Political and Economic Freedom and the Environment: The Case of CO_2 Emissions

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Abstract
In this paper we investigate what effect political and economic freedom has on emissions of CO_2. Furthermore, we concentrate the analysis to differences between high- and low-income. We find that political freedom has no effect on emissions of CO_2, neither for low- nor high-income countries. We apply different measures of economic freedom and find that these have often opposite effects in high- and low-income countries, and that the effects can have different signs depending on the degree of economic freedom. For high-income countries we find that most of the measures of economic freedom have a positive direct effect on emissions of CO_2, while for low-income countries most of the direct effects are negative. However, the indirect effects on CO_2 emissions are in most cases positive, i.e. the indirect effect is that economic freedom increases emissions.

Keywords: Political freedom, Economic freedom, Environmental Kuznets curve, Carbon Dioxide.

JEL classification: O10, O40

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1. Introduction

Among economists, there is a rather strong consensus that economic, but 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).[1] However, some authors have questioned the significance of political freedom on growth, arguing that there could even be a negative effect (especially for low-income countries), and that economic freedom should be prioritised (see e.g. Barro, 1996). Economic growth, or GDP, is not a perfect measure of welfare though; one factor that is not included in GDP is the environmental quality. Therefore, two interesting questions are whether income is positively correlated with environmental quality and whether economic and political freedom is positively correlated with environmental quality. If they are, there could be a "win-win" situation where both economic growth and the environment are improved by increased freedom. In this paper we investigate the effect of political and economic freedom on the level of carbon dioxide (CO_2) emissions, using a panel data set of 77 countries on CO_2 emissions from 1975-1996. Since global warming has been put forward as one of the major environmental problems and since the institutional factors such as political and economic freedom are accepted as crucial for economic development, the relation is of great importance. We also investigate if countries at different income levels respond differently, in terms of emissions per capita, to changes in economic freedom.

The paper is organised as follows. The relations between political and economic freedom and the environment 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 discussed. The final section concludes the paper.

2. Freedom and the Environment

There are a large number of empirical studies of the relationship between income and environmental quality. In particular, much attention has been put on the so-called

[1] However, it should be noted that the stability of the results have been questioned (see e.g. Levine and Renelt 1992, de Haan and Sturm, 2000).

environmental Kuznets curve (EKC) hypothesis. This hypothesis proposes an inverted-U shaped relation between environmental degradation and income, i.e. that environmental degradation is increasing in income at low income levels, reaches a turning point at some level and then is decreasing in income. There are two, partially related, main explanations of the EKC hypothesis. The first is that the EKC is a reflection of structural change, i.e. it reflects a transition from an agricultural-based economy to an industrial economy, and from an industrial economy to a service-based economy. The second is that the EKC is a reflection of an income effect for the environment, where the environment is seen as a luxury good. The underlying hypothesis is that the income effect can counteract the negative impact of the scale effect (i.e. that the economy grows) by an increased demand for environmentally friendly goods and investments, and stricter environmental regulations. The EKC hypothesis has been validated in several studies (see e.g. Grossman and Krueger 1995; Selden and Song, 1994; Shafik, 1994) but also criticized and rejected in other studies (see e.g. Arrow et al., 1995; Holtz-Eakin and Selden 1995; Stern et al., 1996).

In this paper we are specifically interested in CO_2 emissions. CO_2 emissions are different from many other pollutants, such as particulate matters and sulphur dioxide, since CO_2 is a global pollutant. This implies that there is a free-rider incentive for individual countries when it comes to reduction of emissions. There have been several studies of the relationship between CO_2 emissions and income (see e.g. Cole et al., 1997; Holtz-Eakin and Selden 1995; Moomaw and Unruh 1997). Most of the studies have found a monotonically increasing relation between income and emissions although some of the studies have found a cubic, or N shaped, relation between emissions and income, but the turning points are often outside the observed sample.

The presence of the EKC does not automatically lead to the conclusion that economic growth is the remedy for environmental problems. There is no automatic mechanism between income and the environment, even if there is an income effect for environmental quality. One reason for this is that environmental quality in many cases is a public good, which implies that the environmental quality to a certain extent also depends on the quality of the institutions, such as political and economic freedom.

2.1 Political Freedom

Behind the EKC hypothesis is an implicit 7assumption that the increase in demand for environmental quality will induce a policy response in terms of increased environmental regulation. Thus, a political and civil system in which individuals' demand for environmental quality is seen is crucial. However, from this does not follow that there has to be a positive correlation between political freedom and environmental quality. The reason why a less free regime could have a positive effect on environmental quality, at least for low-income countries, may be explained by the same arguments as Barro (1996) uses to explain why restrictions on the political freedom can be good for the growth. In a democratic system with majority voting there is a threat of rich-to-poor redistribution, including land redistribution, which may disencourage investments. Moreover, in a system with representative legislature the role of interest groups is enhanced. If these effects are biased against environmentally unfriendly solutions, the quality of the environment could decrease with political freedom. The effect of political freedom may also be insignificant; in particular if it is a global environmental problem since the individual country has an incentive to free-ride. At the same time, emissions of CO_2 can be correlated with other environmental problems, so there could still be an effect of political freedom. There can also be an indirect effect on CO_2 emissions because of the potential effect of political freedom on income, which in turn effects emissions.

The relation between political freedom and the environment has been studied by a few authors, with ambiguous results, but none of these have included CO_2 emissions. Deacon (1999) discusses reasons for a 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. In the empirical section Deacon (1999) finds that in most cases the least democratic regimes are also the worst when it comes to environmental policy levels and public good

provision. Barrett and Graddy (1998) also find a positive relation between environmental quality and political and civil freedom for several air pollutants, but at the same time a negative relation for several water pollutants. Torras and Boyce (1998) use three measures of democracy; the Gini coefficient of income distribution, literacy and an index of civil liberties. These indicators have in general a positive and significant effect on air and water quality, especially for low-income countries. They also find that the significance of the income variable decreases for several environmental measures when the democracy variables are included. However, Scruggs (1998) does not find any overall positive relation between water and air quality and political freedom.

2.2 Economic Freedom

Economic freedom is often mentioned as a crucial component for improving incentives, productive efforts and an effective resource use. If economic freedom is good or bad for the environment depends largely on how these factors in turn affect the environment. There can be a direct effect of economic freedom on environmental quality through for example more efficient use of resources. Moreover, if economic freedom has a positive effect on growth, there could be an indirect effect on the environment. How economic freedom affects the environmental quality through these effects is not clear, but we will propose a number of hypotheses.

(i) *The Regulation Effect.* Environmental problems are often of a public good character and there can be a need for political interventions, i.e. restrictions on the economic freedom. Environmental regulation implies less economic freedom, and if we expect a positive correlation between environmental regulation and environmental quality, we would have to expect a negative correlation between economic freedom and environmental quality. However, there are other regulations that could have a negative effect on the environment, such as subsidies to natural resource extraction. Which effect that dominates depends on the type and size of the regulations.

(ii) *The Efficiency Effect.* Under the assumption that economic freedom results in efficient and competitive markets, we expect a positive correlation between economic freedom and environmental quality. First, this will result in an efficient

use of resources that have a price. This price can of course be affected by for example a tax correcting for an externality. In the case of for example energy resources this implies lower emissions per produced unit. Second, an efficient and competitive market can more efficiently meet the political regulations. Third, an efficient market can better meet the desires from the consumers. The second and third reasons are simply due to competitive reasons; in order to survive firms have to react to changes in the market environment. Clearly, these two effects are only relevant if there are environmental regulations or a demand for cleaner production/goods from the consumers.

(iii) *The Stability Effect.* Lower inflation rate and clearer pricing signals lead to more efficient investment and consumption decisions. A stable macroeconomic environment also encourages longer investment horizons. Lack of price stability is one problem for development since investments decline when the insecurity of prices increases. Many environmental 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 can have a positive effect on the environment. 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 EKC literature (see e.g. Panayotou, 1997). With more secure property rights individuals can make long-term investments. For example, farmers with less insecure title to their land will be more likely to invest in soil conservation and sustainable cultivation techniques. However, an increased stability will also result in increased investments and consumption in general, and some of these will have a negative effect on the environment. Which type of decisions that will be made depends partly on what phase of the structural change the economy is in.

(iv) *The Credit Effect.* Firms or individuals that place their own wealth into risk, when asymmetric information exists, increase their lender's confidence and thereby reduces the amount of external financing required (Hubbard, 1998). For an equally risky project, individuals with low wealth will therefore be less likely to find credits for a project than a wealthier individual. Hence, financial restrictions mostly affect low-income people, and how the environment is affected when the

restrictions are loosened depends to a larger degree on what kind of investment or consumption decision low-income people will make.

The outcome of the effects of economic freedom is also affected by a *Structural Effect*. The effects are functions of what phase of the structural change the economy is in. For example, the nature of the change in investments is different in an economy dominated by the agricultural sector compared to an economy dominated by the industrial sector. For an economy in the beginning of industrialisation, there will mainly be investments in industry and infrastructure such as roads. For an economy in the end of industrialisation, there will mainly be investment in less resource intensive sectors such as the service sector. The goals of the government, which directly affects the directions of subsidies and government consumption, is also a function of the income level of the country. We expect the goals to be more directed toward the environment in a high-income country than in a low-income country, where other goals are prioritised.

As far as we know there has been no attempt to connect environmental quality with measures of economic freedom in cross-country comparisons, except for property rights/quality of institutions (see e.g. Panayotou 1997).[2] There have however been country specific investigations of the relation between economic policies and the environment. Munasinghe and Cruz (1995) conduct eleven case studies on mainly developing countries. Their main findings are: (i) Removal of price distortions, promotion of market incentives and relaxation of other constraints will in general contribute to both economic and environmental gains. (ii) There can be side effects if some reforms are undertaken, while other policy, market or institutional imperfections persist. (iii) Macroeconomic stability will generally yield environmental benefits, since instability undermines sustainable resource use.

[2] The conclusion from this study was that the quality of policies and institutions can reduce environmental degradation at low income levels and speed up improvements at higher income levels.

3. Data

The CO_2 emissions per capita and GDP per capita data comes from *1999 World Development Indicators CD-Rom* (World Bank, 1999). The data on CO_2 emissions is 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 stemming 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 is converted into international dollars using purchasing power parities.

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. The indices have been reported annually since 1972, although not all countries are included since 1972. Since they are highly correlated we use the average of these two indices, henceforth called political freedom. The political freedom index is measured on a scale between 1 to 7, where 7 is the highest level of freedom. We create dummy variables for different degrees of freedom, following the classification in Freedom House (1999), where not free means that the country score is between 1 and 2.5 and partly free means that the country score is between 3 and 5.

The data on economic freedom is obtained 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. There are no exact measures corresponding to the four effects, or hypotheses, we would like to test (see section 2.2), instead we use some of the categories of the index as

approximations of the effects that we want to examine. The category *Size of Government* represents the Regulation Effect. This category consists of two variables: 1) the share of government consumption expenditure and 2) the share of government transfers and subsidies as a percent of GDP. Countries with a large proportion of government expenditures or a large transfer sector receive lower ratings. The category *Economic Structure and Use of Market* represents the Efficiency Effect. This category is a measure of the share of government production and allocation, and it consists of four 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. The average of the two categories *Monetary Policy and Price Stability* and *Legal Structure and Property Rights*, henceforth called *Price Stability and Legal Security* 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 countries with a more stable monetary policy receive a higher rating. It 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. The category Legal Structure and Property Rights measures the security of property right and the viability of contracts and consists of three variables: 1) risk of confiscation, 2) risk of contract repudiation by the government and 3) institutions supportive to the principles of rule of law. The Credit Effect is represented by the category *Freedom of Exchange in Capital Markets* and this category consists of four variables: 1) the percent of deposits held in privately owned banks, 2) the percent of credit extended to private sector, 3) the absence of credit-market controls and 4) the absence of restrictions on foreign capital transactions.

Consequently, we have four measures of economic freedom. The economic freedom data has been reported every fifth year since 1970, and in addition the data is reported for 1997, but not all countries have been included since 1970. Since the data is reported every fifth year we extrapolate for the years not reported with a moving average between the observed years. This is not without problems but since we are more interested in the long-run effects of freedom on the environment, this should not be of primary concern.

The sample includes 77 countries for the period 1977-1996. The data is unbalanced, especially for the low-income countries, due to missing observations mainly on political and economic freedom.[3] We also estimate the models for two subsets of countries since we are particularly interested in investigating differences between low-income countries and other countries, and thereby study the structural effect more clearly. The grouping of countries is based on the classification made by the World Bank (1999). We classify low- and lower-middle income countries as low-income countries and the rest of the countries as high-income countries. There are 36 low-income countries and 41 high-income countries. Descriptive statistics for all countries and the two subsets of countries are presented in Table 1. Note that CO_2 per capita is in kg emissions per capita and GDP per capita is in thousands of dollars per capita.

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

	All countries		**Low-income countries**		**High-income countries**	
	Mean	Std.	Mean	Std.	Mean	Std.
CO_2 per capita ($C0_2$)	4852.3	5494.3	1171.7	1499.1	7708.2	5762.6
GDP per capita (GDP)	6.8	5.9	2.3	1.5	10.4	5.6
Political freedom (index 1-7)	5.0	1.8	3.8	1.6	5.9	1.5
Politic. not free (dummy)	0.2	0.4	0.3	0.5	0.1	0.2
Politic. partly free (dummy)	0.3	0.5	0.4	0.5	0.2	0.4
Size of government (EF1)	7.4	1.5	8.3	0.8	6.6	1.5
Structure and use of markets (EF2)	4.0	1.8	3.3	1.7	4.6	1.7
Price stability and Legal security (EF3)	6.7	2.2	5.6	1.9	7.6	2.0
Freedom of exchange in capital markets (EF4)	5.7	2.2	4.5	1.9	6.7	2.0
Number of observations	1387		606		781	

The correlation matrices are presented in Table 2. We see that both political and economic freedoms are highly correlated. With the exception of the variable EF1 (size of government), political and economic freedoms are positively correlated with GDP per capita. However, the correlation is much smaller for low-income countries. The correlation between emissions of CO_2 and freedom is also stronger for high-income countries.

[3] We also had data between 1986 and 1996, and 1990 and 1996 for a number of countries. However, using these observations resulted in non-robust estimates, and therefore we excluded them from the analysis.

Table 2. Correlation matrices for variables included in estimations

	All countries						
	GDP	**POL**	**EF1**	**EF2**	**EF3**	**EF4**	**CO_2**
GDP	1.00						
POL	0.60	1.00					
EF1	-0.63	-0.50	1.00				
EF2	0.49	0.36	-0.05	1.00			
EF3	0.63	0.48	-0.50	0.38	1.00		
EF4	0.65	0.50	-0.37	0.67	0.68	1.00	
$C0_2$	0.66	0.42	-0.47	0.38	0.52	0.54	1.00
	Low-income countries						
	GDP	**POP**	**POL**	**EF1**	**EF2**	**EF3**	**EF4**
GDP	1.00						
POL	0.34	1.00					
EF1	0.01	0.04	1.00				
EF2	0.46	0.43	0.31	1.00			
EF3	0.21	0.08	-0.19	0.19	1.00		
EF4	0.64	0.43	0.13	0.69	0.45	1.00	
$C0_2$	0.66	0.07	-0.24	0.05	0.18	0.30	1.00
	High-income countries						
	GDP	**POP**	**POL**	**EF1**	**EF2**	**EF3**	**EF4**
GDP	1.00						
POL	0.43	1.00					
EF1	-0.45	-0.42	1.00				
EF2	0.37	-0.01	0.20	1.00			
EF3	0.63	0.48	-0.40	0.30	1.00		
EF4	0.53	0.20	-0.24	0.54	0.68	1.00	
$C0_2$	0.43	0.16	-0.19	0.27	0.44	0.41	1.00

4. Model Specification

Shafik (1994) suggests four determinants of environmental quality: (i) country-specific endowments such as climate and location, (ii) per capita income, (iii) exogenous factors such as technology which is available to all countries but changes over time and (iv) policies that reflect social decisions about the provision of environmental public goods. Most studies of the EKC hypothesis have included determinants (i) - (iii) but we focus on determinant (iv) by adding political and economic freedom variables to the analysis. We estimate the following model:

$$CO2_{it} = \alpha_i + \gamma_t + \beta_1 Y_{it} + \beta_2 Y_{it}^2 + \beta_3 Y_{it}^3 + + \lambda_1 NF_{it} + \lambda_2 PF_{it} + \sum_j \mu_{1j} EF_{it}^j + \sum_j \mu_{2j} (EF_{it}^j)^2 + \varepsilon_{it}$$

where i is a country index and t a time index. The term α_i reflects country i's fixed effects such as geographical characteristics, fossil fuel availability and prices, energy endowments, output mixes and tastes.[4] The term γ_t reflects the time specific effects such as changes in the world price of oil and technological change. $CO2_{it}$ is per capita emissions of CO_2, measured as a moving average of the current and the previous three years since the current level of emissions to some extent is a function of past levels of emissions. Y_{it} is per capita GDP. NF_{it} and PF_{it} are dummy variables for not free and partly free political systems, EF^j is economic freedom variable j, and e_{it} is a stochastic error term. Since we wish to allow for non-linear effects of economic freedom, a quadratic term is included. However, only significant quadratic terms are included. We also include a quadratic and cubic term for GDP per capita. Note that if $\beta_1 > 0$, $\beta_2 < 0$ and $\beta_3 = 0$, there is an inverted-U relation between income and emissions, but if $\beta_3 > 0$ then there is a N relation. Other specifications than the linear can be considered, and often a log-linear specification has been proposed. However, a PE-test of the specification (Greene, 2000) was inconclusive in the test between linear and log-linear specification, and therefore we only report the results of the linear specification.

For each regression both a random and a fixed effect model was estimated, and in all cases a Hausman test resulted in a rejection of the null hypothesis that the individual effects are uncorrelated with the other regressors. In addition, the fixed effects model is more appropriate since we only wish to draw inference on the set of observed countries. We have also tested for a lagged effect of political freedom on the environment by including the political freedom variable as a moving average of current year and previous three years. This did not affect the result in any significant manner, and we do not report the results of these estimations.

Economic and political freedom can also have indirect effects on the environment through their effect on income. In order to discuss the total effect of freedom on CO_2 emissions, we also need information on the relationship between CO_2 emissions and

[4] All these effects could of course change in the long run but are expected to be constant during the time period we study.

economic and political freedom. There are a number of studies on this issue, but we mainly rely on the results of Carlsson and Lundström (2000).

5. Results

5.1 Pooled Estimation

We begin estimating the model with the pooled sample, mainly because it is of interest to compare the results with previous research. The GDP per capita variables are significant, and both dummy variables for political freedom are insignificant. Interestingly, the model predicts a turning point for GDP at 10 thousands of dollars per capita. All the economic freedom variables are significant. Emissions are decreasing in the size of government when the government size is small, and increasing when the government size is large.[5] The marginal effect for this variable is not significantly different from zero. Market use instead of government allocation has a positive marginal effect, but at very low levels of market use increased market use leads to decreased emissions. Price stability and legal security leads to decreased emissions at low levels of stability and security, and to increased emissions at high levels. The marginal effect is positive and significant. The variable Freedom of exchange in capital markets has a positive marginal effect, even though emissions decrease at high levels of freedom. At this point there does not seem to be a strong case for economic freedom since most variables indicate that economic freedom has a positive effect on CO_2 emissions. As we will see, this does not have to be the case when we look at high- and low-income countries separately.

[5] Note that economic freedom is decreasing in the size of the government.

Table 3. Results of pooled estimations, marginal effects are calculated at sample means. P-values in parentheses.

	Coefficient	**Marginal effect**	**Turning point**
GDP per capita (GDP)	491.6 (0.01)	166.0 (0.05)	10.00 (0.00)
GDP^2	-42.4 (0.00)		
GDP^3	1.0 (0.00)		
Politically partly free	-140.3 (0.52)		
Politically not free	-108.0 (0.68)		
Size of government (EF1)	1410.6 (0.09)	-181.3 (0.21)	6.5 (0.00)
$EF1^2$	-107.7 (0.07)		
Structure and use of markets (EF2)	-375.0 (0.04)	222.3 (0.01)	2.5 (0.00)
$EF2^2$	74.0 (0.00)		
Price stability and Legal security (EF3)	-1241.8 (0.00)	198.1 (0.03)	5.8 (0.00)
$EF4^2$	107.7 (0.00)		
Freedom of exchange in capital markets (EF5)	718.8 (0.01)	180.3 (0.05)	7.6 (0.00)
$EF5^2$	-47.0 (0.03)		
Constant	87.8 (0.99)		
Number of observations			1387
R-squared			0.90

5.2 Estimations for Low- and High-Income Countries

The model is now estimated for the two subsets, high- and low-income countries, and the results are reported in Table 4. Note that we only report significant quadratic terms for the economic freedom variables.

Table 4. Results for low-income and high-income countries, marginal effects are calculated at sample means. P-values in the parentheses.

	Low-income countries			**High-income countries**		
	Coeff.	**Marg.**	**Turning**	**Coeff.**	**Marg.**	**Turning**
GDP per capita (GDP)	713.9 (0.00)	433.1 (0.00)	No	882.4 (0.01)	144.8 (0.21)	12.5 (0.00)
GDP^2	-96.4 (0.00)			-66.0 (0.00)		
GDP^3	7.1 (0.00)			1.5 (0.00)		
Politically partly free	-33.5 (0.25)			-382.9 (0.43)		
Politically not free	19.0 (0.57)			-155.5 (0.82)		
Size of government (EF1)	-126.3 (0.00)			1842.5 (0.20)	-304.4 (0.23)	5.7 (0.00)
$EF1^2$				-161.7 (0.14)		
Structure and use of markets (EF2)	-7.0 (0.80)	-44.3 (0.00)		-626.2 (0.07)	474.9 (0.00)	2.6 (0.00)
$EF2^2$	-5.7 (0.06)			118.9 (0.00)		
Price stability and Legal security (EF3)	48.3 (0.12)	-12.2 (0.26)	4.5 (0.00)	-2467.9 (0.00)	737.0 (0.00)	5.8 (0.00)
$EF3^2$	-5.4 (0.06)			212.5 (0.00)		
Freedom of exchange in capital markets (EF4)	-23.2 (0.10)			1368.8 (0.02)	143.4 (0.40)	7.5 (0.00)
$EF4^2$				-91.59 (0.03)		
Constant	1236.0 (0.00)			664.7 (0.89)		
Number of observations			606			781
R-squared			0.98			0.85

All the GDP per capita coefficients are still significant for the high-income countries, and the turning point for GDP is at 12.5 thousands of dollars per capita. The maximum observed value of GDP per capita for high-income countries is at 28.3 thousands of dollars per capita, so the turning points is within the observed range. For low-income countries the GDP per capita coefficients are significant, but there is no turning point in real numbers, instead there is a monotonically increasing relation between income and emissions.[6] For both subsets the dummy variables for political freedom are still

[6] For a cubic function of the form $y = a_1 x + a_2 x^2 + a_3 x^3$, the turning points are $x_{1,2} = \frac{-2a_2 \pm \sqrt{4a_2^2 - 12a_1 a_3}}{6a_3}$. However, if $4a_2^2 < 12a_1 a_3$, then the turning points are not real numbers.

insignificant, consequently we can conclude that for the sample of countries that we study, political freedom does not have any effects on CO_2 emissions.

For low-income countries there is a monotonically increasing relation between the size of the government and the amount of emissions. A reduction in the size of the government would therefore lead to lower emissions of CO_2. For high-income countries a reduction in the size of the government increases emissions at low degrees of economic freedom. The turning point is at an index value of 5.70 and the marginal effect for the variable is negative (although insignificant). The effect of the government size depends, as we have discussed, on the type of government consumption and regulation, which in turn depends on the prevailing government goals. For low-income countries the regulations seem to have a negative effect on the environment, while for high-income countries the effects depend on the degree of regulation. The result may be explained by that the government in high-income countries is more in favour of environmental regulations than in low-income countries because of an income effect for environmental quality.

Market use instead of government allocation leads to decreased emissions in the low-income country group. This negative effect on emissions is to some extent explained by what we call the efficiency effect. In the high-income group there is an opposite relation where more freedom, i.e. more use of markets, increases the emissions of CO_2, with the exception for low degrees of economic freedom. The turning point is already at an index value of 2.6.

An increased price stability and more secure property lowers CO_2 emissions for low-income countries for most degrees of economic freedom, which could be ascribed to what we call the stability effect. For high-income countries, increased stability and more secure property rights decrease emissions only at low degrees of economic freedom.

An increase in the freedom of exchange in capital and financial markets lowers CO_2 emissions for low-income countries. For high-income countries emissions are increasing in this measure of economic freedom at low degrees of freedom, and decreasing at high.

The overall result for economic freedom is that the different economic freedom variables often have opposite effects on CO_2 emissions depending on the sample. Moreover, the same variable has in several cases opposite effects on the emissions

depending on the degree of economic freedom. For high-income countries most of the direct effects of economic freedom are positive, i.e. increased freedom increases CO_2 emissions, while the opposite is true for low-income countries. The major exception for high-income countries is Government size (the Regulation effect), which implies that there could be an induced policy response that decreases emissions. The results on the Efficiency, Stability and Credit effect of course pose the question why there are differences between low- and high-income countries. One explanation is that there are large inefficiencies in low-income countries, and with increased economic freedom these inefficiencies are reduced. However, this discussion leads us to the question of indirect effects. Before discussing this it is worth emphasizing that our model predicts a turning point for GDP, both in the pooled model and for high-income countries, and these turning points are within the observed sample. This implies that the sign of the indirect effect also depends on the size of GDP.

5.3 Indirect Effects of Economic Freedom

There are a number of studies on the relation between economic and political freedom and growth. Here we rely on the results of Carlsson and Lundström (2000), since this is the only study that estimates the relation between the level of GDP and the different categories of economic freedom, and further divides the sample in high- and low-income countries.[7] For the pooled estimation the only economic freedom variable that has a positive effect on GDP is Legal structure and security of private ownership, which is one of the categories that is included in EF3. For low-income countries Government size, Legal structure and security of private ownership, and Freedom of exchange in capital markets are positive and significant, while Economic structure and use of markets is significant and negative. For high-income countries it is again only Legal structure and security of private ownership that is positive and significant.

If we evaluate the indirect effect at the marginal effect at sample means we can compare these with the direct marginal effects, and calculate the total effect of economic freedom. The results of this exercise are presented in Table 5.

[7] Carlsson and Lundström (2000) analyse the effects of economic freedom both on growth and the level of GDP per capita for the period 1975-1996 for 74 countries. Here we focus on the results for the level of GDP per capita and the economic freedom variables that we have analysed.

Table 5. Direct and indirect effects on CO_2 emissions. (The indirect marginal effects of EF3 is calculated from the category Legal structure and security of private ownership.)

		Size of government	**Structure and use of markets**	**Price stability and legal security**	**Freedom of exchange in capital markets**
All countries	Direct			198.1	
	Indirect			84.7	
	Total			282.8	
Low-income countries	Direct	-126.3	-44.3	- 12.2	-23.2
	Indirect	143.7	-71.3	43.5	46.9
	Total	17.4	-115.6	31.3	23.7
High-income countries	Direct			737.0	
	Indirect			55.6	
	Total			792.6	

For the whole sample and the two subsets, the indirect effect for Price stability and legal security has the same sign as the direct effect. For the other measures of economic freedom, the indirect effects dominate, although the differences are not that big.

6. Conclusions

The results we have found should be interpreted with some care, since our study is not immune to the earlier criticism against the EKC literature. The data is rather unbalanced, mainly due to missing observations on political and economic freedom, and our experience is that for example the classification of high- and low-income countries can affect the result. Moreover, it is not possible to directly relate the economic freedom indices to the hypotheses in Section 2. Therefore it is difficult to reject or accept the hypotheses, and to know exactly what effects that drive the result. However, what we can do is to draw conclusions about the effects of the indices, and in Section 5 we have discussed how these might be related to the hypotheses. With this in mind, there are indeed some interesting results. First of all the study actually predicts a turning point for CO_2 emissions, and this turning point is within the observed sample range. Moreover, we find that political freedom does not have any effect on the level of CO_2 emissions, contrary to the findings for several other air pollutants.

Our results also show the importance of analysing high- and low-income countries separately since they in many cases respond differently to changes in the economic environment. The direct effects of economic freedom on emissions are mainly negative

for low-income countries and positive for high-income countries. Interestingly, the variable that has a negative marginal effect on emissions in high-income countries is Government size. Now the question remains; is the advice for economic growth compatible with a better environment? Are there any ”win-win” situations where economic freedom not only promotes growth but also a better environment? According to our results, economic freedom is in general directly negatively related to CO_2 emissions for low-income countries, which opens up for a “win-win” situation for this sample of countries. However, we also find indications that, with the exception of Structure and use of markets, the total effect (including both direct and indirect effects) of economic freedom gives increased emissions. The general result is thus that there does not seem to be any "win-win" situations in the case of economic growth and environmental quality, for neither high- nor low-income countries, but of course there can be other positive and negative welfare effects of economic freedom.

A natural extension of this work is to study other types of environmental measures and their relation to 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. Another important step in the understanding of the connections between economic freedom and the environment is to develop the measures of economic freedom and regulation. We are now for example not able to measure the effectiveness of environmental regulations per se.

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