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Inverse Relationship between Poverty and Willingness to Pay for Sustainable Environment

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ABSTRACT- Personal interest is prime interest; except in some exceptional cases, most people worldwide continuously pursue their own (and family) concerns first and letter for the rest of the world. This study attempts to determine the relationship between poverty and willingness to pay for a better and sustainable environment. Panel data techniques were used for the econometric analysis. The hypothesis was developed and tested for the whole panel data and then for different regions of the world with high/low-income and developed and developing countries. The study's results support the hypothesis "more the poverty, less the willingness to pay"; there is an inverse relationship between poverty and willingness to pay for sustainable development and an eco-friendly and sustainable environment. The dream of sustainable development cannot be fulfilled without alleviating poverty at a minimum possible level.

Keywords: "deforestation; poverty; sustainable development; willingness to pay."

I. INTRODUCTION

Sustainable development is a commonly used word in research and planning, hence generate many responses. Generally, the concept of sustainable development is an initiative to combine efforts for environmental issues with socio-economic matters. Economic growth, social equality and environmental protection are three main parts of sustainable growth; many researchers agree that these three ideas are the overall sustainability concept.

The most quoted definition was coined by (Bruntland, 1987) "Sustainable development is a development that meets the needs of the present without compromising future generations' ability to meet their own needs". According to this definition, sustainable development can further be divided into two concepts:

- The essential **needs** of the world, especially those that concern the poor, to which extra priority should be given,
- **Limitations** of the environment's ability to meet the present and future needs are imposed by technology and social structure in society.

With the first concept, it can be derived that sustainable development cannot be achieved without the fulfilment of these needs. Not only the needs but with a particular emphasis on the needs of the poor people living in the world who are not even able to think about the world and development no matter sustainable or unsustainable, their priority is to fight poverty.

Poverty is generally the scarcity of necessities or simply a lack of the necessary amount of material possessions or money to accomplish daily needs. It is a complex concept including social, political and economic origins. Poverty can be defined as absolute, which refers to the lack of necessary means to meet basic needs such as clothing, shelter, and food. In contrast, relative poverty refers to the individual's social and economic condition compared to society (Sabates, 2008) (UNESCO, 2019). In economics, income poverty means a family cannot meet the federally recognised standard, varying across the nations. Experts often seek to characterise families whose economic positions do not meet the minimum acceptable level.

The international standard of extreme poverty is set to the possession of less than 1$ a day (UNESCO, 2019). The World Bank set two different poverty headcount standards. It measures poverty based on individuals instead of family income poverty. It revised the standards in 2011, and the new levels are $1.9 a day and $3.10 a day.

Any society or country is a subsystem of a vast global system of the world and life. Every individual in this system plays its role to upgrade or degrade it. Individuals and societies consume the resources they already have or buy at a price they can afford to fulfil their needs. One of the essential resources the world and human beings have are the trees and trees' reserves, namely forests. Forests have a pivotal role in minimising natural disaster threat, i.e. droughts, floods, landslides, and other highly perilous events. At a universal level, forests diminish climate change by carbon sequestration, balancing oxygen, carbon dioxide and humidity in the air; they also shield watersheds, which provide 75% of freshwater globally. Forests are the most diverse ecosystem, cradle about 80% of animals, insects and plants, and provide jobs, security and shelter to the forest-dependent communities. Around 1.6 billion people - including more than 2,000 indigenous cultures - depend on forests for their livelihood. More than 13 million people worldwide are directly employed in the formal forest sector (WWF, 2016) (UN, 2016).

Although the importance of forests for the survival of life on earth, human activities are still making them disappear. Human activities are one of the biggest or can be said that the most significant cause of deforestation. Most of the land occupied by human has faced deforestation, and it is an ongoing process. From 1990 to 2015 world has lost around 129 million hectares of forests, and it is the forests lost and the degradation of the whole ecosystem, with terrible consequences (WWF, 2016).

Incontinent Africa, annual deforestation reached 650 thousand hectares. Increasing demand for agricultural land, grazing fields and infrastructure, growing need for energy products (charcoal and firewood) and construction inputs are the primary cause of this severe deforestation (Kowero, Campbell and Sumaila, 2003). America has lost forests at an average rate of 0.4% annually in the 1990s (Achard et al., 2002). The situation in continent Asia is not much different; for instance, Thailand lost 28% of its forests between 1976 and 1989 (Charles, 1994). Due to its wood-based products trade, Indonesia deforested 300 thousand hectares/year of its land in the 1970s. In comparison, this figure reached 600 in the 1980s, and it was not the end in the 1990s deforestation rose to one million hectares annually (Sunderlin and Resosudarmo, 1996).

It can be stated that the concept of sustainable development cannot be achieved without considering poverty and forests as the determinants of development. In this study, it was tried to find the relationship between these two determinants. This study also made a significant contribution to the literature on the determinants of deforestation. Deforestation has never been used before as an indicator of willingness to pay for a sustainable environment and growth.

Willingness to pay is the maximum price at/or below which a consumer will buy one unit of product, while in economics, some researchers theorise it as a range, not as a fixpoint (Varian, 1992). If sustainable development and environment are considered commodities and people as buyers, this research circled the buyer's behaviour to purchase a sustainable environment and development.

II. RESEARCH METHODOLOGY

Instrumental Variable technique with panel data estimation is used for the analysis in this study.

The Instrumental Variable (IV) technique established by Philip G. Wright and Sewall Wright and further developed by Olav Reiersøl allows for consistent estimation when the independent variables are correlated (Stock and Trebbi, 2003) (Reiersøl, 1941). This correlation occurs when changes in the dependent variable change the value of one or more covariates in the regression. Omitted variables also affect the independent and dependent variables, or in another case, the covariates are subject to measurement errors. These issues are referred to as the endogeneity problem. OLS produces inconsistent and biased estimates (Bullock, Green and Ha, 2010). Simply IV is a variable that does not belong to the explanatory equation but is correlated with the endogenous explanatory variables, conditional on other covariates' value.

However, there are some problems associated with Instrumental Variables. (Bound, Jaeger and Baker, 1995) stated that IV generally produces inconsistent estimates. If they are correlated with a weak instrument's error term and problem, it is also another serious issue. Results with weak instruments will be poor and predicted values would have minimal variation (Bound, Jaeger and Baker, 1995).

IV strength can be assessed directly as the instruments and endogenous covariates both are observable. A standard rule checks whether the omitted instruments are irrelevant in the first stage regression (Stock, Wright and Yogo, 2002). The relationship of instruments with the regression error term cannot be measured in precisely identified models. If there is an overidentified model, then overidentification can be used to test the correlation. Moreover, the assumption is that the residual should not be correlated with the exogenous variable if the instruments are exogenous (Hayashi, 2000).

2.1 Empirical Model and Data Description

The selection of the sample countries for the empirical analyses are based on the previous studies of (Palo, 1999) and (Scrieciu, 2007) that were conducted to assess the reasons for deforestation. They include 68 and 50 countries, respectively, in their research. Initially, twenty countries are selected based on the high population from each continent. North America was not included in the analysis as three big countries are highly populated, e.g., Canada, Mexico, the US, and the rest of the countries are so small regarding the population. The same is the case with the continent of Australia. Nigeria is excluded from Africa, while China, India, Pakistan, and Indonesia were also excluded from Asia's countries. Russia from Europe and Brazil from South America were excluded for the same reasons. These countries from their respective continents were eliminated to avoid the outlier following (Palo, 1999) and (Scrieciu, 2007). North Korea was eliminated for obvious reasons.
In contrast, Iraq, Syria, Afghanistan, Yemen from Asia, and many highly populated countries from Africa were also eliminated from the sample as they are war-affected states. Their respective data was not available for at least one modelled variable throughout the whole period analysed. Therefore, the final dataset includes 70 countries.

The 70 countries from the four continents (Africa=16, South America=18, Asia=16 and Europe=20) were repeatedly observed over 13 years from 2001 to 2013. The dataset employed in the regression analysis fetched from the World Bank, World Development Indicators online database 2016. The GDP per capita is constant at 2011 US dollars. The poverty measure is the headcount index of the international poverty line at US$3.1 per day. However, there were some missing values in the dataset to avoid an unbalanced panel dataset that may complicate the estimation. The missing values were extrapolated by fitting a trend for each country to the existing values. This results in 871 observations and 75 parameters (70 countries plus five modelled independent variables), rendering 796 degrees of freedom. Table 1 presents the descriptive statistics of variables.

2.2 Econometric Model

$$lnForest_{it} = \beta_0 + \beta_1 lnPoverty_{it} + \beta_2 lnPopulation_{it} + \beta_3 lnAgriLand_{it} + \beta_4 DumYear_2 \dots\dots\dots \beta_{16} DumYear_{13} + \eta_i + \lambda_t + \mu_{it} \quad (1)$$

In the above models, 'i' and 't' denote country and time, respectively; β_0 is a constant; (β_1 – β_{16}) are the coefficients of the respective variable to be estimated; η_i and λ_t stand for the place and time-specific effects, respectively; and μ_{it} refers to a random disturbance term. The variables in the model are as follows:

Explained variable *lnForest* is the natural logarithm of the forest-covered area of the country in square kilometres. This is used as the proxy for the willingness to pay. It is hypothesised that it has an inverse relationship with poverty; the forest area will be reduced with increased poverty headcount.

Explanatory Variables:
lnPoverty is the natural logarithm of the population living below the international poverty line in a particular country at that specific year.

lnPopulation is the natural logarithm of the overall population of the particular country at that specific year. It is used as the control variable. Many researchers argued that the increasing population is one of the primary causes of deforestation globally (Rosero-Bixby, 1998) (Ehrhardt-Martinez, 1998).

lnAgriLand is the natural logarithm of agriculture use, including cultivation and grazing land of the country at that specific year. Many previous studies concluded that increasing land use for agriculture purposes cause the decrease of forest area (Carr, 2009) (Mukherjee and Benson, 2003). It is also used as the control variable.

Table 1: Variable Descriptive Statistics

Variable Category	Variable	Description	Obs.	Mean	Std. Dev.	Min.	Max.
Dependent Variable	*lnForest*	Area of Country Covered with Forests	871	4.777	0.646	2.994	6.196
Independent Variable	*lnPoverty*	Poverty headcount	871	6.364	1.109	1.135	8.071
Control Variables	*lnAgriLand*	Land for Agriculture use	871	5.016	0.566	3.582	6.337
	lnPopulation	Population of Country	871	7.302	0.415	6.416	8.196
Instrumental Variables	*lnAgriLabor*	Labor engaged with agriculture activity	871	6.035	0.919	0.723	7.539
	lnUnemployment	Unemployment in the country	871	5.748	0.487	3.887	6.790
	lnRurPopulation	Rural population	871	6.863	0.533	5.233	8.024

Instrumental Variables:
lnAgriLabor is the natural logarithm of the labour force engaged with agriculture and associated sector of the country at that specific year. It is used as the instrumental variable to handle the measurement error and omitted variable bias in the regression model. (Geda et al., 2001) state that labour engagement in agricultural activities is one of the leading causes of relative poverty in a society.

lnUnemployment is the natural logarithm of the unemployed labour force of a particular country at that specific year. It is used as the instrumental variable to handle the measurement error and omitted variable bias in the regression model. The rate of unemployment in a country is one of the critical determinants of poverty. It is a problem in the developing world and affects the West's most advanced democracies (Moller et al., 2003).

lnRurPopulation is the natural logarithm of the population living in rural areas in a particular country at that specific year. It is used as the instrumental variable to handle the measurement error and omitted variable bias in the regression model—the ratio of the urban and rural population affects relative poverty (Coulombe and Mckay, 1996).

III. RESULTS AND DISCUSSION

Stata12 statistical software package was used to perform the regressions and perform the model estimation using static and instrumental variable regression. There is a massive difference between the development levels of continents. To avoid estimation bias, regressions were conducted separately for all four continents. Static panel and instrumental variable regression were conducted. Table 2 lists the regression results for the effects of economies of poverty (*lnpoverty*) and other control variables, agriculture, land, and population (*lnAgriLand* and *lnPopulation*) on deforestation. The joint significance test (F test) with the model indicates that the model is generally adequate. When the statistic panel and instrumental variable estimations are conducted, we use the p-value accompanied in the Hausman test to determine whether to choose a fixed or random-effect model. The test statistic of a weak instrumental variable is the minimum eigenvalue statistic; if the p-value of the Hausman (FE vs RE) test for all regressions is more significant than 0.1, the stochastic effect results are analysed. If not, the result of the fixed effect is analysed and used for the discussion and conclusion. Severe endogeneity may result in the deviation or inconsistency of OLS estimation results; that is why the instrumental variable method (IV) for the estimation is used while *lnAgriLabor, lnUnemployment* and *lnRurPopulation* were used as an instrumental variable and *lnPoverty* was instrumented. Instrumental Variable technique is also used for robustness check; regression results are presented in Table 2 and Table 3 for fixed effect and random effect. The results showed that overall model fitness is good (Prob. F-stat 0.00).

Table 2. Regression results showing that poverty affects the forest differently in different parts of the world (2001–

13)

	1-World	2-World	3-Africa	4-America	5-Asia	6-Europe	7-Non-OECD	8-OECD
	FE	**FE-IV**	**FE-IV**	**FE-IV**	**FE-IV**	**FE-IV**	**FE-IV**	**FE-IV**
lnPoverty	-0.00584***	0.0113	-0.605*	-0.164***	0.0274	0.0107***	-0.129**	0.01635
	(-0.00221)	(-0.012)	(-0.32)	(-0.0423)	(-0.0282)	(-0.0036)	(-0.0549)	(-0.00951)
lnAgriLand	-0.289***	-0.266***	-0.690**	-0.500***	-0.0608	-0.0987*	-0.0678	-0.1560***
	(-0.0299)	(-0.0305)	(-0.272)	(-0.123)	(-0.0548)	(-0.0527)	(-0.106)	(0.06024)
lnPopulation	-0.154***	-0.218***	1.456	-0.193	-0.0713	-0.123**	0.402	0.50220***
	(-0.0238)	(-0.0407)	(-1.084)	(-0.223)	(-0.0686)	(-0.062)	(-0.253)	(0.09788)
lnAgriLabor	-0.0137*							
	(-0.00731)							
lnUnemployment	0.00021							
	(-0.0058)							
lnRurPopulation	-0.1348***							
	(-0.0244)							
Constant	7.463***	7.623***	2.411	9.571***	5.303***	5.990***	3.084	1.6524
	(-0.22)	(-0.284)	(-5.047)	(-1.412)	(-0.538)	(-0.417)	(-1.913)	(0.911)
η_i	No	No	No	No	No	No	No	No
λ_t	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Sqr	0.4397	0.4221	0.0009	0.661	0.1019	0.5009	0.0001	0.5994
N	871	804	192	216	192	204	612	192

Note: *, **, and *** indicate that estimates are at the 10%, 5% and 1% significance levels, respectively; bracketed value is the standard error of the corresponding test statistics. The estimations reported in this table include year dummies.

The analysis presented in this study proposed that it would not be fair to present a generalised macroeconomic explanation of deforestation because results vary from region to region. The results for the global data are not statistically significant and valuable. However, the regional data results and group of countries based on development showed efficient and significant estimates.

In both regressions (Table 2 regression one and Table 3 regression 1), random and fixed effect poverty is significant at 1%, with a negative sign which was expected. This supports the hypothesis of this study that poverty has an inverse relationship with forestation[1]. However, the regressions with the instrumental variables (Table 2 regression two and Table 3 regression 2) show a direct relationship with forestation, but the results are not statistically significant at any level. Increment in agricultural land use, rural population, and labour engagement in agricultural activities have a negative and significant effect on forestation, both with random and fixed-effect models. While unemployment shows a positive but statistically insignificant effect, which is irrelevant in the regression, it shows promising results as instrumental variables.

Regression results of the impact on poverty on the forestation in Africa (Table 2 regression three and Table 3 regression 3) show a negative coefficient of poverty with 5% and 10% significance in fixed and random effect models. Besides, the agricultural land also negatively affects the forestation in Africa, and these results are significant at 5% in both fixed and random effect estimation. At the same time, the population shows positive but statistically insignificant results.

Regression results for poverty's impact on the forestation in America (Table 2 regression four and Table 3 regression 4) show a negative coefficient of poverty with 1% significance in fixed and random effect models. Also, the agricultural land has impacted forest cover in America at a 1% significant level with fixed effect estimation, but agricultural land is not significant with the random effect model. In comparison, the population shows negative but statistically insignificant results.

Regression results for poverty's impact on the forestation in Asia (Table 2 regression five and Table 3

[1] Forestation referred to the Area Covered with the Forests

regression 5) show positive but statistically insignificant with fixed and random effect models estimation. Addition in the agriculture land has a negative but statistically insignificant with both fixed and random effect on the forestation in Asia. At the same time, the population shows negative but statistically insignificant results.

Regression results for poverty's impact on the forestation in Europe (Table 2 regression six and Table 3 regression 6) show positive at 1% significance with both fixed and random effect models estimation. The agricultural land has a negative and significant effect on forestation with fixed effect estimation. While negative and insignificant results with the random effect model on the forestation in Europe. The population negatively affects forestation with fixed effect estimation, while damaging and insignificant results with the random effect model on the forestation in Europe.

Table 3. Regression results showing that poverty affects the forest differently in different parts of the world (2001-13)

	1-World	**2-World**	**3-Africa**	**4-America**	**5-Asia**	**6-Europe**	**7-Non-OECD**	**8-OECD**
	RE	**RE-IV**	**RE-IV**	**RE-IV**	**RE-IV**	**RE-IV**	**RE-IV**	**RE-IV**
lnPoverty	-0.00622***	0.0171	-0.662**	-0.118***	0.0361	0.0102***	-0.135**	0.0173
	(-0.00233)	(-0.013)	(-0.307)	(-0.0431)	(-0.0317)	(-0.0037)	(-0.0577)	(0.0097)
lnAgriLand	-0.211***	-0.191***	-0.556**	-0.106	-0.0127	-0.0535	0.104	-0.131**
	(-0.0304)	(-0.0316)	(-0.253)	(-0.113)	(-0.0585)	(-0.0535)	(-0.0826)	(0.0587)
lnPopulation	-0.132***	-0.205***	1.596	0.1	-0.0536	-0.0992	0.490**	0.516***
	(-0.0249)	(-0.0434)	(-0.977)	(-0.211)	(-0.077)	(-0.0635)	(-0.246)	(0.0962)
lnAgriLabor	-0.0146*							
	(-0.00768)							
lnUnemployment	0.00364							
	(-0.00617)							
lnRurPopulation	-0.1405***							
	(0.0258)							
Constant	6.906***	7.118***	1.068	5.322***	4.876***	5.595***	1.62	1.4263
	(-0.233)	(-0.304)	(-4.491)	(-1.243)	(-0.599)	(-0.43)	(-1.696)	(0.8935)
η_i	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
λ_t	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-Sqr	0.3625	0.4068	0.0086	0.515	0.0639	0.2925	0.1759	0.1982
Observations	871	804	192	216	192	204	612	192

Note: *, **, and *** indicate that estimates are at the 10%, 5% and 1% significance levels, respectively; bracketed value is the standard error of the corresponding test statistics. The estimations reported in this table include year dummies.

Results were also estimated differently for the highly developed, OECD-member countries and non-member countries to understand the relationship between forestation and poor economic outlook. The regressions (Table 2 regression 7 & 8 and Table 3 regression 7 & 8) in the OECD countries prove that poverty has no significant effect on the forestation with random and fixed effect model estimations. In contrast, poverty has a negative and significant effect on forestation in less developed countries. These results are consistent with both random and fixed-effect models. An increase in land use for Agricultural activities has a varying effect on forestation. In the case of OECD countries, it has a negative and significant impact on forestation with both fixed and random effect estimation. However, in non-OECD countries, it has positive results with random effect and negative with fixed effect model estimation, but the results are insignificant in both estimations. Interestingly, the population has a positive and significant effect on forestation. Results with both fixed and random effect estimation show that increasing population may increase the forest-covered areas.

IV. CONCLUSION

Based on panel data of 70 countries from 2001 to 2013, this study analysed the current determinants of deforestation. It examined how changes in major economic indicators may affect deforestation in any country and region.

Population growth and deforestation in this study showed an inverse relationship for the whole sample. The same survey sample showed a significantly positive relationship with forestation in the highly developed democracies around the world. It may be because of their awareness of the importance of forests and technological advancement. It can also be the result of their dependence on more sophisticated technologies and economic structures. These results are consistent with the study of (Rupasingha and Goetz, 2007), who stated that the population growth rate is one of the leading causes of deforestation worldwide. However, these results contrast with (Angelsen and Kaimowitz, 1999), who concluded their study by saying that the population and deforestation thesis is based on weak modelling and lack accurate data

The increase of land area being used for agriculture activities negatively affects the forest-covered area. This effect is the same worldwide, even in the most developed countries with high scientific technologies. These results are consistent with the previous studies (Ehrhardt-Martinez, 1998) and (Mukherjee and Benson, 2003). They argued that without adopting more advanced and efficient scientific and productive technologies and serious research for more yield with fewer inputs, including land, the impact on forest cover keeps increasing by leading to more deforestation.

Results of the estimation show that poverty cannot be ignored in terms of a sustainable environment. However, these results are not consistent with the detailed study of (Ehrhardt-Martinez, 1998), but they rejected this hypothesis based on weak modelling and lack of appropriate data. However, after this study, many other researchers used more filtered data and more sophisticated modelling techniques. They found a positive relationship between the determinants of poverty and deforestation.

This study analysed deforestation from the impoverished population's perspective, constituting nearly 35% of the world population (World Bank, 2012). The poor decide to deforest land based on the parameters of choice and alternates they have, such as the prices and accessibility to the fuel and irrigation facilities to the un-forested land available for agricultural activities. This section of the populace's behaviour is based on the fulfilment of basic needs; deforestation will continue if they have unfavourable living conditions with their current income level. Implementing any policy favouring forestation could only make a difference if it also considers poverty as a cause of deforestation and alleviates poverty. If people do not have the basic needs fulfilled, they have no other way to fulfil them but deforestation.

This study supports the hypothesis that poor people have less or almost no willingness to pay for a better and sustainable environment. They are already suffering from a lack of availability of necessary commodities. They will fulfil their basic needs no matter at what cost they are getting them. These results also lead to a broad spectrum of policy implications. Due to different conditions, priorities may vary in countries; countries with high economic development formulate their future policies with environmental protection at priority. A country suffering from poverty and low per-capita income will not consider environmental protection a priority policy goal. Most notably, deforestation can be taken as an endogenous economic course, compelled logical daily life decisions made by the people living in the country or region. Therefore, government environmental and development policies should be based on fulfilling the people's needs and controlling the elements that directly and indirectly affect deforestation. These elements include education, unemployment, and the population's ratio engaged with agricultural activities to increase awareness and willingness to pay for a better future.

The Idea of sustainable development cannot be materialised until the alleviation of poverty from the world. Mahatma Gandhi once beautifully said, "There are people in the world so poor and hungry that God cannot appear to them except in the form of bread."

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