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Rule of Law and Environmental Policy Stringency

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by

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Abstract

This paper develops a single equation and a simultaneous equation system to analyze how rule of law influences a country's environmental policy stringency. The single equation is to investigate the direct effect of rule of law on the environmental policy. The equation system is to examine the indirect effect of rule of law on stringency that operates through income. Using cross country data in year 2000, the result provides evidence to support the positive relationship between rule of law and environmental policy stringency. The empirical finding indicates that both rule of law and income have direct favorable effects on policy stringency. The simultaneous equation system shows that rule of law and income are mutually reinforcing. The total effect of rule of law on policy stringency is positive and very likely to be stronger than its direct effect.

Keywords: rule of law, environmental policy stringency, income

JEL Classification: Q56, Q58,C30

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1 Introduction

The environmental policy stringency directly affects the environmental quality of a country. Identifying the factors that contribute to the variation of environmental policy stringency among nations is an interesting research topic for scholars who are concerned with sustainable growth. Studies show that economic development is an important determinant for environmental policy stringency. A strand of literature on the Environmental Kuznets Curve (EKC) provides empirical evidence that environmental quality improves after income exceeds a turning point (Grossman and Krueger (1991)(7), Panayotou (1997)(17), Carson, Jeon and McCubbin (1997)(2), Shafik and Bandyopadhyay (1992)(19), Kaufmann, Davidsdottira, Garnhama and Pauly (1998)(11)). An explanation for the inverse U shaped curve is that resource use increases and environmental degradation worsens during the early stages of development in order to satisfy the need of production. But when incomes grow over a certain level, increased demand for environmental quality enters into decision making process which improves policy stringency.

As indicated by the EKC, any factor that significantly affects incomes has environmental implications. In a study of the determinants of economic growth, Barro (1996)(1) finds the maintenance of the rule of law, free markets, small government consumption, and high human capital have positive relationships with higher income per capita. Economic theory provides a framework to analyze the linkage between the last three factors and incomes. But there is not much discussion in the literature of the relationship between the rule of law and incomes . An interesting question worth further study is the effect coming from the interplay of income and rule of law on the environmental policy. While a higher degree of rule of law paves the way for a thriving economy, the increase in living standard could also lead to the improvement of rule of law.

The environmental policy stringency can be defined as ”scope and success in implementation of environmental policy”(9). It includes how ambitious the environmental policy target is, relative to the baseline standard and the determination of the government to enforce the environmental regulation. Based on the definition, governance ability is another important determinant of environmental policy efficacy in addition to economic development. Torras and Boyce (1998)(22) found that a high level of protection for political rights and civil liberties has particularly strong effects on environmental quality in low-income countries. Leventhal (1974)(12) analyzes the increasingly important role courts play in strengthening the enforceability and accountability of the environmental policy. His study shows the fairness and accessibility of procedural justice and the legal system can greatly support a country’s environmental policy. Magnani (2000)(14) suggests that well-defined property rights, democratic voting systems, and respect for human rights can create synergies that lead to increased levels and efficacy of environmental policy. According to a World Bank report on governance(10), human rights protection, a fair judicial system, and well defined property rights are indicative of a country’s rule of law development.

Based on the previous research, both economic growth and the development of rule of law directly affect the environmental policy. But the total effect of rule of law, through the feedback relationship between incomes and rule of law, on environmental policy stringency has not yet been

discussed. The objective of this study is to analyze the overall effect of rule of law on environmental policy efficacy. For this purpose, our study will first examine the direct effects rule of law and economic development have on the environmental policy stringency. Then, we will propose a simultaneous equations model that includes the variables identified as the factors that influence rule of law and incomes. The analysis aims to reveal the effects of rule of law and incomes on each other. By aggregating the direct effect and indirect effect that run through the system of equations, we can gain a clear understanding of the contribution that rule of law makes in improving environmental policy.

The study consists of three parts. The first part will analyze the effects of income per capita and rule of law on the environmental policy stringency. Empirical data will be used to support the argument that it is insufficient to use income per capita alone to explain the differences in environmental standard across countries. The second part of the study will discuss the mutually reinforcing effect between income per capita and rule of law. In this part, the factors that affect the development of rule of law will be identified. Then, the total effect of rule of law on environmental policy stringency will be estimated. Part three is the conclusion, where the implication of the study will be discussed in order to shed light on how to curb the environmental degradation in the developing countries.

2 The effect of rule of law on the environmental policy efficacy

Rule of law directly influences policy stringency by strengthening enforceability and government accountability. At the same time, rule of law promotes economic growth, which in turn creates greater demand for environmental quality. The direct and indirect effects of rule of law on the level of environmental policy stringency are represented by the following equation.

$$S = F(R, Y(R)) \tag{1}$$

S denotes the stringency level. It could be the emission level or a technology standard adopted in the water, air or toxic release regulation. We will provide a detailed definition of environmental policy stringency in the following subsection. R denotes the level of rule of law and Y is the income per capita. Differentiating Equation 1 with respect to the rule of law yields the following result:

$$\frac{dS}{dR} = \frac{\partial F(\bullet)}{\partial R} + \frac{\partial F(\bullet)}{\partial Y}\frac{dY}{dR} \tag{2}$$

According to our previous discussion, $\frac{\partial F(\bullet)}{\partial R}$ and $\frac{dY}{dR}$ are expected to be positive in all countries and $\frac{\partial F(\bullet)}{\partial Y}$ is expected to be positive at least in those countries on the right side of the EKC.

The empirical validity of Equation 1 can be evaluated by estimating a regression based on the following specification:

$$S = \alpha_0 + \alpha_1 R + \alpha_2 Y + \epsilon \tag{3}$$

At the first glimpse, equation 3 may appear to be a minor variation on familiar EKC models. However, two distinctions should be noted. First, in equation 3 the dependent variable is environmental policy stringency instead of environmental quality. Environmental policy stringency is closely related to environmental quality, but they are not equal. Second, the EKC literature has not yet discussed the possible effect of rule of law on environmental policy. According to our previous analysis, α_1 is expected to be positive globally and α_2 is expected to be positive at least for countries past the turning point of the EKC.

A large number of EKC studies use income per capita as the most important variable in explaining the change in environmental quality. This raises the question whether it is necessary to use some other variables in addition to income to explain the policy stringency. Table 1 provides strong support for the argument that income alone is insufficient to explain the efficiency of environmental regulatory regime.

In Table 1, ERRI summarizes the quality of environmental regulatory systems covered by the 2001 Global Competitiveness Report. We use it as an index for environmental policy stringency. As Esty and Porter point out in the report, this index not only provide information regarding which countries rank at the top but which countries rank at the bottom. More importantly, the index helps identify countries with drastic differences in their environmental policy performances despite similar incomes ranks.

In Table 1, a country's stringency score is ranked from high to low. Columns 4 and 8 are the income per capita ranking for that country in year 2000. Reading the stringency score and income ranking at the same time, it is clear that the stringency cannot be simply explained by income. For example, Norway ranks first in income per capita, but its ERRI ranking falls far behind that of Finland, whose income ranking is only 19th. Jordan's income per capita is among the lowest but its ERRI ranking is above average.

Table 1 indicates the necessity to explore other variables besides income to explain environmental policy efficacy. Based on the literature review, we believe rule of law may have a profound impact on the stringency. Equation 3 is a useful starting point for analysis of the direct effect of rule of law on policy stringency. However, equation 3 neglects the indirect effect of rule of law on stringency when rule of law affects income. The solution to this problem is to propose a simultaneous equation system using both income and rule of law as dependent and explanatory variables. If, as we expect, rule of law and economic prosperity mutually reinforce each other, a model with such feedbacks is necessary to capture the interactive relationships of the two variables. A fuller discussion on the specification of the equation system will be presented in the second part of the

Table 1: Environmental Regulatory Regime Index by absolute ranking

ERRI Rank	Country	Score	Income Rank	ERRI Rank	Country	Score	Income Rank
1	Finland	2.303	19	37	Korea	-0.121	26
2	Sweden	1.772	16	38	Malaysia	-0.127	30
3	Singapore	1.771	3	39	Lithuania	-0.146	40
4	Netherlands	1.747	5	40	Slovak Republic	-0.177	33
5	Austria	1.641	6	41	Egypt	-0.224	57
6	Switzerland	1.631	4	42	Panama	-0.242	47
7	Germany	1.522	13	43	Mauritius	-0.290	28
8	France	1.464	15	44	China	-0.348	62
9	Denmark	1.385	10	45	Thailand	-0.389	48
10	Iceland	1.354	7	46	Colombia	-0.416	49
11	New Zealand	1.299	22	47	Bulgaria	-0.584	50
12	Canada	1.297	8	48	Mexico	-0.602	37
13	United Kingdom	1.185	18	49	Greece	-0.619	23
14	United States	1.184	2	50	Peru	-0.722	55
15	Belgium	1.159	12	51	Argentina	-0.732	32
16	Australia	1.083	11	52	Zimbabwe	-0.732	66
17	Japan	1.057	14	53	Bolivia	-0.743	64
18	Norway	1.045	1	54	Indonesia	-0.758	61
19	Ireland	0.546	9	55	India	-0.759	67
20	Italy	0.489	17	56	Vietnam	-0.770	68
21	Spain	0.437	20	57	Russia	-0.895	43
22	Estonia	0.296	38	58	Sri Lanka	-0.936	58
23	Hungary	0.283	31	59	Philippines	-1.014	63
24	Slovenia	0.209	25	60	Dominican Republic	-1.014	46
25	Chile	0.177	29	61	Venezuela	-1.079	36
26	Czech Republic	0.073	27	62	Nicaragua	-1.164	69
27	Uruguay	0.059	34	63	El Salvador	-1.215	54
28	Israel	0.021	21	64	Romania	-1.288	51
29	Poland	0.005	35	65	Ukraine	-1.297	52
30	Jordan	0.002	60	66	Honduras	-1.300	65
31	Portugal	-0.028	24	67	Nigeria	-1.314	71
32	South Africa	-0.029	41	68	Bangladesh	-1.331	70
33	Latvia	-0.036	44	69	Guatemala	-1.532	53
34	Jamaica	-0.037	45	70	Ecuador	-1.616	56
35	Brazil	-0.077	42	71	Paraguay	-1.616	59
36	Costa Rica	-0.078	39				

empirical study.

3 The data

Dependent Variable

Cross-country variation is of primary interest in our analysis. The question to be addressed here is whether counties with a higher level of rule of law also have better environmental regulatory regimes. For this purpose, single regulatory standards are insufficiently representative because the dependent variable should be able to capture the overall efficacy of a country's environmental regulatory regime. For example, a country could have relatively strict air pollution legislation but a lax waste management policy. If the chosen single regulatory standard is air, it may overstate the rigorousness of the country's regulatory regime. Also, policy stringency is often eroded by weak

enforceability and the regime erosion cannot be detected just from reading the environmental standard. Since the regulatory standard cannot really represent that actual state of an environmental regime, an indicator that synthesizes the design of the environmental regime, the regulatory enforcement, institutional engagement, and the general policy stringency should be a more adequate measurement.

In the 2000–2001 Global Competitiveness Report, Esty and Porter(4) provide an environmental regulatory regimes index (ERRI) which measures the efficiency of the national environmental policy. The index contains 71 countries' absolute rankings in year 2001. ERRI is aggregated from data representing different aspects of a country's regulatory approach. The ERRI data categories include:

- stringency of environmental pollution standards
- sophistication of regulatory structure
- quality of the environmental information available
- extent of subsidization of natural resources
- strictness of enforcement
- quality of environmental institution

The stringency of standards category includes measures of the perceived rigor of a nation's air pollution, water pollution, toxic waste, and chemical regulations. The regulatory structure category measures the degree to which a nation's environmental regulations are designed to promote cooperative business-government relations in terms of the flexibility, consistency, progressiveness and structure. The information category measures the degree to which a nation has a sufficient data foundation for policymaking and to support enforcement of environmental regulations. The subsidies measure the extent of a country's subsidization of energy and other materials. The strictness of enforcement assesses the aggressiveness with which a nation's environmental regulations are enforced and the depth of a country's commitment to treaty requirements and other international environmental obligations. The institutional quality category looks into the degree to which intergovernmental organizations and nongovernmental entities (environmental groups, community organizations, business associations, and other elements of civil society) strengthen governmental endeavor in environmental issues.

The ERRI subjective components are drawn from two major sources, Global Competitiveness Report Survey 2000–2001 and Environmental Sustainability Index (ESI) 2001. The latter is a project undertaken by the World Economic Forum. The shortcoming of ERRI is that it contains only 71 countries in the dataset. The countries that are not included are those for which data on some components of the ERRI are missing. These omitted countries include many with lower income per capita. As a result, the left side of the EKC is likely to be under-represented in the

sample of countries for which ERRI has been calculated.

Explanatory Variables

We use one of the World Bank's Worldwide Governance Indicators (WGI)–rule of law, to capture perceptions of the extent to which agents have confidence in and abide by the rules of the society. The rule of law index covers 212 countries and territories. It measures the governance capacity between 1996 to 2008. However, data in year 1997, 1999 and 2001 do not exist. WGI is derived from perceptions-based data, which reflect the views of a diverse range of informed stakeholders, including household and firm survey respondents as well as experts working for the private sector, nongovernmental organization and public sector agencies.

The concept of rule of law is measured by assessment of different aspects of a country's legal development. It includes the following aspects of a country's legal stage:

- The protection of economic rights (i.e. property rights and intellectual property rights) and human rights
- Quality of contract enforcement
- The likelihood of crime and violence
- The quality and accessibility of the judicial system
- Law enforcement (trust in police)
- Respect for law in relations between citizens and administration

The category of protection of human rights and economic rights includes the perceived security of property rights and political rights. The contract enforcement category measures both public and private sectors' accountability in enforcing contracts. The crime and violence category measures the threat individuals and businesses face from crime and the quality of the police force. The judicial system category measures the strength, impartiality and independence of the legal system as well as the fairness of the judicial process. The law enforcement category measures the strictness with which the law is enforced by the authorities. The respect for law category measures the extent to which individuals and governments behave in conformity with the legal rules.

According to Kaufmann, Kraay and Mastruzzi (2009)(10) in the WGI project report, the composite country scores for rule of law in each period are scaled to have a mean of zero and a standard deviation of one. All the country scores are bounded between positive and negative 2.5. Because the renormalization procedure applies to each year's data, we are unable to detect any trends in global averages of rule of law over time. Comparing changes in rule of law across different years is not possible. However, it provides a clear picture in the change of countries' relative positions over time.

Due to the absence of year 2001 data, we use rule of law index for 2000 in our study. The stringency index comes from surveys conducted in 2000–2001. We believe the year 2000 rule of law index is appropriate for the purpose of our research.

The per capita income data comes from the Penn World table. They are expressed in real purchasing power parity (PPP) adjusted dollars. For the 2000 income per capita, the reference year is 1996. The 2001 Global Competitiveness Report shows a strong, positive linear relationship between income per capita and policy stringency for the sample of countries with data for ERRI. Therefore, our model does not use a cubic functional form of income per capita, which is a common practice in many EKC studies (Shafik (1994) (18) and Grossman and Krueger(1995)(8) for example).

Subjective Indicators

Both ERRI and WGI are based exclusively on subjective data rather than objective data. A common argument against using a subjective index is that perceptions can be biased and varied from individual to individual. However, in many cases the objective data could be even worse, because of sharp divergences between *de jure* and *de facto* measures. For example, if country A has a higher crime rate per capita than country B, it could mean that residents of country A violate the law more frequently or that a higher proportion of crimes in country A are reported.

So called "fact-based" data often only captures the notion of law "on the books" which is substantially different from the reality that exists "on the ground". For example, violating environmental regulations could involve criminal, civil and administrative punishment. But if the authority only resorts to administrative measures for noncompliance, any severe criminal or civil punishment written in the law becomes irrelevant. In the same way, using regulatory standards to represent the policy stringency may overstate the level of conservation practiced in a country.

Subjective indicators allow for assessment of aspects of governance for which objective data are not available. For example, to evaluate the quality of the judicial system, it is necessary to ascertain the fairness of courts and the accessibility of legal procedures, which can only be measured subjectively. Individuals choose their actions based on their impression on the government system. When confidence in the the quality of the judicial system is weak, people are unlikely to avail themselves of its services and more likely to violate the society's legal rules.

The major concern about subjective indicators is their margin of error. A reliable estimate should be based on a large sample, which would improve the statistical precision. In our study, the sample sizes for both ERRI and rule of law are very large. It means both indicators should be able to provide a close approximation to the fact.

4 Result

Table 2 shows the results from regressions that use the framework of the previous section. The regression applies to 71 countries. The dependent variable is the environmental policy stringency of year 2001. The explanatory variables are the rule of law index and income per capita of year 2000. The estimates are obtained by using Ordinary Least Squares (OLS).

Table 2: Regression analysis for stringency

Explanatory variable	Constant	Rule of Law	Income per capita (in thousand)
Coefficient	-0.66	0.66	0.02
t-ratio	(-5.73)	(6.05)	(2.59)

Number of observations=71, $R^2 = 0.84$

Table 2 shows rule of law and income per capita are both positively associated with stringency. The estimated coefficient of rule of law index is 0.66 and the t value is 6.05. The estimated coefficient of income per capita is 0.02 and its t value is 2.59. The estimated coefficients of rule of law and income per capita are greater than zero at the .01 significance level or better. The R^2 is 0.84 which shows good fit for the model.

To assess the normality of residuals, we used the Anderson–Darling (AD), Cramer–von Mises (CvM), Lilliefors (Lillie), Pearson, Shapiro, and Shapiro–Francia (SF) test. The results of the tests provide no reason to reject the hypothesis that the residuals are normally distributed (all p-values are greater than 0.05).

To further assess the normality of the disturbance distribution, we plot the standardized residuals from our regression against a similar number of ranked quantiles taken from a normal distribution. The line should be straight if the disturbance is normally distributed. Figure 1 shows a satisfying straight line, consistent with normality. Therefore, we can conclude that the disturbances have the property of normal distribution.

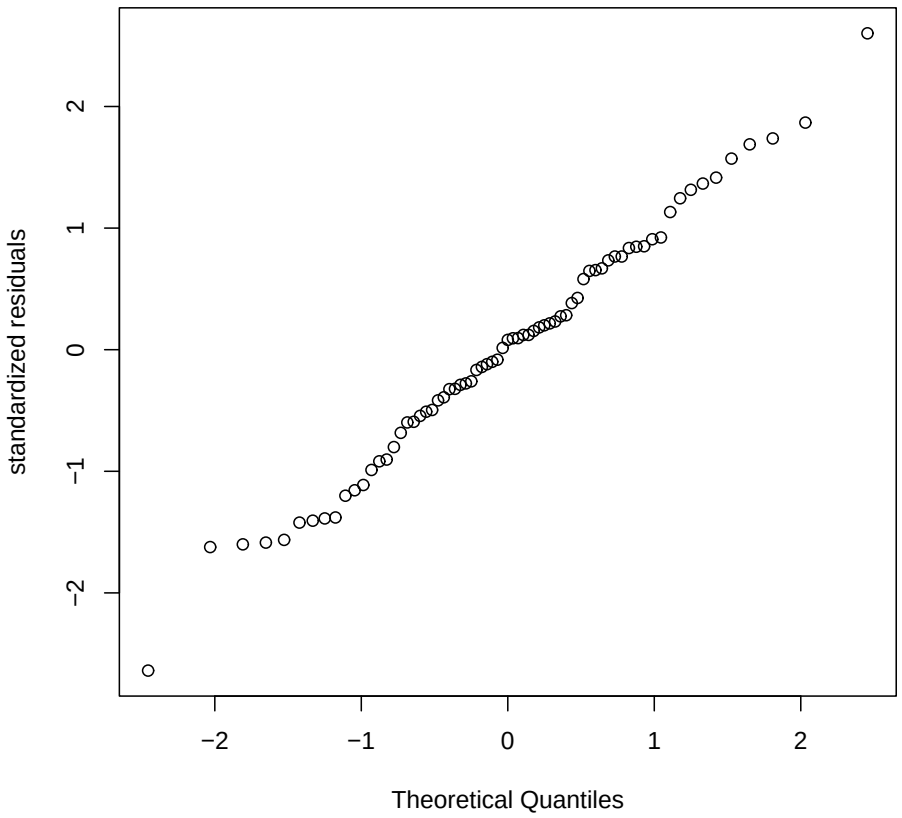

Figure 1: Normal Q-Q plot for the regression residuals

Table 3: Normality test for residuals

Normality test	P-value
AD	0.9027
CvM	0.913
Lillie	0.9243
Pearson	0.7827
SF	0.848
Shapiro	0.9568

5 The mutually reinforcing effects of income and rule of law

Our theoretical model for *S* (equation 1) indicates that *R* influences *S* both directly and indirectly via *Y*. However, the initial regression model for *S* (equation 3) only represents the direct effect. To capture the overall effect of *R* on *S*, we need to supplement equation 3 with equations representing the interaction of *R* and *Y*.

We therefore propose a system of equations to represent the positive feedback loop between rule of law and income as follows:

$$R = \beta_0 + \beta_1 Z + \beta_2 Y + \epsilon_R \tag{4}$$

$$Y = \gamma_0 + \gamma_1 I + \gamma_2 L + \gamma_3 R + \epsilon_Y \tag{5}$$

R denotes the rule of law index, *Z* is some unknown explanatory variable or variables, *Y* is income per capita. *I* is investment as a percent of GDP. *L* is the share of the labor force in population. Equation 4 means that a country's rule of law performance is determined by some unknown factors *Z* and income. Equation 5 indicates that a country's income is affected by its investment rate, labor input, and its development in rule of law.

5.1 The income determinants

Equation 5 is based on Mankiw et al.(1992)(15), who shows that, in a cross section of countries, the share of investment in GDP is a major determinant of GDP per member of the labor force. Given that relationship, GDP per capita must depend on the share of investment in GDP and the share of the labor force in the population. To that simple model, we make one simple extension– adding rule of law as an explanatory variable. For the readers' convenience, we repeat Equation 5 again in this section.

$$Y = \gamma_0 + \gamma_1 I + \gamma_2 L + \gamma_3 R + \epsilon_Y \tag{6}$$

Since the previous year's investment share is believed to have a strong relation with the current year's GDP, we use 1999 investment share of GDP data in the income per capita equation. The data comes from Penn World table. The labor force we use in calculating *L* covers age ranging from 15 to 65. The data for working-age labor and total population comes from CIA World Factbook.

5.2 The rule of law determinants

Further investigation is needed to understand what factors in addition to income also affect rule of law. Summarizing the historical developments and relevant literature on rule of law, we consider the variables in table 4 to be pertinent.

The idea of using parliamentary system as a dummy comes from the connection of the origin of parliamentary system and the development of rule of law in British history. The English Parliament traces its origins to the Anglo-Saxon Witenagemot. In the 11th century, William of Normandy introduced a feudal system, by which he sought advice of a council of tenants-in-chief and ecclesiastics before making laws. In 1215, the tenants-in-chief established the Magna Carta , which asserted that the king may not levy or collect any taxes, without the consent of his royal council, which slowly developed into a parliament.

Magna Carta required King John of England to proclaim certain rights (pertaining to freemen), respect certain legal procedures, and accept that his will could be bound by the law. It was the most significant early influence on the historical process that led to the rule of constitutional law today in the English speaking world. In light of the history, it is likely that if a country has parliamentary system it may show a higher degree of respect for fundamental rights and procedures. Therefore, we use parliamentary system as a dummy variable to explore if parliament style politics is favorable to increases in the level of rule of law. The dummy data is collected according to the CIA the Factbook's definition on individual country's legislature system in year 2000.

One rationale for using the civil war dummy as an explanatory variable for rule of law is that civil war is an indication of conditions that favor insurgency. According to Fearon and Laitin's study(5), these conditions include financially and bureaucratically weak states as well as ethnic

Table 4: Variables related to rule of law

Explanatory variable	Definition
Parliamentary system (Dummy)	a system of government in which the ministers of
Civil war (Dummy)	Armed conflicts that do not have international character
Coup d'état(Dummy)	A sudden unconstitutional deposition of a government
Continuous independence	The country was not under the foreign influence or
(Dummy)	part of a colony after 1950
Resource share GDP	The share of output from extractive industries in the
	the overall output of the economy

and cultural divisions in the society. A second rationale is that civil war could damage the fundamental economic and political structures and cause social disruption, thereby undermining rule of law.

The civil war dummy is based on the Centre for the Study of Civil War (CSCW)'s armed conflict dataset. In the codebook of armed conflict dataset, armed conflict is defined as "a contested incompatibility that concerns government and/or territory where the use of armed force between two parties, of which at least one is the government of a state, results in at least 25 battle-related deaths.". We only use internal armed conflict data for our research. According to CSCW, internal armed conflict refers to a conflict in which both sides belong to the same country. Since civil war could have long run effects on a country's rule of law condition, our study uses different time periods to establish the dummy variable and evaluate its effect on the rule of law.

The use of a coup d'état dummy is to examine if unconstitutional changes in executive authority changes affect a country's rule of law condition. As defined by a military historian(13), a coup "consists of the infiltration of a small but critical segment of the state apparatus, which is then used to displace the government from its control of the remainder"(Luttwak 1979, p.27). Hence, armed force, revolutionary movements, and parliament are not a defining feature of coup d'état. In contrast with civil war rooted in fundamental social fractionalization, coup d'état reflects power struggles within a country's ruling class or political elites.

The data we use in our study comes from Center for Systemic Peace, Coups d'état dataset. This dataset includes four types of coup events: successful coups, attempted (failed) coups, coup plots, and alleged coup plots. Our study counts the four types of coup events to establish a coups d'état dummy. Once again, since coups d'état could have long term effects on rule of law, different periods were used to create this dummy and the time sensitivity of coups d'état is investigated.

The continuous independence variable is thought to be relevant to rule of law because early independence from foreign influence may help a country to establish a more stable legal, political and social structure. Any interruption of independence followed by efforts to regain sovereignty is very likely to instigate social turmoil. Once the turmoil is initiated, decades would pass before the social and legal system can be rebuilt. Hence, we are interested in finding out if continuous independence will affect a country's rule of law development. The continuous independence dummy is extracted from CIA World Factbook.

Previous research shows that resource abundance affects a country's rule of law development. Norman(16) finds that economically large initial natural resource stocks are associated with subsequent lower levels of rule of law but do not directly affect growth. Therefore, our analysis attempts to use the ratio of output produced by extractive industries to GDP as an explanatory variable for rule of law. We use cross country resource output data from United Nations Statistics Division 1993 System of National Accounts (SNA)- mining and quarrying industry output. To make sure our data include the output representative of the extraction industry, we also examine International Standard Industrial Classification of all Economic Activities (ISICEA) on which the SNA bases its delineation of the mining industry. According to the ISICEA, the mining and quarrying industry includes the following activities:

- Mining of coal and lignite; extraction of peat
- Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying
- Mining of uranium and thorium ores
- Mining of metal ores
- Other mining and quarrying

Based on this definition, mining and quarry output from SNA covers all the commodities that are produced by the extractive industry.

6 Data Analysis

To determine which variables affect rule of law, we regress rule of law on each of the variables along with income per capita. The result is summarized in Table 5. Our result shows only the

estimated coefficients of parliament system, civil war and coup d'état differ significantly from zero at the 5% level. The civil war dummy is significant using armed conflict incidents that take place from 1960 to 2000.

Table 5: Regression analysis for rule of law determinant

Variable	Coefficient
Parliament system	0.25
	(2.21)
Civil war (1960-2000)	-0.26
	(-2.19)
Coup d'état(1980-2000)	-0.36
	(-3.14)
Continuous independence	0.002
	(0.013)
Resource share GDP	0.001
	(0.031)
71 observations	t ratio in parentheses

Though the result of the single equation shows parliament system, civil war 1960-2000, and coup d'état 1980-2000 affect rule of law, it does not mean that all of them have similar effect on rule of law in the equation system. To determine which factor is an appropriate instrumental variable in system equation, we run 2 stage least squares for each of the variables. To facilitate statistical analysis on the feedback effect of rule of law and income per capita, we rescale the rule of law index so that it has a similar range of distribution as income per capita. The rule of law index (R) takes values in the interval (-2.5, 2.5). We add 2.5 to the subjective score and then divide the sum by the quantity(2.5-subjective score). Our rescaled rule of law variable takes values between 0 and infinity. For the investment share and the labor participation rate, we maintain the original scale (0, 100).

Conducting 2 stage least squares analysis for each variable, the result shows only coup d'état 1980-2000 is statistically significant at 5% significance level. Table 6 only shows the result of regression analysis using coup d'état as regressor (the statistic results of 2sls using civil war and

parliament system as regressor are in appendix Table 10 and Table 11).

The results from Table 6 indicate that coup d'état has a negative effect on rule of law which is consistent with our previous analysis. In the same equation, income per capita has a positive effect on rule of law and is very significant. For the income per capita equation, we can see that both investment share of GDP and share of the labor force in population have favorable effects on income. Among the 3 variables, the t ratio of rule of law is the largest. It strongly indicates that rule of law has a positive effect on income. All the variables in the system equations have coefficients with the signs that are consistent with our expectation.

Table 6: Regression analysis for the system of equations using 2 SLS using coup d'état as regressor

Dependent variable	Rule of Law	Income per Capita
Constant	0.51	-26.42
	(1.31)	(-2.48)
Coup d'état	-0.69	
	(-2.15)	
Income per capita	0.14	
	(7.05)	
Investment share in GDP		0.21
		(2.27)
Labor force share in population		0.42
		(2.45)
Rule of law		3.84
		(4.75)
R^2	0.78	0.83

t ratio in parentheses

Accordingly, our specification of rule of law equation in the simultaneous system is:

$$R = \beta_0 + \beta_1 C + \beta_2 Y + \epsilon_R \tag{7}$$

, where C stands for coup d'état.

Since we rescale the rule of law index to allow it for a similar range of distribution as income per capita in the simultaneous equation analysis, the rescaled rule of law index should also be used in the stringency equation (equation 8) to investigate the direct effect of rule of law has on stringency. Two sets of regression results relating to the direct effect are shown in Table 7. Model 1 contains results for the original rule of law index but model 2 shows regression result after rescaling. Table 7 shows that both rule of law and income per capita are significant before and after rescaling. The coefficients for rule of law in model 1 is slightly greater than in model 2 and the coefficient of GDP per capita is greater in model 2 than model 1. All the t ratios indicate both variables are significant before and after rescaling.

Table 7: Regression analysis for the direct effect on stringency in rule of law and income per capita

Model 1: before rescaling of ROL

Variable	Constant	Rule of Law	Income per capita
Coefficient	-0.66	0.66	0.02
	(-5.73)	(6.05)	(2.59)

Model 1: After rescaling of ROL

Variable	Constant	Rule of Law	Income per capita
Coefficient	-1.11	0.27	0.03
	(-13.18)	(5.23)	(3.37)

t ratio in parentheses

6.1 The direct and indirect effect of rule of law on environmental policy stringency: Mathematical Analysis

Combining equation 3 and the simultaneous equations 7 and 5, we can derive the direct effect and indirect effect of rule of law on environmental policy stringency. The entire equation system is specified below:

$$S = \alpha_0 + \alpha_1 R + \alpha_2 Y + \epsilon_S \tag{8}$$

$$R = \beta_0 + \beta_1 C + \beta_2 Y + \epsilon_R \tag{9}$$

$$Y = \gamma_0 + \gamma_1 I + \gamma_2 L + \gamma_3 R + \epsilon_Y \tag{10}$$

The direct effect of rule of law is α_1. This is derived by directly differentiating equation 8 with respect to *R*. However, the indirect effect involves a complicated relationship among the 3 equations. Further derivation is required to reveal such an effect. The derivation process is as follows:

First, replace *Y* in equation 9 with the right side of equation 10. The new equation has the following form:

$$R = \beta_0 + \beta_1 C + \beta_2(\gamma_0 + \gamma_1 I + \gamma_2 L + \gamma_3 R + \epsilon_Y) + \epsilon_R \tag{11}$$

Next, we collect the *R* terms on the left side. Then we will have:

$$R(1 - \beta_2\gamma_3) = \beta_0 + \beta_1 C + \beta_2(\gamma_0 + \gamma_1 I + \gamma_2 L + \epsilon_Y) + \epsilon_R \tag{12}$$

Dividing both sides by $1 - \beta_2\gamma_3$, we get:

$$R = \frac{1}{(1 - \beta_2\gamma_3)}[\beta_0 + \beta_1 C + \beta_2(\gamma_0 + \gamma_1 I + \gamma_2 L + \epsilon_Y) + \epsilon_R] \tag{13}$$

Once again, repeat the same process on equation 10. First, replace *R* in equation 10 with the right side of equation 9. Then we have:

$$Y = \gamma_0 + \gamma_1 I + \gamma_2 L + \gamma_3(\beta_0 + \beta_1 C + \beta_2 Y + \epsilon_R) + \epsilon_Y \tag{14}$$

Combining the two Y terms on the left, we obtain:

$$Y(1 - \gamma_3\beta_2) = \gamma_0 + \gamma_1 I + \gamma_2 L + \gamma_3(\beta_0 + \beta_1 C + \epsilon_R) + \epsilon_Y \tag{15}$$

Dividing both sides by $1 - \gamma_3\beta_2$ yields:

$$Y = \frac{1}{(1 - \gamma_3\beta_2)}[\gamma_0 + \gamma_1 I + \gamma_2 L + \gamma_3(\beta_0 + \beta_1 C + \epsilon_R) + \epsilon_Y] \tag{16}$$

Replacing *R* and *Y* in equation 8 with the right sides of equation 13 and equation 16, we get:

$$\begin{aligned} S = \alpha_0 &+ \frac{\alpha_1}{(1 - \beta_2\gamma_3)}[\beta_0 + \beta_1 C + \beta_2(\gamma_0 + \gamma_1 I + \gamma_2 L + \epsilon_Y) + \epsilon_R] \\ &+ \frac{\alpha_2}{(1 - \gamma_3\beta_2)}[\gamma_0 + \gamma_1 I + \gamma_2 L + \gamma_3(\beta_0 + \beta_1 C + \epsilon_R) + \epsilon_Y] \end{aligned} \tag{17}$$

An autonomous increase in rule of law (an increase in β_0 or ϵ_R) has both direct and indirect effects on stringency. The sum of these effects will be called the total effect. To calculate this total

effect, we need to take the derivative of equation 17 with respect to β_0. The result is:

$$\frac{dS}{d\beta_0} = \frac{\alpha_1 + \alpha_2\gamma_3}{1 - \beta_2\gamma_3} \tag{18}$$

We can easily infer the significance of the direct effect from a t-statistic for α_1. In contrast, we will have to use simulation methods to assess the significance for the total effect (a non linear function of four parameters)

7 Simulation for total effect of rule of law on stringency

7.1 Normality Assessment

We can derive the total effect of rule of law on stringency by using equation 18. There are two simulation approaches that can be considered for use in approximating the distribution of the total effect. The first simulation approach, based on normal theory, is to draw from the bivariate distribution of α_1 and α_2 and from the univariate distributions of β_2 and γ_3. These three distributions will be assumed to be normal.[1] Therefore, we need to evaluate the disturbances in their linear regression to see if they are normal. To assess the normality of residuals, we used the Anderson–Darling (AD), Cramer–von Mises (CvM), Lilliefors (Lillie), Pearson, Shapiro, and Shapiro–Francia (SF) tests. First, we apply normality test on equation 8 using the rescaled rule of law index. The Q–Q plot[2] and normality tests results for the rescaled equation 8 are summarized in Figure 2 and Table 8. The Q–Q plot shows a satisfying straight line. Also, the results of the normality tests provide no reason to reject the hypothesis that the residuals are normally distributed (all p-values are greater than 0.05).

Then we conduct normality tests for system equations and the results are summarized in Table 9. For the rule of law equation, all of the p-value fall below the 5% level. It indicates that the residuals of the rule of law equation are not normally distributed. For the income per capita equation, the p-values all indicate that we cannot reject (at conventional significance levels) the hypothesis that the residuals are normally distributed. Since the rule of law equation fails the normality test, we should not draw β_3 from a normal distribution. Thus, we are compelled to consider an alternative approach that does not depend on normality.

[1] Provided that the disturbances have normal distributions, the maximum likelihood (OLS) parameter estimator $\hat{\beta} := (X'X)^{-1}X'Y$ has a multivariate normal distribution $N(\beta, \sigma^2(X'X)^{-1})$ (Mittelhammer et al., 2000, p. 42).

[2] In the Q–Q plot, the standardized residuals from our regression are plotted against a similar number of ranked quantiles taken from a normal distribution. The line should be straight if the disturbance is normally distributed.

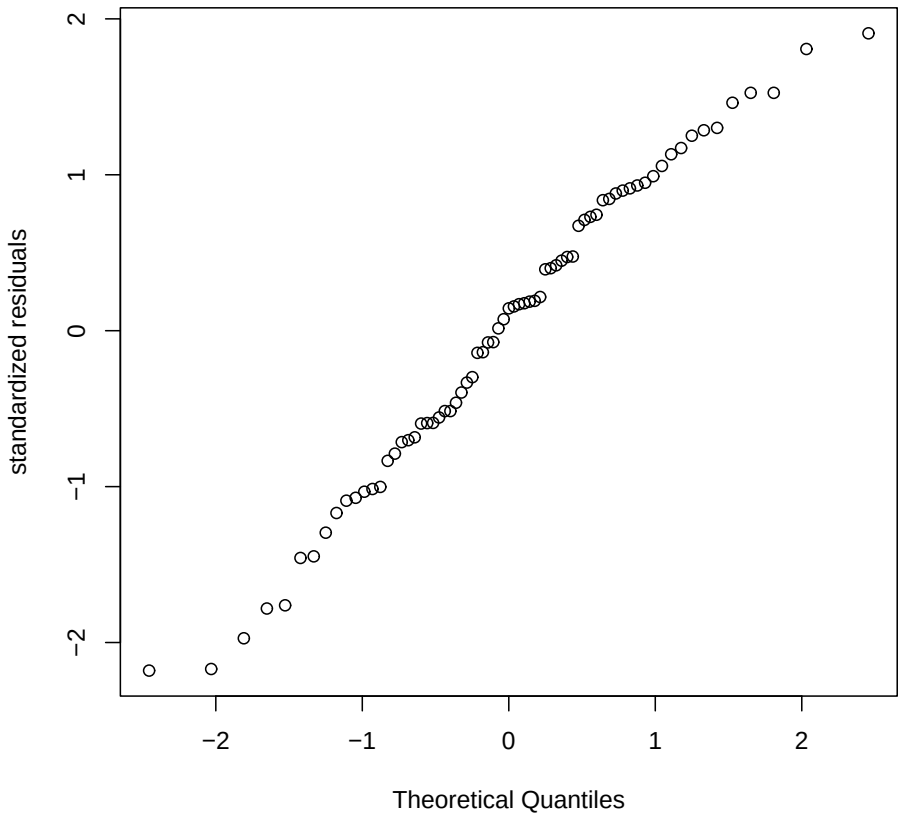

Figure 2: Normal Q-Q plot for the regression residuals (Rescaled rule of law index)

Table 8: Normality test for residuals

Normality test	P-value
AD	0.4201
CvM	0.3974
Lillie	0.4513
Pearson	0.5413
SF	0.4904
Shapiro	0.307

7.2 Bootstrap

The second approach we can use to establish a confidence interval for the total effect of rule of law on stringency is a bootstrap procedure. Such procedures are useful for estimating the distribution of a statistic without relying on the assumption of normality. Bootstrap methods come in handy when there is no analytical form or normal theory to help estimate the distribution of the statistics of interest because bootstrap methods can apply to most random quantities. There are many different kinds of bootstrap methods that have been widely used. Two of them are particularly relevant to this study which can address the potential problems in our data.

The first bootstrap method is considered here is case sampling. Case sampling is also called "pairs bootstrap". The oldest and best-known bootstrap method, it was originally proposed by Freedman (1981)(6). The advantage of the pairs bootstrap is that the dependence structure between the *i*th row of explanatory variable and *i*th row of dependent variable is directly preserved in the bootstrap, thus we expect it to be more robust in situations where heteroskedasticity of unknown form is present in the regression. Since we use cross country data, it is very likely the disturbances are not homoskedastic.

The second bootstrap method that is suitable for our regression model specification is called wild bootstrap. The specific strand of wild bootstrap method that focuses on the case in which there is just one endogenous variable on the right-hand side of regression is proposed by Davidson and MacKinnon (2008)(3). Their wild bootstrap procedure uses efficient estimates of the reduced-form equation and takes account of possible heteroskedasticity of unknown form. It provides reliable

Table 9: Normality test for residuals in system equations

Normality test	P-value for rule of law	P-value for income per capita
AD test	3.895e-06	0.3191
CvM test	2.140e-05	0.4293
Lillie test	0.0007687	0.496
Pearson test	0.0154	0.3539
SF test	3.854e-05	0.1132
Shapiro test	1.364e-05	0.156

inferences from a regression estimated using instrumental variable (IV) when the instruments are are weak. Since our study uses a simultaneous equation system to investigate the relationship between rule of law and income per capita, if the IVs are proven to be weak, according to Davidson and MacKinnon, their wild bootstrap is an appropriate approach to estimate the confidence interval.

We use first-stage F-statistic to assess the performance of IV in our model. The first-stage F-statistic was first proposed by Staiger and Stock (1997)(20) and later was quantitatively defined by Stock and Yogo (2001)(21). According to Staiger and Stock (1997) 's study (20) on a single endogenous regression, the IVs should be declared to be weak if the first-stage F-statistic is less than ten. In our regression model, the first-stage F-statistic for the equation where rule of law is dependent variable is 79 and for the equation where income per capita is dependent variable is 45. Both F statistics exceed the threshold value of 10. We therefore conclude that the IV in our equation system are strong so that wild bootstrap is not an appropriate method for our study. Thus we should choose case sampling to establish the confidence interval for rule of law in our regression model.

7.2.1 Case Sampling

Case sampling uses a Monte Carlo algorithm to resample the original dataset. First, we resample the data with replacement, and the size of the resample must be equal to the size of the original data set. Then the coefficients are computed from the resample from the first step. We repeat this routine many times to get a more precise estimate of the bootstrap distribution of the coefficients. Setting the number of bootstrap samples at 3000, estimates for the total effect of rule of law are obtained based on equation 18. Following this scheme, we obtain 3000 values for the total effect. The results show that only the first 9 draws are negative and the other 2991 draws are all positive, which provides strong support for our theoretical analysis. According to our analysis, the second term in equation 2 should be positive, because a rise in *R* increases *Y*, which in turn boosts S. In terms of the distribution of the 3000 draws, the mean is 0.89 and the median is 0.76. Ranking 3000 draws from low to high, it is obvious that most of the values are between 0 and 1. The minimal value is -100 and the maximum value is 68. Since the extreme values among the 3000 draws are trivial in number, we are interested in the distribution of 95% of the draws that are clustered together. We discard the first and the last 75 draws to construct a density distribution of the central 95% in Figure 3. The mean and median for the 95% draws are 0.83 and 0.85 respectively. The minimal value is 0.37 and the maximum value is 2.22. In Figure 3, the highest frequency is around 0.75 and the second highest is around 0.5. The distribution has a long tail to the right. The curve in Figure 3 is the central 95% draws density line. It indicates that the total effect of rule of law on environmental policy stringency is almost surely positive and very likely greater than the estimated direct effect (0.27).

The results from pairs bootstrap confirms the theoretical analysis that rule of law has a positive effect on environmental policy stringency. A great majority of the draws are positive and it shows right skewness. Moreover, great proportion of the values cluster between 0 and 1. It provides strong evidence to the argument that when a country's rule of law condition improves, the overall efficiency of the country's environmental regulatory regime will also increase.

8 Conclusion

The link between environmental stringency and rule of law involves the effect of economic growth and the mutually reinforcing effects of rule of law and income per capita. The direct effect of rule of law on stringency is strongly positive. With respect to the determination of rule of law, the cross country analysis suggests negative effects from coup d'état. Income per capita has a favorable effect on rule of law, which is consistent with our prediction in the theoretical analysis. Other variables, such as continuous independence and resource output share of GDP, do not seem to have conclusive effects on rule of law.

Our results seem to support the argument that coups have impact on rule of law regardless of the outcome of the coup because the coup d'état data used here include successful or failed, in

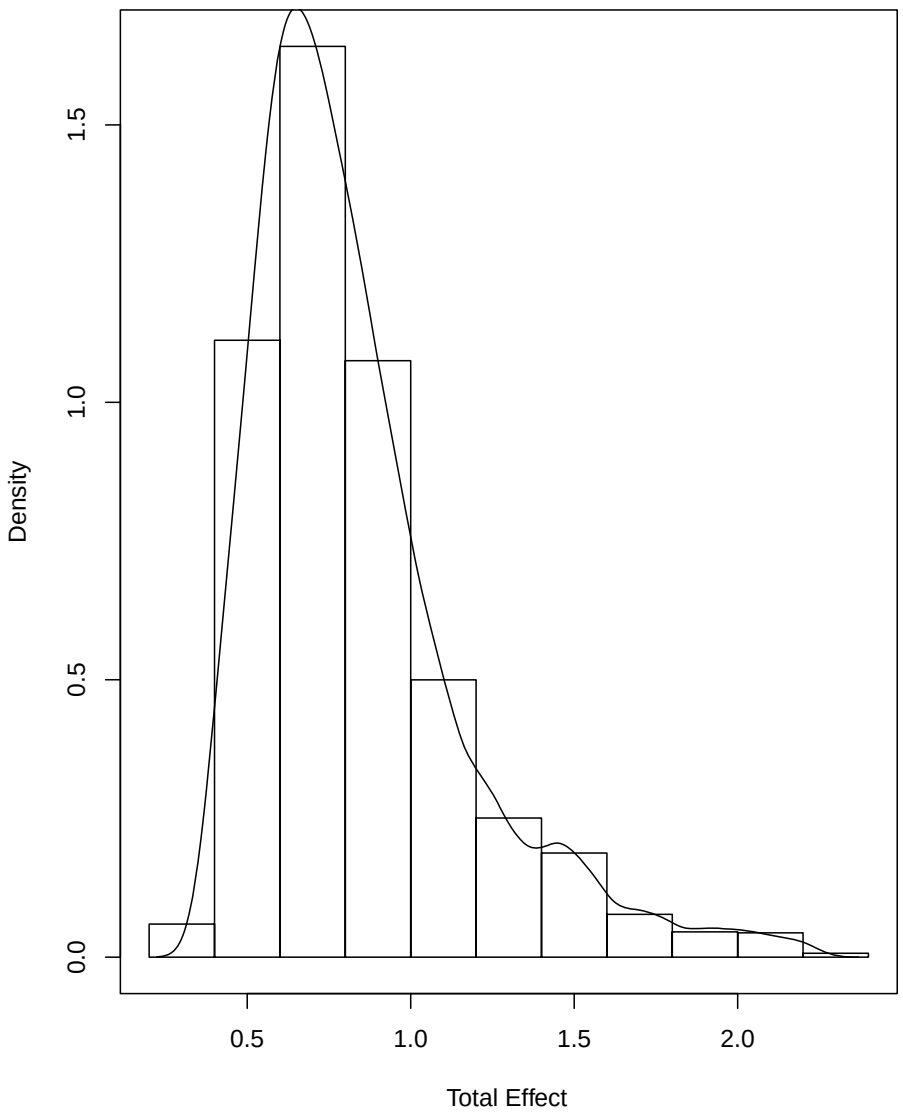

Figure 3: Pairs bootstrap simulation: histogram and density of the total effect of rule of law

action or just plotting coup incidents. This seems to support the argument that political stability plays an important role in determining the degree of a society's rule of law development. As many political science scholars point out, political stability is the foundation for development. Unstable political condition weakens the efficiency of government and, as a result, people lack confidence in the government's capacity for rule of law.

With respect to the determination of income per capita, the analysis indicates that increases in the investment share, labor force share, and rule of law raise the level of income. In particular, rule of law has a strong positive effect on income, which further supports our assumption that the interplay between rule of law and income strengthen each other. The circular effect allows rule of law and income to enhance each other while both foster environmental policy stringency.

The analysis has implications for the desirability of deepening the rule of law in countries that currently lack good governance. Our results convey two important messages. First, rule of law raises governance capacity, which directly improves environmental policy and economic development. A more thriving economy continues to reenforce policy stringency and moral allegiance to the law. The second message is that political instability and internal conflict worsen rule of law development. Through the feedback effect between rule of law and economic growth, an economic setback could worsen rule of law especially when political instability and internal conflict also bring down the economic growth. At the same time, the country's environmental policy also loses ground during the downward spiral.

Economic growth may not be the only channel through which rule of law can affect the environment. Future research is needed to determine if other factors that are related to the environmental stringency are also affected by the rule of law. For example, Welsch (23) shows that corruption indirectly affects pollution via income and that pollution is monotonically increasing in corruption. If rule of law also helps to suppress corruption, it may further strengthen environmental policy indirectly. However, the purpose of our current analysis is to examine the potential contribution of rule of law to economic development and environmental policy efficacy.

A more general conclusion based on our analysis is that environmentally advanced western countries could contribute more to the countries that are currently facing serious degradation problems by exporting their economic and legal systems. The protection of economic rights (such as property rights) and the fairness of judicial systems are the key elements for the maintenance of rule of law. Highly industrialized western countries have mature and complicated political and legal structures to ensure the protection of fundamental rights and procedural justice. These visible and invisible structures enhance capacity to formulate policies based on the emerging preferences associated with economic development. Countries that encounter difficulties both in economic development and environmental protection will certainly benefit from the establishment of such structures in the long run.

9 Appendix

Table 10: Regression analysis for the system of equations using 2 SLS using civil war as regressor

Dependent variable	Rule of Law	Income per Capita
Constant	0.58	-28.58
	(1.20)	(-2.06)
Civil war	-0.54	
	(-1.50)	
Income per capita	0.13	
	(5.56)	
Investment share in GDP		0.24
		(1.84)
Labor force share in population		0.46
		(2.04)
Rule of law		3.58
		(2.72)
R^2	0.76	0.82

t ratio in parentheses

Table 11: Regression analysis for the system of equations using 2 SLS using parliament system as regressor

Dependent variable	Rule of Law	Income per Capita
Constant	0.06	-36.93
	(0.21)	(-0.84)
Parliament system	0.17	
	(0.63)	
Income per capita	0.15	
	(8.39)	
Investment share in GDP		0.31
		(0.75)
Labor force share in population		0.59
		(0.84)
Rule of law		2.60
		(0.51)
R^2	0.77	0.78

t ratio in parentheses

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