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Empirical Analysis of Air Pollution Impacts on Jordan Economy

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ABSTRACT

Pollution and the economy appear to be intertwined throughout human history. Our knowledge of the connection between environmental damage and economic growth is fragmented due to disciplinary biases. Accordingly, the purpose of this research is to gain an understanding of the dynamic relationship that exists between air pollution and the economy of Jordan, as well as to investigate the existence of the Environmental Kuznets Curve (EKC), in order to determine which policy options would be most effective in reducing emissions while still allowing for continued economic growth. This study adopted the Bayer-Hanck Cointegration test and Granger Causality tests to achieve the objectives. Bayer-Hanck cointegration indicate that there exists a long-term relationship between air pollutants and economic growth. Moreover, Granger causality test shows that economic growth has a causal effect on the three air pollutants at a significance level of 0.05. By scholarly contributions to the debate between air pollutants and economic growth, this study aims to fill a gap in the existing literature by investigating the EKC hypothesis and the impacts of air pollution on economic growth in Jordan.

Keywords: Bayer-Hanck, CO_2 emissions, Economic growth, Environmental Kuznets Curve
JEL Classifications: F43, O13, Q53

1. INTRODUCTION

Air pollution refers to a wide range of pollutants that are produced by a single or multiple agent. According to a European Commission study, approximately 82% of Europeans are exposed to air pollution (Gehrsitz, 2017). Lower air quality is a major environmental problem that has an impact on humans due to air pollutants such as ozone, nitrogen dioxide and carbon dioxide (Collivignarelli et al., 2020). Air pollution is more concentrated in urban areas due to increased traffic and population density (Amin et al., 2020).

The association between pollution and economic growth has received considerable attention in both scientific and social sciences (Qiu et al., 2019). Some of the less obvious connections between economic growth and environmental effects have begun to be obscured by the Environmental Kuznets curve (Ozokcu and Ozdemir, 2017). The carrying capacity of the ecological system is an extremely important factor to take into consideration. In addition, the majority of research are carried in narrow contexts, which hinders us from putting an integrated framework to the test. There are often conflicting narratives about economic progress and human development in less developed nations, where pollution levels are fast rising. As a result, trees and agricultural harvests can be adversely affected by air pollution in several ways (Rupakheti, 2015). One probable result of ground-level ozone is a decrease in agriculture and forest yields; decreased tree development; and an increase in vulnerability to plant diseases, pests, and other difficulties (Jebli et al., 2016). When calculating the Cost of Environmental Deterioration (COED) in Jordan, both the immediate and long-term consequences of degradation in a particular year are included. The total COED is estimated to be between 143 and 332 million JD, with an average of 237 million JD, or 2.35% of GDP in 2006, based on a number of well-established and globally recognized approaches. When the cost of emissions on the global environment is considered, Jordan and the rest of the world will pay a total of 393 million JD. In the past decade, the Jordanian government has made great strides in its abilities to mitigate environmental damage (World Bank, 2009).

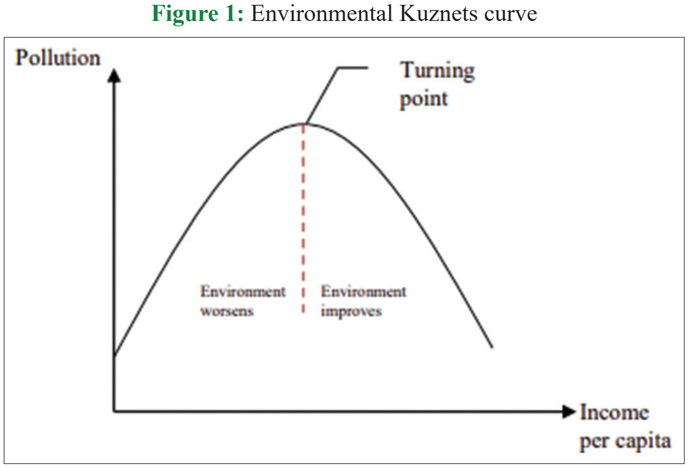
The empirical data in Jordan is still scarce, thus the goal of this research is to evaluate the long- and short-run link between air pollution and economic growth in Jordan using EKC hypothesis. The contribution of this study is predicted to be able to lead to green economic policies in the design of future environmental policies. Without tighter controls, air pollution emissions and concentrations are expected to rise rapidly, posing a serious threat to human health and the environment. The negative health effects of air pollution are expected to result in significant economic costs, with significant annual global welfare costs at the regional and sectoral levels (Jalil and Feridun, 2011). The next section consists of a literature review. The third section presents the analysis and discussion of research findings. The final section presents conclusions.

2. LITERATURE REVIEW

2.1. Theoretical Literature

Kuznets (1955) developed the hypothesis that income inequality and economic growth have an inverted U-shaped connection. This idea was restated in the 1990s as the Environmental Kuznets Curve, a link between economic growth/income and environmental quality (EKC). In the early stages of development, as GDP per capita increases, so do CO_2 emissions per capita. After the tipping point, a certain level of income, CO_2 emissions per capita decrease gradually because, after this point, the sensitivity of countries and individuals to environmental issues will increase, so environmental degradation will decrease as a result of the implementation of preventative measures. As seen in Figure 1, there is thus an inverted U-shaped link between income and environmental deterioration. Grossman and Krueger (1991) published an essay in which they attempt to establish a connection between air quality and economic growth that popularized the EKC hypothesis. While two variables, namely CO_2 emissions and GDP per capita, have been utilized in early empirical investigations of EKC, they are CO_2 emissions and GDP per capita.

Figure 1: Environmental Kuznets curve



2.2. Empirical Literature

A number of Prior studies on environmental deterioration have examined the interaction between CO_2 emissions and economic growth. Long-run interaction between air pollution and economic growth were investigated using the environmental Kuznets Curve (EKC) hypothesis. The EKC theory was based on the Inverted-U relationship between the level of carbon emissions and the level of income in a given nation. When Grossman and Krueger (1995) looked at the relationship between per capita income and environmental factors, they were the first researchers to introduce the EKC hypothesis to investigate the relationship. However, their empirical study was problematic with regard to the EKC hypothesis, since it came up with different results. The EKC theory has been supported by a number of studies, each of which came to different findings. Certain researchers have offered arguments supporting the EKC hypothesis (Rauf et al., 2018; Pata, 2018; Cosmas et al., 2019; Rana and Sharma, 2019; Bekun et al., 2020; Wasti and Zaidi, 2020). Though, some studies refute the EKC hypothesis (Sarkodie, 2018; Koc and Bulus, 2020; Dogan and Inglesi-Lotz, 2020; Leal and Marques, 2020).

In Turkey, Gökmenoğlu and Taspinar (2016) investigated the relationship between foreign direct investment (FDI), economic growth, energy consumption, and CO_2 emissions between 1974 and 2010. They used the Toda Yamamoto causality technique, and their findings demonstrated that there is a two-way causality between CO_2 emissions and FDI inflows, as well as between CO_2 emissions and energy. Furthermore, a one-way causation between real growth and FDI inflows, as well as between energy consumption and real growth, was discovered.

Saboori and Sulaiman (2013) analysed the cointegration and causal relationship between energy consumption, CO_2 emissions, and economic growth for each of the five ASEAN member countries separately. All five nations' economies experienced cointegration of economic growth, CO_2 emissions, and energy consumption, and there was a positive association between CO_2 emissions and energy consumption in both the short and long term, the researchers discovered. The reduction of CO_2 emissions was only shown to be connected with economic growth in Singapore and Thailand, with the reverse finding happening in Indonesia and the Philippines.

Hanif (2018) used a generalized linear model (GMM) to evaluate the relationships between economic growth, the consumption of fossil fuels, renewable energy on CO_2 emissions, urban expansion and solid fuels in Sub-Saharan Africa's economies covering the time period 1995 and 2015. In the study, it was discovered that the use of fossil and solid fuels had a positive influence on CO_2 emissions, but the use of renewable energy had a negative impact on CO_2 emissions.

Heidari et al. (2015) examined the link between EC, CO_2, and GDP in the ASEAN-5 nations using the Panel Smooth Transition Regression technique, which takes into account heterogeneity and temporal instability. Using two threshold parameters, nonlinearity was discovered. In regime one, environmental deterioration accelerated in tandem with rising economic activity, but this was not the case in regime two. Energy consumption Granger caused CO_2 emissions in both regimes.

Zhou and Liu (2016) analysed the effect of income, demographic factors and carbon dioxide emissions. The study used the STIRPAT approach model spanning the period from 1990 to 2012. In China, income has become the major driving force for increasing CO_2 emissions. according to the findings of this study, whereas demographic variables have no effect on increasing CO_2 emissions. However, with the exception of western China, urbanization has increased energy consumption and CO_2 emissions. For environmental impact in China, it is extremely appropriate if the government sets measures to regulate the rate of urbanization and promote energy efficiency.

Khoshnevis and Beygi (2018) used PMG and Granger Causality to explore the relationship between CO_2 emissions, trade openness, financial development, renewable energy and economic growth in 25 African nations. The results showed a unidirectional causality from renewable energy to CO_2 emissions and from real output to CO_2 emissions. Moreover, Munir et al. (2020) examined the relationship between CO_2 emissions and economic and energy from 1980 to 2016. In Malaysia, Singapore, Thailand and the Philippines, the researcher found loop causation linking growth to CO_2 emissions. While in Indonesia, Malaysia, and Thailand, a one-way causation was found between growth and energy consumption; there was indications of a one-way causality in Singapore from growth to energy usage. Based on the literature evaluation, a research gap was identified and the research was conducted to address the gap of research activities on Air pollution in Jordan.

3. DATA, MODEL SPECIFICATION, AND METHODOLOGY

The data collected for this paper work is secondary data extracted from World Bank publications, from the period 2000 to 2020. The model is fitted to predict Jordan's economic growth (GDP Per Capita) with Air pollution variables such as nitrogen dioxide, ozone, and carbon dioxide.

The functional regression model is expressed as;

GDP Per Capita = f (nitrogen dioxide, ozone, and carbon dioxide)

$$\text{GDP Per Capita} = \beta o + \beta 1\, CO_2 + \beta 2\, NO_2 + \beta 3\, O_3 + \ldots \beta nXn + \varepsilon_t \quad (1)$$

Where β1 to β3 are the coefficient estimates of the air pollution variables. Table 1 shows the variables used in this analysis.

3.1. The Augmented Dickey-Fuller Unit Root Test

To accommodate overall ARMA (g, r) models with cryptic orders, Augmented Dickey-Fuller (1984) enhanced the simple autoregressive unit root test. This test is referred to as the ADF test. The test is known as the augmented Dickey-Fuller (ADF) test. The model stipulates that the lag length in auto-regression increases with sample size, T, at a regulated rate <T.1/3. The model's core equation is as follows:

$$N_t = \beta_0 D_t + \propto N_{t-1} + \pi_t \quad (2)$$

$$\propto (V) U_t = \theta (V) \varepsilon t, \varepsilon t \sim MZ(0, \sigma 2) \quad (3)$$

The null hypothesis of the ADF test is that a time series y_t is I(1) if the alternative is I(0). The null hypothesis of the ADF t-test is:

H_O: β = 0 while, the alternative hypothesis of

H_1: β < 0

This is based on the hypothesis that the nuances of the data have an ARMA configuration. The ADF test is based on determining whether or not there is a regression in the test.

$$N_t = \gamma ' S_t + \propto N_{t-1} + \sum_{j=1}^{p} \delta_j \Delta N_{t-j} + \rho_t u_t \quad (4)$$

The deterministic term is denoted by D_t, while the expressions Δy_{t-j} represent the serial correlation.

The t-statistic for the ADF and the normalized bias statistic are as follows:

$$ADF_t = l_{\propto=1} = \frac{\hat{\propto} - 1}{SE(\propto)} \quad (5)$$

ADF_t exhibits asymptotic distributions of $t_\phi = 1$ in the presence of white noise errors if p is selected suitably.

3.2. Bayer-Hanck Cointegration

The time series in the econometric analysis is said to be integrated when various series are independently cointegrated, yet some linear combination of them has a lower order of cointegration. This additionally demonstrated all these cointegration strategies have diverse hypothetical foundations and deliver conflicting outcomes and that the power of positioning cointegration approaches is sensitive with the estimation of irritation estimators (Pesavento, 2004). To enhance the power of cointegration test, with the extraordinary part of producing a joint test-measurement for the invalid of no cointegration in light of Engle and Granger, Phillips and Outliers, Johansen, Boswijk, and Banerjee tests, the supposed Bayer-Hanck test was recently stately by Bayer and Hanck (2013).

Table 1: Variables description and data source

Variable	Definition	Abb.	Period	Source
Economic growth	GDP "per capita (constant 2010 US$)"	GDP	2000-2020	WDI
Carbon dioxide	CO_2 "emitted from fossil consumption in kilotons"	CO_2	2000-2020	WDI
Nitrogen Dioxide	NO_2 "emitted from fossil consumption in kilotons"	NO_2	2000-2020	WDI
Ozone pollution	O_3 "emitted from fossil consumption in kilotons"	O_3	2000-2020	WDI

WDI: World Bank Development Indicators

Since this new procedure enables us to join a few individual cointegration test results to give a more indisputable discovering, it is likewise utilized as a part of this analysis to check the existence of a cointegrating association among Economic growth and its determinant in Jordan. On this, Bayer and Hanck (2013) formulated to combine the computed significance level (p-values) of the individual cointegration test with the following Fisher's formulas:

$$E-J=-2\left[LN\left(PH_E\right)+LN\left(PH_J\right)\right] \quad (6)$$

$$E-J-B-BM==-2[LN\left(PH_E\right)+LN\left(PH_J\right)$$
$$+LN\left(PH_B\right)+LN\left(PH_{BM}\right) \quad (7)$$

Where the p-values of several independent cointegration tests, such as those conducted by Engle and Granger (1987); Johansen (1988); Boswijik (1994); and Banerjee et al. (1998), are shown as PH_E, PH_J, PH_B, PH_{BM} correspondingly. If the premeditated Fisher statistics are higher than the critical values presented by Bayer and Hanck (2013), then it is possible to reject the null hypothesis that there is no cointegration.

4. RESULTS AND DISCUSSION

Since time series data were used in this study, it was important to test whether data were stationary at levels or required to be differenced to make them stationary. The results obtained after data analysis were thus guaranteed to be valid. This study applies the first generation unit root tests which neglect the structural breaks but were commonly utilised in the literature on economic growth, specifically, the Augmented Dicky-Fuller, 1987 (ADF) test. Without exception, all unit root tests assume non-stationarity under the null hypothesis, the results of the data series were tested for stationarity using the Augmented Dicky-Fuller (ADF) methods.

Table 2 below shows the results of the unit root show the results of the unit root analysis of the factor components for Carbon Dioxide, Nitrogen Dioxide, Ozone Pollution and GDP Per capita.

All of the series have a unit root, which indicates that they are non-stationary at their levels; on the other hand, the series are stationary at their initial differences, as shown in Table 2. The findings of the ADF unit root test indicate that CO_2, NO_2, O_3, and GDP are integrated in the same order, I(1). The cointegration relationship among series can therefore be examined using the Bayer-Hanck (2013) cointegration approach while taking into consideration multiple structural breaks.

Table 3 below, reports the results from the combine long-run nexus between the variables using Bayer and Hanck test. Since the unit root test reveals that all variables are integrated at I(1), we used the combine cointegration test. The result shows Fisher-statistics for the combine tests of EG-JH-BO-BA: Johansen (1995), Boswijk (1995) and Bannerjee et al., (1998). The Fisher-statistics value for GDP is >10% of critical values. The values for CO_2 and NO_2 exceeded 5% critical values. The Fisher-statistics value for O_3 is >10% of critical values. These combine statistical tests allow us to reject the null hypothesis of no long-run relationship and

Table 2: Augmented Dickey fuller unit root tests

Variables	Level t stats	p-value	1st Diff. t stats	p-value
CO_2	−2.560	0.2737	−4.7422*	0.000
NO_2	−0.954	0.0011	−8.0119*	0.000
O_3	−0.229	0.0000	−7.0998*	0.000
GDP	−3.070	0.0463	−4.7422*	0.000

Source: Author's calculation using EViews 11.0

Table 3: Bayer and Hanck combine cointegration analysis

Estimated models	EG-JH-BA-BO	Cointegration
GDP=f (CO_2, NO_2, O_3)	39.049*	Yes
Significance level	Critical value	
1% level	30.774	
5% level	20.143	
10% level	15.938	

*Represents significant at 1% level. EG-J means Engel-Granger and Johansen combine tests while EG-J-BA-Bo is the Engel-Grange, Johansen, Banerjee and Boswijk combine tests. "Yes" indicate the presence of cointegration and "No" means there is no cointegration between the variables

Table 4 : Granger causality wald test

Equation	Prob>Chi-2
GDP cause ALL	p<0.05
NO_2 cause ALL	p<0.05
CO_2 cause ALL	p<0.05
CO_2 cause ALL	p<0.05

Source: Author's Calculation using Stata Software

confirmed the existence of cointegration between GDP, and explanatory variables.

The below reveals a Granger causality test output and we can see that GDP cause all at a 5% level which means GDP causes CO_2, GDP causes NO_2, and GDP cause O_3 at a 0.05 significant level. This tells us that there is a causal effect of GDP on the three air pollutants under this study. Besides, CO_2 and NO_2 also cause all at a 0.05 significant level (Table 4).

5. CONCLUSION

Using the Environmental Kuznets Curve, The aim of this study is to explore the linkages between air pollution in Jordan, over the period 2000-2020. In this study, three different pollution parameters are used to assess air quality. The three gases are carbon dioxide (CO_2), nitrogen dioxide (NO_2), and ozone (O_3). They are standard variables in Jordan for regulating air quality. First, stationarity of variables has been examined by Dickey-Fuller unit root test. Then, Bayer-Hanck (2013) cointegration and Granger causality method have been used to analyze data. Bayer-Hanck cointegration method results show that there is a long-run equilibrium relationship among the variables. The Granger causality reveals that GDP per capita has a causal effect on air pollution. These steps, however, are insufficient to reduce environmental pollution without jeopardizing Jordan's economic growth.

As a result, the following additional steps for achieving these goals may be suggested. These measures include revising regulations related to reducing GHG emissions from industry, transportation, and heating, increasing the use of bio-diesel fuel instead of fossil fuels, improving alternative energy sources, particularly solar and wind energy projects, raising public awareness and supporting green investments through the application of tax incentives technologies.

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