The Effects of Economic and Political Freedom on CO_2 Emissions

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***Abstract*:**
In this paper we investigate the effects of political and economic freedom on CO_2 emissions. As far as we know this is the first cross-country study of the relationship between economic freedom and environmental quality. Economic freedom is measured in several ways. We find that increased price stability and legal structure decrease emissions in countries with a small industry share of GDP, but increases emissions in countries with a large industry share of GDP. The decreasing effect from increased use of market is significant but non-robust, and increased freedom to trade does not have any significant effect. The effect of political freedom on CO_2 emissions is insignificant, most probably since CO_2 emissions is a global environmental problem and hence subject to free-riding by the individual countries.

***Keywords*:** Carbon Dioxide, Economic Freedom, Institutions, Political Freedom.

***JEL classification*:** O10, O40

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1 INTRODUCTION

Global warming has been put forward as a major environmental problem with most scientists considering man-made emissions of carbon dioxide (CO_2) to be the main contributor to the global warming problem. In the literature on the environmental Kuznets curve most studies have found a monotonically increasing relationship between income and emissions, while some of the studies have found a cubic (N shaped) relationship, but the turning points are often outside the observed sample (see e.g. Holtz-Eakin and Selden, 1995; Cole et al., 1997; Moomaw and Unruh, 1997). Among economists, there is a fairly strong consensus that economic, and also political, freedom is positively correlated with economic growth. These hypotheses have also been supported in several studies (see e.g. Barro, 1991; Islam, 1996; Gwartney et al., 1999; de Haan and Sturm, 2000).[1] In the light of these results and their policy implications of promoting economic and political freedom, it is of interest to test empirically how increased freedom affects CO_2 emissions. There can be both direct and indirect (through income) effects of freedom on the level of emissions.[2] The purpose of this study is to analyze the less examined first effect, i.e. the direct effect from changes in economic and political freedom on CO_2 emissions, using a panel data set of 75 countries on CO_2 emissions from 1975-1995.

The paper is organized as follows. The relationships between economic and political freedom and CO_2 emissions are discussed in Section 2. The data is presented in Section 3. Section 4 contains the model specification. In Section 5 the results of the estimations are reported and the robustness of the result is analyzed. The final section concludes the paper and discusses the identified direct results in relation to the indirect results found in previous studies.

[1] It should be noted that the stability of the results have been questioned (see e.g. Levine and Renelt, 1992). However, Sturm and de Haan (2001) show that increases in economic freedom are robustly related to growth. Carlsson and Lundström (2002) find that the robustness of the relationship differs between economic freedom measures. Moreover, many studies have concluded that the effects of political freedom on economic growth mainly work through its effects on economic freedom, which in turn effects growth (see e.g. Barro, 1996).

[2] Note that we only study the *direct* effect of freedom on emissions. There may, as mentioned, be *indirect* effects from economic freedom via GDP, but also from political freedom via its effect on economic freedom.

2 FREEDOM AND CO_2 EMISSIONS

2.1 Economic Freedom

Economic freedom is often mentioned as a crucial component for providing incentives resulting in an effective use of resources. We are here interested in how different economic freedom variables, that have been found to be important for economic growth, affect CO_2 emissions.[3] We present three hypotheses regarding the effects. (i) *The Efficiency Effect*. Under the assumption that economic freedom results in efficient and competitive markets, we may expect a negative correlation between economic freedom and CO_2 emissions. For a given production level, fewer resources would be used and less waste produced due to cost minimizing reasons. First, liberalization may result in an efficient use of resources that have a price. This price can, of course, be affected by policies such as a tax correcting for an externality. Second, an efficient market may better meet political regulations and the desires of consumers. The second reason is simply due to competition; in order to survive, firms have to react to changes in the market environment. Clearly, this effect is only relevant if there are environmental regulations, or a demand for cleaner production/goods from the consumers. Because of the global public good character of CO_2 emissions, and hence free-riding possibilities for the individuals as well as the countries, it is not very likely that resource efficiency is primarily directed towards reductions of CO_2 emissions. At the same time, CO_2 emissions are directly related to energy use, and cost minimizing efforts may therefore still result in reduced emissions. (ii) *The Trade Regulation Effect*. Taxes and restrictions on trade lower economic freedom. Trade liberalization may result in a more effective resource allocation as a result of the competitive pressure in international markets. However, there might also be a so called "pollution haven" effect. Trade results in increased specialization, and countries with a large share of capital-intensive production and less strict environmental regulation are more likely to specialize in dirty industries. Therefore, even though global pollution is constant, some countries will

[3] Another type of variable that is indirectly related to economic freedom is environmental regulations (see e.g. Hilton and Levinson, 1998). These are not explicitly included in our study since we are interested in

increase their emissions and some will decrease their emissions. Hence, there are two effects from trade liberalization, the efficiency and the "pollution haven" effect, thus the final expected effect on emissions per unit produced is ambiguous. The effect of increased efficiency is expected to decrease CO_2 emissions, while the pollution haven effect can be both positively and negatively related to emissions depending on the structure of the economy. (iii) *The Stability Effect.* It is likely that increased price stability leads to more efficient investment and consumption decisions. A stable macroeconomic environment also encourages longer investment horizons. Many environmental investments, or efficiency enhancing investments, pay off in the future, and will not be made without a belief that the economy will be stable until the profits are received. Hence, a stable macroeconomic environment may decrease emissions. Another important part of the stability effect is the property rights structure. The importance of security of property rights and viability of contracts has been emphasized in the growth literature and lately also in the growth-environment literature (see e.g. Panayotou, 1997). With more secure property rights individuals can make long-term, efficiency-enhancing investments. However, an increased stability, in terms of a more stable macroeconomic environment or more secure property rights, may also result in increased investments and consumption in general. Again, because of the public good character of CO_2 emissions, it is not very likely that investments are primarily directed towards reductions of CO_2 emissions. However, there might still be an effect on emissions through changes in investments related to energy use.

It is possible, and even likely, that the effect of changes in economic freedom on CO_2 emissions depends on the composition of production in a country, or the pollution intensity of production (see e.g. Antweiler et al. 2001). For example, an increased freedom to trade may, as we have discussed, result in an increased specialization, and hence increased emissions in a pollution intensive country. The effect of an increased stability may also, in a similar manner, depend on the composition, i.e. that increased stability results in increased specialization. On the other hand, the efficiency effect can be expected to be higher for pollution intensive countries.

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the effects of reforms implemented to increase economic growth and not directly to improve the environment.

2.2 Political Freedom

A political and civil system in which an individual's demand for environmental quality can be expressed might be crucial for the environmental quality in a country. Deacon (1999) discusses reasons for a positive correlation between political freedom and environmental quality, and argues that non-democratic regimes are more likely to underprovide public goods, such as environmental quality, compared to regimes that are more democratic. The underlying reason for this is the assumption that the political elite receives a disproportionate share of the country's income, which often implies that they bear a disproportionate share of the cost of the environmental regulation. At the same time, this group receives a proportionate share of the benefits of pollution control. Congelton (1992) presents a similar model with similar arguments to those of Deacon, and in addition argues that less democratic regimes tend to have a shorter planning horizon. However, it does not follow from this that there has to be a positive correlation between political freedom and the environment. In a system with representative legislature the role of interest groups is enhanced. If this effect is biased against environmentally unfriendly solutions, such as subsidies to energy intensive industry, CO_2 emissions could increase with political freedom. The effect of political freedom on the environment may also be insignificant; in particular if it is a global environmental problem such as CO_2 emissions, since the individual country has an incentive to free-ride. At the same time, emissions of global pollutants can be correlated with other environmental problems, so there could still be an effect from political freedom. Moreover, the preferences within a country for global environmental quality can be high because of the risk of global instability or for altruistic reasons, for example, of which the increased number of climate (and other environmental) conventions might be an indication.

The relationship between political freedom and the environment has been studied in a number of papers. Most studies have found a positive relationship between political freedom and environmental quality, but none of these have studied CO_2 emissions. Empirical studies have found a positive relationship between political freedom and the probability to sign international conventions regarding reductions of global pollutants (Congleton, 1992; Fredriksson and Gaston, 1999). However, these

international agreements have only recently started being implemented, and therefore it is not likely that political freedom has yet had a significant effect on the level of emission today.

3 DATA

All data, except the CO_2 emissions data and the freedom data, come from the *1999 World Development Indicators CD-Rom* (World Bank, 1999); the CO_2 emissions data are originally from the Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory. CO_2 emissions, measured in metric tons per capita, are emissions from the burning of fossil fuels and the manufacture of cement. They include contributions to the carbon dioxide flux from solid fuels, liquid fuels, gas fuels, and gas flaring. The GDP data are converted into international dollars using purchasing power parities.

The data on economic freedom are from *Economic Freedom of the World: 2000 Annual Report* (Gwartney et al., 2000). The main components of the economic freedom index are personal choice, protection of property and freedom of exchange. The index of economic freedom is divided into seven categories. Each index is measured on a scale between 0 and 10, where 10 is the highest level of freedom. We use the categories corresponding to the hypotheses presented in Section 2. The category *Economic structure and use of market* (*EFeff*) represents the Efficiency Effect. This category is a measure of the share of government production and allocation.[4] The Trade Regulation Effect is represented by the category *International exchange: Freedom to trade with foreigners* (*EFtrade*).[5] The average of the two categories Monetary Policy and Price Stability, and Legal Structure and Property Rights, henceforth called *Price stability and Legal security* (*EFstab*), represents the Stability Effect. The category Monetary Policy and Price Stability measures the protection of money as a store of value and medium of exchange and the category Legal Structure and Property Rights measures the security of

[4] *Economic structure and use of market* consists of the variables: 1) government enterprises and investment as a share of the economy, 2) the extent of price controls, 3) the top marginal tax rate and 4) the use of conscripts to obtain military personnel.

[5] *Freedom to trade with foreigners* consists of the variables 1) Taxes on international trade and 2) Non-tariff regulatory trade barriers.

property rights and the viability of contracts.[6] The economic freedom data have been reported every fifth year since 1970, but not all countries have been included since 1970.

The political freedom variables are measures based on the Freedom House indices of political and civil freedom (Freedom House, 1999). The political freedom index measures whether a government came to power by election or by gun, whether elections, if any, are free and fair, and whether an opposition exists and has the opportunity to take power at the consent of the electorate. The civil freedom index measures constraint on the freedom of the press, and constraints on the rights of individuals to debate, to assemble, to demonstrate, and to form organizations, including political parties and pressure groups. Since they are highly correlated we use the average of these two indices, henceforth called *Political freedom* (*POL*). The political freedom index is measured on a scale between 1 and 7, where 7 is the highest level of freedom.[7]

Table 1. Descriptive statistics for countries included in the estimations.

	Mean	**Std.**	**Min**	**Max**
CO_2, kg per capita	4266.540	5093.240	42.22	25267.00
GDP, 100 dollar per capita	58.079	56.601	2.68	273.32
Structure and use of markets (EFeff)	3.933	1.809	0	8.64
Freedom to trade with foreigners (EFtrade)	5.930	2.233	0	9.84
Price stability and Legal security (EFstab)	6.419	2.183	0	9.88
Political freedom (POL)	4.781	1.814	1	7.00
Industry sector share of GDP	31.983	8.516	9.88	59.29
Annual GDP growth	3.142	4.334	-12.43	14.67
Number of observations	319			

The sample includes 75 countries for the period 1975-1995. The data is unbalanced, due to missing observations mainly on economic and political freedom.

[6] *Monetary Policy and Price Stability* contains the variables 1) average annual growth rate of the money supply during the last five years minus the growth rate of the real GDP during the last ten years, 2) standard deviation of the annual inflation rate during the last five years and 3) annual inflation rate during the most recent year. *Legal Structure and Property Rights* consists of the variables variables: 1) risk of confiscation, 2) risk of contract repudiation by the government and 3) institutions supportive to the principles of rule of law.

[7] The variable is rescaled since 1 is the highest level of political and civil freedom and 7 the lowest level, in the original data set.

Descriptive statistics are presented in Table 1. Note that CO_2 per capita is in kg emissions per capita and GDP per capita is in hundreds of dollars per capita. CO_2 per capita is measured as a moving average of the current and the previous three years. Additional control variables included in the regressions are also reported in Table 1.

The correlation matrix for the freedom variables, GDP and CO_2 emissions is presented in Table 2. We see that both economic and political freedoms are correlated to a certain extent and that the economic and political freedom variables are all positively correlated with both GDP per capita and CO_2 emissions.

Table 2. Correlation matrices for variables included in estimations

	GDP	**POL**	**EFtrade**	**EFeff**	**EFstab**	**Industry**	**Growth**	**CO_2**
GDP	1.00							
POL	0.58	1.00						
EFtrade	0.63	0.37	1.00					
EFeff	0.42	0.30	0.40	1.00				
EFstab	0.61	0.45	0.55	0.28	1.00			
Industry	0.14	0.06	0.29	0.04	0.08	1.00		
Growth	-0.05	-0.13	-0.05	-0.05	0.10	0.11	1.00	
CO_2	0.74	0.45	0.60	0.31	0.53	0.31	-0.10	1.00

4 MODEL SPECIFICATION

We assume that CO_2 emissions per capita is a polynomial function of income per capita, and a function of the different economic freedom measures and political freedom discussed above. We also want to control for a composition effect on emissions, by including the industry sector's share of GDP as an explanatory variable. This share is a measure of the relation between capital and labor in the country. Finally, the growth of GDP is included to allow for effects of rapidly expanding countries. All models are estimated with country and time specific effects.[8] As we discussed previously, the effect of economic freedom may also depend on the composition of the economy. In order to account for this we investigate whether the effect of economic freedom on CO_2

[8] The country specific effects are assumed to capture effects such as geographical characteristics, fossil fuel availability and prices, energy endowments and tastes. The time specific effects are assumed to capture effects such as changes in the world price of oil and technological change. We also estimated the models with the world price on oil instead of the fixed time effects, but the coefficient for the oil price was consistently insignificant.

emissions depends on the share of the industry sector, relative to GDP, in the country or not. All economic freedom variables are therefore allowed to interact with the industry sector's share of GDP.

In the growth-environment literature the two common specifications are linear and log-linear, with at least a quadratic GDP/log(GDP) variable in order to allow for a turning point, but some studies even include a cubic GDP/log(GDP) variable. However, using a PE-test, both functional forms can be rejected with the present CO_2 data – both for a quadratic and a cubic GDP/log(GDP) specification. In addition, none of the specifications pass a RESET test. Therefore, we apply a Box-Cox regression, where CO_2 emissions per capita are transformed in the following fashion: $\frac{(CO_2)^{\lambda}-1}{\lambda}$. Since the choice of the functional form of the GDP variables is not straightforward, we present the results from four different models. The results for economic freedom do differ somewhat between specifications, and these differences are discussed in the following section.

5 RESULTS

Table 3 presents the result of the Box-Cox regression models. Note that only the models with a cubic term pass the RESET test at the 5% level. The economic freedom variables are jointly significant in all models. Because of the Box-Cox transformation and the different transformations of the GDP variable, interpreting and comparing the results regarding the relationship between GDP and CO_2 emissions is not straightforward. We therefore plot the estimated relationship between GDP and CO_2 emissions. The resulting graphs are presented in the Appendix. All models, apart from the first one, predict a non-negative relationship between the scale of the economy and the level of emissions. This result is in line with the results in previous studies. The composition effect, measured by the Industry sector share of GDP, is also positive, i.e. an increased share of industry production increases emissions. The effect of GDP growth is insignificant in all models.

Table 3. Results of Box-Cox estimations

	Model 1	**Model 2**	**Model 3**	**Model 4**
	Coefficient (P-value)	Coefficient (P-value)	Coefficient (P-value)	Coefficient (P-value)
GDP	0.0680 (0.000)	0.1894 (0.000)		
GDP^2	-0.0002 (0.000)	-0.0011 (0.000)		
GDP^3		0.000002 (0.000)		
ln GDP			3.7448 (0.000)	-0.5944 (0.581)
$(\ln GDP)^2$			-0.0937 (0.043)	1.3666 (0.001)
$(\ln GDP)^3$				-0.1435 (0.001)
Structure and use of markets (EFeff)	0.2189 (0.272)	0.2836 (0.174)	0.0020 (0.987)	0.1244 (0.337)
EFeff * Industry sector share	-0.0103 (0.098)	-0.0130 (0.050)	-0.0037 (0.330)	-0.0072 (0.076)
Freedom to trade with foreigners (EFtrade)	-0.0159 (0.922)	0.0508 (0.762)	0.1490 (0.154)	0.0754 (0.474)
EFtrade * Industry sector share	0.0005 (0.913)	-0.0025 (0.618)	-0.0029 (0.350)	-0.0019 (0.545)
Price stability and Legal security (EFstab)	-0.4385 (0.026)	-0.3783 (0.053)	-0.3518 (0.007)	-0.2800 (0.025)
EFstab * Industry sector share	0.0141 (0.018)	0.0109 (0.062)	0.0086 (0.021)	0.0060 (0.094)
Political freedom	-0.0243 (0.701)	-0.0405 (0.538)	0.0351 (0.384)	0.0261 (0.520)
Industry sector share of GDP	0.0836 (0.008)	9.1600 (0.005)	1.9310 (0.284)	2.9712 (0.112)
Annual GDP growth	-0.0222 (0.116)	-0.0199 (0.166)	-0.0143 (0.108)	-0.0110 (0.214)
Lambda (λ)	0.2203 (0.000)	0.2357 (0.011)	0.1745 (0.011)	0.1808 (0.009)
RESET $\sim \chi^2_{a,3}$	11.11	3.46	9.17	2.72
LR test EF $\sim \chi^2_{a,6}$	15.70	15.30	30.78	25.63

Among the economic freedom variables, only *Price stability and Legal security* has a significant effect on the level of CO_2 emissions. The interaction term between the industry sector share and the degree of freedom for this variable is also significant in all models. The coefficient for *Price stability and Legal security* is negative, indicating that an increased degree of economic freedom decreases CO_2 emissions. However, the coefficient for the interaction term is positive. This implies that the decreasing effect on

CO_2 emissions is lower for a country with a large industry sector share and this it is even positive at a sufficiently high level of industry share. For Model 2, the combined effect is -0.06 at the mean value of the industry share.[9] The interaction term between *Structure and use of market* and the industry sector share is also significant in three of the models. The coefficient is negative, implying that an increase in the degree of freedom decreases CO_2 emissions, and that this decreasing effect is larger for a country with a large industry sector. The coefficient for the variable *Freedom to trade with foreigners* is not significant in any model, not even when it interacts with the industry sector share.

The estimated *Political freedom* coefficient is insignificant in all models. Previous studies have found a negative, and significant, relation for other pollutants, but as we have discussed, the public good character of CO_2 emissions for the individual country makes this type of emission rather different from other types of emissions.

Even though the results are fairly coherent in the different models it is of course unsatisfactory that the significance of the freedom variables differ slightly between the specifications. On the other hand, the category *Price stability and Legal security* is significant in all specifications, and can in that sense be seen as more robust. We also test the robustness of the results in terms of sensitivity of the sample. This is done with a jack-knife type of procedure, where one country is deleted from the sample at a time; hence 74 new models are estimated. Then the share of the number of times each variable is significant, at the 10% level, is calculated. The restricted sample models are estimated based on the Box-Cox transformation obtained from the full sample model since we want to test the sensitivity for a given functional form. The tests show that the significance of the interaction term between *Structure and use of market* and the industry sector share is sensitive to the sample. It is only in the linear model with a cubic GDP term that the share of the number of times that the coefficient is significant is larger than 0.9. In all other models the share is between 0.01 and 0.35. Consequently, we do not find the results regarding a significant effect of this category as robust. *Price stability and Legal security* is also sensitive to the sample in some models, but to a

[9] In our sample the maximum industry share (*Ind*) is 59, the minimum is 10 and the mean is 32 (see Table 1). The combined effect for *EFstab* is (b_1+ b_2*Ind*) where b_1 is the coefficient for *EFstab*, and b_2 is the

lesser degree than the other freedom categories. In the linear model with a cubic GDP term the share is 0.88, but in all other models the share is higher than 0.9. In the two models with a cubic term, the interaction term is also sensitive to the sample.

6 CONCLUSIONS AND DISCUSSION

The purpose of this study was to analyze the direct effects of different economic freedoms and political freedom on CO_2 emissions. Among the economic freedom variables, *Price stability and Legal security* have a decreasing effect on the level of CO_2 emissions for countries with a small industry share of GDP, but an increasing effect in countries with a large share. A possible explanation for this is that increased stability and security increases investments in the production where the country has a relative advantage. The effect of increased investments on emissions in turn depends on the pollution intensity; therefore in a country with high (low) pollution intensity, increased investments are likely to increase (decrease) emissions. When testing our results for robustness, this economic freedom category was the only one that had a robust significant effect on CO_2 emissions. The decreasing effect of *Structure and use of market* was non-robust and *Freedom to trade with foreigners* was insignificant. Moreover, we found that *Political freedom* does not significantly affect CO_2 emissions. A negative relationship between democracy and environmental degradation has been found for several other pollutants, but we cannot confirm the results for CO_2 emissions. We believe that one explanation is that even if several democratic countries have signed international agreements regarding reduction of CO_2 emissions, these have not yet been implemented. Therefore, one may expect a significant effect of political freedom on future levels of CO_2 emissions.

One interesting question is whether CO_2 emissions increase or decrease if we consider both the direct effects of economic freedom and the indirect effects through GDP, which in turn effects emissions. This turns out to depend on the specific category analyzed. For example, Carlsson and Lundström (2002) find that both *Legal structure and Security of private ownership* and *Structure and use of markets* has a significant,

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coefficient for the interaction term. b_1 is approximately –0.38, and b_2 is approximately 0.01 (see Table 3).

and robust, positive effect on GDP growth.[10] However, a simple back of the envelope calculation then reveals that if we convert the marginal increase in growth and the corresponding increase in GDP during a 10 year period, the indirect (positive) effect is larger than the direct (negative) effect for *Price stability and Legal security* but the indirect (positive) effect is smaller than the direct (negative) effect for *Structure and use of market*.[11] Hence, there seems to be an increasing overall effect of economic freedom on CO_2 emissions from *Price stability and Legal security*, but an overall decreasing effect from *Structure and use of market*, although the latter effect is small.

A natural extension of this work is to study other types of environmental measures and their relationship with political and economic freedom. The size and sign of these effects can be expected to differ, depending on the public good character of the environmental good, or the character of the good from which the emissions occur.

[10] Note however that the effect of some economic freedom categories on GDP is negative and robust, and some are insignificant.

[11] The marginal effect of *Legal structure and Security of private ownership* on GDP growth is 0.358. If this category is increased by one unit, all else equal, mean GDP would be 1.00358^{10}*58.1=60.2 after 10 years, instead of 58.1 without the change. The effect of GDP on emissions is for Model 2 0.1894*GDP–0.0011*GDP^2+0.000002*GDP^3 (see Table 3). Hence, the difference in emissions for GDP=58.1 and GDP=60.2 is about 0.12. The increase in Box-Cox transformed emissions by 0.12 units from this indirect effect can then be compared to the direct effect of –0.03 (for Model 2). The overall effect on transformed emissions of a unit increase in this economic freedom category would hence be 0.09. *Structure and use of market* has a marginal effect on growth equal to 0.214. Following the same calculations as above the indirect effect on emissions would be 0.08, which could be compared to the direct effect of –0.13 (for Model 2). Hence, in this case the overall effect on transformed emissions of an increase in economic freedom would be –0.05.

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APPENDIX

Figure 1. Fitted relationship between CO_2 emissions and GDP per capita