizing collection methods that vary from nation to nation (Grainger, 2008). In some nations, forestry statistics can be reliable because they are based on remote sensing surveys (Food and Agriculture Organization, 2010). In other nations, estimates may be substantially less reliable because they are based on expert opinion, extrapolated from an old forest inventory, or estimated from old remote sensing surveys (Grainger, 2008). This introduces measurement error into any analysis and threatens the validity of empirical findings as well as the reliability of

[1] We analyze forest loss in low and middle income nations as classified by World Bank (2016) because high income nations are not eligible for aid from USAID. They include: Albania, Argentina, Armenia, Azerbaijan, Bangladesh, Belarus, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Republic, China, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Ethiopia, Gabon, Georgia, Ghana, Guatemala, Guinea, Guyana, Honduras, Hungary, India, Indonesia, Jamaica, Kazakhstan, Kenya, Kyrgyz Republic, Lesotho, Macedonia, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mexico, Moldova, Mongolia, Mozambique, Namibia, Nepal, Nicaragua, Nigeria, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Romania, Senegal, South Africa, Sri Lanka, Sudan, Suriname, Tajikistan, Tanzania, Thailand, Togo, Turkmenistan, Uganda, Ukraine, Venezuela, Vietnam, Zambia, and Zimbabwe.

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cross-national comparisons. However, this problem can be avoided by using newly available data that eliminates this source of error.

These data may be obtained from the World Resources Institute's Global Forest Watch (2016) online database. The forest loss data are derived from high resolution satellite imagery, where each pixel of the image represents an area of 30 square meters. See Hansen, Stehman, and Potapov (2010) for a discussion of the methodology used to arrive at the estimates. We calculate forest loss using the three step procedure described by Rudel (2013). First, we obtain the hectares of forest cleared from 2001 to 2014 based on a 75% tree cover canopy density level. The tree cover density for a nation represents the estimated percentage of a pixel taken from satellite imagery that is covered by tree canopy (World Resources Institute, 2016). The 75 percent tree cover canopy density level is the level associated with gain or loss of "tropical" or "wet" forests. Second, we obtain a nation's total forest area, measured in hectares, in 2000. Third, the difference in tree cover canopy density from 2001 to 2014 is an unstandardized measure of forest loss. To obtain the rate of forest loss, we divide the number of hectares cleared (from 2001 to 2014) by the country's total forest area in 2000. This variable is logged because it is skewed. The descriptive statistics for all variables are reported in Table 1.

2.3. Independent variables

2.3.1. United States Agency for International Development bilateral aid

This variable measures the total amount of bilateral aid provided to a country in the environmental sector by USAID from 1990 to 2000. The data may be obtained online from AidData.org (2016). We searched using sector code 410 for "general environmental protection." We then identified aid and recorded amounts only if a project involved forest and biodiversity protection, conservation, or management. We were able to obtain this level of detail by using project titles and descriptions, strengthening the validity of our measure. This information also allows us to exclude bilateral aid that may not directly pertain to forests including air pollution or wastewater treatment projects.

We collect the data from 1990 to 2000 for three reasons. First, while the USAID began implementing its environmental reforms in the late 1980s, its first environmental loans and grants were not disbursed in 1990 (Corson, 2010). Second, USAID aid supports projects that are implemented over many years (Corson, 2010). If we used data for one year, we may underestimate the effects of USAID aid. Third, we end the collection of data beyond 2000 to avoid simultaneity bias with forest loss. The data for forest loss are only available for 2001–2014. We expect that higher levels of USAID bilateral aid in the environmental sector should be related to less forest loss.

2.3.2. Agricultural and forestry exports

We include agricultural and forestry exports as a percentage of merchandise exports. These data may be obtained from the World Bank (2016). We expect that higher levels of agricultural and forestry exports should be

Table 1
Descriptive statistics and bivariate correlation matrix for forest loss analysis 2001–2014.

	Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) Forest loss 75% coverage, 2001–2014	−2.677	1.387	1.000															
(2) USAID environmental aid, 1990–2000	2.141	3.327	.097	1.000														
(3) Agricultural and forestry exports, 2000	14.575	27.538	.361	−.131	1.000													
(4) Market access, 2000	62.865	24.358	.184	.234	−.023	1.000												
(5) Non-governmental organizations, 2000	2.780	3.289	−.034	.279	−.114	−.157	1.000											
(6) Gross domestic product per capita, 2000	6.685	1.037	−.138	.150	−.314	−.137	.241	1.000										
(7) Economic growth rate, 1990–2000	.492	.908	.100	.159	−.201	−.134	.137	.324	1.000									
(8) Democracy, 2000	12.309	8.228	−.222	.203	−.184	−.143	.089	.362	.015	1.000								
(9) Corruption, 2000	.658	.176	−.170	−.038	.162	.146	−.405	−.415	−.248	−.202	1.000							
(10) Total population growth rate, 1990–2000	.194	.141	.278	−.106	.071	−.260	.081	−.189	.205	−.229	.030	1.000						
(11) Non-dependent population growth rate, 1990–2000	3.517	2.850	.144	−.039	−.108	−.195	−.108	.359	.354	.151	−.171	.004	1.000					
(12) Rural population growth rate, 1990–2000	.115	.144	.336	−.154	.266	−.072	−.179	−.616	−.062	−.291	.166	.470	−.177	1.000				
(13) Urban population growth rate, 1990–2000	.329	.237	.484	−.098	.191	−.126	.055	−.222	.235	−.388	−.061	.579	.043	.448	1.000			
(14) Agricultural land area, 2000	6.585	1.663	.266	.122	−.059	.575	−.336	−.162	−.187	−.210	.088	−.115	.122	−.038	.002	1.000		
(15) Tropical climate (1 = yes)	.635	.485	.300	.057	.139	−.248	.055	−.019	.313	−.143	−.005	.410	−.140	.255	.427	−.274	1.000	
(16) Forest area (in 1000s), 2000	16,400	53,600	−.105	.425	−.176	.136	.199	.139	.092	.056	−.316	−.084	−.025	−.108	−.049	.032	.067	1.000

related to increased forest loss. This is because exports tend to be concentrated on activities including soy, cotton, cattle ranching, and logging, which are related to forest loss (Austin, 2010).

2.3.3. Market access

This variable is the percentage of a country's total forests that are located within 10 kilometers of infrastructure including roads, highways, rivers, and ports. The data may be obtained from the Food and Agriculture Organization (2010). We expect that a larger percentage of forests within 10 kilometers to infrastructure should be related to increased forest loss. This is because the forests can be exploited and brought to market more easily than when they are not remote (Lewis, 2003).

2.3.4. Non-governmental organizations

We include the number of international non-governmental organizations working on "environmental" and "animal rights" issues in a nation for 2000. The data are collected by Smith and Wiest (2005) from the *Yearbook of International Associations*. We divide it by a country's population size in order to standardize the variable. Schofer and Hironaka (2005) find that higher levels of non-governmental organizations are associated with lower rates of deforestation. This may be the case because non-governmental organizations finance local conservation projects, support social movement activity, and shape the language of environmental laws (Shandra, 2007).

2.3.5. Gross domestic product per capita

We employ a measure of gross domestic product per capita adjusted for purchasing power parity for 2000. The data may be obtained from the World Bank (2016). We log this variable to correct for its skewed distribution. Burns, Kick, and Davis (2003) find that higher levels of economic development are associated with lower rates of forest loss based on wealthier nations "externalizing" their environmental costs by importing natural resources and moving toward economic activities like services that have less impact on forests.

2.3.6. Economic growth

We include the average annual economic growth rate from 1990 to 2000. These data may be obtained from the World Bank (2016). The cross-national research that examines how economic growth affects forest loss yields contradictory findings. On the one hand, economic growth is associated with higher rates of deforestation (Jorgenson, 2006). This is because there are large amounts of capital available for investment in activities (e.g., infrastructure) that accelerate forest loss during periods of economic expansion (Rudel, 1989). On the other hand, an absence of economic growth may increase forest loss. The lack of growth offers rural populations little incentive to migrate to urban centers for work and rather expand agriculture and forestry to survive (Ehrhardt-Martinez, Crenshaw, & Jenkins, 2002).

2.3.7. Corruption

This variable may be obtained online from the Quality of Government Institute (2016) (Dahlberg, Holmberg, Rothstein, Hartmann, & Svensson, 2016). We take the composite index that averages of its executive, legislative, judicial, and public sectors corruption measures. In the executive, legislative, and public sectors, corruption refers to members or agents of the sectors granting favors in exchange for bribes, kickbacks, embezzlement, and misappropriation of public funds for personal or family use (Dahlberg et al., 2016). In the judicial sector, corruption involves judges and their agents receiving undocumented extra payments or bribes from an individual or company to speed up, delay, or obtain a favorable decision (Dahlberg et al., 2016). We hypothesize that higher levels of corruption should be related to forest loss. This is because corruption across sectors diverts government funds away from investment in conservation (Koyuncu & Yilmaz, 2009). Xun and Tamer (n.d.) refer to this displacement as aid being "fungible." Corruption also allows illegal logging and other violations of a country's forestry laws to go unenforced and continue with little fear of punishment (Koyuncu & Yilmaz, 2009).

2.3.8. Democracy

We use Vanhanen's (2014) measure of democracy, which is calculated by taking the average of his political competition index and political participation index. According to Vanhanen (2014), political competition measures the percentage of votes gained by smaller parties in parliamentary and presidential elections. The political participation variable measures the percentage of the population that voted in a parliamentary and presidential election (Vanhanen, 2014). According to Li and Reuveny (2006), democracy should reduce forest loss because democratic nations have more political activism than repressive nations. This situation plays out in democratic nations because they guarantee freedoms of speech, press, and assembly while being able to hold leaders accountable via elections (Li & Reuveny, 2006).

2.3.9. Total population growth

We include the average annual percentage change in total population growth from 1990 to 2000. These data come from the World Bank (2016). Rudel (1989) suggests that "geometric" growth in population outstrips "arithmetic" growth in the means of subsistence, leading to "carrying capacity" problems (e.g. forest loss). We expect that higher rates of population growth correspond with more forest loss.

2.3.10. Non-dependent population growth

York, Rosa, and Dietz (2003) argue it is important to "decompose" demographic factors and consider how different segments of a population impact the natural environment. They argue that the non-dependent population or population aged 18–64 have a disproportionate effect on the natural environment. These data come from the World Bank (2016). This is because adults consume more resources than other portions like the elderly or children

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(York et al., 2003). We include the percentage change in non-dependent population from 1990 to 2000.

2.3.11. Rural and urban population growth

Jorgenson and Burns (2007) find that higher rates of rural population growth are associated with increased deforestation while higher rates of urban population growth are associated with lower rates of deforestation. They argue that expanding urban centers create economic opportunities other than agriculture, which leads to increased rural to urban migration. This must be accompanied by the importing of food, which further reduces pressure on forests (Rudel, 2013). Thus, we examine the impact of the average annual percentage change in rural and urban populations from 1990 to 2000. These data come from the World Bank (2016).

2.3.12. Agricultural land area

We include the percentage of land within nation used for agriculture or land that is permanently under crops or pasture (World Bank, 2016). This variable measures the size of the agricultural sector. We take the square root of this variable to help deal with skewness. We expect that higher amounts of agricultural land correspond with more forest loss because forests are converted to pasture or fields (Austin, 2010).

2.3.13. Tropical climate

We include a dummy variable that represents nations that have a tropical climate. The data are from the World Resources Institute (2016), which defines a tropical climate as land area that has a mean monthly temperature that exceeds eighteen degrees Celsius. We hypothesize that tropical nations have higher rates of deforestation because these nations tend to have more valuable tree species that are in demand on the world market. Rudel and Roper (1997) find support for this hypothesis.

2.4. Analysis strategy

We use a two stage instrument variable regression model to address potential issues with endogeneity on the bilateral aid variable (Easterly, 2005). In a two-stage model, the predicted values for our instrument are obtained in the first stage, which are then used in the second stage to obtain an unbiased estimate of forest loss. We carry out this analysis using Stata version 13 and its "ivreg2" command (Baum, 2006). The equation for our endogeneous explanatory variable is as follows:

$$y2 = \pi 0 + \pi 1 z1 + \pi 2 z2 + v \quad (1)$$

where z1 is an instrument for y2 if it is still correlated with y2 after partialing out the effects of other exogeneous predictors (z2) (Wooldridge, 2015). Note, the set of exogeneous predictors (x1) from Eq. (1) need not be the same as those included in the second equation (z2). By carefully examining Eq. (1), we see that the residuals v are the part of the endogenous variable y2 that remain uncorrelated with the instrument z1. The residuals are then inserted in the second stage to obtain the estimated value of forest loss (y1):

$$y1 = \beta 0 + \beta 1 y2 + \beta 2 \times 1 + \beta 3 z1 + \beta 4 v + \omega \quad (2)$$

Several statistical tests can be used to determine whether receiving aid is endogeneous. We calculated the chi-square and F statistics that are equivalent to the Durbin-Wu-Hausman and Wu-Hausman tests of endogeneity, respectively (Baum, 2006). These tests are approximations because they are robust to violations of conditional homoskedasticity—see below regarding violations of homoscedastic error terms. The null hypothesis in both instances is that the independent variable is exogenous and, as a result, the ordinary least squares estimates have optimal properties (Baum, 2006). We reject the null hypothesis as the F and chi-square statistics reach a level of significance in every model, indicating the USAID variable should be considered endogenous and a two-stage instrumental variable regression model is preferable to the ordinary least squares estimates.

In the first stage, we include one exogeneous predictor of receiving bilateral aid—the number of threatened bird species per square kilometer of area land.[2] We do so because Lewis (2003) finds that a recipient nation's need (i.e., high levels of biodiversity loss) is an important determinant of USAID bilateral aid for the environment. When using this modeling strategy, there are assumptions that must be met concerning the choice of instruments.[3] First, we must determine that the instrument is "relevant" or that they are correlated (statistically dependent) with the endogenous variable but not the dependent variable (Wooldridge, 2015). To test this assumption we look at the coefficients for the Sanderson–Windmeijer chi-square statistic, which are robust to heteroscedasticity. The test statistics reach a level of significance in every model. Thus, we reject the null hypothesis and conclude that our instrument is relevant (Wooldridge, 2015).[4]

Second, we test to see if the instrument is "weak" or explain a small amount of variation of the endogenous variable. This does not appear to be the case here. We calculate Montiel–Pflueger's modified Stock–Yogo values to determine the presence of weak instruments (Pflueger & Wang, 2014). They are modified to allow the use of robust standard errors in their estimation and can be obtained using the "weakivtest" command (Pflueger & Wang, 2014). In every model, the coefficients for the F statistics are greater than ten and always exceed the critical values for a 10% bias level, indicating the instruments are not weak (Pflueger & Wang, 2014).

[2] We tried the circular distance from Washington D.C. to each nation's capital as an instrument. It violated the valid instrument assumption. The diagnostic statistics also indicated it was a weak instrument.

[3] We replicate the models using a limited information maximum likelihood estimator, which often performs better with small samples (Baum, 2006). The results are similar to the findings presented.

[4] We test other variables as instruments in the first stage of the models. They include internal conflict, land area, foreign direct investment, domestic investment, and other regions of the world. They do not perform well as instruments based on diagnostics discussed.

Table 2
Two stage instrumental variable regression estimates of USAID aid on forest loss, 2001–2014.

	2.1	2.2	2.3
USAID environmental aid, 1990–2000	−.224* −.813 (.110)	−.237* −.863 (.102)	−.207* −.753 (.104)
Agricultural and forestry exports, 2000	.018*** .307 (.003)	.017*** .283 (.003)	.017*** .277 (.004)
Market access, 2000	.016* .291 (.008)	.020* .352 (.008)	.016* .291 (.007)
Non-governmental organizations, 2000	.091 2.217 (.088)	.119 2.895 (.086)	.098 2.378 (.082)
Gross domestic product per capita, 2000	−.034 −.043 (.179)	−.167 −.214 (.176)	.194 .248 (.134)
Economic growth rate, 1990–2000	.252 .190 (.141)	.149 113 (.174)	.189 .143 (.134)
Democracy, 2000	.021 .200 (.022)	.017 .161 (.023)	.029 .275 (.021)
Corruption, 2000	−1.506 −.324 (1.143)	−1.427 −.307 (1.116)	−1.024 −.220 (1.060)
Total population growth rate, 1990–2000	1.470 .175 (1.391)		
Non-dependent population growth rate, 1990–2000		.117 .378 (.065)	
Rural population growth rate, 1990–2000			2.364 .379 (1.574)
Urban population growth rate, 1990–2000			1.300 .261 (1.006)
Agricultural land area, 2000	.372** .591 (.121)	.321* .510 (.128)	.367** .583 (.126)
Tropical climate (1 = yes)	1.045* .396 (.411)	1.363*** .517 (.337)	.837* .317 (.406)
Constant	−6.317*** (1.962)	−5.613** (1.943)	−8.502*** (2.268)
R-squared	.829	.827	.850
Number of countries	74	74	74
Highest variance inflation factor score	3.63	3.49	3.58
Mean variance inflation factor score	2.04	2.09	2.15
White–Koenker heteroskedasticity test	20.164*	21.251*	21.205*
Robust F-statistic/chi-square endogeneity test	10.26*/4.81*	13.92*/4.52*	9.97*/5.14*
Sanderson–Windmeijer underidentification test	29.48*	30.74*	32.59*
Montiel–Pflueger weak instrument critical values	24.701*	25.756*	26.864*

Notes: (a) * indicates $p < .05$, ** indicates $p < .01$, and *** indicates $p < .001$ for a two-tailed test. (b) The first number is the unstandardized coefficient, the second number is the standardized coefficient, and the third number is the robust standard error.

In addition to meeting the statistical requirements for the two-stage model, we must also ensure that we are not violating other regression assumptions. First, we calculate mean and highest variance inflation factor scores for each model using the "ivvif" command (Roodman, 2014). We report the values in Table 2. There does not appear to be any potential problems with multicollinearity because mean and highest variance inflation factor scores do not exceed a value of 5 (Tabachnick & Fidell, 2012).

Second, we examine scatterplots of each independent variable against the dependent variables to determine if there are any problems with linearity (Allison, 1999). We transform variables when appropriate with the natural log (Tabachnick & Fidell, 2012). We note any transformation in the preceding section discussing the variables used in our analysis.

Third, we calculate White–Koenker statistics for each model to determine if heteroscedasticity is problematic using the "ivhettest" command (Schaffer, 2013). The null hypothesis for this chi-square test is that the error variances are homoscedastic or equally distributed (Schaffer, 2013). The coefficients for these chi-square statistics reach a level of statistical significance in every model, indicating potential problems with heteroscedasticity (Tabachnick & Fidell, 2012). We present robust standard errors to help deal with the issue.

3. Findings

In Table 2, we present the second stage estimates of forest loss from the two-stage least squares regression model. The first number reported is the regression coefficient, the second number is the standardized regression coefficient, and the third number is the robust standard error. We use two-tailed hypothesis tests.

We include USAID bilateral aid, agricultural and forestry exports, market access, non-governmental organizations, gross domestic product, economic growth, corruption,[5] democracy, agricultural land area,[6] and tropical climate[7] in every equation.[8] In Eq. (2.1), we examine the impact of total population growth.[9] In Eq. (2.2), we include the percentage change in non-dependent population growth. In Eq. (2.3), we include rural and urban population growth rates. Other relevant variables were excluded due to decreased sample size[10] or non-significance.[11]

Let us begin by focusing on the USAID bilateral aid variable. In Eqs. (2.1) through (2.3), we find that bilateral aid in the environmental sector is associated with lower levels of forest loss. The coefficients for this variable are negative and significant in all the models. It is important to note that this variable has the largest standardized coefficients in absolute terms. This supports our hypothesis concerning the beneficial impact of bilateral aid from USAID on forests. The results of our two-stage model that accounts for endogeneity of aid on forest loss contradicts other cross-national work that finds bilateral aid in the environmental sector was related to increased forest loss.

In addition, we find that other factors are associated with forest loss. First, we find higher levels of agricultural and forestry exports are related to higher levels of forest loss. The coefficients for this variable are positive and significant in every equation. Second, we find that market access (a larger percentage of forests within 10 kilometers of roads) to be related to increased forest loss. The coefficients for market access variable are positive and significant in every model. Third, we find that agricultural land area is related to increased forest loss. The coefficients for this variable are positive and significant, consistent with our theoretical expectations. Fourth, we find that tropical nations have higher rates of forest loss than nations with other climates.

There are some non-significant findings that should be discussed. Principally, we find that a number of economic factors are not related to forest loss. These include gross domestic product and economic growth. Further, the coefficients for political characteristics including democracy, corruption, and non-governmental organizations do not reach a level of significance.[7] Finally, we find that the demographic measures do not affect forests. The coefficient for the total, non-dependent, rural, and urban population growth do not reach levels of statistical significance.

4. Discussion and conclusion

We began by noting that existing work on bilateral aid for environmental protection finds that it is associated with increased forest loss. The findings from prior research are somewhat surprising to us given the projects that aid is intended to support, but it does fit into the context of literature that questions the effectiveness of bilateral aid in protecting forests and agroforestry projects among other efforts. This unexpected result along with calls to assess how international organizations impact the natural envi-

[5] Following Hermanrud and de Soysa (2017) and Bare et al. (2015), we include interaction terms to determine if the effect of USAID aid varies at different levels of corruption. The coefficients for the interaction term do not reach a level of significance.

[6] We included percentage of protected forest area in the models. The coefficients do not reach a level of statistical significance.

[7] We include dummy variables for the region of the world in the forest loss models. The results are similar.

[8] We included the total amount of forest area within a nation as a control in the models. The coefficients do not reach a level of statistical significance.

[9] We included the non-dependent population growth rate with the total population growth rate. The coefficients for both variables fail to reach a level of statistical significance. This is most likely the case because of the high bivariate correlation between the variables. We repeat this for the rural and urban population growth models. The results are similar to the findings reported.

[10] We included the percentage of forest area owned by the government. It may well be that higher amounts of public forest area may correspond with increased forest loss because it can be obtained cheaply via lease or theft for extractive activities. The data come from the United Nations Global Forest Resources Assessment (2010). The coefficients do not reach a level of statistical significance. It important to note that including this variable reduces our sample size to 58 nations.

[11] We replicated the models including a square of gross domestic product per capita to test for the presence of an inverted, u-shaped relationship with forest loss. The coefficients for the squared term do not reach a level of statistical significance.

ronment serves as the starting points for our study. Our empirical analysis expands and improves the current literature in novel ways.

We begin by limiting our focus to only United States Agency for International Development aid in the environmental sector. We do so in an effort to isolate the effect of aid from one prominent donor. In doing so, we review the reasons why we would expect USAID's aid in the environmental sector to correspond with lower forest loss while also being open to the reasons why that may not be the case. We also adopt an improved analytic strategy that takes into account the potential for endogeneity in the main independent variable. From the results of our two-stage instrumental variable regression models, we find that higher levels of USAID aid in the environmental sector are related to less forest loss when taking into account the potential impact of selection bias. In using this more appropriate analytic strategy we may thus partly explain the discrepancy between our findings and prior research on this question.

Our findings have theoretical implications for the existing literature. We answer the call of scholars to consider how international organizations affect the natural environment. In doing so, we present findings that contradict the published cross-national work on the topic and arguments regarding its aid being "window dressing" at a minimum or impeding conservation at a maximum. Our research also adds to the nascent but growing cross-national literature on bilateral environmental aid. We believe that by expanding this body of nuanced empirical findings, we may prompt a theoretical reconsideration of what types of development policies are most effective under what conditions.

We follow with some methodological considerations. We consider how bilateral aid from one agency (i.e., USAID) in a specific sector (i.e., environmental protection) impacts forests, rather than lumping together aid to all sectors, which can obscure these more nuanced effects. We also agree Hermanrud and de Soysa (2017) about the importance of using a statistical methods like the two-stage instrumental variable regression used here to take into account the potential problems resulting from donor selection bias. Failure to do so may result in biased coefficients and inefficient tests of statistical significance, thereby leading us to draw potentially faulty conclusions (Easterly, 2005).

There are some policy implications that follow. First, we provide evidence supporting the notion that USAID should increase its bilateral aid in the environmental sector. It may best be served by focusing its efforts on protecting forests near existing infrastructure with our results suggesting these forests are experiencing higher levels of loss. Any "mixed" conservation involving agriculture or forestry should entail a focus on domestic rather than export markets.

Nevertheless, these recommendations can be criticized for being "reformist" for not addressing the fundamental causes of forest loss like export-led growth in the agricultural and forestry sectors. In this regard, USAID may be promoting such activities by imposing a neo-liberal agenda via its environmental aid (Corson, 2010). Goldman (2005) describes a similar situation in how the World Bank promulgated a "green neo-liberal" agenda in Laos. The World Bank supported the building of hydroelectric dams in the country as an environmentally-friendly form on energy production. It began by funding scientific studies carried out by non-governmental organizations identifying areas of biological importance in the country and others where development could proceed unimpeded, like the locations of hydroelectric dams that it was funding. The World Bank then required the government to rewrite laws related to property rights and land tenure as part its environmental sector lending, which specified these changes. The government also placed limits on access and gave recourse for local populations living in areas where mining, damn building, and logging are permitted (Goldman, 2005).

A similar situation may well be playing out as part of USAID aid in the environmental sector given the characteristics of its aid (Corson, 2010). It often puts similar reforms into place via its aid in the environmental sector. Thus, it may be helping to enshrine export-led development in extractive sectors in a government's laws under the guise of conservation, and it may seek to undermine government investments in protecting the environment by relying on non-governmental organizations (Corson, 2010). If this is the case, social movements and concerned citizens may be better served by lobbying USAID officials along with legislators that approve its budget to move away from supporting extractive activities.

Given this discussion, there are some limitations of the study and directions for future research that follow. First, we rely on cross-sectional regression models because the new forest loss data are not yet available over multiple time points. When panel data become available, cross-national research should re-examine this relationship integrating country- and period-specific fixed effects in an effort to control for time-invariant as well as country-specific characteristics of nations that may affect forest loss (Wooldridge, 2015). At the same time, social scientists could supplement this work with case study research to determine if findings diverge or converge across space and time, as well as to help elaborate on the ways in which the natural environment can be successfully conserved. Finally, it may well be that USAID's support for projects in the environmental sector may negatively impact air pollution, water pollution, or biodiversity loss in a different way than what we find for forest loss. Thus, as we expand our body of knowledge about potentially differential effects of bilateral aid, we will be in a better position to offer a holistic evaluation of its potential harms or benefits for the natural environment.

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