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Environmental Indicators and Production Volatility on Carbon Emissions and Economic Development

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Abstract

The purpose of this study is to analyse the relationship between environmental indicators and production volatility, in contrast to previous research that primarily concentrated on the connection between carbon emissions and economic development. Due to the fact that output uncertainty puts both the advancement of the economy and the quality of life in jeopardy, it is considered to be a big worry on a global scale. In this study, the authors investigate the relationship between production volatility and emissions of greenhouse gases in 155 countries between the years 1971 and 2017. The cornerstone of the empirical inquiry is comprised of the Random and Fixed Effects Models, as well as the Pooled Ordinary Least Squares. According to the findings of the empirical research, the volatility of global output is being favourably amplified by emissions of methane (CH4), carbon dioxide (CO2), nitrogen oxide (NOX), and total greenhouse gases (GHGs). In addition, the Principal Component Analysis (PCA) of the pollutant indicators provides further evidence in support of the key conclusions. Carbon emissions, on the other hand, have a more significant impact on the increase in production volatility. Furthermore, a comparative study demonstrates that in agricultural economies, the introduction of any and all pollutants results in a large rise in output volatility. The findings of the Granger causality test confirm the existence of a two-way causal link between production volatility and environmental deterioration, which suggests that there is a problem with endogeneity. In order to solve this issue, the instruments of the output volatility model have been included into the system GMM estimator. The results of the system GMM are consistent with the findings of the main research. It is possible that switching to energy sources that generate less pollutants than greenhouse gases might be a realistic way towards achieving sustainable growth, according to the findings of the study.

Keywords- Environmental indicators, production volatility, carbon emissions, economic development

Introduction

The global economy is rich with instances of macroeconomic oscillations, which are characterised by fluctuations in growth rates. When viewed from this perspective, the British South Sea Bubble of 1711, the oil price shock of 1973 (Kindleberger, 2000), the global financial crisis of 2007–2008, and the African low-income debt crisis of 2018 all provide some indication of macroeconomic cycles that considerably impeded the growth rates of their respective economies. The more precarious the current state of the economy is, the more dramatic the fluctuations in the rate of production growth. (Turan and Iyidogan, 2017) Recent study indicate that growth rate vulnerability impeded the expansion of economic indicators and resulted in large societal costs. This was found to be the case. This is due to the fact that it raised the risk for those who were low-income and caused uncertainty regarding economic policy, which resulted in a decline in the quality of institutions, the level of investments, the level of consumption, and the total factor productivity (Cariolle, 2012). Majeed (2017) and Majeed and Ayub (2018) state that as a consequence of this, the fundamental policy aims of the economies have become the maintenance of consistent growth rates and the achievement of high growth rates. To be more specific, the volatility of output is greater in developing nations (Hakura, 2009), and cariolle (2012) found that they are more susceptible to being affected by shocks from the outside world. A number of additional factors, including the risk-sharing mechanism of the nation and a financial system that is supportive, are among the other factors that greatly impact the volatility of growth. Furthermore, according to Hnatkovska and Loayza (2003), the vulnerability of a nation to economic instability is governed by a number of factors that depend on both the degree of economic expansion and structural changes in the economy over time. A great number of researches have been conducted to investigate a variety of factors of production volatility. Several factors, including economic growth (Badinger, 2010), trade openness (Briguglio, 2018; Mohey-ud-Din and Siddiqi, 2018), terms of trade uncertainty (Hakura, 2009), financial development (Hakura, 2009; Majeed and Noreen, 2018), and inflation volatility (Hart, 2008; Majeed and Noreen, 2018), have been found to have a correlation with output volatility, according to research investigations. Furthermore, the research divides the elements that drive production volatility into three categories: the kind of government (Mobarak, 2004), the expenditures of the government (Moradbeigi and Law, 2014), and the country's population (Popov, 2011; Mobarak, 2004). The volatility of

production is also affected by changes in ecosystems. According to Hu (2017), environmental risk contributes to an increase in growth uncertainty, and environmental deterioration has a negative impact on economic growth. The applied environmental sciences, on the other hand, have given a surprisingly small amount of attention to the linkages between production volatility and climate change. Studies frequently focus on the impact of environmental changes on growth and provide a variety of data about the linkages between environmental changes and economic development. Environmental changes are often the subject of studies. Several studies (Briguglio, 1995; Commonwealth Secretariat, 2000; Gounder and Xayavong, 2002) have found that high volatility is associated with natural catastrophes, which are exacerbated worse by climate changes and sea level rise. These findings have been obtained from a number of different sources. In spite of this, these studies provide very little empirical information that can be used to unravel the links between fluctuations in output and climate change. A few research articles that were issued not too long ago highlighted the fact that climate change is producing issues in terms of output in rural economies. For instance, the Food and Agriculture Organisation of the United Nations (FAO) (2016) said that climate change is a key contributor to severe food crises. This is due to the fact that drought is responsible for more than 80 percent of losses in the agricultural sector, which is caused by the fact that hunger is increasing in countries that are strongly dependent on agriculture. In addition, the loss of biodiversity, the reduction in the quantity and quality of ecosystem services, and the deforestation that occurs as a result of these climatic shocks are also repercussions. In a manner that is analogous, several studies have highlighted the issue of unsustainable growth as a consequence of the deterioration of the environment. The unsound production and consumption structure of developing economies is a barrier to sustainable development, according to the World Economic and Social Survey (2013). This is one of the obstacles that should be overcome. All of these factors have a bigger negative influence on the agricultural sector in emerging countries, particularly a reduction in the amount of arable land, severe weather, and droughts. According to Lobell et al. (2011), this method results in the loss of significant crops such as wheat and maize, and it is believed to have brought about a significant slowdown in the expansion of the agricultural sector. Smoke, fumes, and gases are all examples of forms of air pollution that, in addition to causing harm to humans, can have an impact on physical property and plant life.

As a consequence of this, there are fewer opportunities for economic growth, severe losses in natural and physical capital, and a continuous deterioration in human capital. In spite of the significance of this imperative matter, the impact of environmental deterioration on output volatility is still a subject that is not adequately addressed in the field of economic research. Consequently, the purpose of this study is to evaluate the possible effect that environmental deterioration may have on the volatility of output.This is the format that will be followed throughout the rest of the paper: Section 2 will list relevant research in the form of a survey. The third section contains a description of the data, techniques, and statistical analysis. In Section 4, both the estimated findings and a comprehensive explanation of the empirical data are put up for consideration. In Section 5, the study is finally brought to a close, and some implications for policy are discussed throughout.

2. The Literature Review and Analysis

The theoretical framework of this inquiry incorporates three different lines of literature into its theoretical framework. There are a number of schools of thought that are utilised in the first strand in order to determine the factors that cause fluctuations in the economic cycle. According to the classical economic theory, market forces are responsible for maintaining equilibrium in an economy and preventing the emergence of disequilibrium that may otherwise occur. On the other hand, the "Great Depression" brought to light the flaws of classical theory, which ultimately led to the formation of the Keynesian school of philosophical thinking. Keynesian theory believed that prices and wages are sticky, and that fluctuations in demand-side factors like as net exports, government expenditure, investment, and consumption are the primary drivers of swings in the economic cycle. However, after the stagflation that occurred in the 1970s, the real business cycle theory (RBC theory) arose as an alternative to the Keynesian theory of economic cycles. There are macroeconomic oscillations in an economy that are caused by technological shocks, which are random fluctuations in productivity, according to the models developed by RBC. Shocks can come in many forms, including innovations, adverse weather conditions, changes in the cost of raw materials, and stricter environmental rules and regulations, to name just a few examples. Within the second body of literature, there is a connection between the environment, economic growth, and the amount of instability in output. The Sun-spot theory was proposed by Stanley Jevons in the year 1875 in relation to this

matter. Sunspots, which are the consequence of a strong atomic explosion on the surface of the sun, have an effect on global weather patterns and create uncertainty in both industrial and agricultural production. This is because of the input-output relationship that they have with the agricultural sector. As a consequence of this, variations in the weather initially have an effect on the output of agricultural production before extending its worry over the whole economy. According to the ecological modernization idea, a change towards environmentalism with the potential to increase the benefits to the economy as a whole might be beneficial. The theory was developed by a group of academics at Berlin's Social Science Research Centre and Free University in the early 1980s. They argued that environmental productivity, which is defined as the efficient utilisation of natural resources, could be considered a significant driver of future economic growth, similar to how labour and capital productivity are seen as drivers of economic growth. The fundamental concept behind the philosophy was the protection of the environment by means of the utilisation of green technology and energy sources that are friendly to the environment. These methods also contribute to the reduction of emissions of greenhouse gases within the environment. Additionally, the Environmental Kuznets Curve (EKC) is a type of graph that displays the hypothesised link between environmental deterioration and economic advancement. This relationship is represented as an inverted U. In the early 1990s, there was a functional empirical literature discussing the validity and significance of the EKC. This literature has remained active ever since. This is consistent with the key research conducted by Selden and Song (1994), Panayotou (1993), Shafik and Bandypadhyay (1992), and Grossman and Krueger (1995). The theoretical underpinnings of this work are comprised of a number of additional theoretical issues, which are the last point. According to Armstrong and Read (2002) and Gounder and Xayavong (2002), the primary contributors to environmental degradation that result in economic instability are rising sea levels and climate change. These two elements come together to cause environmental degradation. There are also concerns over the effects of global warming on the economy, particularly in relations to agriculture. The increase in crop optimum temperature that results from global warming leads to a decrease in crop yield. According to the International Monetary Fund (2008), crop yield loss has a negative influence on the earnings of farmers and raises issues about the overall productivity of agriculture. Similar to the previous point, changes in export earnings brought on by natural catastrophes

hamper economic growth by increasing the unpredictability of output and the degree to which the economy is dependent on production. In addition, deforestation has a considerable negative influence on the economy, particularly with regard to the ecosystem, environmental services, personal earnings, and means of sustenance. A decrease in the amount of forest area and biodiversity leads to uncertainty in the tourism industry, which in turn contributes to the instability of the macroeconomic system. Furthermore, according to Jeanjean et al. (2014), the loss in agricultural productivity is connected to the deterioration of both land properties and water resources. As a result of a decrease in income and consumption levels, a rise in earning risks, and an increase in production costs, the quality of the soil is decreasing, which also raises the uncertainty in agricultural output and total factor productivity (Moser and Barrett, 2006). In addition, the productivity of the agricultural, forestry, and fisheries industries is susceptible to the effects of tropical cyclones (Kunze, 2018).

The third body of research establishes a connection between production uncertainty and economic indices such as financial development, trade openness, terms of trade, opportunities for diversification, and uncertainty in economic policy. For example, Acemoglu and Zilibotti (1997) highlight the ways in which diversification opportunities have an effect on the volatility of output.

3. The Information and Methods Available

In order to establish the relationship between environmental deterioration and output volatility, we have developed a model that is based on the existing body of research. The body of research indicates that the volatility of production is impacted by a variety of factors, such as the consumption of the government, the openness of trade, the size of the nation, and the volatility of terms of trade and inflation. The influence of environmental deterioration, which is a substantial component in production volatility, is another aspect that has to be taken into consideration. Drawing from the study conducted by Bhoola and Kollamparambil (2011) as well as the existing body of literature on production volatility, we have developed the regression model that is shown below for the purpose of conducting the empirical analysis: The years 1971 through 2017 are represented by the letter t. The character β0 is used to signify the intercept term. According to Ramey and Ramey (1995), Hakura (2009), Malik and Temple (2009), Majeed and Noreen (2018), and Briguglio (2018), the log of production volatility (LOV) is the log of production volatility as determined by the five-year standard deviation of the annual

GDP per capita based on constant 2010 US dollars. ED is a representation of the degradation observed in the environment. The slope coefficient, often known as β1, acts as a quantitative measure of the impact that variations in environmental degradation have on the volatility of production. The name "Xit" is used to refer to the row matrix, which contains all of the parameters that have the potential to affect output volatility, with the exception of the variables that are being targeted. Both the phrase "country specific unobservable effect" and the term "time specific factor" are abbreviated as $\boldsymbol{\theta t}$ and vi, respectively. The error term that takes into account all of the variables that are not taken into account is referred to as εit. The subscripts i and t, respectively, are used to designate the nation and the time period in question. We make use of the dynamic panel data model by incorporating the lag of the dependent variable as an independent variable (see Dabla-Norris & Srivisal, 2013). This is due to the fact that production volatility is dependent on the influence of economic uncertainty during the lag period. The influence of the lag time is what defines the current output volatility (Piper, 2015). When it comes to production volatility, the impact is long-lasting, and the lag time will decide the present output volatility. For the purpose of taking into account the impact of monetary sector and real sector issues, the model incorporates both inflation and the volatility of terms of trade. distinct shocks to terms of trade have distinct impacts, and these effects vary depending on the sort of economy there is. According to Beck et al. (2006), economies with a higher level of trade liberalisation are considered to be more susceptible to trade shocks. This is because trade shocks directly impact the trade sector, which in turn impacts the overall economy. According to Rumler and Scharler (2011), there is a positive association between terms of trade shocks and output volatility in economies that have a high trade union density. On the other hand, there is a negative correlation in economies that have controlled and coordinated labour markets. The flexibility of the exchange rate has an impact on the nature of the partnership as well since it helps to reduce the impact of shocks that come from sources outside the partnership. The findings of the research on shocks to the monetary sector indicate that there is a connection between the volatility of output and the volatility of inflation that is both positive and negative. According to Hart (2008), when there are shocks to aggregate demand, there is a connection between increased production volatility and higher inflation. On the other hand, when there are shocks to aggregate supply, the

correlation changes to the reverse. On the other hand, the perception that economies with high levels of inflation have higher output volatility is now the one that is held by the majority of people. Trade openness makes the economy more vulnerable to shocks from the outside world, which in turn increases the volatility of output (Tornell et al., 2003). In the other direction, Haddad et al. (2013) suggest that a high degree of product diversity may be beneficial to the stabilisation of economic development. In addition, the proxy of population growth is utilised in order to control the impact of the size of the territory. A large economy that has a strong resource base has a tendency to lessen output volatility, as stated by Furceri and Poplawski (2008). The consumption on the part of the government is a substitute for other methods that might be used to restrict the impact of fiscal policy. The discretionary fiscal policy of an economy contributes to an increase in the production uncertainty of the economy (Hakura, 2009).

The results

Table 1: Fixed Effect Analysis

Dependent Variable: Volatility of Output (1971-2017)					
Variables	(1)	(2)	(3)	(4)	(5)
CO_2	0.0606***				
	(0.005)				
NO_X		0.0223			
		(0.422)			
Methane			0.0533***		
			(0.086)		
Greenhouse Gases				0.0453***	
				(0.019)	
PCA					0.0409
					(0.160)
Volatility of Output t-1	0.7840***	0.7844***	0.7821***	0.7776***	0.7841***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Volatility of TOT	0.0018***	0.0020***	0.0020***	0.0021***	0.0020***
	(0.008)	(0.000)	(0.000)	(0.000)	(0.000)
Volatility of Inflation	-0.0322***	-0.0379***	-0.0367***	-0.0367***	-0.0378***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Trade	0.0007**	0.0008***	0.0008***	0.0008***	0.0008***
	(0.010)	(0.004)	(0.000)	(0.008)	(0.004)
Population	-0.0329***	-0.0452***	-0.0441***	-0.0465***	-0.0437***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Govt. Consumption	0.0009***	0.0010***	0.0010***	0.0010***	0.0010***
	(0.003)	(0.002)	(0.002)	(0.003)	(0.000)
Constant	1.0890***	0.9432***	0.6495***	0.6630***	1.1242***
	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)
Observations	3283	2968	2968	2849	2967
R-squared	0.9593	0.9610	0.9610	0.9608	0.9611
Adjusted R-squared	0.9572	0.9588	0.9588	0.9585	0.9588
F-Statistics	457.81***	432.8***	433.1***	423.3***	433.3***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Probability values are in parentheses (*** p<0.01, ** p<0.05, * p<0.1)					

On the other hand, OLS is based on highly limited assumptions and does not take into account the significant country and temporal implications. It is possible to solve the problem of unobserved country-specific fixed and random effects by employing models that incorporate both fixed effects and random effects. On the basis of the fixed effects model, which operates under the assumption that the intercept term of each cross section is subject to variation, the empirical findings are presented in Table 1. The results of the study indicate that the volatility of output is typically exacerbated by all indicators of environmental degradation. In general, the outcomes of the main research indicate that the variables have the appropriate signs and are not overly sensitive to fixed effects. It is important to note that when fixed variables are considered, the volatility effect of all environmental components is shown to be larger. This finding suggests that the ordinary least squares model (OLS) overstated the role of environmental degradation on output volatility. In terms of selecting a model, we have utilised the Hausman test on the presumption that the null hypothesis of the fixed effects model is correct.

Conclusion

Because it poses dangers to the economy on the financial, social, and economic fronts and can have a detrimental influence on a country's capacity to grow economically, policymakers have been concerned about production volatility for a long time. Because of this, policymakers have been concerned about output volatility. The volatility of production is a matter for concern since it exacerbates a variety of social and economic concerns. This is in addition to the fact that it is necessary to maintain broad macroeconomic stability from time to time. The current investigation makes use of the criminal data collection of 155 countries from 1971 to 2017 in order to investigate the impact that worsening environmental conditions have on the volatility of output. In this particular instance, the output volatility serves as the dependent variable. As proxies for the degradation of the environment, methane, carbon dioxide, nitrogen oxide, and total greenhouse gas emissions are utilised. The findings of models with fixed effects, random effects, and pooled ordinary least squares indicate that the output volatility is frequently increased by all of the indicators of environmental deterioration that are included in the analysis. When compared to emissions of other pollutants, carbon dioxide emissions have a more significant influence on the volatility of output. The endogeneity problem is further complicated by the fact that it is possible to establish a causal relationship in both directions between all of the environmental factors and the production

volatility. System Generalised Method of Moments (GMM) is utilised to address this issue since it provides accurate estimates and is able to deal with endogeneity, heteroskedasticity, and autocorrelation. In addition, the results of the system GMM provide credence to the key conclusions that were reached throughout this inquiry.

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