Global Comparative Analysis of the Relationship among Power, Environmental Performance and Public Health

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Abstract

This study expands upon the work of Dr. James K. Boyce and examines the recursive relationship among Power (self-autonomy), Environmental Performance, and Public Health at the Global Scale. This study analyzed data from 189 countries. The results shows a statistically significant relationship between Power and Environmental Performance. Additionally, it illustrates the relationship between Environmental Performance and Public Health, bolstering the hypothesis that trends among the three are visible at the country level. Furthermore, this research adds to the larger body of research suggesting that Power, rather than income alone, affects both Environmental Performance and Public Health.

1. Introduction:

This study estimates the relationship between Power (self-autonomy) and Environmental Performance, as well as the relationship between Environmental Performance and Public Health at the country-level. The current understanding states there is an intrinsic relationship among the three. Specifically, this study expands upon the work of Dr. James K. Boyce, looking at the relationship between the three at the state level in the U.S.A.[1] The relationships among Power distribution, Environmental Degradation, and Public Health were examined through a cross-sectional analysis of the 50 U.S States. In Dr. Boyce's study, Power was defined as voter participation, tax fairness, Medicaid access, and educational attainment. A recursive model was used linking the distribution of Power to Environmental Stress and Public Health, supporting the hypothesis that increased Power inequality leads to weaker environmental policies, which in turn causes increased Environmental Degradation and adverse Public Health outcomes. While Boyce's research addresses all 50 states in the U.S, there is little research which looks at these general relationships at the global scale. To that end, this paper examines these relationships using country-level data.

The implications of a reduction of Power suggest that inequality drives Environmental Degradation. There are two groups of people in circumstances of Environmental Degradation: those who pollute for profit and those who receive the consequences of the pollution. They can be defined as "winners" and "losers".[7] The winners reap financial gain at the expense of the welfare and wellbeing of the losers. Many times, these winners are more educated, are voters,[8] and are not facing political terror. Winners are constrained by reactions of the losers in the form of informal sanctions and government intervention. However, the transaction costs of these constraints often prevent the attainment of equality for the losers. It is not costless for losers to bargain with winners or lobby for the government, and the reduced relative Power of the losers diminishes the ability of the loser to bear the costs overall. The ability of the powerful to limit Environmental Degradation on those with little Power cannot be expected to offset the failure of the less powerful to limit Environmental Degradation by the powerful. As such, the greater the inequality of Power, the greater the extent of social cost of Environmental Degradation.[18] The variance between the winners and the losers shows the absence of Power (self-autonomy) between all citizens, as such it demonstrates the variance of respective Power within that

country. As winners obtain more of the economic benefits compared to other citizens (losers), it reduces Power of citizens within that country overall.

The underlying hypothesis of this study is that there is both a causal relationship between Power (a metric of influence one has on one's own society) and increased Environmental Performance (the higher the performance, the better the environmental outcomes), as well as a causal relationship between Environmental Performance and Public Health. In order to identify a causal relationship, one must assume all relevant observables are included. Looking at Power rather than Income sets the precedent that Power is a casual factor. This assumption is built upon previous work, where Dr. Boyce and Dr. Torras assessed the relationship between per capita income and environmental quality. They find that the relationship depends on scale composition, and that the response between Environmental Quality and income varies, worsening within some income ranges and improving in others.[17] As income doesn't seem to be the primary driver, and to differentiate the variance in wealth of citizens from Gross National Income (addressing the variance in income as Power rather than income overall), income is controlled for.

Because Power and Public Health are inherently difficult to measure, proxies were utilized for both. Power is measured in five different interpretations: State-Sanctioned Violence (PTS Scale), equality (wealth dispersion within a country as measured by the GINI Coefficient), corruption (as measured by transparency international's corruption perception index) years of schooling (of adults within a country as of 2016) and a Power Index combining the four variables. This assumes that these are good proxies of Power. Life expectancy data and infant mortality data (from the Human Development Index) are used to conceptualize overall Public Health. This assumes that these are encompassing general indicators of Public Health. These metrics are used absent of a Public Health Index to maximize the spread of countries overall, with the understanding that this may be at the cost of more nuanced or detailed data. The global nature of the work is first and foremost the priority when addressing country-level patterns. The intention then is to expand upon the initial hypothesis set by Dr. James K Boyce,[1] demonstrating the relationship between Power, Environmental Performance, and Public Health, and to explore the possibility of this relationship at a global scale.

2. Methodology:

Utilizing a multivariable ordinary-least-squares regression, this study is divided into two sections: assessing the effects of Power on Environmental Performance and assessing the Environmental Performance on Public Health. The foundational hypothesis of this study is that Power affects Environmental Performance, and that Environmental Performance affects Public Health. In the first equation (1), the dependent variable Environmental Performance is measured by the Environmental Performance index (measuring both ecosystem vitality and environmental health metrics). In the second equation (2), the dependent variable is Public Health understood in the context of infant mortality and life expectancy. Assuming that the antithesis of Environmental Degradation is Environmental Performance, the reduction of Power results in greater levels of pollution.[7] The first set of equations, estimate the relationship between Power and Environmental Performance:

$$\text{Environmental Performance} = Bo + B2\ (\textbf{Power}) + B3\ (\text{Gross-National-Income}) + U \qquad (1)$$

The dependent variable is Environmental Performance (1-100, where 100 is high-performance). A composite index by Yale gives countries a score based on environmental health and ecosystem vitality. The independent variable is Power. Power is a measure of self-autonomy, and because Power is inherently difficult to measure, this study utilizes multiple interpretations of Power:

2.1 Political Terror:

$$\text{Environmental Performance} = Bo + B2\ (\textit{Political Terror}) + B3\ (\text{Gross-National-Income}) + U$$

Power can also be distributed among racial or ethnic lines. There is a pattern of disproportionate exposures to toxins and associated health risks among communities of color. There are disparities in outdoor air pollution exposure combined with long-term annual average outdoor concentrations of toxins.[9] While racial inequality is hard to quantify at the global-scale, it can be looked at through the lens of groups who are being persecuted through their governments. Understanding that state sanctioned violence is against minority groups, the Political Terror Scale is a proxy for Power.

2.2 *Years Of Schooling:*

Environmental Performance = Bo + B2 (*Years of Schooling*) + B3 (Gross-National-Income) + U

Information Literacy is a form of Power, understanding that "preferences" about Environmental Degradation can be manipulated and created by information and misinformation campaigns by interest groups.[10] There is an indication of fairness among education. By having a population with high average years of schooling, it indicates a collective commitment to well-educated citizenry throughout a country overall.

2.3 Equality:

Environmental Performance = Bo + B2 (*Equality*) + B3 (Gross-National-Income) + U

When wealth translates into political Power, the incentives of those with Power to work within their interests exceed the Power of the collective, reducing the likelihood of Environmental Performance. Therefore equality is a metric used for Power.

2.4 Transparency:

Environmental Performance = Bo + B2 (*Transparency*) + B3 (Gross-National-Income) + U

Transparency International Index ranks countries by their perceived levels of public-sector corruption. Transparency ensures accountability and can be seen through the lens of an absence of corruption. Allowing citizens to influence their policy, therefore transparency is used as a metric for Power.

2.5 Power*

Environmental Performance= Bo + B2 (Power) + B3 (Gross-National-Income) + U

Power* is an indexed measurement of the combination of the other four proxies of Power. It takes the Political Terror Scale 1-5, (1 being least terror, 5 being most terror) and is an inverse of the scale, where 1 is most terror and 5 is the least. Then it is multiplied by 20, to get a number closer to 100. The utilization of categorical data multiplied and compared to continuous data leaves room for error, however, as absence of terror is a critical component of Power, and the political terror scale covers many countries, it is the best utilization found thus far. The average maximum Years of Schooling in a country is 14.1 years. Years of Schooling were multiplied by 7 to get closer to the 1-100 variable. Both Transparency and Equality are measured out of 100 and thus did not need modification. There are assumptions made to calculate this Power Index. Understanding that Political Terror is categorical, it underestimates the Power in some countries, namely any country under an inverted "5." As Years of Schooling is multiplied by 7, it is understood that it underestimates the impact of schooling compared to the other three categories overall. It is important to use this Power Index as an estimation and a continuation of the four interpretations of Power, rather than an absolute understanding of Power overall. It should be taken as what it is: a rough estimation combining the four interpretations of Power laid out above.

Poverty and Inequality can be understood from the perspective of "capability deprivation" with Environmental Degradation. The quality of one's air, soil, and water affect their degrees of freedom.[11] The quality of our Environment affects our health substantially. The World Health Organization estimates that 13 million deaths are attributable to preventable environmental causes each year, and disproportionately affect the developing world. Additionally, 24% of the burden of global diseases and 23% of all premature deaths are attributable to environmental factors.[12] Bernauer and Koubi found that democratic freedoms were associated with reduced concentrations of ambient SO_2.[13,16] Scruggs found that income inequality was positively associated with less particulate matter. However, his study was limited to 17 industrialized democracies,[14] and there is substantial evidence against this claim. The bulk of relevant literature suggests that at the country level, most studies support the hypothesis that income inequality is a determinant of Public Health. After a peer review of 45 country-level papers, 83% had conclusions which were wholly supportive of this

hypothesis, along with 70% of the papers analyzed at the state/regional level,[15] Public Health is more easily quantifiable than Power, and as such, two general indicators of Public Health were utilized as Proxies.[16] The second set of equations estimate the relationship between Environmental Performance and Public Health:

3. Public Health = Bo + B2 (Environmental Performance) +B3 (GNI, per capita) + U   (2)

Public Health is dependent on Environmental Performance. Notice that although in the previous equation Power had a causal relationship with Environmental Performance, Environmental Performance is now the independent variable as it pertains to Public Health. This is in line with Dr. James K Boyce's recursive model. This study utilizes multiple interpretations of Public Health: Infant Mortality and Life Expectancy. The assumption is that both interpretations are common and adequate conceptualizations of Public Health overall.

3.1 Infant Mortality

Infant Mortality = Bo + B2 (Environmental Performance) +B3 (GNI, per capita) + U

3.2 Life Expectancy

Life Expectancy = Bo + B2 (Environmental Performance) +B3 (GNI, per capita) + U

3. Data:

The cross-sectional data comes from multiple sources and is all country-level data. Environmental Performance Data (2016) is from Yale University's Environmental Performance Index.[3] Transparency Data is from Transparency International (2016).[4] State Sanctioned Violence Data (2016) is from UNC Asheville's Political Terror Scale utilizing State Department data.[5] All other variables (Years of Schooling, Life Expectancy, Infant Mortality, Equality, Gross National Income) are from the UN's Human Development Index (2016).[6]. Data is chosen not only from the reliability of the source but also how many countries this data covers. Since data reported by country varies, it is important to find datasets that incorporate both the developed and developing world to look at larger global trends. Sample sizes were at least 175 countries, and when the regressions were run, the results encompassed at a minimum 164 countries. While there is some missing data, it is small, and there is a fairly good spread of countries. However, developed countries and larger countries may have more data, which may skew the results.

Table 1. Descriptive Statistics of All Data

[Countries 189]	Sample Size	Description	Mean	Standard Deviation
Environmental Performance Index [EPI]	175	Index: 1-100, 100 being high performance	56.45	12.89
Transparency	173	Index: 1-100, 100 being least corrupt	42.83	19.2
Life Expectancy	189	Measured in Years	71.89	7.69
Infant Mortality	189	Deaths per 1,000	22.46	20.07
Equality (GINI)	186	Index: 1-100, 100 being most equal	70.63	15.32
GNI (Gross National Income)	187	International Dollar amount (U.S $ equivalent)	17,721.34	19,369.47
Political Terror Scale	194	Political Terror 1-5 (where 1 is low terror, and 5 is high-terror),	2.39	1.196

The equality index was proportionally multiplied by 100 for the sake of clarity when looking at regression results, the political terror scale ranges from 1-5, (1 being low terror, 5 being high-terror), the Political Terror Scale is categorical, all other variables are continuous. Around the world, life expectancy is relatively high at 71.89 years. On average, GNI per capita is 17,721 dollars, at the U.S. $ equivalent. Globally there is substantial variation in all these categories.

4. Results and Discussion

The more Power (either equality or transparency) a country has, the higher the Environmental Performance, controlling for income. Additionally, the higher the Environmental Performance, the higher the life expectancy, controlling for income. Specifically, Power is associated with increased Environmental Performance, and Environmental Performance is associated with better Public Health outcomes.

4.1 The effect of Power on Environmental Performance

Independent Variable (Power):	Coefficient (standard error)	Predicted Sign
Political Terror	-2.6938*** (0.6759)	-
Years of Schooling	2.2680*** (0.2425)	+
Equality	0.2498*** (0.0484)	+
Transparency	0.2973*** (0.0501)	+
Power Index	0.4877*** (0.0522)	+

Note: ***= $p<0.001$ Table illustrates different representations of Power. Each row represents one regression. One unit increase in Political Terror (which is substantial considering the 1-5 scale) will yield a 2.693 unit decrease in Environmental Performance, controlling for income (GNI), $R^2 = 0.4983$. One unit increase in Years of Schooling (where 14 is the largest number of years of schooling), will yield a 2.268 unit increase in Environmental Performance (EPI), controlling for income, $R^2 = 0.6396$ (GNI). One unit increase in Equality will yield a .250 unit increase in Environmental Performance (EPI), controlling for income (GNI) $R^2 = 0.5263$. One unit increase in Transparency will yield a .297 unit increase in Environmental Performance (EPI), controlling for income, $R^2 = 0.5595$. One unit increase in Power Index where power (where Powers Maximum is 93.52), will yield a .488-unit increase (out of 100) in the Environmental Performance Index, controlling for income, $R^2 = 0.6511$.

The higher the Political Terror a country has, the lower the Environmental Performance overall. The more years of schooling one has, the higher the Environmental Performance. The higher the Equality and Transparency within a country, the higher the Environmental Performance. Overall, the Power* Index seems to have both a statistically and practically significant relationship with Environmental Performance. Again, the Power Index is both a rough estimation of Power and a continuation of the four interpretations rather than an absolute understanding of Power overall. It does, however, reaffirm the trends indicated and shows that both the conglomerate Index of Power as well as different interpretations of Power are correlated with Environmental Performance, and Environmental Performance with Public Health. When looking at Transparency and Equality, a 1 unit increase out 100 in Equality or Transparency, yielded .25 and .297 units respectively, which is substantial. This is demonstrated again when a 1 year of schooling yielded a 2.2 unit increase out of 100, in Environmental Performance controlling for income. This indicates that controlling for income, there is still a relationship between Power and Environmental Performance, and that it is practically significant as well. Moreover, it shows there is an increased effect when the proxies are averaged, then the proxies independently.

This adds to the larger body of research which supports the hypothesis that greater Power inequality leads to greater Environmental Degradation, understanding that as Environmental Degradation increases, Environmental Performance decreases. It adds to the larger body of research which indicates that regardless of income, Power dynamics within countries contribute to environmental degradation. By understanding the role of Power on the environment, it reframes the incentives of increasing Power not only in the context of extended human rights and self-autonomy, but also as an Environmental issue as well.

4.2 The effect of Environmental Performance on Public Health

Independent Variable:	Coefficient (Standard Error)	Predicted Sign
Life Expectancy	0.3421*** (0.0471)	+
Infant Mortality	-0.8610*** (0.1191)	-

Note: ***= p<0.001 Table illustrates different representations of Power. Each row represents one regression. One unit increase in Environmental Performance is associated with a life expectancy increase of .342 years, controlling for income, R^2.= 0.4327 One unit increase in Environmental Performance is associated with an infant mortality reduction of .860 per thousand babies controlling for income (GNI), R^2 =0.4577.

Overall, Environmental Performance seems to have both a statistically and practically significant relationship with Public Health, understanding that as Environmental Performance Increases, so does Public Health. This is demonstrated when a one unit increase in Environmental Performance is correlated with a reduction of infant mortality at .83 per thousand, or 83 per 10,000 per births. The practical significance is also demonstrated when a one unit increase of Environmental Performance is correlated with an increase of Life Expectancy by approximately three months. This provides more evidence towards the hypothesis that Environmental Performance has a relationship with Public Health, controlling for income.

This contributes to the larger body of research that says an increase in Environmental Performance leads to an increase in Public Health metrics overall, reaffirming the explicit link between the two. The impact of Environmental Performance on Public Health can be assessed in both the duration of life and the likelihood of a child surviving infancy. By understanding that Environmental Performance affects the very quality of life, and that Power is a causal mechanism of Environmental Performance, it is possible to see how Power dissonance is not merely a benefit to society but affects the very life expectancy and survival rate of people overall. By assessing that there is firstly a relationship between Power and Environmental Performance, and secondly a relationship between Environmental Performance and Public Health, it is possible to infer that there is an intrinsic link between the three. This is particularly relevant to countries with dissonance between income and Power, like the U.S.A.

The implications of a lack of self-autonomy contribute to a reduction of life-span and reduces the odds of growing past the initial stages of infancy. By re-affirming the initial hypothesis that looked at these links at a state level and expanding this research globally, it helps us contextualize the results of Power imbalance as a collective experience, regardless of income.

5. Next Steps:

Moving forward, if this hypothesis continues to hold true, there is space to expand on this work broadly, creating variables to look at specific indicators, like water contaminations and air-pollutants respectively. Broadly, as researchers address inequality in policy terms, there can be added benefits in realizing its implications to physical, and social environments. This explicitly demonstrates the relationship between Power and Inequality issues, specifically in the context of Public Health. In order to create meaningful policy, clear and complete indicators of Power, Environmental Degradation and Public Health should be accurate and accessible for even the most remote countries. Further research should explore looking at trends between different paces of growing economies and different stages in development. As more complete data is analyzed, the extent of these patterns can be fully realized, and using different datasets would be valuable to reaffirm this relationship.

6. Acknowledgments:

7. References:

1. Boyce, James, Andrew R. Klemer, Paul H. Templet, Cleve E. Willis. "Power distribution, the environment and public health: A state-level analysis*", Ecological Economics, Volume 29, Issue 1,* (Massachusetts: Edward Elgar, 1999), pages 127-140

2. Boyce, James: Inequality and the Environment (speech, Medford MA, March 28, 2017), Political Economy Research Institute University of Massachusetts Amherst, https://www.peri.umass.edu/images/BoyceInequality_and_the_Environment_-_Leontief_lecture.pdf.

3. Hsu, A., Esty, D. C., de Sherbinin, A., Levy, M. A., et al. (2016). Environmental Performance Index: Global Metrics for the Environment. New Haven, CT: Yale Center for Environmental Law & Policy, https://epi2016.yale.edu/.

4. Transparency International (2016) Corruption Perceptions Index, https://www.transparency.org/research/cpi/cpi_early.

5. Gibney, Cornett, Wood, Haschke (2018).The Political Terror Scale 1976-2017. Date Retrieved, from the Political Terror Scale, http://www.political terrorscale.org.

6. United Nations Development Programme. (2016). *Human development Data 2016 http://hdr.undp.org/en/data*

7. Boyce, James, "Inequality as a cause of environmental degradation", *Ecological Economics, Volume 11, Issue 3,* (1994), pages 169-178.

8. Dassonneville, Ruth, and Marc Hooghe. "Voter Turnout Decline and Stratification: Quasi-Experimental and Comparative Evidence of a Growing Educational Gap." *Politics* 37, no. 2 (May 2017): 184–200.

9. Morello-Frosch, R., Pastor, M., Porras, C., and Sadd, J. Environmental justice and regional inequality in southern California: implications for future research. *Environmental health perspectives*, *110 Suppl2,* (2002), 149-54.

10. Becker, G.S. "A theory of competition among pressure groups for political influence" *Quarterly Journal of Economics, 48(3)*, (1983), pages 371-400.

11. Sen A." Development as Freedom". New York: Alfred Knopf; (1999), pages 1-10.

12. Remoundou, K., and Koundouri, P. Environmental effects on public health: an economic perspective. *International journal of environmental research and public health*, (2009) *6*(8) 2160 78, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2738880/.

13. Bernauer T, Koubi V. (2009) "Effects of Political Institutions on Air Quality" *Ecological Economics Volume 68,* (2009), pages 1335-1165

14.Scruggs LA. "Political and economic inequality and the environment" *Ecological Economics Volume 26* (1998), pages 259-275

15. Wilkinson. R., Pickett, .K "Income inequality and population health: A review and explanation of the evidence, Social Science and Medicine" Volume 62, Issue 7, (2006), pages 1768-1784,

16. Cushing, L., Morello-Frosch, R., Wander, M., et al "The haves, the have-Nots, and the Health of Everyone: The Relationship Between Social Inequality and Environmental Quality" (2015) *Annual Review of Public Health*, pages *193-209*

17.Boyce. J., Torras, M., "Rethinking the environmental Kuznets Curve" (2002) *The Political Economy of the Environment*, pages *47-67*

18.Boyce. J., "Inequality as a Cause of Environmental Degradation" (2002) *The Political Economy of the Environment*, pages *33-46*