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COINTEGRATION AND CAUSAL RELATIONSHIP AMONG CONTRIBUTION OF AGRICULTURE, INDUSTRY AND SERVICE SECTOR TO GROSS DOMESTIC PRODUCT IN BANGLADESH

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ABSTRACT

The present study has been conducted to make econometric analysis of the relationship between contribution of agriculture, service and industry to Gross Domestic Product (GDP) in Bangladesh. Time series data ranging from fiscal year 1983-1984 to 2011-2012 on the above variables have been collected from Bangladesh Bureau Statistics (BBS). Augmented Dickey Fuller (ADF) test has been used for checking the stationarity of the variables. Different information criterion has been used to select appropriate lag length for the multivariate model. Furthermore, the Johenson Cointegration test has been used to detect the long-term relationship among the three variables. Again, vector error correction model has been used to determine the nature of long run and short run equilibrium relationship among them. This empirical study also investigates the multivariate granger causality among the variables. We also forecast contribution of agriculture, service and industry to GDP for upcoming 10 years through the estimated model.

KEYWORDS

Agriculture, Service, Industry, Gross Domestic Product, Granger Causality, Forecast.

INTRODUCTION

To study the role of agriculture, Industry and Service in the process of economic growth is of crucial important. Bangladesh is developing country so it does not have such a rich GDP condition, its total amount of GDP of 2012 is 118.7 billion of US dollars, and purchasing power parity is 305.5 billion US dollars. Economic growth of Bangladesh is compiled of three main sectors. As a developing country, Bangladesh has several production sectors which have greater contribution on GDP. They are playing important role over our GDP. The major sectors in this issue are shown in chart:

Agriculture includes farming crops, animals, fishery and foresting contributions. Farming corps includes paddy, wheat, jute, vegetables, sugarcane, pulses etc; animal farming includes dairy, poultry, fishery, sericulture etc. Agricultures contribution to GDP is 19.29% (current prices) for the fiscal year 2011-2012 (Bangladesh Bureau of Statistics 2011-2012).Industry is the second largest sector in the percentage contribution to GDP which includes garments & knitting sectors, factories, leather industry, food and beverage etc. The contribution of Industry sector to GDP is 31.26% (current prices) for the fiscal year 2011-2012 (Bangladesh Bureau of Statistics, 2011-2012).

Service is the largest sector in the percentage contribution to GDP. It includes all services activities. It consists of trade service, construction, transport, storage and communication, housing, public administration and defense, education, health, financial intermediates such as bank, insurance and other social and personal activities. Service organization's contribution of GDP of Bangladesh is 49.45% (current prices) for the fiscal year 2011-2012 (Bangladesh Bureau of Statistics, 2011-2012)

Rahman et al (2011) examine the causal relationship among GDP, agricultural, industrial and service sector output for Bangladesh using time series data from 1972 to 2008. In this study, we used the granger causality/block exogeneity Wald tests statistics to examine the causal relationship among these variables. From empirical study we found the existence of long run equilibrium relationship among these variables and bidirectional causality is observed between GDP and agricultural sector, industrial sector and GDP, and also industrial sector and service sector. Katircioglu (2004) established the causal relationship among GDP, agricultural, industry and service in case of North Cyprus. Subramaniam and Reed (2009) estimated an econometric model that incorporates the linkages among agriculture, manufacturing, service and trade sectors using a vector error correction model for Poland and Romania. From this study, we found that agricultural, industry and service are three main source of Bangladesh's economy. So it is always interesting for researchers to find out the causal relationship among these variable for any country.

METHODOLOGY

DATA AND VARIABLES

The variables used in this study are Contribution of Agriculture, Service and Industries to GDP of Bangladesh. The sample period covers annual data from fiscal year 1983-1984 to 2011-2012. All the data is obtained from Bangladesh Bureau of Statistics (BBS).

UNIT ROOT TEST

Since macroeconomic time-series data are usually non-stationary (Nelson and Plosser, 1982) and thus conducive to spurious regression, we test for stationary of a time series at the outset of cointegration analysis. For this purpose, we conduct an augmented Dickey-Fuller (ADF) test, which is based on the t-ratio of the parameter in the following regression.

$$\Delta x_t = \kappa + \emptyset + \Theta_i X_{t-i} + \sum_{i=1}^{n} \varphi_i \Delta X_{t-i} + \varepsilon_t \quad (1)$$

Where, X is the variable under consideration, Δ is the first difference

It is essential at the onset of co-integration analysis, that we should solve the problem of optimal lag length because multivariate cointegration analysis which we are going to conduct in the study is very sensitive to lag length selection. The most commonly used lag length selection criteria are the Final *prediction error* (*FPE*), *Akaike's information criterion* (*AIC*), Schwarz's Bayesian information criterion (*SC*), *Hannan-Quinn* Criterion (HQ) (Reference)

COINTEGRATION TEST

The econometric framework used for analysis in the study is the Johansen (1998)and Johansen and Juselius (1990) Maximum- Likelihood co-integration technique, which tests both the existence and the number of cointegration vectors. This multivariate cointegration test can be expressed as:

$$Z_t = K_0 + K_1 \Delta Z_{t-1} + K_1 \Delta Z_{t-1} + \dots\dots\dots.. + K_p \Delta Z_{t-p} + \prod Z_{t-p} + \mu_t \quad (2)$$

Where

$Z t$ = (CA, CS, CI)

Zt = a 3 x 1 vector of variables that are integrated of order one [i.e. I (1)]
CA, CS, CI are contribution of Agriculture, Service and Industries to GDP respectively.
K = a 3 x 3 matrix of coefficients
Π = 3 x 3 matrix of parameters and
μt = a vector of normally and independently distributed error term.

The presence of r cointegrating vectors between the elements of Z implies that Π is of the rank r ($0 < r < 2$) (less than equal). To determine the number of cointegrating vectors, Johansen developed two likelihood ratio tests: Trace test (λtrace) and maximum eigenvalue test (λmax.).If there is any divergence of results between these two tests, it is advisable to rely on the evidence based on the λmax test because it is more reliable in small samples (see Dutta and Ahmed, 1997 and Odhiambo, 2005).

GRANGER CAUSALITY

If we exploit the idea that there may exist co-movements among contribution of Agriculture, Service and Industries to GDP and possibilities that they will trend together in finding a long run stable equilibrium, by the Granger representation theorem (Engle and Granger 1987), we may posit the following testing relationships, which constitute our vector error-correction model:

$$\Delta CA_t = \alpha_1 + \sum_{i=1}^{l} \beta_{1i}\Delta CA_{t-1} + \sum_{i=1}^{m} \gamma_{1i}\Delta CS_{t-1} + \sum_{i=1}^{n} \delta_{1i}\Delta CI_{t-1} + \sum_{i=1}^{r} \theta_{1i} ECT_{r,t-1} + \xi_{1t} \quad (3)$$
$$\Delta CS_t = \alpha_2 + \sum_{i=1}^{l} \beta_{2i}\Delta CA_{t-1} + \sum_{i=1}^{m} \gamma_{2i}\Delta CS_{t-1} + \sum_{i=1}^{n} \delta_{2i}\Delta CI_{t-1} + \sum_{i=1}^{r} \theta_{2i} ECT_{r,t-1} + \xi_{2t} \quad (4)$$
$$\Delta CI_t = \alpha_3 + \sum_{i=1}^{l} \beta_{3i}\Delta CA_{t-1} + \sum_{i=1}^{m} \gamma_{3i}\Delta CS_{t-1} + \sum_{i=1}^{n} \delta_{3i}\Delta CI_{t-1} + \sum_{i=1}^{r} \theta_{3i} ECT_{r,t-1} + \xi_{3t} \quad (5)$$

Where CA ,CS,CI have been explained in previous section , Δ is a difference operator, ECT refers to the error-correction term(s) derived from long run co-integrating relationship via the Johansen maximum likelihood procedure, and ζit's (for i = 1, 2, 3) are serially uncorrelated random error terms with mean zero.

VECTOR ERROR CORRECTION MODEL

In a VAR model I have to include the variables which have bilateral causality with each other. A VAR model consists of a set of variables $Y_t = (Y_1, Y_{2........} Y_{Kt})$ which can be represented as:

$$Yt = \alpha + A_1 Y_{t-1} + A_2 Y_{t-2} + ... + A_p Y_{t-p} + u_t \quad (6)$$

With A_i are (K×K) coefficient matrix for i=1, 2….p and u_t is a K dimensional process with
E (u_t) = 0 and covariance matrix $E(ut\, ut^T) = \Sigma$. If 's are co-integrated the VAR model can be rewritten as VECM:

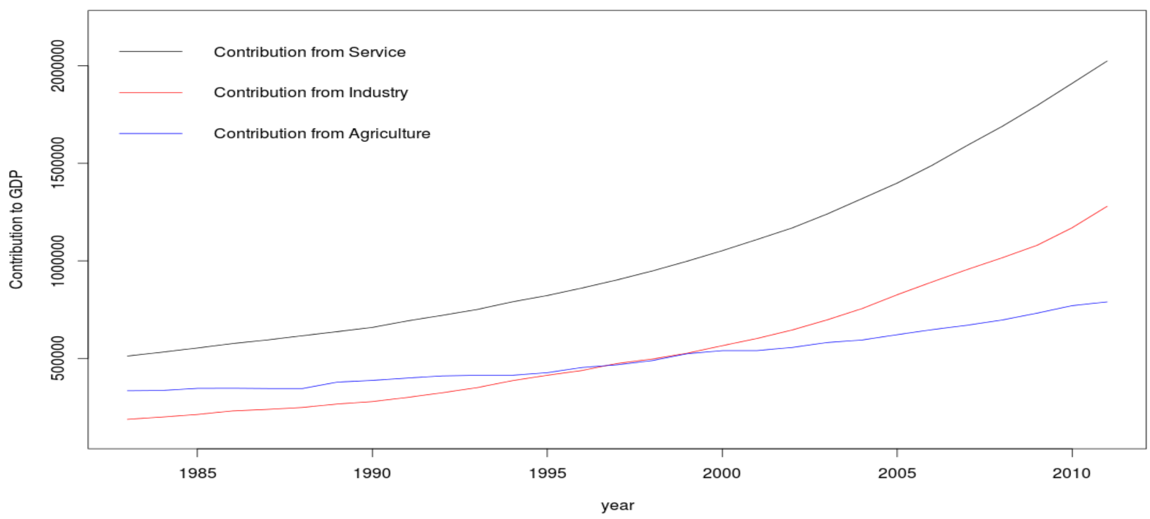
$$\Delta Y_t = \Pi Y_{t-p} + \Sigma\, \Gamma_i\, \Delta Y_{t-i} + u_t \quad (7)$$

Where, $\Pi = -(I - A_1 - A_2 \ldots A_p)$ and $\Gamma_i = -(I - A_1 - A_2 \ldots A_i)$.If the coefficient matrix Π has reduced rank r < k, then there exist k × r matrices α and β each with rank r such that Π = α β′ and β′ Y_t is stationary. r is the number of cointegrating relations and each column of β is the co-integrating vector.

RESULT AND DISCUSSIONS

ADF Unit Root Tests: Plots of the three time series data are shown in Figure 1. From Figure 1 it is clear that contribution to Agriculture, Industry and Service shows an upward trend and they have a tendency to move together, implying that they are causally linked to each other.

FIGURE 1: TIME SERIES PLOT FOR ACTUAL DATA FORM 1982-83 TO 2011-2012



The ADF test of unit root for the three variables of our concern, at suggested lag length three is presented below-

TABLE 1: AUGMENTED DICKEY FULLER (ADF) UNIT ROOT TEST

Null Hypothesis	Variable	Absolute Value of Test Statistic	1 percent critical value	5 percent critical value	10 percent critical value
The variable is non stationary	Contribution from industry	2.91	-3.58	-2.93	-2.60
	Contribution from service	1.05	-3.58	-2.93	-2.60
	Contribution from agriculture	2.50	-3.58	-2.93	-2.60

From the above table we can see that the absolute value of the Augmented Dicky Fuller test statistic is less than the 1 percent critical value for the variables contribution to GDP form service and contribution to GDP from agriculture and for the variable contribution to GDP from industry it is less than 5 percent critical value. So, we can declare the variables as non stationary. As the original variable are found to be non stationary, we difference them at order one and do ADF test again, the results are shown below in table 2.

TABLE 2: ADF TESTS AFTER FIRST DIFFERENCE

Null Hypothesis	Variable	Absolute Value of Test Statistic	1 percent critical value	5 percent critical value	10 percent critical value
The variable is non stationary	Contribution from industry	1.23	-3.58	-2.93	-2.60
	Contribution from service	2.04	-3.58	-2.93	-2.60
	Contribution from agriculture	2.61	-3.58	-2.93	-2.60

As all the three variables appears to be non stationary, we difference them at order one and perform the Augmented Dicky Fuller test again. The results are presented in the above table from which it can be seen that the absolute value of the Augmented Dicky Fuller test statistic is less than even the 10 percent critical value for contribution from industry and contribution from service and less than 5 percent critical value for contribution from agriculture. So, we can declare, even after differencing all the three variables remain non stationary.

TABLE 3: ADF TESTS AFTER SECOND DIFFERENCE

Null Hypothesis	Variable	Absolute Value of Test Statistic	1 percent critical value	5 percent critical value	10 percent critical value
The variable is non stationary	Contribution from industry	3.20	-3.58	-2.93	-2.60
	Contribution from service	4.42	-3.58	-2.93	-2.60
	Contribution from agriculture	6.41	-3.58	-2.93	-2.60

To make the variables stationary, we difference them again. The results of Augmented Dicky Fuller test for the second differenced data are presented in the above table 3 and from the table we can see that all the three variables are now stationary and we can say it even with 99% level of confidence for contribution from service and for contribution from agriculture and can say the same thing for contribution from industry 95% confidence.

VAR Lag Order Selection: Before fitting the model, we have to select the appropriate lag length of the vector error correction model. The value of different information criteria of the model at different lag length are given below in table 4.

To fit a VAR model at first we have to determine the appropriate lag length and for this purpose we take the help of the information criterion. Here are the values of some information criteria based on different lag length.

TABLE 4: LAG LENGTH CRITERIA

Criterion	Lag				
	1	2	3	4	5
AIC	53.41	53.33	53.19	52.76	52.04
HQ	53.57	53.61	53.58	53.26	52.66
SC	54.00	54.37	54.66	54.67	54.39
FPE	1.586549e+23	1.535603e+23	1.482419e+23	1.203987e+23	9.115755e+22

The above table clearly indicates that we should fit our vector autoregressive model with lag length five as all the criterion except SC give smallest value at this lag.

Johansen Co-integration Test

TABLE 5: JOHANSEN COINTEGRATION TEST BASED ON TRACE STATISTICS

Null Hypothesis	Test Statistic	10 Percent Critical Value	5 Percent Critical Value	1 Percent Critical Value
r <= 2	4.71	7.52	9.24	12.97
r <= 1	15.36	17.85	19.96	24.60
r = 0	53.95	32.00	34.91	41.07

TABLE 6: JOHANSEN COINTEGRATION TEST BASED ON MAXIMUM EIGEN VALUE STATISTICS

Null Hypothesis	Test Statistic	10 Percent Critical Value	5 Percent Critical Value	1 Percent Critical Value
r <= 2	4.71	7.52	9.24	12.97
r <= 1	10.65	13.75	15.67	20.20
r = 0	38.59	19.77	22.00	26.81

Granger Causality Test: The result of multivariate Granger causality test of the three variables of our concern is given below in Table 7.

TABLE 7: RESULTS OF GANGER CAUSALITY TEST

Null Hypothesis	F-Statistic	P-value
Agricultural contribution does not Granger-cause industrial contribution and service contribution	1.06	0.427
Industrial contribution does not Granger-cause agricultural contribution and service contribution	1.93	0.091
Service contribution does not Granger-cause agricultural contribution and service contribution	2.28	0.048

From the above table, it can be seen that there is unidirectional causality from service contribution to the other two variables, but the same thing cannot be said for the other two variables.

Johansen co-integration test is conducted to check the existence of cointegration which is shown below in Table 5 and Table 6. The next step is to determine the order of co-integration in this system. The results of both Johansen trace statistic based and maximum eigen value based tests are presented below.

From both tests the null hypothesis of no cointegration and less than or equal to one co-integration can be rejected even for one percent critical value, but the for the null hypothesis of less than or equal to two co-integration is failed to reject even for 10 percent critical value, the same can be said for the hypothesis of less than or equal to two co-integrating vector. So, we may simply conclude that there is one cointegrating relationship in this system.

The estimated value of the co-integration vector beta is given in the following table.

TABLE 8: ESTIMATING LONG RUN RELATIONSHIP

Variable	Cointegration Coefficient
Agricultural factor	1.00
Industrial factor	-1.27
Service factor	0.06
Constant	-244709.30

From the above result we can establish an equation among the three variables as-

Agricultural factor=-1.27industrial factor+.06 service factor-244709.30

This equation gives us a clear idea that one unit increase in contribution of industrial factor to GDP causes 1.27 unit decreases in contribution of agriculture to GDP and for the same unit increase in the service factor causes 0.06 unit increase in the agricultural factor on an average.

The value of the error correction terms of the vector error correction model is presented in the following table 9.

TABLE 9: SUMMARY RESULT FORM VECM

Error correction term	Estimated value	Standard error	t statistic	P value
For the equation of agricultural contribution	-0.93	0.22	-4.14	0.002
For the equation of industrial contribution	-0.35	0.15	-2.43	0.033
For the equation of service contribution	-0.06	0.12	-0.48	0.640

The negative sign of all the error correction terms of this model indicate that the concerned variables respond to any shock or deviation in the system at a balancing manner. The value of this term for the equation of contribution of agriculture to GDP is 0.93 with a negative sign that means this variable converges towards the long run equilibrium state of the system at a significant rapid rate of 93% per year. The value of this term for the equation of industrial contribution is also significant with the value of -0.35 indicating the speed of converge of this variable towards equilibrium is 35% per year after any shock or disturbance in the system. The value of the same term for the equation of service is also negative though very much insignificant, that means the variable will converge or adjust towards the desired state though the speed for this adjustment will be very slow.

Diagnostic Checks

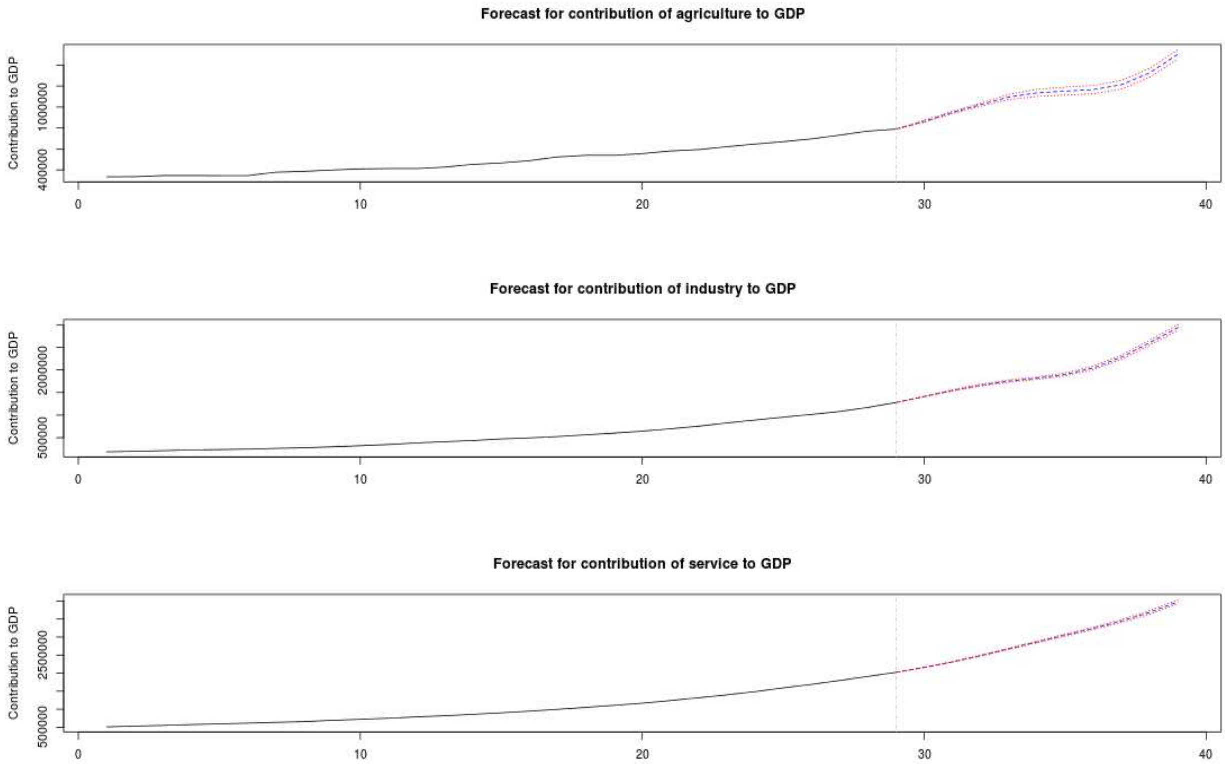
Portmanteau test: To check the adequacy of the model, the multivariate Portmanteau tests are conducted. Here the null hypothesis is the residuals of the model are white noise. The value of the test statistic at lag 16 (about one third of the length of the data set) and the corresponding P value are given below in Table 10- To check the adequacy of the model, the multivariate Portmanteau tests are conducted. Here the null hypothesis is the residuals of the model are white noise. The value of the test statistic at lag 13 and the corresponding P value are given below. Again to check whether heteroscadasticiy is present in the error of the model we conduct Breusch-Godfrey LM test, the result of this test is also presented in the following table.

TABLE 10: RESULTS OF DIAGNOSTIC CHECKING

Type of the test	Lag used	Value of the test statistic	DF	P value
Portmanteau	13	87.72	75	0.15
Breusch-Godfrey LM	11	72.00	99	0.98

From the above conducted tests we can say that the error terms of the model are white noise and heteroscedasticity free and we can declare these with more than 99% level of confidence.

FIGURE 2: FORECASTED VALUE ALONG WITH THE ORIGINAL VALUE OF CONTRIBUTION OF AGRICULTURE, INDUSTRY, & SERVICE TO GDP FOR UPCOMING 10 FISCAL YEAR



CONCLUSION

This study examined the causal relationship among contribution of agriculture, industry and service to gross domestic product of Bangladesh from fiscal year 1982-1983 to 2011-2012 in Bangladesh. In this study, Augmented Dicky Fuller test after second differenced variables performs stationary. In lag selection criterion, vector autoregressive model with lag length five is our selected model. From Johansen cointegration tests based on both trace statistics and maximum eigen value statistic, we can conclude that there is one cointegrating relationship in this system. We also illustrates that increase in contribution of industrial factor to GDP causes decreases in contribution of agriculture to GDP and for the same unit increase in the service factor causes increase in the agricultural factor. Again, the model identifies the system to be quite stable though contribution of service to GDP has an insignificant rate of adjustment. To check the adequacy of the model, the multivariate portmanteau test is conducted and for checking heteroscadasticiy in our error model we conduct Breusch-Godfrey LM test. In this study we forecast agriculture, industry and service to gross domestic product of Bangladesh for 10 years and result shows there are increasing trend in every sector.

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