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Does Energy Related Aid Affect Emissions? Evidence from a Global Dataset[1]

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Abstract: Donor countries have been using international aid in the field of energy for at least three decades now. The stated objective of this policy is to reduce emissions and promote sustainable development in the global south. In spite of the widespread use of this policy tool, very little is known about its effect on emissions. In this paper we perform an empirical audit of the effectiveness of energy related aid in tackling CO_2 and SO_2 emissions. Using a global panel dataset covering 128 countries over the period 1971 to 2011 and estimating a parsimonious model using the Anderson and Hsiao estimator we do not find any evidence of a systematic effect of energy related aid on emissions. We also find that the non-effect is not conditional on institutional quality or level of income. Countries located in Europe and Central Asia do better than others in utilising this aid to reduce CO_2 emissions. Our results are robust after controlling for the Environmental Kuznets Curve, country fixed effects, country specific trends, and time varying common shocks.

JEL classification: D72, O11

Key words: Energy Related Aid; Emissions

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1 Introduction

Modern industrial society runs on fossil fuel. Burning fossil fuel releases thermal energy which is then transformed into electricity. Electricity is a key input in the production of goods and services destined for mass consumption. Consumers derive satisfaction from the consumption of these mass produced goods. In modern society, sustained improvement in the average level of consumption is a key indicator of material wellbeing and improved living standards. The use of fossil fuel not only generates thermal energy but it also releases greenhouse gases (carbon dioxide, sulphur dioxide, methane and others) into the atmosphere causing global warming and climate change. Until recently the environmental consequences of industrialisation were largely ignored. The global threat of a catastrophic climate change has helped raise awareness and brought countries together in favour of a coordinated policy response.

In a globalised world of free trade and migration (to a lesser extent), global governance of emissions mitigation is challenging. It is relatively inexpensive for industrial production to cross borders and move to cheaper locations. Indeed, starting from the 1980s the world has noticed a significant dislocation of industries from the industrialised nations to the emerging markets significantly increasing the latter's share of greenhouse gas emissions. Coupled with the global challenge of reducing greenhouse gas emissions the abovementioned migration of polluting industries brings in a key question of distributive justice in a Rawlsian sense[1]. To what extent the emerging market economies should be allowed to emit so that the objectives of sustainable development and reducing global greenhouse gas emissions could be achieved?

[1] Note that Rawls (1971) explicitly refrained from applying his principles of justice beyond the confines of a territorial state. Relevance of Rawlsian principles to global governance were discussed in later interpretations elsewhere (see Pogge, 1989).

At the operational level, states around the world have aimed to address these challenges by making use of both bilateral and multilateral institutional mechanisms. In particular, countries have used the mechanism of international transfers especially in the field of energy to achieve the twin objectives of emissions reduction and sustainable development. Policymakers have been using these policy tools for at least three decades now yet the effects are not very well known. To the best of our knowledge, there is hardly any systematic quantitative research on the effect of energy related aid on emissions in the aid recipient countries. In this paper, we seek to explore this very question: Do we notice a perceptible difference in the level of emissions in the aid recipient countries as a result of energy related aid going back to the 1970s?

A cursory look at the global aggregates reveal that both foreign aid commitment and disbursement for the energy sector (especially electricity generation) have exploded over the last decade. For example, per capita aid disbursement for power generation over the 2000s have grown by 4 percent on average every year whereas the annualised growth rate of aid commitment in power generation for the same period is approximately 5 percent. Carbon dioxide (CO_2) emissions however have increased at an annualised rate of 2.5 percent over the same period. Emissions of sulphur dioxide (SO_2) have declined since the mid-1990s largely due to the introduction and subsequent adoption of unleaded fuels for transport. Figures 1 – 4 presents this data.

Even though there has been some degree of co-movement between emissions and energy related aid it is problematic to interpret this association as causal. What we plot are global trends which ignore variations within and across countries. A third latent factor could also be responsible for the co-movement which hardly makes this perceived association causal. Furthermore, there is no obvious theoretical prior when it comes to the effect of energy related aid on emissions. On the one hand policymakers in donor countries would expect results in terms of reduced emissions through better targeting of the energy infrastructure in the recipient countries. On the other hand this aid could very well be off target and is spent on projects that have little discernible impact on emissions. Therefore, the lack of a strong prior either way makes this policy design a prime candidate for empirical audit. A more detailed and systematic modelling is necessary to understand the co-movement in the raw time series data.

In this paper we aim to systematically explore the effect of energy related aid on CO_2 and SO_2 emissions. In particular, we analyse the effect of an energy related aid shock on emissions using a panel data model. We exploit a global panel dataset covering 128 countries over the period 1971 to 2011. Note that our aid data is sourced from AidData.org. This dataset is an improvement over the Creditor Reporting System (CRS) maintained by the OECD's Development Assistance Committee (DAC) and offers far wider country coverage. Furthermore, our dataset also allows us to distinguish between renewable and non-renewable sources of power generation, and energy supply infrastructure. We estimate a parsimonious model using fixed effects, Arellano and Bond, and Anderson and Hsiao estimators and do not find any evidence of a systematic effect of energy related aid on emissions. Some would argue that the effect of aid is perhaps conditional on country specific fundamentals such as nature of policy or quality of institutions. We are unable to distinguish the average effect from zero even after interacting the aid variable with the rule of law index, corruption, degree of democracy, private property rights, government effectiveness, and openness to trade.

The zero effect could be driven by potential heterogeneity across very low income and relatively advanced economies. It is entirely plausible that relatively advanced economies are far more efficient in adopting greener technologies for power generation whereas the very low income economies are rather slack. If this is indeed the case then one would expect to see opposing effects across the two samples. To our surprise we observe no such evidence of non-linearity in the relationship and the average effect stays zero.

We also test any potential heterogeneity across continents by dividing the sample into Asia, Europe and Central Asia (ECA), Latin America and the Caribbean (LAC), and Middle East and North Africa (MENA). With the exception of ECA the average effect remains zero across all other continents. We notice some evidence of emission reduction as a result of environmental aid in ECA. Our results are robust to the inclusion of country fixed effects, country specific trends, time varying common shocks, GDP per capita, and GDP per capita squared as controls. The exclusion of outliers and the inclusion of additional covariates such as trade openness, urbanisation, human capital, investments, population density, and per capita energy use do not alter our fundamental result of zero average effect.

Empirically identifying the causal effect of energy related aid on emissions is challenging because potential biases from reverse causation and measurement error. These challenges are not specific to the macro environmental economics literature but in fact part of a broader challenge associated with the aid and development literature. We follow the empirical methodology of Clemens et al. (2012) to tackle identification challenges. A credible identification strategy is also useful in addressing measurement error challenges. Clemens et al. (2012) argue that it may take time for most aid disbursement to have an impact on other macroeconomic variables as they are generally lumpy and work through multiple channels. Therefore, they show that transparent methods of lagging and differencing the data are superior to using poor quality instrumental variables which tends to magnify the problem of reverse causation. Following Clemens et al. (2012) we use five year averages as observations and use lags in the model. The model is estimated using the Anderson and Hsiao method along with fixed effects and Arellano and Bond dynamic panel data estimation methods. Clemens et al. (2012) present Anderson and Hsiao estimates as their preferred results. In addition to presenting the Anderson and Hsiao estimates, we also carefully catalogue our treatment of the aid data in the Aid Data Annex to avoid measurement error.

The paper makes the following contributions. First, it performs a much needed econometric audit of the policy of energy related aid. Emissions are a major challenge of our generation and it is extremely important that some of the existing macro policies are thoroughly scrutinised using scientific means. To our surprise, we did not find any other study asking the obvious question: what impact energy related aid has on emissions? Second, by bringing this scientific result to the academy and the policymakers our paper opens the way for much needed future scientific scrutiny of policies in this arena.

Our paper is related to a large literature on the determinants of emissions. This literature could be divided into two strands: (1) a literature based on the Stochastic Impacts by Regressions on Population, Affluence and Technology (SIRPAT) methodology and (2) a literature based on the Environmental Kuznets Curve (EKC). Examples of the former are Narayan and Narayan (2010), Menz and Kühling (2011), and Menz and Welsch (2012). Narayan and Narayan (2010) focus on the effect of affluence by using economic growth as the key explanatory variable whereas Cole and Nemayer (2004), Menz and Kühling (2011) and Menz and Welsch (2012) focus on population size and population aging. Numerous other studies seek to verify the EKC. The EKC model predicts an inverted U shaped relationship between income and emissions. In other words, environmental pollution is increasing in income up to a certain threshold beyond which environmental pollution is in fact declining in the level of income. Torras and Boyce (1998), Auci and Becchetti (2006), York et al. (2003), Shahbaz et al.(2017a, b), and Balsalobre-Lorente et al. (2018) are good examples of empirical studies of EKC. Dinda (2004) presents a review of the EKC literature.

In addition to the SIRPAT and EKC based studies, a large literature examines additional determinants of pollution. This literature finds that trade openness (Grossman and Krueger, 1993), quality of political institutions (Scruggs, 1998; Farzin and Bond, 2006; and

Bernauer and Koubi, 2009), and urbanisation (Zhu et al., 2012; and Sadorsky, 2014) affects air quality.

Finally, our paper is also related to a voluminous empirical literature on aid and development. Griffin and Enos (1970) launch this literature with bivariate regressions on aid and growth followed by Weisskopf (1972) and Papanek (1972). More recently some of the notable studies are Boone (1996), Burnside and Dollar (2000), Collier and Dollar (2002), Easterly (2003), Rajan and Subramanian (2008), and Clemens et al. (2012). In spite of the volume of time and energy that economists have dedicated to debate the empirical relationship between aid and growth, the issue still remains inconclusive.

The remainder of the paper is structured as follows: Section 2 discusses the empirical strategy and data. Section 3 presents evidence on the effects of energy related aid on emissions. It also distinctly examines the effects of aid in renewables, non-renewables, and energy supply infrastructure on emissions. Furthermore, this section thoroughly examines any potential good policy, governance or income based heterogeneity in the data. Section 4 reports on a battery of robustness tests and section 5 concludes.

2 Empirical Strategy

We use a panel dataset covering 128 countries observed over the period 1971 to 2011.[2] To estimate the direct effects of energy related aid on emissions, we use the following dynamic model:

$$E_{it} = \alpha E_{it-1} + \beta Aid_{it-j} + \mathbf{X}_{it}\Gamma + \delta_t + \lambda_i t + \psi_i + u_{it} \qquad (1)$$

where E_{it} represents emissions of CO_2 and SO_2 in country i at year t, ψ_i is the country

[2] Due to data limitations, not all specifications cover 128 countries. In most specifications, the panel is unbalanced. The sample size is somewhat truncated for SO_2 emissions and aid disbursement and covers the time period 1971-2005. The aid commitment sample covers 1961-2011 and 1961-2005 for CO_2 and SO_2 emissions respectively. Missing data is the only reason behind excluding a country-year from the sample. Appendix A1 presents a list of the 128 countries included in the sample which corresponds to table 3 column 3.

fixed effects, δ_t is a year dummy variable controlling for time varying common shocks, $\lambda_i t$ are country specific time trends. Country specific trend captures potential country specific time varying heterogeneity such as fuel subsidy, investments, economic crisis, urbanization, migration etc. that might affect emissions. The variable Aid_{it-j} is an indicator of energy related aid received by country i in the year $t-j$. We also control for additional covariates including GDP per capita and GDP per capita squared. This is represented by the vector $\mathbf{X}_{it}$. We estimate this model for contemporaneous effects and lags j thus $j \in \{0,1\}$. All variables in equation 1 are defined as per capita and expressed in natural logarithms with the exception of the aid variable. The aid variable Aid_{it-j} is defined using the generic transformation $\ln[1+x]$ to account for zero observations. This transformation eliminates excessive skewness and kurtosis in the data. Furthermore, all observations used to estimate equation 1 are five year averages. Thus, each country in the panel dataset includes a maximum of 8 vertical (time series) data points with the 2010 data point being the average of the years from 2005 to 2011. Note that we also estimate the model with $\ln[x]$ and aid disbursement dummy to tackle the issue of zero aid. The results do not change.

Our main focus of enquiry is the effect of energy related aid Aid_{it-j} on emissions E_{it}. Therefore, our coefficient of interest is β which represents the average marginal effect (or elasticity) of energy related aid on emissions. A negative and statistically significant coefficient would imply that such aid is effective in lowering the levels of CO_2 and SO_2 emissions. Alternatively, a positive and statistically significant coefficient would imply that a higher level of energy related aid is associated with adverse emissions outcome. Finally, another potential possibility is that the average marginal effect cannot be distinguished from zero which would imply that these transfers have very little discernible effect on emissions in the aid recipient countries.

We include GDP per capita and GDP per capita squared to account for a potential inverted U shaped relationship between the level of income and emissions commonly known as the Environmental Kuznets Curve (EKC). Shafik and Bandyopadhyay (1992), Panayotou, (1993) and Grossman and Krueger (1993) were the first to detect such empirical relationship. They provide evidence that while economic growth is detrimental to the environment at early stages of development the relationship between environmental quality and economic growth reverses beyond a threshold level of development.

Our key dependent variables (E_{it}) are CO_2 and SO_2 emissions. The CO_2 emissions data is sourced from the World Development Indicators (WDI) database of the World Bank and is measured in metric tons. This data is collected by the Carbon Dioxide Information Analysis Centre of the Environmental Sciences Division, Oak Ridge National Laboratory of the United States located in Tennessee. Atmospheric CO_2 is a key contributor to climate change and global temperature rise. Combustion of fossil fuels is the predominant source of CO_2 emissions.

The SO_2 emissions data is sourced from Smith *et al*. (2010) who provide estimates of country-level emissions over the period 1850 to 2005. The dataset has been developed by using calibrated country-level inventories information compiled from a number of sources. Note that Smith *et al*. (2010) reports SO_2 emissions in gigagrams rather than kilotons. To facilitate uniformity of measurement across the two emissions variables we multiply SO_2 emissions by 1000 to convert it into kilotons.

Unlike CO_2, SO_2 is a local pollutant. SO_2 emissions mainly come from the combustion of coal and petroleum. Emission levels of SO_2 peaked in 1991 and since then it experienced a steady decline. The decline in coal fired power stations in Europe and the adoption of unleaded fuels for car may have contributed to this decline.

Environment quality is a multidimensional concept. Therefore there is some merit in using a composite measure of environmental quality as opposed to emissions of individual pollutants. One such measure is the Environmental Performance Index developed by Emerson *et al*. (2010). This index is based on a large number of variables ranging from the percentage of population with access to drinking water to CO_2 emissions by the industrial sector. However, poor data coverage is a major limitation of this dataset. Similarly, one could also consider indices of other forms of environmental degradation. For example, one could consider the measures of water quality, land degradation and deforestation. Again these variables are restricted to a limited number of countries and time periods. In contrast, the CO_2 and SO_2 emissions data are available for a large number of countries and time periods. They are also very widely used. It is worthwhile noting that we focus on emissions instead of concentration of CO_2 and SO_2 because the former closely track economic activity rather than the latter.

Rates of emission vary considerably across countries. For example, CO_2 emission ranges from 13.9 tons per capita in Chad over the period 1991 – 1995 to approximately 60 gigatons per capita in Qatar over the period 1996 – 2000. In contrast, SO_2 emission ranges from 0.2 tons per capita in Botswana over the period 1976 – 1980 to 403 tons per capita in Zambia over the period 1961 – 1965.

Our key independent variable is energy related aid. This data is sourced from the AidData.org, research release 2.1. This dataset is compiled by Tierney *et al*. (2011). The Tierney *et al*. (2011) database distinguishes between development finance as loans from governments or agencies from transfers. The AidData.org project is run by the Bingham Young University, the College of William and Mary, and the Development Gateway. It emerged out of two earlier projects on the Accessible Information on Development Activities and Project-Level Aid. Both projects compiled project level aid data.

The bulk of the data in AidData.org comes from the Creditor Reporting System (CRS), which collects annual data from 22 member countries dating back to 1973. In addition to CRS, AidData.org also includes data from other official sources. For instance, it records bilateral donations from non-OECD donors to non-DAC recipients as well as donations from multilateral organisations. In line with CRS, AidData.org adopts a five digit classification system of projects. The classification system identifies the sector, the activity code, and the purpose of each project. A major advantage of the dataset is that it distinguishes between aid commitment and aid disbursement. The 2.1 research release that we use covers a large number of countries over the period 1947 to 2011.[3]

AidData.org records aid commitment and disbursement for a large variety of projects. It however mentions that the disbursements could be tied to projects during the commitment year or any previous years. We limit our attention to aid for energy projects. In particular, we focus on: (i) power generation projects from renewable sources, (ii) power generation projects from non-renewable sources and (iii) energy generation and supply projects. The energy generation and supply projects include power generation from renewables and non-renewables, energy policy and administrative management, energy transmission, energy education, and energy research.[4]

A zero value for the aid variable would imply that the donors did not commit or disburse any money. A quick scrutiny of the raw data reveals that Palau received the highest amount of energy related international financial assistance per capita over the period 1996 – 2000 (USD 554 in 2009 constant prices) closely followed by Iceland 1966-1970 (USD 502 in 2009 constant prices) and Bahrain 1976-1980 (USD 432 in 2009 constant prices).

[3] We only use data from 1960 because the CO_2 emissions data starts at 1960.

[4] Note that power generation from renewables and non-renewables correspond to the purpose codes 23030 and 23020 respectively. The energy generation and supply corresponds to the following purpose codes: 23000, 23005, 23010, 23020, 23030, 23040, 23050, 23061, 23062, 23063, 23064, 23065, 23066, 23067, 23067, 23068, 23069, 23070, 23081, 23082, 31120, 31181, 31182, 21020, 32120, 32181, 32182, 32310, 31220, 31281, 31282, 41010, 41081, 41082, and 41020. The Aid Data Annex provides further details.

How does the size of an average donation compare to the cost of the project? We compute the aid commitment to total project cost ratio by country as well as for the overall sample. In the overall sample the ratio is 0.57 which means that, on average, donations cover 57% of the total cost of the project. This ratio varies from 18% in Bahrain to 100% in countries such as Portugal, Guyana and Iceland. Furthermore, we also observe that an increase in the number of donors increases the likelihood of having additional donors in the future.

Other variables used in the study are: GDP per capita, law and order index, corruption, democracy scores, trade openness index, trade share, private property rights, government effectiveness. Tables 1 reports summary statistics on key variables and Appendix A2 presents detailed definition of variables.

There are econometric challenges associated with estimating equation 1. These challenges are unobserved heterogeneity, non-stationarity of the variables, reverse causation, simultaneity bias, and bias due to the dynamic nature of the model. We closely follow Clemens *et al*. (2012) to tackle these challenges. We address the unobserved heterogeneity challenge by demeaning the data and estimating the model using fixed effects. However, the fixed effect estimator is unable to tackle the challenge of non-stationarity. In a time series dataset variables could have similar trends yielding statistically significant correlation. However, this correlation could simply be reflective of their co-movement and not a causal relationship. Therefore, estimating econometric models with variables that have a significant time dimension and are not stationary would lead to spurious inference of causality when there is none. To address this challenge we check stationarity of the variables by using the Fisher type Adjusted Dickey Fuller (ADF), Levin–Lin–Chu, and Harris–Tzavalis varieties of unit root tests. The Levin–Lin–Chu and the Harris–Tzavalis tests account for bias emanating from cross-sectional association. We find that the key variables are I(1) or difference stationary and therefore we use first difference of variables in the regressions. These tests are reported in table 2. Note that Clemens et al. (2012) also reports similar results in the context of aid and growth.

The level of emissions might dictate energy related aid flows rather than causality running in the opposite direction. We address reverse causation and simultaneity challenges by using five year averages and lags. Five year averages smooth noise and potential business cycle fluctuations in the data. It also helps tackle the problem of attrition in the aid data as it is plagued by sparse coverage. An alternative approach is to use the instrumental variable (IV) method. However, Clemens et al. (2012) demonstrates that using lags is a much cleaner and transparent way of dealing with reverse causation as opposed to searching for an appropriate instrument. Furthermore, they also show that the paucity of strong and valid instruments permeates the aid and growth literature.

Finally, using a lagged dependent variable as an independent variable in the model invites additional challenges. In particular, the differenced lagged dependent variable ΔE_{it-1} could be correlated with the differenced error term Δu_{it} contaminating inference. However, for serially uncorrelated errors Δu_{it} would not be correlated with ΔE_{it-2} opening the possibility of using ΔE_{it-2} as an instrument for ΔE_{it-1}. This is precisely what the Anderson and Hsiao (1981) estimator does which we adopt here.

Clemens et al. (2012) favor the Anderson Hsiao estimator over OLS because the latter in the presence of a lagged dependent variable yields biased estimates. They estimate the effect of aid on growth and they deal with a lagged GDP variable in their model. Here we deal with a lagged emissions variable and therefore adopting the Clemens et al. (2012) approach is a sensible way forward. Furthermore, the Anderson and Hsiao estimator tackles the two challenges of weak instruments and instrument proliferation better than rival estimators such as the system GMM.

3 Evidence

3.1 Energy Related Aid and Emissions: Baseline Results

Table 3 conducts an empirical audit of the effects of energy related aid on emissions. The key independent variable here is the aid for power generation using both renewable and non-renewable resources. We first concentrate on the effect of aid disbursement in panel A. In column 1 we estimate equation 1 using the fixed effect estimator. We find that 1 percentage point increase in aid for power generation using either renewable or non-renewable resources reduce per capita CO_2 emissions by 0.03 percent. To put this into perspective, a 0.03 percent decline in per capita CO_2 emission is equivalent to Qatar's emission over the period 1996 – 2000 declining from 60 gigatons per person to 59.8 gigatons per person.

Even though the coefficient on aid is significant, we cannot be confident that it is unbiased. The estimate could very well be driven by omitted factors or reverse causation. In column 2, we replace the contemporaneous aid variable by lagged aid (both measured in lagged difference as they are I(1) in levels). This results into a drop in sample size and country coverage. This is because countries with less than three observations and countries with three observations but with an embedded gap are dropped from the sample. The average effect of lagged aid on per capita CO_2 emission becomes indistinguishable from zero. In column 3 we estimate the model using the Anderson and Hsiao instrumental variable method and the null effect result remains. Appendix A1 presents a list of 128 countries included in this sample. Note that this is also the preferred method of Clemens et al. (2012).

Since we are estimating a dynamic model with a lagged dependent variable, therefore there is merit in pursuing the Arellano and Bond estimation method. We do exactly that in column 4 without much difference in outcome. The average effect of lagged aid on per capita CO_2 emission cannot be distinguished from zero.

In columns 5 – 8 we repeat these estimations with SO_2 emission as the dependent variable. Irrespective of the estimator used, we are unable to distinguish the average effect of aid disbursement for power generation using renewables and non-renewables from zero. In panel B we verify whether the effect is any different with aid commitment as the key independent variable as opposed to actual aid disbursement. It is plausible even though unlikely that aid commitments might affect expectations and preferences of policymakers in aid recipient countries incentivising them to implement emission reduction plans. We find that aid commitments have very little discernible impact on per capita emissions.

Emissions were not a widespread concern in the 1970s and 1980s and the no effect result could be driven by opposite patterns of aid between the early and later part of our sample. Furthermore, most countries are likely to have data for the later periods as opposed to the earlier periods. This could also be driving the non-result. To check, we re-estimate the models reported in columns 3 and 7 of panels A and B of table 3 for the subsample 1990-2011. The results remain unchanged.

CO_2 emissions occur as a result of fossil fuel combustion, biomass burning, land use changes, and other industrial processes. Our CO_2 emissions variable sourced from the World Bank includes gases from the burning of fossil fuels and cement manufacture, but excludes emissions from land use changes and deforestation. Many of the developing countries that we include in our sample witnessed deforestation during the sample period. Therefore this measurement error in our CO_2 emissions variable could be a source of omitted variable bias if CO_2 emissions due to deforestation systematically affect energy related aid. Such a systematic effect of deforestation on lagged energy related aid is unlikely. Nonetheless, deforestation is country specific and time varying therefore they should be picked up by the country specific trends and the country-year fixed effects.

It is possible that by aggregating aid for power generation in renewable and non-renewable sources we are weakening statistical power. Perhaps there is heterogeneity in the data. At least in theory, increasing the share of power generation using renewable resources could rapidly reduce emissions. In contrast upgrading existing non-renewable resource based power plants or building new power plants may not have the desired emissions reducing effect. Figures 5 and 6 plot foreign aid disbursement per capita for renewables and non-renewables which shows significant growth in the former and much tepid growth in the latter since mid-2000s. Therefore we divide the aid data for power generation into renewables and non-renewables in table 4 columns 1, 2, 4, and 5. The effect stays insignificantly different from zero. This perhaps attests to the fact that aid recipient countries are mostly developing countries and their energy needs are going up. Therefore, renewable and non-renewable appear as complements, almost by construction.

We also check whether power generation using renewable resources crowd out the use of non-renewables in power generation. We find that the pairwise correlation is 0.42 which is also confirmed by regression estimates. This albeit crudely suggests that renewables and non-renewable are complements when it comes to power generation.

In columns 3 and 6 we explore any potential impact of aid in energy generation and supply. Energy generation and supply is a broad measure of energy related aid which includes power generation, energy policy and administration, energy transmission infrastructure, energy awareness education, energy research, industry development, industrial education and training, technological research and development, construction policy and administrative management, environmental policy, environmental education, environmental research, and biosphere protection. To our surprise we do not find any effect of such aid on per capita emissions after controlling for country specific and global factors.

The sample size varies across specifications in table 4. For example, the sample size varies across columns 1-3 because the Aid_{t-1} variable is different across specifications. They are renewables, non-renewables, and energy generation and supply respectively. Therefore, the reported data points and the issue of missing data across these variables in Tierney et al. (2011) is also different. Reported data for a particular country-year for a particular variable does not necessarily imply that the dataset reports a value for all other variables for that particular country-year. In columns 4-6 the dependent variable is different – 'SO_2 Emissions'.

Another issue that contributes to the variable sample size is the reporting of aid disbursements and commitments. Tierney et al. (2011) reports commitments better than disbursements which also contributes to the variable sample size across specifications.

So far we have demonstrated that energy related aid has no effect on emissions. It could be due to the combination of higher energy use and greater energy efficiency. In table 5 we regress energy related aid disbursement and commitment on energy use and energy efficiency. Again we find no statistically significant effect suggesting that aid has very little impact on energy use and energy efficiency. This is consistent with our emissions result.

3.2 Energy Related Aid and Emissions: The Role of Institutions and Policy

The effectiveness of aid could be conditional on the country specific initial conditions. Countries that have good policy and good institutions could be in a far better position to respond to aid than others. Emissions respond better to aid in these locations because efficient policy and institutions channel the funds effectively to the appropriate projects reducing waste and administrative obstacles. If this is indeed the case then we would expect to see non-linear effects of institutional quality on emissions.

We test the role of policy and institutions by introducing interaction terms in table 6. In particular, we interact the aid for power generation variable with the rule of law index, corruption, democracy scores, private property rights, government effectiveness, and trade openness. We do not find any evidence of non-linearity in the data. The average effect of climate aid on CO_2 and SO_2 emissions is zero regardless of the quality of institutions.

3.3 Energy Related Aid and Emissions: Is there a Rich and Poor Divide?

Upgrading to a new energy infrastructure or building a new power plant is not costless. On the contrary these ventures are often expensive and require additional resources on top of the aid money. Richer nations could afford these ventures and therefore they are far more effective in upgrading their energy infrastructure or building new power plants. They could also tap into a relatively skilled labour force to work on energy related projects. All this taken together could contribute positively towards reducing per capita emissions.

If the hypothesis outlined above is indeed true then we would expect to see heterogeneity in the data along income lines. However, in table 7 we do not find any evidence that the level of income influences the effectiveness of energy related aid.

3.3 Energy Related Aid and Emissions: The Role of Geography

Certain geographic locations could possess an advantage over others when it comes to implementing emission reduction policies. Cleaning up the energy sector, upgrading to a new energy infrastructure, and building new power plants require significant investments. It also requires importation of capital goods and skills. Therefore, proximity to these inputs matter. If a country is located in the same neighbourhood where green technology is advancing then it is likely to be part of the same network. These countries are more likely to utilise their energy related aid money effectively.

We test this hypothesis in table 8 by estimating our canonical model separately for Asia, Europe and Central Asia (ECA), Latin America and the Caribbean (LAC), and Middle East and North Africa (MENA). We find that ECA countries are far more effective in reducing their CO_2 emissions using aid. Numerically, we find that 1 percentage point increase in aid for power generation would reduce CO_2 emissions by 0.31 percent. This amounts to approximately 0.3 ton reduction in per capita emission in an average ECA country.

4 Robustness

The non-relationship between energy related aid and emissions could be driven by outliers or omitted variables. We check the robustness of our main result by controlling for outliers and omitted covariates. In table 9 we estimate the model by eliminating potential outliers from the sample. We do this systematically by identifying outliers using the formulas of DFITS, Cooks Distance, and Welsch Distance. Dropping outliers from the sample do not alter our main result.

In table 10 we introduce additional control variables. The environmental studies literature have identified trade openness, urbanisation, school enrolment, investments, energy use, and the fraction of population aged between 15 to 64 as important determinants of CO_2 and SO_2 emissions. We control for these variables and observe that the ineffectiveness of energy related aid on emissions remain. In column 7 we explicitly control for energy efficiency measured by GDP per unit of energy use (PPP $ per kg of oil equivalent) and again the result remains unaffected.

The EKC literature suggests that aid should have different effects along the development path. To test whether this is indeed the case we interact aid with GDP and GDP squared. Our main result remains unaffected.

In our main specification in table 3 columns 3 and 7 (panels A and B) we include a linear country specific trend. However, a linear country-specific trend is unable to capture fuel subsidy, investments or energy efficiency gains if these changes are non-linear. For example, if a country needs the support of the IMF in year t, then, in that year the country could receive aid from many agencies which could raise the output and emissions related to power generation leading to a positive coefficient between aid and emissions. However, at the same time, a structural adjustment plan imposing the lifting of fuel subsidies could reduce emissions from transport yielding a negative coefficient between aid and emissions. This potentially could lead to an undetermined aggregate coefficient between aid and emissions. The example described above is country specific and time varying. Therefore, the introduction of country-year fixed effects should capture such dynamic. This is what we do in table 11 and the results are unaffected.

Missing observations across variables imply that the number of countries and observations fluctuate across specifications. In table 12 we stick with our core specification (table 3, column 3) and conduct additional robustness tests. First, in column 1 we restrict the sample period to 1990-2011 for the base sample of countries. The coefficient on aid disbursement is insignificant. In column 2 we focus on the Europe and Central Asia sub sample and the coefficient is positive and insignificant for this period. We repeat this exercise using aid commitment as explanatory variable in columns 3 and 4 and the result remains unchanged. Note that all four specifications run on very small sample size therefore the results should be treated with caution. Furthermore, we are unable to run Anderson-Hsiao estimates for SO_2 emissions as the dependent variable using this truncated sample as the sample collapses to a cross-section.

5 Conclusions

Emissions are significant challenges of our generation. The recent climate change conference COP21 held in Paris in December 2015 calls for a significant reduction in greenhouse gas emissions. Nations and multilateral organisations have used a plethora of policy tools to achieve emissions reduction. One such policy is energy related aid. The idea is to assist aid recipient countries to clean up existing energy infrastructure, build new greener power plants, and switch from fossil fuel based energy mix to a renewables based energy mix. Undoubtedly this is a worthy cause and donor countries have devoted significant amount of resources to support this venture. Yet we know very little about the potential outcome of this policy.

In this paper we perform an empirical audit of this policy by systematically exploring the effect of energy related aid on CO_2 and SO_2 emissions. Using a global panel dataset and estimating a parsimonious model using fixed effects, Arellano and Bond, and Anderson and Hsiao estimators we do not find any evidence of a systematic effect of energy related aid on emissions. To our surprise, we also find that the non-effect is not conditional on institutional quality or level of income. Countries located in ECA do better than others in utilising energy related aid to reduce CO_2 emissions. Our results are robust to the inclusion of country fixed effects, country specific trends, time varying common shocks, GDP per capita, and GDP per capita squared as controls. The exclusion of outliers and the inclusion of additional covariates such as trade openness, urbanisation, human capital, investments, population density, per capita energy use, and the share of adult population do not alter our fundamental result of zero average effect.

Our results call into question the merit of energy related aid as a policy tool to achieve the emission reduction objectives outlined in the Kyoto Protocol and beyond. It exposes that aid of this nature has been fairly ineffective in the past. Therefore, policymakers would need to be more circumspect while applying aid as a policy tool to address climate change. At the very least our result calls for more scientific scrutiny of energy related aid.

Appendices

A1. List of Countries in the Table 3, Column 3 Sample:

Afghanistan*	1976-2011	Chile	1981-2011	Georgia	1991-2011	Macedonia	1996-2011	Panama	1976-2011	Tajikistan	1996-2011
Albania	1991-2011	China	1976-2011	Ghana	1971-2011	Madagascar	1976-2011	Papua N.G.*	1976-2011	Tanzania	1976-2011
Algeria	1981-2011	Colombia	1976-2011	Guatemala	1981-2011	Malawi	1976-2011	Peru	1976-2011	Thailand	1971-2011
Argentina	1971-2011	Congo D.R.	1976-2011	Guinea	1976-2011	Malaysia	1971-2011	Philippines	1971-2011	Togo*	1976-2011
Azerbaijan	1991-2011	Congo R.	1996-2011	Guinea-B.	1981-2011	Maldives	1981-2011	Poland	1991-2011	Tonga*	1976-2011
Bahamas	1981-1995	Costa Rica	1976-2011	Guyana*	1976-2011	Mali	1976-2011	Romania	1971-2005	Tunisia*	1961-2011
Bangladesh	1971-2011	Ivory Coast	1976-2011	Haiti	1976-2011	Marshall I.	1996-2011	Russia	1991-2011	Turkey*	1971-2011
Barbados*	1976-2011	Croatia	1996-2011	Honduras	1976-2011	Mauritania	1976-2011	Rwanda	1971-2011	Turkmenistan*	1991-2011
Benin	1976-2011	Cuba	1991-2011	Hungary	1991-2005	Mauritius	1976-2011	Samoa	1971-2011	Uganda	1991-2011
Bhutan	1981-2011	Czech R.	1991-2005	India	1971-2011	Mexico	1981-2011	Sao T&P	1981-2011	Ukraine	1991-2011
Bolivia	1986-2011	Djibouti	1976-2011	Indonesia	1971-2011	Micronesia	1996-2011	Senegal	1976-2011	Uruguay*	1976-2011
Bosnia & H.	1996-2011	Dominica	1981-1995	Iran	1991-2011	Mongolia	1991-2011	Seychelles*	1976-2011	Uzbekistan	1996-2011
Botswana*	1976-2011	Dominican R.	1976-2011	Jamaica	1971-2011	Morocco	1971-2011	Sierra Leone*	1976-2011	Vanuatu*	1981-2011
Brazil*	1976-2011	Ecuador	1971-2011	Jordan	1971-2011	Mozambique	1976-2011	Slovak R.	1991-2006	Venezuela*	1981-2011
Bulgaria	1991-2011	Egypt	1971-2011	Kazakhstan	1991-2011	Namibia	1991-2011	Solomon I.	1976-2011	Vietnam	1981-2011
Burkina F.	1976-2011	El Salvador	1976-2011	Kenya	1976-2011	Nepal	1976-2011	S. Africa	1996-2011	Yemen	1971-2011
Burundi*	1976-2011	Equatorial G.	1981-2005	Kiribati	1986-2011	Nicaragua	1976-2011	Sri Lanka	1976-2011	Zambia	1981-2011
Cabo Verde	1981-2011	Eritrea	1991-2011	Korea, R.	1996-2011	Niger	1976-2011	St.Vinc.&G.*	1976-2011	Zimbabwe	1981-2011
Cambodia	1991-2011	Ethiopia	1976-2011	Kyrgyz R.	1991-2011	Nigeria*	1976-2011	Sudan*	1971-2011		
Cameroon*	1976-2011	Fiji	1976-2011	Lao PDR	1971-2011	Oman*	1976-2011	Suriname*	1986-2011		
Cent. Afr. R.*	1981-2011	Gabon*	1981-2011	Latvia	1991-2005	Pakistan	1971-2011	Swaziland*	1976-2005		
Chad	1976-2011	Gambia*	1976-2011	Lithuania	1991-2011	Palau	1996-2011	Syria	1971-2011		

Notes: * denote countries with embedded gaps

A2. Data Appendix:

Variable	Description	Source
CO_2	Carbon Dioxide emissions (metric tons per capita)	World Development Indicator (World Bank)
GDP	GDP per capita (constant 2005 US$)	
Trade	Sum of exports and imports (% of GDP)	
Urban	Urban population	
School	Secondary school enrolment (% gross)	
Ki	Gross capital formation (% of GDP)	
Energy	Energy Use (kg of oil equivalent per capita)	
Energy Efficiency	GDP per unit of energy use (PPP $ per kg of oil equivalent)	
P15-64	Population, ages 15-64 (% of total)	
Trade Openness	Trade volume as a share of GDP	
SO_2	Sulphur Dioxide emissions (gigagram)	Smith *et al*. (2010)
Aid (ren)	Aid disbursed (committed) for renewable power generation ($ 2009 USD)	Aid Data 2.1.
Aid(nonren)	Aid disbursed (committed) for non-renewable power generation ($ 2009 USD)	
Aid(energy)	Aid disbursed (committed) for general energy generation and supply ($ 2009 USD)	
Law and Order	Law and Order (0 to 6). Higher values indicate higher quality of government	ICRG
Corruption Index	Corruption (0 to 6). Higher values indicate lower levels of corruption	
Democracy Score	Democracy Index (-10 to 10). Higher values indicates higher degree of democracy	Marshall *et al.* (2013)

A3. Aid Data Annex:

The AidData is a project developed in conjunction with the Bingham Young University, the College of William and Mary and the Development Gateway. It was born out of the union of two earlier projects, the Accessible Information on Development Activities (AiDA), started in 2001, and Project-Level Aid (PLAID), started in 2003. Both projects were conceived to improve statistics on international aids. They were merged in 2009 and the first version of the AIDdata was released in 2010. This paper makes use of version 2.1.

The AidData README file version 3 lists a series of caveats. We focus on two main caveats here and encourage interested parties to check their website for a full list. The first caveat is the incompleteness of data specific to disbursements before the year 2013. This is precisely the reason why disbursement has been excluded in the version 3.0. The second caveat involves incomplete coverage of commitments. Although AidData has been launched to provide the most comprehensive dataset on foreign aid, it is unlikely that it covers all aid activities which have taken place. Such caveats call for some caution about our empirical findings, especially the ones related to disbursements. Further research is needed as more data become available.

AidData complements that CRS database with additional data sourced from donor annual reports and website, documents released by aid agencies and data collected directly from donor agencies (website and databases). In line with the CRS, the AidData 2.1 version reports both commitments and disbursements.

The data file used in this paper to construct our aid variables aggregates aids by donor, recipient, year and purpose. It includes 12 variables and an overall of 569747 observations. It covers the years spanning 1947-2012. Both disbursements and commitment are in USD 2009. In line with the CRS, The AidData classifies the projects with a five digit coding that indicates the sector and the purpose. In particular, the code denotes the sector of the recipient's country which the aid activity is aimed to assist, such as education, health and communication. In addition, the AidData encodes the projects with two further digits to track the activity code.

To construct aid for power generation from renewable resources we use the following CRS compatible purpose codes: 23030 (Power Generation / Renewable Sources), 23065 (Hydro-electric power plants), 23066 (Geothermal Energy), 23067 (Solar Energy), 23068 (Wind Power), 23069 (Ocean Power), 23070 (Biomass). AidData.org divides the CRS code 23030 into the following sub-codes or activity codes: 23030.01 (power generation/renewable resources, activity unspecified or does not fit elsewhere in group), 23030.02 (Hydro-electric power plants), 23030.03 (Geothermal energy), 23030.04 (solar energy), 23030.05 (Wind power), 23030.06 (Ocean power), 23030.07 (Biomass). Therefore, when we aggregate this in Stata, we keep the codes 23030, 23065, 23066, 23067, 23068, 23069, 23070, 23030.01, 23030.02, 23030.03, 23030.04, 23030.05, 23030.06, 23030.07.

Similarly, to construct aid for power generation from non-renewable resources we use the following CRS compatible purpose codes: 23020, 23061, 23062, 23063, and 23064. AidData.org divides the CRS code 23020 (power generation/non-renewable resources) into the following sub-codes or activity codes: 23020.01 (power generation/non-renewable resources, activity unspecified or does not fit elsewhere in group), 23020.02 (oil-fired power plants), 23020.03 (gas-fired power plants), 23020.04 (coal-fired power plants), 23020.05 (Nuclear power plants), 23010.06 (combined heat and power plants). Again we aggregate this in Stata and keep the codes: 23020, 23061, 23062, 23063, 23064, 23020.01, 23020.02, 23020.03, 23020.04, 23020.05, and 23010.06.

Aid for energy generation and supply includes 23030 and 23020 as well as the following additional CRS purpose codes: 23000 (Energy generation and supply, combinations of activities), 23005 (Energy generation and supply, purpose unspecified or does not fit under any other applicable codes), 23010 (Energy policy and administrative management), 23040 (Electrical transmission/ distribution), 23050 (Gas distribution), 23055 (Petroleum distribution and storage), 23081 (Energy education/training) and 23082 (Energy research), industry development (32120), industrial education and training (32181), technological research and development (32182), construction policy and administrative management (32310), environmental policy (41010), environmental education (41081), environmental research (41082), and biosphere protection (41020). These purposes codes include the following activity codes: 23005.01 (Energy generation and supply, activity unspecified or does not fit under any other applicable codes), 23010.01 (Energy policy and administrative management, activity unspecified or does not fit elsewhere in group), 23010.02 (Energy sector policy, planning and programs), 23010.03 (Institution capacity building, Energy), 23010.4 (Aid to energy ministries), 23010.05 (Energy conservations), 23040.01 (Electrical transmission/ distribution, activity unspecified or does not fit elsewhere in group), 23040.02 (Electrical distribution from power source to end user), 23040.03 (Transmission lines), 23050.01 (Gas distribution activities), 23050.02 (Gas storage activities), 23081.01 (All energy education/training activities) and 23082.01 (All energy research activities).

References

Anderson, T. W. and C. Hsiao (1982). Formulation and Estimation of Dynamic Models Using Panel Data. *Journal of econometrics*, 18(1): 47-82.

Auci, S., and L. Becchetti (2006). The Instability of the Adjusted and Unadjusted Environmental Kuznets Curves. *Ecological Economics*, 60(1): 282-298.

Balsalobre-Lorente, D., M. Shahbaz, D. Roubaud, and S. Farhani (2018). "How economic growth, renewable electricity and natural resources contribute to CO2 emissions?" *Energy Policy*, 113(C): 356-367.

Bernauer, T., and V. Koubi (2009). Effects of Political Institutions on Air Quality. *Ecological Economics*, 68(5): 1355-1365.

Boone, P. (1996). Politics and the Effectiveness of Foreign Aid. *European Economic Review*, 40(2): 289-329.

Burnside, C. and D. Dollar (2000). Aid, Policies, and Growth. *American Economic Review*, 90(4): 847–68.

Clemens, M. A., S. Radelet, R. R. Bhavnani and S. Bazzi (2012). Counting Chickens When They Hatch: Timing and the Effects of Aid on Growth. *The Economic Journal*, 122(561): 590-617.

Collier, P. and D. Dollar (2002). Aid Allocation and Poverty Reduction. *European Economic Review*, 46(8): 1475-1500.

Dinda, S. (2004). Environmental Kuznets Curve Hypothesis: A Survey. *Ecological Economics*, 49(4): 431-455.

Easterly, W. (2003). Can Foreign Aid Buy Growth? *Journal of Economic Perspectives*, 17(3): 23-48.

Emerson, J., D. C. Esty, C. Kim, T. Srebotnjak, M. A. Levy, V. Mara, A. Sherbinin and M. Jaiteh (2010). Environmental Performance Index. New Haven: Yale Center for Environmental Law and Policy.

Farzin, Y. H., and C. A. Bond (2006). Democracy and Environmental Quality. *Journal of Development Economics*, 81(1): 213-235.

Griffin, K. B., and J. L. Enos (1970). Foreign Assistance: Objectives and Consequences. *Economic Development and Cultural Change*, 18(3): 313-327.

Grossman, G. M., and A. B. Krueger (1993). Environmental Impacts of the North American Free Trade Agreement. In P. Garber, *eds.: The U.S. –Mexico Free Trade Agreement.* MIT Press, Cambridge, pp. 13–56.

Menz, T., and J. Kühling (2011). Population Aging and Environmental Quality in OECD Countries: Evidence from Sulfur Dioxide Emissions Data. *Population and Environment*, 33(1): 1-25.

Menz, T. and H. Welsch (2012). Population Aging and Carbon Emissions in OECD Countries: Accounting for Life-Cycle and Cohort Effects. *Energy Economics*, 34(3): 842-849.

Narayan, P. K., and S. Narayan (2010). Carbon Dioxide Emissions and Economic Growth: Panel Data Evidence from Developing Countries. *Energy Policy*, 38(1): 661-666.

Panayotou, T. (1993). Empirical Tests and Policy Analysis of Environmental Degradation at Different Stages of Economic Development. ILO, Technology and Employment Programme, Geneva.

Papanek, G. (1972). The Effect of Aid and Other Resource Transfers on Savings and Growth in Less Developed Countries. *Economic Journal*, 82(327): 934-950.

Pogge, T. (1989). Realizing Rawls. Cornell University Press, Ithaca: New York.

Rajan, R., and A. Subramanian (2008). Aid and Growth: What Does the Cross-Country Evidence Really Show? *The Review of Economics and Statistics*, 90(4): 643-665.

Rawls, J. (1971). A Theory of Justice. Harvard University Press, Cambridge: MA.

Sadorsky, P. (2014). The Effect of Urbanization on CO_2 Emissions in Emerging Economies. *Energy Economics*, 41: 147-153.

Scruggs, L. A. (1998). Political and Economic Inequality and the Environment. *Ecological Economics*, 26(3): 259-275.

Shahbaz, M., S. Solarin, S. Hammoudeh, and S. Shahzad (2017a). "Bounds testing approach to analyzing the environment Kuznets curve hypothesis with structural beaks: The role of biomass energy consumption in the United States," *Energy Economics*, 68(C): 548-565.

Muhammad, S., M. Bhattacharya, and K. Ahmed (2017b). "CO emissions in Australia: economic and non-economic drivers in the long-run," *Applied Economics*, 49(13): 1273-1286.

Shafik, N., and S. Bandyopadhyay (1992). *Economic Growth and Environmental Quality: Time Series and Cross country Evidence*. Background Paper for the World Development Report 1992, The World Bank, Washington, DC.

Smith, S., J. Van Aardenne, Z. Klimont, R. J. Andres, A. Volke, and S. D. Arias (2010). Anthropogenic Sulfur Dioxide Emissions: 1850–2005. *Atmospheric Chemistry and Physics Discussions*, 10 (6): 16111-16151.

Tierney, M., D. L. Nielson, D. G. Hawkins, J. T. Roberts, M. G. Findley, R. M. Powers, B. Parks, S. E. Wilson, and R. L. Hicks (2011). More Dollars than Sense: Refining Our Knowledge of Development Finance Using AidData. *World Development*, 39 (11): 1891-1906.

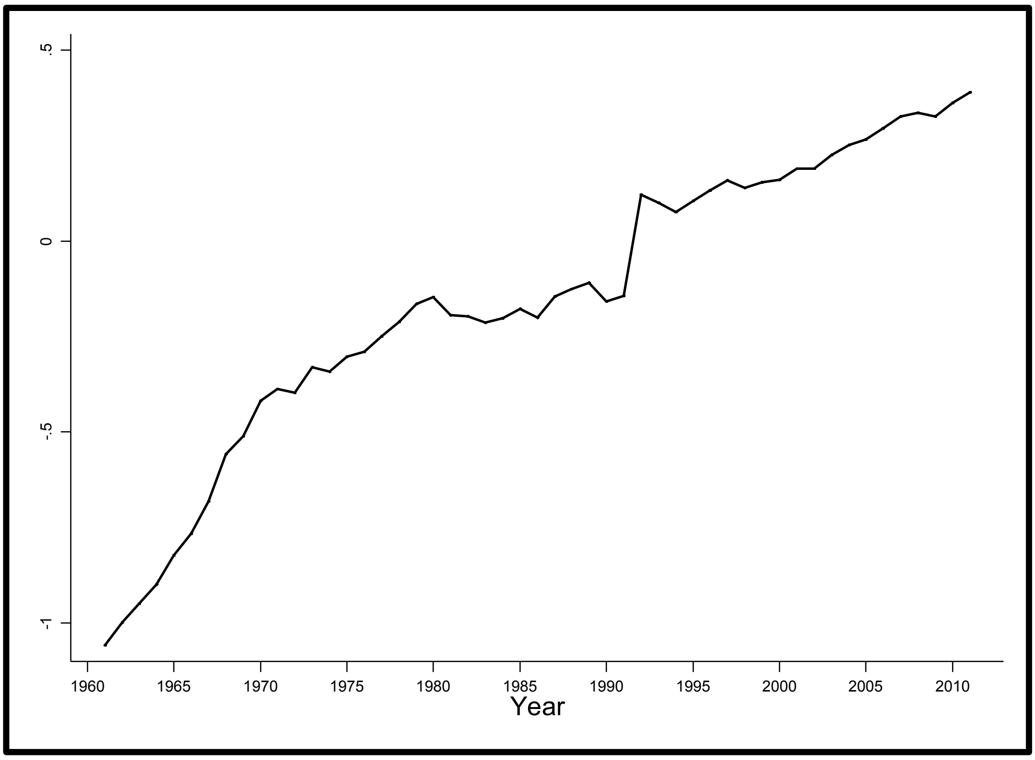
Torras, M., and J. K. Boyce (1998). Income, Inequality, and Pollution: A Reassessment of the Environmental Kuznets Curve. *Ecological Economics*, 25(2): 147-160.

Weisskopf, T. (1972). The Impact of Foreign Capital Inflow on Domestic Savings in Underdeveloped Countries. *Journal of International Economics*, 2(1): 25-38.

York, R., E. A. Rosa, and T. Dietz (2003). STIRPAT, IPAT and ImPACT: Analytic Tools for Unpacking the Driving Forces of Environmental Impacts. *Ecological Economics*, 46(3): 351-365.

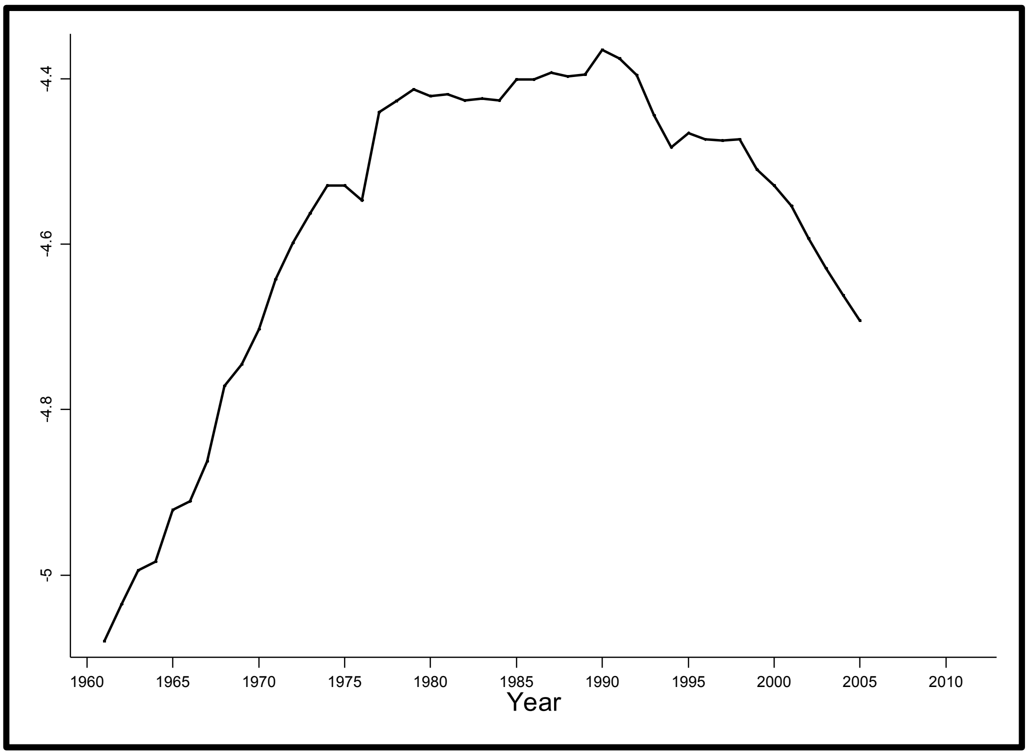
Zhu, H. M., W.H. You and Z. Zeng (2012). Urbanization and CO_2 Emissions: A Semi-Parametric Panel Data Analysis, *Economics Letters*, 117(3): 848-850.

Figure 1: Global CO_2 Emission per capita since 1961



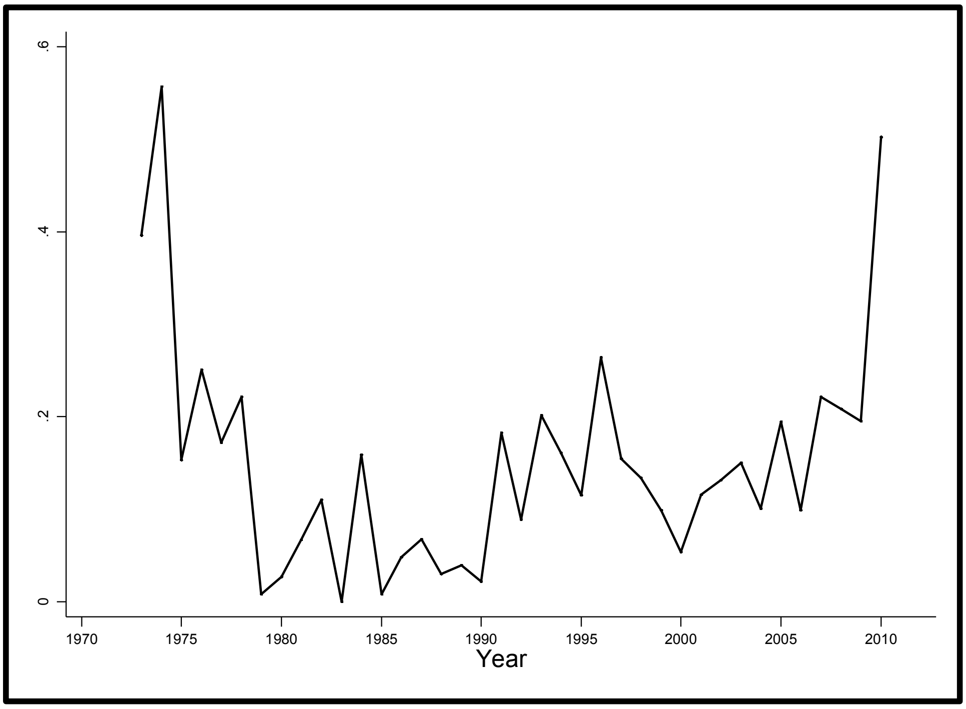
Notes: Natural log of global CO_2 emission per person covering the period 1961-2011. CO_2 emission measured in metric ton.

Figure 2: Global SO_2 Emissions per capita since 1961



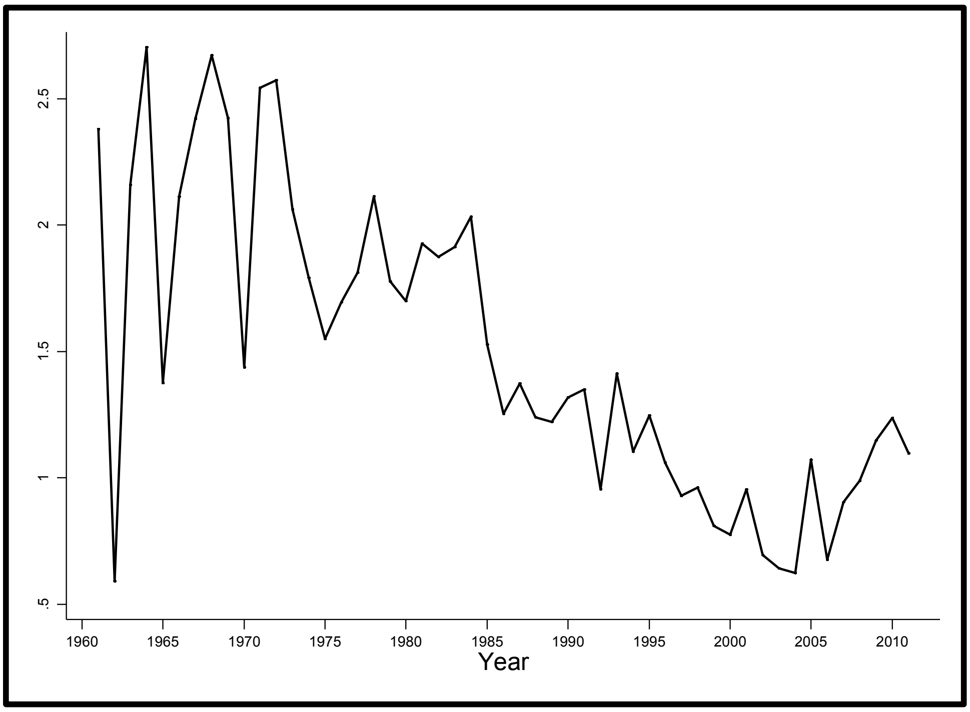
Notes: Natural log of global SO_2 emission per person covering the period 1961-2005. SO_2 emission measured in gigagram.

Figure 3: Foreign Aid Disbursement for Power Generation per capita from Renewable and Non-Renewable Sources since 1973



Notes: Aid disbursement per person is defined as $\ln(1+ Aid / Population)$ covering the period 1973-2010. Aid disbursement measured in 2009 constant US dollars.

Figure 4: Foreign Aid Commitment for Power Generation per capita from Renewable and Non-Renewable Sources since 1961



Notes: Aid commitment per person is defined as $\ln(1+ Aid / Population)$ covering the period 1961-2011. Aid commitment measured in 2009 constant US dollars.

Figure 5: Foreign Aid Disbursement for Power Generation per capita over 1976-2011 (Renewable Sources)

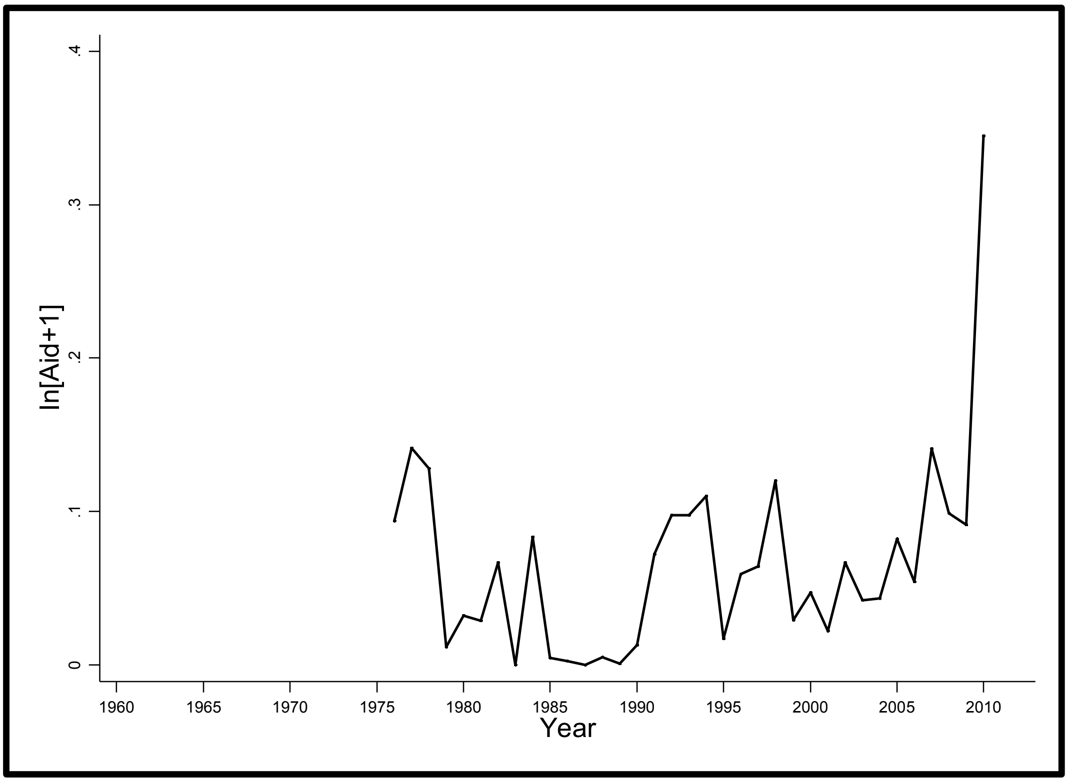


Figure 6: Foreign Aid Disbursement for Power Generation per capita over 1971-2011 (Non-Renewable Sources)

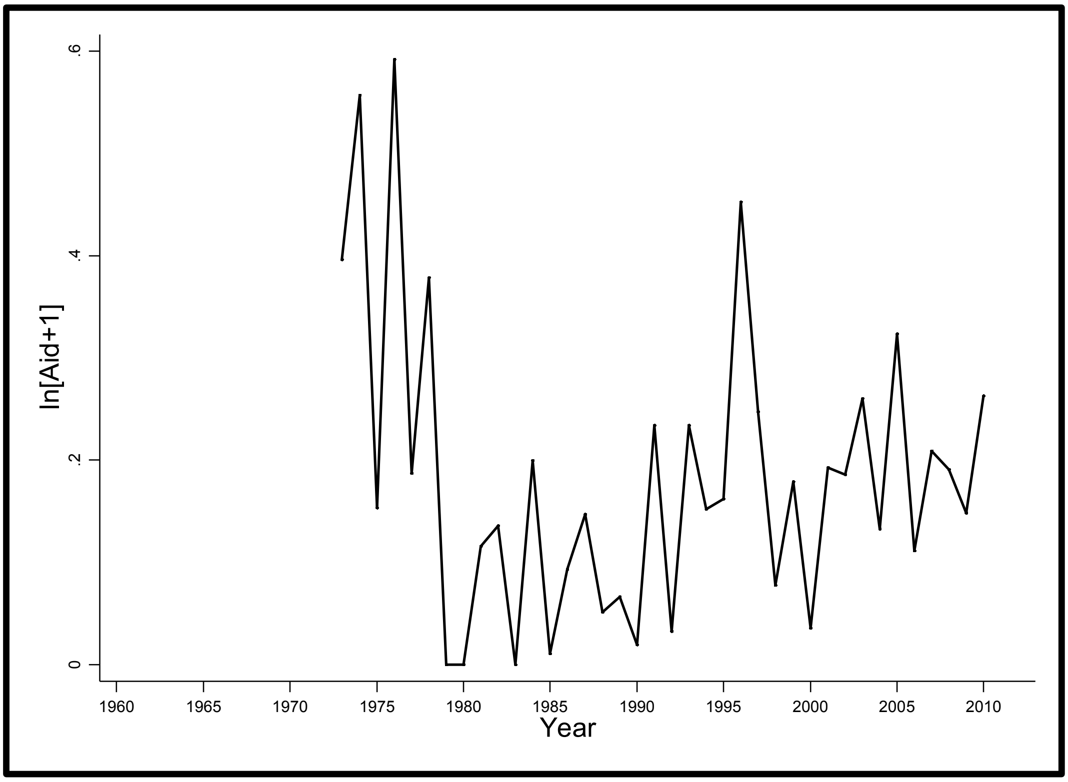


Table 1: Summary Statistics [1961-2011]

Variables	Mean	Std.Dev.	Min	Max
CO_2	2.346	4.246	0.014	60.7
SO_2	0.022	0.042	$1.9\text{x}10^{-4}$	0.402
Aid(ren+nonren) disb.	1.848	22.016	0.000	551.785
Aid(ren) disb.	0.291	1.979	0.000	36.531
Aid(nonren) disb.	2.387	25.957	0.000	551.785
Aid(energy) disb.	2.261	21.478	0.000	551.785
Aid(ren+nonren) comm.	12.997	42.901	$2.1\text{x}10^{-4}$	727.049
Aid(ren) comm.	9.488	27.006	$7.6\text{x}10^{-5}$	303.621
Aid(nonren) comm.	9.919	44.636	$3.5\text{x}10^{-5}$	727.049
Aid(energy) comm.	18.567	53.636	$6.2\text{x}10^{-4}$	1103.57
GDP	2864.5	4273.572	123.529	53107

Notes: The table illustrates summary statistics of the main variables used throughout the empirical analysis. CO_2 and SO_2 emissions are the dependent variables. Aid(ren+nonren) is aid for power generation from both renewable and non-renewable sources. Aid (ren) is aid for power generation from renewable sources only. Aid(noren) is aid for power generation from non-renewable sources only. Aid(energy) is aid for energy generation and supply. Disb. and comm. indicate disbursement and commitment, repectively. All variables are measured in per capita terms. The analysis on CO_2 (SO_2) emission covers the years between 1960 and 2011 (1960 and 2005). CO_2 and SO_2 emissions are measured in Metric tons and Gigagrams respectively. All aid variables are measured in USDs deflated at constant 2009 prices. GDP is measured in USDs deflated at constant 2005 prices.

Table 2: Unit Root Test

	CO_2	SO_2	Aid Disb	Aid Comm
Panel A: Levels				
Inverse chi-squared	0.000	0.951	0.921	0.005
Inverse normal	0.218	0.996	0.844	0.102
Inverse logit t	0.038	0.998	0.264	0.000
Modified inv. chi-squared	0.000	0.945	0.915	0.002
Panel B: First Difference				
Inverse chi-squared	0.000	0.000	0.000	0.000
Inverse normal	0.000	0.000	0.000	0.000
Inverse logit t	0.000	0.000	0.000	0.000
Modified inv. chi-squared	0.000	0.000	0.000	0.000

Notes: The table illustrates the p-values from Fisher-type ADF unit root tests. All variables are measured as log of per capita terms. The aid variables are measured as $\ln(1+x)$. The Aid variables used in this table are the *'Aid for Power Generation using Renewable and Non-renewable Resources'* Commitment and Disbursement. Each line refers to a specific transformation used to combine the p-values form unit-root tests computed for each panel individually. We also conduct Levin-Lin-Chu and Harris-Tzavalis varieties of unit root tests. These tests account for bias emanating frm cross-sectional association. The results are qualitatively similar

Table 3: Energy Related Aid and Emissions

	CO_2 Emissions 1971-2011				SO_2 Emissions 1971-2005			
Panel A: Disbursement								
	(1) OLS	**(2) OLS**	**(3) A-H**	**(4) A-B**	**(5) OLS**	**(6) OLS**	**(7) A-H**	**(8) A-B**
y_{t-1}	0.157***	0.135*	0.421*	0.388***	0.157	0.166**	0.372**	0.319
	(0.050)	(0.075)	(0.237)	(0.085)	(0.136)	(0.072)	(0.175)	(0.347)
Aid_t	-0.032*				0.020			
	(0.018)				(0.065)			
Aid_{t-1}		-0.009	0.002	0.004		0.008	0.012	-0.021
		(0.029)	(0.026)	(0.024)		(0.049)	(0.051)	(0.076)
GDP_t	0.812	1.876***	1.793***	2.083***	2.448*	2.332	2.417**	3.245**
	(0.906)	(0.480)	(0.666)	(0.662)	(1.467)	(1.413)	(1.201)	(1.286)
GDP^2_t	0.003	-0.088***	-0.091**	-0.108**	-0.133	-0.163	-0.171**	-
	(0.071)	(0.033)	(0.045)	(0.046)	(0.103)	(0.101)	(0.086)	(0.092)
Observations	509	420	420	420	293	217	217	217
Countries	135	128	128	128	87	78	78	78
R^2	0.301	0.221			0.079	0.058		
Weak test			5.922				6.725	
AR(2)				0.428				0.309
Hansen test				0.034				0.042
	1961-2011				**1961-2005**			
Panel B: Commitment								
	(1) OLS	**(2) OLS**	**(3) A-H**	**(4) A-B**	**(5) OLS**	**(6) OLS**	**(7) A-H**	**(8) A-B**
y_{t-1}	0.164***	0.146**	0.611**	0.446***	0.173	0.179**	0.580***	0.229
	(0.049)	(0.072)	(0.276)	(0.150)	(0.134)	(0.080)	(0.221)	(0.230)
Aid_t	-0.000				0.077*			
	(0.010)				(0.046)			
Aid_{t-1}		-0.007	-0.013	-0.014		0.008	-0.037	0.003
		(0.008)	(0.009)	(0.009)		(0.026)	(0.031)	(0.029)
GDP_t	0.772	1.710***	1.701**	2.211***	1.786	1.159	1.569	1.872
	(0.852)	(0.536)	(0.755)	(0.632)	(1.495)	(1.539)	(1.127)	(1.548)
GDP^2_t	0.008	-0.068*	-0.081	-0.114***	-0.08	-0.057	-0.092	-0.099
	(0.067)	(0.038)	(0.051)	(0.044)	(0.105)	(0.111)	(0.081)	(0.116)
Observations	534	455	455	455	313	245	245	245
Countries	137	131	131	131	88	80	80	80
R^2	0.312	0.261			0.125	0.072		
Weak test			6.829				10.229	
AR(2)				0.374				0.164
Hansen test				0.039				0.045

Notes: The table reports Ordinary Least Squares (OLS), Anderson–Hsiao (A-H) and Arellano and Bond (A-B) estimates. All variables are expressed as first difference as they are I(1). They are also measured in logs of per capita. y_{t-1} denotes the lagged dependent variable. The aid variables here are expressed as $\ln(1+x)$. The Aid variable used in this table is the *'Aid for Power Generation using Renewable and Non-renewable Resources'*. The figures in the parentheses are clustered standard errors with clustering at the country level. The last two lines of the table reports the p-values of the Arellano and Bond test (AR2) and Hansen test. Weak test is the Stock-Yogo F-test for weak instruments. F-statistic greater than 10 implies strong instrument. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. All specifications include country and year dummies, and country specific trend.

Table 4: Aid for Power Generation and Emissions

	CO_2 Emissions			SO_2 Emissions		
	Panel A: Disbursement					
	Renewables	**Non-renewables**	**Energy Generation & Supply**	**Renewables**	**Non-renewables**	**Energy Generation & Supply**
	(1) 1976-2011	**(2) 1971-2011**	**(3) 1961-2011**	**(4) 1976-2005**	**(5) 1971-2005**	**(6) 1961-2005**
Aid_{t-1}	-0.018	0.015	0.008	0.155	-0.037	0.022
	(0.038)	(0.033)	(0.018)	(0.206)	(0.026)	(0.031)
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t					
Observations	315	242	645	156	152	356
Countries	108	90	150	57	63	97
Weak test	4.383	1.937	13.699	14.466	4.863	12.799
	Panel B: Commitment					
	Renewables	**Non-renewables**	**Energy Generation & Supply**	**Renewables**	**Non-renewables**	**Energy Generation & Supply**
	(1) 1961-2011	**(2) 1961-2011**	**(3) 1961-2011**	**(4) 1961-2005**	**(5) 1961-2005**	**(6) 1961-2005**
Aid_{t-1}	-0.013	-0.029	-0.009	0.005	-0.068**	0.025
	(0.011)	(0.018)	(0.008)	(0.033)	(0.029)	(0.040)
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t					
Observations	351	247	653	188	157	364
Countries	109	92	150	58	65	97
Weak test	4.032	3.104	13.138	12.759	7.155	13.973

Notes: The table reports Anderson–Hsiao (A-H) estimates. All variables are expressed as first difference as they are I(1). They are also measured in logs of per capita. y_{t-1} denotes the lagged dependent variable. The aid variables here are expressed as $\ln(1+x)$. The Aid variable used in columns 1 and 4 is the *'Aid for Power Generation using Renewable Resources'*. The Aid variable used in columns 2 and 5 is the *'Aid for Power Generation using Non-Renewable Resources'*. The Aid variable used in columns 3 and 6 is the *'Aid for Energy Generation and Supply'*. The figures in the parentheses are clustered standard errors with clustering at the country level. Weak test is the Stock-Yogo F-test for weak instruments. F-statistic greater than 10 implies strong instrument. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. All specifications include a constant.

Table 5: Energy Related Aid and Energy Use and Energy Efficiency

	Energy Use		Energy Efficiency	
	(1) Disbursement 1981-2011	**(2) Commitment 1971-2011**	**(3) Disbursement 1996-2011**	**(4) Commitment 1996-2011**
Aid(t-1)	-0.016	-0.005	0.660	0.145
	(0.015)	(0.006)	(0.400)	(0.118)
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t			
Observations	299	313	188	188
Countries	87	88	82	82
Weak test	28.677	28.959	5.345	5.599

Notes: The table reports Anderson–Hsiao estimates. All variables are expressed as first difference as they are I(1). They are also measured in logs of per capita (except energy efficiency). y_{t-1} *denotes the lagged dependent variable. The figures in the parentheses are clustered standard errors with clustering at the country level. Weak test is the Stock-Yogo F-test for weak instruments. F-statistic greater than 10 implies strong instrument. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. All specifications include country and year dummies, and country specific trend.*

Table 6: Energy Related Aid and Emissions: The Role of Institutions and Policy

	CO_2 emissions				SO_2 emissions			
	Panel A: Disbursement							
	(1) 1976-2011	**(2) 1976-2011**	**(3) 1971-2011**	**(4) 1971-2011**	**(5) 1976-2005**	**(6) 1976-2005**	**(7) 1971-2005**	**(8) 1971-2011**
Aid_{t-1}	0.012	0.013	-0.055	-0.008	-0.023	0.047	0.019	0.006
	(0.028)	(0.028)	(0.037)	(0.028)	(0.058)	(0.063)	(0.091)	(0.046)
INS_t	0.033	0.011	0.003	0.003*	0.079***	-0.015	0.004	0.002
	(0.023)	(0.018)	(0.003)	(0.001)	(0.027)	(0.030)	(0.006)	(0.002)
$INS_t \times Aid_{t-1}$	-0.014	-0.000	0.010	0.001	0.131	0.070	-0.008	-0.005
	(0.075)	(0.049)	(0.008)	(0.001)	(0.089)	(0.084)	(0.061)	(0.007)
INS	Law and Order	Corruption Index	Democracy Score	Trade Openness	Law and Order	Corruption Index	Democracy Score	Trade Openness
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t							
Observations	304	304	391	409	187	187	215	213
Countries	88	88	112	124	70	70	78	77
	Panel B: Commitment							
	(1) 1976-2011	**(2) 1976-2011**	**(3) 1961-2011**	**(4) 1961-2011**	**(5) 1976-2005**	**(6) 1976-2005**	**(7) 1961-2005**	**(8) 1961-2011**
Aid_{t-1}	0.002	0.002	-0.018	-0.011	-0.015	-0.039	-0.036	-0.059
	(0.014)	(0.013)	(0.012)	(0.009)	(0.032)	(0.033)	(0.033)	(0.037)
INS_t	0.035	0.011	0.003	0.002	0.073***	-0.038	0.004	0.001
	(0.022)	(0.020)	(0.003)	(0.002)	(0.027)	(0.034)	(0.006)	(0.003)
$INS_t \times Aid_{t-1}$	0.002	-0.000	0.000	-0.001	0	-0.088**	-0.001	0.004
	(0.023)	(0.015)	(0.003)	(0.001)	(0.027)	(0.042)	(0.005)	(0.003)
INS	Law and Order	Corruption Index	Democracy Score	Trade Openness	Law and Order	Corruption Index	Democracy Score	Trade Openness
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t							
Observations	294	294	513	444	246	246	307	241
Countries	88	88	115	127	70	70	80	79

Notes: The table reports Anderson–Hsiao (A-H) estimates. All variables are expressed as first difference as they are I(1). They are also measured in logs of per capita. y_{t-1} denotes the lagged dependent variable. The aid variables here are expressed as $\ln(1+x)$. The Aid variable used in this table is the *'Aid for Power Generation using Renewable and Non-renewable Resources'*. Law and Order, Corruption Index, Democracy Score, and Trade Openness are used as proxy measures of institutions and policy. The figures in the parentheses are clustered standard errors with clustering at the country level. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. All specifications include a constant.

Table 7: Energy Related Aid and Emissions: The Effect of Income

	CO_2 emissions		SO_2 emissions	
	1961-2011		1961-2005	
	(1) Disbursement	(2) Commitment	(3) Disbursement	(4) Commitment
Aid_{t-1}	0.004	-0.009	-0.038	-0.036
	(0.025)	(0.011)	(0.031)	(0.034)
Low	-0.031	-0.019	-0.024	-0.027
	(0.029)	(0.031)	(0.050)	(0.064)
Low*Aid_{t-1}	0.068	-0.026	0.863***	-0.030
	(0.093)	(0.027)	(0.193)	(0.072)
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t			
Observations	420	455	217	245
Countries	128	131	78	80

Notes: The table reports Anderson–Hsiao (A-H) estimates. All variables are expressed as first difference as they are I(1). They are also measured in logs of per capita. y_{t-1} denotes the lagged dependent variable. The aid variable here is expressed as $\ln(1+x)$. The Aid variable used in this table is the *'Aid for Power Generation using Renewable and Non-renewable Resources'*. Low is a dummy variable for low-income countries as classified by the OECD DAC. The figures in the parentheses are clustered standard errors with clustering at the country level. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. All specifications include a constant.

Table 8: Energy Related Aid and Emissions: Examining Heterogeneity Across Continents

	CO2 emissions				SO2 emissions			
	Panel A: Disbursement							
	1971-2011				1971-2005			
	(1) ASIA	(2) ECA	(3) LAC	(4) MENA	(5) ASIA	(6) ECA	(7) LAC	(8) MENA
Aid_{t-1}	0.051	-0.31***	0.063	-0.025	0.238	10.08	0.064	-0.001
	(0.035)	(0.10)	(0.117)	(0.045)	(0.288)	(170.01)	(0.165)	(0.051)
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t							
Observations	98	41	86	195	53	20	58	86
Countries	28	22	26	52	14	16	20	28
	Panel B: Commitment							
	1961-2011				1961-2005			
	(1) ASIA	(2) ECA	(3) LAC	(4) MENA	(5) ASIA	(6) ECA	(7) LAC	(8) MENA
Aid_{t-1}	-0.050	0.007	-0.020	-0.009	-0.122	0.15	-0.083	-0.053
	(0.041)	(0.028)	(0.018)	(0.015)	(0.105)	(0.08)	(0.078)	(0.040)
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t							
Observations	108	44	97	206	61	23	69	92
Countries	29	23	26	53	15	17	20	28

Notes: The table reports Anderson–Hsiao (A-H) estimates. All variables are expressed as first difference as they are I(1). They are also measured in logs of per capita. y_{t-1} denotes the lagged dependent variable. The aid variable here is expressed as $\ln(1+x)$. The Aid variable used in this table is the *'Aid for Power Generation using Renewable and Non-renewable Resources'*. ASIA, ECA, LAC and MENA indicate Asian (East and South Asia and Pacific), European and Central Asian, Latin American and Caribbean and Middle East and African region, respectively. The figures in the parentheses are clustered standard errors with clustering at the country level. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. All specifications include a constant.

Table 9: Energy Related Aid and Emissions: Outlier Sensitivity Tests

	CO2 emissions			SO2 emissions		
	Panel A: Disbursement					
	1971-2011			**1971-2005**		
	(1) DFITS	**(2) COOK**	**(3) WELSCH**	**(4) DFITS**	**(5) COOK**	**(6) WELSCH**
Aid_{t-1}	0.031	0.031	0.026	-0.004	-0.004	-0.019
	(0.020)	(0.020)	(0.018)	(0.060)	(0.060)	(0.051)
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t					
Observations	394	394	407	199	199	205
Countries	124	124	127	71	71	75
	Panel B: Commitment					
	1961-2011			**1961-2005**		
	(1) DFITS	**(2) COOK**	**(3) WELSCH**	**(4) DFITS**	**(5) COOK**	**(6) WELSCH**
Aid_{t-1}	-0.013	-0.013	-0.007	-0.035	-0.035	-0.032
	(0.010)	(0.010)	(0.010)	(0.026)	(0.026)	(0.026)
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t					
Observations	424	424	441	229	229	233
Countries	125	125	130	73	73	76

Notes: The table reports Anderson–Hsiao (A-H) estimates. All variables are expressed as first difference as they are I(1). They are also measured in logs of per capita. y_{t-1} denotes the lagged dependent variable. The aid variable here is expressed as $\ln(1+x)$. The Aid variable used in this table is the *'Aid for Power Generation using Renewable and Non-renewable Resources'*. In columns 1&4 observations are omitted if $|Cooksd_i|>4/n$; in columns 2&5 observations are omitted if $|DFITS_i|>2(k/n)^{1/2}$; and in columns 3&6 observations are omitted if $|Welschd_i|>3k^{1/2}$. Here n is the number of observation and k is the number of independent variables in the regression model including the intercept. The figures in the parentheses are clustered standard errors with clustering at the country level. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. All specifications include a constant.

Table 10: Energy Related Aid and Emissions: Additional Covariate Tests

Panel A: CO2 emissions and Disbursement

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Aid_{t-1}	0.001	0.001	0.012	-0.007	0.02	-0.003	0.017
	(0.024)	(0.026)	(0.024)	(0.038)	(0.02)	(0.035)	(0.028)
Sample Period	1971-2011	1971-2011	1971-2011	1971-2011	1971-2011	1971-2011	1981-2011
Additional Covariates	Trade Share	Urban	Schooling	Cap. Form	Energy Use	Pop 15-64	Energy Efficiency
Observations	409	420	350	396	314	416	248
Countries	124	128	112	120	101	125	96

Panel B: CO2 emissions and Commitment

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Aid_{t-1}	-0.015	-0.013	-0.022	-0.005	-0.01	-0.01	-0.005
	(0.010)	(0.009)	(0.014)	(0.009)	(0.01)	(0.01)	(0.012)
Sample Period	1961-2011	1961-2011	1961-2011	1961-2011	1961-2011	1961-2011	1981-2011
Additional Covariates	Trade Share	Urban	Schooling	Cap. Form	Energy Use	Pop 15-64	Energy Efficiency
Observations	424	424	441	229	229	233	248
Countries	125	125	130	73	73	76	96

Panel C: SO2 emissions and Disbursement

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Aid_{t-1}	0.01	0.01	-0.04	0.02	0.05	0.01	0.116
	(0.05)	(0.05)	(0.03)	(0.05)	(0.05)	(0.05)	(0.073)
Sample Period	1971-2005	1971-2005	1971-2005	1971-2005	1971-2005	1971-2005	1981-2005
Additional Covariates	Trade Share	Urban	Schooling	Cap. Form	Energy Use	Pop 15-64	Energy Efficiency
Observations	213	217	184	215	217	217	154
Countries	77	78	70	78	78	78	72

Panel D: SO2 emissions and Commitment

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Aid_{t-1}	-0.04	-0.04	-0.04	-0.02	-0.02	-0.04	0.024
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.036)
Sample Period	1961-2005	1961-2005	1961-2005	1961-2005	1961-2005	1961-2005	1981-2005
Additional Covariates	Trade Share	Urban	Schooling	Cap. Form	Energy Use	Pop 15-64	Energy Efficiency
Observations	241	245	203	240	239	245	154
Countries	79	80	70	80	80	80	72

Notes: The table reports Anderson–Hsiao (A-H) estimates. All variables are expressed as first difference as they are I(1). They are also measured in logs of per capita. y_{t-1} denotes the lagged dependent variable. The aid variable here is expressed as $\ln(1+x)$. The Aid variable used in this table is the *'Aid for Power Generation using Renewable and Non-renewable Resources'*. Trade Share, Urban and Schooling indicate the sum of exports and imports as a percentage of GDP, size of urban population and secondary school enrolment respectively. Cap Form, Energy Use and Pop 15-64 indicate gross capital formation as a percentage of GDP, energy use (kg of oil equivalent per capita) and population aged 15-64, respectively. Energy efficiency is measured by GDP per unit of energy use (PPP $ per kg of oil equivalent).The figures in the parentheses are clustered standard errors with clustering at the country level. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. All specifications include a constant, a legged dependent variable, country and year dummies, country specific trend, $GDP_{t,}$, and GDP^2_t.

Table 11: Energy Related Aid and Emissions with Country-Year Fixed Effects

	Disbursement		**Commitment**	
	(1) CO2 1971-2011	**(2) SO2 1971--2005**	**(3) CO2 1961-2011**	**(4) SO2 1961-2005**
Aid_{t-1}	-0.020	-0.031	-0.018	-0.041
	(0.029)	(0.035)	(0.012)	(0.029)
Controls	Country dummies, Year dummies, Country-Year Dummies, $y_{t-1,}$ $GDP_{t,}$ GDP^2_t			
Observations	420	217	455	245
Countries	128	78	131	80
Weak test	10.614	2.587	11.372	2.727

*Notes: The table reports Anderson–Hsiao estimates. All variables are expressed as first difference as they are I(1). They are also measured in logs of per capita. y_{t-1} denotes the lagged dependent variable. The aid variables here are expressed as ln(1+x). The Aid variable used in this table is the 'Aid for Power Generation using Renewable and Non-renewable Resources'. The figures in the parentheses are clustered standard errors with clustering at the country level. Weak test is the Stock-Yogo F-test for weak instruments. F-statistic greater than 10 implies strong instrument. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. All specifications include country fixed effects (or dummies), year fixed effects (or dummies), and country-year fixed effects (or dummies).*

Table 12: Energy Related Aid and Emissions since 1990

	Disbursement		Commitment	
	Dependent Variable: CO_2 Emissions			
	(1) 1990-2011 All	**(2) 1990-2011 ECA**	**(3) 1990-2011 All**	**(4) 1990-2011 ECA**
Aid_{t-1}	0.009	2.45	0.006	0.039
	(0.025)	(3.36)	(0.019)	(0.042)
Controls	Country dummies, Year dummies, Country specific trend, y_{t-1}, GDP_t, GDP^2_t			
Observations	202	37	202	37
Countries	115	22	115	22
Weak test	4.689	4.281	4.316	3.916

Notes: The table reports the estimates from Anderson–Hsiao (A-H) estimator. All variables are expressed as first difference as they are I(1). They are also measured in logs of per capita. y_{t-1} denotes the lagged dependent variable. The aid variables here are expressed as *ln(1+x)*. The Aid variable used in this table is the 'Aid for Power Generation using Renewable and Non-renewable Resources'. The figures in the parentheses are clustered standard errors with clustering at the country level. The last two lines of the table reports the p-values of the Arellano and Bond test (AR2) and Hansen test. Weak test is the Stock-Yogo F-test for weak instruments. F-statistic greater than 10 implies strong instrument. ***, ** and * denote statistical significance at the 1%, 5% and 10% level, respectively. All specifications include country and year dummies, and country specific trend.