ASYMMETRIC VOLATILITY TRANSMISSION BETWEEN EMPLOYMENT, EXPORT, EDUCATION, AND NEW BUSINESS ESTABLISHMENT

Dr. Muhammad Mustafa
School of Business
South Carolina State University
USA

Dr. Haile M Selassie
School of Business
South Carolina State University
USA

ABSTRACT

This paper uses the Multi- variate EGARCH model to investigate the volatility spillovers between employment growth rates, exports, number of degrees awarded (proxy for education) and new business establishments for South Carolina. To our knowledge, similar empirical study is not available for South Carolina. The results provide evidence of significant mean spillover effects from changes in export, education and new business establishment to employment growth; from changes in employment growth and new business establishment to export; from changes in employment, export, and new business establishment to number of degrees awarded. However, there is no significant mean spillover from change in number of degrees awarded to export. Results show the existence of volatility spillover from export, degrees awarded and new business establishment to employment growth. The results also indicate volatility spillover from employment growth to number of degrees awarded, and from employment growth to new business establishment. Yet, there is no volatility spillover effect from employment growth, number of degrees awarded, and new business establishment to export. Also, there is no volatility spillover effect from export and new business establishment to number of degrees awarded; and from export and degrees awarded to new business establishment. The measure of asymmetry (π) is positive and statistical significant at the 1 percent level in case of employment growth and export models. The result indicates that positive shocks (good news) are likely to produce greater volatilities than negative shocks of the same magnitude. These results provide policy implication on how to mitigate the problem of volatility in employment growth. Policy makers should stabilize export, provide the right type of education that meets industry requirements and attract the establishment of new businesses.

Keywords: Employment Growth, Volatility Spillovers, Asymmetric Volatility, EGARCH.

INTRODUCTION

South Carolina continues to lag in national and regional averages that measure economic and social well-being. South Carolina had higher poverty rates when compared to the average poverty rates for the U.S. and those of other Southern states. In 2014 and 2015, while the national poverty rates for the U.S. were 12.6%, and 14.9% respectively, South Carolina's poverty rates exceeded those of national average at the level of 15%, and 18% respectively (Source: U.S. Census Bureau). South Carolina trails most U.S. states based on per capita income. In terms of per capita income, South Carolina ranked 46th, 48th and 48th in 2010, 2012, and 2014 respectively, among all states and Washington D.C. (Source: BLS). Unemployment rate in South Carolina exceeded the U.S. unemployment rate and that of most Southeastern States. Table 1below shows detailed statistics.

Table 1: Unemployment, Poverty Rate and Per Capita Income

State/Year	Unemployment Rate				Poverty Rate			Per Capita Income		
	2008	2010	2014	2015	2010	2014	2015	2010	2012	2014
South Carolina	6.8	10.1	6.6	6.4	11.1	15	18	32193 (46)	34266 (48)	36677 (48)
Virginia	4	7.1	5.5	5.2	8.3	9.2	11.8	47082 (8)	44134 (7)	50345 (10)
North Carolina	6.3	10.8	6.7	6.1	12.5	13.1	17.2	37049 (38)	34604 (36)	39171 (39)
Tennessee	6.6	9.9	7.3	6.7	13.5	15	18.3	37678 (34)	35103 (35)	40457 (36)
Florida	6.3	11.3	6.1	6.3	11	11.1	16.5	38545 (24)	40344 (27)	42737 (28)
Mississippi	6.8	10.6	7.7	7.8	14.9	20.1	21.5	30841 (50)	33073 (50)	34431 (50)
Georgia	6.3	10.2	7.9	7.2	12.1	14.4	18.3	34531 (37)	368692 (40)	38980 (40)
Alabama	5	9.2	6.6	6.8	13.3	16.7	19.3	33710 (42)	35625 (42)	37512 (44)
National	5.8	9.6	5.4	5.3*	11.3	12.6	14.9*	41,560.00	42,693	46,049

Within Parenthesis=Rank

*denotes average of all states

Variable	Source	Link
Poverty Rate	Center for American Progress	http://talkpoverty.org/poverty
Per Capita Income	Bureau of Economic Analysis	http://www.bea.gov/
Unemployment Rate	Bureau of Labor Statistics	http://www.bls.gov/

LITERATURE REVIEW

The disparity between the economic well-being of South Carolina and other states is a major concern and sets the foundation for this study. The outcome of this study can be useful for those involved in making strategic policies for economic development of South Carolina. According to Ford and Stone (2007) there is a growing concern in the state regarding the effectiveness of the state's long-standing economic development policies. Browne (1984) explored why South Carolina has lower than average wage rates. Falk and Lyson (1988) investigated why the South continues to lag the rest of the country in income (with urban incomes far greater than rural incomes), despite significant industrial development in recent decades.

Schunk (2002) focuses on the importance of high-technology employment, identified strengths and weaknesses in attracting high-technology investments and discussed lack of high quality education at all levels. Shannon (2007) provides an overview on the Workforce Innovation Network grant received by the South Carolina State Chamber of Commerce. Herriot and Torrey (2003) examine the problem of shrinking labor market in South Carolina and how an updated legislation can help change the situation. Gambrel and Chydzinski (2008) focus on the USC/Columbia Technology incubator, designed to create high paying jobs to provide economic development in South Carolina. Carlino and Mills (1987) studied the U.S. county employment and population growth during the 1970s, and found that taxes had little impact on employment or population growth. In addition, they find that education may be an important component in county growth.

Ford, Lacy, and Stone (2007) focus on the economic development strategies of South Carolina as it entered the twenty-first century. According to the authors, there is a growing concern in the state regarding the effectiveness of the state's long standing economic development policy. Miley and Associate (2010) explain the impact of Boeing and BMW's investments on manufacturing employment and gross state product. The study indicates that these two investments have significant impact on South Carolina's

manufacturing jobs and incomes of the people. Kuker (2011) offers an analysis of the impact of incentives to the Boeing Company provided by South Carolina through the House Bill 3130 that comes in the form of property taxes, tax exemptions, and economic development bonds.

Woodward (2013) uses South Carolina's economic development experience as a case study of significant challenge in regional development. The author urges caution regarding development of incentives as a regional strategy and suggests stronger agglomeration and cluster-based strategies which are better suited to promote economic development. Workman (2014) discusses the economic benefits of creating a private sector economic development organization (EDO) in Chesterfield County, South Carolina. The article explores the declining economy in a rural county that struggled to turn its economic activity. It indicates the creation of economic development alliance which drives market competitiveness and economic development in Chesterfield County. Meacham (2010) examines economic development policies created North and South Carolina to attract aircraft industry manufacturing facilities.

The primary objective of this paper is to empirically examine the issue of volatility spillover effects between employment growth, export, number of degrees awarded and new business establishment for South Carolina. This is an issue of great importance because the findings from this study may have profound economic development policy implications for the State of South Carolina. To achieve this objective, a Multi- variate EGARCH model is applied. To our knowledge, similar empirical study is not available for South Carolina. The rest of the paper is organized as follows: Section 2 discusses empirical methodologies. Section 3 provides data and empirical results. Discussions are presented in Section 4. Section 5 offers summary and concluding remarks followed by acknowledgement and references cited.

EMPIRICAL METHODOLOGY

This paper applies the modified Dickey Fuller (DF-GLS) unit root test developed by Elliott, *et al.* (1996) and the modified Phillips-Perron (MZ_{α}) to ascertain the time series behaviors of log of total employment (TEM), log of total export (SEX), log of total degrees awarded (TDA), and log of new business establishment (NBE). Elliot, *et al.* (1996) and Ng and Perron (1995) suggest that these unit root tests have better power than the standard Dickey-Fuller and Phillips-Perron (Phillips and Perron, 1988). This study, also, uses KPSS (1992) unit root tests. These procedures are especially useful for testing the null hypothesis that the time series in the system have one order of integration I (1) against the alternative that they have zero order of integration I (0). The DF-GLS unit root test is based on the following expression:

$$\Delta y_t^d = \alpha_0 y_{t-1}^d + \sum_{J=1}^{P} \beta_j \Delta y_{t-j}^d + \mu_t \quad \ldots\ldots (1)$$

Where p represents the maximum lag, y_t^d stands for locally de-trended series of y_t [i.e. $y_t^d = y_t - z_t\tilde{\beta}$, where $z_t = (1, t)$ and $\tilde{\beta}$ represents the regression of ŷ on ž]. The optimal lags were determined by means of the Modified Akaike Information Criterion (MAIC) (Ng and Perron, 1995, 2001, 2002). Under the DF-GLS unit root test, the null hypothesis is that $\alpha_0 = 0$, while the alternative is $\alpha_0 < 0$.

This paper applies the following multivariate VAR-EGARCH (p, q) models of employment growth, export, total degrees awarded and new business establishment. The mean equation is based on:

$$\Delta y_t^d = \alpha_0 y_{t-1}^d + \sum_{j=1}^{p} \beta_j \Delta y_{t-j}^d + \mu_t \qquad (2)$$

Where,

$$\mu_t | \theta_{t-1} \sim N(o, \sigma_t^2) \qquad (3)$$

The variance equation is given by:

$$\log \sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} a_i \left[\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right] + \sum_{i=1}^{p} b_i \log(\sigma_{t-i}^2) + \pi \left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right) \qquad (4)$$

In equation (2), R represents the series in the system (i.e. (TEM (log employment), SEX (log export), TDA (log total degrees awarded), and NBE (log of new business establishment), and μ_t stands for the error term. In equation (3), θ_{t-1} is the information set available to economic agents at time $t-1$ and σ_t^2 represents the conditional variance. The error term (μ_t) is assumed to be normally distributed with zero mean and variance of σ_t^2. In equation (2) each of the series is regressed on its past values and those of the other series in the system. For example, export is regressed on its lagged values as well as the past values of the employment, degrees awarded, and new business establishment. Based on the MAIC the appropriate lag for the conditional mean equation was determined to be one.

Equation (4) is the conditional variance equation. As can be seen in equation (4), the variance is conditioned on its own past values as well as the standardized residuals ($\varepsilon_{t-1}/\sigma_{t-1}$). Persistence in volatility is measured by $\sum_{i=1}^{q} b_i$. A smaller value of $\sum_{i=1}^{q} b_i$ indicates that persistence weak is after a shock. The parameter π measures the degrees of asymmetry. Positive and negative shocks have equal effect if the measure of asymmetry is unity (i.e. π =1). On the other hand, if π < 0, it indicates that negative shocks will generate higher volatility than positive shocks of the same size. By the same token, positive shocks will produce higher volatility than negative shocks of the same magnitude, if π >0.

To test for spillover effects from export, degrees awarded, and new business establishment to employment, the squared residuals for export, degrees awarded, and new business establishment are introduced as exogenous variables in the conditional variance equation for employment growth. Similarly, to test for spillover effects from employment, degrees awarded, and new business establishment to export, the squared residuals for employment, degrees awarded, and new business establishment are introduced as exogenous variables in the conditional variance equation for export. The conditional variance of equation (4) can be rewritten in terms of the notations used in the study as follows:

$$\log \sigma^{2}_{TEMGARCH,t} = \alpha_0 + \sum_{i=1}^{q} a_i \left[\frac{\varepsilon_{TEMGARCH,t-1}}{\sigma_{TEMGARCH,t-1}} \right] + \sum_{i=1}^{q} b_i \log(\sigma^{2}_{TEMGARCH,t-i}) + \pi \left(\frac{\varepsilon_{TEMGARCH,t-1}}{\sigma_{TEMGARCH,t-1}} \right)$$
$$+\delta_1 \log\left(\sigma_{SEXGARCH}\right) + \delta_2 \log\left(\sigma_{TDAGARCH}\right) + \delta_3 \log\left(\sigma_{NBEGARCH}\right) \text{.....(5)}$$

$$\log \sigma^{2}_{SEXGARCH,t} = \alpha_0 + \sum_{i=1}^{q} a_i \left[\frac{\varepsilon_{SEXGARCH,t-1}}{\sigma_{SEXGARCH,t-1}} \right] + \sum_{i=1}^{q} b_i \log(\sigma^{2}_{SEXGARCH,t-i}) + \pi \left(\frac{\varepsilon_{SEXGARCH,t-1}}{\sigma_{SEXGARCH,t-1}} \right)$$
$$+\delta_1 \log\left(\sigma_{TEMGARCH}\right) + \delta_2 \text{.....} \log\left(\sigma_{TDAGARCH}\right) + \delta_3 \log\left(\sigma_{NBEGARCH}\right) \text{ .....(6)}$$

$$\log \sigma^{2}_{TDAGARCH,t} = \alpha_0 + \sum_{i=1}^{q} a_i \left[\frac{\varepsilon_{TDAGARCH,t-1}}{\sigma_{TDAGRCH,t-1}} \right] + \sum_{i=1}^{q} b_i \log(\sigma^{2}_{TDAGARCH,t-i}) + \pi \left(\frac{\varepsilon_{TDAGARCH,t-1}}{\sigma_{TDAGARCH,t-1}} \right)$$
$$+\delta_1 \log\left(\sigma_{TEMGARCH}\right) + \delta_2 \log\left(\sigma_{SEXGARCH}\right) + \delta_3 \log\left(\sigma_{NBEGARCH}\right) \text{ ..... (7)}$$

$$\log \sigma^{2}_{NBEGARCH,t} = \alpha_0 + \sum_{i=1}^{q} a_i \left[\frac{\varepsilon_{NBEGARCH,t-1}}{\sigma_{NBEGARCH,t-1}} \right] + \sum_{i=1}^{q} b_i \log(\sigma^{2}_{NBEGARCH,t-i}) + \pi \left(\frac{\varepsilon_{NBEGARCH,t-1}}{\sigma_{NBEGARCH,t-1}} \right)$$
$$+\delta_1 \log\left(\sigma_{TEMGARCH}\right) + \delta_2 \log\left(\sigma_{SEXGARCH}\right) + \delta_3 \log\left(\sigma_{TDAGARCH}\right) \text{ ..... (8)}$$

Where TEMGARCH, SEXEGARCH, TDAGARCH, NBEGARCH are the volatility measures, respectively for employment growth, export, total degrees awarded, and new business establishment. In equation (5), spillover effects run from export, capital investment, and total degrees award to employment growth, if the regression coefficients on SEXEGARCH (δ1), TDAGARCH (δ2) and NBEGARCH (δ3) are statistically significant at the conventional levels.

DATA AND EMPERICAL RESULTS

Annual data from 1980 through 2015 are employed. Data on total employment growth, South Carolina export, total degrees awarded and new business establishment are from Bureau of Economic Analysis, SC Department of Commerce, Bureau of Economic Analysis, US Census Bureau and SC Department of Commerce respectively.

Empirical Results

Prior to estimating the mean and variance equations, the study applies both the modified ADF (DF-GLS) (Dickey and Fuller 1981) and the KPSS unit root tests to ascertain the time series properties of log of total employment (TEM), log of total degrees awarded (TDA), log of new business establishment (NBE) and log of export (SEX). The unit root tests were conducted with a constant only. Table 2 displays the unit root test results. The ADF-GLS results presented in Panel A of Table 2 suggest that the null hypothesis of a unit root should be rejected in all cases at the 1 or 5 percent level of significance. Similarly, the KPSS results presented in Panel B of Table 2 suggest that the null hypothesis of nonstationarity should be

rejected in all cases at the 1 percent level of significance. From these results, we can conclude that the series have zero order of integration.

Table 2: Unit Root Test Results

Panel A: Dickey-Fuller GLS (DF-GLS) Unit Test Results		
Variable Levels	Level	First Difference
TEM	-0.08707	-3.75619***
SEX	- 1. 8837	-10.1504***
TDA	-2.6309	-3.6988***
NBE	-1.4584	-3.5058***
Panel B: KPSS Unit Test Results		
Variable Levels	Level	First Difference
ΔTEM	0.64484	0.455326**
ΔSEX	0.71571	0.063613***
ΔTDA	0.6933	0.21355***
ΔNBE	0.82684	0.11548***

***, **, and * indicate level of significance at the 1%, 5% and 10%, respectively. The null hypothesis is the series has a unit root. TEM = log of total employment, SEX = log of South Carolina export, TDA= log of total degrees awarded. Calculations based on EGARCH (1, 1). Results obtained from Eviews 9.5.

Mean Spillover Effects

The results from the mean spillover effects are presented in Panel A in Tables 3A through 3D. The results presented in Panel A show evidence of mean spillover effect from changes in export, total degrees awarded and new business establishment to employment growth rate, as the regression coefficients on $SEX_{((t-1)}$, $TDA_{(t-1),}$ and $NBE_{(t-1)}$ are statistically at the 1 percent level of significance.

Table 3A: Multivariate -EGARCH (1, 1) Estimates (Dependent Variable: TEM)

Series	Coefficient	T-*Ratio*	P-v*alue*
Panel A: Mean Equation			
Constant	-0.022887***	-65.052	0.0000
$\Delta SEX_{(t-1)}$	-0.015900***	-2-78645	0.0053
$\Delta TDA_{(t-1)}$	-0.102186***	-7.34965	0.0000
$\Delta NBE_{(t-1)}$	0.166871***	7.892496	0.0000
Panel B: Variance Equation			
Constant	-5.178096***	-27.8991	0.0000
α_1	6.014572***	3.711503	0.0002
b_1 (Volatility Measure)	0.791452	0.867406	0.3857
π (Asymmetry)	1.065807***	48.6193	0.0000
δ_1(SEXEGARCH/Spillover)	11.52300***	2.455558	0.0169
δ_2(TDAEGARCH/Spillover)	-27.689397***	-2.382954	0.0169
δ_3(NBEEGARCH/Spillover)	17.38334**	5.44324	0.0000
Panel C: Diagnostic Tests on Standardized Residuals†			
	LB (2)	LB^2(8)	ARCH (3)
	4.0176	7.0319	0.391648
	[0.547]	[0.533]	[0.5359)

***, **, and * indicate level of significance at the 1%, 5% and 10%, respectively. TEM = log of total employment, TDA= log of total degrees awarded, SEX = log of South Carolina export, NBE= log of new business establishment. Calculations based on EGARCH (1, 1). Results obtained from Eviews 9.5.

The results presented in Panel A of Table 3B suggest the existence of mean spillover effects from changes in employment growth rate and changes in new business to changes in export, as the coefficients of TEM ($_{t-1}$) and NBE $_{(t-1)}$ are significant at the 1 percent level. The results presented in Panel A of Table 3C suggest the existence of mean spillover effects from changes in employment growth, export, and new business, as the coefficients TEM ($_{t-1}$), SEX$_{((t-1}$) and NBE$_{(t-1)}$ are statistically at the 1 percent level of significance. The results from the mean equation presented in Panel A of Table 3D suggest that the existence of mean spillover effects from changes in employment growth rate, export and total degrees awarded to changes in new business, as the regression coefficients on TEM ($_{t-1}$), SEX$_{((t-1}$), and TDA$_{(t-1)}$ are statistically at the 1 percent level.

Volatility Spillover Effects

Turning next to the results from the variance equation presented in Panel B of Tables 3A through 3D, it can be observed that the measure of volatility (b_i) is not statistically significant for any model. The measure of asymmetry (π) is positive and statistical significant at the one percent level in case of employment growth model presented in Panel B of Table 3A, and is positive and significant in case of export model in Panel B of Table 3B. The result indicates that positive shocks (good news) are likely to produce greater volatilities than negative shocks of the same magnitude. However, for total degrees and new business establishment models the measure of asymmetry (π) is statistically insignificant indicating that positive shocks (good news) and negative shocks (bad news) exert equal influence on education and new business establishment.

The results for volatility effects from the variance equations are reported in Panel B of Tables 3A through 3D. The results in Table 3A indicate the presence of spillover effects from changes in export, total degrees awarded and new business to employment growth, given that the regression coefficient on SEXGARCH, TDAGARCH, NBEGARCH are statistically significant at the 1 percent level of significance. However, in Panel B of Table 3B the regression coefficients on TEMGARCH and NBEGARCH $_{(t-1)}$ are statistically significant indicating the absence of volatility spillover effect from changes in employment growth rate, total degrees awarded and new business.

The results in Table 3C indicate the presence of spillover effects from changes in employment growth model to total degrees awarded, given that the regression coefficient on TEMGARCH $_{(t-1)}$ is statistically significant at the one percent level of significance. However, the regression coefficients on SEXGARCH $_{(t-1),}$ and NBEGARCH $_{(t-1)}$ are statistically insignificant indicating the absence of volatility spillover effect from changes export and new business to total degrees awarded.

The results in Panel B of Table 3D indicate the presence of spillover effects from changes in employment growth model, given that the regression coefficient on TEMGARCH $_{(t-1)}$ is statistically significant at the 1 percent level of significance. However, the regression coefficients on SEXGARCH $_{(t-1),}$ and $_{\text{TDAGARCH (t-1),}}$ are statistically insignificant indicating the absence of volatility spillover effect from changes export and total degrees awarded to new business establishments.

Diagnostic Test Results

The study applies the Ljung-Box Q-test for serial correlation in residuals, ARCH in residuals, Ljung-Box Q-test for serial correlation in squared residuals. The results from these diagnostic tests are presented in Panel C of Tables 3A through 3D. The Ljung-Box Q-test (LB) results suggest that the null hypothesis of no serial correlation in the residuals should be accepted in the equations for employment growth, changes in export, education and new business establishment.

The *p*-values exceed the conventional levels of significance in all the cases. Similarly, the results from the *F*-test of no ARCH versus ARCH in the residuals, indicate that the null hypothesis should not be rejected based on the test statistics and the *p*-values presented in Panel C of Tables 3A through 3D.

The test statistics for the Ljung-Box Q-tests [LB^2] indicate that the null hypothesis of no serial correlation in the squared residuals should not be rejected for the equations for employment growth, changes in export, changes in education and new business establishment. Taken together, the results provided by the three diagnostic tests implemented by the study, reveal that the conditional mean and variance equations for employment growth, export, education and new business establishment are correctly specified and that they possess the qualities of good models.

Table 3B: Multivariate -EGARCH (1, 1) Estimates (Dependent Variable: SEX)

Series	Coefficient	T-*Ratio*	P-v*alue*
Panel A: Mean Equation			
Constant	-0.022887***	-65.052	0.0000
$\Delta TEM_{(t-1)}$	-0.62499***	-3-75663	0.0000
$\Delta TDA_{(t-1)}$	0.000170	-0.00320	0.9974
$\Delta NBE_{(t-1)}$	0.0795431***	15.22990	0.0000
Panel B: Variance Equation			
Constant	-3.963659***	-2.8991	0.0057
α_1	1.401323	1.576891	0.1148
b_1 (Volatility Measure)	0.000734	0.001548	0.9988
π (Asymmetry)	0.37159**	1.867968	0.0571
δ_1(TEMEGARCH/Spillover)	-40.53689	-0.991125	0.3216
δ_2(TDAEGARCH/Spillover)	20.87439	1.076489	0.2817
δ_3(NBEEGARCH/Spillover)	-46.07783	-1.567226	0.1171
Panel C: Diagnostic Tests on Standardized Residuals†			
	LB (4)	LB^2(4)	ARCH (1)
	10.727	0.5099	0.2352
	[0.30]	[0.973]	[0.6310)

***, **, and * indicate level of significance at the 1%, 5% and 10%, respectively. TEM = log total employment, TDA = log of degrees awarded, and NBE =Log of new business establishments. Calculations based on EGARCH (1, 1). Results obtained from Eviews 9.5.

Table 3C: Multivariate -EGARCH (1, 1) Estimates (Dependent Variable: TDA)

Series	Coefficient	T-*Ratio*	P-v*alue*
Panel A: Mean Equation			
Constant	0.022883	11.21394	0.4445
$\Delta TEM_{(t-1)}$	0.066191***	0.764675	0
$\Delta SEX_{(t-1)}$	-0.059117***	-5.97391	0
$\Delta NBE_{(t-1)}$	-0.030285***	-3.13569	0.0017
Panel 3B: Variance Equation			
Constant	-7.996580***	-2.503249	0.0123
α_1	1.873363	0.802656	0.4222
b_1 (Volatility Measure)	-0.354238	-0.58309	0.5598
π (Asymmetry)	0.172088	0.725164	0.4684
δ_1(TEMEGARCH/Spillover)	71.17751***	2.493299	0.0127
δ_2(SEXEGARCH/Spillover)	6.43741	0.780967	0.4348
δ_3(NBEEGARCH/Spillover)	-32.3859	-1.28765	0.1979
Panel C: Diagnostic Tests on Standardized Residuals†			
	LB (5)	LB^2(4)	ARCH (1)
	8.6569	5.2491	0.1791
	[0.193]	[0.263]	[0.6749)

***, **, and * indicate level of significance at the 1%, 5% and 10%, respectively. TEM = log total employment, SEX = log of export, and NBE =Log of new business establishments. Calculations based on EGARCH (1, 1). Results obtained from Eviews 9.5.

Table 3D: Multivariate -EGARCH (1, 1) Estimates (Dependent Variable: NBE)

Series	Coefficient	T-*Ratio*	P-v*alue*
Panel A: Mean Equation			
Constant	0.034581***	4.840478	0.0000
$\Delta TEM_{(t-1)}$	0.12336***	1,35819	0.0000
$\Delta SEX_{(t-1)}$	-0.12376***	-2.8798	0.0000
$\Delta TDA_{(t-1)}$	-0.2703***	-2.10375	0.0017
Panel 3B: Variance Equation			
Constant	-5.47195	-.840176	0.4008
α_1	1.873363	0.802656	0.4222
b_1 (Volatility Measure)	-0.354238	-0.583090	0.5598
π (Asymmetry)	0.172088	0.725164	0.4684
δ_1(TEMEGARCH/Spillover)	71.17751***	2.493299	0.0127
δ_2(SEXEGARCH/Spillover)	6.437410	0.780967	0.4348
δ_3(TDAEGARCH/Spillover)	-32.3859	-1.287650	0.1979
Panel C: Diagnostic Tests on Standardized Residuals†			
	LB (4)	LB^2(1)	ARCH (1)
	0.5528	0.0432	0.8506
	[0.968]	[0.998]	[0.0364]

***, **, and * indicate level of significance at the 1%, 5% and 10%, respectively. TEM = log total employment, SEX = log of export, and TDA= log of total degrees awarded. Calculations based on EGARCH (1, 1). Results obtained from Eviews 9.5.

DISCUSSION

This paper has applied the multivariate VAR-EGARCH (1, 1) model to explore the volatility spillover effects between employment growth, export, education and new business

establishment for South Carolina for the period running from 1980 through 2015. This paper has used the DF-GLS and KPSS unit root tests to determine the time series properties of employment growth, export, education and new business establishments. The results from the DF-GLS and KPSS unit root tests reveal that employment growth, export, education and new business establishments are either stationary at the level or after first differencing. The results show the mean spillover effects from changes in export, total degrees awarded and new business to employment growth, as the regression coefficient on $\Delta SEX_{(t-1)}$, $\Delta TDA_{(t-1)}$ and $\Delta NBE_{(t-1)}$ are statistically significant at the 1 percent level of significance. In export model, the regression coefficients on $\Delta TEM_{(t-1)}$ and $\Delta NBE_{(t-1)}$ are statistically significant at 1 percent level indicating the presence of mean spillover effect from changes in employment growth rate and new business establishments. In TDA (total degrees) model, the regression coefficients on $\Delta TEM_{(t-1)}$, and $\Delta SEX_{(t-1)}$; and $\Delta NBE_{(t-1)}$ are statistically significant at 1 percent level indicating the presence of mean spillover effect from changes in employment growth rate, export and new business establishment. Also, in NBE model (new business establishment), the regression coefficients on $\Delta TEM_{(t-1)}$, and $\Delta SEX_{(t-1)}$, and $\Delta TDA_{(t-1)}$ are statistically significant at 1 percent level indicating the presence of mean spillover effect from changes in employment growth rate, export and total degrees awarded.

The measure of asymmetry (π= 1.0658) is positive and statistical significant at the 1 percent level in case of employment growth model, and (π= 0.37159) is positive and significant at 5% level in case of export model. Since π is (π= 1.0658) > 1 in employment growth model, it indicates that positive shocks (good news) are likely to produce greater volatilities than negative shocks of the same magnitude. Since π is (π= 0.37159) > 0 in export model, it indicates that positive shocks (good news) are likely to produce greater volatilities than negative shocks of the same magnitude. However, for total degrees and new business establishment the measure of asymmetry (π) is statistically insignificant indicating that positive shocks (good news) and negative shocks (bad news) exert equal influence on education and new business establishment.

SUMMARY AND CONCLUSIONS

The multivariate VAR-EGARCH (1, 1) framework was applied to explore both the volatility spillover effect and the possible asymmetric responses between the employment growth, export, education and new business establishment. The results obtained from the multivariate VAR-EGARCH (1, 1) models reveal the presence of significant mean spillover effects from changes in export, education and new business establishment to employment growth, from changes in employment growth, export, and new business establishment to education, and from changes in export, education and employment growth to new business establishment. However, there is no evidence of mean spillover effects from changes in education to export.

The results reveal the presence of asymmetries in the relationships between changes in employment growth and export models. These results imply that positive shocks (good news) to employment growth and changes in export are likely to produce greater volatilities than negative shocks (bad news) of the same size. The results also provide evidence of significant volatility spillover effects from in changes export, total degrees awarded, and new business establishment to employment growth. These results imply to mitigate the problem of volatility in employment growth, the policy makers should stabilize export, provide right type of education and promote new business establishment.

ACKNOWLEDGEMENTS

This article is based upon work that is supported by the National Institute of Food and Agriculture (NIFA), U.S. Department of Agriculture, Evans-Allen project number SCX-101-08-15. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the view of the U.S. Department of Agriculture.

REFERENCES

Browne, L. E. (1984). "How Different Are Regional Wages? A second Look." *New England Economic Review*, Number21, pages 40-47.

Carlino G. and Leonard O. Mills. 1996. "Convergence and the U.S. States: A Time Series Analysis." *Journal of Regional Science*, 36: 597-616.

Elliot G., Rothenberg T. and J. Stock. 1996. "Efficient Test for Autoregressive Unit Root." *Econometrica*, 64:813-836.

Falk, W.W. and Lyson, T.A (1988). High Tech, Low Tech, and No Tech: Recent Industrial and Occupational Change in the south, Albany, NY: State University of New York Press.

Ford, Jr., Lacy K. and R. Phillip Stine. (2007). "Economic Development and Globalization in South Carolina." *Southern Cultures*, spring, vol. 13 Issue 1, 18-50.

Gambrel, J. and A. Chydzinski. (2008). "Non-traditional Economic Development." *Economic Development Journal*, winter, vol. 7 Issue 1, p26-31.

Herriott, Don and Margaret Torrey. 2003. "Staying in the (Workplace) Race." *Business & Economic Review*. Vol. 50 Issue 1:3-7.

Kuker, A. (2011). "An Analysis of South Carolina's Incentives to Boeing Company." *Journal of International law & Business*, fall, Vol.8 Issue 1, 165-203.

Miley & Associates. (2010). "The Economic Impact of Boeing in South Carolina." Miley & Associates.

Mecham, Michael. (2010). "Big Ambitions." *Aviation Week & Space Technology*, Vol. 172, Issue 42, 50.

Ng, S. and P. Perron (2001). "Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power." *Econometrica*, 64: 813-836.

Philips, P.C.B. and P. Perron (1988). Testing for a Unit Root in Time Series Regression. *Biometrika*, 75,335-346.

Schunk, Donald. 2002. "High-Tech Employment: A South Carolina Perspective." *Journal of State Government*, spring 2002, Vol. 75 Issue 2:31.

Shannon, Sue-Ann Gerald. 2007. "Reshaping South Carolina's Workforce." *Business & Economic Review*, Jan-Mar2007, Vol. 53 Issue 2:3-6.

Woodard, Douglas. (2013). "Industry Location, Economic Development Incentives, and Clusters." *The Official Journal of the Southern Regional Science Association*, 5, 23.

Workman, B. (2014). "Creating a private Sector Edo." *Economic Development Journal*, winter. Vol.13 Issue 1, p 36-46.