INSTITUTIONS AND ENVIRONMENT: THE ENVIRONMENTAL KUZNETS CURVE, PROSPERITY, AND CIVIL INSTITUTIONS

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Abstract

The Environmental Kuznets Curve (EKC), first hypothesized in the early 1990s, theorizes that as a developing nation's GDP increases, pollution will peak and then fall. Essentially, domestic wealth enables the development of environmental protection. However, as China's GDP surges ever higher and the nation solidifies its place as a global economic powerhouse, its environmental practices continue to worsen. With this anomalous data point, China's lack of internal environmentalism demands a nuanced approach to the EKC. This study proposes and tests the hypothesis that good environmental policy requires a combination of economic prosperity, economic freedom, and stable, free civic institutions. This hypothesis is primarily tested through comparative analysis of China and the United States to determine whether economic prosperity is the sole and exclusive determinant of environmental protection. The disparity between Chinese and American air quality indicates that economic and civic freedoms may be necessary elements to environmental protection policies. However, similar trends between American and Chinese water quality offer researchers an additional data point.

Introduction

In 2010, the United Nations Environment Programme issued a report that warned that current environmental degradation could lead to an eighteen percent reduction in overall global economic output by the year 2050 ("Universal Ownership," 2010). Current global environmental policy appears to be insufficient in light of such fateful predictions. With this in mind, it is imperative that policymakers begin to understand what conditions are necessary to foster the development of environmentally-sustainable government policies and business practices. What can be done to achieve environmental sustainability within both developed and developing nations? How can bottom-up environmental concern be triggered at the grassroots level rather than relying on states and lawmakers to push top-down environmental policies?

In the early 1990s, Gene Grossman and Alan Kreuger (1995) proposed the Environmental Kuznets Curve (EKC) theory as a new application of the original Kuznets Curve theory. The original Kuznets Curve theory, created in the mid-twentieth century, hypothesized that as a nation's overall per capita income increases, income inequality gradually shrinks. In a similar manner, Grossman and Kreuger speculated that environmental protection policies are directly linked to industrialization. As a nation's per capita income increases to $8,000, the overall frequency of both air and water pollutants decreases.

The EKC has proven to be an accurate descriptive theory for many western countries post-industrialization. However, today, policymakers, economists, and environmentalists face an anomalous data point: the economic rise of the People's Republic of China. When adjusted for inflation, China has far surpassed the per capita income level that Grossman and Kreuger originally hypothesized would trigger environmental protection policies. Nonetheless, China has failed to institute substantial environmental protection laws or practices. Meanwhile, life-threatening smog continues to envelop Beijing, and China's polluted rivers are drying up (Berlinger, George, & Wang, 2017). This reality demands the question: Are there factors beyond mere industrial capacity and economic prosperity that are necessary for the development of national environmental sustainability?

This study seeks to answer the question: Does the Environmental Kuznets Curve hypothesis work properly in countries with relatively low economic and civic freedom? This study hypothesizes that economic prosperity is a necessary but insufficient predictor of environmental policies. Further, this study tests the hypothesis that two additional variables—civic and economic freedom—are necessary trigger mechanisms for environmental protection policies. If the hypothesis is correct, environmental protection policy should begin somewhere at the intersection of economic prosperity, economic freedom, and civic liberty.

Likewise, if the hypothesis is true, wealthy countries with relatively low economic and civic freedom should not reflect the EKC's predictions, while wealthy countries with relatively high economic and civic freedom should follow the EKC. This will be the case in spite of both countries having met requisite per capita income standards.

In order to evaluate the hypothesis, this study examines the case studies of China and the United States. It considers various metrics for evaluating relative economic and civic freedoms in the United States and China. Further, it analyzes secondary data from longitudinal studies of the air and water quality of the two nations. This longitudinal data enables an evaluation of the increase or decrease in environmental quality, relative to changes in economic prosperity.

Literature Review

Much ink has been spilled over the relationship between industrialization and environmental preservation. Grossman and Krueger (1995) proposed the Environmental Kuznets Curve (EKC), which indicated that a country's economic industrialization causes a highly-polluting phase, which is followed by a reduction in environmental degradation. As per capita income approaches $8,000 in 1995 dollars, air pollution levels will gradually fall. As Harbaugh, Levinson, and Wilson (2002) noted, the EKC has two important policy implications. First, it predicts that developing countries will automatically become cleaner as their economies grow. Second, it asserts that it is natural for countries in the developing world to become more polluted before they improve. Environmental protection should follow an inverted bell curve: Environmental degradation spikes as national wealth increases, and environmental degradation decreases after a country has achieved an annual per capita income of $8,000 in 1995 dollars (Harbaugh et al., 2002).

In contrast, Anderson and Cavendish (2001) discovered that there may be a two-way incentive structure driving the EKC. While rising per capita GDP causes citizens to shift from a survival mentality to a quality-of-life mentality, it is environmental regulations that stimulate technical innovation that enables the reduction of pollution. Essentially, regulations are sometimes necessary prerequisites to the technology needed to improve air and water quality. Anderson and Cavendish further noted that technological innovations created by the developed world may now enable developing countries to reduce pollution at an earlier point in development than states before them. Existing technology may allow the EKC to be shifted to the left as national environments begin to improve at a lower per capita GDP than Grossman and Kreuger believed was necessary.

While China reports annual GDP increases of 8% to 9%, the World Bank (n.d.) found that China is nonetheless the world's largest source of sulfur dioxide (SO_2), a toxic air pollutant. Due to China's one-party system, Zheng and Kahn (2013) found a number of factors that play a determinative role in Chinese environmental policy. They hypothesized that middle class demand for quality of life is a more accurate predictive variable of the rise of environmentally-protective policies than per capita GDP. Zheng and Kahn's study discovered that the Chinese electorate must demand information transparency and sustainability from local politicians before China will improve environmentally.

Zheng and Kahn's findings corroborated a previous study by Liu (2008) that demonstrated that Chinese eco-communities enabled environmental improvement to coexist with economic growth in early stages of industrial development. These targeted eco-communities are concentrated in Eastern China but are specifically government-sponsored. Liu, Zheng, and Khan's recent studies fulfilled predictions by Dasgupta, Laplante, Wang, and Wheeler (2002) that institutional capacity is a more determinative indicator of environmental quality than economic benefit is. Such findings have also proven true in the United States. As List and Sturm (2006) discovered, single-issue voters in the United States have made electoral incentives one of the most important determinants of environmental policy.

Data and Methods

This study employs the definition of economic prosperity used in the original Environmental Kuznets Curve study. Grossman and Krueger (1995) found that environmental pollutants generally reached a turning point prior to a per capita income of $8,000. Adjusted for inflation to 2017 dollars, societies should enact substantive environmental policies that significantly improve environmental quality before reaching an annual per capita income of $12,599 ("CPI Inflation Calculator," n.d.). For ease of use, the figure used as a metric of economic prosperity in this study is rounded to $12,600.

Annual per capita income is measured, compared, and contextualized through the window of Gross Domestic Product Purchasing Power Parity (PPP). PPP offers a better assessment of overall quality of life than a mere comparison of raw annual per capita GDP provides. PPP measures per capita GDP based on the rate at which the currency of one country would have to be converted into that of another country to buy the same amount of goods and services (Callen, n.d.). This statistical methodology allows researchers to have better insight into the comparative day-to-day lives of individuals in two or more separate nations. Given the EKC's proposed relationship between individual prosperity and environmental quality, this measurement is necessary to more precisely evaluate quality of life on an individual scale. Longitudinal PPP data is drawn from the World Bank's yearly analysis and contextualization of global per capita income.

This study utilizes the Fraser Institute's definition of economic freedom, drawn from its *Economic Freedom of the World Index*. Economic freedom exists when markets are coordinated by personal choice, voluntary exchange, and clearly-defined and enforced property rights (Gwartney, Lawson, & Hall, 2016). This study draws from Gwartney, Lawson, and Hall's surveys to provide statistics for relative economic freedom in China and the United States. Likewise, this study measures stable, free civic institutions by considering data generated by the annual Freedom House *Freedom in the World Index*. Information about the relative health and freedom of civic institutions is taken from Freedom House's 2017 *Freedom in the World Index*. Taken in combination, the relative strength of each of these factors will demonstrate the stability and freedom of political institutions in China and the United States.

When considering the development of environmental policy in China and the United States, this study analyzes air and water quality data over time. Grossman and Kreuger (1995) employed two metrics in their original EKC study: air quality and water quality. For the purposes of this study, air quality is measured by employing a wide variety of longitudinal secondary data compiled by World Bank environmental quality assessment studies. Air quality variables include the relative presence of PM2.5, an industrially-generated air pollutant, and carbon dioxide emissions.

Up-to-date, longitudinal ground, surface, and drinking water quality data is readily available for the United States from a variety of domestic and international sources. This study employs longitudinal data compiled by Lindsey and Rupert (2012) about groundwater quality generated by the United States Geological Survey from 1988 to 2010. This data provides information about chloride, dissolved solids, and nitrates in American groundwater. Unfortunately, similar data is not available from China. China's state environmental agencies have released virtually no water quality data since the 1990s (Hsu, Yan, & Cheng, 2017). Perhaps due to overall environmental degradation, the Chinese government has kept all forms of water quality data from the public, and researchers are left with massive gaps in statistics. The World Bank maintains a limited amount of Chinese river water quality data from the 1990s, and this dataset is employed in this paper as a possible indicator of trends leading into the 2000s. However, it is by no means intended to be indicative of current realities in the country. American data is provided from an overlapping time period, in order to allow some amount of contextualized comparison.

Research

Each year, the World Bank releases contextualized per capita GDP statistics for all of the countries of the world. In the most recent data cycle, the World Bank estimated that the PPP of China was $14,450.17 per capita ("GDP Per Capita," n.d.). In substantial contrast, the United States' estimated PPP was $56,115.72 in the same timeframe ("GDP Per Capita," n.d.). Based on World Bank data, between 2012 and 2013 China surpassed the EKC-predicted benchmark for national prosperity, as the per capita PPP increased from $11,351.06 in 2012 to $12,367.97 in 2013. The longitudinal trends of the per capita PPP of both the United States and China from 1990 to 2015 are reflected in Figure 1, and all figures are adjusted for inflation to 2017 dollars.

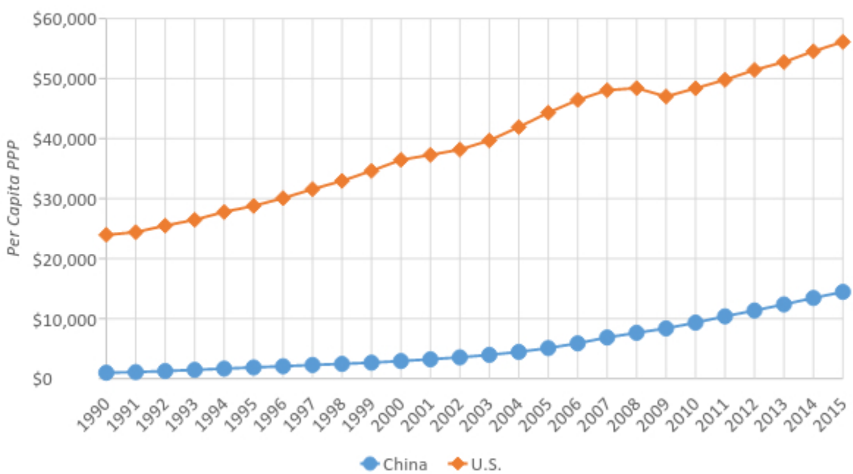

Figure 1: Longitudinal Purchasing Power Parity

Each year, the Fraser Institute releases its annual economic freedom rankings. Each of the 159 countries in the world is evaluated on a number of metrics and assigned points relative to the quality of each variable, with zero being the worst and ten being the best. The Fraser Institute's report is based on the assumption that economic freedom can be judged through five metrics. The first is the size of government, analyzed by considering expenditures, taxes, and enterprises. The second is legal structures and the security of property rights. The third is access to sound money. The fourth is freedom to trade internationally. The final variable is the regulation of credit, labor, and business (Gwartney et al., 2016). These data points are combined in an attempt to create a holistic picture of the economic realities of each country. Consideration of each of the variables is important, as the presence of one or two factors does not necessarily indicate that citizens of a country truly enjoy economic freedom.

According to the Fraser Institute report conducted by Gwartney et al. (2016), on the first metric, size of government, China's most recent ranking was a 5.1, placing it at 134th on the global scale. In contrast, the United States received a 6.4, ranking 78th globally. On the second metric, legal structures, China received a 5.8, or 65th globally, in comparison to the United States' score of 7.1, for a rank of 27th. For the third metric, access to sound money, China received an 8.2, for the 92nd rank globally. The United States scored a 9.4 on this metric, ranking 40th globally. On the fourth metric, freedom to trade internationally, China received a score of 6.8, ranking 95th globally. Comparatively, the United States received a score of 7.6, for a rank of 60th. China's score on the final metric, regulation of credit, labor, and business, was 6.3, for a rank of 131st. The United States, in contrast, received a score of 8.3, for a rank of 8th globally. These relative score values are reflected in Figure 2. China received an overall score of 6.45, coming in at 113th globally. The United States received a total score of 7.75, for a rank of 16th around the world (Gwartney et al., 2016).

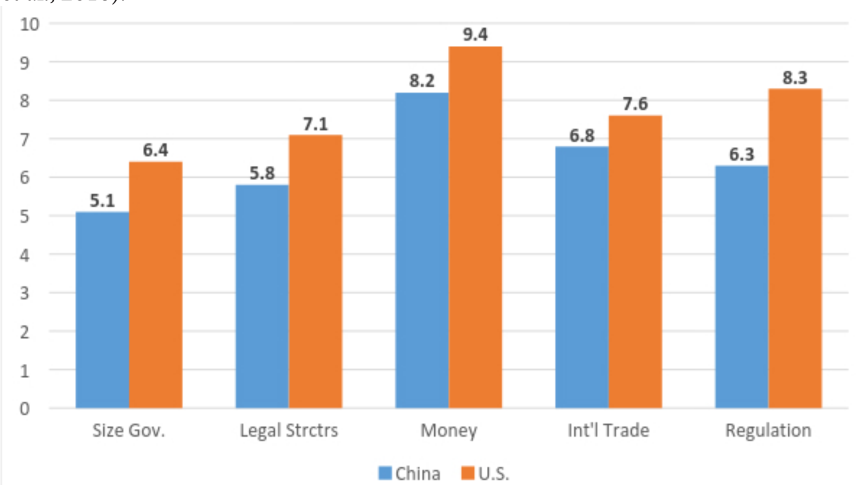

Figure 2: Fraser Index of Economic Freedom

Each year, the Freedom House analyzes twenty-five data points to gauge the relative freedom of every nation on the globe. Reported in the *Freedom Index of the World*, these data points are divided into ten political rights indicators and fifteen civil liberties indicators (Puddington & Roylance, 2017). The political rights indicators fall into three subcategories: Electoral Process, Political Pluralism and Participation, and Functioning of Government. Likewise, the civil liberties indicators are divided into four subcategories: Freedom of Expression and Belief, Associational and Organizational Rights, Rule of Law, and Personal Autonomy and Individual Rights. Variables are measured on a scale of zero to four, with zero being the lowest degree of freedom and four the highest degree

(Puddington & Roylance, 2017). Like the Fraser economic freedom indicators, each of the variables within the *Freedom Index of the World* must be considered to truly understand the political realities of a given country. Based on Freedom House's data, each country and territory is given two numerical ratings between one and seven. The first rating is for political rights, and the second rating is for civil liberties. Within Freedom House's study, a rating of one is the highest degree of freedom, while a rating of seven is the lowest degree. An additional aggregate rating is then generated from these numbers (Puddington & Roylance, 2017).

The Freedom House survey gathers data by asking a number of complicated, multi-part questions. These include, but are not limited to, inquiries about the status of free and fair elections, the relative fairness of electoral laws, and the freedom of political association. Within the civil liberties category, Freedom House researchers ask about media censorship, public religious expression, and political indoctrination in the classroom (Puddington & Roylance, 2017).

According to the *Freedom Index of the World* produced by Puddington and Roylance (2017), China received a rating of seven for political rights and six for civil liberties, for a total ranking of fifteen in 2017. This ranking has worsened over time. In 2016, China received an aggregate ranking of sixteen. In contrast, the United States received a score of one for political rights and one for civil liberties, for a total ranking of ninety. Within the total rankings, zero is the least free, and one-hundred is the most free. Based on these Freedom House statistics, the relative freedom of individuals residing in China is substantially lower than the freedom of comparable individuals living in the United States (Puddington & Roylance, 2017).

In assessing environmental quality, the World Bank conducts routine evaluations of the air qualities of countries around the globe. One of the metrics employed is PM2.5, atmospheric particulate matter smaller than 2.5 micrometers in diameter. These tiny particles are suspended in air and can easily become entrapped within human lungs, causing significant health problems. Also called "fine particles," production of these airborne substances is linked to industrialization. PM2.5 is generated by all kinds of combustion, including motor vehicles, power plants, residential wood burning, forest fires, agricultural burning, and certain industrial processes ("Particle Pollution," n.d.). Based on World Bank data, the average Chinese resident's mean annual exposure to PM2.5 concentration increased by 6.6 micrograms per cubic meter from 2000 to 2005 ("DataBank," n.d.). In contrast, the average American resident's mean annual exposure to PM2.5 concentration decreased by 2.2 micrograms per cubic meter over the same period ("DataBank," n.d.). The overall trend is reflected in Figure 3.

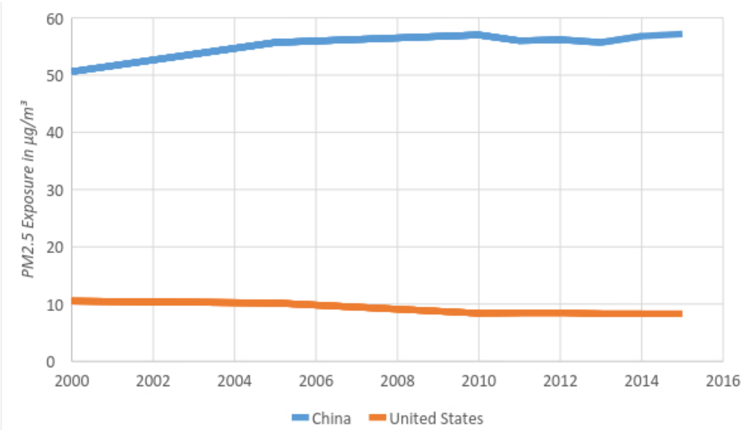

Figure 3: Longitudinal Air Quality

For context, the World Bank also analyzes overall national air quality in relationship to the World Health Organization's guideline values for acceptable exposure to PM2.5. Given PM2.5's ability to penetrate human lungs, exposure to PM2.5 in relatively high concentrations has significant implications for both environmental quality and public health. Of the variables considered in this study, PM2.5 concentration has perhaps the greatest direct impact on individual quality of life within a country. Since 2000, residents of mainland China have consistently been exposed to one-hundred percent of the WHO's estimated safe levels of annual exposure to airborne fine particles ("DataBank," n.d.). In contrast, residents of the United States have been exposed to only twenty-three percent of acceptable levels ("DataBank," n.d.). These statistics are represented in Figure 4.

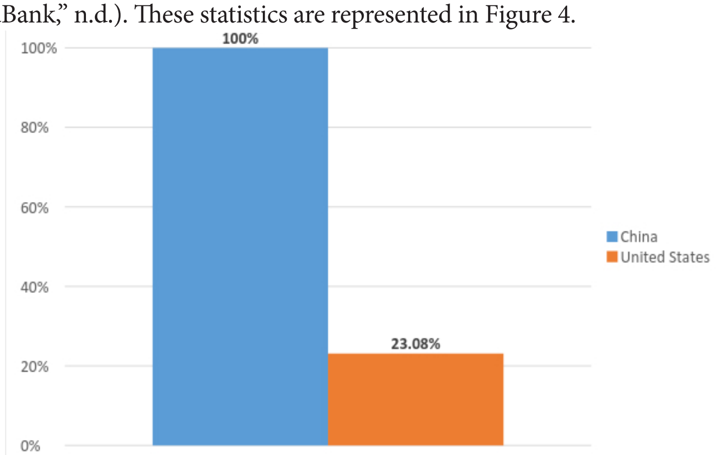

Figure 4: WHO Air Quality Contextualized

Since 1990, the World Bank has also tracked carbon dioxide emissions from both the United States and China. From 1990 to 2013, per capita carbon dioxide emissions in China spiked from 2.2 metric tons to 7.6 metric tons annually ("World Development Indicators," n.d.). In contrast, per capita carbon dioxide emissions in the United States dropped from 19.3 metric tons to 16.4 metric tons annually in the same time period ("World Development Indicators," n.d.). These statistics are reflected in Figure 5. The relatively high per capita carbon dioxide emissions in the United States are likely due to her relatively small population, compared to China's population. Nonetheless, the longitudinal trends of carbon dioxide emissions in each country indicate relative environmental improvement or degradation. These trends are the most important component in evaluating the strength of the EKC.

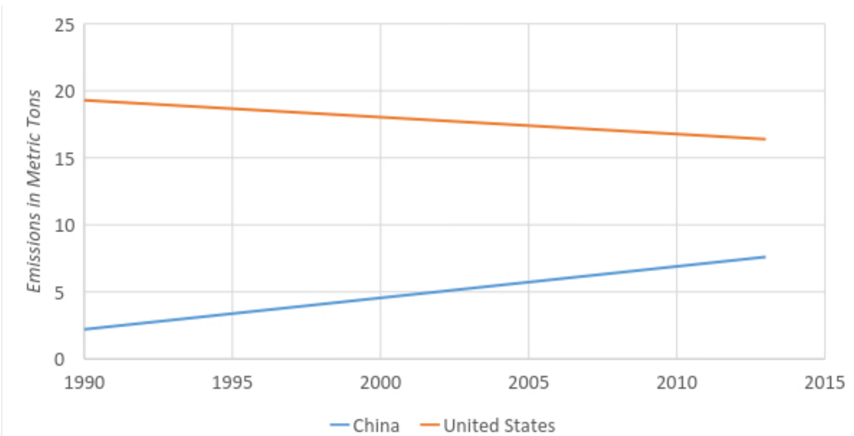

Figure 5: Per Capita Carbon Dioxide Emissions

From 1988 to 2010, the United States Geological Survey (USGS) measured groundwater quality around the country through the National Water-Quality Assessment Program (Lindsey & Rupert, 2012). The USGS evaluated water quality in fifty-one river basins and aquifers. These water networks included the Upper Illinois River Basin, the New England Coastal Basins, the Rio Grande Valley, and the Apalachicola-Chattahoochee-Flint River Basin. Water networks were primarily tested using biennial samples from several wells within each area.

The United States Geological Survey produced by Lindsey and Rupert (2012) tracked three specific variables over the the twenty-two year period. The USGS measured water quality in terms of chloride, dissolved solids, and nitrate concentrations. When measuring chloride concentration, the USGS reported that

43% of water networks increased in chloride concentration from 1988 to 2010. In contrast, 4% of water networks in the United States decreased in average annual chloride concentration. Over the two decades that the USGS tracked pollutant data, most water networks in the United States saw an overall increase in chloride concentration (Lindsey & Rupert, 2012).

Similarly, Lindsey and Rupert (2012) reported in the USGS that, from 1988 to 2010, 41% of water networks increased in the concentration of dissolved solids within the water supply. Only 2% of water networks recorded a decrease in dissolved solid concentration during the time period. Nitrates, likewise, saw an overall increase in concentration within water networks. However, this increase was not as severe as the increases of other variables. 23% of water networks indicated an increase in nitrate concentration. 9% of water networks reported a decrease in nitrate concentration, a much higher reduction than the percent reduction of the other variables in the study (Lindsey & Rupert, 2012). Across variables, the USGS data indicated that water pollutant concentration increased throughout the United States from 1988 to 2010. This data is reflected in Figure 6.

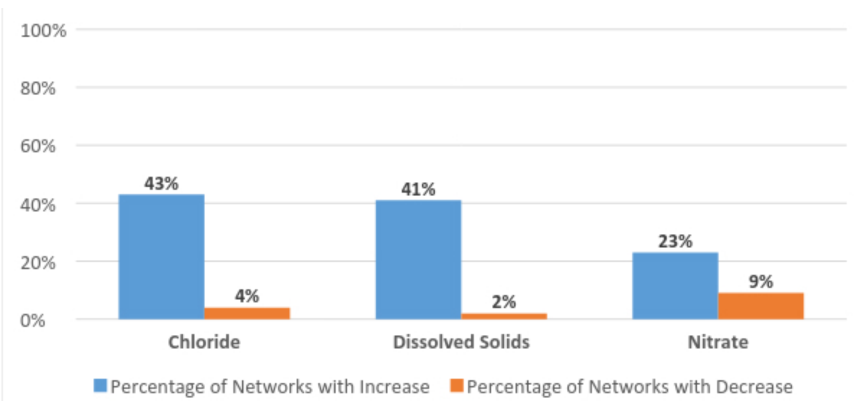

Figure 6: Change in Water Pollutant Concentration, 1988-2010

From 1990 to 1995, the World Bank tracked the surface water quality of major Chinese rivers using a number of variables. Data was generated from the China Environmental Yearbook, published by China's National Environmental Protection Agency ("Pollution Indicators," n.d.). The report tracked the water quality of five rivers: the Songhua River, the Daliao River, the Yellow River, the Yangtze River, and the Huai River. Longitudinal water quality was measured in terms of pH, Suspended Solids (SS), Dissolved Oxygen (DO), and oil, among other variables. Aside from pH levels, all data was reported as annual averages in milligrams per liter (mg/l) ("Pollution Indicators," n.d.).

From 1990 to 1995, the pH of the five rivers tended to fall, indicating the rivers were becoming more acidic and thereby more polluted ("Pollution Indicators," n.d.). The presence and frequency of suspended solids in the rivers had mixed trends. During the reporting period, frequency of suspended solids increased in the Songhua and Yangtze rivers ("Pollution Indicators," n.d.). However, the frequency of suspended solids in the Daliao, Yellow, and Huai rivers fell in the same timeframe ("Pollution Indicators," n.d.). Within environmental quality standards, dissolved oxygen is an important indicator of organic life and overall water quality. Higher frequency of dissolved oxygen indicates better water quality.

Like the suspended solids data, changes in the frequency of dissolved oxygen in Chinese rivers was mixed during the five year period. From 1990 to 1995, the Songhua and Daliao rivers improved, and the Huai and Yellow rivers got worse ("Pollution Indicators," n.d.). Data for the Yangtze River in 1990 was not reported by the Chinese government, making longitudinal analysis impossible ("Pollution Indicators," n.d.). The frequency of oil particles in Chinese rivers during the five year period generally dropped. The Daliao and Yangtze rivers had decreases in oil particulates, but the Yellow River had an increase ("Pollution Indicators," n.d.). Data for the Songhua and Huai rivers in 1990 was not reported by China, again excluding these rivers from any longitudinal analysis. Precise statistics from the China Environmental Yearbook, published by China's National Environmental Protection Agency ("Pollution Indicators," n.d.), are listed in Table 1.

River	Year	pH	SS	DO	Oil
Songhua	1990	7.4	77.2	7.04	n/a
Songhua	1995	7.43	113.55	7.98	0.04
Daliao	1990	7.54	277.899	3.24	3.85
Daliao	1995	7.09	190.05	6.75	3.11
Yellow	1990	8.26	7088.64	10.1999	2.41
Yellow	1995	7.98	4506.6	7.75	2.51
Yangtze	1990	7.61	329.75	n/a	0.17
Yangtze	1995	8.05	497.399	7.95	0.095
Huai	1990	8	91.2999	6.01	n/a
Huai	1995	7.59	65.3499	5.9	0.06

Table 1: Pollution Indicators

Conclusion

China's per capita income, as measured by PPP, surpassed the necessary benchmark for EKC-predicted environmental policy between the years 2012 and 2013. However, this relative increase in wealth has not been accompanied by a relative improvement in environmental quality. If the EKC's original predictions were correct, China's overall air quality, as measured by PM2.5 concentrations and carbon dioxide emissions, should have begun to improve after 2013. However, the available data indicates that this is not the case. Various indicators of China's air quality have only continued to worsen since 2013, and the country demonstrates little to no evidence that these trends will be changing sometime in the near future. This disparity indicates that the original EKC hypothesis is not sufficient for predicting the evolution of environmental policies in developing nations like China.

Nonetheless, both Chinese and American water quality appeared to decline during the 1990s. While EKC indicates that the United States' water quality should only continue to improve, the United States demonstrated significant setbacks in national water quality metrics. Although data is not available for Chinese water quality for the entire period from 1988 to 2010, river water degradation from 1990 to 1995 mimicked American trends. This data calls into question the relevance of water quality to discussions of the EKC. Further research should be conducted of developing nations with more readily-available water quality data to determine if the EKC can be a useful predictive element of both air *and* water quality within countries.

While both China and the United States have met the necessary PPP metrics for EKC-triggered environmental quality, there are two important differences between the two countries. Various indicators demonstrate that Chinese citizens lack both the economic and civic freedom that American citizens enjoy. The relative presence of economic and civic freedoms in the United States, where the EKC hypothesis has been successfully applied, may indicate that environmental protection policies are at least partially driven and triggered by the presence of personal liberty.

However, variables indicating economic and civic freedom cannot be construed as directly causative. Further research is needed to determine whether or not these variables are merely a chance correlation. Additional longitudinal case studies should be conducted to establish or disprove the relevance of economic and civic freedom to environmental policy. If such a causative relationship can be established, additional longitudinal studies may be helpful to identify the exact intersection point between relative levels of economic freedom, civic freedom, and PPP that trigger environmental policy. Another potential explanation for the failure of the EKC hypothesis in the country of China could be China's relatively weak middle class. While China's PPP has grown, her middle class has not. In contrast to upper and lower classes, middle classes have historically been the chief champions of environmental policy in developed nations. At the same time, a higher per capita baseline than that established by Grossman and Kreuger may be needed.

Given the findings of this study, the nation of China provides evidence that the EKC theory does not work perfectly in the absence of economic and civic freedoms. While no direct link is proven, there is a strong possibility that there is some relationship between economic and civic freedoms and environmental policy. If this is the case, governments in developing nations should first focus on fostering free civic institutions and lowering barriers to individual and economic liberty. Once these are established and baseline economic prosperity has been achieved, grassroots environmental protection should develop organically, offering a promising solution to a global environmental crisis.

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