An empirical investigation of Internet usage, Electricity consumption and Economic growth nexus in Bangladesh: A Granger causality approach

SubrotoDey[1] & Homamul Islam[2] shakil mahmood saon[3]

[1]Lecturer, Department of Economics, Mawlana Bhashani Science and Technology University, Tangail, Bangladesh.
[2]Student, Department of Economics, Mawlana Bhashani Science and Technology University, Tangail, Bangladesh.
[3] Lecturer, Department of Economics, Mawlana Bhashani Science and Technology University, Tangail, Bangladesh.

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Abstract: The influence of internet facilities and electric power supply on economic growth is significant today. Several studies have been tested the causal relationship between internet usage, electricity consumption, and economic growth. Most of these studies carried on panel data analysis to show there causal relationship, i.e. Australia, China, India, South Africa. All of this has provided mixed results. This study, on the other hand, investigated the relationship between internet usages, electricity consumption and economic growth in Bangladesh. In order to investigate, we have used annual time series data of Bangladesh for the period of 1994-2018. To diagnosis time-series property of the data, the Augmented Dickey-Fuller (ADF) model for the unit root has been employed. Short-run and long-run dynamics and joint causality have been demonstrated by using a Vector Error Correction Model (VECM) and Granger causality test. Johansen co-integration test suggests co-integrated variables exist among variables. Vector Error Correction Model (VECM) revealed that there exist significant long-run and short-run relationships among variables and Granger causality test showed there was bidirectional causality among internet usage and electricity consumption to gross domestic product (GDP). This study also considered foreign direct investment and export earning as two control variables. This finding reveals the importance of power supply and internet usage for economic growth in Bangladesh.

Keywords: GDP, Internet use, Electricity consumption, FDI, Export, ADF test, Johansen co-integration, VECM, Granger causality

Introduction

Economic growth is a desirable phenomenon for every country but accelerates economic growth in an underdeveloped economy becomes a difficult task. Historical evidence reveals that many countries come to be developed in different ways. Natural resources and geographical location bounded to be important factors for economic growth. Classical growth theory [3] express that desirable economic growth inaugurated by shifting excess labor forces from agriculture to industrial sector where neo-classical theory [4] says economic growth comes from technological advancement. Neo-classical theory answers many countries growth problem but this theory ignores the role of labor force. After 1985 new theory of growth emerges. New theory [5] explains the pitfall of neo-classical theory. New theory exerts that economic growth comes from developing human capital because

[1]Lecturer, Department of Economics, Mawlana Bhashani Science and Technology University, Tangail, Bangladesh. e-mail: subrotodey2216@gmail.com
[2]Student, Department of Economics, Mawlana Bhashani Science and Technology University, Tangail, Bangladesh. e-mail: homamulmbstu@gmail.com
[3] Lecturer, Department of Economics, Mawlana Bhashani Science and Technology University, Tangail, Bangladesh. e-mail: shakilmahmood7053@gmail.com

[3] Classical growth theory was developed by economists during the period between industrial revolution and 1956.
[4] Growth theory between time period 1956 to mid-1980s are termed as neoclassical or exogenous growth theory, Robert Solow and Trevor Swan first introduced the neoclassical growth theory in 1956.
[5] After mid-1980s, till today growth theory referred as new theory. New theory also referred as endogenous growth theory.

human has the capacity to innovate and only new innovation accelerate economic growth in the long run. Knowledge spillover [6] spread these innovative ideas from one firm to another and from one country to other. So every modern government wants to take appropriate policy to increase investment in human capital for multiple developments.

In this study, we take an attempt to investigate some factors which accelerate economic growth in Bangladesh. Among them, we take two important factors which currently lauded i.e. internet and electricity.

Internet usage is one of the important conducive factors for knowledge spillover. By using internet people get almost all kind of information around the world and uses this for taking better economic decision. Internet makes entire world like a global village. It increases the productivity of human capital and also helps to bringing the market mechanism to be in equilibrium.

Internet usage in Bangladesh has been increasing rapidly since the entrance of internet in Bangladeshsince early 1990s. After 2014 there has been a rapid growth in the number of internet users. The internet is a comprehensive technology that supports the real economy by improving access to market information, facilitating business processes and creating new jobs, and enhancing the economy's performance. Now a day's many economic activities directly depend on internet like e-commerce, internet base freelancing[7], transport agency, online banking etc. According to Oxford Internet Institute (OII) [8]of Oxford University in the UK, Bangladesh now contributes 16.8% of all outsourced online workers in the world, a rate which is second only to India on 24.6%. Its market value is about 100 million US$. There are about 650,000 registered freelancers in Bangladesh of them 500,000 are online freelancer whose earning activity depends on internet facilities. In this purposes internet directly reduces the deadly problem of youth unemployment in Bangladesh's-commerce is playing a leading role now for income generation for urban young and educated groups, who are involved different kinds of economic and business initiatives, without direct engagement in job market and formal sector. It's highly mentionable that e-commerce has already been recognized as growth sector and an energetic segment for generation income and contributing source for GDP. Bangladesh observed a sharp upward growth in ride-sharing space[9] with the emergence of Pahoa, the most popular local ride sharing company which got off the ground in 2016 and the entrance of Uber[10] in Bangladesh market in late 2016. As of November 2017, an estimated 500,000 commuters have opted to avail ride-hailing on cars and bikes via apps also known as e-hailing. This area has been also counted as new contributing sector in GDP.

On the other hand, electricity is an inseparable factor in production activity. Industrial and agricultural production now largely depends on continuous electricity supply. According to "The world bank in Bangladesh" report published in 2019, unreliable power supply leads to voltage drops and outages resulting in about 2 percent loss of gross domestic product (GDP) in Bangladesh.

According to World Bank 93% of the people of Bangladesh have access to electricity in 2019, which was only 47 percent before 2009. Now total electricity installed capacity is about 21,419 megawatt (MW) as of September, 2019 and maximum electricity generation in 2019 is 12738.00 megawatt (MW) as on 5 August, 2019.

Bangladesh government takes a long run policy to expand electricity production and support future increase demand for electricity. The BPDB[11] has taken up an extensive capacity expansion plan to add about 11,600 megawatt over the next five years, aiming to generate 24,000 megawatt of electricity by 2021, and 40,000 megawatt by 2030, for which a mammoth investment of around $80 billion is needed. Bangladesh will need an estimated 34,000 megawatt of electricity supply by 2030 to sustain its economic growth of over 7 percent. Recently

[6] Knowledge spillover is an exchange of ideas among individuals.
[7] Online freelancer is a person who offer his services on a contractual base and contract together in online.
[8]Oxford Internet Institute (OII) is a multidisciplinary research and teaching department of the University of Oxford, dedicated to the social science of the Internet.
[9] Ride-sharing services are companies that match drivers of private vehicles to those seeking local taxicab like transportation.
[10]Uber is an American multinational ride-sharing company; its platforms can be accessed via its websites and mobile apps.
[11] BPDB means Bangladesh Power Development Board.

Bangladesh started construction of the 2.4-gigawatt (GW) Rooppur Nuclear Power Plant expected to go into operation in 2024. Given the potential importance of these two factors, current study investigates the impact of this into economic growth in Bangladesh.

Literature Review

Economic growth has voluminous impact on the development of any economy. In previous time, numerous authors study the determinant of this economic growth. Empirical study find that electricity and internet has the important determinants for achieving high level of economic growth though they do not have any large direct impact on gross domestic product but they both improve the productivity of factors of production which indirectly have large impact on gross domestic product. For this reason, large number of study has been undertaken in this ground. Most of the previous work about economic impact of internet and electricity are panel analysis. Some of this previous study has been cited here.

Afzal et al. (2019) their study investigate the impact of information communication technology and economic growth on electricity consumption for a panel consisting of five emerging economic powerhouses, namely Brazil, Russia, India, China and South Africa. Their finding shows a positive and statistically significant effect of information communication technology uptake on electricity consumption. They also find that economic growth also has a positive and statistically significant effect on electricity consumption in these five countries.

Ahamad et al. (2011) they examine the causal relationship between per capita electricity consumption and per capita GDP of Bangladesh using the vector error correction specified Granger causality test to search their short-run, long-run and joint causal relationships for the period of 1971–2008. Empirical findings reveal that there is a short-run unidirectional causal flow running from per capita electricity consumption to per capita GDP without feedback. Joint causality reveals that lag electricity jointly causes per capita GDP. By contrast, long-run results show a bi-directional causality running from electricity consumption to economic growth with feedback.

Bakari, Sayef (2019) in their article using 76 developed and developing countries panel data and use panel ARDL model, in their paper empirical results indicate that there is a positive unidirectional long run relationship between innovation and economic growth. They also find that the internet has a positive effect on innovation and economic growth in the long run.

Begum et al. (2018) they estimates the long-run association between FDI and economic growth for Bangladesh. Results from dynamic ordinary least squares demonstrate positive and significant long-run relationship between FDI and economic growth. Bidirectional causality also exists between them.

Choi, C., &Hoon Yi, M. (2009) they find that the internet plays a positive and significant role in economic growth after investment ratio, government consumption ratio, and inflation is used as control variables in the growth equation using cross-country panel data.

Hussain, M., &Haque, M. (2016) their study reveals that there is a relationship between foreign direct investments, trade, and growth rate of per capita GDP for Bangladesh. The Vector Error Correction Model (VECM) analysis shows that there is a long-term relationship between these variables.

Khatun, F., &Ahamad, M. (2015) in this paper they present a discussion on energy and power situation of Bangladesh, and examine the causal relationship between FDI in the energy and power sector, and economic growth. They find that there are robust positive and unidirectional short-run causal relationships running from FDI to energy use and from energy use to GDP growth.

Kumari, A., & Sharma, A. K. (2018) postulates the causal directions among FDI, electricity consumption, and GDP in India, using the ADF Unit Root Test, Johansen co-integration approach, Granger causality, and VECM. Granger causality analyses confirm two unidirectional causalities from electricity consumption to GDP and GDP to FDI and bidirectional causality between electricity consumption and FDI.

Pradhan et al. (2013) their study investigates the causal relationships between internet, economic growth, government expenditure and inflation in 34 OECD [12] countries. Using panel co-integration, empirical results show that they are co-integrated. Moreover, there exists bidirectional causality between internet and economic growth, inflation and economic growth and inflation and internet.

Raza, S. A., Jawaid, S. T., &Siddiqui, M. H. (2016) their study investigates the effect of electricity consumption on economic growth of four South Asian countries, namely Pakistan, India, Bangladesh and Sri Lanka, by employing time series annual data from 1980 to 2010. Pedroni's panel co-integration results confirm that there exists valid long-run relationship between electricity consumption and economic growth in South Asia. Results of random effects model suggest the positive and significant impact of electricity consumption on economic growth. Results of panel Granger causality test confirm the unidirectional causal relationship runs from electricity consumption to economic growth

Salahuddin, M., &Alam, K. (2015) their study estimates the short- and long-run effects of the internet usage and economic growth on electricity consumption using annual time series macro data for Australia for the period 1985–2012. ARDL bounds test for co-integration and Granger causality test for causal link are applied. Results from ARDL indicate that the internet use and economic growth stimulate electricity consumption. Internet usage and economic growth have no significant short-run relationship with electricity consumption. Multivariate Granger causality test confirm unidirectional causal link running from internet usage to economic growth and electricity consumption.

Salahuddin, M., &Gow, J. (2016) they estimates the effects of internet usage, financial development and trade openness on economic growth using unit root test and Johansen and ARDL co-integration tests for South Africa. Findings from ARDL co-integration tests indicate a long-run relationship between the variables. Results from the ARDL estimates indicate a positive and significant long run relationship between internet usage and economic growth. The Granger causality test reveals that both internet usage and financial development Granger-cause economic growth in South Africa.

Samad, A. (2019) they investigate the causal relation between export, economic growth, and financial development of nine South and South East Asian countries during 1974-2015. The significance of the error correction term (ECT) established short and long run dynamics.

Sarker, M. A. R., &Alam, K. (2010) they employs Granger-causality test between economic growth and electricity generation using Bangladesh data covering the period 1973-2006. The test results indicate that only unidirectional causal relationship exists between electricity generation and economic growth.

Zhang et al. (2019) in their paper they try to estimate panel causality relationships between variables, they estimate the relationships between electricity consumption and economic growth in 45 BRI [13] countries during 1990–2015. The empirical results indicate that there are unidirectional short-run and long-run causality relationships running from economic growth to electricity consumption in all low and medium-income countries. A unidirectional long run causality running from economic growth to electricity consumption is observed for high-income countries and the bi-directional short-run causality is found in OPE Countries [14].

Zhong et al. (2019) this article has reassessed the dynamic nexus of economic growth, electricity consumption, and labor force in China during the period of 1971–2009 by the ARDL approach. The estimated models successfully pass diagnostic tests and both the long-run and short-run elasticity are found to be statistically significant. The study also indicates the existence of short-run and long-run causalities from electricity consumption and employment to economic growth.

[12] OECD means Organization for Economic Co-operation and Development is an intergovernmental economic organization with industrially developed 36 member countries, founded in 1961 to stimulate economic progress and world trade.

[13]BRI means Belt and Road Initiative is a global development strategy adopted by the Chinese government in 2013 involving infrastructure development and investments in nearly 70 countries.

[14]OPEC means Organization of the Petroleum Exporting Countries is an intergovernmental organization of 13 countries.

Description about the Variables

Variables	
Dependent	Independent
Gross domestic product(lnGDP)	Internet user(lnIU)
	Electricity consumption(lnEC)
	Foreign direct investment(lnFDI)
	Export(lnEXP)

In this paper, we would like to use five variables i.e. gross domestic product, internet usage, electricity consumption, foreign direct investment and export earnings. In our econometric model we use GDP as dependent and all other four variables are independent. In order to simplify our analysis we should take log value to all the variables. So the variables become lnGDP, lnIU, lnEC, lnFDI and lnEXP respectively. And when we take first difference then the variables appears in the form DlnGDP, DlnIU, DlnEC, DlnFDI and DlnEXP. Where 'D' mean first difference operator and 'ln' means logarithm value. A brief summary of this variables are given in the table cited above.

Data & Methodology

Data description

This empirical study adopts annual time series data of Bangladesh spanning the period of 1994–2018, including gross domestic product (Current US$), individuals using the internet, electric power consumption (kWh), foreign direct investment net inflows (BoP, current US$)[15], and exports of goods and services (BoP, current US$) that are denoted as GDP, IU, EC, FDI and EXP respectively.GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. Dollar figures for GDP are converted from domestic currencies using single year official exchange rates. Internet users are individual who have used the internet (from any location) in the last 3 months. FDI is the sum of equity capital, reinvestment of earnings, and other capital invested by foreigners. GDP, FDI and EXP are expressed in billion US dollar. Period of data is selected because of its availability and convenience. All of this data is collected from World Development Indicators database (WDI, 20December, 2019).

Model Specification

This paper seeks to trace the relationship among Gross Domestic Product (GDP), Internet User(IU) Electricity Consumption(EC),Foreign Direct Investment(FDI) and Export (EXP) in the context of Bangladesh economy for the years 1994 through 2018. As part of the methodological design, the basic estimating equations in log form are specified as follows:

$$lnGDP_t = \alpha_0 + \beta_1 lnIU_t + \beta_2 lnEC_t + \beta_3 lnFDI_t + \beta_4 lnEXP_t + e_t$$

Where α_0, $\beta_1, \beta_2, \beta_3$ and$\beta_4$are parameters to be estimated and e_t is stochastic error term assumed to be independently and identically distributed.

Unit Root Test

The time series property of each variable is investigated through the Augmented Dickey-Fuller (ADF) test for the unit root. This test is conducted by "augmenting" the Dickey-Fuller equation[16] by adding the lagged values of the dependent variable ΔY_t. The ADF test here consists of estimating the following equation.

[15]BoP means balance of payment.

[16] Dickey-Fuller basic equation has the form$\Delta Y_t = \delta Y_{t-1} + \varepsilon_t$

$$\Delta Y_t = (\varrho - 1)Y_{t-1} + \sum_{i=1}^{1} \alpha_i \Delta Y_{t-i} + \varepsilon_t \quad 1$$

$$\Delta Y_t = \delta Y_{t-1} + \alpha_1 \Delta Y_{t-1} + \varepsilon_t \quad 2$$

Where Y is a time series, t is a linear time trend, Δ is first difference operator andε_t is a random error term. In equation 2, coefficient δ is equal to $(\varrho - 1)$ in equation 1. We should test as $\delta = 0$which indicates that $\varrho = 1$ that implies there isa unit root problem in that variable.

Vector Error Correction Model (VECM)

If find a co-integrating relationship and all the variables are I (1), a vector error correction model (VECM) is estimated to find the long run causality and short run dynamics. The purpose of VECM model is to indicate the speed of adjustment from the short run equilibrium to the long run equilibrium state. VECM model is specified as follows:

$$\Delta \ln GDP_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{i1} \Delta \ln GDP_{t-i} + \sum_{i=1}^{m} \alpha_{i2} \Delta \ln IU_{t-i} + \sum_{i=1}^{m} \alpha_{i3} \Delta \ln EC_{t-i} + \sum_{i=1}^{m} \alpha_{i4} \Delta \ln FDI_{t-i} + \sum_{i=1}^{m} \alpha_{i5} \Delta \ln EXP_{t-i} + \beta_i ECT(-1) + \varepsilon_t$$

Where ε_t is the error term, ECT(-1) is the error correction term, β_i captures the long run impact. The greater the β_i higher the speed of adjustment of the model from short runs to long run. The size and statistical significance of the coefficient of the ECT measures the tendency of each variable to return to the equilibrium. The short run effects are captured through the individual coefficients of the differenced terms (α). Because of data insufficiency maximum lag value $m = 2$ should be used for all the mentioned variables.

Granger Causality

In order to determine whether a change in one variable is a cause of changes in another, we employed the Granger (1988) causality test. Granger causality is a way to investigate causality between two variables in a time series. In Granger causality we check the joint causality, here says joint causality because in Granger test we take different lagged value of one variable and find out whether this all lagged value jointly cause another variable. Since all the variables are stationary at first difference, the Granger causality test is performed as follows:

$$\Delta lnGDP_t = \sum_{i=1}^{k} \alpha_{1i} \Delta lnGDP_{t-i} + \sum_{i=1}^{k} \beta_{1i} \Delta lnIU_{t-i} + \sum_{i=1}^{k} \gamma_{1i} \Delta lnEC_{t-i} + \sum_{i=1}^{k} \delta_{1i} \Delta \ln FDI_{t-i} + \sum_{i=1}^{k} \lambda_{1i} \Delta lnEXP_{t-i} + u_{1t}$$

$$\Delta lnIU_t = \sum_{i=1}^{k} \beta_{2i} \Delta lnIU_{t-i} + \sum_{i=1}^{k} \alpha_{2i} \Delta lnGDP_{t-i} + \sum_{i=1}^{k} \gamma_{2i} \Delta lnEC_{t-i} + \sum_{i=1}^{k} \delta_{2i} \Delta \ln FDI_{t-i} + \sum_{i=1}^{k} \lambda_{2i} \Delta lnEXP_{t-i} + u_{2t}$$

$$\Delta lnEC_t = \sum_{i=1}^{k} \gamma_{3i} \Delta lnEC_{t-i} + \sum_{i=1}^{k} \alpha_{3i} \Delta lnGDP_{t-i} + \sum_{i=1}^{k} \beta_{3i} \Delta lnIU_{t-i} + \sum_{i=1}^{k} \delta_{3i} \Delta \ln FDI_{t-i} + \sum_{i=1}^{k} \lambda_{3i} \Delta lnEXP_{t-i} + u_{3t}$$

$$\Delta\, ln\mathrm{FDI}_t = \sum_{i=1}^{k} \delta_{4i}\, \Delta\, ln\mathrm{FDI}_{t-i} + \sum_{i=1}^{k} \alpha_{4i}\, \Delta\, ln\mathrm{GDP}_{t-i} + \sum_{i=1}^{k} \beta_{4i}\, \Delta\, ln\mathrm{IU}_{t-i} + \sum_{i=1}^{k} \gamma_{4i}\, \Delta\, ln\, \mathrm{EC}_{t-i} + \sum_{i=1}^{k} \lambda_{4i}\, \Delta\, ln\mathrm{EXP}_{t-i} + u_{4t}$$

$$\Delta\, ln\mathrm{EXP}_t = \sum_{i=1}^{k} \lambda_{5i}\, \Delta\, ln\mathrm{EXP}_{t-i} + \sum_{i=1}^{k} \alpha_{5i}\, \Delta\, ln\mathrm{GDP}_{t-i} + \sum_{i=1}^{k} \beta_{5i}\, \Delta\, ln\mathrm{IU}_{t-i} + \sum_{i=1}^{k} \gamma_{5i}\, \Delta\, ln\, \mathrm{EC}_{t-i} + \sum_{i=1}^{k} \delta_{5i}\, \Delta\, ln\mathrm{FDI}_{t-i} + u_{5t}$$

Above equation is estimated by using first difference value for all variables because Granger causality test requires stationary time series data. In above equation maximum lag value k=2 should be used.

Table 1: Hypothesis and implied restriction for Granger causality

	Hypothesis	Implied restriction
1	Lags of ΔlnIU do not explain current ΔlnGDP	β_{1i}=0
2	Lags of ΔlnEC do not explain current ΔlnGDP	γ_{1i}=0
3	Lags of ΔlnFDI do not explain current ΔlnGDP	δ_{1i}=0
4	Lags of ΔlnEXP do not explain current ΔlnGDP	λ_{1i}=0
5	Lags of ΔlnGDP do not explain current ΔlnIU	α_{2i}=0
6	Lags of ΔlnGDP do not explain current ΔlnEC	α_{3i}=0
7	Lags of ΔDlnGDP do not explain current ΔlnFDI	α_{4i}=0
8	Lags of ΔlnGDP do not explain current ΔlnEXP	α_{5i}=0

To testing for Granger causality above hypothesis and their implied restrictions on the parameter should have tested.

Empirical Results

Stationary Result

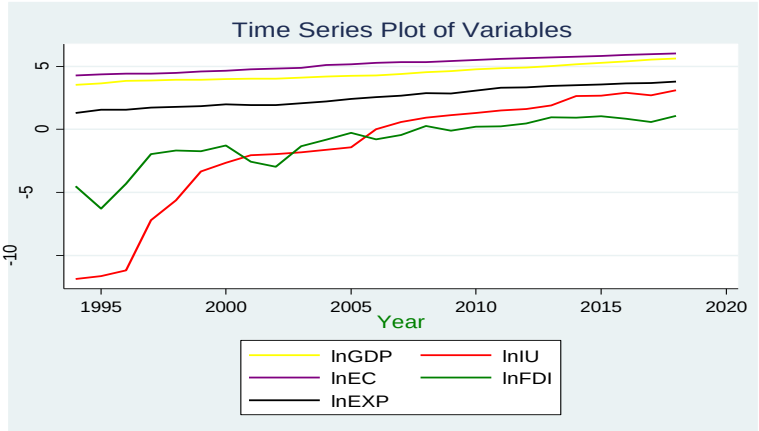

Figure 1:Time series plot of variables in levels.

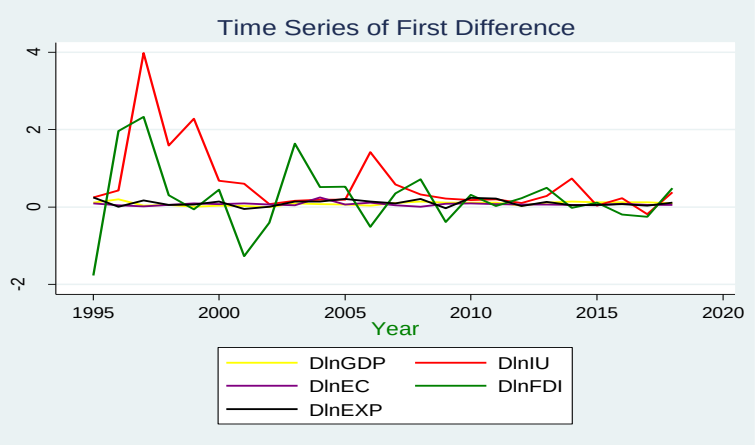

Figure 2: Time series plot of first difference.

Table 2: Augmented Dickey-Fuller (ADF) unit root test

Variables	At level		At first difference		Order
	t-stat (P-Value)	5% critical value	t-stat (P-Value)	5% critical value	
lnGDP	1.513 (0.9976)	-3.000	-3.160 (0.0224)	-3.000	I(1)
lnIU	-3.134 (0.0242)	-3.000	-3.269 (0.0163)	-3.000	I(0)I(1)
lnEC	-0.592 (0.8727)	-3.000	-5.065 (0.0000)	-3.000	I(1)
lnFDI	-1.696 (0.4331)	-3.000	-5.218 (0.0000)	-3.000	I(1)
lnEXP	-0.582 (0.8750)	-3.000	-6.033 (0.0000)	-3.000	I(1)

Source: Authors' own computation

From Table 2 Augmented Dickey-Fuller (ADF) unit root test express that all the variables except internet usage are non-stationary at level because related p-value is extremely high (above 5%) but when we take first difference all of them becomes stationary. So we can say all the variables are integrated of order one I(1). We know when all the variables are I(1) Johansen-Juselius co-integration approach is applied to examine the long run relationship among variables.

Co-integration Result

Johansen and Juselius (1990) theory advised that for small samples the best lags should be limited to 1 or 2 for the well-organized results. Since in this study sample size is relatively small we should use two lag for all the variables.

Sample: 1994– 2018
Number of obs = 25
Lags = 2

Table 3:Trace Statistics for Johansen co-integration test

Maximum Rank	Eigenvalue	Trace statistics	5% Critical Value
0		74.6226	47.21
1	0.76316	41.4938	29.68
2	0.71353	12.7407*	15.41
3	0.41880	0.2594	3.76
4	0.01121		

Table 4: Max Statistics for Johansen co-integration test

Maximum Rank	Eigenvalue	Max Statistics	5% Critical Value
0		33.1288	27.07
1	0.76316	28.7530	20.97
2	0.71353	12.4814	14.07
3	0.41880	0.2594	3.76
4	0.01121		

Source: Authors' own computation

Table 3 and 4 presents the Johansen co-integration test result. When trace statistics or max statistics greater than critical value then the null hypothesis (Maximum rank r=0, 1, 2, 3 or 4) can be rejected. According to trace statistics from Johansen test indicates that there are two co-integrated relationship exist and max statistics further insure this results. So there exists long run relationship among variables. In this circumstance one should estimate an error correction model (ECM). As a result, the vector error correction model is estimated in this study.

Vector Error Correction Model (VECM)

Table 5: VECM Long Run Association

No. of Co integrating Equation	Coefficient	Standard Error	T-Statistics	P-Value
Error Correction Term (ECT 1)	-.2207857	.015365	-14.37	0.000
Error Correction Term (ECT 2)	-.0147299	.0041249	-3.57	0.000

Source: Authors' own computation

Since all the variables under consideration are I (1) and Johansen co-integration result suggest there exits long run association among variables, so we estimate vector error correction model. Table 5 presents VECM long run result. There are two co-integrated equation and associated coefficient are both negative and statistically significant. In our study, ECT 1 is important one which indicates that there is long-run causality running from lnIU, lnEC, lnFDI, and lnEXP toward lnGDP.The estimated coefficient of the first error correction vector is -.22078, means the speed of adjustment correcting back disequilibrium at the rate of 22% percent in each period, which is considerably large.

Table 6: VECM Short Run Association

Variable	Coefficient	Standard Error	T-Statistics	P-Value
Constant	.0222663	.0128069	1.74	0.082
DlnGDP lag (-1)	-.0218371	.0677158	-0.32	0.747
DlnGDP lag (-2)	.043763	.0567831	0.77	0.441
DlnIU lag (-1)	.013373	.004118	3.25	0.001
DlnIU lag (-2)	.0074984	.0034675	2.16	0.031
DlnEC lag (-1)	-.1338879	.0616928	-2.17	0.030
DlnEC lag (-2)	-.4193139	.064313	-6.52	0.000
DlnFDI lag (-1)	.007469	.0058769	1.27	0.204
DlnFDI lag (-2)	-.0255883	.0034945	-7.32	0.000
DlnEXP lag (-1)	-.2206505	.0343701	-6.42	0.000
DlnEXP lag (-2)	-.225689	.0303943	-7.43	0.000

Source: Authors' own computation

Table 6 shows short run individual causality running from DlnGDP, DlnIU, DlnEC, DlnFDI, and DlnEXP toward DlnGDP. In this estimation process two lag values for every variable are used which shows their individual short run impact on DlnGDP. Estimated result reveals that both lags for DlnIU, Dln EC and DlnEXP have short run significance impact on current DlnGDP. DlnEC lag (-1) and DlnEC lag (-2) have negative coefficient which indicates previous consumption of electricity negatively affect current GDP. In theory current GDP depends on current consumption of electricity while previous electricity consumption creates burden on current consumption which affect current GDP negatively, so productive use for each unit of electricity is important. On the other hand lags IU has positive and lags EXP has negative impact on current GDP while in this study it has been found that lags GDP has no significant impact on current GDP.

Granger Causality Test

Table 7: Granger causality Wald tests

Null Hypothesis	χ^2 (P- value)	Decisions	Results	Conclusion
DlnIU doesn't granger cause to DlnGDP	16.70 (0.0002)	Reject	IU↔GDP	Bidirectional Causality
DlnGDP doesn't granger cause to DlnIU	11.49 (0.0032)	Reject		
DlnEC doesn't granger cause to DlnGDP	31.53 (0.000)	Reject	EC↔GDP	Bidirectional Causality
DlnGDP doesn't granger cause to DlnEC	6.08 (0.0479)	Reject		
DlnFDI doesn't granger cause to DlnGDP	36.39 (0.000)	Reject	FDI→GDP	Unidirectional Causality
DlnGDP doesn't granger	0.09 (0.9547)	Accept		

cause to DlnFDI				
DlnEXP doesn't granger cause to DlnGDP	90.68 (0.0000)	Reject	EXP→GDP	Unidirectional Causality
DlnGDP doesn't granger cause to DlnEXP	0.45 (0.7983)	Accept		

Source: Authors' own computation

VECM short run causality shows individual impact of each lag value where Granger causality exhibits does all the lags of one variable jointly causes another variable. Table 7 shows there exist bidirectional short run causality among DlnIU and DlnEC to DlnGDP while unidirectional causality from DlnFDI to DlnGDP and DlnEXP to DlnGDP.This result indicate internet usage and GDP influence each other this is true for electricity consumption and GDP while FDI and export influence GDP and not vice versa.

Conclusions

This study finds the relationship among internet usage, electricity consumption, foreign direct investment and export towards gross domestic product with the help of annual time series data from 1994 to 2018.This study reveals the importance of modern communication facilities like internet and electric power supply in Bangladesh. Empirical result shows not only use but also proper utilize of electric power supply is important because current consumption of electricity create burden on the future. This study conducted by using Vector Error Correction model and Granger causality test. On this, Vector Error Correction Model shows significant short run and long run relationship among variables. Granger causality result exhibit, there exist bidirectional joint causality among internet usage and electricity consumption to gross domestic product and unidirectional causality from foreign direct investment and export towards gross domestic product.

All this demonstrate the effects of internet, electricity, foreign direct investment and export for achieving desirable economic growth. High speed internet facilities and adequate power supply create investment friendly environment which encourage foreign direct investment and expand export earning which all have positively affect domestic production. Internet facilities itself create employment opportunities for educated and semi-educated young people by outsourcing activities. Internet base E-commerce activities now become emerging sector in any economy as well as Bangladesh. So government should take appropriate policy to provide cheap and high speed internet facility and also provide adequate and reliable electricity supply across the country. Government can also take any extensive IT training program which provides basic skill to educate or semi-educated unemployed person about outsourcing activities which become conducive to elevate unemployment problem in Bangladesh.

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