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VECM for Measuring the Impact of Macroeconomic Variables on GDP

Research Article

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Abstract: The main goal of this research is to model the GDP of Bangladesh, one of the world's fastest growing economies, using the Vector Error Correction Model (VECM) on macroeconomic variables such as exchange rate, inflation rate, foreign direct investment (FDI), remittance, and export. To scrutinize the impact of macroeconomic variables on GDP, annual time-series data covering the period 1996-2018 is used for the study. The Augmented Dickey-Fuller (ADF) test is used to analyze the time series properties of data to determine the existence of stationarity. The analytical findings show that after taking the first difference, all variables become stationary; i.e., variables are combined in order one, I. (1). Cointegration is conducted under Johansen test and a VECM model is applied here depending on the result as it can be used for non-stationary data series. Then, Granger Causality test is applied to analyze the causal relationship and pathway of causality between GDP and macroeconomic variables. Furthermore, the VECM model is used to visualize the movement of one variable in order to provide a response related to a shock generated by another macroeconomic variable using an Impulse Response Function graph (IRF).

Keywords: *Augmented Dickey-Fuller (ADF) • Cointegration, VECM • Granger Causality Analysis • Impulse Response Function (IRF)*

1. Introduction

Economic development is defined as the improvement of an economy's ability to manufacture goods and services from one period of time to another, and it is a measure that reflects a country's economic condition. It is reported in the printed media that Bangladesh's economy is growing through Covid 19, while others are still struggling. The purpose of this study is to find out what helped Bangladesh maintain a positive economic growth rate when compared to other economies. Economic growth in a country can be determined by the rise in the overall market value of goods and services generated using estimation of the country's Gross Domestic Product (GDP). GDP can be calculated in three ways: production, expenditure, or income. The growth rate of GDP computes the percentage change in real GDP from one period to another. It can be either positive or negative (World meters, n.d.).

GDP, a common target for business and economics researchers, describes the financial stability of a country as a whole. GDP has emerged as one of the most concerning factors amongst macroeconomic variables, and data on GDP is regarded as a significant index for evaluating national economic growth and assessing the overall health of the macroeconomy (Ning, 2010).

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Basically, macroeconomic variables such as FDI and remittance have a positive effect on GDP while exchange and inflation have downsides on GDP. The effect of FDI on economic development is a disputed topic in developing countries. According to Dutt (1997), dependency theory asserts that foreign investment has a detrimental effect on the receiving country's economic growth. Brecher and Diaz-Alejandro (1977) endorse Dutts' hypothesis, arguing that FDI may have a negative impact on the host country's economic development if FDI-financed firms repatriate disproportionate income to the parent country. Experts agree that FDI has a negative impact on economic growth because it crowds out domestic investment. Furthermore, FDI increases the imports of developing countries because FDI-financed businesses often need high-tech capital equipment and intermediate products that are not always available in the host country (Rahman, 2008). Increasing imports, according to Fry (1999), could have a negative effect on economic development due to the resulting trade deficit. Senhadji (2001) investigated the relationship between inflation and development in 140 developing and industrialized countries from 1960 to 1998. The author discovered that inflation had an adverse impact on growth that was above the estimated threshold mark. Furthermore, Ozler (1988) used an autoregressive conditional heteroscedasticity method to calculate the volatility of export earnings. According to the findings of this report, export insecurity had a negative impact on the economic growth of developing countries. In addition, Emmanuel (2015) found in his study "Modeling GDP using Vector Autoregressive (VAR) Models: Empirical Evidence from Ghana" that the contribution of inflation rate to the economic growth of Ghana was approximately 0.311842. On the other hand, the exchange rate had a negative effect with a significant contribution to the growth model.

2. Materials and Methods

Secondary data from Bangladesh Bank is used to complete the analysis. The study makes use of annual time series data on the inflation rate, FDI, remittances, exchange rate, exports, and GDP growth of Bangladesh from 1996 to 2018. These figures were compiled and sorted from the Bangladesh Bank's published Statistical Year Book and Bulletins (2011 to 2020).

In this study, real GDP is used as a dependent variable while FDI, inflation rate, exchange rate, remittance, and export are used as independent variables. Real GDP is a measurement that reflects the total value of all goods and services generated by an economy in a given year and it provides more authentic growth than nominal GDP. The real exchange rate is determined as the ratio of a foreign price level to the domestic price level, multiplied by the nominal exchange rate.

The VECM model is estimated to quantify the effect of macroeconomic variables on GDP after testing the stationarity of data and co-integration relationship. The Granger Causality test is then used to analyze the causality between variables and determine the course of the systems' causality. The impulse response function is then used to double-check the results of the co-integration test.

3. Results

3.1 Stationarity Test

To determine whether time series data is stationary, the time series plot, correlogram ACF, and unit root test are used.

Figure 1.1 provides the time series plots for the elected variables at each level, and it can be seen that all the variables are non-stationary because they show an upward trend. In order to reduce the fluctuations in the data, first order differences are made in six sequences. Figure 1.2 provides the time series plots for the elected variables at their first difference. It can be ensured from the various figures that the variables become stationary after the first difference.

It can be discerned from the Figures 2.1 to 2.6 that all the variables at their base level are non-stationary as the autocorrelation function is gradually going down for all the variables. From the Figures 3.1 to 3.6, it can be discerned that all the variables at their first difference are stationary.

Tables 1.1 and 1.2 abridges the outcomes of the unit root test. According to the results, all variables are non-stationary at levels but become stationary after the first difference since the p-values are greater than 0.05 at levels but less than 0.05 at first difference for the ADF test. It can be interpreted from the outcomes that the null hypothesis is accepted at certain levels but rejected at the first difference. As a consequence, the series becomes integrated into order one, i.e., I (1).

Table 1.1. The ADF unit root test

At Labels (for lag-2)

Variable	t-statistic	*p*-Value
RGDP	-1.245401	0.6343
Remittance	-0.149301	0.9312
Inflation	-2.633940	0.1022
FDI	0.653162	0.9878
Export	1.576763	0.9989
Exchange	-1.763906	0.3855

Table 1.2. The ADF unit root test

After First Difference

Variable	**t-statistic**	***p*-Value**
DRGDP	-4.124271	0.0051
DRemittance	-3.682598	0.0130
DInflation	-6.236024	0.0001
DFDI	-5.393742	0.0003
DExport	-4.193537	0.0044
DExchange	-4.138829	0.0053

3.2 Co-integration Test

The rank of co-integration (CI) is assessed using Johansen's methodology to determine if there is a co-integration relationship among the variables.

Start by testing the following hypothesis

$H_o : r = 0$. If it rejects, repeat for $H_o : r = 1$.

In this study, eigen value statistic is not rejected for $H_o : r = 2$ at the 5% level ($23.6793 < 27.07$). Hence, the test indicates that there are two co $-$ integration relation among the variables. So, rank $(\pi) = 2$ which is less than the total number of variables. Thus, we employ VECM model instead of VAR model to model the GDP of Bangladesh on macroeconomic variables.

Table 2. Johansen Test for co-integration rank

Trend: Constant					No. of Obs= 20
Sample: 3-22					Lags=2
Maximum Ranks	Prams	LL	Eigen Value	Max Statistic	5% Critical Value
1	53	-512.58965	0.99083	69.5574	33.46
2	62	-477.81096	0.96913	23.6793	27.07
3	69	-465.97133	0.69394	21.6556	20.97
4	74	-455.14356	0.66135	13.6909	14.07
5	77	-448.2981	0.49568	5.3986	3.76
6	78	-445.59879	0.23657		

Table 3. Lag order selection for VECM

Selection-order criteria								
Sample: 3-22							Number of Obs= 20	
			df	P	FPE	AIC	HQIC	SBIC
0	-627.099				1.30E+20	63.3099	63.3682	63.6086
1	-528.452	197.29	36	0.000	2.90E+17	57.0452	57.4534	59.1362
2	-445.599	165.71*	36	0.000	9.9e+15*	52.3599*	53.118*	56.2432*

Note: *Star (*) indicates the minimum value of the criterion among different lag order*

3.3 Estimation of the model

To estimate the VECM model, the first step to be taken is determination of the optimum lag by comparing every lag using the mentioned criteria. The following table reports lag-order selection statistics. From the following table, it can be observed that at lag order two, all the selection criteria: *AIC, HQIC, SBIC,* and *LR* give a minimum value, so we precede subsequent tests with lag 2 and co-integration rank. Hence, the VECM (p) model which is used is VECM (2).

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SBIC: Schwarz information criterion
HQIC: Hannan-Quinn information criterion

Table 4. Vector Error Correction Model

Cointegrating Equations			
Equation	Parms	Chi2	P>Chi2
_ce1	4	962.7975	0.000
_ce2	4	1220.795	0.000
Identification: beta is exactly identified			

Johansen Normalization Restrictions Imposed							
Beta		Coeficient	Std. Err.	Z	P>|z|	95% CI	
_ce1	RGDP	1	.	.	.	.	.
	FDI	-1.73E-18	.	.	.	.	.
	Exchange	-0.2628121	0.0260611	-10.08	0.0000	-0.3138909	-0.211733
	Remittance	0.0003727	0.0001427	2.61	0.009	0.000093	0.0006524
	Export	-0.0000816	0.0000824	-0.99	0.322	-0.0002431	0.0000798
	Inflation	-1.022765	0.0618126	-16.55	0.0000	-1.143916	-0.901615
	_cons	11.08708	.	.	.	.	.
_ce2	RGDP	0	(Omitted)				
	FDI	1	.	.	.	.	.
	Exchange	-53.10445	7.847831	-6.77	0.0000	-68.48591	-37.72298
	Remittance	0.0531067	0.0429744	1.24	0.217	-0.0311216	0.137335
	Export	-0.0591021	0.024803	-2.38	0.017	-0.107715	-0.010489
	Inflation	-232.678	18.61374	-12.5	0.0000	-269.1603	-196.1957
	_cons	2935.642	.	.	.	.	.

Hence, the *VECM (2)* model is

$$RGDP = -1.73e^{-18}FDI - 0.2628121Exchange + 0.0003727Remittance - 0.0000816Export - 1.022765Inflation - 11.08708$$

From the above equation, it can be interpreted that a one percent rise in remittances would increase RGDP growth by 0.000373% in the long-run, and the estimate is significant. Furthermore, a 1% increase in FDI, exchange rate, exports, and inflation requires us to reduce RGDP growth by 0.000000026%, 0.26281%, 0.0000816%, and 1.0228% in the long run, respectively. That means FDI, exchange, remittance, export, and inflation have significant effects on RGDP in the long-run.

Table 5. Results of normality of residuals for VECM model

Jarque-Bera Test			
Equation	chi2	df	Prob > chi2
D_RGDP	0.416	2	0.81227
D_FDI	1.503	2	0.47169
D_Exchange	0.598	2	0.74165
D_Remittance	0.667	2	0.71649
D_Export	1.266	2	0.53097
D_Inflation	0.243	2	0.88576
All	4.692	12	0.96748

H_0: *Residuals are Normally Distributed*

The above table displays that the null hypotheses are not rejected in the Jarque-Bera test for all residuals, indicating that they are normal. Therefore, we conclude that the residuals are normally distributed with 95% level of significance.

3.4 Granger Causality Test

Granger Causality test is performed to analyze the causality between variables and determine the direction of the causality of the systems.

Table 6. Granger Causality Test

Null Hypothesis	Obs	F-Statistic	Prob.
FDI does not Granger Cause RGDP	20	3.2676	0.0664
RGDP does not Granger Cause FDI		1.44219	0.2674
EXCHANGE does not Granger Cause RGDP	20	2.75515	0.0957
RGDP does not Granger Cause EXCHANGE		3.73136	0.0484
REMITTANCE does not Granger Cause RGDP	20	2.39956	0.1247
RGDP does not Granger Cause REMITTANCE		2.02426	0.1666
EXPORT does not Granger Cause RGDP	20	2.53197	0.1129
RGDP does not Granger Cause Export		0.36264	0.7018
INFLATION does not Granger Cause RGDP	20	0.40503	0.674
RGDP does not Granger Cause INFLATION		0.58975	0.5668
EXCHANGE does not Granger Cause FDI	20	1.77603	0.2031
FDI does not Granger Cause EXCHANGE		0.01517	0.985
REMITTANCE does not Granger Cause FDI	20	4.02141	0.04
FDI does not Granger Cause REMITTANCE		0.02375	0.9766
EXPORT does not Granger Cause FDI	20	6.06338	0.0118
FDI does not Granger Cause EXPORT		0.58879	0.5673
INFLATION does not Granger Cause FDI	20	0.51318	0.6087
FDI does not Granger Cause INFLATION		0.78446	0.4742
REMITTANCE does not Granger Cause EXCHANGE	20	1.25569	0.3132
EXCHANGE does not Granger Cause REMITTANCE		2.78288	0.0938
EXPORT does not Granger Cause EXCHANGE	20	4.05726	0.039
EXCHANGE does not Granger Cause EXPORT		2.48926	0.1165
INFLATION does not Granger Cause EXCHANGE	20	0.1051	0.9009
EXCHANGE does not Granger Cause INFLATION		1.37066	0.284
EXPORT does not Granger Cause REMITTANCE	20	0.03309	0.9675
REMITTANCE does not Granger Cause EXPORT		9.46554	0.0022
INFLATION does not Granger Cause REMITTANCE	20	1.36758	0.2847
REMITTANCE does not Granger Cause INFLATION		3.14835	0.0722
INFLATION does not Granger Cause EXPORT	20	0.97244	0.4008
EXPORT does not Granger Cause INFLATION		1.47134	0.2609

The above table provides the result of pair wise analysis. Thus, the Granger Causality test at a 5% level of significance is used in the study to examine the cause-and-effect relationship among variables. P-values are used to make a decision about the null hypothesis. The study rejects the null hypothesis if the P-value is less than

or equal to the significant level, which is 0.05. It otherwise accepts the null hypothesis. It is found that the majority of the variables are Granger-causal for RGDP at significant level. However, there is unidirectional causality between Exchange and RGDP, Remittance and FDI, Export and FDI, Export and Exchange, Export and Remittance. Also, there is no causality between FDI and RGDP, REMITTANCE and RGDP, EXPORT and RGDP, INFLATION and RGDP, EXCHANGE and FDI, INFLATION and FDI, REMITTANCE and EXCHANGE, INFLATION and EXCHANGE, INFLATION and REMITTANCE, and INFLATION and EXPORT.

3.5 Impulse response Function (IRF)

The Impulse Response Functions provide information to analyze the dynamic behavior of a variable due to a random shock or innovation in other variables. Specifically, the Impulse Response Functions trace out the effects on current and future values of the endogenous variables of one standard deviation shock to a variable. The study uses impulse response function as an additional check of the co-integration test's findings. Cholesktypes of contemporaneous identifying restrictions are employed to draw a meaningful interpretation. The recursive structure assumes that variables appearing first contemporaneously influence these latter variables but not vice versa. It is important to list the most exogeneous looking variables earlier than the most endogenous looking variables.

The initial responses of GDP to a unit change of FDI, exchange, remittance, and export are feeble, but the response of GDP has started oscillating over increasing time. On the other hand, the initial response of GDP to a unit change in inflation is neutral, i.e., irresponsive.

3.6 Variance Decomposition Analysis

The following table shows the outcomes of variance decomposition of RGDP. This research is used as an additional evidence to provide more information about the variance relationships between GDP and macroeconomic variables.

The results of Table 7 of the variance decomposition of RGDP show that by the fourth year period, approximately 85.7% of the variance in RGDP is portrayed by 6.81% of variance in remittance, 0.133% of variance in inflation rate, 4.87% of variance in FDI, 1.17% of variance in export, and 1.34% of variance in exchange rate. The 6.67% variation in RGDP is represented by a 24.17% variation in remittances, a 0.06% variation in the inflation rate, a 54.6% variation in FDI, a 7.29% variation in export, and a 7.23% variation in the exchange rate.

Table 7. Variance decomposition of RGDP

Variance Decomposition of RGDP							
Period	S.E.	RGDP	FDI	Exchange	Remittance	Export	Inflation
1	0.704	100	0.000	0.000	0.000	0.000	0.000
2	1.025	90.877	3.135	0.706	4.886	0.395	0.002
3	1.080	89.716	2.964	1.176	4.844	1.178	0.122
4	1.105	85.689	4.867	1.338	6.805	1.168	0.133
5	1.231	69.592	16.255	4.649	7.393	1.826	0.284
6	1.335	59.350	21.993	3.959	9.914	4.494	0.290
7	1.588	42.498	30.726	5.038	17.133	4.398	0.207
8	1.959	28.154	39.972	7.925	18.046	5.701	0.202
9	2.837	13.443	50.004	8.083	22.681	5.689	0.100
10	4.055	6.670	54.577	7.231	24.171	7.292	0.059

Note: *The purpose of the study is to find out the impact of macroeconomic variables on GDP, that's why impact of macroeconomic variables on GDP is scrutinized only.*

4. Discussion

The main purpose of this study is to model the GDP of Bangladesh using the Vector Error Correction Model (VECM). There are also five specific objectives of this study; (i) examining the cointegration link between the series variables, (ii) determining the long-run equilibrium relationship between all variables, (iii) examining the causal relationships between all variables, (iv) explaining the impluse response function between the series variables. (v) Describe the series variables' variance decomposition.

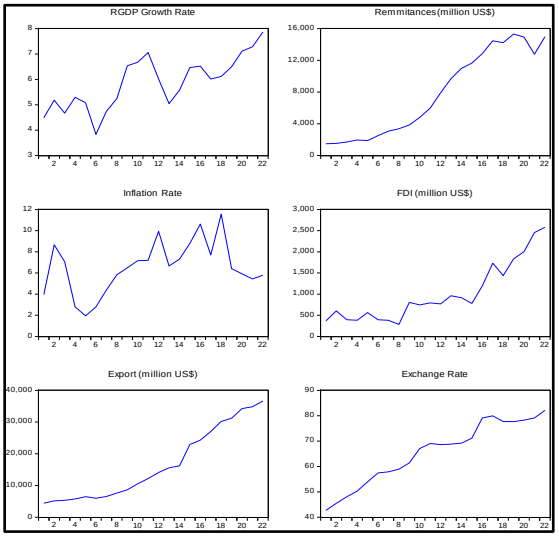
The study discloses the presence of a long-run equilibrium relationship between real GDP growth, FDI, the exchange rate, remittance, exports, and inflation based on the evidence from the Johansen Co-integration test. The long-term relationship indicates that the contribution of remittances to GDP growth is positive while FDI, exchange, exports, and inflation have a negative contribution to GDP. It can be noted that, though generally, export and inflation have a positive effect on GDP, our study designates the adverse relationship between inflation and GDP as well as between export and GDP. This may occur because of the presence of extreme values in the data, and over the period studied, Bangladesh seems to have experienced export-led growth. The works of Mallik and Choudhry (2001) and Bruno and Easterly (1998) see inflation as harmful to a country's economic growth. The findings of these studies confirmed the findings of Dornbush (1993), who concluded that there are extreme values that influence the relationship between economic growth and inflation. Bruno and Easterly (1998) analyzed and concluded that economic growth in any country suffers greatly during periods of high inflation and then improves immediately when inflation falls. According to Jung and Marshall (1985), increasing exports from some forms of inward foreign direct investment may reduce domestic output owing to different distortions. According to Dodaro (1993), export growth may lead to a decline in output growth when exports are promoted at the expense of domestic consumption and efficiency, while Kemal et al. (2002) point out that adopting export-led growth strategies by a number of less developed countries at the same time may be self-defeating due to excessive competition in the global market.

The Granger Causality test indicates a unidirectional causality between exchange and RGDP, remittance and FDI, export and FDI, export and exchange, export and remittance. The estimated coefficient of ECT in the real GDP growth equation is statistically significant and has a negative sign, which confirms the existence of a long-run equilibrium relationship between the independent and dependent variables at 5 per cent level of significance. Based on the graph of the Impulse Response Function (IRF), the study establishes that the response of GDP toward the shock of FDI, Remittance, Exchange and Export is oscillating over time. Furthermore, Variance Decomposition publishes that the variance in GDP is primarily explained by remittances and FDI.

5. Conclusion

Based on the discussion and results detailed above, we can conclude that there is a long-run relationship between GDP growth and these macroeconomic variables. Specifically, these findings indicate that remittances have a positive impact on GDP growth. So, the government should take care of this sector very carefully and ensure the upward flow of remittances into the country. This sector will help to boost GDP. Since the statistical research of this study exhibits a negative correlation between FDI and GDP, it may be a concern for the government of Bangladesh. A low-capital country like Bangladesh cannot ignore the significance of foreign investment for sustainable growth. It is found in many studies that FDI plays a significant role in improving the GDP growth of foreign countries. That's why future research should be focused on finding solutions to this problem and trying to better understand the role of FDI in Bangladesh.

Appendix



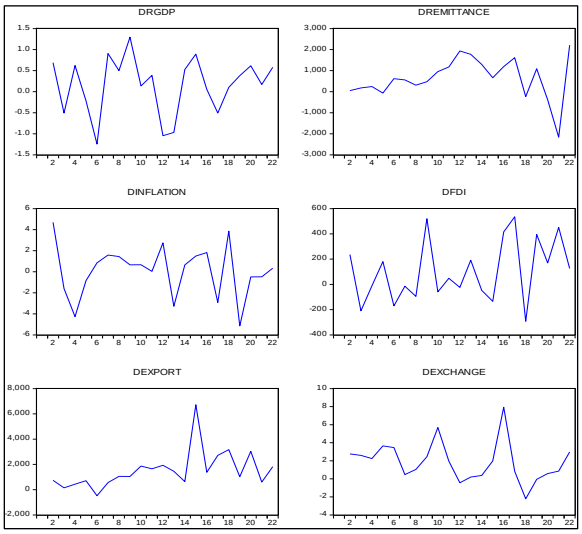
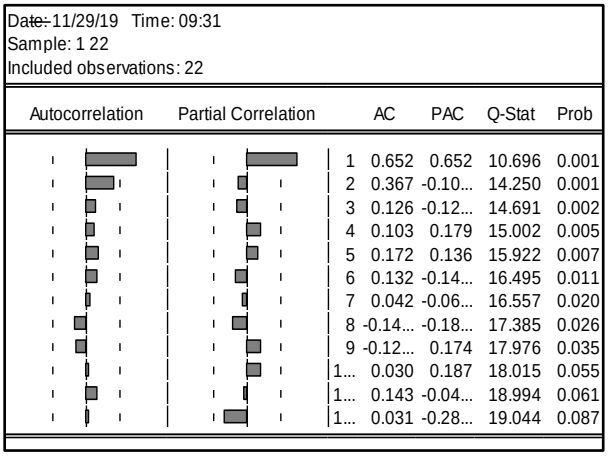
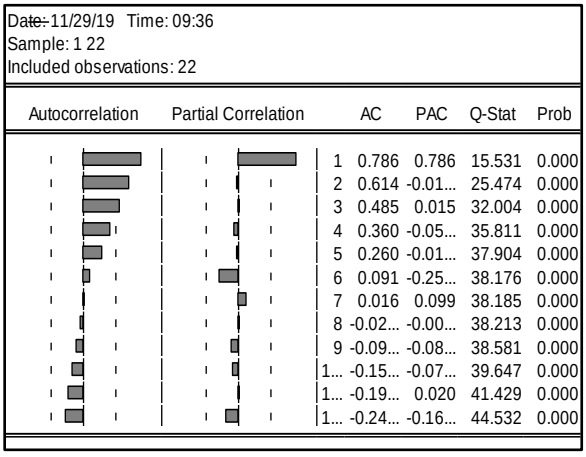


Figure 1.1. Time Series Plots at levels


Date: 11/29/19 Time: 09:31
Sample: 1 22
Included observations: 22

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.652	0.652	10.696	0.001
		2	0.367	-0.10...	14.250	0.001
		3	0.126	-0.12...	14.691	0.002
		4	0.103	0.179	15.002	0.005
		5	0.172	0.136	15.922	0.007
		6	0.132	-0.14...	16.495	0.011
		7	0.042	-0.06...	16.557	0.020
		8	-0.14...	-0.18...	17.385	0.026
		9	-0.12...	0.174	17.976	0.035
		1...	0.030	0.187	18.015	0.055
		1...	0.143	-0.04...	18.994	0.061
		1...	0.031	-0.28...	19.044	0.087

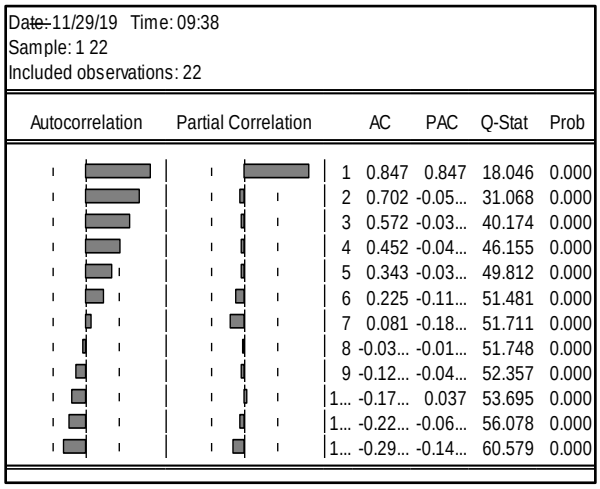
Figure 1.2. Time Series Plots after first difference


Date: 11/29/19 Time: 09:36
Sample: 1 22
Included observations: 22

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.786	0.786	15.531	0.000
		2	0.614	-0.01...	25.474	0.000
		3	0.485	0.015	32.004	0.000
		4	0.360	-0.05...	35.811	0.000
		5	0.260	-0.01...	37.904	0.000
		6	0.091	-0.25...	38.176	0.000
		7	0.016	0.099	38.185	0.000
		8	-0.02...	-0.00...	38.213	0.000
		9	-0.09...	-0.08...	38.581	0.000
		1...	-0.15...	-0.07...	39.647	0.000
		1...	-0.19...	0.020	41.429	0.000
		1...	-0.24...	-0.16...	44.532	0.000

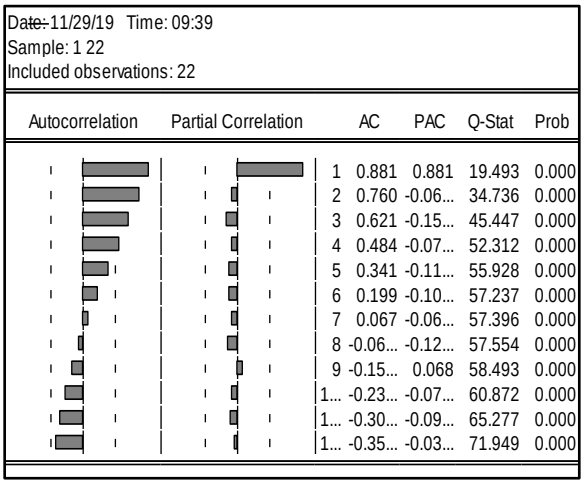
Figure 2.1. Correlogram of RGDP

Figure 2.2. Correlogram of FDI


Date: 11/29/19 Time: 09:38
Sample: 1 22
Included observations: 22

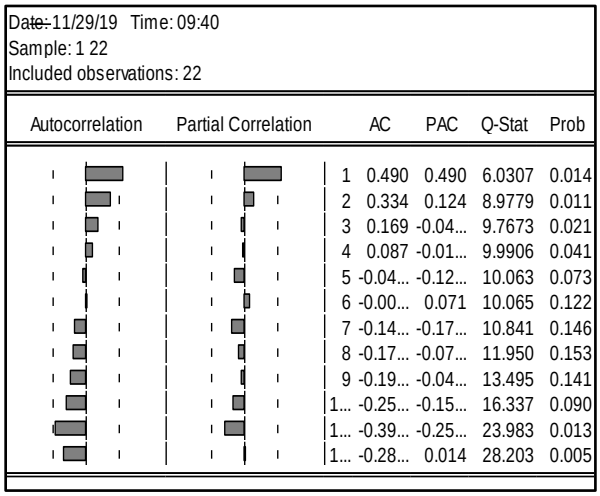
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.847	0.847	18.046	0.000
		2	0.702	-0.05...	31.068	0.000
		3	0.572	-0.03...	40.174	0.000
		4	0.452	-0.04...	46.155	0.000
		5	0.343	-0.03...	49.812	0.000
		6	0.225	-0.11...	51.481	0.000
		7	0.081	-0.18...	51.711	0.000
		8	-0.03...	-0.01...	51.748	0.000
		9	-0.12...	-0.04...	52.357	0.000
		1...	-0.17...	0.037	53.695	0.000
		1...	-0.22...	-0.06...	56.078	0.000
		1...	-0.29...	-0.14...	60.579	0.000

Figure 2.3. Correlogram of Exchange


Date: 11/29/19 Time: 09:39
Sample: 1 22
Included observations: 22

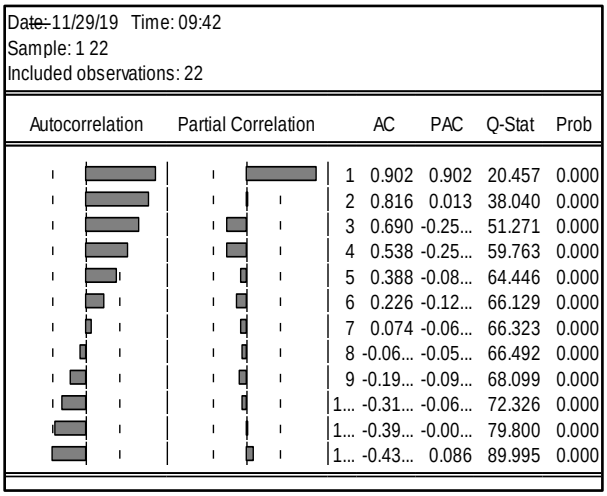
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.881	0.881	19.493	0.000
		2	0.760	-0.06...	34.736	0.000
		3	0.621	-0.15...	45.447	0.000
		4	0.484	-0.07...	52.312	0.000
		5	0.341	-0.11...	55.928	0.000
		6	0.199	-0.10...	57.237	0.000
		7	0.067	-0.06...	57.396	0.000
		8	-0.06...	-0.12...	57.554	0.000
		9	-0.15...	0.068	58.493	0.000
		1...	-0.23...	-0.07...	60.872	0.000
		1...	-0.30...	-0.09...	65.277	0.000
		1...	-0.35...	-0.03...	71.949	0.000

Figure 2.4. Correlogram of Export


Date: 11/29/19 Time: 09:40
Sample: 1 22
Included observations: 22

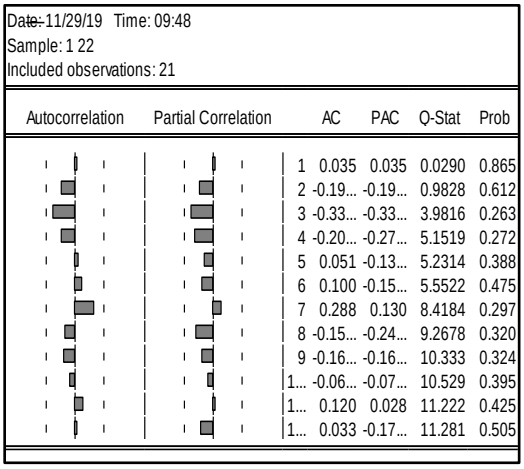
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.490	0.490	6.0307	0.014
		2	0.334	0.124	8.9779	0.011
		3	0.169	-0.04...	9.7673	0.021
		4	0.087	-0.01...	9.9906	0.041
		5	-0.04...	-0.12...	10.063	0.073
		6	-0.00...	0.071	10.065	0.122
		7	-0.14...	-0.17...	10.841	0.146
		8	-0.17...	-0.07...	11.950	0.153
		9	-0.19...	-0.04...	13.495	0.141
		1...	-0.25...	-0.15...	16.337	0.090
		1...	-0.39...	-0.25...	23.983	0.013
		1...	-0.28...	0.014	28.203	0.005

Figure 2.5. Correlogram of Inflation


Date: 11/29/19 Time: 09:42
Sample: 1 22
Included observations: 22

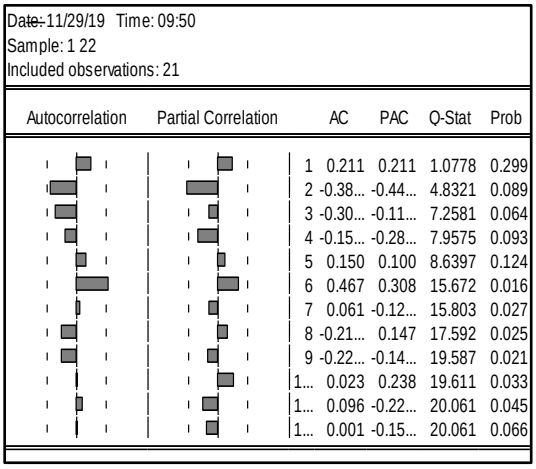
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.902	0.902	20.457	0.000
		2	0.816	0.013	38.040	0.000
		3	0.690	-0.25...	51.271	0.000
		4	0.538	-0.25...	59.763	0.000
		5	0.388	-0.08...	64.446	0.000
		6	0.226	-0.12...	66.129	0.000
		7	0.074	-0.06...	66.323	0.000
		8	-0.06...	-0.05...	66.492	0.000
		9	-0.19...	-0.09...	68.099	0.000
		1...	-0.31...	-0.06...	72.326	0.000
		1...	-0.39...	-0.00...	79.800	0.000
		1...	-0.43...	0.086	89.995	0.000

Figure 2.6. Correlogram of Remittance


Date: 11/29/19 Time: 09:48
Sample: 1 22
Included observations: 21

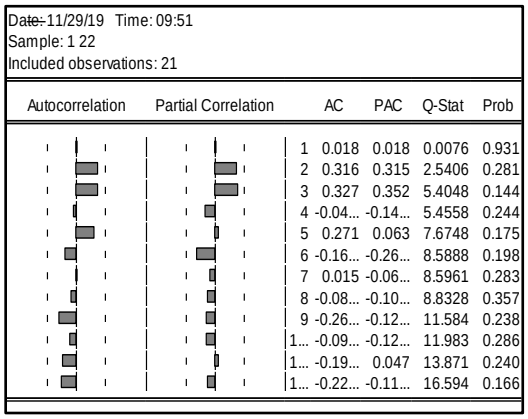
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.035	0.035	0.0290	0.865
		2	-0.19...	-0.19...	0.9828	0.612
		3	-0.33...	-0.33...	3.9816	0.263
		4	-0.20...	-0.27...	5.1519	0.272
		5	0.051	-0.13...	5.2314	0.388
		6	0.100	-0.15...	5.5522	0.475
		7	0.288	0.130	8.4184	0.297
		8	-0.15...	-0.24...	9.2678	0.320
		9	-0.16...	-0.16...	10.333	0.324
		1...	-0.06...	-0.07...	10.529	0.395
		1...	0.120	0.028	11.222	0.425
		1...	0.033	-0.17...	11.281	0.505

Figure 3.1. Correlogram of DRGDP


Date: 11/29/19 Time: 09:50
Sample: 1 22
Included observations: 21

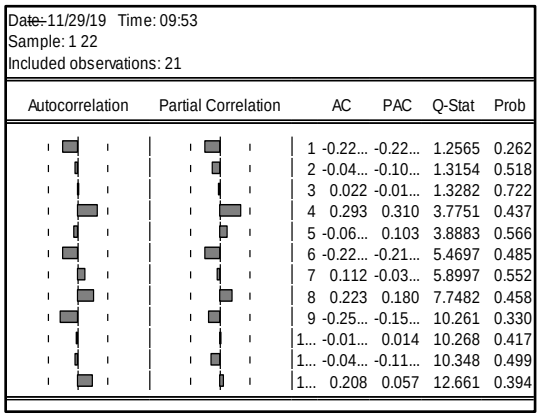
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.211	0.211	1.0778	0.299
		2	-0.38...	-0.44...	4.8321	0.089
		3	-0.30...	-0.11...	7.2581	0.064
		4	-0.15...	-0.28...	7.9575	0.093
		5	0.150	0.100	8.6397	0.124
		6	0.467	0.308	15.672	0.016
		7	0.061	-0.12...	15.803	0.027
		8	-0.21...	0.147	17.592	0.025
		9	-0.22...	-0.14...	19.587	0.021
		1...	0.023	0.238	19.611	0.033
		1...	0.096	-0.22...	20.061	0.045
		1...	0.001	-0.15...	20.061	0.066

Figure 3.2. Correlogram of DExchang


Date: 11/29/19 Time: 09:51
Sample: 1 22
Included observations: 21

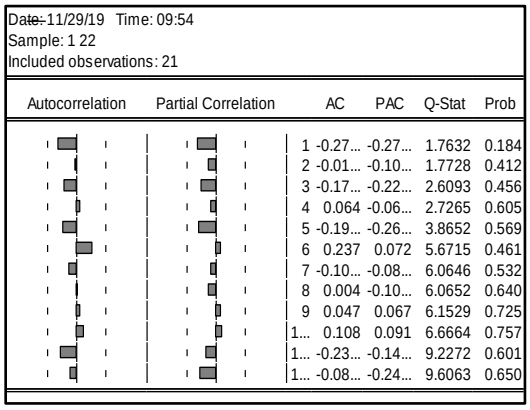
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.018	0.018	0.0076	0.931
		2	0.316	0.315	2.5406	0.281
		3	0.327	0.352	5.4048	0.144
		4	-0.04...	-0.14...	5.4558	0.244
		5	0.271	0.063	7.6748	0.175
		6	-0.16...	-0.26...	8.5888	0.198
		7	0.015	-0.06...	8.5961	0.283
		8	-0.08...	-0.10...	8.8328	0.357
		9	-0.26...	-0.12...	11.584	0.238
		1...	-0.09...	-0.12...	11.983	0.286
		1...	-0.19...	0.047	13.871	0.240
		1...	-0.22...	-0.11...	16.594	0.166

Figure 3.3. Correlogram of DExport


Date: 11/29/19 Time: 09:53
Sample: 1 22
Included observations: 21

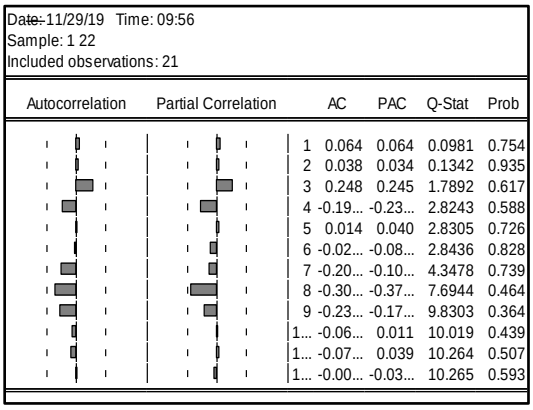
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.22...	-0.22...	1.2565	0.262
		2	-0.04...	-0.10...	1.3154	0.518
		3	0.022	-0.01...	1.3282	0.722
		4	0.293	0.310	3.7751	0.437
		5	-0.06...	0.103	3.8883	0.566
		6	-0.22...	-0.21...	5.4697	0.485
		7	0.112	-0.03...	5.8997	0.552
		8	0.223	0.180	7.7482	0.458
		9	-0.25...	-0.15...	10.261	0.330
		1...	-0.01...	0.014	10.268	0.417
		1...	-0.04...	-0.11...	10.348	0.499
		1...	0.208	0.057	12.661	0.394

Figure 3.4. Correlogram of DFDI


Date: 11/29/19 Time: 09:54
Sample: 1 22
Included observations: 21

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.27...	-0.27...	1.7632	0.184
		2	-0.01...	-0.10...	1.7728	0.412
		3	-0.17...	-0.22...	2.6093	0.456
		4	0.064	-0.06...	2.7265	0.605
		5	-0.19...	-0.26...	3.8652	0.569
		6	0.237	0.072	5.6715	0.461
		7	-0.10...	-0.08...	6.0646	0.532
		8	0.004	-0.10...	6.0652	0.640
		9	0.047	0.067	6.1529	0.725
		1...	0.108	0.091	6.6664	0.757
		1...	-0.23...	-0.14...	9.2272	0.601
		1...	-0.08...	-0.24...	9.6063	0.650

Figure 3.5. Correlogram of DInflation


Date: 11/29/19 Time: 09:56
Sample: 1 22
Included observations: 21

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.064	0.064	0.0981	0.754
		2	0.038	0.034	0.1342	0.935
		3	0.248	0.245	1.7892	0.617
		4	-0.19...	-0.23...	2.8243	0.588
		5	0.014	0.040	2.8305	0.726
		6	-0.02...	-0.08...	2.8436	0.828
		7	-0.20...	-0.10...	4.3478	0.739
		8	-0.30...	-0.37...	7.6944	0.464
		9	-0.23...	-0.17...	9.8303	0.364
		1...	-0.06...	0.011	10.019	0.439
		1...	-0.07...	0.039	10.264	0.507
		1...	-0.00...	-0.03...	10.265	0.593

Figure 3.6. Correlogram of DRemittanc

References

Adela, D. (2016). The impact of remittances on economic growth: An econometric model. *Science Direct.* 18(2), http://sciencedirect. com/science/journal/ 15177580.

Dutt, A. (1997). The pattern of direct foreign investment and economic growth. *World Development,* 25(11): 1925-1936.

Antwi, E. A. (2013). The Impact of Macroeconomic Variables on Gross Domestic Product:

Empirrical Evidence from Ghana. *International Business Research*. 6(5) : 2013.

Brecher, R. A., & Diaz-Alejandro, C. F. (1977). Tariffs, Foreign Capital, and Immiserizing Growth. *Journal of International Economics*, 7(4): 317–322.

Emmanuel, A. (2015). Modelling GDP using Vector Autoregressive (VAR) models: An empirical from Ghana. http://197.2555.68.203/handle/123456789/8154.

Fry, M. (1993). Some lessons for South Asia from developing country experience with foreign direct investment. The World Bank, Washington D.C. Report No.: IDP-127, Type:IDP.

Kemal A.R., Din, M., Qadir, U., Fernando, L. and Colombage S.S. (2002) *Exports and economic growth in South Asia*, South Asia Network of Economic Research Institutes, Islamabad. http://thepdr.pk/pdr/index.php/pdr/article/download/1956/1996.

Mallik & Choudhry (2001). Inflation and Economic Growth: Evidence from Four South Asian Countries. *Asia-Pacific Development Journal* , 8(1).

Ning. (2010). Analysis and forecast of Shaanxi GDP based on the ARIMA Model. *Asian Agriculture Research*, 2(1): 34-41.

Ozler, S. (1988). Export Instability and Growth. [Working Paper] No. 486 (University of California, Los Angeles), CA 90024.

Senhadji, M. S. (2001). Threshold Effects in the Relationship Between Inflation and Growth. *IMF Eorking Paper, WP/00/110*.

Statistical Yearbook, http://www.bbs.gov.bd/site/page/29855dc1-f2b4-4dc0-9073-f692361112da/Statistical-Yearbook

https://scroll.in/article/976457/why-is-bangladeshs-gdp-growing-despite-covid-19-while-other-economies-are-contracting