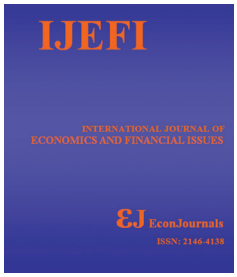

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The Determinants of Economic Growth: An Empirical Investigation of North Carolina

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ABSTRACT

This paper examines the determinants of economic growth in North Carolina using autoregressive distributed lag (ARDL) model approach, co-integration, and bounds tests. The state's gross domestic product, gross investment, labor force, literacy rate, and foreign direct investments data were estimated. The bounds test revealed that all of the variables in the models are co-integrated, meaning that they have long-run relationships with economic growth of the state. The estimated coefficients are statistically significant at 5% level, and have the expected positive signs. Gross investment, labor force, literacy rate and foreign direct investments variables are strong determinants of economic growth in the state of North Carolina. The implications from the study are that government policies encouraging increased gross investment spending, lowering unemployment rate of the labor force, encouraging inflow of foreign direct investments, and increasing investments in human capital should be strongly pursued by the state policy makers.

Keywords: North Carolina, Cointegration, Autoregressive Distributed Lag Modeling, Economic Growth
JEL Classifications: E21, C23, C52

1. INTRODUCTION

North Carolina is a state in southeastern region of the United States. Like other states in the United States, North Carolina was adversely affected by the 2007 recession that resulted in high unemployment rate, housing market collapse, manufacturing sector collapse, increase in consumer bankruptcies, huge budget deficits, banking sector distress, etc. Following the 2007 recession, the economy of North Carolina has transitioned from reliance on tobacco, textiles and furniture-making to a more diversified type. Construction and Engineering, pharmaceuticals, energy, biotechnology, food processing, vehicle parts, tourism, accommodation and food services, health care and finance sectors are strongly gaining grounds, and hoping to sustain the economy.

According to Policy, Research, and Strategic Planning Division of the North Carolina Department of Commerce (2011), North Carolina is transitioning from traditional labor intensive industries (textiles, furniture) to knowledge-based or service related industries. During the recession period, manufacturing, construction and trade, transportation and utilities lost 99,300, 85,900 and 60,300 jobs respectively between December 2007 and January 2011. Between 2010 and 2011, Education and Health services lost 11,100 jobs while Government lost 31,500. In 2009, the state's economy started to turn around. Real gross domestic product (GDP) of the state grew faster than that of the nation. Further reviews revealed that the government was the leading contributor of this growth followed by finance and insurance, real estate (rental and leasing), and non-durable goods manufacturing. By 2011, 4 largest industries accounted for more than 55% of employment in the state. These largest industries or employers are: Government, Health Care and Social Assistance, Retail trade, and Manufacturing. Also, the top 5 North Carolina occupations in terms of employment are: Office and Administrative supports, Sales, Food preparations and servings, Production, Transportation and materials moving.

Economists have performed substantive studies across countries trying to explore and explain economic growth and its determinants. They have used both theory and empirical

methodologies incorporating time series and cross-sectional data in some instances to explain the cause of economic growth. The research findings varied from study to study, and from country to country. Economic researchers such as Robert (1956), Swann (1956), and Romer (1986) have provided theoretical frameworks on which most previous studies are based. Following their work, others such as Meltzer (1995) and Barro and Xavier (1995) have conducted extensive empirical work to test established hypotheses relating to economic growth. Another empirical work by Barro (1996) also used health status measured by life expectancy in trying to gauge the path of economic growth.

The state of North Carolina is once again thriving and rebounding from the 2007 recession. However, it is still important to empirically ascertain the permanent factors that are responsible for the recent economic growth that is being experienced. In addition, it is hoped that the study's findings will help policy makers to understand that capital accumulation by itself cannot explain sustained economic growth. This statement is based on the fact that the process underlying economic performance and growth path of any economy is poorly understood, and the foundation of this misunderstanding can be partly attributed to mixed economic research findings, and lack of knowledge about the structural dynamics of the distinct economies and other contributing factors. This study will focus on the state of North Carolina, and it will employ to certain extent the empirical models of economic growth proposed by Robert (1956) and Barro (1996). It will also include relevant economic growth variables obtained from various economic literature reviews. While numerous studies have focused their attentions on country's economic growth, few have paid attention to individual state economies. Certainly, there have been minimal empirical studies that specifically looked into factors that determine growth in a specific state like North Carolina. Secondly, since economic growth process is a very dynamic one, it is obvious that studies that are based on cases hundreds of years ago might not be as relevant now. The technological changes in the last few decades have revolutionized the way nations as well as states enhance their economic growth. This study will certainly help to shade more light on the economic recovery path and strategies being followed by the state of North Carolina. The study will also bring forth policy implications that will be beneficial to the state policy makers.

The remainder of the paper is organized as follows. Section 2 will discuss the literature reviews. Section 3 will discuss the data and methodology of study. Section 4 will discuss the empirical results and findings. Section 5 finalizes the study by summarizing findings and results, stating policy implications, and providing suggestions for further studies relating to this topic.

2. LITERATURE REVIEW

Economic growth has been defined in different terms and estimated using various frameworks. At the basic descriptive level, economic growth is an increase in real national income or real national output. Based on the neoclassical framework, Robert (1956) estimated the economic growth path for the U.S. economy from 1909 to 1949. He found that 80% of growth in output per labor hours over those periods was due to technical progress. Robert (1957) further stated that the important determinants of GDP growth are technical progress, increases in labor supply, and capital accumulation, in that order. He also said that increase in population increases GDP, but actually decreases GDP per capita. He explained that each 1.0 percentage point of labor force growth leads to a 0.75% point increase in output. There is no 1-to-1 percentage point ratio between these relationships. The reason is that if you increase the number of workers without proportionately increasing the number of machines, there will be diminishing marginal returns. The average worker will be less productive due to availability of less equipment or machines to work with.

Knight et al. (1993) looked into economic growth path and processes. Their study showed that exogenous technological improvements which are absorbed domestically through imports of capital goods, the degree of economy's openness, and the level of fixed capital investments undertaken by the government are all important factors when the growth of an economy is totally considered. They further emphasized that the neoclassical models also relied on the premise that total output of any economy depended on the quality and the average skill levels of their labor force. That once an economy reaches the full employment level, additional growth in the stock of capital per worker will only occur if productivity increases. This increase can either occur through enhanced capital stock accumulation or through improvements in the labor force quality.

According to Barro (1999), economic growth or output grows through increases in resources (inputs) and through increases in productivity. This increase in productivity is also associated with changes in improved technology and more able workforce. Through his growth accounting theory, Barro reviewed economic growths in sections, examining changes in factor inputs and the Robert residuals. He looked at Robert residual, also known as technical progress, in the context of endogenously changing levels of technology. Barro also mentioned that capital and labor can be disaggregated among types and qualities. Education could be disaggregated as highly educated labor force compared to low educated labor force. Capital can also be divided as long-lived such as building and short-lived such as machines. Overall, growth rate of output can also be disassociated between factor accumulation and technological progress. The intercept term from the regression can be used to measure Robert residuals. This residual is typically viewed as a measure of technological progress, and can be associated with R&D outlays, public policies, software applications, internet, and other technological factors.

Dewan and Hussein (2001) in their panel study started by saying that to achieve and maintain high economic growth, policy makers need to understand the determinants of growth, as well as how policies affect growth. Their study combined cross-sectional and time series data, and used a sample of 41 middle-income developing countries including Fiji to develop an empirical model of growth. Their study focused on explaining determinants for sustained economic growth. They stated that a strong macroeconomic policy framework is conducive to economic growth. Countries with strong macroeconomic fundamentals tend to grow faster

than those without them. Their paper also suggested that growth in labor force, investment in both physical and human capitals as well as low inflation and open trade policies are necessary for the growth of any economy. This also involves trade liberalization, and the ability to incorporate technological progress in order to increase efficiency.

Barro (2013) study looking at the relationship between health and economic growth acknowledged that economic growth as a topic has experienced a boom recently. He stated that this experience started with the work of Romer in 1986 and others, and they termed their work as new endogenous growth theories. Their studies focused on productivity advances which relied on technological progress and increased infusion of human capital from the point of education as the driving forces of economic growth. Other studies using the new endogenous approach included allowance for open economies, migration of persons, fertility choices and variable labor supply. They also included the roles of governments because they can maintain property rights, encourage free markets, taxation, education and public infrastructures. They also maintained that convergence property will still depend on the structure of the economy. Barro (2013) stated that if all economies are the same in terms of structure, except for their starting capital intensities, convergence is expected to happen. Poor countries would tend to grow faster than rich countries. However, if economies differ in various regards such as poor governmental policies, then the convergence force will only apply in a conditional term. The growth rate tends to be high if the starting per capita GDP is low compared to its intended long-run path. This idea stems from the fact that economies that have less capital per worker relative to their long-run capital per worker tend to have higher rates of return and higher growth rates.

Rudiger et al. (2014) stated that the level of labor and capital inputs contribute amounts equal to their individual growth rates multiplied by their share of that input in income. Also, the rate of improvement of technology, sometimes called technical progress or growth of total factor productivity, is very essential in economic growth. With available technological progress, more inputs mean more outputs, and marginal products of labor and capital are both positive in relationship to economic growth rates. It is also important to note that labor productivity certainly increases as a result of capital per worker and technological progress. Consequently, capital accumulation certainly comes from the level of savings rate in the economy. Overall though, capital accumulation alone does not foster nor sustain economic growth of a nation.

3. THEORETICAL BACKGROUND AND FRAMEWORK

The theoretical foundation of this study takes from the neoclassical works of Robert (1956) and Swan (1956). They both tried to show the routes through which macroeconomic variables impact economic growth. To reiterate, economic growth is the expansion of the productive capacity, output, income levels, and the standard of living of a nation's citizens. Productive capacity includes all resource factors essential in the expansion of economic growth in the economy. They aid in the production of goods and services that are demanded by the society. Robert (1956) model tried to differentiate between economic fluctuations resulting from business cycles and the long-run economic growth path or trend of the economy. Robert started with a Cobb-Douglas production function of this form:

$$Y=AF(K, L) \quad (1)$$

Equation (1) relates the level of output (Y) to the level of inputs; where K represents Capital, L represents Labor, and A represents technological progress or productivity. Also, the marginal products of both capital and labor are positive. Hence, MPK > 0, and MPL > 0. Equation (1) can also be expressed in terms of growth rate as follows:

$$\Delta Y/Y=\Delta K/K+\Delta L/L+\Delta A/A \quad (2)$$

This equation shows the relationship between the growth rate of an economy's output and the growth rates of the factor inputs of capital and labor including technology. The equation illustrates how output depends on labor growth, capital growth, and technical progress. This is sometimes referred to as total factor product. Technological progress comes from technology, and it is assumed to be exogenous in that they are given and not determined by the changes in capital and labor. Better technology certainly enhances the productive abilities of the existing capital. Consequently, as capital productive efficiency improves, labor productivity grows as well. Even though there is a debate as to whether both capital and technology are completely independent of one another, it is still feasible to argue that an increase in human capital will lead to improvement and increases in technology. Based on Robert's analysis, capital accumulation also stems from savings (s) in the economy minus depreciation (δ) of existing capital stock.

$$\Delta K=sY-\delta K=sF(K, L)-\delta K \quad (3)$$

It is therefore believed that savings is a function of income and is used for investment. Part of savings is also used to replace used up capital stock denoted as depreciation. Hence, change in capital stock (positive net investment) must equal to total savings minus the savings used for depreciation. Not only is savings crucial when discussing economic growth, population growth is also vital. When population grows, there is an increase in supply of labor, and output can be measured in per capita terms as y = Y/L and capital per worker will now be expressed as k = K/L. Incorporating both per capita terms in the capital stock growth equation (3) results to the following equation:

$$\Delta K=sY-(n+\delta)K \quad (4)$$

In Equation (4), n represents the change in labor force. And when technological progress is factored into the equation, the equation (4) becomes:

$$\Delta K=sY-(n+\delta+a)K \quad (5)$$

In Equation (5), letter (a) represents the component of savings that must be invested into technology, or be looked as the contribution of technology in the economic growth process. Therefore, net investment will only be positive or increase in capital stock will only be possible when total savings in the system can replace depreciated capital, maintain a constant capital labor ratio for new workers and keep up with expenditures geared towards technological advancements.

4. DATA AND METHODOLOGY

North Carolina economic annual data from 1995 to 2015 were used in the study. Gross state product data were collected from the U.S. Bureau of Economic Analysis and Department of Numbers. State gross investment data were collected from the North Carolina Office of State Controller, Comprehensive Annual Financial Report. Literacy rate data were collected from U.S. Census Bureau and Education North Carolina Insight. Labor force data were from the U.S. Labor and Statistics while Foreign Direct Investment data came from the U.S Department of Commerce, International Trade Administration, U.S. Bureau of Economic Analysis, and Business Roundtable Organization.

Based on the theoretical background from Robert and others, let's consider the following Cobb-Douglas production function as the foundation model for this study.

$$Y_t=AtF(K_t, LF_t, LR_t, F_t,) \quad (6)$$

From Equation (1), variables K, LF, LR, F are Physical capital, Labor force, Human capital (literacy rate), and Foreign direct investments respectively. A_t is the technological progress which also embodies the quality of government management and level of policies. LR_t on the other hand, represents literacy rate.

Since the study is concentrating on the growth rate of the state of North Carolina's economy, Equation (6) will be expressed as:

$$\Delta Y/Y=\Delta A/A+\Delta K/K+\Delta L/L+\Delta LR/LR+\Delta F/F \quad (7)$$

However, for any unbiased research study involving time-series data, it is necessary to ascertain the long-run properties of these variables. The theory and empirical interests in cointegration proposed by Granger (1981) and developed by Engle and Granger (1987) allow researchers to seriously consider two contradictory facts. One of them is the contradiction of whether typical time series economic data possess unit roots or have stochastic trends. Another is that economic theory often suggests the existence of equilibrium or long-run relationships between variables. Also, certain economic or financial time series data should be correlated or have a long-run relationship, I(0). However, that is not always the case because some I(1) variables can be linearly combined to generate a stationary process, I(0). If this happens, the I(1) variables are said to be co-integrated. They may diverge substantially from the equilibrium in the short run, but converge in the long-run. Whatever may be the case, it becomes necessary to determine if the variables have these long-run relationships, (co-integrated and stationary). According to Wooldridge (2000), the notion of cointegration was given a formal treatment in Engle and Granger (1987). Cointegration therefore makes regressions involving I(1) variables potentially meaningful. Murthy and Okunade (2016) also emphasized that in conducting a cointegration analysis, it is important to determine whether the data series in their levels are stationary or non-stationary. It is also important to ascertain the order of the series co-integration I(d). In other words, a process is integrated to order d if taking repeated difference d times yield a stationary process. Therefore, the letter d stands for the order of integration and reports the minimum number of differences required to obtain a covariance stationary series. Hence, that order could be I(0), I(1), or beyond. Studies have shown that I(1) processes should not be regressed against another I(1) process because they tend to diverge as time (T) approaches infinity. Their unconditional variances are proportional to time (T). Secondly, I(1) variables never seem to establish a long-run equilibrium. There are numerous stationarity or co-integration tests which can be applied. In this study, the augmented dicky fuller (ADF) unit root tests are applied to assess stationarity. The ADF test requires that the following conditions or properties exist:

$$X_t=\alpha+\rho X_{t-1}+u_t \quad (8)$$

Where rho, ρ=1, indicating non-stationary variables. Subtracting X_{t-1} from both sides of the equation will yield this result:

$$X_t-X_{t-1}=\alpha+(\rho_{-1})X_{t-1}+u_t \quad (9)$$

However, if ρ<1, then equation (9) will become the following:

$$\Delta X_t=\alpha+\theta X_{t-1}+u_t \quad (10)$$

where $\theta=(\rho_{-1})$. As long as ρ<1, t-statistics can be used under ADF for unit root test to ascertain stationarity of the variables. The lag length of K in the ADF testing is determined using the Akaike and Schwarz criteria.

Once these conditions are met, Equation (11) can be estimated without biased results.

$$\begin{aligned}\Delta EG = \; & 0+\sum_{i=0}^{n=4} ai1\Delta EGt-1+\sum_{i=0}^{n=4} ai2\Delta Kt-1+\\ & \sum_{i=0}^{n=4} ai3\Delta LFt-1+\sum_{i=0}^{n=4} ai4\Delta LRt-1+\\ & \sum ai5\Delta FDIt-1+\beta 1EGt-1+\beta 2Kt-1+\\ & \beta 3LFt-1+\beta 4LRt-1+\beta 5FDIt-1+Ut\end{aligned} \quad (11)$$

Estimating non-stationary equations or models normally result to spurious results. Spurious regressions normally suggest that long-run relationships exist between the variables of study while in reality, there are none. It is therefore very necessary that stationarity among the variables be established before a reliable estimation can be performed.

Table 1 shows summary statistics of the variables used in the study. The state of North Carolina's Economic growth represented by State Domestic Product ranged from $295.95billion to $442.49

billion with a high standard deviation of $47.06 billion. Gross investment ranged from $36.99 billion to $52.75 billion with a standard deviation of $5.55 billion. Labor force ranged from 3.83 to 4.85 million with the least standard deviation of 0.30. Literacy rate in the state ranged from 78% to 94.12%, also with a low standard deviation value of 3.34%. The state attracts significant Foreign Direct Investments ranging from $20billion to $250 billion with the highest standard deviation value of $58.68 billion. Regressing non-stationary time series variables without unit root tests certainly will lead to spurious results, and falsely overstates or understates the estimated coefficients.

5. EMPIRICAL RESULTS

Economic theories often suggest that certain economic or financial time series data should be correlated or have long-run relationships. However, that is not always the case. It is also discouraged to regress I(1) process against another I(1) process because they are non-stationary variables. Non-stationary means they exhibit unit root problems, and the variables tend to change or diverge as time (T) approaches infinity. Their unconditional variances become proportional to T, making it impossible to establish a long-run equilibrium. However, autoregressive distributed lagged (ARDL) approach can still be used to estimate the model. One advantage of using ARDL approach is that it does not require the pre-testing of the orders of integration. However, in this very study, the proposed variables were tested for unit roots using Dicky-Fuller GLS test statistics. Perron and Nagel (2001) emphasized that appropriate selection of lag length and thorough construction of unit root tests are essential for valid empirical estimations. This study utilized Akaike and Schwarz information criteria, for the lag selection. Optimal lag lengths and relevant estimation models were determined, and the variables were also determined to be stationary, I(0). In applying this test, the null hypothesis statement is that each variable in the model has a unit root, rho equal to 1. The alternative is that they do not have unit roots. Decision is made to reject the null hypothesis of unit root if any of the estimated t-statistics value is greater than the critical t-statistics at each significance level. When estimated at levels using ordinary least square approach, (OLS), all of the variables were not significant, and did not have the correct signs based on economic theories.

Results from Table 2 show gross investment and labor force have the correct positive signs and significant at the 5% level. However, literacy rate and foreign direct investment have the correct signs, but are insignificant even at the 5% significance level. Furthermore, the R^2 was extremely high at 97%, and the Durbin Watson statistics was 1.617. These results are spurious and indicate serious multicollinearity problem. In essence, the model has unit root problems, and the variables are not stationary. Differencing is required, and the lag length must be determined for better model estimations. By using differencing, the Akaike and Schwarz criteria, all the variables included in the model became stationary and significant at various significance levels.

The results from Table 3 show that the variables are all stationary and significant at 1% or 5% level, as designated by the asterisks.

Table 1: Summary statistics of variables in the model

Variables	EG	IG	LF	LR	FDI
Mean	374.21	46.28	4.38	87.90	86.10
Median	384.12	46.16	4.52	88.10	68.00
Minimum	295.95	36.99	3.83	78.01	20.00
Maximum	442.49	52.76	4.85	94.12	250.00
Std. deviation	47.06	5.55	0.30	3.34	58.68

Note: EG: Economic growth (State domestic product) is $Billions, IG: Gross Investment $Billions, LF: Labor force in millions, LR: Literacy rate is %, FDI: Foreign Direct Investment is $Billions. Sources: EG (State gross product) obtained from U.S. Bureau of Economic Analysis (BEA), and Dept. of Numbers; Gross Investment from NC Office of the State Controller Comprehensive Annual Financial Reports, Fiscal Year Ending June 30, 2015; Labor force, U.S Bureau of labor and Statistics; Literacy rate from U.S. Census Bureau, Education North Carolina Insight, and NC literacy Association; and FDI obtained from U.S Dept. of Commerce, U.S. Bureau of Economic Analysis, and Business Round Table Organization

Table 2: Estimations without unit root tests

Variables	Coeff.	Std. Error	t-statistics	P value	R^2
IG	2.951170	0.973301	3.03213	0.008404	0.3800
LF	75.078400	23.089900	3.25157	0.005365	0.4134
LR	1.577490	0.961799	1.64015	0.121772	0.1520
FDI	0.100909	0.068399	1.47530	0.160812	0.1267
Constant	−238.569000	95.272200	−2.50407	0.024309	0.2947

R^2=0.97; Adj. R^2=0.9676; F (4/15)=142.73; P=0.000009; D.W.=1.61702

Table 3: Elliott-Rothenberg-stock ADF-GLS unit

Root test statistics	Test critical values
Test statistics	
1%	−3.770000
5%	−3.190000
10%	−2.890000
Variable series	Estimated t-statistics
EG	−3.191495**
ΔEG	−3.421612**
LF	−3.790388*
ΔLF	−8.694572*
LR	−3.846311*
ΔLR	−4.134917*
IG	−3.326522**
ΔIG	−4.325134*
FDI	−4.134917*
ΔFDI	−3.845333*

Symbols *,**, and *** denote significant levels at 1%, 5%, and 10% respectively.
ADF: Augmented dicky fuller,

Table 4: ARDL Bounds tests: Long-run relationships between variables

Test statistics	Value	K
F-statistics	4.692`426	4
Critical value bounds		
Significance	I0	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

ARDL: Autoregressive distributed lag

As the results from Table 3 further indicate, the series used in this study are of order one, I(1). ARDL bounds tests can be applied to confirm the existence of stationarity and co-integration of the variables in the model. Co-integration test normally answers the question of whether a long–run relationship exists between

two or more non-stationary or I(1) variables. In that context, it is possible for two or more variables to be I(1), and a certain linear combination of those variables will be I(0). In essence, a linear combination of these variables will become integrated of order zero. Those variables that are combined are said to be co-integrated, and will have long-run relationships amongst each other. The direction of the relationships will however be uncertain until the model is regressed. According to Pindyck and Rubinfeld (1998), it is also important to know the direction of the relationships and sense of causations. However, what is crucial for co-integration is that the series share a common stochastic trend (error terms), and that they are at least integrated of order 1. The variables must obey an equilibrium relationship in the long-run; although, they may diverge substantially from that equilibrium in the short run. Contrary to these statements, Molana (1991) found that consumption and income do not have a long-run relationship either. Lee et al. (2006) still insist that researchers must confirm whether their variables are stationary around deterministic trends or stochastic trends. The most well known test, suggested by Engle and Granger (1987) (sometimes known as the EG test) is to run a static regression (after first having verified that Y_t and X_t both are I(1)), and $Y_t = \theta X_t + e_t$, where x_t is one- or higher-dimensional). Also, Dickey and Fuller (1981), Perron (1988) and Perron and Hansen (1990) also applied various unit root tests to economic variables. Consequently, there is a general consensus that if two or more series are individually integrated in the time series sense but some linear combination of them has a lower order of integration, then the series are said to be co-integrated. As an illustration, suppose X_{1t} and X_{2t} variables co-integrate, then the deviation $U_t=X_{1t}-\mu-\beta_2X_{2t}$ is a stationary process with mean equal to zero. Shocks to X_{1t} and X_{2t} have permanent effects. However, X_{1t} and X_{2t} co-vary, and error terms become stationary (U_t~I(0)).

From the Wald bound test, the results from Table 4 show an F-statistics of 4.692426. The obtained F-statistics is really significant at even the 2.5% Pesaran et al. (2001) critical bounds values, but not at the 1% values. The rule for the statistical decision is that we reject the null hypothesis of no co-integration if estimated F-statistics value is lower than the upper critical bound value for any of the significant levels.

To further confirm Table 4 results, each variable in the model was regressed as a dependent variable against the rest of the other variables one at a time. The results are tabulated in Table 5. Each coefficient was significant, and has the right sign as expected. Furthermore, the coefficients also show the short-run relationships between the variables in the model. A 1% increase in foreign direct investment has a 0.23% short-run positive effect on the state's regional gross product. Also a 1% increase in labor force has a 0.28% short-run positive effect on the gross regional product. A 1% increase in literacy rate has 0.30% short-run positive effect on the state's economic growth. The results from Table 5 also suggest that although the variables may deviate a little bit from the long-run equilibrium, their speed of adjustment to that long-run equilibrium from the short-run is very high at 83.57% speed.

Table 5: ARDL: Co-integration and Short-run error correction model

Variables	Coefficients	Std. Error	t-statistics	Prob.
Δ(FDI)	0.023796	0.007338	3.242845	0.0032
Δ(LF)	0.287965	0.129735	2.219647	0.0448
Δ(LLR)	0.305803	0.125973	2.427512	0.0312
Δ(IG)	0.208424	0.035793	5.823038	0.0001
C	−231.554188	71.402870	−3.242926	0.0064
CointEq(−1)	−0.835763	0.259965	−3.214901	0.0068

ARDL: Autoregressive distributed lag

Table 6: ARDL: Co-integration and long-run coefficients results

Variables	Coefficients	Std. error	t-statistics	Prob.
FDI	0.103139	0.083071	1.241584	0.0236
LF	0.322697	0.139178	2.318592	0.0373
LLR	0.351222	0.083998	4.181283	0.0481
IG	0.249347	0.082910	3.007441	0.0101
CointEq: RGP=(−231.5541+0.1031*FDI+0.3226*LF+0.3512*LR+0.2493*IG)				

ARDL: Autoregressive distributed lag

Table 7: Serial correlation and heteroskedasticity tests

Breusch-Godfrey serial correlation LM test	
F-statistic: 3.455661	Prob. F(2,11): 0.6455
Obs*R^2: 1.453668	Prob. Chi-square(2): 0.4834
Heteroskedasticity Test: Breusch-Pagan-Godfrey	
F-statistic: 2.384751	Prob. F(5,13): 0.8505
Obs*R^2: 2.449208	Prob. Chi-Square(5): 0.7841
Scaled explained SS: 4.067233	Prob. Chi-Square(5): 0.5398

In order to ascertain the existence of long-run relationships between all the variables in the model, differencing of each independent variable was established, and the intent is to test for long–run co-integration. These short-run coefficients denoted contributions made by each of these variables in North Carolina's state gross product or economic growth. The coefficients have the right signs, and are significant at the 5% significance level.

The results from Table 6 show co-integration and long-run coefficients at levels. The constant term is negative, and all of the independent variables have inelastic coefficients since their values are <1. Although their values are <1, they are still very important variables. They are positively contributing to the economic growth of the State of North Carolina. The results further indicate that in the long-run, a percentage increase in foreign direct investment will result in a 0.10% contribution to economic growth in the long-run, a 1% increase in labor force results in a 0.32% increase in economic growth, 1% increase in literacy rate results in a 0.35% increase, and a 1% increase in gross investment spending will result in 0.24% percentage increase in economic growth.

Other analyses that were performed are the Breusch-Godfrey serial correlation LM and heteroskedasticity tests. Serial correlation test is performed to see if the disturbance terms in the model are auto-correlated. According to Gujarati (1988), the disturbance term Ut is a surrogate for all those variables that are omitted from

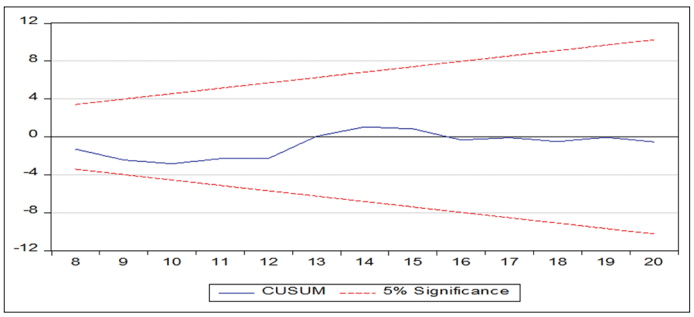
the model, but collectively affect the dependent variable. Gujarati (2003) based on classical assumptions stressed that researchers must confirm that the stochastic (disturbance) term is normally distributed. The question being addressed or answered here is whether a disturbance emerging from or relating to an observation in the model is influenced by the disturbance term from another observation also in the model. When $E(UiUj) = 0$, where E is the expected value (or mean) and $i \neq j$, then there is no autocorrelation. However, if $E(UiUj) \neq 0$, then autocorrelation exists. In making autocorrelation or serial correlation decision, null hypothesis will state that H_0: $p = 0$, meaning that the error terms are not serially correlated. Alternative hypothesis: H_i: $p \neq 0$. Also, given a selected significance level of say 0.05, if calculated p-value is less than 0.05, we will reject the null hypothesis and accept the alternative. From Table 7 top, the Breusch-Godfrey serial correlation test result shows the obs*R^2. This indicates the LM test statistics for the null hypothesis of no serial correlation. A low probability value of <0.05 associated with that obs*squared value will indicate the presence of serial correlation in the residuals. The result shows all P > 0.4834 which is much higher than 0.05. Clearly, the results show no serial correlations in the residuals.

Also, the lower part of Table 7 shows results associated with heteroskedasticity test. This test actually checks to see if the disturbances, U_t, in the model are homoscedastic. Statistically, homo means equal and scedasticity means equal spread or variance. In essence, the test checks to see if the variances of the disturbances are of the same values. $E(U_i^2) = \sigma_i^2$; where i = 1, 2, 3, ~ N; indicating having equal variances. The observed R^2 value is 2.4492 with a Chi-square probability value of 0.7841. This value is actually higher than the critical or selected P value of 0.05; hence, the disturbance variances are homoscedastic.

Econometrically, estimating a wrong model creates spurious results. A model must be well specified, and the ARDL application must be accurate with appropriate lag lengths for the estimated coefficients to be reliable. To ascertain the reliability of the short-run and long-run coefficients, cumulative sum (CUSUM) and CUSM square tests are performed. According to Figures 1 and 2, the model is reliable. The projected or estimated plots from the model are within the critical boundaries of 5% level. Consequently, the estimated coefficients show parameter stability and reliability. The economic growth forecast or plot lies within the critical boundaries, with only a plus or minus 2 standard error points.

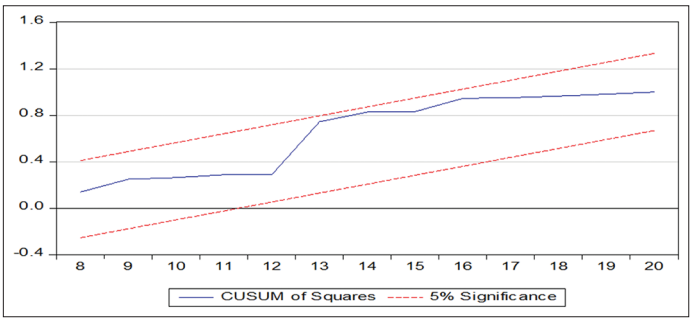
5.1. Reliability Test

Figure 1: Cumulative sum test of recursive residuals



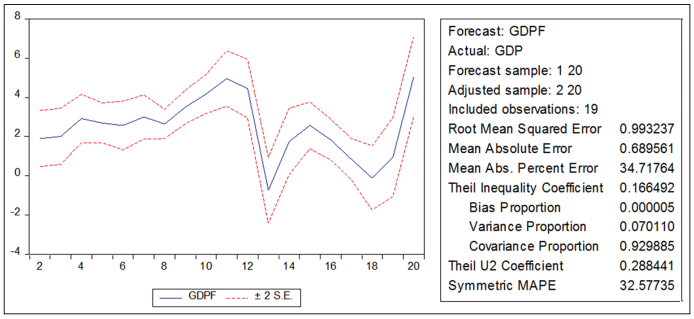
5.2. Stability Test

Figure 2: Cumulative sum square stability test of rescursive residuals



5.3. Regional Gross Product (Economic Growth) Forecast Path (Figure 3)

Figure 3: Regional gross product (economic growth) forecast path



6. CONCLUSION AND POLICY IMPLICATIONS

North Carolina is a state in southeastern region of the United States. Like other states in the United States, North Carolina was adversely affected by the 2007 recession that resulted in high unemployment rate, housing market collapse, manufacturing sector collapse, increase in consumer bankruptcies, huge budget deficits, banking sector distress, etc. Following the 2007 recession, the economy of North Carolina has transitioned from reliance on tobacco, textiles, and furniture-making to a more diversified type. According to Policy, Research and Strategic Planning Division of the North Carolina Department of Commerce (2011), North Carolina is transitioning from traditional labor intensive industries (textiles, furniture) to knowledge-based or service related industries. By 2009, the state's economy started to turn around. Real GDP of the state grew faster than that of the nation. Further reviews revealed that the North Carolina government was the leading contributor of this growth followed by finance and insurance sector.

In addition to the roles played by the government of North Carolina and other industries to stimulate economic growth, what other factors have consistently determined economic growth in that state? Economists have performed substantive studies trying to explore and explain economic growth and its determinants. Following the works of Robert (1956), Swann (1956), Barro (1996) and a host of others, this study used ARDL approach to determine if state's gross investment, labor force, literacy rate, and inflow foreign direct investments have significantly contributed to economic growth in the state of North Carolina.

The empirical results from the estimations relating to the short-run effects of these independent variables on economic growth of North Carolina are tabulated in Table 5. Each coefficient was significant, and has the right theoretical sign as expected. Furthermore, the coefficients also show that the variables are co-integrated, and have long-run relationships with the economic growth of the state. Foreign direct investment has a 0.23% short-run relationship with regional gross product, Labor force, literacy rate and gross private investment. Also a 1% increase in foreign direct investment in the state of North Carolina will result in a 0.23% increase in economic growth in the state. Labor force has 0.28% short-run relationship with the rest of the variables in the model and will impact the state's economic growth at that rate as well. The results from Table 5 also suggest that although the variables may deviate a little bit from the long-run equilibrium, their speed of adjustment to that long-run equilibrium is very high at 83.57%.

In order to ascertain the long-run relationships between all of the variables in the model, a long-run co-integration analysis is performed. The results are tabulated in Table 6. The coefficients, each denoting the elasticity of North Carolina economic growth with respect to each independent variable, have the right theoretical signs. In addition, they are significant at 5% significance level. Although we have a negative constant term, the results show that all of the independent variables have inelastic coefficients, since their values are <1. However, they are very important and necessary variables that positively contribute to the economic growth of the state of North Carolina. It can also be stated that a 1% increase in foreign direct investment will result in a 0.10% positive contribution to economic growth in the long-run, a 1% increase in labor force results in a 0.32% increase in economic growth, 1% increase in literacy rate results in a 0.35% increase, and a 1% increase in gross investment spending will result in 0.24% percentage increase in economic growth.

In Table 7 top, the Breusch-Godfrey serial correlation test result shows the obs*R^2. This result indicates the LM test statistics for the null hypothesis of no serial correlation. A low probability value of <0.05 associated with that result will indicate the presence of serial correlation in the residuals. The result shows a P value of 0.4834 which is much higher than 0.05. Clearly, the result shows no serial correlations in the residuals. Also, the lower part of Table 7 shows results associated with the heteroskedasticity test. This test actually checks to see if the disturbances, U_t, in the model are homoscedastic. Statistically, homo means equal and scedasticity means equal spread or variance. In essence, the test checks to see if the variances of the disturbances are of the same values. $E(U_i^2) = \sigma_i^2$; where i = 1, 2, 3, ~ N; indicating having equal variances. The observed R-squared value is 2.4492 with a Chi-square probability value of 0.7841. This value is actually higher than the critical or selected P value of 0.05. Hence, the result from the Table 7 shows that the disturbance variances are homoscedastic.

The policy implications are numerous. Increased spending on state's gross investment is essential and very necessary. There is a positive long-run relationship between increased spending on state's gross investment and economic growth. The state must continue to pay attention to increased investment spending which generally results from aggregate savings in the state. Another important variable is labor force. As labor force number or rate increases, economic growth in the state increases, provided the labor force is considerably or fully employed. Efforts must be exerted to encourage full employment of the labor force. Theoretically, there is a negative relationship between high unemployment of the labor force and potential output level attainment. Literacy rate growth is also very essential. The state must continue to encourage human capital growth. This can take many forms including fostering education and other strategies to improve human capital. As analyzed in Tables 5 and 6, increased literacy growth has positive long-run relationship with economic growth in the state of North Carolina. Another essential variable is foreign direct investment. Although this study looked at the inflow foreign direct investments, the state is encouraged to allow both inflow and outflow FDI. Foreign direct investments create jobs, employment opportunities, and allow for financial capital inflows into the state. Foreign direct investment will also help the export markets for the state.

REFERENCES

Akaike, H. (1973), Information Theory and an Extension of the Maximum Likelihood Principle, in 2nd International Symposium on Information Theory. In: Petrov, B.N., Craki, F.,editors. Budapest: Akademiai Kiado.

Barro, R.J. (1996), Determinants of Economic Growth: A Cross-Country Empirical Study, NBER Working Papers, No. 5698.

Barro, R.J. (1999), Notes on growth accounting. Journal of Economic Growth, 4(2), 119-137.

Barro, R.J. (2013), Health and economic growth. Annals of Economics and Finance, 14-2(A), 305-342.

Barro, R.J., Xavier, S.M. (1995), Economic Growth. New York: McGraw-Hill.

Dewan, E., Hussein, S. (2001), Determinants of Economic Growth, Economics Department, Reserve. Suva, Fiji: Bank of Fiji.

Dickey, D., Fuller, W. (1981), The likelihood ratio statistics for autoregressive time series with a unit root. Econometrica, 49(1), 1057-1072.

Dornbusch, R., Fischer, S., Startz, R. (2014), Macroeconomics. 12th ed. New York, United States: Irwin-McGraw-Hill Publishing Company.

Engle, R.F, Granger, C.W. (1987), A cointegration and error correction: Representation, estimation and testing. Econometrica, 55, 251-276.

Granger, C.W.J. (1981), Some properties of time series data and their use in econometric model specification. Journal of Econometrics, 16, 121-130.

Gujarati, D. (1999), Essentials of Econometrics. 2nd ed. New York, United States: Irwin-McGraw-Hill Publishing Company.

Gujarati, D. (2003), Basic Econometrics. 4th ed. New York, United States: Irwin-McGraw-Hill Publishing Company.

Knight, M., Norman, L., Delano, S.V. (1993), Staff papers. International Monetary Fund, 40(3), 512-541.

Lee, J.S., List, J.A., Strazicich, M.C. (2006), Non-renewable resource prices: Deterministic or stochastic trend? Journal of Environmental Economics, 51, 354-370.

Meltzer, A.H. (1995), Information, sticky prices and macroeconomic foundations. St. Louis Review, 77(3), 101-118.

Molana, H. (1991), The time series consumption function: Error correction, random walk and the steady state. Economic Journal, 101, 382-403.

Murthy, V.N., Okunade, A.A. (2016), Determinants of U.S. health

expenditure: Evidence from autoregressive distributed lag (ARDL) approach to co-integration. Economic Modelling, 59, 67-73

NC Department of Commerce. (2011), Policy, Research and Strategic Planning Division Report.

NC Office of the State Controller. (2015), Comprehensive Annual Financial Reports, Fiscal Year Ending.

Ng, S., Perron, P. (2001), Lag length selection and the construction of unit root tests with good size and power. Econometrica, 69, 1519-1554.

Pesaran, M.H., Yongcheol, S., Richard J.S. (2001), Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16, 289-326.

Phillips, P., Perron, P. (1988), Testing for a unit root in time series regression. Biometrica, 75, 335-346.

Phillips, P.C.B., Hansen, B.E. (1990), Statistical ınference in ınstrumental variables regression with I(1) processes. Review of Economic Studies, 57, 99-125.

Pindyck, R.S., Daniel L.R. (1998), Econometrics Models and Economic Forecasts. 4th ed. New York: McGraw-Hill. p243.

Pollock, D.S.G., Lekka, N. (2004), Deconstructing the Consumption Function New Tools and Old Problems. Mineograph. Queen Mary: University of London, United Kingdom.

Robert, M.S. (1955-56), The production function and the theory of capital. Review of Economic Studies, 23.2, 101-108.

Robert, M.S. (1956), A contribution to the theory of economic growth. Quarterly Journal of Economics, 70.1, 65-94.

Robert, M.S. (1957), Technical change and the aggregate production function. Review of Economics and Statistics, 39, 312-320.

Romer, P.M. (1986), Increasing returns and long-run growth. Journal of Political Economics, 94, 1002-1037.

Swann, T.W. (1956), Economic growth and capital accumulation. The Economic Record, 32(2), 334-361.

Wooldridge, M.J (2000), Introductory Econometrics: A Modern Approach. Cincinnati, United States: South-Western Publishing. p. 586