"Environmental Impact of Economic Growth in BRICS"

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Abstract

It is important to determine if high economic growth can be sustained within environmental constraints or without exceeding ecological thresholds. This paper aims to test the existence of the Environmental Kuznets Curve (EKC) in developing economies using panel data analysis. The EKC states that pollution increases as income goes up, and after reaching a turning point, it starts to decrease. By analyzing the relationship between GDP per capita and greenhouse gas emissions, I conclude that the EKC curve does exist for China, India, and South Africa, which will continue to pollute, while the hypothesis does not hold for Brazil and Russia. Additionally, WTO membership and, more specifically, trade openness, increases emission levels.

Key Words: Environmental Kuznets curve, economic growth, trade openness, environmental degradation, World Trade Organization, BRICS.

1. Introduction

Environmental pollution is an important issue in the process of economic growth. Since Brazil, Russia, India, China, and South Africa opened to trade in the years 1995, 2012, 1995, 2001, and 1995 respectively, there has been remarkable economic growth. Developing countries, who are members of the World Trade Organization (WTO), benefit from new rules and regulations that secure their access to the markets of trading partners. Despite the benefits and the impressive economic performance, the environmental qualities in these countries have deteriorated in the past decades. A 2014 report estimates the economic impact of air pollution across the world's most economically developed nations, including China and India, at $3.5 trillion (Neff, 2016). There are several factors that affect environmental quality such as international trade, foreign direct investment, income, and economic structure.

I am interested in answering the following question: How does economic growth and trade openness affect environmental quality in developing economies? I will focus on the most prominent emerging economies of today, best known as BRICS. BRICS is an acronym, given by Goldman Sachs chief economist Jim O'Neil, for an association of five major emerging economies. These countries are distinguished by their large, fast growing economies and influence on global affairs. I will examine the impact of economic growth and trade openness on pollution, and it is essential to determine if the high economic growth can be sustained within environmental constraints or without exceeding ecological thresholds.

I am interested in studying how economic activities and policies affect the environment in which we live, how firms and individuals behave when production and consumption involve externalities, and how this benefits or damages the environment. Finally, I am interested in the added pressure developing countries face to maintain a sustainable economic growth once trade is liberalized.
This paper intends to put several factors together, using panel data analysis to test whether EKC exists in each country, and where they are on the curve.

2. Literature Review

To answer my question, I review the literature to have a more comprehensive understanding of the topics related to my research. The literature is organized as follows: first, I review the relationship between economic development and environmental quality. To do so, I review the most commonly debated problems regarding the existence of the Environmental Kuznets curve, the Pollution Havens hypothesis, and lastly the race to he bottom hypothesis. Second, I evaluate the relationship between income, trade liberalization, and pollution. Finally, I assess the research that has been done regarding developing economies' trade and environment that will be useful for my study.

The environmental impact of economic growth has been a topic of disagreement between advocates of free trade and environmental activists. Trade liberalization leads to specialization, and countries that specialize in less pollution-intensive goods are expected to have a cleaner environment, and vice versa. Local environmental pollution has become global because of international trade, foreign direct investment, and technology transfer, creating an obstacle to sustainable economic growth. Recently, attention has shifted from environmental pollution to the causes and mechanisms that lead to environmental degradation, with one of the most controversial problems being the relationship between capital flows and the environment. The relation between economic development and environmental quality has become important to economic and environmental policy making for sustainable growth. Governments in developing economies are incentivized to lower environmental standards in order to attract foreign investment and capital, which leads to the divergence of international environmental conditions. The most commonly debated problems are those regarding the existence of the Environmental Kuznets Curve, the Pollution Havens Hypothesis, and the Race to the Bottom Hypothesis.

As mentioned before, the Environmental Kuznets Curve suggests that environmental degradation increases up to a certain point as income goes up, after reaching a turning point, pollution starts to decrease. This holds especially for developing countries. Some argue that poor countries do not efficiently regulate externalities, while others conclude that environmental progress becomes a natural consequence of economic growth. Kuznets (1965,1966) showed that during the various economic development stages, income inequalities first increase and then begin to decrease. Along these lines, some economists believe that there is an inverted U-shaped relationship between economic growth (per capita income) and environmental degradation. When a country has low income per capita, a rise in economic growth may result in environmental degradation while in a higher income per capita level, a rise in economic growth might have a positive effect on its environment (Halkos, 2003; Lopez and Mitra 2000).

The Pollution Havens Hypothesis shows how in order to reduce costs and expenses imposed by higher environmental standards, developed countries relocate production to countries with laxer environmental regulations and lower pollution control costs, worsening, most of the times, the developing country's environment.

The Race to the Bottom Hypothesis indicates that to cope with the pressure of international competition for foreign direct investment, developing countries tend to lower environmental standards and regulations.

Economists argue that there is enough evidence suggesting that more open and outward economies outperform the economies that pursue protectionism. The more open an economy is, the greater the impact of foreign trade on a country's environment. The effects of trade openness and industrialization are still mixed. I mentioned some of the problems with trade openness, but openness could also have a positive impact on environmental quality. First, trade can stimulate managerial and technological innovations that have positive effects on both the economy and the environment. Second, multinational corporations tend to bring clean production techniques from high standard source countries to the developing country.

Today, an extremely active field of research concerns the relationship between per capita income and pollution; the evidences on this relationship are mixed, especially for developing countries. There have been arguments about whether environmental protection unevenly favors the wealthy at the expense of the poor. The inverted U-shaped Kuznets curve results, linking income to environmental quality, offer evidence that the overall benefits of environmental regulations might be only positive at higher income levels. As trade and economic growth increase incomes, higher incomes cause people to increase the demand for environmental regulations. The more rigorous these regulations are, the more incentive to shift towards cleaner technologies people have.

The main two goals of these studies are to see if the EKC exists, and to find the turning point if the EKC does exist. Shafik and Bandyopadhyay (1992) used different functional forms to estimate the curve for different pollutants. They found that the emissions of SPM and SO2 first increase and then decrease as income goes up. Galeotti and Lanze (1999) studied the interactions between carbon dioxide and per capita income. Their results showed that the EKC exists for carbon dioxide. On the other hand, Selden and Song (1994) conducted a survey on four pollutants including sulfur dioxide, carbon oxide, nitrous oxide, and suspended particulate matter. Their results support the existence of the EKC curve.

According to past investigations, not all environmental pollutants show the same results for the existence of the EKC. Dinda (2002) states that pollution-income relations differ from one group of countries to another, while De Bruyn (1997) says that the structural changes between countries probably affect the pattern of causality between income and pollution. The trade factor should not be omitted when studying the EKC because of the importance of other hypotheses such as pollution havens, and race to the bottom, that characterize developing economies such as the ones I will be studying. Suri and Chapman (1998) found that higher export share generates more emissions and higher import share generates lower emissions. Stern et al (1996) suggest that there are other factors existing in data from different countries that might affect the relationship between income and pollution. This is why I will be conducting multiple regressions, first using a group that includes countries with different levels of income, and then using a group that includes only developing countries such as BRICS.

Some researchers have taken other factors into consideration, such as structural change of production or consumption (Panayotou et al., 2000), international trade and FDI (Suri and Chapman, 1998; Antweiler et al., 2001), political freedom and pollution (Lopez and Mitra, 2000), environmental policy (Panayotou, 1997), and inequality (Magnani, 2000).

3. Data & Methodology

In this paper I analyze the impact of economic growth and trade openness on pollution in Brazil, Russia, India, China, and South Africa. Given that pollution-income relations differ from one group of countries to another, I run a primary regression including a group of 167 countries with different levels of income and development. The second regression looks at pollution levels only for Brazil, Russia, India, China, and South Africa. The goal here is to understand how different is the environmental impact of economic growth for developing economies when comparing to the first group of 167 countries. Since the trade factor cannot be omitted when studying the EKC hypothesis, due to the existence of the pollution havens, and race to the bottom hypotheses that characterize developing economies, I include a dummy variable in a third regression: WTO=1 if the country is a member of the World Trade Organization, and WTO=0 if not.

I control for country-specific effects such as culture, political system, environmental regulations, or geographical conditions. The time specific intercepts are intended to account for time-varying omitted variables.

By doing this, I hope to find whether the pollution-income relations differ from one group of countries with similar characteristics to a larger group that includes diverse countries or not. Then, determine if the EKC hypothesis exists for BRICS and find their point on the curve.

The models are the following:

- $Em_{\iota\tau} = \beta 0 + \beta 1\, GDP_{\iota\tau} + \beta 2\, (GDP_{\iota\tau})^2 + \beta 3\, POP_{\iota\tau} + \upsilon_{\iota\tau}$
- $Em_{\iota\tau} = \alpha_\iota + \gamma_\tau + \beta 1\, GDP_{\iota\tau} + \beta 2\, (GDP_{\iota\tau})^2 + \beta 3\, POP_{\iota\tau} + \upsilon_{\iota\tau}$
- $Em_{\iota\tau} = \alpha_\iota + \gamma_\tau + \beta 1\, GDP_{\iota\tau} + \beta 2\, (GDP_{\iota\tau})^2 + \beta 3\, POP_{\iota\tau} + \beta 4\, WTO_{\iota\tau} + \upsilon_{\iota\tau}$

Where:

ι: country

τ: year

α_ι : country specific effects

γ_τ: time specific effects

$Em_{\iota\tau}$: Total greenhouse gas emissions (kt of CO_2 equivalent)

$GDP_{\iota\tau}$: GDP per capita

$WTO_{\iota\tau}$: World Trade Organization membership

$POP_{\iota\tau}$: total population

$\upsilon_{\iota\tau}$: error term

To answer my question I use panel data with a time period from 1992 to 2012. The data that is most useful for this research is found in the World Development Indicators database from The World Bank. As indicator for pollution I use total greenhouse gas emissions (kt of CO_2 equivalent). According to the World Bank, "total greenhouse gas emissions in kt of CO_2 equivalent are composed of CO_2 totals excluding short-cycle biomass burning, but including all anthropogenic CH_4 sources, N_20 sources, and F gases (HFC, PFC, SF_6). The CO_2 emissions of a country are only an indicator of one greenhouse gas. For a more complete idea of how a country influences climate change, gases such as methane, and nitrous oxide should be taken into account. This is particularly important for agricultural economies. Converting all other greenhouse gases to CO_2 equivalents makes it possible to compare them and to determine their individual and total contributions to global warming". $POP_{\iota\tau}$ is the figure at the year-end. $GDP_{\iota\tau}$ is year-ending GDP per capita for each country. $WTO_{\iota\tau}$ is a dummy variable that corresponds to membership of the WTO and is used as indicator for trade openness in each country. Everything will be measured in US dollars.

The turning point level of per capita income where pollution is at maximum can be found using the following formula: $[-\beta1/(2\beta2)]$.

- If $\beta1 < 0$ and statistically significant, and $\beta2$ is statistically insignificant, then the indicators show an unambiguous improvement with rising per capita income.

- If $\beta1 > 0$ and statistically significant, and $\beta2$ is statistically insignificant, then the indicators show an unambiguous deterioration as income increases.
- If $\beta1 > 0$ and statistically significant, and $\beta2 < 0$ and statistically significant the EKC has a maximum turning point.

4. Results

I begin by estimating the relationship between pollution and income per capita using my first sample, which includes 167 countries, 3507 observations, and covers the period from 1992-2012.

Column 1 shows an initial regression with no controls for country and time effects. The results show that the threshold income at which emissions are supposed to decrease is $33,675. I look at GDP per capita levels for these countries in 2012 and I find that this turning point is the more commonly reached (30 out of 167 countries). GDP per capita is statistically significant at 1% significance level, as so is population. In Column 2, I control for year effects. The coefficient on GDP per capita increases by a small amount, and is still significant at 1% significance level. The turning point, after including year fixed effects, increases to $38,113, and similarly, only 29 countries have reached that point. For the regression in Column 3, I control for time-invariant country effects and for year effects. The results show that the threshold income is now at $53,609, a point only reached in 2012 by 12 countries. The coefficient on GDP per capita is now significant at 10% significance level. Adding year fixed effects and country fixed effects does not explain a lot in my regression, and I am concerned that the level of significance decreased. I tried log-

log, level-log, and log-level regressions, but none of them were a good fit or statistically significant. It is possible that year fixed effects take away not only bad variation, but also good variation. Since the impact is not as big as what I expected, I also try dividing total greenhouse gas emissions by population. The results were not significant and they showed more variation in emissions per capita than total emissions per country.

After doing a broader analysis, I want to show what the impact for BRICS is. In Column 4, my regression includes BRICS countries only. From the results shown, the turning point at which emissions are expected to decrease is $8,100. This threshold has only been reached in 2012 by Brazil and Russia, while China, India, and South Africa seem to be a few thousand dollars behind. The impact of economic growth on environmental quality in developing economies is much more significant than in underdeveloped and developed countries. The results show that a $100 increase in GDP per capita increases emissions only in China, India, and South Africa by 25,258.4, 83,656.4, and 9,973.4 kt of CO_2 equivalent respectively. On the other hand, a $100 increase in GDP per capita in Brazil and Russia, decreases expected emissions by 40,822.6 and 75,955.6 kt of CO_2 equivalent respectively.

If you recall, I discuss some other possibilities and variables that could affect the relationship between income and pollution. Now, I look beyond per capita income as growth indicator, and look at trade openness. Column 5 shows the impact of WTO membership on emissions. Joining the WTO and, more specifically, opening to trade, increases levels of pollution by 1,410,247 kt of CO_2 equivalent. The turning point is now lower $7,684.7. One argument can be that income levels might be higher after joining the organization and countries start to invest in industry intensive production so the threshold becomes more reachable. The impact of economic growth in emissions when controlling for WTO membership, shows that a $100 increase in GDP per capita increases emissions only in China, India, and South Africa by 18,530, 71,954.8, and 4,314.8 kt of CO_2 equivalent respectively. On the other hand, a $100 increase in GDP per capita in Brazil and Russia, decreases expected emissions by 42,315 and 74,550 kt of CO_2 equivalent respectively.

I create graphs for each country of BRICS in order to see if the EKC does exist or not. Each figure represents the EKC for each country. It has total greenhouse gas emissions on the y-axis and GDP per capita on the x-axis. The graphs show the fitted values and the data points of each country.

Figure 1 shows the EKC for China. By looking at emission levels, and comparing to the other countries, it is clear China is polluting the most. This could be for many reasons; the main one being the absence of environmental regulations and the fact that globalization promotes a "race to the bottom" in environmental standards.

The same story goes for India, in Figure 2, who has high pollution levels. One could argue that these pollution levels are due to lack of well-defined property rights, lack of institutions that require polluters to internalize the externalities, and other overriding priorities that might fuel the situation of higher emissions.

In Figure 3, we can see that Brazil's curve does not follow the hypothesis. Out of the 5 countries, Brazil is the one that pollutes the least, one reason for this could be the fact that Brazil uses hydropower and has introduced renewable energy into its industries. Although this source of energy is considered to be clean, its uses also generate some externalities that lead to pollution.

As for Russia in Figure 4, the explanation as to why the EKC does not hold is that while the other developing countries had a fairly constant increase in their GDPs, Russia went through a major historic event, and went from being a communist country to a more market-oriented economy. These were significant changes, but for some, considered too much too fast. There was a massive disparity in wealth, which is believed to have held back Russia's economic growth. Its GDP decreased for some of the years in study, so the EKC hypothesis does not hold for Russia.

Lastly, Figure 5 shows South Africa, which seems to be the country that is getting closer to the threshold point where environmental quality is important for the policy makers and the population in general.

But, where are the BRICS countries compared to the other 167 countries? To answer this, I plot the EKC curve for the 167 countries, and find the turning point. To calculate it, I use again the turning point formula [$-\beta 1/(2\beta 2)$]. The GDP per capita that any country needs to reach in order for it to decrease pollutions is at $53,609. GDP per capita levels in BRICS for 2013, according to the World Bank, are the following:

- Brazil $11,208.08
- Russia $14,611.7
- India $1,498.87
- China $6,807.43

- South Africa $6,617.91

By looking at the numbers, it is evident that these rapidly emerging economies still have very low-income levels, so they are expected to keep polluting given how far away from the threshold these per capita incomes are on the curve.

Some of the implications of my results could be that the choice of pollutants plays an important role in this relationship. Or it could also be that GDP per capita has shortcomings in representing the development of a country. Many argue that GDP per capita fails to represent welfare, so maybe other indicators, such as Human Development Index or Green National Income, would better capture the relationship between environment and economic growth.

5. Conclusion

While reducing pollution may be easy for developed countries, abating environmental pollution may challenge economic growth and competitiveness of developing countries. Most of the developed countries have achieved significant economic growth and can focus on environmental goals. In their desire to develop and improve living conditions, developing countries prefer to achieve economic growth goals, and this leads to environmental degradation. My results show that BRICS, even though they rely on different industries, are expected to keep polluting before reaching the turning point where environmental regulations are implemented, and people are willing to pay for environmental quality.

I conclude that the pollution-income relations differ from one group of countries with similar characteristics to a larger group that includes all levels of income. Researchers have not done analysis on countries such as BRICS, and they measured openness to trade using variables such as exports, imports, and FDI. I do this differently by using, as an indicator for trade, WTO membership. The impact of opening to trade on greenhouse gas emissions will depend on the magnitude of the scale, composition, and technique effects. I am not concerned with an omitted variable bias given that I control for country and time specific effects, which account for important variables such as geographical conditions, culture, political system, and environmental regulations. According to the results, an increase in GDP per capita increases expected greenhouse gas emissions in China, India, and South Africa; while decreases emission levels in Brazil and Russia. Similarly, the EKC relationship holds for China, India, and South Africa, but it does not seem to hold for Brazil and Russia. As the availability of environmental data continues to improve, in case of further research would be interesting to go beyond the regression model for the EKC and add variables such as energy consumption, water use, pollution abatement expenditure, and income distribution and analyze their combined impact on different pollutants such as CO_2, N_20, SF_6, and CH_4. Finally, although the EKC methodology has been said to be too simplistic, one common conclusion is that economic growth facilitates the required regulations and investment to reduce emissions of some pollutants.

6. Tables

Table 1. EKC Results

	(1)	(2)	(3)	(4)	(5)
GDPPC	6.7349***	7.6226***	7.3337*	1027.144	894.498
	(1.5693)	(1.9347)	(4.0108)	(217.25)	(626.2020)
GDPPC2	-0.0001***	-0.0001***	-0.0001*	-0.0634	-0.0582
	(0.0001)	(0.0001)	(0.0001)	(0.0119)	(0.0373)
Pop	0.0071***	0.0071	0.0105	0.0067	0.0044
	(0.0002)	(0.0002)	(0.0075)	(0.0028)	(0.0067)
WTO					1410247***
					(413591.2)
Country FE	N	N	Y	Y	Y
Year FE	N	Y	Y	Y	Y
R2	0.55	0.55	0.55	0.59	0.47
Obs.	3507	3507	3507	105	105

Notes: Dependent variable in each regression is total greenhouse gas emissions. Regressions 1-3 are the full sample. Regression 4 is for BRICS countries only. Regression 5 includes wto binary variable. * is 10% significance level, ** is 5% significance level, *** is 1% significance level.

Figure 1. China EKC

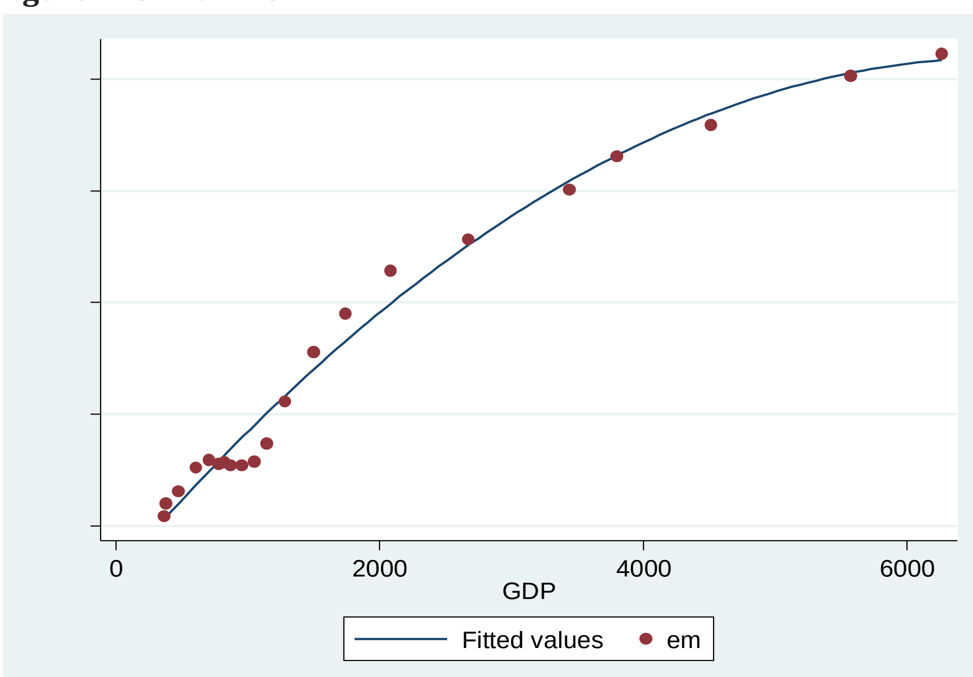


Figure 2. India EKC

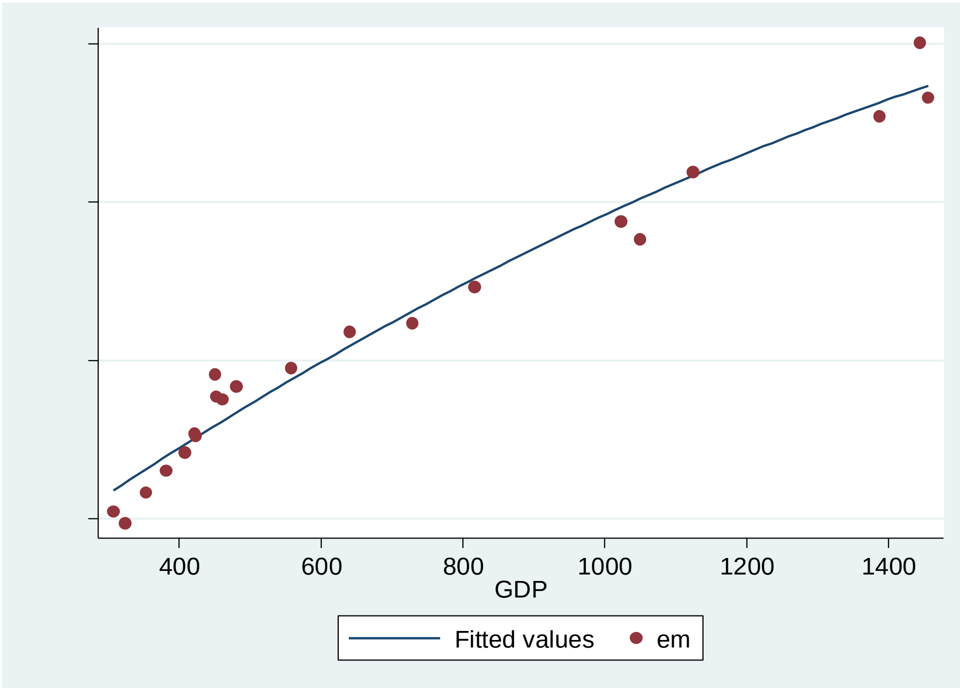


Figure 3. Brazil EKC

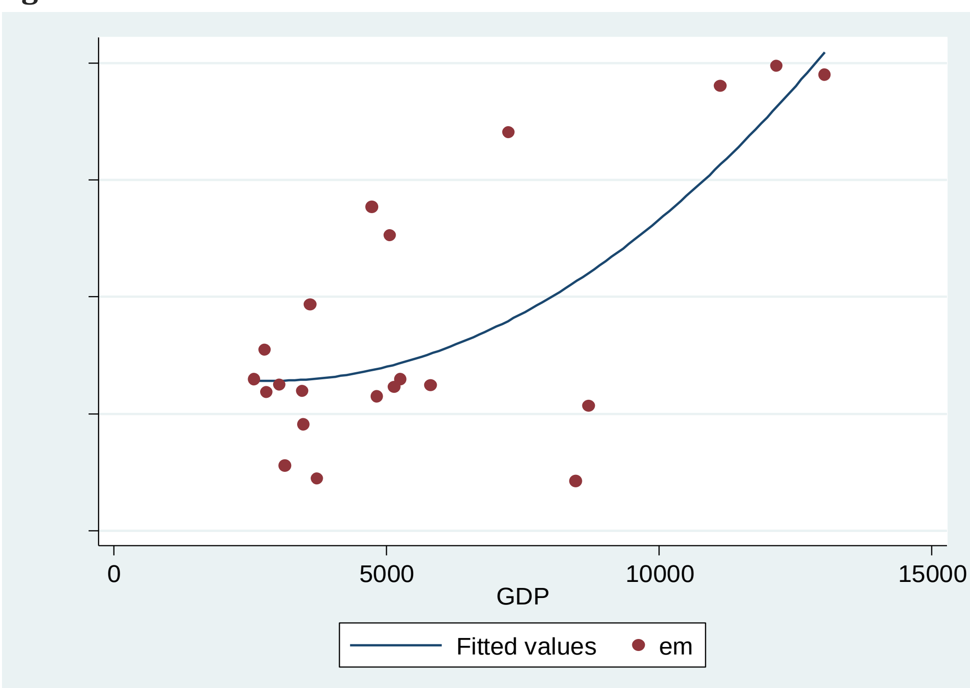


Figure 4. Russia EKC

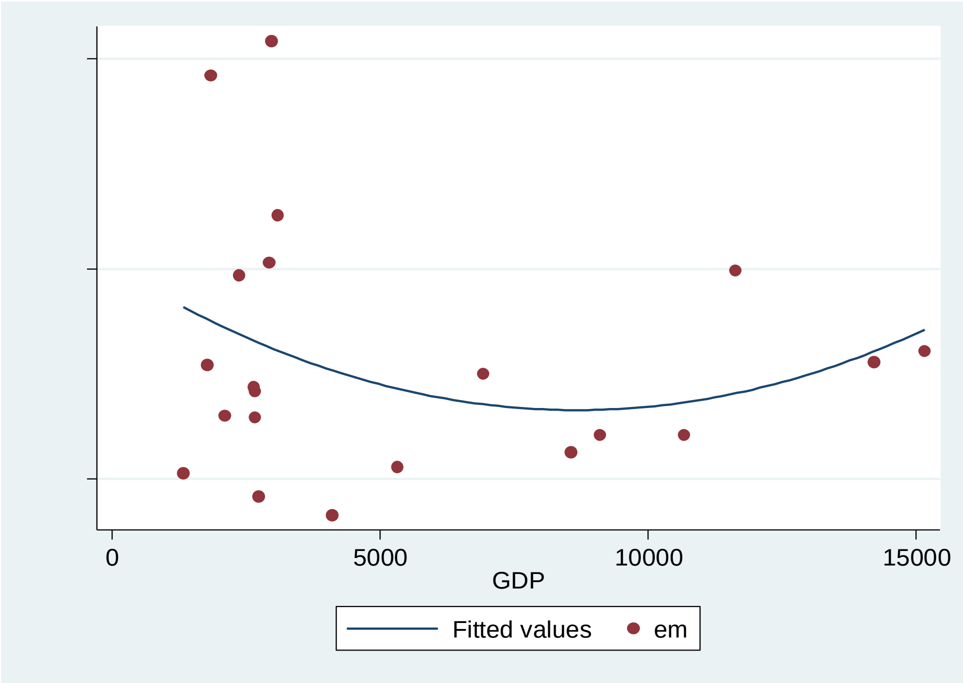
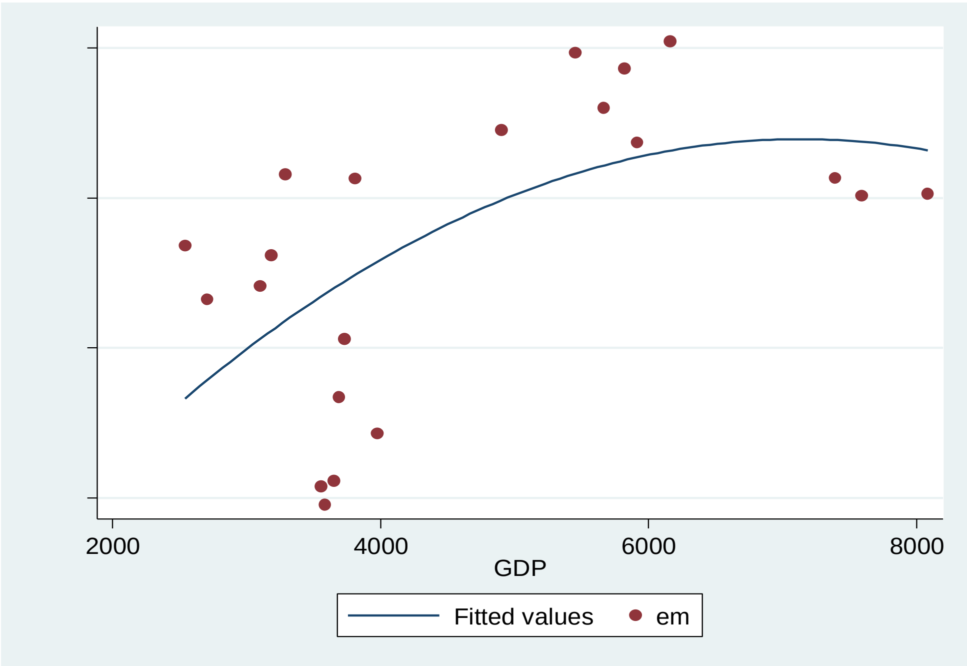


Figure 5. South Africa EKC



7. Appendix

Robustness Check

Furthermore, I examined how certain core regression coefficient estimates behave when, adding or removing regressors, modifies the regression specification. In Column 1, instead of total greenhouse gas emissions my dependent variable is percent change in total emissions. The coefficient on GDP per capita is small and statistically significant at 10%. In Column 2, I use emissions per capita by diving total greenhouse gas emissions by population, but once again the results were not statistically significant. There were tons of outliers that were showing more variation in total emissions per capita than in total greenhouse gas emissions of a country. In Columns 3 through 5, I try different functional forms. In Column 3, I use log-log form. My dependent variable is natural log of emissions, while my independent variables are all in log form. The coefficient on log of GDP per capita and log of population were statistically significant, even if the magnitude of the impact of income on pollution is not large. In Column 4, I use log-level form. The coefficient on GDP per capita and population are statistically significant at 10% significance level. The coefficient on GDP per capita is negative, which makes little sense to me. Finally, in Column 5, I use the level-log model. The coefficient on GDP per capita increases by a lot and was statistically significant at 1% significance level. The GDP per capita squared and population parameters were not statistically significant and had very low t-statistics. I decided to use the standard EKC regression model, a quadratic function of the levels of income, which benefits the data for the curve and allows for the determination of the turning point. The results using unit form were more conclusive and statistically significant; and allowed me to find the turning point in in the curve in a more accurate way. Also, the literature does level-level regression. The fact that functional forms and estimation techniques all provide different results suggests that the EKC relationship is fragile. In Column 6, the sample size is now BRICS countries only. I create a interaction term WTO*GDPPC, and the results show 1% significance level for the coefficient on GDP per capita, while population is significant at 5% significance level. I decided to not include this regression in my final results because WTO and WTO*GPDPC had very low t-statistics and were statistically insignificant. One critique of the EKC concerns the problem of simultaneity. I found no evidence of it, and the pattern that emerged was that causality runs from income to emissions in developing countries. As far as adding new variables in my regression, instead of focusing on WTO membership, I decided to create a trade openness variable by adding exports and imports and then diving by GDP per capita. The results showed very low coefficients and no significance. These results are not included in the table.

Table 2. EKC Results/Robustness Check.

	(1)	(2)	(3)	(4)	(5)	(6)
GDPPC	0.0032*	4.50E-08	0.319**	-7.28E-06*	221623.1**	701.73***
	(0.0008)	(0.0000)	(0.0632)	(0.0000)	(52822.85)	(150.88)
GDPPC2	-3.59E-08	-1.43E-12	-0.015**	2.68E-11	-6109.342	-0.0443
	(0.0000)	(0.0000)	(0.0041)	(0.0000)	(3436.1)	(0.0095)
Pop	1.44E-07	4.18E-12	9.93E-01**	1.42E-09*	-37324.2	5.10E-03**
	(0.0000)	(0.0000)	(0.0608)	(0.0000)	(50865.03)	(0.0019)
WTO						486611.7
						(325001.9)
WTO*GDPPC						78.14
						(64.65)
Country FE	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	N
R2	0.0073	0.0095	0.85	0.065	0.0043	0.52
Obs.	3507	3507	3507	3507	3507	105

Notes: Dependent variable in each regression is total greenhouse gas emissions, in different functional forms. Regressions 1-5 are the full sample. Regression 6 is for BRICS countries only. Regression 6 includes wto binary variable and interaction term. * is 10 percent significance level, ** is 5 percent significance level, *** is 1 percent significance level.

8. Bibliography

Beladi, H. (2011). Does Trade Liberalization Increase Global Pollution? *Resource and Energy Economics, 33*(1).

Chen, Wen. "Economic Growth and the Environment in China." *Policy Innovations* (2007): n. pag. Web.

Copeland, B., & Taylor, S. (2001). International Trade and The Environment: A Framework for Analysis. *Natural Bureau of Economic Research*. X

Dasgupta, Susmita, David Wheeler, Hua Wang, and Benoit Laplante. "Confronting the Environmental Kuznets Curve." *Journal of Economic Perspective* 16 (2002): n. pag. Web.

De Brueyn, S.M., 1997, "Explaining the Environmental Kuznets Curve: Structural Change and International Agreements in Reducing Sulphur Emissions", *Environment and Development Economics,* 2(4): 485-503.

Dean, J. M., Lovely, M. E. and Wang, H. 2005. Are foreign investors attracted to weak environmental regulations? Evaluating the evidence from China. *World Bank Working Paper No. 3505*

Dinda, S., 2004, "Environmental Kuznets Curve Hypothesis: a Survey", *Ecological Economics,* 49(4): 431-455

Ederington, J., Levinson, A., & Minier, J. (2004). Trade Liberalization and Pollution Havens. *Advances in Economic Analysis & Policy, 4*(2), 75.

Halkos, G., & Tzeremes, N. (2011) Growth and Environmental Pollution: Empirical Evidence from China. *Journal of Chinese Economic and Foreign Trade Studies*, Vol. 4 Iss: 3, pp.144 – 157

Hubbard, T. (2013). Trade and Transboundary Pollution: Quantifying The Effects of Trade Liberalization on CO2 Emissions. *Journal of Applied Economics*.

Information and External Relations Division. "10 Things The WTO Can Do." *World Trade Organization* . WTO Publications , n.d. Web.

Itoh, A., & Tawada, M. (2003). Environment, Trade and The Welfare Gains from The Transfer of Pollution Abatement Technology. *Papers in Regional Science, 82*(4), 519-534.

Kirkpatrick, C., & Scrieciu, S. (2008). Is Trade Liberalization Bad for The Environment? A Review of The Economic Evidence. *Journal of Environmental Planning and Management*.

López, R., 1994, “The Environment as a Factor of Production: The Effects of Economic Growth and Trade Liberalization”, *Journal of Environmental Economics and Management,* 27(2): 163-184.

Magnani, E., 2000, “The Environmental Kuznets Curve, Environmental Protection and Income Distribution”, *Ecological Economics,* 32(3): 431-443.

Neff, Jason. *A Changing Planet*. N.p.: Pearson , 2016. Web.

Omoju, Oluwasola. "Environmental Pollution is Inevitable in Developing Countries." *Breaking Energy*. N.p., n.d. Web.

Panayotou, T., A. Peter, and J. Sachs, 2000, *Is the Environmental Kuznets Curve Driven by Structural Change? What Extended Time Series may Imply for Developing Countries,* Consulting Assistance on Economic Reform II, Discussion Paper No. 80.

Stern, D. I., 2004, “The Rise and Fall of the Environmental Kuznets Curve”*, World Development*, 32(8):1419-1439.

-,and M.S. Common, 2001, “Is there an Environmental Kuznets Curve and for Sulphur?”, *Journal of Environmental Economics and Management*, 41(2):162-178.

-,M.S. Common, and E. B. Barbier, 1996. “Economic Growth and Environmental Degradation: The Environmental Kuznets Curve and Sustainable Development.” *World Development*, 24 (7): 1151-1160.

Suri, V. and D. Chapman, 1998, “Economic growth, Trade and the Energy: Implications for the Environmental Kuznets Curve”, *Ecological Economics,* 25(2):195-208.

Taylor, S., Anweiler, W., & Copeland, B. (2001). Is Free Trade Good for The Environment. *American Economic Review*.

Xu, L. (2012). *China's Economy in The Post-WTO Environment; Stock Markets, FDI and Challenges of Sustainability* (1st ed., Vol. 27). Portland: Ringgold.