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Ecological Indicators

The impact of trade openness on global carbon dioxide emissions: Evidence from the top ten emitters among developing countries

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ABSTRACT

This study aims to analyze the relationship between carbon dioxide (CO_2) emissions, trade openness, real income and energy consumption in the top ten CO_2 emitters among the developing countries; namely China, India, South Korea, Brazil, Mexico, Indonesia, South Africa, Turkey, Thailand and Malaysia over the period of 1971–2011. In addition, the possible presence of the EKC hypothesis is investigated for the analyzed countries. The Zivot–Andrews unit root test with structural break, the bounds testing for cointegration in the presence of structural break and the VECM Granger causality method are employed. The empirical results indicate that (i) the analyzed variables are co-integrated for Thailand, Turkey, India, Brazil, China, Indonesia and Korea, (ii) real income, energy consumption and trade openness are the main determinants of carbon emissions in the long run, (iii) there exists a number of causal relations between the analyzed variables, (iv) the EKC hypothesis is validated for Turkey, India, China and Korea. Robust policy implications can be derived from this study since the estimated models pass several diagnostic and stability tests.

1. Introduction

Both the volume of international trade and carbon dioxide (CO_2) emissions are simultaneously growing for decades. More precisely, the amount of carbon emissions increased by 75% between 1980 and 2012 according to the U.S. Energy Information Administration (EIA) and the total value of international trade increased by 450% in the same period according to the World Development Indicators (WDI) (EIA, 2013; WDI, 2015). Moreover, not only CO_2 emissions in developing countries have recently gone up at a rapid pace but also carbon emissions in developing countries are anticipated to be 127% higher than in developed countries by 2040 (EIA, 2013: 7).

Some empirical studies (Pao and Tsai, 2010; Alam et al., 2011; Wang et al., 2014) argue that this expectation may occur due to lasting large demands for energy in developing countries while

some claim that it may result from free trade policies such that developed countries reduce their dirty-intensive good productions with the advantages of globalization (Carvalho et al., 2013; Shahbaz et al., 2013e). Therefore, important discussions are carried out on the environmental impacts of carbon dioxide emissions embodied in international trade in recent years both in academic and political circles (Mehra and Das, 2008). In this line, Lawrence Summer who was the chief economist of the World Bank further inflamed debates on this issue with the following question "... shouldn't the World Bank be encouraging more migration of the dirty industries to the less developed countries?" (Hausman and McPherson, 2000: 9) According to this view, developing or less developed countries consent to environmental degradation to increase prosperity and life standards through the dirty industries. Therefore, increase in international trade and transfer of production in dirty industries from developed countries to developing and less developed countries, for the sake of tax incentives, inevitably brings along environmental problems. Although developed countries were historically responsible for a large percentage of worldwide emissions, the level of emissions in developing countries appears to be relatively much higher in recent years (IEA, 2014: 13). According to the International Energy Agency (IEA), the total amount of CO_2 emissions emitted by the top 25 countries corresponded to 80% of the 2012 worldwide emissions. Furthermore, 60% of those were caused by

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[1] The opinions expressed in this paper are those of the authors and do not necessarily reflect the opinions of the Undersecretariat of Turkish Treasury.

Table 1
Key indicators of top 25 countries emitting highest CO_2 emissions.

World rank	Total CO_2 Emissions (2012) (million tons) and % change (1990–2012) Source: IEA	CO_2 emissions/GDP (2012) Source: IEA	CO_2 intensity (kg per kg of oil equivalent energy use) (2012) Source: World Bank	Per capita energy consumption (2011) Source: IEA	Openness (Trade/GDP) (2012) Source: World Bank	Per capita GDP (2012) Source: World Bank	GDP (billon) (current, 2012, US$) Source: World Bank
1. China[a]	8250 (262%)	1.73	3.29	2029	45.71	6092	8229
2. United States	5074 (4%)	0.36	2.45	7032	30.6	51,495	16,163
3. India[a]	1954 (236%)	1.41	2.77	613	55.5	1503	1858
4. Russian Fed.	1659 (−23%)	1.69	2.47	5113	51.8	14,090	2017
5. Japan	1223 (15%)	0.26	2.34	3610	31.3	46,679	5954
6. Germany	755 (−20%)	0.25	2.26	3811	85.9	43931	3533
7. Korea, Rep.[a]	592 (158%)	0.55	2.27	5231	109.8	24453	1222
8. Canada	533 (24%)	0.41	1.98	7333	62.0	52,409	1821
9. Iran, Isl. Rep.	532 (197%)	2.17	2.71	2812	–	6578	502
10. Saudi Arabia	458 (203%)	0.92	2.41	6738	83.7	25,945	733
11. United King.	457 (16%)	0.19	2.44	2973	62.5	41,053	2614
12. Brazil[a]	440 (128%)	0.39	1.57	1371	25.2	11,319	2248
13. Mexico[a]	436 (64%)	0.42	2.47	1559	66.3	9817	1186
14. Indonesia[a]	435 (198%)	1.02	2.05	857	49.5	3551	876
15. Australia	386 (48%)	0.42	3.04	5500	42.7	67,524	1534
16. South Africa[a]	376 (48%)	1.22	3.23	2740	60.7	7313	382
17. Italy	374 (−5%)	0.22	2.38	2819	56.1	35,132	2091
18. France	333 (−5%)	0.15	1.38	3869	59.2	40,908	2686
19. Turkey[a]	302 (138%)	0.48	2.83	1539	57.7	10,660	788
20. Poland	293 (−14%)	0.72	3.12	2629	90.3	12879	496
21. Ukraine	281 (−59%)	2.94	2.30	2766	104.0	3873	1766
22. Spain	266 (29%)	0.23	2.11	2686	59.0	28992	1355
23. Thailand[a]	256 (219%)	1.15	2.51	1789	148.8	5479	365
24. Kazakhstan	225 (−4%)	2.59	3.34	4717	75.5	12,120	203
25. Malaysia[a]	195 (288%)	0.99	2.98	2639	158.9	10,439	305

Note: Using IEA (2014) and WDI (2015), the table is composed by authors.

[a] The developing countries analyzed in this study.

developing countries. Furthermore, it is expected that 80% of the global emissions will be emitted by developing countries in the near future (Huwart and Verdier, 2013). On the contrary, non-Annex-I parties in the Kyoto protocol are mostly developing countries with no obligation to reduce carbon emissions. Yet, the responsibilities of developing countries about the environment have not been intensively discussed at a global framework.

Table 1 shows the main indicators of the top 25 CO_2 emitters in 2012. As one can realize that the percentage increases in CO_2 emissions of developing countries between 1990 and 2012 are more than those of developed countries.[2] On the other side, developed countries had a lower CO_2/GDP ratio than developing countries. This may happen since developed countries in Annex-I made commitments to the Kyoto protocol so as to lower the level of CO_2 emissions while developing countries did not. There are mainly two possible reasons why developing countries did not want to assume obligations in these issues. First, developing countries historically contributed to global CO_2 emissions less than developed countries. Second, developing countries believed that environmental regulations would negatively affect their economic growth.

There is another dimension in this carbon emissions problem. The downward trend in gas emissions in developed countries as a result of the policies implemented with regard to the first commitments period of the Kyoto Protocol seem to be consistent with the Environmental Kuznets Curve (EKC) hypothesis which claims that increases in income after a certain threshold provide environmental improvements and the relationship of income–environment is

an inverted U-shape in the long run. However, developed countries indeed reduce their own national gas emissions since they shift their dirty industries to developing countries through the globalization and freer trade according to Carvalho et al. (2013). Therefore, international organizations should consider the problem of *outside pollution* when discussing global environmental problems (Guo et al., 2010). This emerging dilemma with international trade is explained by *pollution-haven hypothesis.* This hypothesis implies that demand for a cleaner environment increases as per capita income raises, and thus dirty industries in developed countries are looking for other places with less environmental standards (Kukla-Gryz, 2009). People living in developing and less developed countries are believed to have less environmental concerns than those in developed countries wherein the former group more cares about increases in income and welfare (Tang, 2015). In response to the desires of population, these pollution-haven countries usually prefer higher levels of income to higher levels of environmental quality.

The fact that Annex-I countries made environmental regulations in accordance with the Kyoto Protocol and host countries for the dirty industries (developing or less developed economies) apply low environmental standards in order to ensure competitive advantage, and thus the carbon-intensive productions flow from developed countries to their own lands. As a result, gas emissions follow an increasing trend in developing countries while CO_2 emissions decline in countries with more stringent regulations. This effect is called as *carbon leakage* in the literature (Kuik and Gerlagh, 2003). According to this view, free trade reveals the impact of *race to bottom* which basically implies that environmental standards in countries decline as long as less environmental standards yield comparative advantages and attract multinational enterprises (Olney, 2013). Hence, unrestricted regulations may lead to an increase in the number of firms producing pollution-intensive export goods and an increase in the volume of dirty-goods

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[2] This study uses the World Economic Outlook 2015 published by IMF divides the world into two groups: advanced countries and developing countries. The document is available at the following link: http://www.imf.org/external/pubs/ft/weo/2015/01/weodata/groups.htm (accessed on March 2, 2016).