The Impact of Government Corruption on Fresh Water Supply

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Abstract

This paper will attempt to find the relationship between a corrupt government and the amount of public fresh water available to the citizens under that government. Many countries around the world have corrupt governments. These corrupt governments generally do little to protect their natural resources. This paper will attempt to explore the impact of corrupt governments on public fresh water supply available to citizens. The model used in this paper will attempt to use many factors including terms of trade, percent of population with access, control of corruption and amount of sanitation. The control of corruption factor is the amount of bribes government officials are willing to take in exchange for allowing environmental degradation. The data used in this paper will be taken from the year 2004. The year 2004 is used because it contained the most complete data for the countries in this paper.

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I. Introduction

Most people are familiar with the meaning of corruption. The dictionary has nine different definitions of corruption: perversion of integrity, the act of corrupting or state of being corrupt, moral perversion or depravity to name a few. Many things can be considered to be corrupt behavior; such as a police officer taking a bribe from a drug dealer; a politician who lies and cheats his way into office; or a teacher who lets things slide on a test just so all her students will pass to the next grade whether they are academically ready or not. Corruption in this paper will be defined as the "*use of public office for private gain*." [11].

Governments can often be seen as corrupt. The way a country governs itself can be a display of corruption. North Korea is ruled by a dictator, while Japan and England have elected prime ministers. The level and type of governance in a country will greatly effect how the citizens of that country and other nations will look upon it in terms of corruption

Governance as defined by the World Bank [5] is the government selection process, the effectiveness of government policies, and the respect of citizens for state institutions. The World Bank has six dimensions of governance. Only one of those dimensions will be used in this paper: Control of Corruption. "…*Control of Corruption is a measure of the extent of corruption, conventionally defined as the exercise of public power for private gain. It is based on scores of variables from polls of experts and surveys.*" [Sic]

Barbier (2005) describes how the lobbying of special interest groups in developing countries has played an important role in influencing government policies.

This lobbying results in rent-seeking opportunities for the benefit of special interest groups. As a result government corruption occurs. The corrupt governments then place importance on the interest of the lobbing party and not on social welfare.

In some corrupt governments such as Afghanistan only thirty nine percent of the population has access to the public water supply. In the Netherlands which has very little corruption by the World Bank definition has one hundred percent access to the public fresh water supply. This is not proof that corruption leads to less public water access, however across the collection of data more corrupt governments have less public access to clean fresh water. Not all of them have public access as low as thirty nine percent, however the majority of them have less than one hundred percent access.

Many governments contribute to the preservation of natural resources through policies like anti-pollution laws and park preserves. Corrupt governments in general are not committed to conservation. Corrupt governments are willing to accept bribes in exchange for allowing the environmental degradation of natural resources such as fresh water reserves. People depend upon this water for their very lives. Millions of people live in corrupt governments that do little to ensure that there is enough fresh drinking water for their citizens. Having a corrupt government is not a prerequisite for limiting public fresh water access, but the effect it does have will be examined in this paper.

The research presented in this paper will attempt to show that a country with a corrupt government will have less access to an improved water supply when compared to other countries, exhibit less corruption.

II. Literature Review

Political factors are responsible for the use and change in natural resources. Barbier (2005) argues that a corrupt government will often take bribes in exchange for the exploitation of tropical forests. Special interest groups lobby self interested governments achieving greater agricultural land conversion. In Central America the governments support cattle ranching, forestry, and large scale agriculture that results in deforestation. He shows how a more corrupt government allows special interest groups greater access to tropical forests, creating deforestation as agriculture, forestry, and cattle ranching expands. A self interest government will place less importance on social welfare than it does about the bribes it receives. The more bribes [corrupt] a government receives [is], the less that government will place importance on social welfare and environmental preservation.

The basic theoretical ideas for this paper are drawn from Barbier (2005), where governments compare the costs of social welfare programs versus using the public office for private gain by accepting bribes for land conversion. The political decisions of a government have a direct effect on the allocation of natural resource use and environmental degradation.

Barbier (2001) explains how land deforestation is primarily the result of agricultural development. Barbier (2001) reveals how economic factors can influence deforestation resulting from agricultural expansion. He also develops the idea that income will vary in regions and may not always follow an Environmental Kuznets Curve. According to the EKC model an environmental "bad" will first increase then eventually fall as income rises. This paper will not use the EKC model, however it will use the variable GDP as real GDP per capita (constant 2000 US dollars), to try and capture a certain amount of the effects that could be represented in an EKC model.

Lopez (2000) describes that pollution levels are always above social optimums, irrespective of firm and government cooperation. Lopez (2000) also goes on to define that the turning point in the pollution per capita relationship on the EKC model is at a higher income level than would be expected as a result of corruption. Corruption then does not preclude the existence of the Environmental Kuznets Curve; however the turning point is at a higher level then income and socially optimum. Even as income rises, as a result of corruption environmental degradation will occur at a higher rate than without corruption.

Gray (2003) discusses political involvement in pollution abatement. He states that the more pro-environment the state government the more pollution abatement and the effect this has on plant output of pollution. Gray (2003) observes that paper mills in poorer areas will emit more pollution. He also finds that plants with a more politically active population living nearby will emit less pollution. A government with greater corruption is less likely to have a more politically active population. The corrupt government will be less likely to enforce or create pollution abatement policies.

This paper builds from Gray (2003) by taking away the idea that pollution emitting facilities in countries with more corruption will have less incentive to reduce the amount of pollution. As these countries receive bribes they have a higher incentive to allow resource degradation, and therefore have a lower incentive for environmental protection. Most corrupt countries receiving bribes allow for resource degradation, not resource improvement. The firms providing the bribes are doing so in order to avoid using or creating sanitation facilities and other methods that reduce pollution or environmental degradation.

This paper will use sanitation, based upon the percentage of citizens with access to it, as a factor in fresh water access. Theoretically a corrupt government will invest less in the people, thereby having less sanitation facilities and more plants emitting pollution. Bribes allow for more resource consumption as less weight is given by the government on social welfare. A government that places less importance on social welfare will likely do very little to invest in sanitation facilities or create policies that restrict or limit pollution.

Wilson (2004) summarizes that corruption is one of the major causes of environmental degradation in developing countries. And according to the World Bank illegal activity creates a resource loss from public lands between $US10 and $US15 billion annually. Wilson (2004) shows that corruption has a huge impact on resource use. While his paper goes on to show that political competition can affect the level of contributions and policy reforms, that subject will not be broached in this paper. What will be discussed is that corruption does play a large role in resource conservation or degradation. He also discusses how corruption takes place at two levels; the policy makers and the bureaucrats. The policy makers and the bureaucrats each are willing to take bribes in exchange for allowing special interest groups access to natural resources.

His paper delves into the idea that government corruption results at all levels of government. Therefore a corrupt government will likely be corrupt from the top down. It is not just the policy makers or the low level bureaucrats that create corruption, but a sum of all levels of government.

When corruption is low, trade liberalization sets social welfare considerations at a higher level [10]. Damania (2003) hypothesizes that less government corruption implies a greater concern for social welfare. The overall effect of trade liberalization is however conditional on the level of corruption. A reduction in environmental degradation should occur when there is an improvement in trade liberalization and a reduction in corruption. If there is not a lower corruption level, increasing trade liberalization will not necessarily decrease environmental degradation.

III. Methodology

The model used in this paper is similar to the model presented in Barbier (2005). Barbier (2005) uses variables specific to agricultural expansion and deforestation for his model. Barbier (2005) focuses on tropical forests; his paper however explains that the model he used can be applied to any natural renewable or nonrenewable resource. The variables in this paper will focus on water usage and improvement. Variables that do not focus on water data will be the same as those used by Barbier (2005)

Consider the following two models used for this paper.

$$WA = \alpha_0 + \alpha_1 CC + \alpha_2 lntw + \alpha_3 Dep + \alpha_4 San + \alpha_5 ToT + \alpha_6 lngdp + \alpha_7 TC + \varepsilon$$

$$WA = \alpha_0 + \alpha_1 CC + \alpha_2 lntw + \alpha_3 Dep + \alpha_4 ToT + \varepsilon$$

WA is Water Access. CC is Control of Corruption. Lntw is log of Total Water. Dep is Dependency. San is Sanitation. ToT is Terms of Trade. Lngdp is log of GDP per capita. TC is Terms of Trade multiplied by Control of Corruption.

The first model was run using a probit regression using marginal effects to interpret the results. When this was done variables were declared missing in the data set by the statistical program used. That data set was trimmed down, removing incomplete data, from 167 countries to 54 with only 48 being used in the regression. All variables in this regression were significant at the ninety nine percent level. The computer however gave the marginal effect of each variable on all the different point estimates for Water Access. There were thirty three different point estimates for the Water Access variable. This meant that there were thirty three different marginal effects of each variable on Water Access. These results could not be interpreted as there would have to be an correctly with such output.

Due to time constraints a Linear Probability Regression was run, in lieu of attempting to correct the output of the marginal effects on the probit regression using the smaller data set with only 54 countries. After examining the results of the Linear Probability Regression a correlation test was also run. Some of the variables were found to be correlated with the explanatory variable control of corruption. The correlated variables were removed and the second model was used in the Linear Probability Regression.

The Sanitation, TC and lngdp variables were found to be highly correlated with Control of Corruption and were removed from the model, thus leaving the second shorter model to be used in this paper. The results of the regression from this model will be explained more in the results section.

Water Access (WA) is the total percentage of the population with access to an improved water source. The smaller Water Access the smaller the percentage of access to an improved water supply. This is the variable the model is attempting to explain.

CC is the Control of Corruption variable describing the ability of a given government to control the level of corruption in that country. As previously defined corruption is the "*use of public office for private gain*". [11] The more corruption in a government the more bribes that government is willing to accept. Using the second model this paper will attempt to display that the level of corruption as measured by the World Bank [5], has an effect on the percentage of citizens with access to an improved water supply.

Lntw is the log of Total Water. Total water is the amount of total fresh water in a country measured in cubic kilometers. This variable is used to take into account any effects the amount of water in a country has on the percent of access to an improved water supply. A country with more water should theoretically have a higher water access rate than a country with less total water. The Water Access, Dependency and Sanitation variables are all measured in percentage terms. By taking the log of Total Water it makes it a better fit into this model.

The Dependency (Dep) variable is used to measure the percentage of citizens dependant on the public water supply. If more citizens of a given country are dependent on the public water supply; than they should be given more access to it. Sanitation (San) measures the percentage of citizens with access to sanitation facilities. The more sanitation in a country the greater the chances of that country having improved water supply. Even if a country has no corruption, without sanitation ability there can be no way to improve the water supply.

ToT is terms of trade (2000 = 100). Damani (2003) states that trade liberalization can decrease environmental degradation if there is a low level of corruption. An improved Terms of Trade with less corruption should result in greater water access.

GDP (Gross Domestic Product) per capita (in constant 2000 US dollars) was added to the model following the hypothesis of the Environmental Kuznets Curve (EKC) which states that poor countries will have more environmental degradation. As income increases so will the degradation until a higher income level. At a high enough income level the curve will change slope and environmental degradation will decrease as income rises. GDP per capita thus is used in this model to attempt to capture the effects of the EKC.

The variable in this model is the log of GDP. It was necessary to log GDP since many other variables in this model are measured in percentage terms. By logging GDP it becomes a better fit for this model.

The variable TC is Terms of Trade multiplied by Control of Corruption. In other papers [9, 10] environmental degradation decreases when trade liberalization improves and corruption is low. This paper will use TC as a statistical control for this effect, as Barbier (2005) used it in his model.

The coefficient α_1 for the Control of Corruption variable is expected to be positive. Corruption is recorded as a negative value. Therefore a positive parameter estimate will yield a negative overall value. As corruption increases water access is expected to go down. Water access and corruption are expected to be inversely related. The coefficient α_2 for the log of Total Water variable is expected to be positive. The greater the amount of total water in a country the more access people should have to that water supply.

The expected sign of the coefficient α_3 for the Dependency variable is uncertain at this time. The author was unable to make a determination about this variable. It would be difficult to say how the percentage of people dependant on an improved water supply would have an impact on the amount of access and if that impact would be positive or negative.

The coefficient α_4 for the Terms of Trade variable is expected to be negative. Theoretically the more sanitation a country has the greater the ability of its citizens to access clean water. Following from Barbier (2005) as terms of trade increases resource conversion and higher bribes received by a government will increase. Therefore as Terms of Trade increases Water Access should decrease.

IV. Results

Running a probit regression resulted in a best fit model with every variable significant. As previously stated the marginal effects output was not in a format that allowed for straight forward interpretation. The Linear Probability Regression (LPR) was then used with results that could be better interpreted.

A disadvantage of the LPR is that it does not make sense that the variables should have a linear probability. Probability models should have an "S" shape graphical representation. The LPR does not have an "S" shape graphical representation, but retains the straight line format. But not having the "S" shape an LPR can go outside the parameters of 0 and 1. Probability models for their best fit should stay inside the parameters of 0 and1.

This model did result in an F value of 9.82 which means that we reject the null hypothesis that all the coefficients are equal to zero. The R-squared value was 0.4774.

This is not incredibily high for this test. However it is not significantly low enough to, without other model comparisons to justify tossing out the model. In the event that a regression with a higher R-squared value was run it should be given more weight.

The explanatory variable, Control of Corruption, was significant at the ninety nine percent level. The other remaining variables in this regression; lntw, Dep, ToT, were not significant. A lack of significance does not mean that the variable should be excluded from the model. It does mean that the variable cannot be used to explain a change in Y. In the linear probability model that is used for final interpretation the parameter estimates followed the expected signs.

Once corrected for correlation the Linear Probability Regression did show that the explanatory variable, Control of Corruption, has an effect on Water Access. Since no other variables had significance in this model, Control of Corruption explained all the variation or change in Water Access. This model with the LPR may be the simplest method, but in not necessarily the most complete method of explaining change in Water Access. Many regressions may have more than one variable that can explain change in the dependant variable Y.

V. Data

All data for this paper is taken from the year 2004. Data for this model is taken from various international websites including the World Bank [5/6], United Nations Statistical Division [7], and the FAO Aquastat [4] website. The Water Access, Terms of Trade, Sanitation and GDP per capita variables are taken from the World Bank's online resource World Development Indicators [6]. The Dependency and Total Water variables are taken from the Food and Agricultural Organization of the United Nations, Aquastat website [4]. The dependant variable Control of Corruption comes from the World Bank website's learning section on Worldwide Governance Indicators [5]. All the data is taken from the year 2004 and involves 167 countries. The year 2004 was chosen, because it contained the most complete data for all the variables.

Each data set had a slightly different set of countries. This meant creating a single data set matching up the countries from each data set and removing countries that were not in all three data sets. In the end 167 countries were selected for this paper. This is still the majority of the countries in the world providing a good sample size for world data. As explained in the methodology section however only 54 countries did not have missing values, the statistical program used in this regression only reading 48 of those observations claiming the other six countries had missing observations. In the end only 48 countries with data from the year 2004 were used and interpreted in the final model.

VI. Conclusion

From the output of the Linear Probability Regression it can be determined that Control of Corruption does have an effect on the access of an improved water supply. Policy implications should be thoroughly considered before making decisions based upon this regression model. It is not likely that this model is the best fit since it is running a probability model on a linear regression. A better fit for running a probability model would be to use a probit or logit regression. This will keep the variables between 0 and 1, which a Linear Probability model does not.

When the probit regression was run on the full model, it was difficult to correctly interpret the marginal effect output, since it was given as the marginal effect of a variable on every point for Water Access, instead of the average marginal effect of a given variable on Water Access.

While policy based upon the Linear Probability Regression should be considered thoroughly the regression does show that a decrease in corruption will affect the percentage of the population with access to an improved water supply. It would be possible to change the percentage of access to an improved water supply by changing the level of corruption. As shown in previous sections the model does have explanatory ability for X on Y. Based upon this regression an eleven percent change in corruption would result in a one percent change in water access. Therefore a large improvement (decrease) in corruption would be needed for a significant amount of change in improved water supply access.

Future work on this subject should attempt to correct the problem with the marginal effect output and provide a better model fit. Future research should also gather more complete data. The final data set used was one third the size of the orginal data set. A larger and more complete data set will likely yield better results. Obtaining more complete data could be difficult however, since it is obtained from the World Bank and United Nations who rely on individual countries responding to surveys and releasing data.

Table 1
Parameter estimates for the Linear Probability Regression Variables

Variable	Parameter Estimate	Standard Error	Significance	Min	Max	Mean
CC - Control of Corruption	0.11745	0.01938	***	-1.39	2.51	-0.10
Lntw - log of Total Water	0.01607	0.01412		-0.40	2.95	1.57
Dep - Dependency ratio	0.00481	0.08090		0.00	0.97	0.36
ToT - Terms of Trade (2000 =100)	0.00095869	0.00137		29.51	130.70	100.35

Significance levels
99 percent = ***
95 percent = **
90 percent = *

F value = 9.82
R-squared = 0.4774

Table 2
Parameter estimates for the Probit Regression Model

Variable	Parameter Estimate	Standard Error	Significance	Min	Max	Mean
CC -Control of Corruption	-9.53	2.83	***	-1.72	2.51	-0.083
Lntw -Log of Total Water	0.58	0.15	***	-2.30	6.80	3.22
Dep - Dependency Ration	9.06	1.19	***	0.003	1	0.36
San -Percentage of population with access to sanitation	16.23	2	***	0.09	1	0.67
ToT -Terms of Trade (2000 =100)	0.099	0.03	***	29.51	136.744	99.55
TC -Term of Trade * Control of Corruption	0.14	0.03	***	-214.08	265.09	-0.467
Lngdp -Log of GDP per capita	1.76	0.44	***	4.48	10.8	7.59

Significance levels
99 percent = ***
95 percent = **
90 percent = *

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