E C O N O M I C S B U L L E T I N

Trade Liberalization and the Environment: Carbon Dioxide for 1960−1999

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Abstract

This paper examines the empirical question of whether free trade is harmful or beneficial for the environment. Using a comprehensive panel data for 63 developed and developing countries over 1960 E999, the result for CO2 suggests further trade liberalization will increase the emissions with the elasticity of 0.579. In my best knowledge, this is the first study that estimates the overall effects of trade liberalization to the environment.

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1. Introduction

Role of free trade on the environment has been a focus of the policy debate. Openness to international trade will have both positive and negative impacts on the environment and these impacts are decomposed into three pieces: scale, technique and composition effects (Grossman and Krueger, 1993). The scale effect explains the negative environmental consequences after expansion of economic activity if the nature of the economic activity remains unchanged. The technique effect explains the positive environmental consequences of increases in income that call for cleaner production methods. The composition effects explain the trade-induced changes in the composition of output that affect pollution level.

Antweiler, Copeland, and Taylor (2001) add up scale, technique and trade-induced composition effects using sulfur dioxide data for 43 countries over 1971-1996. Their estimates show consistently higher elasticity of technique effect over scale effects. Trade induced composition has shown to have positive environmental consequences. Therefore, they conclude free trade is good for environment[1]. Cole and Elliott (2003) estimate a combined scale and technique effects for SO_2, NO_x, CO_2, and BOD. They find technique effects are dominating scale effects for SO_2 and BOD with scale effects dominant for NO_x and CO_2.

Frankel and Rose (2002) have modeled the effect of trade on the environment, controlling for income and other relevant factors. The main contribution of their paper is to address the endogeneity of income and especially trade, the latter by means of instrumental variables drawn from the gravity model of bilateral trade. According to the gravity model, trade is determined by indicators of country size (GDP, population, and land area) and of distance between the pair of countries in question (physical distance as well as dummy variables indicating common borders, linguistic links, and landlocked status). Such gravity instruments have recently been used to isolate the effect of trade in studies of economic growth. Frankel and Rose (2002) estimate a system of two equations, environmental degradation and economic growth equations using 41 countries data in 1990. While the use of instrumental variables did not radically reverse the results of OLS studies, they have found that trade appears to have a beneficial effect on some measures of environmental quality such as SO_2, organic water pollution, and to some extent NO_2. To my knowledge, there are no existing studies that have estimated the overall effects of trade liberalization to the environment though separate impact of scale, technique, and composition effects are estimated.

Emission of CO_2 and its analysis have great political concern and surely it is a greatest concern for environmentalist. However, CO_2 emissions have not received a great deal of regulation mainly because of the lack of a local impact for CO_2. It is also worth bearing in mind that CO_2 is a purely global externality, and unlikely to be addressed by national level regulation. In this study, I obtain larger dataset for 63 countries over 1960-1999 and test the hypothesis free trade is good for environment (i.e., reduction in carbon dioxide level). Methodologically, I follow the simultaneous study of Frankel and Rose (2002) and change the environmental equation to the one developed by Antweiler, Copeland, and Taylor (2001) to take account the scale, technique and trade-induced composition effects. The result suggests further trade liberalization will increase the emissions with the elasticity of 0.579.

[1] Harbaugh, Levinson, and Wilson (2002) also study SO_2 using GEMS in the framework of Environmental Kuznets Curve. They also support the view trade is beneficial to environment.

2. The Empirical Model and Data

The environmental quality model is represented by;

$$\ln E_{it} = \alpha_0 + \alpha_1 \ln S_{it} + \alpha_2 \ln I_{it} + \alpha_3 \ln T_{it} + \alpha_4 \ln T_{it} \ln I_{it} + \alpha_5 P_{it} + \alpha_6 P_{it} \ln I_{it} + \sum \alpha_{7i} D_i + \sum \alpha_{8t} D_t + \varepsilon_{it} \quad (1)$$

where *S* is gross domestic product (GDP) per capita for country *i* and year *t*, *I* is lagged income[2], *T* is trade intensity defined as the ratio of aggregate export and import to GDP following the norm in the growth literature as a proxy for openness, *P* is Polity, which measure how democratic is the structure of the government, rating from –10 (strongly autocratic) and to +10 (strongly democratic), *D* is dummy variables. I use log form following reduced form of theoretical model by Antweiler, Copeland, and Taylor (2001). Variables *S*, *I*, and *T* capture the scale, technique and trade-induced composition effects, respectively.

Growth equation is represented, following Frankel and Rose (2002), by;

$$\ln S_{it} = \beta_0 + \beta_1 \ln T_{it} + \beta_2 H_{it} + \beta_3 \ln S_{it-10} + \beta_4 \ln I_{it-10} + \beta_5 G_{it} + \beta_6 Sch1_{it} + \beta_7 Sch2_{it} + \sum \beta_{8i} D_i + \sum \beta_{9t} D_t + \mu_{it} \quad (2)$$

where *H* is growth rate of population, *G* is gross investment divided by GDP, *Sch1* and *Sch1* are estimates of human capital investment based on primary and secondary schooling enrolment rates, respectively. I control population growth, initial income, investment, and human capital following neoclassical growth theory. All variables are described in Frankel and Rose (2002). Where there is a missing data and if it is statistically possible, I use two-step estimation procedure to correct for censoring of observations (Heckman, 1979; Greene, 1981). My dataset composed of 63 countries over 1960-1999[3]. Contrast to the literature, my dataset has more data for developing countries.

3. Results

Table 1 presents the results of carbon dioxide emission equation (1) from my OLS and instrumental variable (IV) estimation[4]. Both of them have statistical significant results of scale effect, *GDP*, and technique effect, *Income*. These results imply that total amount of pollution must increase after expansion of economic activity. Also the results imply that total amount of pollution must decrease after country's wealth increase with increasing in the demand of better environmental quality. The scale elasticity and the independent technique elasticity are between 0.62 and 1.37, and between –0.71 and –0.83, respectively. The coefficient of openness, *Trade Intensity*, is positive. The coefficient of the interaction terms between openness and income is mixed for OLS and IV estimations. The sign changed to positive once IV estimation and used. This positive or negative sign, however, does not necessary directly imply that trade is bad or

[2] See Antweiler, Copeland, and Taylor (2001) for the reason of using these proxy variables.
[3] An additional technical appendix is available on request, which contain more detailed data descriptions.
[4] The instrumental variables I choose are same as Frankel and Rose (2002).

Table 1. Determinants of Carbon Dioxide Emission: 1960-1990

Estimated Method	OLS	IV
GDP per capita	1.369 ***	0.620 ***
	(13.90)	(14.90)
Income	−0.834 ***	−0.709 ***
	(−60.70)	(−30.52)
Trade Intensity (TI)	1.161 ***	0.732 ***
	(6.02)	(7.01)
*TI*Income*	−0.085 ***	0.052 ***
	(−3.48)	(9.73)
Polity	−0.173 ***	−0.191 ***
	(−9.71)	(−9.50)
Polity Income*	−0.010 ***	−0.011 ***
	(−9.75)	(−9.26)
Intercept	−5.517	−4.547
Overall effects of trade (elasticity)	1.108	0.579
R^2	*0.890*	*0.865*
Observations	2520	2520

Note: *** Significant at 1 %. t statistics are in parentheses.
Coefficients for dummy variables are not listed in this Table.

good for environment. An increase in trade openness increases the value of state output, composition, and real income in a small open economy. Since the value of output and the value of income rise by the same percentage approximately, I am able to compare scale and technique effects. Following Antweiler, Copeland, and Taylor (2001), value of output and income are assumed to rise by the same percentage. Antweiler, Copeland, and Taylor (2001) show the overall impact of openness are found by taking derivative of pollution level with respect to openness given by[5]:

$$\frac{dE}{dT}\frac{T}{E} = \left[\alpha_1^{'} + \alpha_2^{'} + \alpha_4^{'}\ln T_{it} + \alpha_6 P_{it}\right]\frac{dS}{dT}\frac{T}{S} + \alpha_3^{'} \qquad (3)$$

Derivative of scale to openness, term after the bracket $\frac{dS}{dT}\frac{T}{S}$, is estimated in (2) to be 1.719 (see Table 2) as I explain later. Using this value and three coefficients in (3) (see the results of IV estimates in Table 1), I am able to find the overall impact of trade liberalization. I find the overall estimate is 0.579, which imply, one percent increase in trade openness increases carbon dioxide at 0.579 percent[6]. The estimated effect of the polity variable on carbon dioxide is negative, suggesting that improved governance has a beneficial effect.

[5] Dash sign of coefficients in (3) imply these are coefficients of original reduced form equation (i.e., no error term).
[6] Antweiler, Copeland, and Taylor (2001) do not estimate the overall impact for SO_2 since both of first bracket in (3) and second terms are negative. Thus, clearly, overall impact is negative.

Table 2. Determinants of Growth Equation: 1960-1990

Estimated Method	OLS	IV
Trade Intensity	0.426 ***	1.719 ***
	(15.52)	(19.29)
Population growth	−0.004	−0.039 ***
	(−0.43)	(−2.76)
GDP per capita $_{t-10}$	−0.009	−0.020
	(−0.88)	(−1.17)
Income $_{t-10}$	0.169 ***	0.363 ***
	(15.35)	(16.76)
Investment	0.015 ***	−0.008 ***
	(10.32)	(−2.73)
School1	0.002 ***	0.002 **
	(3.43)	(2.24)
School2	0.017 ***	0.014 ***
	(26.50)	(13.18)
Intercept	1.156	−5.725
R^2	*0.8307*	*0.6529*
Observations	2520	2520

Note: *** Significant at 1 %, ** Significant at 5 %. t statistics are in parentheses.
Coefficients for dummy variables are not listed in this Table.

Table 2 reports the results of growth equation (2). All of the variables of OLS show significant in right sign except population growth and lagged GDP per capita. Once I introduce IV estimation, all of the variables become significant except lagged GDP per capita. The estimated coefficient on openness shows significant positive sign indicating the strong impact of trade on economic growth. Thus, trade promotes economic growth. Population growth has the negative sign with statistical significance for IV estimates hypothesized by the neoclassical model, where Frankel and Rose (2002) find not statistically significant results. The effects of investment and both schooling variables are statistically significant and shown to have positive impact on growth.

4. Concluding Remarks

This study has analyzed the impact of trade liberalization to carbon dioxide level on 63 countries over 1960-1999. I am able to find the ”right directions” for trade’s effect within a more complete theoretical framework (Copeland and Taylor, 2003). Trade is found to have harmful effects to environment. One percent increase in trade openness increases carbon dioxide at 0.579 percent. This result is consistent with the recent study by Cole and Elliott (2003), which estimate the positive separate estimate of scale and technique, and composition effects tough they do not estimate the overall impacts. Contrary to the small observations in Cole and Elliott (2003) that use 32 countries data for the period 1975–1995, this study enlarges the dataset to 63

countries for the for the period 1960–1999. The contribution of this paper to the literature is twofold. First, this is the first study that estimates the overall impact of trade liberalization to the environment. Second, simultaneous model has proven to be beneficial. With the endogeneity of economic growth and trade, my significance level of growth model improved.

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