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Explaining Human Influences on Carbon Dioxide Emissions across Countries

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By Karin Peterson

Abstract

Global climate change is a vital issue facing the planet today, posing significant risks to both humans and the natural environment. This dangerous phenomenon is largely caused by the release of carbon dioxide into the atmosphere, resulting from such activities as energy production and vehicle travel. This paper examines the factors leading to differences in carbon dioxide emissions among countries, including income, energy use, and government institutions. A cross-sectional regression indicates that an inverted-U relationship exists between per capita income and carbon dioxide emissions, but that the turning point at which pollution begins to decrease occurs at a very high level of income, suggesting that increasing income does not present a feasible solution to the climate change problem. Several other variables, including political openness and coal dependency, are also found to have significant impacts in the model. These results generate important conclusions, and lay ground for future studies analyzing impacts on climate change.

In recent years, the theory of global climate change has raised rapidly growing concern throughout the world. It is now widely acknowledged that the warming of the Earth is a well-founded, scientifically tested phenomenon, which has the potential to wreak serious havoc on natural systems and human populations alike. It is also evident that these changes are a result of anthropogenic impacts. Over the past 50 years, the average global temperature has increased at the fastest rate ever documented, and the consequences of this phenomenon are already becoming visible. In 2003, extreme heat waves caused over 20,000 deaths in Europe and over 1,500 deaths in India (Global Warming). It is estimated that the Arctic's polar ice cap is declining at a rate of 9 percent per decade, causing changes in sea levels and ocean currents that could trigger devastating damage throughout the world.

Addressing this critical issue is complicated by the fact that climate change transcends national boundaries, affecting nations on opposite ends of the globe. However, although all countries are affected, they do not all contribute to the issue in the same way. It has become evident that certain countries release much more pollution in the form of heat-trapping greenhouse gases than others. An important component of tackling the issue of global climate change is investigating why these disparities exist.

There are many factors that impact the emission of greenhouse gases at a country-level. This paper aims to explore these factors, and how they have led to the current global pattern of carbon dioxide emissions. The results provide an indication as to the most effective plan of action for international policy seeking to reduce the impacts of global warming.

This paper is structured as follows: Section I gives an overview of the presiding theory regarding determinants of carbon dioxide emissions. Section II explains the data and empirical model used in this study. Section III gives the results of the empirical model. Finally, Section IV provides concluding remarks and policy implications that may be drawn from this experiment, as well as suggestions for future avenues of research.

I. Theory/Literature Review

For years, economists, political scientists, and biologists alike have struggled to explain the factors that drive the course of man-driven environmental degradation. One of the first and most influential theoretical frameworks encompassing this issue was developed in the early 1970s by several researchers who hypothesized that environmental impacts were caused by three central variables: population, affluence, and technology (Commoner, 1971). This was formulated into what became known as the IPAT equation, $I = P \times A \times T$, in which I represents impact, and P, A, and T represent population, affluence, and technology respectively. In this equation, population (P) accounts for the pressure a growing population may exert on the environment by increasing the frequency of activities leading to pollution and resource exhaustion, such as vehicle travel and energy consumption. Affluence (A), or income, which can be measured by gross domestic product (GDP), generally speaking has a positive relationship with pollution, due to the tendency of wealthier societies to consume more resources. However, income may have a much more complex impact on pollution, which is described in the following section. Finally, technology (T) represents the impact of varying production processes, tools, and machinery on the environment.

Since its introduction, IPAT has been modified and applied to a number of studies analyzing anthropogenic effects on the environment, including global climate change. Waggoner and Ausubel (2002) propose a revised IPAT identity, referred to as ImPACT, which is applicable specifically to carbon dioxide emissions. The study suggests that a third variable, consumption (C) be added to the right side of the equation, such that $I = P \times A \times T$. Consumption represents the intensity of energy use, and may be measured by energy consumed over income, or GDP. This signifies the choice of a country to devote economic power to activities that release carbon dioxide. The ImPACT equation corresponds to a formula known as the Kaya Identity, which is used by the Intergovernmental Panel on Climate Change to estimate carbon dioxide emissions (IPCC, 2001). When ImPACT is divided through by population, it may be written as a calculation of impact per capita, such that $I = P \times A \times C \times T$. Each term of this equation relates with a part of the Kaya Identity.

ImPACT Equation

$$I / P \quad = \quad A \quad \times \quad C \quad \times \quad T$$

Kaya Identity

$$\frac{CO_2}{Population} = \frac{GDP}{Population} \times \frac{Energy\ Consumption}{GDP} \times \frac{CO_2}{Energy\ Consumption}$$

The major drawback to the IPAT, ImPACT, and Kaya formulas is that they do not allow for hypothesis testing, due to the fact that they are mathematical identities (York, 2003). Nonetheless, these formulas are an important part of the literature examining human impacts on the environment. For this study, the Kaya Identity will not be used as an exact model, but rather will serve as an indication of general factors which may influence carbon dioxide emissions.

In addition to the variables included in the Kaya equation, the literature presents several other factors that influence carbon dioxide emissions. Institutional variables, such as political openness, take into account the impact of climate change regulation on emissions (Torras, 1998). It may also be important to consider geographic variables, such as population density, which measure carbon dioxide emissions from transportation, and have been found to be significant in analyzing country-level contributions to global climate change (Neumayer, 2003). Changes in land use may also have a significant influence on carbon dioxide emissions, as carbon dioxide is released from burning of forests, and absorbed in reforestation (WWF, 2008).

Income

Among the numerous variables that affect per capita carbon dioxide production, per capita income is the factor which has prompted the largest amount of theoretical and empirical analysis. There is an abundance of economic literature investigating the relationship between per capita income and the environment, the vast majority of which centers around the Environmental Kuznets Curve (EKC). The EKC demonstrates an inverted-U relationship between a country's per capita income and the amount of pollution it emits. In other words, studies have shown that countries emit an increasing amount of pollution as they grow up to a certain level. After a turning point is reached, however, pollution begins to decrease with further development. While there is empirical support of the EKC for certain pollutants, there is significant controversy over whether the relationship is applicable to carbon dioxide.

The basic explanation behind the EKC shape found in most literature is that at very low levels of per-capita income, populations rely primarily on subsistence activity which has little impact on the environment, and therefore emit low levels of pollution (Stern, 2004). As these economies industrialize, they tend to use cheaper, dirtier technologies that emit large amounts of pollution. Furthermore, developing nations have poor environmental regulation, and generally lack resources to educate the public on environmental issues (Dasgupta, 2002; Stagl, 1999). Thus, as poor countries develop, the amount of pollution emitted initially increases rapidly. However, once a certain level of income is reached, people begin to value the environment more highly. Furthermore, as income increases, industries can afford cleaner technologies, and effective governmental regulations are implemented. The shift in the relationship between income and pollution from positive to negative is referred to as the "de-linking" of economic growth from environmental degradation (Stagl, 1999).

There is an abundance of empirical support of the EKC for certain pollutants. *Economic Growth and the Environment*, by Grossman and Krueger (1995), formed the fundamental basis for many econometric tests of the EKC done over the past 10 years. The study uses several indicators of water contamination as a measure of pollution, testing the Kuznets curve on a local, rather than national, level. Grossman and Krueger find an inverted-U relationship between GDP and pollution, and pinpoint the turning point of the curve at $8,000 per capita. Since Grossman and Krueger's study, there have been many empirical tests of the EKC for other pollutants. For example, Selden and Song

(1994) find inverted-U relationships for sulfur dioxide, nitrogen dioxide, particulate matter, and carbon monoxide.

However, applying the Kuznets curve relationship to carbon dioxide is questionable, due to the fact that CO_2 is a global, rather than local, pollutant. In other words, the primary issue caused by carbon dioxide production is climate change, which may only be addressed on a global level, and involves long-term costs (Stagl, 2001; Arrow, 1995). This is different from a pollutant such as sulfur dioxide, whose effects may be observed and reduced locally, on a short-term basis. Because addressing global warming requires coordinated action between countries, a higher level of national income may not necessarily correspond with greenhouse gas reductions (Strand, 2002). Furthermore, due to the difficulty of reducing carbon dioxide levels, it may not be possible to lower emissions sufficiently to cause an inverted-U phenomenon.

The EKC also tends to be more applicable to those pollutants which are noxious in nature. Sulfur and nitrogen oxides can produce visible haze and are generally offensive to come into contact with. Carbon dioxide, on the other hand, is non-toxic, and virtually undetectable in the atmosphere. Thus, it is relatively unlikely that higher income nations will mobilize to reduce carbon dioxide, thus reducing the likelihood of an inverted-u in emissions.

A number of articles have emerged finding no empirical support for an inverted U-relationship between income and carbon dioxide emissions (Chimeli, 2007; Harbaugh, 2002; Romero-Avila, 2008; Wagner, 2008). Many of these articles argue that previous studies supporting the EKC have been flawed. Furthermore, those that do support an EKC for carbon dioxide have found that the turning point occurs at extremely high levels of income which may never be attainable for any country, making the EKC essentially irrelevant (Stagl, 1999). Estimated turning points for the carbon EKC have ranged from $20,000 to $8,000,000 per capita.

Energy Intensity

Energy intensity is measured by the ratio of total energy consumption to GDP. Total energy use includes consumption in the residential, commercial, industrial, and transportation sectors (Annual, 2008). Dividing energy consumption by income allows the term to measure the extent to which a country devotes its economic power to activities that release carbon dioxide. Thus, other things equal, the greater the energy intensity, the greater a nation's contribution to climate change. This variable is particularly important because energy production is a significant contributor to carbon dioxide emissions. In the U.S., electricity generation is the largest source of carbon dioxide emissions, contributing 41% of emissions (Human-Related, 2009). Energy intensity may be reduced by actions that increase energy efficiency.

Coal Dependence

As demonstrated by the Kaya Identity, it is possible to measure the environmental impacts of energy use by dividing emissions by total energy consumption. When estimating environmental impacts, it is important to note that some sources of energy are more emissions-intensive than others. Because burning coal releases a large amount of carbon dioxide relative to other fuels, dependence on coal has a significant impact on emissions (Zhuang, 2008). Thus, this coal dependence serves as a reasonable indicator of the extent to which productive technology is environmentally-friendly, and therefore represents the important technological factor outlined by the IPAT model.

Institutional Factors

Institutional factors may be other important determinants of carbon dioxide emissions. Torras and Boyce (1998) find that political factors are significant in determining emissions sulfur dioxide, smoke, and particulate matter. They conclude that a higher influence of those who bear the costs of pollution, obtained through governmental systems that allow for a more equal distribution of power, leads to lower pollution emissions. Whether this effect is applicable to carbon dioxide again requires an analysis of global vs. local pollution. It is likely that regulatory action initiated as a result of open political voice would be more apparent for pollution that is contained within national borders (Torras, 1998). Nonetheless, institutional factors are often acknowledged as additional considerations in analyses examining carbon dioxide emissions, although not many studies use political variables as a focal point (Dietz, 1997; Duro, 2006). Dolsak (2001) cites political openness as an important determinant of national commitment to climate change regulation, arguing that increased public concern over the issue can influence political leaders to take action. Some claim that public influence is a main driver of the current progressive climate change policies in the European Union (Harrison, 2007).

Population Density

Recently, literature has emerged indicating that geographical factors may significantly effect greenhouse gas emissions. It has been hypothesized that countries with less dense, scattered populations emit high levels of carbon dioxide, due to high transportation costs (Neumayer, 2003; Emrath, 2008; Grazi, 2008). Denser, urban populations, on the other hand, tend to produce relatively less CO_2, as people travel less distance and utilize more public transportation. Thus, population density could act as an important tool in analyzing carbon dioxide emissions from vehicle travel. In 2004 the transport sector accounted for one-fifth of the world's carbon dioxide emissions from energy (Grazi, 2008). Furthermore, this is expected to grow at a rate of 1.7% per year over the next several decades. Thus, transportation is clearly a relevant factor in assessing carbon dioxide emissions.

Deforestation

It is estimated that deforestation contributes about 20% of the world's greenhouse gas emissions (WWF, 2008). Significant amounts of carbon dioxide are emitted when forests are burned, which often occurs when land is cleared in tropical areas for agricultural use (Carbon Dioxide Emissions, Anthropogenic, 2009). CO_2 may also be emitted from the decomposition of trees which are harvested for lumber and the burning of wood for fuel. However, since vegetation also acts as a sink for carbon dioxide, reforestation may essentially reverse a portion of the impact of pollution caused when forests are destroyed. This makes the calculation of carbon dioxide emissions from land-use change particularly complex. It is perhaps for this reason that deforestation does not appear as a variable in many economic studies estimating impacts on carbon dioxide emissions.

II. Data/Empirical Model

The empirical model used in this study aims to explain carbon dioxide emissions by taking into account the factors described in the theory section of the paper, including the Kaya Identity, Kuznets Curve theory, and other related literature. This study utilizes data from 126 countries in the year 2004 to construct the following regression:

$$CO_2 \text{ Emissions/Capita} = \alpha_1 + \beta_1(\text{GDP/Capita}) + \beta_2(\text{GDP/Capita})^2 + \beta_3(\text{Energy Intensity}) + \beta_4(\text{Coal Dependence}) + \beta_5(\text{Political Openness}) + \beta_6(\text{Population Density})$$

A summary of the variables used in the regression is presented in Table 1. Emissions data in thousand metric tons of CO_2 are obtained from the Carbon Dioxide Information Analysis Center (CDIAC), through the UN Statistics Division (Carbon Dioxide Emissions Thousand, 2004). GDP in current U.S. dollars is obtained from the Key Global Indicators database, which is also available through the UN Statistics Division (GDP, 2004). The variable for energy intensity is Energy Consumption/GDP, with total energy in quadrillion Btu obtained from the U.S. Energy Information Administration (International, 2004). Coal dependence is calculated as Coal Consumption/Energy Consumption, with data on coal consumption in Quadrillion Btu from the U.S. Energy Information Administration.

Political openness is measured using 2004 data from the index of "Voice and Accountability," which is one of the six dimensions of the World Bank's Worldwide

Governance Indicators (Worldwide, 2004). The index measures the degree to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media (Government Matters, 2008). The index values range from -2.5 to 2.5, with the higher values representing higher levels of openness.

Population density is measured by population per hectare, data on land area is gathered by the Food and Agriculture Organization, and acquired through the UN Statistics Division (Land Area, 2004).

In this model, if de-linking of pollution and income in fact occurs, β_2 should be negative, β_1 should be positive, and the resulting shape of the regression should be an inverted-u. This is because, assuming there is an eventual negative relationship between GDP and pollution, the squares of GDP will have an increasing negative effect on pollution levels, and eventually overcome the initial positive relationship between GDP and emissions.

The variables other than income in the model have varying projected impacts on carbon dioxide emissions. Intensity is expected to have a positive effect on emissions, due to the fact that energy consumption is a large contributor to greenhouse gas emissions. It is anticipated that dependence on coal will also have a positive effect on carbon dioxide emissions, because coal is a carbon-intensive and pollution-intensive fuel. Greater openness is expected to have a negative coefficient, due to the effect of public influence on climate change regulations. Finally, it is hypothesized that population density will have a negative impact on emissions, because increased density theoretically leads to a decrease in carbon dioxide emissions released by the burning of fossil fuels from transportation.

Table 1: Variables and Descriptive Statistics

Expected Sign	***Variable***	***Definition***	***Mean***	***Std. Deviation***
	Carbon Dioxide per capita	Carbon dioxide emissions in thousand metric tons/Population	6.002	8.891
+	GDP per capita	GDP in thousands U.S. dollars/Population	10.749	14.960
-	GDP per capita squared	$(\text{GDP in thousands U.S. dollars/Population})^2$	337.573	755.740
+	Energy Intensity	Total energy consumption in Quadrillion (10^{15}) Btu/GDP in thousands U.S. dollars	0.134	1.258
+	Coal Dependence	Coal consumption in Quadrillion (10^{15}) Btu/Total energy consumption in Quadrillion Btu	0.107	0.178
-	Political Openness	Measurement of voice and accountability present in a country, on a scale from -2.5 to 2.5	0.071	1.046
-	Population Density	Population/hectare	1.358	2.093

Deforestation is not included in this model because it is not apparent that emissions from deforestation are factored into the calculation of carbon emissions by the CDIAC. According to a description of the data, production of CO_2 from non-energy sources is not included in the estimation of carbon dioxide emissions (Factors, 2004). Thus, deforestation would not have an impact on emissions if included in this particular regression. This issue illustrates the complexity of calculating emissions from carbon dioxide, and the importance of investigating the methods used in estimating data prior to formulating a model.

III. Results

The results of the initial regression indicate the existence of an inverted-U relationship between income and carbon dioxide emissions (Table 2). GDP per capita has a statistically significant positive effect on emissions, while the coefficient of the squared GDP term is negative and significant at the .01 level. This suggests that the EKC relationship may in fact exist for global as well as local pollutants, as countries are exhibiting a pattern of decreasing growth in pollution as income rises. However, the results also indicate a turning point at 56,000 US$ per capita, a level of income that only one country (Luxembourg) has reached to date. This may be due to the fact that pollutants such as carbon dioxide are more difficult to regulate

pollutants, and therefore most high-income countries are not able to decrease emissions sufficiently to achieve a turning point.

The most statistically significant variable other than income is political openness, which has a negative coefficient, suggesting that public voice may be a major driver of climate change policies aiming to reduce carbon dioxide. Thus, higher levels of democratization may be better suited toward mitigating global climate change.

The variable for population density is not significant and does not have the expected sign. One reason for the insignificance of this factor may be that nation-wide population density does not account for regional variations within each country that may impact emissions. For example over 90% of the population in China lives in the Eastern third of the country (Asia, 2009). Consequently, actual population density is much greater than the nation-wide measure indicates. Furthermore, the reduction in transportation emissions in dense, urban populations may be offset by the intensive industrial processes that emit pollution in those areas. Thus, it is clear that population density is a complex factor that necessitates a greater amount of analysis in order to understand its true effects on carbon emissions.

Table 2: Model 1 Regression Results

Variable	***Coefficient (t)***
GDP per capita	0.780*** (5.548)
GDP per capita squared	-0.007*** (-2.837)
Political openness	-2.658** (-3.213)
Population Density	0.049 (-0.160)
Energy Intensity	0.543 (1.059)
Coal Dependence	3.960 (1.089)
R-Squared	0.398
Sample Size	126

***=Significance at the .001 level
**=Significance at the .01 level

While neither energy intensity nor coal dependence is statistically significant in the model, both variables have positive coefficients. This suggests that increasing both overall energy consumption and the ratio of coal consumption to total consumption increases carbon dioxide emissions. Thus, despite the insignificance of these variables, the results at least correspond with their predicted roles as contributors to carbon dioxide emissions.

In addition to testing the model across all countries, nations were separated into high and low income categories, in order to determine whether the coefficients of the independent variables differ across levels of development. Countries were grouped according to World Bank classifications of High or Upper Middle Income, and Lower Middle or Low Income (World Bank). The classifications of the countries used in this study are listed in the appendix. The squared income term produced insignificance due to the short ranges of income in each group, and was therefore dropped from these regressions. The results (Table 3) show several interesting findings.

GDP per capita remains significant in the second model. This indicates that income is an important factor in determining emissions, regardless of a country's level of development. The coefficient for per capita GDP is smaller for more developed nations, fitting with the results of the previous regression, which suggest that emissions grow at a decreasing rate with income.

Political openness has a significant negative impact on emissions in high income nations, but is insignificant in the low income category. The coefficient is also considerably larger in high income than in low income countries. This suggests that government openness may have more of an impact on emissions in wealthier nations, which tend to have democratic leadership, and are therefore more liable to grant citizens political voice.

Table 3: Model 2 Regressions Results

Variable	***Coefficient (t)***	
	High/Upper Middle Income	Low/Lower Middle Income
GDP per capita	0.353*** (4.264)	0.811*** (4.227)
Political openness	-5.303*** (-3.640)	-0.674 (-1.717)
Population Density	0.130 (0.245)	-0.051 (-0.414)
Energy Intensity	0.792 1.169)	2.142 (0.405)
Energy Mix	-3.150 (-0.048)	6.235*** (4.482)
R-Squared	0.422	0.296
Sample Size	62	64

***=Significance at the .001 level
**=Significance at the .01 level

Population density remains insignificant in both income categories, suggesting that a better measure of transportation is needed in the analysis. However, although it is insignificant, the negative coefficient for low income countries suggests that the negative impact of reduced fossil fuel use on carbon emissions in dense areas may be more applicable in less developed nations. For example, it is possible that people in poor urban areas are less likely than those in wealthier nations to own vehicles, and therefore have a greater tendency of finding alternative methods of transportation.

An additional interesting finding in the Model 2 regression is that coal dependence is highly significant for lower income nations. Furthermore, there is a very clear difference in the significance of this variable between low and high income countries. The coefficient is positive and significant at the .001 level for less developed countries, but negative and insignificant for wealthier nations, with a t-value of only –0.048. This suggests that the impact of coal use on carbon dioxide emissions may be greater for low income than high income nations. It is possible that this result reflects the tendency for industry to be relatively more pollution-intensive in less developed nations. In other words, because low income nations tend to have lower environmental restrictions and fewer resources than wealthy countries, it is likely that clean technologies (i.e. scrubbers and filters) are used less. Furthermore, low-cost coal, which tends to emit higher levels of pollution, is more likely to be used in developing countries, causing the use of coal in production to exhibit a relatively greater impact.

IV. Conclusion

The results of this study generate a number of conclusions and questions concerning the factors affecting human impact on global climate change. Population, affluence, and technology, as first outlined in the IPAT identity 40 years ago, are found to be applicable in a modern analysis of carbon dioxide emissions. However, it is clear that the factors influencing greenhouse gas emissions are much more complex than this simple equation would suggest. Affluence generates an inverted-u shape when regressed against carbon emissions, but the high turning point found in the analysis confirms the results of previous literature, which has suggested that this relationship does not present a viable policy solution for reducing global pollutants. Political openness exhibits high significance in the model, suggesting that institutional factors, not included in the impact theories, are important in determining carbon dioxide emissions. It is also apparent that certain variables may affect countries differently across varying levels of development, further complicating the analysis.

Discovering an EKC relationship for carbon dioxide is a surprising result of this study, considering that it is a non-noxious, global pollutant. Nonetheless, the high turning point found in the analysis is consistent with many previous studies, and suggests that the global nature of greenhouse gases impacts the level that nations reach on the EKC. Because carbon dioxide is a global pollutant that must be addressed on an international level, high-income nations are less likely to dedicate their economic muscle to reducing CO_2 relative to local pollutants. Thus, although emissions increase at a decreasing rate as income rises, suggesting that higher income nations tend to emit relatively less carbon dioxide per unit of income, the point at which emissions actually decrease with rising income is rarely achieved. It is therefore clear that increasing income in itself does not present a viable solution for reducing carbon dioxide emissions.

The finding of political openness as significant to the model has important implications for mitigating global climate change. It is apparent that countries that allow their citizens greater political voice may have much more success in reducing carbon dioxide emissions. However, changing the governmental structures of certain nations is hardly a reasonable solution to the climate problem. Rather, these results serve as an indication that international bodies aiming to reduce carbon dioxide emissions should strive to increase political voice in member states. For example, governing bodies such as the IPCC could ensure that all nations are allowed full participation in negotiations, and develop international forums for citizens to express opinions and concerns on environmental issues.

The results of the study open many avenues for more intensive research focusing on transportation and population density. For example, if data were used on emissions specifically from transportation, it would be possible to avoid the influence of emissions from other industrial processes on the results. Alternatively, a panel study could be done, investigating the influence of population density on emissions across time. This would allow for more focus on one particular area, rather than including a number of countries which may exhibit different impacts. However, the insignificance of population density in this model suggests that a different proxy for transportation may be needed. For example, data on road mileage could be used as an indication of vehicle travel within each country.

The variable for energy mix in this analysis also generates important conclusions on the effects of technology on carbon dioxide emissions. The fact that coal consumption was found to have a significant impact for lower income countries suggests that the use of coal may be particularly detrimental in poor countries, which do not have the technology to invest in alternative fuels or pollution-reducing equipment. These results indicate that international policy solutions which funnel more resources to developing nations for better productive technology would be useful in mitigating global carbon dioxide emissions.

The disastrous consequences of global climate change which are already becoming visible indicate that immediate action is needed to reduce human impact on the environment. The results of both this study and previous analyses have suggested not only that there are many complex factors influencing anthropogenic emissions of carbon dioxide, but these effects vary across countries, making it extremely difficult to develop international policy to curb the effects of pollution. However, the more these factors are studied and analyzed, the more likely it is that efficient policy solutions may be developed to combat global climate change.

Appendix

High/Upper Middle Income

Antigua
Argentina
Australia
Austria
Bahrain
Barbados
Belgium
Belize
Botswana
Brunei Darussalam
Canada
Chile
Costa Rica
Croatia
Cyprus
Czech Republic
Denmark
Equatorial Guinea
Estonia
Finland
France
Germany
Greece
Hungary
Iceland
Ireland
Israel
Italy
Japan
Korea, Republic
Kuwait
Latvia
Lithuania
Luxembourg
Malaysia
Malta
Mauritius
Mexico
Netherlands
New Zealand
Norway
Oman
Poland
Portugal
Qatar
Russian Federation
Saudi Arabia
Seychelles
Slovakia
Slovenia
South Africa
Spain
St. Lucia
St. Vincent
Sweden
Switzerland
Trinidad
Turkey
United Arab Emirates
United Kingdom
United States
Venezuela

Low/Lower Middle Income

Afghanistan
Albania
Angola
Armenia
Bangladesh
Belarus
Benin
Bhutan
Bolivia
Bosnia and Herzegovina
Brazil
Bulgaria
Burkina
Burundi
Cambodia
Cape Verde
Central African Republic
Chad
China
Comoros
Cote d'Ivoire
Djibouti
Ecuador
Eritrea
Ethiopia
Gambia
Guinea
Guinea-Bissau
Haiti
India
Iran
Jamaica
Jordan
Kazakhstan
Kenya
Kiribati
Kyrgyzstan
Lao People's Democratic Republic
Liberia
Maldives
Mali
Mauritania
Mongolia
Morocco
Nepal
Nicaragua
Niger
Pakistan
Paraguay
Peru
Romania
Rwanda
Samoa
Sao Tome and Principe
Senegal
Sierra Leone
Solomon
Sri Lanka
Sudan
Suriname
Thailand
Ukraine
Uzbekistan
Yemen

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