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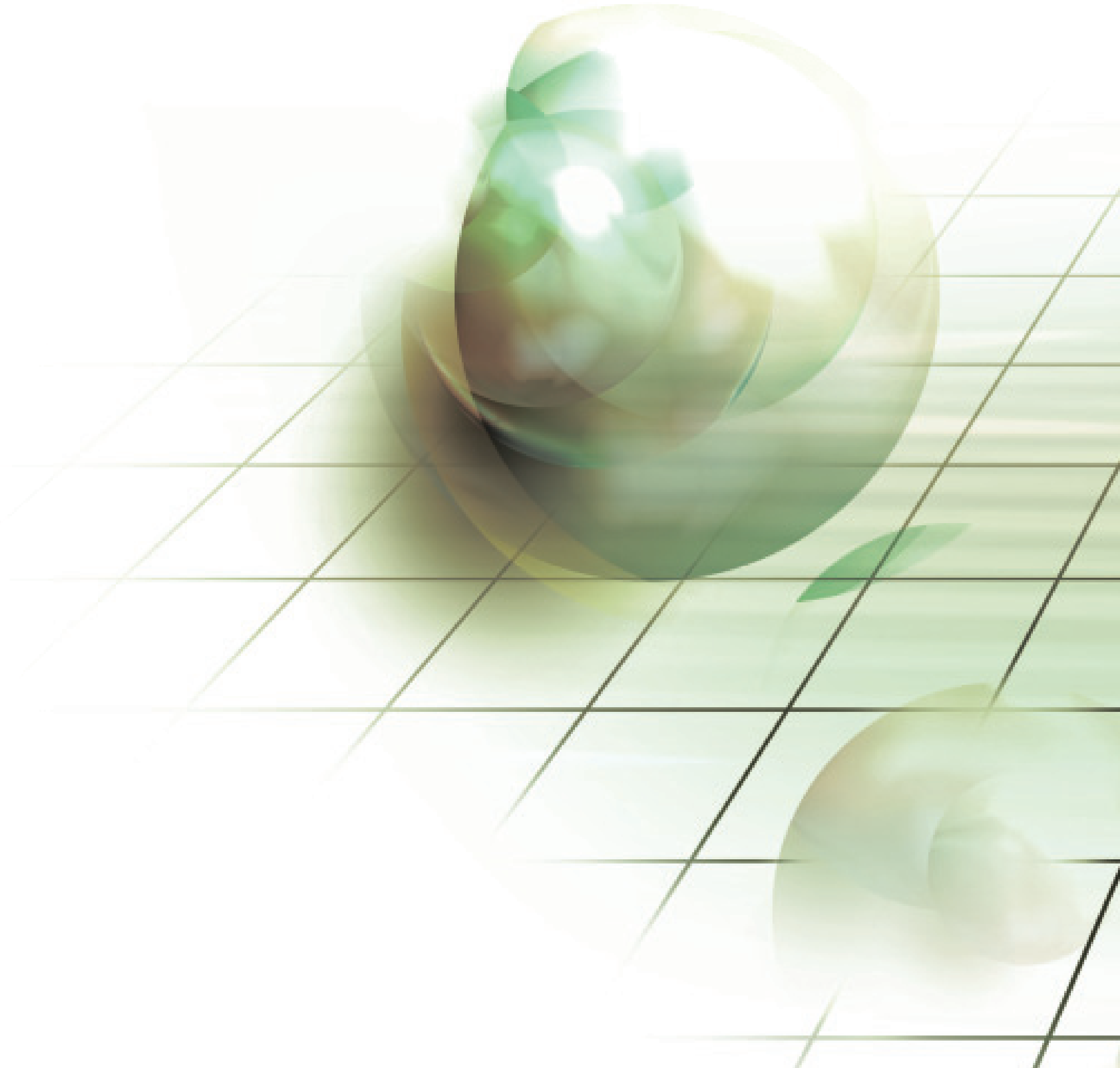
Inequality and the Environment



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Inequality and the Environment

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Abstract

This study examined the relationship between inequality and the environment, focusing on CO_2 emissions. The effects of inequality differ among OECD and non-OECD countries. In OECD countries, the environmental situation worsens as inequality increases. In non-OECD countries, the opposite results are obtained.

1. Introduction

Traditionally, researchers have been interested in the relationship between environmental quality and economic activities. Separating economic growth from environmental deterioration has attracted great attention. Therefore, the environmental Kuznets curve (EKC) hypothesis has been discussed in many studies.[1]

Recent studies have focused on the effect of inequality on environmental quality. Some researchers are concerned that achieving economic growth might not be enough to construct a sustainable society, not only from the viewpoint of distribution, but also from that of environmental issues. However, the number of studies investigating the relationship between inequality and the environment is much smaller than those investigating the relationship between economic growth and the environment. Therefore, this study focuses on the relationship between inequality and the environment. We conduct a review of the available literature and present the results of our empirical estimation.

Many studies have used the Gini coefficient as a proxy of income inequality. However, this approach often suffers from missing values and limited observations. Therefore, we use data pertaining to the "loss" of the Human Development Index (HDI) due to inequality, which are calculated by the United Nations Development Program (UNDP). To our knowledge, this study is the first to use this index as the variable of inequality. Using this index, we are able to consider several kinds of inequality in addition to income inequality. Our empirical results show that in the member countries of the Organization for Economic Co-operation and Development (OECD), more inequality results in increased CO_2 emissions. Moreover, in non-OECD countries, the opposite results are obtained.

This study is structured as follows. In section 2, we overview inequality in Asian countries. Section 3 reviews the literature investigating inequality and the environment. In section 4, we present the estimation models and data used in our study. Section 5 discusses the results. Finally, section 6 provides concluding remarks.

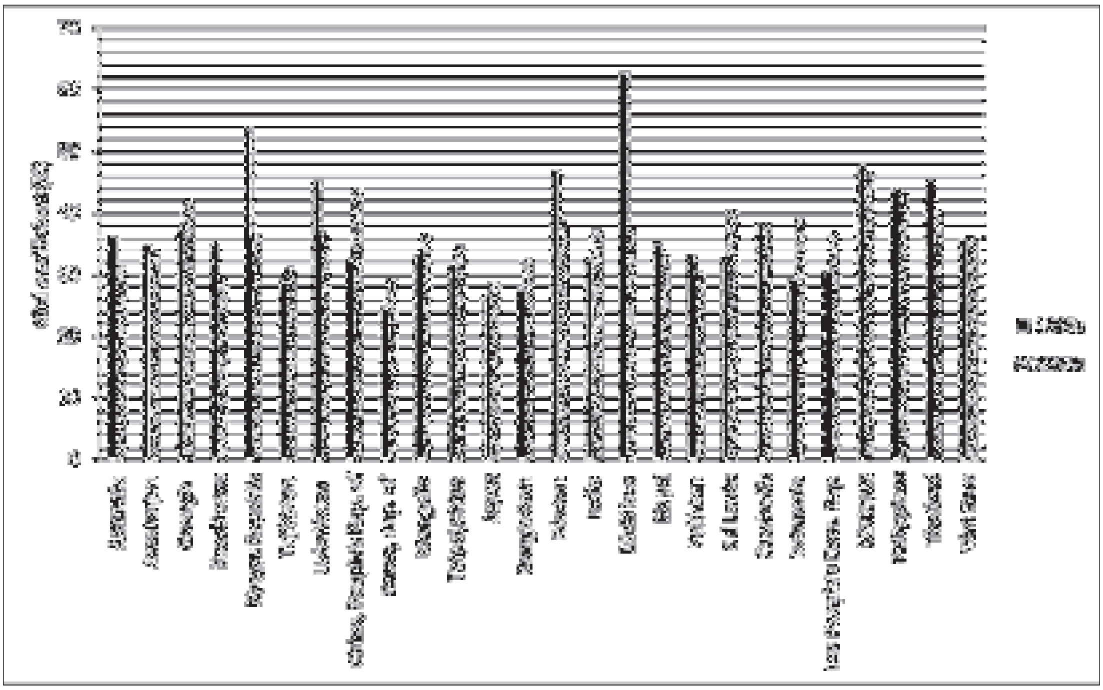
[1] For example, see Dinda (2004).

2. Overview of inequality in Asia

The Asian region has experienced high economic growth. However, the region faces growing inequality. The Asian Development Bank (2012) noted that "of the 28 countries that have comparative data between the 1990s and 2000s, 11—accounting for about 82% of developing Asia's population in 2010—experienced rising inequality of per capita expenditure or income, as measured by the Gini coefficient,"[2] and warned that "rising inequality can damp the poverty impact of economic growth, and even undermine the basis of growth itself."

Figure 1 shows the Gini coefficient for Asian countries, comparing the inequality between the 1990s and the 2000s. Georgia, China, the Republic of Korea, Mongolia, Taipei, Japan, Bangladesh, India, Sri Lanka, Indonesia, and the Lao People's Democratic Republic have experienced expanding inequality.

Figure 1. Gini coefficients of Asian countries (1990s and 2000s)

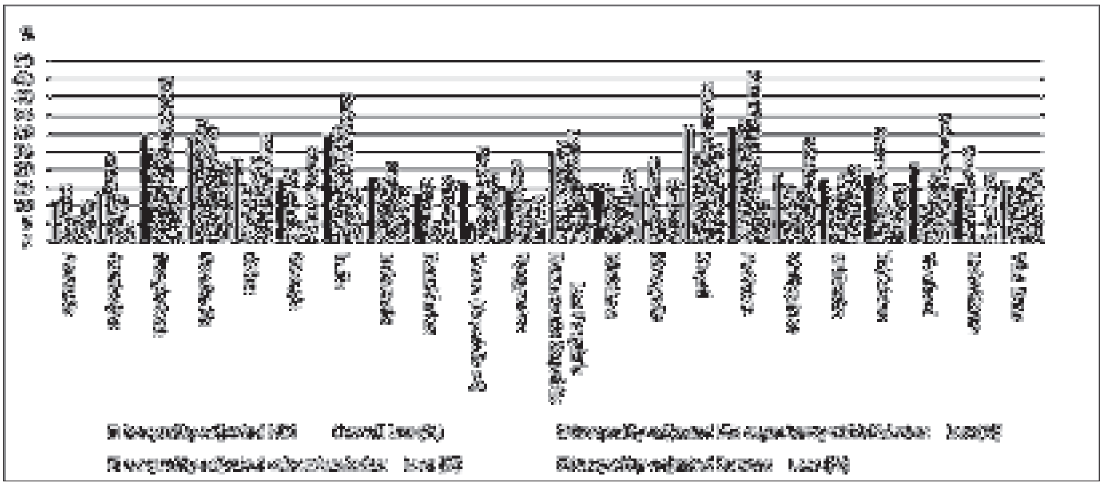


Note) With the exception of Japan, the data are obtained from the Asian Development Bank (2012). The data for Japan are obtained from Nishizaki et al. (1998) and the website of the Ministry of Internal Affairs and Communications, Statistics Bureau.

The Gini coefficient is calculated based on income or expenditure, depending on the availability of statistics. Therefore, this index focuses on economic aspects. In order to enable further investigation into inequality, UNDP (2010) developed the Inequality-adjusted Human Development Index (IHDI) and calculated loss of Human Development Index caused by inequality. In the index, UNDP (2010) classified inequality into three categories: first, a long and healthy life (life expectancy); second, access to knowledge (education); and third, a decent standard of living (income). These indices are further explained in section 4. Figure 2 shows the loss due to inequality.

[2] According to the Asian Development Bank (2012), the term "developing Asia" indicates "the 44 developing member countries of the Asian Development Bank and Brunei Darussalam, an unclassified regional member."

Figure 2. Loss in the Human Development Index caused by inequality in 2010



Note) The data are obtained from UNDP (2010).

Therefore, many researchers tend to focus on inequality itself, and a vast amount of literature is devoted to this aspect. We introduce a small portion of these studies here.

According to the Asian Development Bank (2012), the Gini coefficient for China increased from 32.4 in the 1990s to 43.4 in the 2000s. Many studies have addressed the inequality issue in China. For example, Liu (2013) used a new approach called the sequential panel selection method to conclude that 20 regions in China have not experienced a decrease in income inequality. Zheng and Kuroda (2013) examined the effect of knowledge infrastructure and transportation infrastructure on regional inequality and growth in China using simultaneous equations methods. Li and Luo (2008) argued that the government should shift to a more labor intensive development strategy, support small and medium enterprises, and unify the labor market.

For India, the Gini coefficient increased from 32.5 in the 1990s to 37.0 in the 2000s (Asian Development Bank, 2012). Barua and Chakraborty (2010) showed that regional inequality in India has been increasing and examined the effect of economic liberalization on interregional inequality. Asadullah and Yalonetzky (2012) addressed the inequality issue from the viewpoint of educational opportunity.

For the Republic of Korea, the Gini coefficient increased from 24.5 in the 1990s to 28.9 in the 2000s (Asian Development Bank, 2012). Sato and Fukushige (2009) examined the determinants of the Gini coefficient for income and expenditure. They investigated the effect of opening the goods and capital markets on income inequality. Sung and Park (2011) focused on the redistribution effects of tax and benefits in order to reduce inequality.

Therefore, various studies have dealt with inequality issues. However, the number of studies focusing on the relationship between inequality and environmental issues is considerably less. Therefore, in the next section, we introduce such studies, which are not limited to Asia.

3. Literature on inequality and the environment

The various ways in which inequality affects the environment have been investigated in the following literature.

Boyce (1994) proposed the political economy argument. He theoretically proposed the power-weighted social decision rule (PWSDR),[3] according to which the degree of environmental degradation is determined by the balance of power between the winner, who derives the net benefit from the environmental degrading activity, and the loser, who bears the net cost. When the winners are more powerful than the losers, the environmental issue will worsen. Torras and Boyce (1998), Boyce et al. (1999), and Boyce (2007) also examined the effect of inequality on the environment from the viewpoint of the political economy. These studies suggest that greater inequality of power results in greater environmental degradation, especially for environmental issues, such as air and water pollution, whose damage emerges in the short term.[4]

Among the many kinds of power inequalities, most of the empirical analyses in such literature have focused on income. The impact of income inequality on the environment was reviewed by Boyce (2007). Torras and Boyce (1998) used the Gini coefficient as a measure of income inequality to examine the impacts on air and water pollution, access to safe water, and sanitation facilities. The results differ across environmental impacts. For example, for sulfur dioxide (SO_2) and smoke, higher inequality is associated with greater environmental damage in low-income countries, while this does not hold for high-income countries. For heavy particles, higher inequality is associated with a better environment in low-income countries. Boyce et al. (1999) also considered other power inequalities besides income inequality. They investigated the relationship among power distribution, the environment, and public health using cross-sectional data of 50 US states. A measure of power distribution was derived from voter participation, tax fairness, Medicaid access, and educational attainment. They constructed a composite index as a measure of environmental policy. They found that more equal distribution of power is associated with stronger environmental policies and lower environmental stress, and that both environmental stress and power inequality are associated with adverse public health outcomes.

Scruggs (1998) believed that two implicit assumptions were made in Boyce (1994), who argued that equality results in a better environment. The assumptions are that the rich prefer environmental degradation and that democratic social choice generally results in the best outcome. Scruggs (1998) argued that these assumptions are too restrictive. Scruggs (1998) employed the Gini coefficient in the empirical analysis and argued that the results suggesting a systematic positive relationship between inequality and the environment, such as water and air pollution, are not robust enough.

Magnani (2000) showed that individual heterogeneity, relative income effect, and political framework are important to decrease the environmental burden. Magnani (2000) empirically examined the effect on public R&D expenditure for environmental protection using data from OECD countries and found that the Gini coefficients did not show a significant impact. On the other hand, when the ratio of income shares of the first and fourth quintile of the income distribution is used as the index of inequality, the estimated impacts were negatively significant in some models.

Heerink et al. (2001) focused on the relationship between income and environmental damage. When the relationship is concave, redistributing income from rich households to poor households increases the total level of environmental damage. Therefore, decreasing inequality increases the environmental burden. This contradicts the PWSDR. However, when the relationship between income and environmental damage is convex, decreasing inequality reduces the environmental damage. This is in agreement with the PWSDR. In the empirical analysis, Heerink et al. (2001) used the Gini coefficient as the index of inequality and showed that income equalization improves access to safe water and urban sanitation. They showed that deforestation could also be prevented by income equalization. However, their results indicated that income inequality reduces the problems associated with CO_2 emissions and soil nutrient depletion.

[3] Boyce (2007) summarized five types of power (purchasing power, decision power, agenda power, value power, and event power) influencing decisions on environmental protection. Boyce (2007) noted that depending on the society in question, these powers are correlated to wealth, income, race, ethnicity, gender, age, and so on.

[4] Another contribution of these studies is their examination of the possibility that less powerful people bear a disproportionate cost of environmental degradation. For example, the location of hazardous waste sites tends to be correlated to power. For a review on this issue, see Boyce (2007). In this article, however, we focus on how inequality in a society affects the overall environment burden.

Coondoo and Dinda (2008) used the Lorenz curve and the specific concentration curve to show that the distributional inequality of income as well as the mean income is associated with environmental damage. They showed that environmental damage changes its characteristics from a luxury good to a necessary good, and further to an inferior good, as income grows. They tried to theoretically link intra-country income distribution and intra-country demand for environmental damage. For their empirical analysis, they used the cointegration approach and focused on inter-country income distribution. Their results showed that inter-country income inequality has a significant effect on mean CO_2 emission levels and inter-country inequality of CO_2 emission levels.

Vona and Patriarca (2011) used the dynamic model and theoretically showed that in rich countries, environmental innovations are promoted by equal income distribution. In their empirical analysis, they examined the effects of income inequality (Gini coefficient) on the development of environmental technologies (public environmental R&D, turnover of eco-industries, and the quota of priority patent applications in selected environmental domains) using OECD data, since innovations tend to be conducted by rich countries. The results showed that inequality negatively affects environmental innovations and per capita income tends to be the paramount factor in poorer ones.

Farzin and Bond (2006) conducted an empirical analysis and found that the effects of democracy and freedom on the environment differ among pollutants. The effect of income inequality measured by the Gini coefficient also varied depending on the pollutants. The interaction term between income inequality and the degree of democracy was positively estimated for CO_2 and ambient SO_2 concentrations. Therefore, more inequality increased CO_2 and ambient SO_2 concentrations, and this effect was found to be stronger for democratic countries. However, the interaction terms were negative for non-methane volatile organic compounds (VOCs) and SO_2 emissions. For CO_2, VOCs, and SO_2 emissions, the signs of the interaction terms among income inequality, degree of democracy, and gross domestic product (GDP) are the opposite of the signs of the interaction terms between inequality and democracy.

Kempf and Rossignol (2007) adopted the political-economy perspective and used the endogenous growth model in order to examine the relationship between inequality and the environment in a growth economy. Based on the majority decision-making rule in politics, they theoretically showed that the poorer the median voters, the more they value material wellbeing over environmental protection. Therefore, public expenditure is used to support material growth instead of environmental protection. This means that the more unequal the society, the more damage the environment.

UNDP (2011) discuss the issue on sustainability and equity from a broad perspective, including how environmental damage affect inequality.

4. Model and data

In section 3, we reviewed the previous literature. In sections 4 and 5, we introduce our empirical study. In the previous studies, the Gini coefficient was the most popular index of inequality. Our study is unique in that we use the loss in the HDI due to inequality, which was calculated by UNDP (2010), as the index of inequality. Using this index, we can consider several kinds of inequalities in addition to income inequality. We do not restrict our sample to Asian countries, since such a restriction would reduce our sample size.

In this section, we present the econometric models and the data used to examine the relationship between inequality and the environment. Notably, we focus on CO_2 emissions. CO_2 has global, indirect, and long-term impacts. Therefore, it is quite difficult to identify the income level at which CO_2 emissions start to decrease, compared to other substances that have short-term and local impacts.[5] Therefore, we have to further investigate

[5] For a related literature review and discussion on this issue, see Dinda (2004).

the possible factors influencing CO_2 emissions. Accordingly, we estimate expression (1).

$$\ln\left(CO_2\,per\ capita_i\right) = \alpha + \beta_1 \ln\left(GDP\ per\ capita_i\right) + \beta_2 \{\ln\left(GDP\ per\ capita_i\right)\}^2 +$$

$$\beta_3\ Popdensity_i + \beta_4\ Urbanpop_i + \beta_5\ Democracy_i + \beta_6\ Inequality_i + u_i \qquad (1)$$

The dependent variable is the log of CO_2 per capita in each country. The data of CO_2 emissions were calculated using the sectoral approach by the International Energy Agency (2012).

The dependent variables include the log of GDP per capita and its square. These terms are included to observe the impact of economic wealth on CO_2 emissions. GDP is measured by purchasing power parity (current international $). The data are sourced from *World Development Indicators* (WDI) published by the World Bank.

Popdensity indicates population density, measured by people per square km of land area. The data are obtained from WDI. For areas with low population density, the transport sector may tend to emit large amounts of CO_2 given the poorer availability of public transportation. For details about the link between population density and CO_2 emissions, see Grazi et al. (2008).

Urbanpop indicates the share of the urban population in the total population. The data are obtained from WDI. Rivera-Batiz (2002) discussed that urbanization might be associated with agglomeration economies, leading to new industries, goods, and services. This means that innovation is stimulated. According to Dinda (2004), technological progress entails mixed effects. One aspect is that technological progress allows higher efficiency in the use of energy. Another aspect is that new technologies might produce potential dangers in the environment. Torras and Boyce (1998) noted that while urbanization is related to heavier pollution, it may reduce the environmental burden through economies of scale.

Democracy indicates the degree of democracy. Democracy is likely to be associated with the environment. For example, Farzin and Bond (2006) argued that democracy contributes to the environment, in that people can state their preference for the environment more effectively, compared to autocracy. In our analysis, the data for democracy are obtained from the Polity IV Project. We use the polity2 score as the independent variable. This score ranges from +10 (strongly democratic) to −10 (strongly autocratic).

Inequality indicates the index of inequality. The previous studies reviewed in section 3 focused on income inequality. In our analysis, in addition to income inequality, we analyze inequality in a broader sense. The *Human Development Report* published by UNDP provides calculations of the HDI. According to the UNDP (2010), the HDI measures the average achievements in three basic dimensions of human development: a long and healthy life (life expectancy index), access to knowledge (education index), and a decent standard of living (income index) (for details about the HDI, see UNDP (2010)). The UNDP (2010) has developed the Inequality-adjusted HDI (IHDI). According to its technical note, "The IHDI accounts for inequalities in HDI dimensions by 'discounting' each dimension's average value according to its level of inequality. The IHDI equals the HDI when there is no inequality across people but is less than the HDI as inequality rises." UNDP (2010) reports not only the IHDI and the HDI, but also the "loss" due to inequality in each dimension, which is explained as follows: "The 'loss' in potential human development due to inequality is given by the difference between the HDI and the IHDI and can be expressed as a percentage." Therefore, we use the "loss" due to inequality as the measure of inequality. In particular, we use two indices. The first index is the overall loss index, which includes inequalities in all the three dimensions (we name the variable *Overall_loss*). The second index is the income loss index, which shows the inequalities related to income (we name the variable *Income _ loss*).

Due to data availability, our sample period is restricted to the year 2010, which is the only year for which both the IHDI and CO_2 emissions values are available at the date when we collected the data. The sample countries are those for which IHDI data are available. However, when data of other variables are missing for a country, we exclude it from the sample. We separate the sample countries into OECD and non-OECD countries, since these two groups tend to have different characteristics.[6]

Inequality might be an endogenous variable. Therefore, we conduct the test of endogeneity. When inequality is found to be an endogenous variable, we use the instrumental variable method. In doing this, the additional instrumental variable is *Youngpop*, which indicates the share of the young population (under age 14 years) in the total population. We obtain this data from WDI. We use robust standard errors in the estimation.

The descriptive statistics are shown in Table 1.

Table 1. Descriptive statistics

OECD	Mean	Std. Dev.	Min	Max
$\ln(CO_2\, per\ capita)$	−11.62	0.42	−12.30	−10.78
$\ln(GDP\ per\ capita)$	10.55	0.27	10.15	11.35
Popdensity	164.19	151.19	2.87	508.86
Urbanpop	78.87	10.004	60.51	97.46
Democracy	9.77	0.61	8	10
Overall_loss	9.3	2.42	6.5	16.7
Income_loss	17.17	3.63	11.3	23.9
non-OECD	Mean	Std. Dev.	Min	Max
$\ln(CO_2\, per\ capita)$	−13.37	1.36	−16.81	−10.34
$\ln(GDP\ per\ capita)$	8.68	0.97	5.92	10.19
Popdensity	107.10	145.40	1.75	1160.99
Urbanpop	54.20	19.05	13.44	93.31
Democracy	4.24	5.76	−9	10
Overall_loss	22.88	9.92	6.1	45.3
Income_loss	24.55	12.04	4.4	68.3

[6] Our sample includes the following countries. OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Korea (Republic of), Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.
Non-OECD countries: Albania, Angola, Armenia, Azerbaijan, Bangladesh, Belarus, Benin, Bolivia (Plurinational State of), Brazil, Bulgaria, Cambodia, Cameroon, Chile, China, Colombia, Congo, Congo (Democratic Republic of the), Costa Rica, Croatia, Cyprus, Czech Republic, Dominican Republic, Ecuador, Egypt, El Salvador, Estonia, Ethiopia, Gabon, Georgia, Ghana, Guatemala, Haiti, Honduras, Hungary, India, Indonesia, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Latvia, Lithuania, Mexico, Moldova (Republic of), Mongolia, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Nigeria, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Romania, Russian Federation, Senegal, Serbia, Slovakia, Slovenia, South Africa, Sri Lanka, Syrian Arab Republic, Tajikistan, Tanzania (United Republic of), Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Turkmenistan, Ukraine, Uruguay, Uzbekistan, Venezuela (Bolivarian Republic of), Viet Nam, Yemen, Zambia. In the analysis for *Income_loss*, we also included Malaysia.

5. Results

The results for OECD and non-OECD countries are summarized in Table 2 and Table 3, respectively.

Table 2. Results for OECD countries

Dependent variable	Log of CO_2 per capita	
$\ln(GDP\ per\ capita_i)$	14.6776	6.4497
	(1.19)	(0.53)
$\{\ln(GDP\ per\ capita_i)\}^2$	−0.6384	−0.2562
	(−1.12)	(−0.46)
$Popdensity_i$	−0.0003	−0.0001
	(−0.48)	(−0.18)
$Urbanpop_i$	0.0183*	0.0167*
	(2.09)	(1.94)
$Democracy_i$	0.1483	−0.0484
	(1.26)	(−0.34)
$Overall\_loss$	0.1124***	
	(3.48)	
$Income\_loss$		0.0543**
		(2.62)
$Constant$	−99.2539	−52.8905
	(−1.47)	(−0.80)
Sample size	22	22
R^2	0.49	0.46

Note) Values in parentheses are *t*-values.*, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

In the analysis of OECD countries, the robust Durbin–Wu–Hausman test could not reject the hypothesis that the inequalities are exogenous. Therefore, we use the generalized regression model with robust standard errors. In the analysis of non-OECD countries, the robust Durbin–Wu–Hausman test rejected the null hypotheses that *Overall_loss* is exogenous at 5% and that *Income_loss* is exogenous at 1%. Therefore, we use the instrumental variable method with robust standard errors for non-OECD countries.

In (*GDP per capita*) is positively significant for non-OECD countries and not significant for OECD countries. This might be partly because the variance for OECD countries is small. The quadratic term is not significant for non-OECD countries. Therefore, for non-OECD countries, CO_2 levels increase as the GDP increases.

Urbanpop is positively significant only for OECD countries. Therefore, living in urban areas in OECD countries emits much CO_2.

Table 3. Results for non-OECD countries

Dependent variable	Log of CO_2 per capita	
$\ln(GDP\ per\ capita_i)$	2.4252**	3.3218**
	(2.42)	(2.43)
$\{\ln(GDP\ per\ capita_i)\}^2$	−0.0828	−0.1251
	(−1.32)	(−1.52)
$Popdensity_i$	−0.00004	−0.0005
	(−0.14)	(−1.13)
$Urbanpop_i$	−0.0035	−0.0004
	(−0.53)	(−0.05)
$Democracy_i$	−0.0295**	−0.0109
	(−2.21)	(−0.56)
$Overall\_loss$	−0.0447***	
	(−3.62)	
$Income\_loss$		−0.0485***
		(−2.76)
$Constant$	−26.7677***	−31.3531***
	(−6.70)	(−5.61)
Sample size	81	82
Wald's χ^2	483.78	308.17
Test of endogeneity	4.75	11.03

Note) Values in parentheses are *z*-values. *, **, and *** denotes significance at the 10%, 5%, and 1% level, respectively.

Democracy is negatively significant for non-OECD countries. The degree of democracy differs widely among non-OECD countries, ranging from −9 to 10 for non-OECD countries, and from 8 to 10 for OECD countries. In non-OECD countries, democracy might be associated with CO_2 reduction. However, the relationship is not robust, since it is not significant when we use *Income_loss* as the index of inequality.

The effect of inequality differs between OECD and non-OECD countries. For OECD countries, inequality is positively significant. This result is consistent with those of Vona and Patriarca (2011) and Kempf and Rossignol (2007), namely that environmental degradation worsens as inequality grows in rich countries and democratic countries, respectively.

The situation described in Kempf and Rossignol (2007) might be partly similar to the situation in some OECD countries. It seems that the existence of inequality makes the introduction of positive environmental policies difficult.

Although Japan is not included in our sample (due to missing data), we present an example from Japan. Japan could not have introduced effective climate change policies. Although the country introduced the emissions trading scheme in 2005, it was implemented on a voluntary basis only.[7] In 2012, the tax policy for climate change mitigation

[7] Tokyo city introduced a mandatory emissions trading scheme. However, it is limited to facilities in Tokyo city.

was introduced. However, the tax rate is not high.[8] The Ministry of Health, Labour and Welfare (2013) noted that the Gini coefficient for Japan increased in the 2000s. Before the redistribution of income, the Gini coefficient was 0.4720 in 2000, 0.5263 in 2006, and 0.5536 in 2011.[9] GDP per capita growth rates were 2.1% in 2000, 1.7% in 2006, 4.7% in 2010, and –0.9% in 2011 (World Bank, 2013). Therefore, in the 2000s, Japan's condition pertaining to inequality and economic growth rate was not good. It is possible that the growing inequality is one of the reasons for the failure in introducing effective environmental policies in Japan. However, it is difficult to separate the effect of inequality from that of low economic growth, in order to attribute one or the other to the failure in introducing specific policies.

Korea is included in our sample as an OECD member country. Among the 22 OECD countries in the sample, Korea ranked 1st in *Overall_loss* and 9th in *Income_loss* in 2010. GDP per capita growth rates were 7.6% in 2000, 4.7% in 2006, 5.8% in 2010, and 2.9% in 2011 (World Bank, 2013). Although, per capita growth rates are higher than those in Japan, it is not easy to introduce climate change policies in this country either. For example, around 2010, Korea postponed the introduction of the emissions trading scheme, the future of which remains unclear.[10] Both countries assigned higher priorities to industrial competitiveness and business condition.

In non-OECD countries, inequality is negatively significant. This result is consistent with the situation described in Heerink et al. (2001), that decreasing inequality increases environmental burden when the relationship between income and environmental damage is concave. Like our study, their empirical result shows that inequality has a negatively significant effect on CO_2 emissions per capita.

6. Conclusion

This study examined the relationship between inequality and the environment. In many cases, large inequality itself is of great concern. In addition, some researchers are interested in the effects of inequality on the environment. Previous studies have shown both positive and negative relationships depending on the characteristics of the countries and their environmental problems.

We conducted an empirical analysis focusing on CO_2 emissions. The effects of inequality differ among OECD and non-OECD countries. In OECD countries, the environmental situation worsens as inequality increases. In non-OECD countries, the opposite results are obtained. We need detailed data for each country in order to investigate specific characteristics for individual countries.

[8] Details for this tax can be found at the website of the Ministry of the Environment http://www.env.go.jp/en/policy/tax/env-tax.html (accessed October 2013).

[9] According to the Ministry of Health, Labour and Welfare (2013), after redistribution of income, the values of the Gini coefficients become 0.3814, 0.3873, and 0.3791 for 2000, 2006, and 2011, respectively.

[10] According to Lee (2013), one of the major reasons for this is Japan's failure in introducing a mandatory emissions trading scheme. In this case, the introduction of mandatory emissions trading in Korea alone would have reduced its competitiveness, since these two countries are market competitors.

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