Examining the Environmental Kuznets Curve: The Economy's Toll on the Environment

Hussein Mohamed Mohamed-Gouda(*Management Technology: Economics*) and **Dina M. Yousri** (*Dr*): **The German University in Cairo**

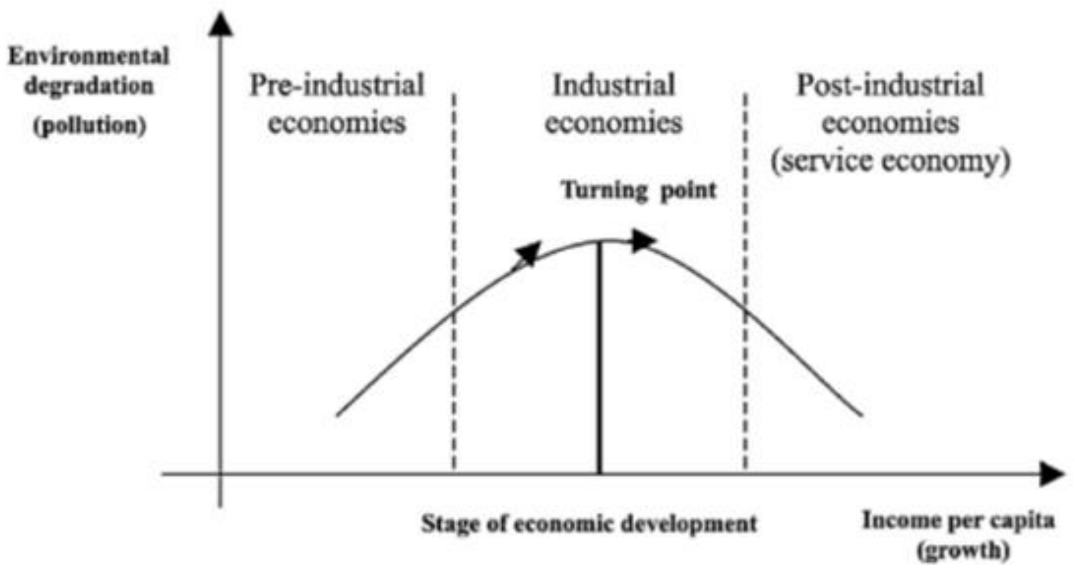
hussein.wahdan@student.guc.edu.eg Dina.elsayed@guc.edu.eg

Introduction

Ever since the Roman Empire's heyday, we have always failed to address the very difficult and costly to mend damage our activities cause to the planet through negative externalities. As our economies and populations grow we put the planet at grave risk; some say it would even take 1.73 planet Earths to sustain us. However, according to the EKC, this damage only keeps on going until economies reach a threshold where they can start offsetting the damage they've done. This study aims to test the validity of the EKC hypothesis in the United States and China between 1960 and 2020.

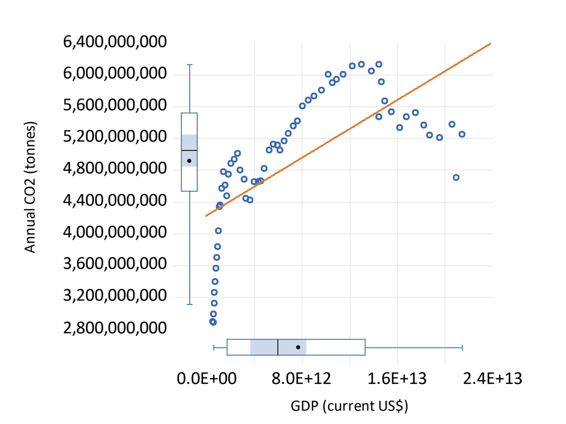
Literature Review

The EKC is usually split into three stages, starting with an economy that's heavily dependent on agriculture and primary industries, which affects the environment, through soil erosion and deforestation. As the economy develops and shifts from an agricultural based economy to a much more industrial one, the type of environmental damage also changes from soil erosion and deforestation to polluting emissions alongside the harmful effects that had already existed. Not only does this affect the still developing countries, but it also affects those still relying on agriculture in those industrial countries due to inequalities when it comes to urbanisation. Those who manage to get their economies to grow well, are then able to utilise better technology and equipment, assisting in slowing down the rate at which these countries are causing damage to the environment. As the economy reaches its later stages of development where industry starts to phase out or continue while leveling off its emissions and technology, information and the service sector start to take over, the curve starts taking a turn – the economy continues to grow while the environmental damage starts to go down.



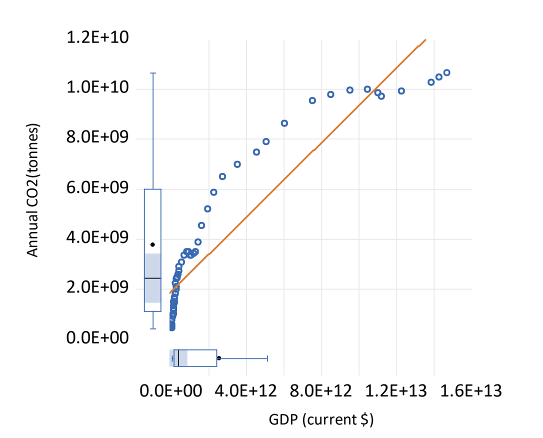
The Environmental Kuznets Curve

Source: Panayotou (1993)



The EKC in the United States

Source: World Development Indicators, World Bank (2022)



The EKC in China

Source: World Development Indicators, World Bank (2022)

Methodology

After a few data transformations and after gaining better insight about the data through descriptive analysis, I conducted an Augmented Dickey and Fuller unit root test to check for the variables' staionarity to be able to proceed with the tests further ahead. I moved on to determining the optimal number of lags relying on the Akaike Information Criterion (AIC), then conducted the autoregressive distributed lag model regression (ARDL). To conclude the regression analysis, I conducted a long run form and bounds test to learn more about the long run relationship between the annual percentage change in CO2 emissions, the dependent variable, and the annual percentage change in GDP as well as the annual percentage of the urban population of the whole population. To make sure of the robustness of the model, three tests were used – the LM serial correlation test, the Breusch Pagan Godfrey hetereoscedasticity test and the normality test. The model used is as follows:

$$CO_2 = \beta_0 + \beta_1 GDP + \beta_2 URB + \varepsilon$$

Results

A

Dependent Variable: CO2
Method: ARDL
Date: 05/22/22 Time: 19:07
Sample (adjusted): 1964 2020
Included observations: 57 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): GDP URB
Fixed regressors: C
Number of models evaluated: 64
Selected Model: ARDL(3, 3, 3)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CO2(-1)	0.012030	0.144114	0.083473	0.9338
CO2(-2)	-0.336531	0.133568	-2.519542	0.0154
CO2(-3)	0.331472	0.108733	3.048502	0.0038
GDP	0.787185	0.147190	5.348074	0.0000
GDP(-1)	-0.242833	0.184059	-1.319319	0.1937
GDP(-2)	-0.216070	0.186915	-1.155982	0.2538
GDP(-3)	-0.272168	0.176019	-1.546244	0.1291
URB	0.859314	6.575733	0.130680	0.8966
URB(-1)	-5.958792	15.98457	-0.372784	0.7111
URB(-2)	18.32450	16.37390	1.119129	0.2690
URB(-3)	-13.57398	7.104291	-1.910673	0.0624
C	25.29180	15.81601	1.599127	0.1168

R-squared	0.706686	Mean dependent var	0.781106
Adjusted R-squared	0.634987	S.D. dependent var	3.432372
S.E. of regression	2.073712	Akaike info criterion	4.481221
Sum squared resid	193.5127	Schwarz criterion	4.911337
Log likelihood	-115.7148	Hannan-Quinn criter.	4.648379
F-statistic	9.856299	Durbin-Watson stat	1.914538
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

The ARDL Test Results for the United States

B

Dependent Variable: CO2
Method: ARDL
Date: 05/22/22 Time: 19:13
Sample (adjusted): 1963 2020
Included observations: 58 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): GDP URB
Fixed regressors: C
Number of models evaluated: 36
Selected Model: ARDL(2, 0, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CO2 (-1)	0.441661	0.129361	3.414174	0.0012
CO2 (-2)	-0.158348	0.109205	-1.450005	0.1529
GDP	0.185368	0.091793	2.019403	0.0485
URB	-0.079480	0.056938	-1.395914	0.1686
C	4.719196	2.129374	2.216236	0.0310

R-squared	0.295362	Mean dependent var	5.791007
Adjusted R-squared	0.242182	S.D. dependent var	6.945525
S.E. of regression	6.046270	Akaike info criterion	6.519023
Sum squared resid	1937.541	Schwarz criterion	6.696647
Log likelihood	-184.0517	Hannan-Quinn criter.	6.588211
F-statistic	5.553987	Durbin-Watson stat	1.935654
Prob(F-statistic)	0.000826		

*Note: p-values and any subsequent tests do not account for model selection.

The ARDL Test Results for China

Conclusion

The hypothesis hasn't been tested before with a comparison between a developing country and a developed one, especially between the world's two biggest economies; the USA, a country that has achieved a lot both economically and environmentally, and China, a country that might have achieved a lot in terms of economic growth, but still has quite a long road to offset its environmental damage that it continues to cause in its pursuit of a better economy.

Previous studies on the United States either falsified the hypothesis or couldn't validate it in some of the states, but the mixed bag of fluctuating positive and negative coefficients of the dependent variables and their lags in the case of the United States supports the validity of the EKC in the United States – 70% of the variation in annual change in CO2 emissions is due to changes in GDP, the percentage of the urban population and both of their lags. As for China, the result couldn't be more conclusive and in line with previous researches. The EKC is not valid in China where percentage change in GDP has a positive and significant relationship with percentage change in CO2 emissions.

This proves that when an economy grows enough, it can start investing in offsetting its externalities. We only have to look at financial solutions like green bonds in the United States and their ambitious plan of a green new deal. With the fact that climate change could cause 10, 000 diseases to give us new pandemics through zoonotic spillover and that the global food production is at risk, China and other developing countries need to start rounding the curve fast with help from developed countries or we may end up reaping the whirlwind of the wind we have sown.

References

1. Harper, K. (2016). The environmental fall of the Roman Empire. Daedalus, 145(2), 101-111.
2. Hughes, J. D. (2009). An environmental history of the world: humankind's changing role in the community of life. Routledge.
3. Alvarado, R., & Toledo, E. (2017). Environmental degradation and economic growth: evidence for a developing country. Environment, Development and Sustainability, 19(4), 1205-1218.
4. Dogan, E., & Turkekul, B. (2016). CO2 emissions, real output, energy consumption, trade, urbanization and financial development: testing the EKC hypothesis for the USA. Environmental Science and Pollution Research, 23(2), 1203-1213.
5. Carlson, C. J., Albery, G. F., Merow, C., Trisos, C. H., Zipfel, C. M., Eskew, E. A., ... & Bansal, S. (2021). Climate change will drive novel cross-species viral transmission. BioRxiv, 2020-01.
6. Zhao, X., & Sun, Z. (2020). The effect of satisfaction with environmental performance on subjective well-being in China: GDP as a moderating factor. Sustainability, 12(5), 1745.
7. Ahmad, M., Ahmed, Z., Yang, X., Hussain, N., & Sinha, A. (2022). Financial development and environmental degradation: do human capital and institutional quality make a difference?. Gondwana Research, 105, 299-310.
8. Emas, R. (2015). The concept of sustainable development: definition and defining principles. Brief for GSDR, 2015, 10-13140.
9. Aşıcı, A. A. (2013). Economic growth and its impact on environment: A panel data analysis. Ecological indicators, 24, 324-333.
10. Tiba, S., & Frikha, M. (2019). The controversy of the resource curse and the environment in the SDGs background: the African context. Resources Policy, 62, 437-452.
11. Bo, S. (2011). A literature survey on environmental Kuznets curve. Energy Procedia, 5, 1322-1325.
12. Kaika, D., & Zervas, E. (2013). The Environmental Kuznets Curve (EKC) theory—Part A: Concept, causes and the CO2 emissions case. Energy Policy, 62, 1392-1402.
13. Panayotou, T. (1993). Empirical tests and policy analysis of environmental degradation at different stages of economic development (No. 992927783402676). International Labour Organization.
14. Zhang, J. (2021). Environmental Kuznets curve hypothesis on CO2 emissions: evidence for China. Journal of Risk and Financial Management, 14(3), 93.
15. Flammer, C. (2020). Green bonds: effectiveness and implications for public policy. Environmental and Energy Policy and the Economy, 1(1), 95-128.
16. Barbier, E. (2010). How is the global green new deal going?. Nature, 464(7290), 832-833.
17. Carlson, C. J., Albery, G. F., Merow, C., Trisos, C. H., Zipfel, C. M., Eskew, E. A., ... & Bansal, S. (2021). Climate change will drive novel cross-species viral transmission. BioRxiv, 2020-01.
18. Vermeulen, S. J., Campbell, B. M., & Ingram, J. S. (2012). Climate change and food systems. Annual review of environment and resources, 37, 195-222.

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