Policy Sci (2015) 48:181–205
DOI 10.1007/s11077-014-9205-6

Foreign aid, economic globalization, and pollution

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Published online: 23 September 2014

Abstract This paper explores how trade and foreign direct investment (FDI) condition the effect of foreign aid on environmental protection in aid-recipient countries. We suggest that (1) environmental protection should be viewed as a public good and (2) all else equal, resource flows from abroad (via aid, trade, and FDI) influence governments' incentives to provide public goods. (3) Because these resources shape governments' incentives differently, their interactive effects should be examined. We begin with the assumption that developing country governments seek some optimal level of environmental protection, a level conditioned by their factor-intensive growth phase. We hypothesize that at low levels of export receipts or FDI inflows from the developed world, foreign aid is associated with superior environmental protection. This is because foreign aid, as an environmentally neutral addition to revenue, allows recipient governments to partially relax the trade-off between economic growth and environmental protection. As levels of export receipts or FDI inflows from the developed world increase, however, the salutary effect of foreign aid will diminish and eventually be reversed. This is because foreign aid mitigates the recipient government's dependence on traders and investors in the developed world, and concomitantly reduces their pro-environmental policy leverage. Our analysis of 88 aid recipients, for the period 1980–2005, lends support to our argument.

Keywords Foreign aid · Economic globalization · Diffusion · Pollution

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Introduction

Foreign aid is an important instrument for shaping public policy. Donors provide aid for a range of objectives, including economic development, democratization, security, and disaster relief. This paper examines the unanticipated consequences of foreign aid on environmental protection in aid-recipient countries. The literature is inconclusive on this subject: While some suggest a negative relationship between aid and environmental protection, others argue that aid supports environmental protection. There are few empirical tests conducted on this subject, and the results are mixed (Arvin and Lew 2009). We suggest that this inconclusiveness arises when scholars ignore how the effect of aid is conditioned by alternative resource inflows from abroad. Thus, rather than evaluate the average or unconditional relationship between aid and environmental protection, we examine how exports to and foreign direct investment (FDI) inflows from developed countries (*globalization flows from the North*, hereafter) condition the association between foreign aid and the environmental protection.

We introduce and test a theory that posits that at low levels of globalization flows from the North, increased foreign aid reduces pollution in aid-recipient countries. At high levels of globalization flows from the North, however, the salutary effect of aid on environmental protection diminishes and eventually reverses. While we discuss the mechanism behind such a seemingly counterintuitive interactive effect later in the paper, we provide a summary below.

Governments pursue multiple, sometimes contradictory, objectives. These include economic growth and environmental protection. We assume that developing country governments seek some optimal level of environmental protection; a level conditioned by their factor-intensive growth phase. Although governments recognize the negative environmental consequences of economic growth, their immediate focus tends to be on economic growth in the short run, simply because it supports their political survival. The former Malaysian Prime Minster, Dr. Mahathir Mohamad, controversially alluded to the growth–environment trade-off in response to criticism about rampant deforestation in his country:

> … But we are also acutely conscious that we are a developing country which needs the wealth afforded by our forests. We do not cut down our trees foolishly. We need living space, we need space for agriculture, and we need the money from the sale of our timber (Mohamad 1992).

We expect this trade-off between growth and environmental protection would be most pronounced for governments not having access to external resources and seeking to mobilize resources domestically to finance their operations. Such governments often allow, or even participate in, resource plunder—e.g., extracting minerals, hydrocarbons, and timber at rates that exceed the optimal rate—which leads to environmental degradation. Thus, the level of environmental protection in the absence aid and globalization flows from the North is *lower* than the optimal level desired by governments.

Enter foreign aid in the context of such an economy. We suggest that while aid, in and of itself, is neutral in relation to environmental protection,[1] it allows developing country

[1] While environmental groups have actively lobbied multilateral organizations such as the World Bank, and the Bank has instituted policies such as the Strategic Environmental Assessment and Environmental Impact Assessment (Gutner 2002; Nielson and Tierney 2003; Park 2005), such groups nonetheless tend to lack the leverage that would lead donors to prioritize environmental issues over other goals. A recent empirical study also suggests that aid is largely “environmentally neutral” (Hicks et al. 2008).

governments to partially relax the trade-off between economic growth and environmental protection. Thus, at low levels of globalization flows from the North, an increase of foreign aid is expected to be associated with an *improvement* in environmental stewardship.

Now consider the introduction of globalization flows without aid flows. As levels of globalization flows from the North rise, developed country importers and investors begin to exercise political leverage over developing country governments. As suggested by the literature on "trading up" (Vogel 1995; Greenhill et al. 2009) and "investing up" (Prakash and Potoski 2007), the preferences of traders and investors located in developed countries are, on average, pro-environmental. Thus, at high levels of globalization flows from the North, the *level* of environmental protection is *higher* than the optimal level desired by governments and closer to foreign stakeholders' ideal point.

What if such a country *also* receives foreign aid, the issue we examine in this paper? As an environmentally neutral addition to government revenue, aid mitigates the recipient government's dependence on globalization flows from the North. Recall, trade and FDI led a developing country to provide protection above its ideal point. With aid, the political leverage of foreign traders and investors over developing country governments is reduced, and governments can begin to supply protection at their ideal point, which is below the ideal point of Northern traders and investors. Thus, our theory predicts that aid in the presence of trade and FDI will reduce the level of environmental protection in developing countries.

We find empirical evidence for this seemingly paradoxical interaction effect between globalization flows and aid flows. A series of dynamic panel data analyses of 88 official development assistance (ODA) recipients over 26 years (1980–2005) suggest that aid is associated with higher levels of environmental protection at low levels of globalization flows from the North. As globalization flows from the North rise, however, the marginal effects of aid are diminished and are eventually reversed.

The rest of the paper is organized as follows. In the following section, we review the literature on the environmental implications of foreign aid and economic globalization. We then outline our theoretical framework and hypotheses, which will be followed by a section summarizing the data and methods for empirical analyses and our findings. The last section concludes and tenders policy implications based on our findings.

Aid, globalization, and pollution: what do we know?

The debate on how foreign aid influences a recipient's environment remains inconclusive (Castro and Hammond 2009). Roughly, there are two camps. Some researchers suggest that foreign aid can help protect the environment. Aid provides resources to recipient governments to clean up pollution and to proactively invest in environmental protection. By enhancing economic development and increasing income in poorer nations, aid might improve the environment indirectly as well. If environmental protection can be viewed as a normal good, citizens' demand for environmental protection would increase as the economy grows (Arvin and Lew 2009). Some suggest that donors can explicitly dispense foreign aid to help bolster environmental protection. Although "green aid" still remains a small fraction of the total flows of foreign aid, the share composed by so-called "dirty aid" has diminished significantly over the past few decades (Hicks et al. 2008).

Conversely, because donors typically provide aid for reasons that are not associated with environmental protection, aid may be unlikely to encourage pro-environmental policies in recipient countries. In fact, by encouraging economic development, foreign aid may create incentives for resource plunder or the growth of polluting industries, all under the guise of economic development. In addition, some suggest that aid creates perverse incentives by encouraging leaders to delay socioeconomic reforms (Gibson et al. 2005) and undermines the development of democratic political institutions (Djankov et al. 2008). Consequently, aid may work as a "resource curse" (Knack 2001): Because governments no longer have to rely on their populations for fiscal revenues and political support, they under supply public goods demanded, including environmental protection.

There is a relatively small literature that empirically examines how aid influences recipients' environmental outcomes. Most studies have assessed the effects of environmental aid on specific environmental projects (Ross 1996), a specific country recipient (Gutner 2002), or even a specific donor agency (Dauvergne 2001). When it comes to an analysis of a broader set of countries, Arvin and Lew (2009) are the rare exception. They study the relationship between foreign aid and three ecological indicators in developing countries (CO_2 emissions, water pollution, and deforestation), and find that while foreign aid reduces CO_2 emissions, it increases water pollution and deforestation.

How might one explain these contradictory theoretical expectations and inconclusive empirical findings? Part of the problem is that the literature focuses on the average, unconditional, impact of aid on environmental protection. Indeed, Arvin and Lew (2009: 298) conclude by suggesting that "the economic and social conditions of individual recipient countries" should be examined to understand such mixed findings. We contribute to this literature by examining how other types of resources flows from developed countries can condition the effect of foreign aid on recipient countries' environmental protection. We are most interested in examining trade and FDI inflows. While foreign aid is a direct and intergovernmental resource transfer from donors to recipient governments, trade and FDI also generate resources for recipient governments indirectly, through economic interactions in the private sector. It would therefore not be all too surprising if trade and FDI condition the effect of foreign aid on the incentives faced by governments to protect the environment in aid-recipient countries.

Much attention has been given to how trade influences pollution levels in exporting countries (Antweiler et al. 2001). Two competing arguments have received attention: the "pollution haven" hypothesis (Eskeland and Harrison 2003) and the "California effect" hypothesis (Vogel 1995; Prakash and Potoski 2006). The "pollution haven" hypothesis suggests that trade openness leads to industry flight. Dirty industries located in developed countries with strict environmental regulations relocate to pollution havens in developing countries with less stringent regulations. Because stringent regulations are associated with higher production costs, international trade provides a mechanism for mobile firms to avoid higher costs by relocating to lower cost locations, a pattern of industrial flight that conforms to the sorting mechanism identified in the fiscal federalism literature (Tiebout 1956). The consequences for developing countries are obvious: Trade leads to increased pollution because they now host dirty industries that have relocated from developed countries (Jaffe et al. 1995).

Other scholars are more optimistic about the effects of trade on pollution in developing countries. Levinson's (2010) analysis of US imports for the period 1972–2001 does not find support for the pollution haven hypothesis. To the contrary, he finds that the composition of US imports shifted toward relatively clean goods, and much to his surprise, the green shift of US imports is found to be larger than the corresponding green shift of US domestic manufacturing. What might work against the pollution haven incentives? Scholars suggest that the cost savings by relocating to (and/or exporting from) pollution havens are often offset by the negative publicity firms receive at home. Stakeholders actively scrutinize firm behavior in their home countries and abroad—including the practices of their foreign suppliers. Firms importing from developing countries will face pressure from stakeholders in their home countries for environmental protection abroad (Prakash and Potoski 2007). Thus, trade can serve as a vehicle for transmitting the environmental preferences of importing countries to exporting countries. In particular, when developing countries' key export markets have stringent environmental standards, trade can lead developing country governments to ratchet up environmental standards at home (Perkins and Neumayer 2012).

In addition to trade, there is a burgeoning literature examining the effects of FDI inflows on environmental protection in the developing world. Similar to the trade debate, two schools of thought have emerged: one pessimistic and the other optimistic. Some studies suggest FDI inflows have a negative effect on the environment in developing countries. As profit-seeking actors, MNCs headquartered in developed countries are likely to channel investments to developing countries offering competitive advantages: lower labor costs, less regulation, and lower production costs (Caves 1996; Dunning 1993). Moreover, MNCs may deploy technologies and management practices in host countries that are cheaper and inferior to the ones used in their home countries (Frank 1967).

Other scholars suggest that MNCs have incentives to transfer technologies and management practices that are significantly influenced by those used in their home country (Pauly and Reich 1997). In a recent study, Rivera and Oh (2013) find that European MNCs tend to invest in countries with environmental regulations that are more stringent than home country regulations. In the context of the Chinese automobile industry, Saikawa (2013) finds that in order to attract foreign FDI and promote trade, the Chinese government made regulatory standards at home as strict, if not stricter, than abroad. Madsen (2009) finds that FDI inflows are not deterred by the stringency of host countries' environmental regulations.

Why would MNCs diffuse superior environmental practices to the developing world? One good reason is legal liability. This became especially relevant in the wake of the 1984 Bhopal disaster, a deadly gas leak in India that was among the worst industrial accidents in history, and left nearly 3,000 people dead. In that case, Union Carbide, a multinational conglomerate, was found liable for punitive damages caused by the disaster because its Indian subsidiary had deployed technologies that were inferior to those used by Carbide in its US operations. As a consequence, MNC subsidiaries in developing countries have increasingly adopted the environmental practices and technologies used in host countries. And MNCs have also encouraged and sometimes required their suppliers to adopt these superior environmental standards and practices (Rivera and Oh 2013).

Another reason why MNCs might promote environmental protection in host countries is the so-called liability of foreignness (Zaheer 1995). MNCs and their supply chains are typically subjected to extra scrutiny by local groups. Hence, MNCs have incentives to be environmentally responsible and diffuse norms that promote environmental sustainability throughout their supply chain (King and Shaver 2001). Moreover, given the relative immobility of FDI, MNCs often have economic incentives to ensure that the host country adopts their preferred technologies and practices.[2] This serves two purposes. First, it levels the playing field, so that the MNCs are not at a cost disadvantage in relation to local firms.

[2] As the salience of FDI originating from developing countries such as China and India increases, the pro-environmental pressures of FDI on the host economy might diminish. However, in the time period of our study, 1980–2005, the bulk of FDI received by developing countries originated from the North. According to Aykut and Ratha (2004), by the end of 1990s, over two thirds of the total FDI inflows to the developing world originated from the high income countries.

Second, recognizing that environmental mishaps or pollution-related stories in the host country would besmirch their reputation in global markets, MNCs have a vested interest in ensuring that environmental laws, practices, and standards in host countries are up to par (Ahlquist and Prakash 2010).

To be sure, claims about MNCs' environmental stewardship should be viewed with caution. MNCs can and do indulge in "greenwashing" and cheap talk (Egels-Zandén 2007). Hence, we subject the claims about the pro-environmental effects of trade and FDI to rigorous empirical tests in this paper, rather than assume that these preferences exist.

Theoretical framework

We begin with the assumption that governments in developing countries pursue political survival, and promoting economic growth is an important component of their survival strategy. Yet, growth and environmental stewardship often work at cross-purposes in the developing world. While most incumbents recognize that they cannot completely ignore the environmental consequences of growth, and invariably face pressures to provide environmental protection at some level, they often face strong incentives to favor policies that generate economic growth and material prosperity at the expense of the environment.

How do incumbents protract their survival in office? We draw on retrospective voting models to provide an answer (Ferejohn 1986, 1999). A class of these models posits that to secure reelection, incumbents and their political allies must please a winning political coalition by improving macroeconomic performance—most importantly, they must stimulate economic growth (Hibbs 2000, 2001). Recent contributions to this literature are more inclusive, and put economic performance at the heart of any effort to maintain political power across regimes, both democratic and autocratic. One class of models treats the domestic political elites, those who have a say in the selection of leader, as having incomplete information about incumbent's ability. They rely on objective indicators of performance to infer said ability. Economic growth and material prosperity are an effective signal, as its benefits tend to be tangible and quickly realized (Rogoff 1990). The political elites then use their updated knowledge to decide whether to keep or displace the leader (Galetovic and Sanhueza 2000). Other researchers put forth complete information models. In these models, the executive can make an economic investment in the first period but nonetheless be replaced in the second period (Gallego and Pitchik 2004). In such a scenario, the decision to keep the incumbent versus replace her is based on the difference between the benefits generated by the leader's investment and the opportunity costs of ousting her. Because economic growth spurred by a productive investment increases these opportunity costs, it deters leader replacement.

Our own framework is flexible, and agnostic about the level of information possessed by an incumbent's selectorate and the ultimate reason why economic growth is paramount to political survival. We posit that incumbents tend to be politically vulnerable and risk being replaced if their supporters' material prosperity is compromised. Thus, incumbents who hope to survive are incentivized to pursue economic growth and the rents it provides them, which often leads to the under-provision of environmental protection.

The conflict between economic growth and environmental protection should be especially strong in developing countries that are in the resource intensive phase of industrialization. The Environmental Kuznets Curve (Grossman and Kreuger 1995) literature suggests that, during this phase, governments and citizens prioritize economic growth over environmental protection. As India's former Rural Development Minister Jairam Ramesh candidly noted:

> The last 25–30 years, with accelerated economic growth and the pressure that economic growth has brought to bear on our natural resources, it has created this new animal of ecological poverty that we have to now address.[3]

We now discuss how incumbents' disposition changes as external resource inflows are introduced. Figure 1 summarizes the effect of different resource inflows in a hypothetical developing country whose optimal level of environmental protection (denoted as *O*) is located somewhere on the environmental protection continuum. We begin with a null scenario when the country has low levels of aid and globalization flows from the North; that is, little external resource inflows. To finance economic growth, governments seek to extract resources from the domestic economy. Given the low level of development and a small tax base, resource plunder is often the most readily available strategy (Haber and Menaldo 2011; Hamilton and Clemens 1999). At said levels of fiscal poverty, the provision of public goods such as a clean environment is not a governmental priority. The level of environmental protection provided will be far below the optimal level, denoted as A_1 on the continuum.

Suppose, however, that this government was to receive an increased amount of foreign aid. Recall that foreign donors are motivated by a host of objectives, including their economic interests, security, and democratization. Consequently, the bulk of foreign aid is neither purposefully environmentally destructive nor environmentally protective (Hicks et al. 2008). Because much of the aid flows directly into the government's coffers, however, the incumbent can use the aid to improve the material prosperity of her supporters, trading off environmentally destructive resource plunder in the process.[4] Therefore, the infusion of aid allows the incumbent to get closer to the optimal level of environmental protection and reduce pollution levels without having to kill political support. Thus, the level of environmental protection provided will be somewhere above A_1 and below *O*, denoted as A_2 on the continuum.

Now consider increased globalization flows from the North, but without an increase in foreign aid. As discussed in the previous section, globalization flows from the North serve as a mechanism to transmit the pro-environmental preferences of the developed countries' stakeholders. These pro-environmental pressures are shaped by the incentives traders and investors face at home; stakeholders such as environmental and labor groups have sought to improve the environmental practices in subsidiaries and supply chains (Prakash and Potoski, 2007; Rivera and Oh 2013; Saikawa 2013). Consequently, a developing country's government depending heavily on globalization flows from the North faces pressure to provide environmental protection closer to the level that matches the preferences of developed country stakeholders. This level exceeds the optimal level desired for a developing country and is denoted as A_3 on our continuum (see Fig. 1). The liberalization

[3] http://health.india.com/news/indias-public-health-system-has-collapsed-jairam-ramesh/.

[4] We believe that our characterization of foreign aid as a free addition to recipient government's coffers holds even for earmarked aid or in-kind aid. There is a literature suggesting that aid earmarked for the provision of specific public goods such as schools and hospitals is largely fungible, and can produce fiscal displacement. Feyzioglu et al. (1998), for instance, find that developing-country governments receiving loans for agriculture, education, and energy can reduce public investments in these sectors. Farag et al. (2009) find that an increase in donor funding for health is associated with a proportionate decrease in government health spending. Foreign aid, even when it is earmarked for a specific purpose, still enables governments to divert resources elsewhere, according to their own priorities (Waddington 2004).

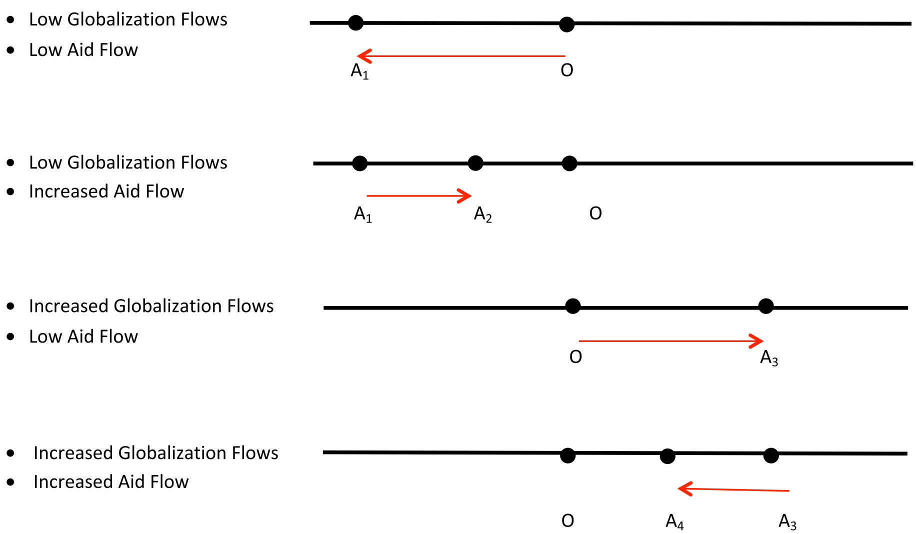

Fig. 1 Provision of environmental protection continuum

of trade and capital flows therefore represents, in a sense, a "globalization" tax that distorts behavior in a developing country.

Lastly, suppose that this globalized economy was also to receive an increased amount of foreign aid. Here, aid has an unexpected consequence. By reducing recipient governments' dependence on globalization flows from the North, aid undermines the leverage of foreign traders and direct investors who hold pro-environmental preferences. With foreign aid as a new revenue source, recipient governments have greater leeway to pursue policies that improve their chances of political survival without providing for environmental protection above their own, desired level. Instead, they will provide environmental protection at a level that better coheres with their political needs. Given the weak endogenous domestic demand for environmental public goods in most developing countries, foreign aid would encourage their governments to either lower regulatory standards or simply not adequately enforce them (Cao and Prakash 2010). The level of environmental protection would decline from A_3 down to A_4.

Therefore, our key hypotheses are as follows:

Hypothesis 1 Foreign aid has a pro-environmental effect when the recipient country has low-economic dependence on globalization flows from the North.

Hypothesis 2 Foreign aid has a negative effect on the environment when the recipient country has high-economic dependence on globalization flows from the North.

Our hypotheses are tested in the following section. In addition, we empirically demonstrate how our theoretical framework is supported over alternative explanations such as the conventional rentier story and is robust to endogeneity concerns. We also empirically investigate how our hypothesized relationship is affected by the incentives and constraints provided by different donors and domestic political institutions.

Data, methods, and findings

To test the relationship between aid and environmental protection conditional on levels of globalization flows from the North, we construct an unbalanced time series cross-sectional dataset of aid-recipient countries over a 26-year period, 1980–2005. This sample includes all countries that ever received ODA based on data from the Organization for Economic Cooperation and Development (OECD). Due to missing data on control variables, the regression models with the most coverage have 88 aid-recipient countries. The model with the largest number of observation has 1,569 observations.

We measure the dependent variable, pollution intensity, as sulfur dioxide (SO_2) emissions (Stern 2005) per dollar of GDP in constant 2000 US dollars. This is a widely employed pollution measure in the environmental politics and policy literatures. For our purposes, SO_2 is an excellent indicator of pollution for several reasons. First, it is a direct result of economic activities, industrial production in particular. The largest share of SO_2 emissions stem from stationary sources such as electricity generation, iron, and the steel industry, all reflecting the backbone of the industrialization process in developing countries. Second, because SO_2 emissions have high visibility, there is political awareness about its negative consequences among governments, the media, and various interest groups (Cao and Prakash 2010). Third, governments across the world seek to regulate SO_2.[5] Consistent with the literature, we take the natural log of this measure; the logged measure exhibits close to a normal distribution.[6] In robustness check, we show that our results hold when we employ SO_2 (logged, but not GDP denominated) as our dependent variable (Bernauer and Koubi 2009) while controlling for the size of GDP separately.

Our key explanatory variables are indicators of foreign aid, exports, and FDI inflows.[7] For foreign aid, we use the OECD's data on ODA. Consistent with the foreign aid literature (Alesina and Dollar 2000 and Younas and Bandyopadhyay 2009), we use ODA per capita (in constant 2009 dollars) as our primary indicator of foreign aid. This measure combines bilateral aid from government donors who are members of the Development Assistant Committee (DAC) in the OECD and multilateral aid from intergovernmental institutions such as the World Bank. In a robustness check, we show that our results hold when we employ ODA as percentage of GDP as an alternative indicator of foreign aid.

To measure exports, consistent with the California effect hypothesis, we examine exports destined to developed donor countries as percentage of exporting countries' GDP.[8] For FDI, we primarily use net FDI inflows, but also present a specification that uses FDI stocks as a

[5] We also evaluated other dependent variables such as biochemical Oxygen demand (BOD), as a proxy for water pollution, and NO_2 (Nitrous Oxide). Data for both of these pollutants is available for a smaller number of countries, and for much limited time period (from mid and late 1990s for most countries). Hence, we did not include these analyses in our study. While the data on CO2 intensity is widely available, we do not use the CO_2 indicator because it is not a regulated pollutant in developing countries during most of the period covered in our study, and therefore is not appropriate as a proxy for the government's commitment to environmental protection.

[6] Fisher type Augmented Dickey-Fuller (ADF) panel unit root tests conducted with several different lag length selections (1–5 years) reject the null hypothesis of a unit root.

[7] In using the OECD foreign aid dataset, we treat all reported missing values as truly missing (and thus exclude them from the analysis).

[8] Exports to donor countries were calculated using bilateral trade data from the Correlates of War Project (COW 2008). We treat all reported missing values as truly missing (and thus exclude them from the analysis), and accept all reported zeros as true zeros. Donor countries refer to the members of the Development Assistance Committee (DAC) in the OECD. Greece, Portugal, South Korea, and Spain are excluded due to their very recent membership into the DAC.

robustness check.[9] We use aggregated FDI inflows rather than the subset of FDI from donor countries for three reasons. First, the disaggregated statistics (based on bilateral FDI flows) are highly unreliable for many developing countries during the period covered in this study. Second, the majority of FDI to developing countries is from the developed world: around 95 % of the total FDI in the early 1980 s and still over two-thirds of total FDI in the last decade.[10]

We also control for economic, political, and demographic factors used in the literature on pollution levels. We control for total trade because overall trade openness might influence levels of pollution intensity.[11] We control for (logged) GDP per capita in constant 2007 dollars and adjusted for purchasing power parity[12] and its squared term to allow for the possible curvilinear relationship between economic development and environmental protection as suggested by the Environmental Kuzents Curve. We also control for annual GDP growth and the size of the industry valued added as a percentage of GDP.[13] The Polity 2 Score[14] is included to capture the effect of regime type on pollution (Bernauer and Koubi 2009; Li and Reuveny 2006). To control for demographic characteristics, our models include population density and urban population as a percentage of total population.[15] Descriptive statistics of the key variables included in our analysis are summarized in Table 1.

Our research strategy proceeds as follows. We first estimate some parsimonious specifications that regress SO_2 emissions per unit of GDP on foreign aid, exports to donors, FDI, and the interaction terms between foreign aid and the two measures of globalization flows. A basic set of control variables, described above, will also be added to these models. We then proceed to test our mechanism against potential alternative explanations and reverse causation, explore more nuanced versions of our theoretical mechanism, and conduct several robustness checks.

Model

We model the annual SO_2 emission per unit of GDP in country i during year t as a function of foreign aid (ODA per capita), globalization flow, their interaction term, and other control variables. The restricted dynamic OLS equation can be expressed as follows:

$$\begin{aligned} \text{SO}_2\ \text{Intensity}_{it} = {} & \phi_1 \text{SO}_2\ \text{Intensity}_{i,t-1} + \gamma_1 \text{Aid}_{i,t-1} + \gamma_2 \text{Globalization Flow}_{i,t-1} \\ & + \gamma_3 \text{Aid} \times \text{Globalization Flow}_{i,t-1} + X_{i,t}\beta_1 \\ & + \alpha_i + \tau_t + \varepsilon_{it} \end{aligned}$$

where *Globalization Flow* represents either export to donors or FDI inflows; $\gamma_1, \gamma_2,$ and γ_3 represent the coefficient estimates of the foreign aid, globalization flow, and their interaction term, respectively; X is the matrix of control variables; β represents the vector of

[9] FDI flow data is from the World Bank Development Indicators (WBDI); FDI stock data is from the United Nations Conference on Trade and Development (UNCTAD). Both FDI indicators are expressed as a percentage of GDP, and the correlation between the two is 0.41. We treat all reported missing values as truly missing (and thus exclude them from the analysis), and accept all reported zeros as true zeros.

[10] Outward FDI from China has become an important phenomenon only in the recent years. Chinese FDI stock by the end of 2006 only accounted for 0.85 % of the world's total FDI (Yang 2008).

[11] Total trade data are from the WBDI.

[12] The data are from Haber and Menaldo (2011).

[13] The data are from the WBDI. The industry value added indicator comprises value added in the mining, manufacturing, construction, and energy (electricity, water, and gas) sectors.

[14] The data are from Polity IV (2010).

[15] The data are from the WBDI.

Table 1 Determinants of pollution intensity

	Null	Main				Robustness checks			
	Model 1 No interaction	Model 2 With interaction	Model 3	Model 4 Control for natural resources	Model 5	Model 6 Control for environmental aid	Model 7	Model 8 GMM	Model 9
ODA	−0.007 (0.008)	−0.026^{+} (0.016)	−0.025* (0.011)	−0.024 (0.015)	−0.024* (0.011)	−0.024* (0.011)	−0.0002 (0.0045)	−0.018** (0.004)	−0.018** (0.003)
Export to donors	−0.005 (0.006)	−0.008^{+} (0.005)	−0.004 (0.006)	−0.007 (0.005)	−0.004 (0.006)	0.008 (0.007)	0.013 (0.008)	−0.008** (0.002)	−0.006** (0.002)
ODA × export to donors		0.001* (0.0005)		0.001* (0.0004)		0.0013** (0.0004)		0.001** (0.0002)	
FDI	−0.005 (0.011)	−0.005 (0.012)	−0.026** (0.010)	−0.005 (0.012)	−0.045* (0.010)	−0.003 (0.005)	−0.014* (0.007)	0.009** (0.003)	−0.006 (0.004)
ODA × FDI			0.006** (0.001)		0.005** (0.002)		0.003* (0.0015)		0.004** (0.001)
Trade	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	−0.004 (0.004)	−0.004 (0.004)	0.000 (0.001)	0.000 (0.001)
GDP per capita	2.771** (0.920)	2.380 (0.874)	2.477** (0.886)	1.951* (0.835)	2.036* (0.841)	0.453 (1.351)	0.564 (1.322)	1.580 (0.527)	1.949** (0.534)
GDP per capita^2	−0.157** (0.048)	−0.132** (0.046)	−0.137** (0.046)	−0.109* (0.044)	−0.114** (0.044)	0.025 (0.081)	0.018 (0.078)	−0.091** (0.031)	−0.113** (0.032)
GDP growth	0.003 (0.006)	0.003** (0.006)	0.003 (0.006)	0.004 (0.006)	0.004 (0.006)	0.000 (0.004)	0.001 (0.004)	−0.004** (0.001)	−0.003** (0.001)
Polity2	−0.010 (0008)	−0.010 (0.008)	−0.010 (0.008)	−0.009 (0.008)	−0.010 (0.008)	0.008 (0.010)	0.008 (0.010)	0.010** (0.003)	0.011** (0.002)
Industry (% GDP)	0.008 (0.005)	0.009* (0.005)	0.008^{+} (0.005)	0.014** (0.005)	0.013** (0.005)	−0.004 (0.005)	−0.006 (0.004)	0.004* (0.002)	0.004* (0.002)
Population density	0.003** (0.001)	0.003** (0.001)	0.003** (0.001)	0.003** (0.001)	0.003** (0.001)	0.002** (0.001)	0.003** (0.001)	0.002** (0.001)	0.003** (0.001)
Urban population	0.030** (0.007)	0.030** (0.007)	0.029** (0.007)	0.030** (0.007)	0.029** (0.007)	0.005 (0.013)	0.004 (0.012)	0.033** (0.004)	0.032** (0.004)
Natural resources				−0.008** (0.003)	−0.008** (0.003)				
Environmental aid						0.010 (0.007)	0.008 (0.007)		
Lagged D.V.	0.657** (0.068)	0.657** (0.067)	0.657** (0.067)	0.653** (0.069)	0.653** (0.069)	0.530** (0.135)	0.537** (0.136)	0.158^{+} (0.096)	0.163^{+} (0.084)
N(n), max T	1,569 (88), 26	1,569 (88), 26	1,569 (88), 26	1,568 (88), 26	1,568 (88), 26	632 (75), 10	632 (75), 10	1,410 (85), 26	1,410 (85), 26

Dependent Variable is (logged) SO_2 per GDP in grams; only LRMs are shown (except for the lagged D.V.); For Models 1–7, Driscoll-Kraay standard errors are in parentheses; For Model 8–9, heteroscedasticity-consistent standard errors calculated from sandwich variance–covariance estimators in parentheses; country and year fixed effects are estimated for Models 1–5 and Models 7–8, and only country fixed effects are estimates for Models 6–7 coefficient estimates of the control variables; α and τ represent country and time fixed effects, respectively, and ε_{it} is the error term. We include country fixed effects to control for country-specific and time-invariant heterogeneity that may influence a country's propensity to pollute. This includes factors such as ethnic fractionalization, geography, and history. Because pollution intensities may reflect common shocks or trends, we also estimate year fixed effects.

The lag structure of the variables is as follows. *Globalization Flow*, foreign aid, and their interaction term are lagged by 1 year because their effect on government decision making is not instantaneous. A lag of the dependent variable, SO_2 intensity$_{t-1}$, is included in the equation to explicitly model the dynamic process by which pollution adjusts to changes in the independent variables: current pollution is equal to past pollution plus a delayed adjustment to a new level of pollution induced by a permanent increase in the independent variables.[16] To identify the long-run (cumulative) effects of the independent variables, we calculate each variable's long-run multiplier (LRM): the coefficient on the independent variable divided by (1,the coefficient on the lagged dependent variable, ϕ). For instance, the LRM for foreign aid is calculated as follows:

$$\mathrm{LRM}_{\mathrm{Aid}} = \frac{\gamma_1}{1 - \phi_1}$$

The models' standard errors are adjusted in several ways. First, the delta method is used to calculate the correct standard errors for the LRM since it is computed as the ratio of two estimated regression coefficients. We also adjust the standard errors with the Driscoll-Kraay variance–covariance estimator, a nonparametric technique designed for panel data estimated with country fixed effects. Driscoll-Kraay standard errors address both groupwise contemporaneous correlation and heteroskedasticity (Driscoll and Kraay 1998). The results are also robust to estimating panel-corrected standard errors or robust (Huber-White-Sandwich) standard errors clustered by country.

Findings

Column 1 in Table 1 reports the results from the most parsimonious model specification, which lacks any interaction term. None of the resource flows—aid, trade, and FDI—is statistically significant. Column 2 includes an interaction term for aid, measured as ODA, and exports to donors. Column 3 includes an interaction term for ODA and FDI inflows. All of these models include the control variables outlined above. The results of the Column 2 and Column 3 models support our theoretical narrative. First, the negative coefficient estimates obtained for export to donors (−0.008, in Model 2) and FDI inflows (−0.026, in Model 3) as lower-order terms confirm the pollution-reducing effect of these revenue flows in developing countries that receive no foreign aid. We infer that this implies that pro-environmental pressures emanating from investors and importers located in the North are affecting host governments. Second, the negative and significant coefficient estimate of the foreign aid as a lower-order term (−0.026 in Model 2 and −0.025 in Model 3) suggests that foreign aid has a pollution-reducing effect in countries with no globalization flows originating in the developed world. This is consistent with Hypothesis 1.

[16] We test for remaining serial correlation across our LDV models, and do not find any remaining serial correlation. Although our main models are partial adjustment models, we also estimate a more general Autoregressive Distributed Lag (ADL) specification as a robustness check.

The interaction terms are positive and significant in both models. Following Brambor et al. (2006), in Figs. 2 and 3, we display the marginal effect of foreign aid on pollution intensity conditional on recipient countries' exposure to globalization flows from the North. Any particular point on the interior solid sloping line is the long-run marginal effect of foreign aid at different levels of globalization flows.[17] The exterior and interior dotted lines are 95 and 67 % confidence intervals, respectively. They reveal the range of globalization flows under which foreign aid has a statistically significant effect on the pollution intensity. Aid has a statistically significant pollution-increasing effect whenever lower bounds of the confidence interval are above the dashed horizontal line marked zero.

Consistent with Hypothesis 2, we find that foreign aid has a pollution-increasing effect when the recipient country exhibits a greater dependence on globalization flows from the North. In Fig. 2, the solid sloping interior line indicates that, at the very low levels of exports to donors, foreign aid has a pollution-reducing effect. The effect is only significant at the 67 % confidence level, however, which is a weak relationship. The marginal effect of aid becomes pollution increasing as exports to donors increase. When the level of exports to donors is greater than 38 %, the pollution-increasing effect of aid is significant at a 95 % confidence level.[18] Likewise, Fig. 3 shows that the marginal effect of aid is pollution reducing at low levels of FDI, but is pollution increasing when the level of FDI inflows is greater than 7 % of GDP.[19]

What are the substantive effects of these interactive relationships? Since the variables that operationalize both foreign aid and pollution are logged, the magnitude of the marginal effect can be stated as elasticities. When FDI inflows are close to zero, a 1 % increase in foreign aid per capita leads to about a 0.03 % *decrease* in SO_2 per unit of GDP. In a large FDI recipient where FDI inflows are close to 20 % of GDP, however, the same 1 % increase in foreign aid leads to about a 0.1 % *increase* in SO_2 per unit GDP.

Alternative explanations and reverse causality

Although our findings are consistent with our theoretical narrative, it behooves us to consider the possibility that alternative explanations may potentially account for the same finding. Our theoretical narrative emphasizes that developing country governments' ability to pursue economic growth, possibly at the expense of the preferences of foreign pro-environmental stakeholders, increases as a function of the degree of foreign aid it receives.

A potential alternative explanation, however, is a conventional rentier mechanism. A rentier story would suggest that governments whose budgets depend on nontax sources of revenue may fail to supply public goods. The logic is that the fiscal link between citizens and the government is severed by the fact that an aid-dependent government would no longer need to "rely" on regular taxation to finance its operations or remain in power. This would render an aid-dependent government politically unaccountable, and more likely to ignore citizens' desire for a clean environment (Table 2).

[17] $LRM_{Aid} + LRM_{Interacton.term} \times Globalization\,Flows.$

[18] Exports and FDI tend to be highly correlated. By including both in our model, we are estimating only their unique (non-overlapping) effects on pollution intensities. It makes little sense to drop either of them because that would lead to an under-specified model. Nevertheless, because of this collinearity, the results we present should be viewed as conservative estimates.

[19] In different geographic regions and time periods, we find cases where developing countries receiving high levels of globalization flows from the North (i.e., levels close to or above the cut points we estimate) also receive increasing amounts of foreign aid. Among the cases are Singapore (during the early 1980s), Congo, Angola, and Cambodia (all during the mid 1990s), and the Czech Republic in the early 2000s.

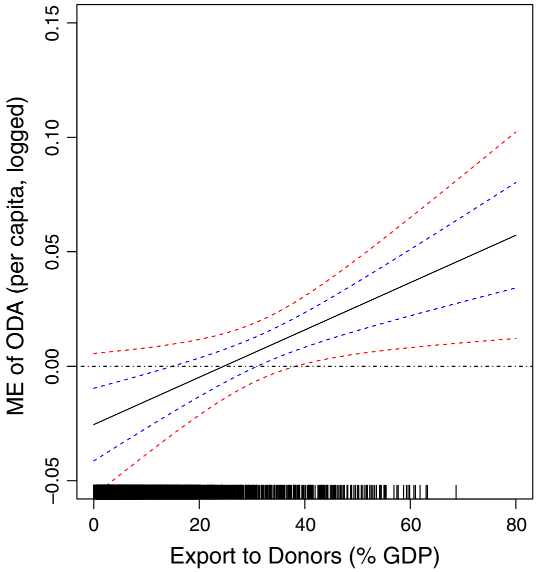

Fig. 2 Long-run marginal effect of ODA on pollution intensity (over various levels of exports to donors)

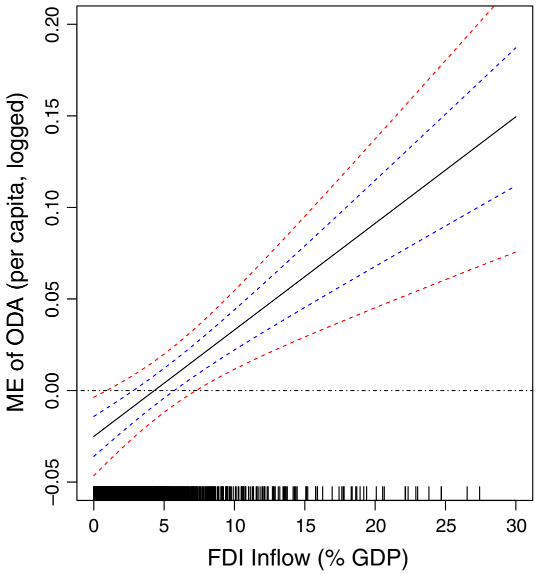

Fig. 3 Long-run marginal effect of ODA on pollution intensity (over various levels of FDI inflows)

Does the evidence support this alternative mechanism? For several reasons, it does not. First, a rentier story implicates an unconditionally pollution-increasing effect of foreign aid. Contrary to such an expectation, the un-interacted coefficient of aid is insignificant in the null model (Model 1), and the lower-order term for aid is negative (i.e., pollution reducing) in the interaction models (Model 2 and Model 3). Second, if there is indeed a rentier mechanism by which unearned sources of income allow governments to stop investing in public goods desired by citizens—in this particular case, a clean

Table 2 Determinants of pollution intensity: aid disaggregation and split sample analyses

	Model 10 ODA increase driven by bilateral aid	Model 11 ODA increase driven by multilateral aid	Model 12 Non/limited democracies	Model 13 Full democracies	Model 14 Below or median veto point	Model 15 Above median veto point
ODA	−0.016 (0.008)+	−0.030 (0.010)**	−0.020 (0.009)*	0.028 (0.010)**	−0.014 (0.006)*	0.011 (0.019)
Multilateral ODA	−0.006 (0.004)+					
Bilateral ODA		0.008 (0.004)+				
FDI	−0.025 (0.012)*	−0.030 (0.010)**	−0.035 (0.009)**	0.062 (0.017)**	−0.039 (0.010)**	0.001 (0.015)
ODA × FDI	0.006 (0.001)**	0.006 (0.001)**	0.008 (0.002)**	−0.008 (0.002)**	0.011 (0.003)**	0.001 (0.004)
Export to donors	−0.001 (0.008)	−0.005 (0.005)	−0.006 (0.007)	−0.003 (0.013)	−0.014 (0.007)*	0.016 (0.012)
Trade	−0.000 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.004)	−0.001 (0.002)	−0.001 (0.005)
GDP per capita	1.512 (0.920)	1.865 (0.811)*	0.400 (0.792)	10.103 (3.785)**	2.157 (0.918)*	4.758 (2.793)*
GDP per capita^2	−0.076 (0.050)	−0.094 (0.044)*	−0.001 (0.042)	−0.623 (0.199)**	−0.116 (0.048)*	−0.294 (0.160)*
GDP growth	0.002 (0.008)	0.003 (0.006)	0.002 (0.005)	0.004 (0.007)	−0.0002 (0.005)	0.001 (0.011)
Polity2	−0.004 (0.007)	−0.011 (0.008)	−0.017 (0.010)		−0.011 (0.008)	0.011 (0.021)
Industry (% GDP)	0.007 (0.006)	0.006 (0.005)	−0.004 (0.006)	0.021 (0.010)*	0.002 (0.006)	0.025 (0.009)**
Population density	0.003 (0.001)**	0.003 (0.001)**	0.002 (0.001)**	0.006 (0.005)	0.006 (0.001)*	0.003 (0.001)**
Urban population	0.017 (0.007)**	0.026 (0.007)**	0.029 (0.006)**	0.028 (0.013)*	0.049 (0.010)*	−0.008 (0.017)
Lagged D.V.	0.708 (0.043)**	0.629 (0.064)**	0.589 (0.066)**	0.763 (0.028)**	0.474 (0.071)*	0.842 (0.041)**
ObsN (n), Max T	1,457 (80), 26	1,459 (80),26	1,061 (70), 26	506 (45), 26	785 (68), 25	782 (64), 26

Notes Dependent Variable is (logged) SO_2 per GDP in grams; only LRMs are shown (except for the lagged D.V.) with Driscoll−Kraay standard errors in parentheses; country and year fixed effects are estimated environment—then it follows that other types of unearned income should have a pollution-increasing effect for the same reason. Because natural resource rents are a big source of unearned income, in Models 4 and 5, we add natural resources rents (as % of GDP) to the model specification to test this hypothesis.[20] While the effect of natural resources appears to be *pollution reducing*, our main findings with regard to the foreign aid effect hold.[21] These findings are consistent with our theory, which clearly differs from a conventional rentier story. Rather than be inherently destructive to the environment, foreign aid works through its effect on the policy leverage exercised by pro-environmental globalization flows. When foreign aid is dispersed to open economies, their governments can afford to ignore the environmental demands made by foreign investors and import partners.

We also explore the possibility that our finding is driven by reverse causality. While we have interpreted our findings to suggest that *the effect of foreign aid on pollution intensity* is conditioned by the level of globalization flows, it is equally possible, econometrically speaking, that *the effect of pollution intensity on foreign aid* is conditioned by the level of globalization flows. We tackle this issue of reverse causality in two ways. First, we consider and rule out a plausible theoretical mechanism that might induce reverse causality. Second, we avail an econometric strategy that allows us to address omitted variable bias and reverse causation through instrumental variables.

A possible way in which reverse causation may drive our results is if donors actively seek to ameliorate environmental degradation of their major economic partner countries. In this scenario, developing countries with greater levels of pollution may attract *more* aid when globalization flows are *high,* but not when their globalization flows are low. This is because donors might provide aid to polluters who are close economic partners to help them reduce their pollution intensity, but be less inclined to help polluters that are *not* their close economic partners, perhaps because they cannot exert as much leverage over the latter. In Models 6 and 7, we rule this explanation out by controlling for the amount of aid that is earmarked by donors for protecting the environment.[22] After controlling for environmental aid, we still find a pollution-increasing effect of aid high levels of globalization flows from the North.[23]

To address any remaining concern about reverse causality, in Models 8 and 9, we employ a dynamic panel model estimated via a Generalized Method of Moments (GMM)

[20] The data are from WBDI. Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents.

[21] The negative coefficient estimate of natural resource rent may be attributable to the fact that SO_2 is an industrial pollutant. Its major emission sources include power plants, locomotives, ships, and other industrial processes. Resource extraction processes in resource rich developing countries generate trivial amounts of SO_2, and therefore involve fewer SO_2 emissions compared to manufacturing intensive production in countries at the same level of income. And although refineries produce sizable quantities of SO_2, the world's largest refineries are located in the US and South Korea, not in the oil exporting countries of the developing world.

[22] Environmental aid is the segment of the ODA dedicated (committed) to environmental protection based on the classification of OECD's Creditor Reporting System (CRS).

[23] Unlike other models where the coefficient estimates for the lower order aid term were negative, this term is not statistically significant in Model 7. That is, aid does not reduce pollution even when FDI levels are low. Why so? This might be the result of controlling for environmental aid, but might also be attributable to the fact that Model 7 only covers the period between 1996–2005 due to the limited availability of disaggregated aid data. While Model 7 controls for Export to Donors, the average export from the South to the North in mid 1990s and 2000s is already much greater than that in the 1980s. Thus when only the later period is included in the analysis, even the observations with low FDI levels might be considerably globalized in terms of exports. If so, the lower order aid term can no longer capture the marginal effect of aid at little or no globalization flows.

approach.[24] Specifically, we employ a structure (difference) GMM approach designed for "small T, large N" panel datasets (Roodman 2009a) and suited for a stationary-dependent variable such as our own. While the structure GMM estimation transforms the equation into first differences to expunge the country fixed effects, the potentially endogenous regressors are instrumented with some of their lags in levels. This is possible because these lags should be uncorrelated with the error term. Specifically, while the first-differenced LDV is instrumented with its second through fourth lags in levels, we instrument aid, globalization flows (Export to Donors/FDI), and its interaction term with their second lags in levels.[25]

Our main finding is robust to this strategy. The significant and negative coefficient estimates of the lower-order terms for aid in both models suggest aid is pollution reducing at low levels of Export to Donors (in Model 8) and FDI (in Model 9). And as the significant and positive coefficient estimates of the interaction terms suggest, aid becomes pollution increasing as the levels of globalization flows rise. Moreover, the GMM assumptions appear to be satisfied in both Model 8 and Model 9. A Sargan test of the over-identifying restrictions returns a chi-square test statistic of 85 (p value $= 0.99$) in both, failing to reject the hypothesis that the instrumental variables required by the GMM approach are exogenous. An Arellano-Bond test of AR(2) returns a z-score of 1.028 (p value $= 0.15$) in Model 8 and a z-score of 0.75 (p value $= 0.23$) in Model 9, satisfying the requirement that there will be no autocorrelation in levels.

Donor characteristics and domestic politics

In this section, we discuss the more nuanced versions of our theoretical mechanism. The gist of our argument has been that foreign aid as an environmentally neutral source of revenue enhances the resources at a recipient government's discretion, possibly at the expense of pro-environmental leverage of globalization flows. Yet, there might be variation in *how much discretion* recipient governments enjoy. Specifically, this discretion might vary by (1) the type of donor the government receives aid from, and also by (2) a recipient country's domestic political institutions.

When it comes to the type of donor, we focus on the potential difference between bilateral ODA and multilateral ODA. Bilateral ODA is more likely to be driven by narrowly defined common interests between two governments, such as the political survival of the recipient's government or exploiting the recipient's market for donor's economic interests (Wagner 2003). This should align the incentives of donors and political incumbents, allowing the latter to pursue their political agenda unencumbered by the pressures from external stakeholders. Specifically, this should give recipient governments more leeway to neglect environmental protection in favor of economic growth. Multilateral ODA, on the other hand, tends to more sensitive to the long-run sustainability of the recipient's development strategy (Lebovic and Voeten 2009). Multilateral donors might encourage recipient governments to engage in sustainable development as a quid-pro-quo for future aid. If so, the pollution-reducing effect of aid (Hypothesis 1) might be weaker in

[24] This technique also addresses the possibility that, in our previous models, Nickell bias is distorting our results due to the correlation between the lagged dependent variable and country fixed effects.

[25] As we have a relatively long time dimension (the maximum is 26 years), to prevent instrument proliferation we use instruments at these lag depths rather than using all available lags (Roodman 2009b).

the context of bilateral aid, while the pollution-increasing interaction effect (Hypothesis 2) might be more pronounced.

We find some support for this argument in Model 10 and Model 11. In Model 10, we control for multilateral aid to examine the marginal effect of ODA when an aid increase is in the form of bilateral aid. In Model 11, we control for bilateral aid in the model to examine the marginal effect of ODA when an aid increase is driven by multilateral aid. While the size of the interaction term coefficients is similar in both models (0.006), the coefficient estimates of the lower-order ODA term are more pollution reducing when ODA increases are driven by multilateral aid (−0.030, Model 11) versus bilateral aid (−0.016, Model 10). This suggests that the pollution-reducing effect of bilateral ODA is not only weaker to begin with, but also the effect is more easily nullified and reversed at relatively modest level of FDI (about 2.6 % of GDP) than the pollution-reducing effect of multilateral ODA (which are nullified at FDI inflows greater than 5 % of GDP).

It should also be the case that variation in domestic politics, centered on differences in formal institutions, affects the hypothesized relationship between aid, trade/FDI, and environmental protection.[26] This is because governments' willingness to respond to/neglect pressures from foreign stakeholders is influenced by institutional constraints that pluralize political power (Spilker 2012). Following Tsebelis (1995) and Henisz (2010), a larger number of veto points can make executives less responsive to demands made by pressure group. Institutions such as independent judiciaries, separately elected legislatures, competitive political parties, and a free media would make it much harder for these groups, including foreign traders and investors, to capture policymaking, for either good or ill.

We expect executives that face a greater number of such constraints to be less susceptible to pressures (either pro-environmental or anti-environmental) from foreign stakeholders than those who face fewer constraints. If pro-environmental foreign stakeholders' leverage is weak to begin with, the level of globalization flows from the North is unlikely to serve as a conditioning environment of foreign aid effect. Thus, our hypothesized mechanism will be more pronounced in countries where executives face fewer institutional constraints.

We test this hypothesis by conducting split sample analyses.[27] We first split countries by their level of democracy; specifically, by whether they are full versus limited democracies, following Gleditsch and Ward (2006). We then split countries by their veto points using the Political Constraint Index III (Henisz 2010), separating observations into those below or at the median number of veto points and those above the median. The results from the split sample analyses are summarized in Models 12 through 15. The results are consistent with our expectations. Our findings hold in the sample of limited/nondemocracies, but not in full democracies where executives tend to face many domestic constraints. Similarly, our findings hold in countries with low political constraints expressed as veto points, but not when incumbents face a large number of veto points.

[26] In our earlier models, the Polity 2 Score was included as a control variable. The coefficient estimates of this variable (which capture the average marginal effect of regime type on pollution intensity) were insignificant.

[27] Rather than introducing three-way-interaction terms, we conduct split sample analyses to allow the effects of independent and control variables to vary by regime type as well.

Additional robustness checks

We report several additional robustness checks in the "Appendix" (Model 16-Model 23). Model 16 employs (logged) SO_2 emissions in grams without being denominated in terms of GDP as the dependent variable. Model 17 employs ODA as a percentage of GDP (Lundsgaarde et al. 2007) instead of ODA per capita. Model 18 employs a stock measure of FDI instead of FDI measured as a flow. The interaction effects are significant across each of these models; therefore, our findings are not sensitive to the ways in which the key variables are operationalized.

In addition to the interaction between ODA and FDI, Model 19 adds an interaction term between ODA and natural resources, and Model 20 adds an interaction between environmental aid and FDI. Even when these additional interaction dynamics are included, our main finding holds. The newly added interaction terms are positive (i.e., pollution increasing), but their substantive effects are small and not statistically significant. These results suggest that while many different sources of revenue may potentially work in interaction to influence a developing country government's incentives, the more prominent interaction affecting pollution intensity is between the economic globalization flows and the overall ODA. In Model 21, we examine whether our finding is being driven by the Cold War period, when donor countries' environmental consciousness was arguably overwhelmed by geopolitical confrontations. Our results hold when a Cold War dummy variable is included in the specification. The coefficient estimates of the lower-order ODA term and the interaction term are very similar to those from Model 3, our main model.

In Model 22, we examine whether our findings are being driven by donorwise variation in environmental preferences. Instead of treating foreign aid as an undifferentiated category, we construct a spatial lag variable capturing the variation in the environmental intensities of bilateral donors, as reflected in their own pollution intensity. The new variable, bilateral aid context (BAC), is the weighted average of donors' SO_2 intensity:

$$\text{Bilateral Aid Context }(\text{BAC})_i = \sum_{1}^{j} \text{SO}_2 \text{ Intensity}_j \times \left(\text{Bilateral Aid}_{ij}/\text{Total Bilateral Aid}_i\right)$$

where county i is the bilateral aid recipient that receives aid form j number of donors. We include a 1-year lag of the logged BAC in the model specification. Low values of BAC suggest that the recipient has an environmentally conscious aid context. Our results hold when BAC is controlled for.

Lastly, Model 23 examines whether our finding is driven by the dynamic model specification. It has been shown that partial adjustment models, such as those we reported above, potentially impose invalid restrictions on the structure of the data, thereby biasing the results (De Boef and Keele 2008). Thus, in Model 18, we estimate a rational, infinitely distributed lag model as an autoregressive distributed lag model (ADL). Such a model allows us to be agnostic about the lag structure and does not run the risk of imposing invalid restrictions on the dynamic process and allows us to estimate the long-run effect of a change of the independent variables on the level of the dependent variable. Specifically, the model specification now includes the 1-year lag of the dependent variable and the independent variables of interest are entered both contemporaneously and with a 1-year lag.[28] As with the partial adjustment models estimated above, the

[28] $\text{SO}_2\text{Intensity}_{it} = \phi_1 \text{SO}_2\text{Intensity}_{i,t-1} + \gamma_1 \text{Aid}_{it} + \gamma_2 \text{Aid}_{i,t-1} + \gamma_3 \text{Globalization Flow}_{it} + \gamma_4 \text{Globalization Flow}_{i,t-1} + \gamma_5 \text{Aid} \times \text{Globalization Flow}_{it} + \gamma_6 \text{Aid} \times \text{Globalization Flow}_{i,t-1} + x_{it}\beta_1 + \text{x}_{i,t-1}\beta_2 + \alpha_i + \tau_t + \varepsilon_{it}$.

standard errors of the LRM coefficients, which is the sum of the coefficients on the independent variables at time *t* and *t−1* divided by (1-the coefficient on the lagged dependent variable, ϕ), are computed. Our findings are robust to this estimation strategy. This suggests that the partial adjustment models estimated above are not imposing invalid restrictions.

Conclusion

Since the 1980s, developing countries have been urged, and sometimes coerced by the IMF and the World Bank, to liberalize their economies. This trend accelerated in the 1990s. In the last decade, there have also been calls to increase levels of foreign aid flows to developing countries. While the intentions behind such efforts are laudable, we believe the interactive effects of globalization flows and foreign aid have not been adequately understood. Our paper provides some evidence that aid can have unexpected, negative environmental consequences in many developing countries that depend heavily on globalization flows from the North. Because aid is an intergovernmental flow and trade and FDI are private flows, their negative interaction effect on environmental quality poses interesting policy challenges to donors, recipients, and firms alike.

Empirically, the *negative* interaction effect between aid and globalization flows is driven by aid *increases* in a country with *a high level of export receipts/FDI inflows* from the North. Our theory suggests that the main actor driving this effect is the recipient government, which uses the aid as leverage against pro-environmental pressures emanating from foreign importers/investors to drive economic growth to its preferred level. The key to addressing this negative interaction effect thus lies in changing the recipient governments' incentives.

One strategy to accomplish this is to foster environmental demand among the constituents that developing country governments are responsive to, perhaps by creating institutions that link environmental protection with profits in the domestic private sector. Once in place, certain domestic actors would develop a vested interest in maintaining such institutions, regardless of their linkages with, and responsiveness to, foreign pro-environmental exporters and investors. For example, creating a market for pollution (e.g., a cap-and-trade system) might potentially create and provoke pro-environmental preferences among domestic firms who can then lobby the government in this regard. There is some evidence that market-oriented environmental policies have been successfully adopted in the developing world (Coria and Sterner 2010; Grieg-Gran, et al. 2005). Indeed, China is currently implementing cap-and-trade systems across the country to include Shenzhen, Beijing, Tianjin, Shanghai, and Chongqing, as well as the provinces of Guangdong and Hubei. These polices can be combined with other, more traditional, regulations that seek to reduce pollution, such as command and control regimes that impose limits on emission rates, Pigovian taxes on harmful emissions, or subsidies for green technologies—the latter having the advantage of also helping to create stakeholders that have a pecuniary interest on sustaining pro-environmental policies.

The recipient countries' incentives may change if they are subjected to a powerful countervailing force that can neutralize the leverage provided by foreign aid. Developed country governments could include explicit and "hard" environmental clauses in trade agreements with developing countries, or link these agreements with environmental treaty ratifications. While there is much debate on the efficacy of international treaties, one advantage is that they make a country's commitments internationally visible. The fear of incurring reputational damage might subsequently deter governments from violating these treaties or withdrawing from them.

Last but not least, recipient countries' incentives might change if they receive explicit environmental pressure from aid donors. For example, donors can seek to offer aid incentives based on recipients' environment-related performance, including conditioning the size of future aid flows. One way in which this can be facilitated is by empowering domestic stakeholders to monitor both recipient governments and donors in a manner similar to the Extractive Industries Transparency Initiative (EITI) that has taken hold among oil and mineral producers in the developing world. The EITI is a voluntary, multilateral system. To be designated as compliant, a country must satisfy twenty-one requirements, each of them quite stringent. These include completing a validation audit within two and a half years of becoming a candidate and undergoing validation every 5 years after becoming a candidate. The validation process is overseen by a multi-stakeholder consortium that guarantees that EITI standards are met. EITI participation also calls on contract disclosure in general, which helps government agencies, citizens, and NGOs monitor and inspect extractive sectors in the developing world.

Such a system could be duplicated for foreign aid and include covenants that obligate developing country governments to invest the flows in environmentally responsive ways. Recipient governments, not just donors, would be required to publish and disseminate the amounts of foreign aid they received and for what purposes it was deployed. Moreover, foreign importers and investors might form part of the group of stakeholders who monitor compliance with EITI-type requirements.

We believe this paper opens up an important area for future research. Policy scholars should build on to our suggestion and discuss measures to create incentives that can ameliorate the negative effects of the aid and economic globalization combination. What are the sticks and carrots that can be availed to make this combination of resource inflows work better for developing countries? How can international institutions and donors constrain the discretion of recipient governments that deploy foreign aid toward growth strategies that neglect environmental sustainability when their economies are highly integrated with the global economy? How can the domestic actors in recipient developing countries be incentivized to constrain their own governments from trading off too much environment protection for growth in the short run? Future research should attempt to offer answers to these vital questions.

Appendix

See Tables 3 and 4.

Table 3 Additional robustness checks

	Model 16 (SO_2 in Grams)	Model 17 (ODA as % GDP)	Model 18 (FDI Stock)	Model 19 (resource × ODA)	Model 20 (Env.ODA × FDI)	Model 21 (Cold War)	Model 22 (BAC)	Model 23 (ADL)
ODA	−0.017 (0.010)$^{+}$	−0.016** (0.005)	−0.016 (0.012)	−0.033* (0.015)	0.002 (0.005)	−0.026* (0.011)	−0.023^{+} (0.012)	−0.031^{+} (0.016)
FDI	−0.023** (0.009)	−0.021* (0.011)	−0.002 (0.002)	−0.024* (0.010)	−0.00 (0.010)	−0.036* (0.014)	−0.035** (0.013)	−0.048** (0.014)
ODA × FDI	0.004** (0.002)	0.003** (0.001)	0.0003* (0.0001)	0.005** (0.002)	0.0029^{+} (0.0017)	0.006* (0.002)	0.006** (0.002)	0.008** (0.003)
BAC							−0.004 (0.006)	
Export to donors	−0.003 (0.006)	−0.005 (0.006)	0.001 (0.006)	−0.004 (0.006)	0.013 (0.008)	−0.0 (0.007)	0.003 (0.008)	−0.006 (0.007)
Trade	0.000 (0.002)	0.001 (0.002)	0.0002 (0.002)	0.001 (0.002)	−0.004 (0.004)	−0.00 (0.002)	0.000 (0.002)	0.001 (0.002)
GDP per capita	3.767** (0.928)	2.304** (0.892)	3.225** (0.895)	1.936* (0.824)	0.453 (1.276)	2.07^{+} (1.148)*	2.815* (1.414)	1.731 (0.908)$^{+}$
GDP per capita^2	−0.200** (0.051)	−0.130** (0.047)	−0.187 ** (0.047)	−0.108* (0.043)	0.025 (0.076)	−0.133 (0.063)	−0.183* (0.079)	−0.097 (0.061)
GDP growth	0.008 (0.006)	0.004 (0.006)	−0.0001 (0.006)	0.004 (0.006)	0.001 (0.004)	−0.00 (0.006)	−0.006 (0.005)	0.00 (0.010)
Polity2	−0.005 (0.009)	−0.012 (0.008)	−0.011 (0.009)	−0.009 (0.008)	0.009 (0.010)	−0.01 (0.012)	−0.016 (0.012)	−0.009 (0.008)
Industry (% GDP)	0.008 (0.005)	0.008 (0.005)	0.011* (0.006)	0.013** (0.005)	−0.005 (0.004)	0.01 (0.006)$^{+}$	0.013* (0.006)	0.007 (0.007)
Population density	0.002** (0.001)	0.003** (0.001)	0.003** (0.001)	0.003** (0.001)	0.003** (0.001)	0.002* (0.001)	0.002* (0.001)	0.003* (0.001)
Urban population	0.340** (0.008)	0.029** (0.007)	0.027** (0.001)	0.029** (0.007)	0.004 (0.012)	−0.00 (0.012)	−0.014 (0.011)	0.035*(0.007)
Size of economy	−0.258** (0.093)							
Cold war						0.149 (0.086)$^{+}$		
Natural Resource				−0.009** (0.003)				
Resource × ODA				0.0005 (0.0003)				
Environmental ODA					0.002 (0.009)			
Environmental ODA × FDI					0.0017 (0.0011)			
Lagged D.V.	0.631** (0.078)	0.653** (0.068)	0.647** (0.070)	0.654** (0.069)	0.535** (0.138)	0.705** (0.069)	0.700** (0.067)	0.641** (0.069)
ObsN (*n*), Max T	1,569 (88), 26	1,569 (88), 26	1,523 (89), 25	1,568 (88), 26	632 (75), 10	1,569 (88), 26	1,510 (88), 25	1,531 (85), 26

Notes Dependent Variable is (logged) SO_2 in grams for Model 16 and (logged) SO_2 per GDP in grams for all other models; only LRMs are shown (except for the lagged D.V.) with Driscoll-Kraay standard errors in parentheses; country fixed effects are estimated for Model 21, and country and year fixed effects are estimated for all other models

Table 4 Descriptive statistics

	Minimum	Mean	Max	Standard deviation
SO_2 per GDP	0.00007	0.20	8.11	0.74
ODA per capita	0	52.82	1,616.37	106.91
Export to donors (% GDP)	0	12.18	68.66	11.58
FDI inflow (% GDP)	−10.67	2.52	50.38	4.18
Trade (% GDP)	9.10	74.04	423.57	42.72
GDP per capita	449.8	6,240.6	68,973.8	6,553.65
GDP growth	−44.90	3.51	26.42	5.89
Polity2	−10	0.77	10	6.88
Industry (% GDP)	6.47	32.83	77.23	12.02
Population density	1.23	100.57	6,273.24	337.77
Urban population (% total population)	6.10	51.67	100.00	21.44

Notes Descriptive statistics are based on 1,569 observations included in the main interaction models (Model 2 and Model 3). A small fraction of ODA and FDI inflow observations that are negative are treated equal to zero

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