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The Dynamics of Carbon dioxide [CO_2] Emission on Nigerian Capacity Utilization

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Abstract: On utilizing the available resources in Nigeria, carbon dioxide and other environmental substances are emitted into the atmosphere, which pollutes the Economy. Dynamically, this research work employs quarterly time series on the variable of interest, given the integration of the same order [I(1)] of the series, and co-integration via Bound-Testing Technique, this work utilizes the Auto-regressive Distributed Lag (ARDL) Model and discovered that at present, Emission of Carbon Dioxide (CE) is statistically significant and positively related to the Average Manufacturing Capacity Utilization (AMCU) in the short and long run, denoting that the emission of Carbon Dioxide is in-line with Green Economics; which however will not jeopardize future production and consumption. On the other hand, Manufacturing Value Added (MVA) is inversely related with Average Manufacturing Capacity Utilization (AMCU), in the short and long-run. These findings agree with Zhen and Jing (2009), Anietie (2011) and DiNapoli (2007). The Researchers however suggest utilization of available capacities in adding value to goods and services and a more effective and tightened Carbon Emission Tax System (CETS) like Cap-and-Trade, Carbon Tax, Pigouvian Tax, etc. which will keep in check, the quantity of Emitted Carbon Dioxide in Nigeria and consequently, not affect the birds of the air and earth (Livestock), aquatic animals, and human beings. Hence creating a future better Nigeria with respect to production and Consumption.

Keywords: Carbon Dioxide Emission, Environmental Pollution, Environmental Pollution Tax, Capacity Utilization, and Green Economics.
JEL Classification: D21, E22, E23, H23, I18, and Q5

INTRODUCTION

Man's environment ought to be protected from all forms of hazard so as to maintain a balanced environment for the good of both the present and future generations. Zhen and Jing (2009) recorded that the data from the Institute for Environmental Studies reports that the effects of emissions of CO2 and other greenhouse gases on the global climate are becoming visible, causing changes in temperature, sea level rise, atmospheric circulation patterns, ecosystems and so on. Enhanced greenhouse effect is not natural. It refers to the changes in the earth's radiation balance due to the anthropogenic accumulation in the atmosphere of radiatively active greenhouse gases. In addition to carbon dioxide, other greenhouse gases include methane, nitrous oxides, tropospheric ozone and chlorofluorocarbons. Their effect is to accelerate the warming effect beyond acceptable levels [1].

Carbon dioxide (chemical formula: CO_2) is a colorless, odorless, and slightly acid-tasting gas, sometimes called carbonic acid gas, the molecule of which consists of one atom of carbon joined to two atoms of oxygen (CO_2), (Encarta; 2009). Carbon dioxide is naturally occurring but can also be produced as an unrecovered side product of four technologies: combustion of fossil fuels, production of hydrogen by steam reforming, ammonia synthesis, and fermentation. It can also be obtained by distillation from air. At concentration of 2,500 ppm to 5,000 ppm, CO_2 can cause headaches. At extremely high levels of 100,000 ppm, people lose consciousness in ten minutes, and at 200,000 ppm, CO_2 can lead to death.

According to Wikipedia, there are both natural and human sources of carbon dioxide emission (the letting out or giving out of carbon dioxide). The natural sources include decomposition, ocean release and respiration. Human sources come from activities like cement production, deforestation as well as the burning of fossil fuels like coal, oil and natural gas. Human sources of carbon dioxide emissions are much smaller than natural emissions but they have upset the natural balance that existed for many thousands of years before the influence of humans. This is because natural sinks remove around the same quantity of carbon dioxide from the atmosphere than are produced by natural sources. This had kept carbon dioxide levels balanced and in a safe range. But human sources of emissions have upset the natural balance by adding extra carbon dioxide to the atmosphere without removing any burning form of fossil fuel releases energy, but carbon dioxide is also produced as a byproduct. This is because almost all the carbon that is stored in fossil fuels gets transformed to carbon dioxide during this process. About 87 percent of all human-produced carbon dioxide emissions come from the burning of fossil fuels like coal, natural gas and oil, which is most commonly turned into heat electricity, or power for transportation. Coal is the most carbon intensive fossil fuel, it produces the most carbon dioxide and is responsible for 43% of carbon dioxide emissions from fuel combustion, oil is responsible for 36% and natural gas is responsible for 20% emissions The remainder of the emission results from the clearing of forests and other land use changes (9%), as well as some industrial processes such as cement manufacturing (4%). Industry besides generating process-related emissions of CO2, also generates emissions of nitrogen dioxide (N2O), methane (CH4), hydro fluorocarbon (HFCs), perfluorocarbons (PFCs) and SF6 [2]. According to Wikipedia, industrial processes emissions can be physically measured by inserting sensors and flow meters in chimneys and stacks in some countries, but many types of activity rely on theoretical calculations for measurement. Depending on local legislation, these measurements may require additional checks and verification by government or third party auditors, prior or post submission to the local regulator.

An economy that aims at the reduction of ecological scarcity, environmental risks and hazards as well as improvement of sustainable development without degrading the environment is known as green economy. Environmental economics primarily focuses on maximizing the social value of resource usage. It is an outgrowth of the theory of externalities and it is that allocation of resources obtained in a perfectly competitive general equilibrium [3].

Climate scientists according to Will Oremus (2013) have estimated that, in order to avoid runaway global warming, the world would need to cut its carbon emissions roughly in half by 2050. Anietie [4] listed hazards that could result from global warming to include among others "the vulnerability of the economic sector to the recurrent droughts, flood and cyclones, decline of some plant and animal populations, spread of diseases vectors including malaria, freezing and breaking-up of ice on rivers and lakes, reduction in food production, increase in death rate and threat to sustainable development." As a result of these and other factors including the fact that Nigeria's economy relies to a large extent on fossil fuel (petroleum), it is necessary to study how carbon emission affects the economy of Nigeria, particularly its influence on the capacity utilization of the manufacturing sector, bearing in mind its effect on the atmosphere.

There are many ways countries have used and can adopt to reduce emissions including the use of a Command-Control approach, such as regulation, direct and indirect taxes, a price instrument (which fixes the price while the emission level is allowed to vary according to economic activity), safety valve (where emitters have the choice of either obtaining permits in the marketplace or purchasing them from the government at a specified trigger price), cap and trade, etc. Emissions trading or cap and trade is a market-based approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants.

Wikipedia records that in cap and trade, "a central authority (usually a governmental body) sets a limit or cap on the amount of a pollutant that may be emitted. The limit or cap is allocated or sold to firms in the form of emissions permits which represent the right to emit or discharge a specific volume of the specified pollutant. Firms are required to hold a number of permits (or allowances or carbon credits) equivalent to their emissions. The total number of permits cannot exceed the cap, limiting total emissions to that level. Firms that need to increase their volume of emissions must buy permits from those who require fewer permits. The transfer of permits is referred to as a trade. In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for having reduced emissions. Thus, in theory, those who can reduce emissions most cheaply will do so, achieving the pollution reduction at the lowest cost to society. The overall goal of an emissions trading plan is to minimize the cost of meeting a set emissions target or cap. The cap is an enforceable limit on emissions that is usually lowered over time, aiming towards a national emissions reduction target."

However, the objective of this work is to establish the short and long-run dynamics of carbon dioxide emission on capacity utilization of Nigeria. This is justified vis the emergence of the rationales of Green Economics.

Carbon Leakage

Carbon leakage is the effect that regulation of emissions in one country/sector has on the emissions in other countries/sectors that are not subject to the same regulation, Barker et al (2007) cited in Wikipedia. The leakage rate is defined as the increase in CO_2 emissions outside of the countries taking domestic mitigation action, divided by the reduction in emissions of countries taking domestic mitigation action. Accordingly, a leakage rate greater than 100% would mean that domestic actions to reduce emissions had had the effect of increasing emissions in other countries to a greater extent, i.e., domestic mitigation action had actually led to an increase in global emissions.

Manufacturing Capacity Utilization

Capacity utilization has to do with the percentage of total production capacity that a company or industry uses. Capacity utilization rate has to do with the percentage of total production capacity that a company, industry or economy is using. Encarta dictionary, (2009).

THEORETICAL LITERATURE

Pollution Haven Hypothesis

According to Umed [5], the pollution haven hypothesis (PHH) predicts that, under free trade, multinational firms will relocate the production of their pollution-intensive goods to developing countries, taking advantage of the low environment monitoring in these countries. Over time, developing countries will develop a comparative advantage in pollution intensive industries and become “havens” for the world’s polluting industries. Thus developed countries are expected to benefit in terms of environmental quality from trade, while developing countries will lose. Arik [6] noted that the pollution haven hypothesis, or pollution haven effect, is the idea that polluting industries will relocate to jurisdictions with less stringent environmental regulations. This hypothesis posits that companies locate their plants and industries mainly in developing countries where the cost of pollution is cheaper because of less strict environmental regulations.

The Environmental Kuznets Curve (EKC)

Proponents of the Environmental Kuznets Curve (EKC) hypothesis argue that “at higher levels of development, structural change towards information-intensive industries and services, coupled with increased environmental awareness, enforcement of environmental regulations, better technology and higher environmental expenditures, result in leveling off and gradual decline of environmental degradation.” Panayotou cited in Stern [7]. Stern [7] further explains the environmental Kuznets curve saying that in the early stages of economic growth, degradation and pollution increase, but beyond some level of income per capita (which will vary for different indicators) the trend reverses, so that at high-income levels economic growth leads to environmental improvement. This implies that the environmental impact indicator is an inverted U-shaped function of income per capita.

The EKC can be divided into three parts: scale, composition and technique. Stern [7] explains this saying that if as an economy grows the 'scale' of all activities increases proportionally, pollution will increase with economic growth. If growth is not proportional but is accompanied by a change in the 'composition' of goods produced, then pollution may decline or increase with income. If richer economies produce proportionally fewer pollution-intensive products, because of changing tastes or patterns of trade, this composition effect can lead to a decline in pollution associated with economic growth. Finally, if richer countries use less pollution-intensive production 'techniques', perhaps because environmental quality is a normal good, growth can lead to falling pollution.

The Polluter Pays Principle

The polluter pays principle is basically one of the principles guiding the resolution of conflicts that may arise in connections with environmental pollution. De Lucia [8] records that the Polluter Pays Principle is an environmental policy principle which requires that the costs of pollution be borne by those who cause it, noting that the first mention of this principle at the international level is found in the 1972 Recommendation by the OECD Council on Guiding Principles concerning International Economic Aspects of Environmental Policies, where it stated that, "The principle to be used for allocating costs of pollution prevention and control measures to encourage rational use of scarce environmental resource and to avoid distortion in international trade and investment is the so-called Polluter-Pays Principle." According to Cordato [9], a correct interpretation of the polluter pays principle would define pollution as any byproduct of a production or consumption process that harms or otherwise violates the property rights of others. The polluter would be the person, company, or other organization whose activities are generating that by-product. And finally, payment should equal the damage and be made to the person or persons being harmed. The PPP according to De Lucia [8] is widely acknowledged as a general principle of International Environmental Law.

Generally speaking there are two approaches to applying the polluter pays principle. The most traditional and straightforward is the Pigouvian excise tax. In this case the polluter is forced to "pay" either through a tax that is equivalent to the "pollution costs" per unit of output or per unit of effluence. The second is through tradable emissions permits. In this case an "efficient" level of pollution is determined and permits to pollute which total to this efficient level are bought and sold in the marketplace. The polluter is forced to pay either explicitly by having to purchase permits in the market or implicitly by having to forgo selling the permits that he holds Cordato [9].

First Come First Served

In situation where property rights are unclear, for example, two companies are attempting to use the same resource for conflicting purposes, with neither of them nor anyone else having clear rights to the use of the resource. The problem that is generating the conflict is the lack of property rights definition. In this case the goal is to determine who has the right to use the resource. We cannot determine that the rights go to the person whose use will maximize the overall value of production. The better option would be to adopt the first come, first serve principle. With the knowledge that a first user rule is likely to be upheld by the courts someone who desires to use a resource in a way that conflicts with a known first user will either decide not to go ahead with his plans or will go to the first user to negotiate a compromise. This also increases the level of certainty for the first user who can go ahead and implement his plans with reasonable expectations that his rights to use the relevant resource will be enforced in the face of others whose future plans might conflict [9]

Empirical Literature

Zhen and Jing (2009) studied the macroeconomic effects of carbon dioxide emission Reduction: cost and benefits. The work focused on the situation in China. It used the MACRO model and the data covered over 20 years. The empirical results showed that CO2 direct mix: empirical evidence from 93 countries used a panel dataset over the period 1960-2008. The result indicated emissions control has great effect on reducing the CO2 emission; it however causes a great loss on GDP. Combining the GDP loss and effect on CO2 emissions reduction, the empirical results show the carbon tax on coal will have great effects and less economic loss and thus will be the best strategy for China.

Stolyarova [10] in his paper, "Carbon Dioxide Emissions, economic growth and energy a short-run relationship between CO2 emissions and its determinants. Using series from 1960-2008 from 93 countries. Using Dynamic panel data and WITHIN MODELS, he found that the growth rate of per capita CO2 emissions depends positively on the growth rate of per capita GDP and negatively on the growth rate of energy mix.

Achike, Onoja and Agu [12] investigated and analyzed the determinants of Carbon Dioxide (CO2) emission in Nigeria. The study covered a period of 40 years (1970-2009). The data were analyzed using Zellner's Seemingly Unrelated Regression (SURE) model. The results show that fossil energy demand or consumption, rents from forestry trade, agricultural land area expansion and farm technology were significant determinants of green-house gas (GHG) emission in Nigeria. They also found out that fossil fuel energy demand was exogenously determined by economic growth rate (proxied by GDP growth rate) and farm technology applied in the country. It was recommended among other things that Nigeria should put in place policies that will tax companies or firms emitting GHGs, that existing and new technologies for adapting to climate change and variability be developed.

Anietie [4] looked at the relationship between economic growth and co2 emissions and the effects of energy consumption on co2 emission patterns in Nigerian economy over the period 1980-2009, the paper used the Standard Version of Granger and the Restricted VAR Model (VECM) for the analysis. The analysis showed the carbon emissions patterns in Nigeria have greater effects on the levels of economic growth in the short run but a neutral hypothesis holds in long run. They recommend formulation of policies that are expected to reduce or control the level of carbon emissions.

DiNapoli [11] in his thesis "Theory and Evidence…Carbon Emissions: Credit Trading versus Taxation" concludes that Cap-and-trade is the best policy for the issue of global warming as it can be integrated globally, reacts quickly and will ensure the desired emissions reductions in the face of uncertainty.

Stern [7] studied the Environmental Kuznets Curve and concludes that the statistical analysis on which the environmental Kuznets curve is based is not robust.

Umed [5] examined how free international trade affects the environment in the developed and less developed worlds. Using input-output techniques, tests of the pollution haven hypothesis (PHH) and the factor endowment hypothesis (FEH) for the US and China were empirically carried out. They found that China gains and the US loses in terms of CO2, SO2 and NOx emissions from increased trade, and the US is not exporting capital intensive goods. Therefore both the PHH and the FEH were rejected, which implies that explaining the trade of pollutants remains unresolved.

METHODOLOGY

The choice of model is justified Auto-regressive Distributed Lag (ARDL) model in the sense that, past levels of Capacity Utilization goes a long way in determining the present level of Capacity Utilization in an economy. The model is functionally specified thus:

$$AMCU_t = f(CE_t, \quad MVA_t, \quad and \;\; AMCU_{t-i}) \ldots\ldots\ldots (1)$$

AMCU; is the Economy's Average Manufacturing Capacity Utilization, CE; is Carbon dioxide Emission, and MVA; is Manufacturing Value Added. The choice of the functional specification form of a model can be informed using Box-Cox, Mackinnon-White-Davidson (MWD) estimations, etc. This work employed the estimation test of MWD and rejected the null hypothesis of linear form model and do not reject the alternative hypothesis of log-linear model at 5% level of significance (**See Appendices, Section**

Two). The model is therefore a log-linear model where the log form is denoted as 'ln'. Note, AMCU is in rates (percentage) and thus not logged. The Autoregressive Distributed Lag Model (ARDL) functional specified above is therefore, infinitely and econometrically specified thus $ARDL_{(n,m)}$:

$$AMCU_t = \alpha_0 + \sum_{i=1}^{n} \beta_i lnAMCU_{t-i} + \sum_{j=0}^{m} \gamma_j lnCE_{t-j} + \sum_{k=0}^{m} \theta_k lnMVA_{t-k} + \mu_t \dots \dots (2)$$

All variables of interest were elicited from the World Bank Data for Nigeria, except that of AMCU, which was gotten from the Central Bank of Nigeria Statistical Bulletin. Cubic match last conversion mechanism was used to convert the annual series (2000 - 2012) to quarterly series.

Using the restricted lag length Information selection criteria, the infinite $ARDL_{(n,m)}$ becomes $ARDL_{(3,3)}$(**See Appendices, Section Three**). As a pre-estimation test of unit-root, for using time series; the variables of interest were all found to be stationary at first integrated order (**See Appendices, Section One**). Consequently denoting a Cointegration ARDL model. The Restricted and Unrestricted Error Correction Mechanism (RECM and UECM) will be employed, to however show the Short and Long run Dynamics, Given that:

- The model disturbance term is serially not correlated
- The Auto-regressive component of the model is Dynamically Stable using the ARMA (Auto-Regressive Moving Average) Structure graph, and
- The model also exhibited a long run relationship using the Bound testing mechanism (**See Appendices, section four, five and six**).

However, the Restricted and Unrestricted Error Correction Mechanism (RECM and UECM) model are finitely and respectively stated below:

$$\Delta AMCU_t = \alpha_0 + \sum_{i=1}^{3} \Delta\beta_i AMCU_{t-i} + \sum_{j=0}^{3} \Delta\gamma_j lnCE_{t-j} + \sum_{k=0}^{3} \Delta\theta_k lnMVA_{t-k} + \sigma ECM_{t-1} + v_t \dots \dots \dots \dots (3)$$

$$\Delta AMCU_t = \alpha_0 + \sum_{i=1}^{3} \Delta\beta_i AMCU_{t-i} + \sum_{j=0}^{3} \Delta\gamma_j lnCE_{t-j} + \sum_{k=0}^{3} \Delta\theta_k lnMVA_{t-k} + AMCU_{t-1} + lnCE_{t-1} + lnMVA_{t-1} + \epsilon_t \dots \dots \dots \dots (4)$$

RESULTS ANALYSIS AND INTERPRETATION

Table 1: Bound Test Result

Null Hypothesis	F-Stat	Lower Bound	Upper Bound	Decision	Conclusion
$C(13) = C(14) = C(15) = 0$	6.130379	3.79	4.85	$C(13) \neq C(14) \neq C(15) \neq 0$	**There exist a long run equilibrium relationship**

Source: Researchers' computation

The lower and upper bound values as show above are that of 5% from Paseran Table, implying that there exist a long-run relationship between the variables of interest. Thus rejecting the null hypothesis of no long-run relationship.

Table 2: Short run Dynamics, using RECM Result

Dependent variable: $\Delta AMCU_t$			
Variable	**RECM Coefficient**	**T-Statistic**	**P-Values**
$Constant$	-0.155336	-0.928149	0.3599
$\Delta lnCE_t$	28.38582	7.538408	0.0000
$\Delta lnMVA_t$	-9.683450	-1.223605	0.2295
ECM_{t-1}	-0.862640	-3.043743	0.0045

Source: Researchers' computation (see appendices 7.2, for full result)

Given that the series of interest are not stationary at level form but all at level one, indicates a case of cointegration regression and hence, the RECM is estimated to show not only the short run impacts of the choice of independent variables on the dependent variable, but also to show the magnitude and speed of adjustment of the short run fluctuations.

Holding every other variable constant, the elasticity of a change in the Average Manufacturing Capacity Utilization of Nigeria as a result of a positive change in the Emission of Carbon dioxide (CO^2) is approximately 28.4 in the short run, statistically significant at 5% and even 1% significance of level. Also, holding other things constant, the elasticity of a change in the Average Manufacturing Capacity Utilization of Nigeria as a result of an inverse change in Manufacturing Value Added is 9.68 in the short run and it's statistically significant at 25% level of significance.

Magnitude-wise, approximately 86.3% of the distortions in the short run equilibrium of the model is corrected in a period (a quarter). While the speed of adjustment for full realisation of equilibrium is three (3) months and fourteen (14) days (i.e. 1 quarter and 14 days). The ECM coefficient conforms to a priori expectations of magnitude, direction and of statistical significance.

Table 3: Long-Run Dynamics, using UECM Result

Variable	UECM coefficients	P-values	T-Statistics	Long Run Impact
$AMCU_{t-1}$	-0.066435	0.0006	-3.793999	
$lnCE_{t-1}$	2.831598	0.0022	3.326605	42.622082
$lnMVA_{t-1}$	-0.776842	0.0002	-4.179380	-11.693264

Source: Researchers' computation (see appendices 7.1, for full result)

In the long run, there are statistically significant long run elasticity impact of a change in Nigerian Average Capacity Utilization, for a change in Manufacturing valued added and/or a change in Emission of Carbon Dioxide, both at 5% and 1% significant level.

In the long run, the elasticity impact of a change in emission of carbon dioxide will lead to approximately 42.6 change in capacity utilization of Nigeria, while a change in manufacturing value added will lead to an inverse change of 11.7 approximately on Nigeria capacity utilization rate.

CONCLUSION AND RECOMMENDATION

Green Economics advocates rationality in the production of goods and services so as to meet and maximize present consumption needs and profit, and at the same time, not depriving or hindering future production, consumption and profit maximization. There is a cost for excessive utilization of natural and unnatural resources, which may include rendering the soil infertile, contaminated rainfall (acidic rainfall), killing livestock, humans, etc.

Consequently, an example of this havoc that results from present production of goods and services is that of the emission of carbon dioxide co^2. If this emission is not properly managed, the economics of the future generation will be jeopardized. Pigouvian tax, carbon and trade, carbon tax, etc. have been devised to manage this phenomenon.

From the findings of this research work, emission of carbon dioxide CO^2 is statistically significant and positively related to manufacturing capacity utilization of Nigeria both in the short run and long run. This conforms to a priori expectation. On the other hand, manufacturing value added is inversely related and statistically significant in the short and long run. This findings agree with Zhen and Jing (2009), Anietie [4] and DiNapoli [11].

The researchers thus conclude that even on the verge of maximizing manufacturing capacity utilization of the economy, they should also look out for the green economics' impact on the economy which will result from the increase of carbon dioxide emission. On the other hand, the manufacturing value added of the economy is inversely related denoting that Nigeria is not practically utilizing its capacity in adding value to their raw materials; producing the finished product.

We however recommend a total and serious check on the emission of carbon dioxide in the economy and at the same time, try to add value to inventories using the available capacity of the economy.

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APPENDICE

SECTION ONE: UNIT ROOT TEST

1.1 AMCU (AVERAGE MANUFACTURING CAPACITY UTILIZATION) at First Difference

Null Hypothesis: D(AMCU) has a unit root				
Exogenous: Constant				
Lag Length: 1 (Automatic - based on SIC, maxlag=10)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.144990	0.0020
Test critical values:	1% level		-3.571310	
	5% level		-2.922449	
	10% level		-2.599224	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(AMCU,2)				
Method: Least Squares				
Date: 07/25/14 Time: 21:01				
Sample (adjusted): 2000Q4 2012Q4				
Included observations: 49 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AMCU(-1))	-0.133254	0.032148	-4.144990	0.0001
D(AMCU(-1),2)	0.821592	0.084054	9.774575	0.0000
C	0.019032	0.042013	0.453000	0.6527
R-squared	0.686896	Mean dependent var		-0.006122
Adjusted R-squared	0.673283	S.D. dependent var		0.510885
S.E. of regression	0.292017	Akaike info criterion		0.435264
Sum squared resid	3.922612	Schwarz criterion		0.551089
Log likelihood	-7.663958	Hannan-Quinn criter.		0.479208
F-statistic	50.45813	Durbin-Watson stat		1.595539
Prob(F-statistic)	0.000000			

Null Hypothesis: D(LNCE) has a unit root				
Exogenous: Constant				
Lag Length: 1 (Automatic - based on SIC, maxlag=10)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-6.535503	0.0000
Test critical values:	1% level		-3.571310	
	5% level		-2.922449	
	10% level		-2.599224	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNCE,2)				
Method: Least Squares				
Date: 07/25/14 Time: 21:07				
Sample (adjusted): 2000Q4 2012Q4				

Included observations: 49 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNCE(-1))	-0.214725	0.032855	-6.535503	0.0000
D(LNCE(-1),2)	0.703203	0.066383	10.59314	0.0000
C	0.000950	0.001234	0.770493	0.4449
R-squared	0.796033	Mean dependent var		-0.002976
Adjusted R-squared	0.787165	S.D. dependent var		0.018159
S.E. of regression	0.008377	Akaike info criterion		-6.667272
Sum squared resid	0.003228	Schwarz criterion		-6.551447
Log likelihood	166.3482	Hannan-Quinn criter.		-6.623328
F-statistic	89.76342	Durbin-Watson stat		1.132400
Prob(F-statistic)	0.000000			

1.2 LNCE (Log of Carbon Dioxide Emission) at First Difference

1.3 LNMVA (Log of Manufacturing Value Added) at First Difference

Null Hypothesis: D(LNMVA) has a unit root				
Exogenous: Constant				
Lag Length: 0 (Automatic - based on SIC, maxlag=10)				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-3.455229	0.0135
Test critical values:	1% level		-3.568308	
	5% level		-2.921175	
	10% level		-2.598551	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(LNMVA,2)				
Method: Least Squares				
Date: 07/25/14 Time: 21:13				
Sample (adjusted): 2000Q3 2012Q4				
Included observations: 50 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNMVA(-1))	-0.324137	0.093811	-3.455229	0.0012
C	0.006650	0.001918	3.466841	0.0011
R-squared	0.199181	Mean dependent var		0.000232
Adjusted R-squared	0.182497	S.D. dependent var		0.003747
S.E. of regression	0.003388	Akaike info criterion		-8.497897
Sum squared resid	0.000551	Schwarz criterion		-8.421416
Log likelihood	214.4474	Hannan-Quinn criter.		-8.468773
F-statistic	11.93861	Durbin-Watson stat		2.062365
Prob(F-statistic)	0.001160			

SECTION TWO: MACKINNON, WHITE & DAVIDSON (MWD) TEST
2.1 LINEAR MODEL RESULT

```
      Source |       SS       df       MS              Number of obs =      52
-------------+------------------------------           F(  2,    49) =   67.76
       Model |   1862.556      2  931.278001           Prob > F      =  0.0000
    Residual |  673.492329     49  13.7447414           R-squared     =  0.7344
-------------+------------------------------           Adj R-squared =  0.7236
       Total |  2536.04833     51  49.7264379           Root MSE      =  3.7074

------------------------------------------------------------------------------
         mcu |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          ce |   .0005383   .0000467    11.52   0.000     .0004444    .0006322
         mva |  -4.89e-11   7.08e-11    -0.69   0.494    -1.91e-10    9.35e-11
       _cons |   1.915387   4.621894     0.41   0.680    -7.372657    11.20343
------------------------------------------------------------------------------
```

2.2 LOG-LINEAR MODEL RESULT

Source	SS	df	MS
Model	1765.43825	2	882.719123
Residual	770.610086	49	15.7267364
Total	2536.04833	51	49.7264379

Number of obs	=	52
F(2, 49)	=	56.13
Prob > F	=	0.0000
R-squared	=	0.6961
Adj R-squared	=	0.6837
Root MSE	=	3.9657

mcu	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnce	42.83399	4.043614	10.59	0.000	34.70804	50.95993
lnmva	-.9894844	1.741729	-0.57	0.573	-4.489621	2.510652
_cons	-415.5452	60.93989	-6.82	0.000	-538.0085	-293.0819

2.3 DECISION RULE RESULT

Source	SS	df	MS
Model	1942.58639	3	647.528796
Residual	593.461944	48	12.3637905
Total	2536.04833	51	49.7264379

Number of obs	=	52
F(3, 48)	=	52.37
Prob > F	=	0.0000
R-squared	=	0.7660
Adj R-squared	=	0.7514
Root MSE	=	3.5162

mcu	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ce	.0016628	.0004442	3.74	0.000	.0007697	.0025559
mva	-7.46e-11	6.79e-11	-1.10	0.278	-2.11e-10	6.20e-11
z	2.194687	.8626227	2.54	0.014	.4602675	3.929106
_cons	.7539875	4.407271	0.17	0.865	-8.107424	9.615399

SECTION THREE: RESTRICTED LAG-LENGTH SELECTION TEST

3.1 AMCU (Average Manufacturing Capacity Utilization)

VAR Lag Order Selection Criteria
Endogenous variables: AMCU
Exogenous variables: C
Date: 07/25/14 Time: 21:20
Sample: 2000Q1 2012Q4
Included observations: 49

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-160.2143	NA	42.19507	6.580175	6.618783	6.594823
1	-81.39125	151.2115	1.761019	3.403724	3.480941	3.433020
2	-27.07191	101.9873	0.199828	1.227425	1.343251	1.271369
3	-5.387458	39.82858*	0.085919*	0.383162*	0.537596*	0.441754*

* indicates lag order selected by the criterion

3.2 LNCE (Log of Carbon Dioxide Emission) and LNMVA (Log of Manufacturing Value Added)

VAR Lag Order Selection Criteria
Endogenous variables: LNCE LNMVA
Exogenous variables: C
Date: 07/25/14 Time: 21:22
Sample: 2000Q1 2012Q4
Included observations: 49

Lag	LogL	LR	FPE	AIC	SC	HQ
0	34.51049	NA	0.000909	-1.326959	-1.249741	-1.297663
1	307.0939	511.7893	1.58e-08	-12.28955	-12.05790	-12.20166
2	365.6716	105.2007	1.70e-09	-14.51721	-14.13112	-14.37073
3	392.8004	46.50649*	6.64e-10*	-15.46124*	-14.92072*	-15.25617*

* indicates lag order selected by the criterion

SECTION FOUR: SERIAL CORRELATION

4.1 SERIAL CORRELATION TEST FOR THE ERROR TERM

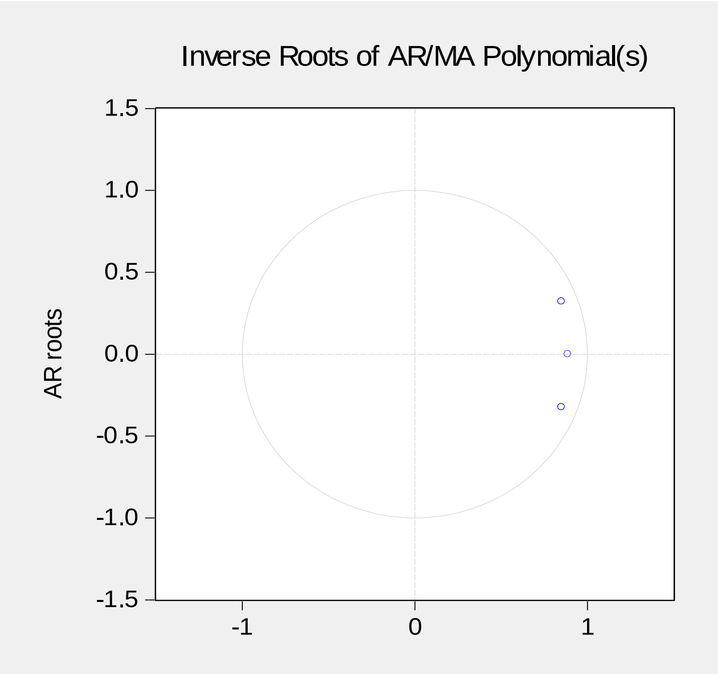
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	0.007843	Prob. F(1,32)		0.9300
Obs*R-squared	0.011761	Prob. Chi-Square(1)		0.9136
Test Equation:				
Dependent Variable: RESID				
Method: Least Squares				
Date: 07/25/14 Time: 21:25				
Sample: 2001Q1 2012Q4				
Included observations: 48				
Presample missing value lagged residuals set to zero.				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.450655	8.782153	0.051315	0.9594
D(AMCU(-1))	0.044716	0.529925	0.084382	0.9333
D(AMCU(-2))	-0.055792	0.670523	-0.083207	0.9342
D(AMCU(-3))	0.019490	0.251150	0.077604	0.9386
D(LNCE)	0.011286	3.781712	0.002984	0.9976
D(LNCE(-1))	-1.044883	14.06334	-0.074298	0.9412
D(LNCE(-2))	1.172565	15.63917	0.074976	0.9407
D(LNCE(-3))	-0.216546	5.301672	-0.040845	0.9677
D(LNMVA)	0.274105	9.095545	0.030136	0.9761
D(LNMVA(-1))	0.861970	13.44896	0.064092	0.9493
D(LNMVA(-2))	-0.698041	11.90151	-0.058651	0.9536
D(LNMVA(-3))	0.512594	9.656005	0.053086	0.9580
AMCU(-1)	0.002527	0.033624	0.075164	0.9406
LNCE(-1)	-0.114446	1.554707	-0.073613	0.9418
LNMVA(-1)	0.029670	0.384542	0.077158	0.9390
RESID(-1)	-0.052161	0.589003	-0.088558	0.9300
R-squared	0.000245	Mean dependent var		8.37E-15
Adjusted R-squared	-0.468390	S.D. dependent var		0.130167
S.E. of regression	0.157733	Akaike info criterion		-0.594627
Sum squared resid	0.796149	Schwarz criterion		0.029107
Log likelihood	30.27104	Hannan-Quinn criter.		-0.358917
F-statistic	0.000523	Durbin-Watson stat		1.973728
Prob(F-statistic)	1.000000			

4.2 LAG-LENGTH SELECTION FOR THE ERROR TERM

VAR Lag Order Selection Criteria						
Endogenous variables: U						
Exogenous variables: C						
Date: 07/25/14 Time: 21:23						
Sample: 2000Q1 2012Q4						
Included observations: 45						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	27.45835	NA*	0.018065*	-1.175927*	-1.135779*	-1.160960*
1	27.45954	0.002282	0.018886	-1.131535	-1.051239	-1.101602
2	28.63742	2.198697	0.018740	-1.139441	-1.018997	-1.094540
3	29.20119	1.027325	0.019112	-1.120053	-0.959461	-1.060186
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

SECTION FIVE: DYNAMIC STABILITY

5.1 ARMA GRAPH



SECTION SIX: BOUND TEST

6.1 WALD TEST

Wald Test:			
Equation: Untitled			
Test Statistic	Value	df	Probability
F-statistic	6.130379	(3, 33)	0.0020
Chi-square	18.39114	3	0.0004
Null Hypothesis: C(13)=C(14)=C(15)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(13)		-0.066435	0.017511
C(14)		2.831598	0.851198
C(15)		-0.776842	0.185875
Restrictions are linear in coefficients.			

SECTION SEVEN: (UN)-RESTRICTED ERROR CORRECTION MODEL (UECM)

7.1 UECM RESULT

Dependent Variable: D(AMCU)				
Method: Least Squares				
Date: 07/25/14 Time: 21:35				
Sample (adjusted): 2001Q1 2012Q4				
Included observations: 48 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-10.06374	7.049103	-1.427663	0.1628
D(AMCU(-1))	1.159310	0.158367	7.320409	0.0000
D(AMCU(-2))	-0.386335	0.226070	-1.708920	0.0969
D(AMCU(-3))	-0.011047	0.119158	-0.092709	0.9267
D(LNCE)	23.96285	3.722314	6.437624	0.0000
D(LNCE(-1))	-28.59732	7.536812	-3.794352	0.0006
D(LNCE(-2))	12.50231	8.196708	1.525285	0.1367

D(LNCE(-3))	-5.477890	4.632839	-1.182405	0.2455
D(LNMVA)	-20.65569	8.423146	-2.452254	0.0197
D(LNMVA(-1))	11.94602	9.140331	1.306957	0.2003
D(LNMVA(-2))	-17.01142	8.782052	-1.937066	0.0613
D(LNMVA(-3))	8.248557	7.611754	1.083661	0.2864
AMCU(-1)	-0.066435	0.017511	-3.793999	0.0006
LNCE(-1)	2.831598	0.851198	3.326605	0.0022
LNMVA(-1)	-0.776842	0.185875	-4.179380	0.0002
R-squared	0.990687	Mean dependent var		0.137500
Adjusted R-squared	0.986737	S.D. dependent var		1.348857
S.E. of regression	0.155344	Akaike info criterion		-0.636048
Sum squared resid	0.796344	Schwarz criterion		-0.051298
Log likelihood	30.26516	Hannan-Quinn criter.		-0.415070
F-statistic	250.7562	Durbin-Watson stat		1.987337
Prob(F-statistic)	0.000000			

7.2 RESTRICTED ERROR CORRECTION MODEL (RECM) RESULT

Dependent Variable: D(AMCU)				
Method: Least Squares				
Date: 07/25/14 Time: 21:36				
Sample (adjusted): 2001Q2 2012Q4				
Included observations: 47 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.155336	0.167361	-0.928149	0.3599
D(AMCU(-1))	1.925534	0.232718	8.274101	0.0000
D(AMCU(-2))	-1.181374	0.362752	-3.256698	0.0026
D(AMCU(-3))	0.203029	0.165783	1.224665	0.2291
D(LNCE)	28.38582	3.765492	7.538408	0.0000
D(LNCE(-1))	-52.68647	8.019545	-6.569758	0.0000
D(LNCE(-2))	30.48106	10.39313	2.932809	0.0060
D(LNCE(-3))	-4.587975	5.076931	-0.903691	0.3725
D(LNMVA)	-9.683450	7.913869	-1.223605	0.2295
D(LNMVA(-1))	20.75193	9.886453	2.099027	0.0433
D(LNMVA(-2))	-20.92978	10.37557	-2.017218	0.0516
D(LNMVA(-3))	16.74635	7.445188	2.249285	0.0311
ECM(-1)	-0.862640	0.283414	-3.043743	0.0045
R-squared	0.990788	Mean dependent var		0.121277
Adjusted R-squared	0.987537	S.D. dependent var		1.358698
S.E. of regression	0.151682	Akaike info criterion		-0.704656
Sum squared resid	0.782253	Schwarz criterion		-0.192913
Log likelihood	29.55942	Hannan-Quinn criter.		-0.512084
F-statistic	304.7437	Durbin-Watson stat		2.003292
Prob(F-statistic)	0.000000			