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Causal Relationship between Agriculture, Industry and Services Sector for GDP Growth in Bangladesh: An Econometric Investigation

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Abstract
This study examines the contribution of agriculture, industry and services sectors to economic growth in Bangladesh by using time series data from 1980 to 2013. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests show that the time series data stationary at first difference. Then, the cointegration analysis indicates that each economic sector has strong, positive and significant linear relationship with economic growth. Granger causality test found bi-directional causality between agriculture and GDP and also industry and agriculture. This empirical study also found the unidirectional granger causality from services sector to agriculture and industry sector to services sector. Finally, the Vector Error Correction Model (VECM) also used to examine the short and long run equilibrium relationships among the variables. This study gives the guideline to the investors and policy makers.
Keywords: economic growth, economic sectors, econometric analysis, Bangladesh

1. Introduction

Agriculture is the core sector for the economy of Bangladesh since its independence (1971) and still contributing around 18 percent to GDP. Besides providing employment to 48.1 percent labor force, this sector provides accommodation 62 percent manpower of the nation, and 84 percent of the population of Bangladesh living in rural areas, directly or indirectly depends upon agriculture for their livelihood. It is the primary source of employment, livelihood, and food security for the majority of rural people. It also provides raw material to industry and contributes to country's exports. So any strategy change for agriculture sector will affect the economy and a large section of population in the country (Alam, 2008a). However, due to rapid development and reformation of a country, the agriculture sector has been gradually neglected. Nevertheless, understanding the role of agriculture and its linkages to economic growth is important. The industry sector includes manufacturing, construction, public utilities and mining, growing gradually with increase in employment in Bangladesh. According to Kaldor (1967), manufacturing is an engine of economic growth as industrial goods have a higher-income elasticity of demand. In Bangladesh, industries could not develop much due to hinder by political instability and natural disasters. Despite these negative factors, the export sector has accelerated with the average growth of 30% and economic growth has been surprisingly stable, averaging 6.3% in the past 5 years (Rahman, 2011). The services sector is increasingly seen as a means to promote economic development and reduce poverty. It is fast becoming the largest sector, in terms of its share of GDP and employment, in most developing countries (Hussin and Yik, 2012). The services sector is highly diverse, ranging from infrastructure services, financial services, business services and social services. Since this sector contributes significantly to GDP in Bangladesh, therefore it is also included as a variable in this study. Recently, service is the largest sector in the percentage contribution to 53.9 % of GDP.

Wang, et al. (2010) shows that there has always been a positive relation between agriculture and economic growth and discuss how agriculture contributes to economic growth. They concludes that although the share of agriculture in GDP has declined significantly over time, the contribution of agricultural growth has maintained an upward trend and it has made an important bazaar, foreign exchange and output contributions to non-agricultural growth and remains an exceptional driving force for economic growth. Andzio and Kamitewoko, (2004), analyze that the influence of agriculture on GDP of China and three Sub-Saharan African (SSA) countries by using multiple regression models and demonstrate that agriculture remains as the cornerstone of China and the SSA countries where it has a significant effect on GDP in these countries. Subramaniam and Reed (2009) estimated an econometric model that incorporates the linkage among agriculture, manufacturing, service and trade sectors using a vector error correction model for Poland and Romania. Chang et al., (2006), mention that the revenue generation effect dominates the comparative advantage effect; higher agricultural productivity enhances industrialization and increases long run economic growth in Japan, Taiwan and Korea. The results show that higher agricultural productivity will subsequently increase industrial sectors' employment and thus will enhance economic growth. Sultan (2008) states that industry value-added as a possible source of economic growth in addition to export and import that can contribute more than the growth rate of export-import towards

the growth rate of GDP in Bangladesh. He found that the existence of co-integration and a long run relationship between GDP and industry value added using bivariate co-integration test.

This paper aims to investigate how three different sectors namely, agriculture, Industry and Service sector are affecting the GDP growth in Bangladesh. It also intends to measure the relationship between the concerned variables and their overall impact on GDP.

The rest of the study is organized as follows. The data and methodology are explained in Section 2. The empirical results are discussed in Section 3. Findings and concluding remarks are discussed in the last section.

2. Data and Methodology

2.1 Data

This paper uses annual time series data of Agriculture, Industry and Service sector of their value added contribution in GDP covering the period from 1980 to 2013 of Bangladesh. Real per capita GDP is taken as US dollar ($). The data obtained from online version of World Development Indicators (WDI), the World Bank. As this study examines the contribution of agriculture, industry and service sector to economic growth in Bangladesh, secondary data is appropriate for the study.

Methodology

Assessment of Granger causality between the variables and the direction of their causality in a vector error correction framework requires three steps. The first step is to test the non-stationarity property and determine order of integration of the variables, the second step is to detect the existence of long run relationship and the third step is check the direction of causality between the variables.

2.2 Model Specification

This study investigates the contribution of economic sectors to economic growth in Bangladesh from 1980 to 2013. Correlation analysis and multiple regression analysis are used to examine the relationship between the dependent variable and the independent variables in the study. The following model represents the relationship between per capita real Gross Domestic Product (GDP) and the three economic sectors, namely agriculture, industry and services sectors for Bangladesh. The equation for the multiple regression analysis is:

$$GDP = \beta_0 + \beta_1 Agr + \beta_2 Ind + \beta_3 Serv + \mu \quad (1)$$

Where,

GDP = Real Gross Domestic Product per capita, Agr = Share of value added in agriculture sector to real GDP per capita, Ind = Share of value added in industry sector to real GDP per capita, Serv = Share of value added in services sector to real GDP per capita, β_0 = Intercept, $\beta_1, \beta_2, \beta_3$ = Co-efficient and μ = Error Term

2.3 Stationarity Test

The annual time series data cover a period of 34 years from 1980 to 2013 is used to determine the relationship between economic sectors and economic growth in Bangladesh. In the first step of the estimation process, this study examines the stationarity properties of the data series.

According to Nelson and Plooser (1982), most of the time series that appear in the economy will have to be differenced in order to become stationary. In fact, most economic variables show a trend and therefore in most cases are non-stationary. Thus, before moving further analysis of the variables, it needed to ensure stationary properties of the variables.

This study uses Augmented Dickey Fuller (ADF) test (Dickey and Fuller, 1979, 1981) to perform the unit root tests. The ADF test includes extra lagged terms of the dependent and independent variables, which are real GDP per capita, agriculture sector, industry sector and services sector in order to eliminate autocorrelation. This study uses a regression model that includes an intercept and a time trend:

$$\Delta Y_t = \beta_0 + \beta_1 t + \beta_2 Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-i} + \mu_t \quad (2)$$

The ADF regression tests for the existence of unit roots of Y_t, namely all model variables at time *t*. The variable Y_{t-i} represents the first differences with *k* lags while μ_t is a variable that adjusts the errors of autocorrelation. β_0, β_1 and α_i are the coefficients values.

The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests use intercept and trend and test for variables' stationarity at levels and first differences.

Table 1: Augmented Dickey-Fuller and Phillips-Perron unit root test results for both Trend and Without Trend of four variables in Level and First Difference

Results of Augmented Dickey-Fuller (ADF) Unit Root Test								
Variables	Statistics	Critical value			Statistics	Critical value		
	With intercept	1%	5%	10%	With trend and intercept	1%	5%	10%
Level Form								
GDP	**9.419240 (3)**	**-3.646342* 2.615817***	**-2.954021***	**-**	**1.269301(3)**	**-4.262735 3.209642**	**-3.552973**	**-**
Agr	**-0.109793(3)**	**-3.646342 2.615817**	**-2.954021**	**-**	**-1.437283(3)**	**-4.262735 3.209642**	**-3.552973**	**-**
Ind	**2.894713(3)**	**-3.653730 2.617434**	**-2.957110**	**-**	**0.370566(3)**	**-4.262735 3.209642**	**-3.552973**	**-**
Serv	**9.481123(3)**	**-3.646342* 2.615817***	**-2.954021***	**-**	**1.024465(3)**	**-4.262735 3.209642**	**-3.552973**	**-**
Difference Form								
GDP	**-0.495073(3)**	**-3.670170 2.621007**	**-2.963972**	**-**	**-5.583312(3)**	**-4.273277* 3.212361***	**-3.557759***	**-**
Agr	**-4.902326(3)**	**-3.653730* 2.617434***	**-2.957110***	**-**	**-4.989913(3)**	**-4.273277* 3.212361***	**-3.557759***	**-**
Ind	**-1.165824(3)**	**-3.661661 2.619160**	**-2.960411**	**-**	**-4.436691(3)**	**-4.273277* 3.212361***	**-3.557759***	**-**
Serv	**-0.281874(3)**	**-3.670170 2.621007**	**-2.963972**	**-**	**-5.627280(3)**	**-4.273277* 3.212361***	**-3.557759***	**-**
Results of Phillips-Perron (P.P.) Unit Root Test								
Variables	Statistics	Critical value			Statistics	Critical value		
	With intercept	1%	5%	10%	With trend and intercept	1%	5%	10%
Level Form								
GDP	**8.561314(3)**	**-3.646342* 2.615817***	**-2.954021***	**-**	**1.324681(3)**	**-4.262735 3.209642**	**-3.552973**	**-**
Agr	**-0.147886(3)**	**-3.646342 2.615817**	**-2.954021**	**-**	**-1.599793(3)**	**-4.262735 3.209642**	**-3.552973**	**-**
Ind	**5.906690(3)**	**-3.646342* 2.615817***	**-2.954021***	**-**	**0.190999(3)**	**-4.262735 3.209642**	**-3.552973**	**-**
Serv	**8.795120(3)**	**-3.646342* 2.615817***	**-2.954021***	**-**	**1.248112(3)**	**-4.262735 3.209642**	**-3.552973**	**-**
Difference Form								
GDP	**-1.167976(3)**	**-3.653730 2.617434**	**-2.957110**	**-**	**-5.604910(3)**	**-4.273277* 3.212361***	**-3.557759***	**-**
Agr	**-4.863733(3)**	**-3.653730* 2.617434***	**-2.957110***	**-**	**-4.948256(3)**	**-4.273277* 3.212361***	**-3.557759***	**-**
Ind	**-1.504459(3)**	**-3.653730 2.617434**	**-2.957110**	**-**	**-4.432500(3)**	**-4.273277* 3.212361***	**-3.557759***	**-**
Serv	**-1.321171(3)**	**-3.653730 2.617434**	**-2.957110**	**-**	**-5.627878(3)**	**-4.273277* 3.212361***	**-3.557759***	**-**

Note: The test is conducted using Eviews 7.0.0.1

Table 1 reports the results of the ADF and PP unit root test for four variables in the levels and differences. Interestingly, all the variables are not stationary in their levels but become stationary after first differencing. On the base of critical value, * denotes that the rejection of null hypothesis of unit root at 1%, 5% and 10% levels of significance. Here we consider the variables with intercept only, and with trend and intercept, both in level and first difference form. Number in the bracket denotes lag length.

3. Empirical Results

3.1 Results of Cointegration

After examining the stationarity of these series we used Johansen's and Juselius (1990) method to test for

cointegration between the series of Agriculture, Industry, Service sector and GDP growth. Cointegration means that despite being individually non-stationary, a linear combination of two or more time series data can be stationary (Gujarati, 2011). When a linear combination of non stationary variables is stationary, the variables are said to be cointegrated and the vector that is quite possible for a linear combination of integrated variables to be stationary. In this case the variables are said to be cointegrated. The cointegration technique uses two tests-the maximum Eigen value statistics and trace statistics in estimating the number of cointegration vectors. The trace statistic evaluates the null hypothesis that there are at most r cointegrating vectors whereas the maximal Eigen value test evaluates the null hypothesis that there are exactly r cointegrating vectors.

Table 2: Johansen Test for Co-integration

Maximum Eigen value test							
Variables	Null hypothesis	Alternative	Without trend		With trend		Conclusion
	hypothesis		Test Statistics	Critical Value	Test Statistics	Critical Value	
	r=0	r=1					
GDP & Agr			23.071	14.264	26.665	19.387	At most one
GDP & Ind			23.966	14.264	24.252	19.387	cointegration
GDP & Serv			18.278	14.264	26.713	19.387	euation
Trace test							
GDP & Agr			28.820	15.494	36.614	25.872	At most one
GDP & Ind			26.080	15.494	32.134	25.872	cointegration
GDP & Serv			29.405	15.494	38.656	25.872	equation

Note: The test is conducted using Eviews 7.0.0.1

From Table 2, we found that Maximum Eigen value test and Trace test, the estimated test statistics is not less than the critical value for r=0 for both with and without trend at 5 % level of significance. This indicates that there is one cointegration equation and the variables- share of value added of Agriculture in GDP, share of value added of Industry in GDP and share of value added of Service sectors in GDP and total GDP have the long run relationships. So, it is clear that there is one linear cointegration equation, long run relationship and liner deterministic trend among the variables.

3.2 Results of Granger Causality Test

Granger Causality (1969) analyzed that if the variables are cointegrated then there should be at least one direction of causality between the two variables and this causality has been tested by F-statistics. Table 3 shows the results of sector wise Granger causality between the variables. Result shows that GDP and Agriculture sector Granger causes each other bi-directionally. Industry sector Granger causes GDP very strongly but GDP does not cause Industry sector. Service sector and GDP do not cause each other. Industry and Agriculture sector Granger cause each other i.e. these sectors are dependent on each other strongly for their contribution to GDP. On the other hand Service sector Granger causes Agriculture sector but Agriculture sector does not granger cause Service sector. Finally, Service sector does not cause Industry sector but Industry sector Granger causes Service sector in the study.

Table 3: Granger Causality between the Variables (Agr, Ind, Serv and GDP)

Null Hypothesis	Lag	Obs.	F-Statistics	Probability	Decision
Agr does not Granger Cause GDP			9.00446	0.0055	Rejected*
GDP does not Granger Cause Agr	1	32	7.16345	0.0121	Rejected*
Ind does not Granger Cause GDP			13.8317	0.0009	Rejected*
GDP does not Granger Cause Ind	1	32	0.28329	0.5986	Accepted
Serv does not Granger Cause GDP			0.93063	0.3427	Accepted
GDP does not Granger Cause Serv	1	32	0.95781	0.3358	Accepted
Ind does not Granger Cause Agr			8.28894	0.0074	Rejected*
Agr does not Granger Cause Ind	1	32	3.82381	0.0602	Rejected*
Serv does not Granger Cause Agr			6.47463	0.0165	Rejected*
Agr does not Granger Cause Serv	1	32	0.01084	0.9178	Accepted
Serv does not Granger Cause Ind			0.72681	0.4009	Accepted
Ind does not Granger Cause Serv	1	32	3.56209	0.0692	Rejected*

Note: The test are performed using the software Eviews 7.0.0.1

Here, GDP = Real Gross Domestic Product per capita, Agr = Share of value added in agriculture sector to real GDP per capita, Ind = Share of value added in industry sector to real GDP per capita, Serv. = Share of value added in services sector to real GDP per capita. * denotes significance of the results and rejection of hypothesis. From these results it can be said that Agriculture and Industry sector closely related to GDP but Service sector and GDP do not cause each other in the process.

3.3 Error Correction Modeling (ECM)

Granger and Engle (1983) analyzed that if the variables are integrated of order one and cointegrated, then there exists the Error Correction Term (ECT) and these variables bears the steady state situation or in equilibrium situation.

Considering the following equation which exist each other relationship as:

$$\Delta Y_t = \beta_0 + \beta_1 t + \beta_2 Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-i} + \alpha_i ECT_{t-i} + \varepsilon_t \qquad (3)$$

Where Y_t denotes the variables, ECT_{t-i} is the error correction term which is the lagged residual series of the cointegrating vector, ' Δ 'denotes the first difference and ' ε_t 'denotes the white noise term. Here the error correction term capturing the disequilibrium situation. The negative and significant coefficient of error term suggests that there is a short run adjustment process working behind the long run equilibrium relationship among the variables. Coefficient parameters of error correction term are the speed of adjustment for the short run imbalances. In fact, in the vector error correction model all the variables are endogenously determined within the model. When the variables are cointegrated, there is a systematic and general tendency of the series to return to their equilibrium situation. This means that the dynamics of adjustment is intrinsically embodied in the theory of cointegration. Moreover, Granger Representation Theorem indicates how to model a cointegrated series in a Vector Auto Regressive (VAR) format. VAR can be constructed either in terms of level data or in terms of their first differences with the addition of an error correction to capture the short run dynamics.

Table 4: Results of Vector Error Correction Test

	Coefficient	t	F		Coefficient	t	F
$GDP = \int(Agr)$	0.982340	[5.05069]*	65.77730	$Arg = \int(GDP)$	0.974313	[4.63887]*	5490.832
$GDP = \int(Ind)$	1.290914	[5.90940]*	3695.575	$Ind = \int(GDP)$	0.542014	[2.37872]*	5877.375
$GDP = \int(Serv)$	1.046382	[3.46780]*	4122.288	$Serv = \int(GDP)$	1.125299	[3.82203]*	4349.018
$Ind = \int(Agr)$	1.245163	[5.94460]*	3893.794	$Agr = \int(Ind)$	0.712110	[3.54371]*	60.91731
$Ind = \int(Serv)$	1.163396	[6.06999]*	3975.236	$Serv = \int(Ind)$	0.825961	[4.76882]*	64.51354
$Agr = \int(Serv)$	0.965888	[4.47870]*	4468.485	$Serv = \int(Agr)$	1.260664	[6.15870]*	3849.605

Note: The test are performed using the software Eviews 7.0.0.1

Note: * denotes the rejection of the hypothesis at 5% level of significance. The (*) values are statistically significant and shows the estimated coefficient of lagged variables. Values in the third brackets are t-statistics.

Table 4 shows that the vector error correction results are significant for agriculture and GDP growth, industry and GDP growth, service sectors and GDP growth and service sectors and agricultural development, indicating

the long run and short run causal effects on each other.

The significant lagged ECT coefficient indicates that the current outcomes are affect by the past equilibrium errors. If the two variables are cointegrated, there must it exists an error correction mechanism. This implies that error correction model is associated with the cointegration test. The long term effects of the variables can be represented by the estimated cointegration vector. The adjusted coefficient of error correction term (ECT) shows the long term effect and the estimated coefficient of lagged variables shows the short term effect. Causality test among the variables are based on Error Correction Model with first difference.

4. Findings and Concluding Remarks

This paper examined the causal relationship among GDP per capita, agriculture, industry and services sectors for Bangladesh for the year 1980-2013. The study found the existence of the long run causal relationship among these variables. To search for the nature of the relationship between the variables, we have implemented the granger causality tests and found bi directional relationship between GDP and agricultural which indicate that the agricultural and GDP influence on each other to grow in case of Bangladesh. And also bi directional causality is obtained in case of agriculture and industry. So, the results showed that industry and agriculture sector influence on each other for the growth of our GDP. We also found unidirectional granger causality from industrial sector to GDP growth and service sectors to industrial growth. So, it is clear that if agriculture and industry sector will boost, then its influence to increase the GDP of Bangladesh where as service sectors do not influence the GDP of Bangladesh individually. But, services sector is a more significant contributor (53.9%) to economic growth in Bangladesh and day by day its involvement is increasing. Therefore this sector should be given priority in the planning of national development policies. In addition, the country should devise strategies to attract more foreign investments into its industry and agriculture sectors to contribute in GDP growth. Thus, the three sectors are closely connected with each other and any changes of strategy in any sector will affect the economy and the livelihoods of the people that is why government and policy makers should take the decision with updated and significant result of research.

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