INTERNATIONAL JOURNAL OF RESEARCH IN BUSINESS AND SOCIAL SCIENCE 9(5)(2020) 318-325

Business & Social Science IJRBS

Research in Business & Social Science

IJRBS VOL 9 NO 5 ISSN: 2147-4478

Available online at www.ssbfnet.com

Journal homepage: https://www.ssbfnet.com/ojs/index.php/ijrbs

Impact of digital technology in higher education: Perspective from Bangladesh

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ARTICLE INFO

Article history:
Received 31 June 2020
Received in rev. form 12 August 2020
Accepted 28 August 2020

Keywords:
Digital Technology; Higher Education; VECM; Bangladesh

JEL Classification:
C01, I25, L86, O53

ABSTRACT

In the current era, digital technology cannot be overlooked in higher education and other economic factors. Digital technology introduces scopes that expedite blended, e-learning, and online in higher education; suggests a multiple of ways to communicate, learn, correspond, cooperate, and collaborate. Also, digital technology has been more and more widely used in higher education for the continuous development of the economy. This study replicates on the growing importance of digital technology on higher education in Bangladesh over the period 1988-2018. Besides, the study exploits the Johansen cointegration and vector error correction model (VECM) for investigating the positive relationship between digital technology and higher education. The Johansen's cointegration outcomes ascertain that digital technology, higher education, and gross domestic product are cointegrated in the long-run. Furthermore, the VECM outcomes suggest that digital technology can stimulate higher education in both the long run and short run, where learners, educators, and nations are consistently gainer of this country. The study also highlights that higher education consistently contributes to gross domestic product. This research would do twisting up higher education in the kind of digital technology that effectively contributes to educational institutions and countries to remain long-term response. Bangladesh must be beneficial by growing technological development in higher education. For the rapid changes in higher education, the research is advocated that the successful execution of digital technology needs to concentrate on interconnecting structures for transformation: the educator, the educational institutions, and the policymakers. Consequently, public policies would make educational changes in practicing the digital technology of Bangladesh.

Introduction

In the modernization of socio-economies, digital technology has directed as a critical role in higher education in economic development (Baliamoune-Lutz, 2003; Chacko, 2005; Kottemann & Boyer-Wright, 2009; Unwin, 2019). Correspondingly, digital technology has prejudiced higher education, and it has changed people's daily life from all perspectives. Hence, education is an influential interest in social, institutional, and economic change for every nation, where education trains a lot of talents through digital technology.

Consequently, digital technology stimulates economic development and provides a substantial contribution to education. The rapid growth of the economy makes people clearly understand that technology provides a significant role in promoting higher education in economic development. However, the economy can only rely on technological progress to attain sustainable development, and education can take part in better and faster development; accordingly, technology, education, and economic growth are inseparable. However, the developing economies are achieving dynamic growth by advanced technology and higher education over the past few decades (World Bank, 2019).

Conventionally, technological advancement has not been uniform transversely in different segments of economic activities. Higher education has been the entire productive segment for the adoption of new technologies, be responsible for certain services, such as learning, sharing, teaching, medical care, performing arts, public administration, etc. for the nation. However, the reality is not

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https://doi.org/10.20525/ijrbs.v9i5.815

providing similar statistics for the developing countries due to the bundle of rules, lack of adoption ability, and low investment for new technology. Hence, the useful, suitable, organized, and transformative use of advanced technology may increase the participation, networking, teaching, learning, empowerment, and innovation practices, which would have substantial effects in terms of countries growth (Billon, Crespo, & Lera-Lopez, 2017; Capello & Spairani, 2006).

The foremost trend of research motivates the standing of this research on the assessment of the association-ship between digital technology and higher education in Bangladesh over the period 1988-2018. Here, digital technology has defined by telecommunications technology, namely internet users (Donou-Adonsou, 2019). The study contributes to the very new concepts in scientific research and never studied for Bangladesh, where only Donou-Adonsou (2019) study studied for sub-Saharan African countries before. However, this study applies the Johnsen cointegration test (Johansen, 1988) and vector error correction model (VECM) for finding the relationship between digital technology and higher education, whereas the VECM is an entirely appropriate and effective procedure for assessing the relationship between variables both long and short-run, where all the variables must stationary in first difference. However, this model would correctly identify the serial correlation, heteroscedasticity, and normal distribution problems from the series. Hence, the main motto of this research is that higher education may upgrade through access of digital technology to better economic development of Bangladesh.

The research has been systematized as follows: the review of previous literature discusses in section 2, section 3 stipulates the data, empirical methodology, and section 4 describes the findings and discusses. Finally, the research concludes with significant policies and future research.

Literature Review

Some studies have defined that today's world today is existing in digital technology for higher growth of the country (Baum & Rowley, 2008; Castells, 2004; Chen & Wellman, 2004; Newby, Hite, Hite, & Mugimu, 2013), the reason why the learners and educators are getting access to digital technology. Hence, digital technology can positively support learning and teaching if it is adopted and implement effectively with skills in higher education in developing countries and the global economy (Newby et al., 2013). The literature review has been segmented by two parts, e.g., theoretical and empirical parts, which discussed below.

Theoretically, still in its initial stages in higher education with digital devices has been defined and explained in a multiple of ways (Gikas & Grant, 2013). There are several digital technologies executed in higher education of learning (Garrison & Vaughan, 2008; Gikas & Grant, 2013; Moore & Kearsley, 2011; Ng'ambi & Bozalek, 2015). However, educators should have useful training, adequate knowledge of technology for excellent teaching, and institutions should have the capability and availability of technological infrastructure such as computers, computers lab, etc. for getting quality education from the students (Newby et al., 2013). Also, Digital technology shows numerous arguments that might remarkably touch cultural behaviors and in need of sustained learner-lectures technological efficiencies improvement. However, Sub-Saharan Africa and South Asia have already been documented with slow digital technology evolutions (Gikas & Grant, 2013). However, it is the spirit of e-learning-accessing knowledge, data, information, and educational materials anyplace and anytime from digital technology that educators and learners are used to "carrying everywhere with them" and that they "regard as friendly and personal" (Traxler, 2007). Recently, more than one-third of educators either demonstrate themselves or practice their remaining expertise to support digital pedagogy and also to distribute materials they use learning management systems (LMS) which are both digital and non-digital apparatuses; The LMS might make the teachers more trained up to use digital resources to write; communicate as well as for best practices. My study tries to find the relationship between digital technology, higher education, and gross domestic product. For this, I have used Johansen cointegration test, proposed by (Johansen, 1988) and vector error correction model (VECM), suggested by Engle & Granger (1987), Pegkas & Tsamadias (2014) and Katircioğlu, Fethi, & Kilinç (2010) to scrutinize the effects of digital technology on higher education, and its effect on gross domestic product of Bangladesh.

There is developing international consent that digital technology, mostly Internet, is stipulating a new structure and massive opportunities for education, political, economic, social, and community development. Hereafter, Donou-Adonsou's study investigated the effect of education in technological progress towards GDP growth by the fixed-effects GMM estimator in Sub-Saharan Africa (SSA) over the year from 1993 to 2015. The results suggest that the Internet promotes economic growth through better access towards education in countries; however, mobile phones do not gain any direct effect on the GDP growth of SSA countries. It seems that mobile phone usage is irrelevant without the Internet for higher education. Hence, if mobile phones might pay access to the Internet, mobile phones may perform such as online classes, video calls, group meetings, doing research, viewing at the map, to remark a few, resulting in higher education may get the benefit. It may contribute to the economy as well (Donou-Adonsou, 2019).

Pegkas & Tsamadias (2014) estimated the influence of higher education on GDP growth in Greece by using co-integration and VECM over the epoch of 1960–2009. The empirical assessment exposes that there exists a long-run association between GDP growth, physical capital investments, and higher education. Moreover, the findings recommend that higher education and physical capital investments depict one-way causality toward GDP growth in the long-run and short-run.

Katircioğlu, Fethi, & Kilinç (2010) analyzed a long-run equilibrium interconnection between the higher education and real income by the autoregressive distributed lag (ARDL) and VECM techniques from 1979 to 2007 in the Turkish Republic of Northern Cyprus

(TRNC). They reveal that there is a long and short-run equilibrium relationship consecutively from the higher education sector to the real income growth of this economy. Another study inspected the influence of higher education human capital on GDP per capita of African countries with a transformed neoclassical growth model, and a dynamic panel estimator over the year 1960–2000 period. The study found that all levels of education human capital depict a positive and significant link on GDP per capita in African counties (Pegkas & Tsamadias, 2014).

Kottemann & Boyer-Wright (2009) observed that education quality is suggestively and positively connected with information communication technology (ICT) and per capita income in 122 countries and individual countries. Thus, the study has suggested that per capita income can stimulate by technological development and quality education, where ICT has played an essential role in quality education in these countries.

Billon, Crespo, & Lera-López (2017) estimated to signify the considerable outcome between educational inequality, technology, and economic growth of different levels of economies (high, middle and low income) for the 1995–2010 period. They reveal that educational inequality has a pessimistic effect on ICT use on the economic growth of these economies. Likewise, Wunnava & Leiter (2009) employ panel data using the ordinary least square method in 100 developed and developing countries. The study shows that education depicts a positive and significant effect on ICT in these countries. Ifa & Guetat (2018) investigated the influence of the Tunisian and Moroccan economy during the period 1980-2015 using the ARDL model. The empirical findings stat that education is positive for Moroccan economic growth but negative for the Tunisian economy in the short-run. Conversely, in the long run, education positively assists in increasing the economic growth of these two countries. Furthermore, the research suggests that there are many opportunities to broaden people's knowledge and improve their skills with higher education. It is also blessings for factors of growth, which could assist in research & development and the accumulation of human capital & skilled labor. Asongu & Odhiambo (2019) tried to explore the role of basic formal education on information technology on comprehensive human development of 49 SSA countries by instrumental quantile regressions throughout 2000-2012. The paper reveals that poor primary education reduces the optimistic influence of technological involvement on overall human development. Hence, quality education can improve by increasing the number of schools and teachers as well as increasing the government budget in education. Tsamadias & Prontzas (2012) inspected the effect of education on GDP growth in Greece throughout 1960–2000 by using the Solow growth model represented by Mankiw, Romer, & Weil (1992). Consequently, the outcomes imply that education statistically depicts a significant and positive impact on economic growth. Moreover, physical capital, human capital, and labor also have a positive influence on economic growth in Greece. Conversely, the Greek educational system faced a series of problems in the twenty-first century, for example, the low quality and low effectiveness of education at all levels, graduate joblessness, draining brain, massive student migration in abroad, misallocation of wealth, condensed human capital investment, degenerating social transmissions, etc. But currently, the Greek educational system is overcoming the problems day by day. Picatoste, Pérez-Ortiz, & Ruesga-Benito (2018) examined the effect of ICT technology on education for EUROSTAT to young people (16-24 years) by applying structural equation modeling (SEM). The findings reveal that cultured informal ICTs stimulate employment and teaching in computer management. Hence, the EUROSTAT needs to provide channels of informal private training to adopt the requirements of temporal and longitudinal accessibility of each.

The above theoretical and empirical literature also confirms that the learners and educators require to potentially use of digital technology for the enormous diffusion of higher education.

Therefore, the study fixes some objectives as follows:

a) There is strong evidence between digital technology and higher education in the long-run and short-run, and

b) The digital technology contributes positively to higher education with better access in Bangladesh.

Research and Methodology

The study uses data from 1988-2018 for Bangladesh as a developing country. Therefore, the study has collected data from World Bank (WDI, 2019). All the variables data has converted into a natural logarithm form before starting the econometric analysis. However, the study uses total educational attainment by population 25 years old and over as proxy of higher education, total internet users as a proxy of digital technology, and real gross domestic product (GDP) in $US (constant 2011) is an explanatory variable. The econometric models have constructed on scientific observations. The researchers also use the same technique when they proceed into account to find out the effect between variables; so that specific relationships between variables can be examined. Afterward, they select the appropriate econometric procedures to estimate the extent and direction of the linkage. The researchers also develop either new theoretical thought about the phenomenon or recommend the existing theory based on the findings. Hence, the construction of the correct growth model is the key to define the relationship between regressors and regressand in order to get exact estimates. Meanwhile, this study aims to estimate the influence of digital technology on higher education for Bangladesh. The study has been used the Johansen cointegration test and VECM procedures for econometric analysis (Katircioğlu et al., 2010; Pegkas & Tsamadias, 2014), which dynamically stipulates the results of the series. Thus, these analyses are the utmost suitable and effective process for assessing the relationship between digital technology and higher education. However, if we run the baseline model, there would exist the endogeneity issues, as the maximum of the regressors might not be accurately exogenous. The application of appropriate explanatory variables can meet the proper solution. Hence, the study forms a preceding equation as follows:

$LE = f(LT, LY)$……………………………………………………………………………………………………….. (1)

Where L's denote logarithm form. E means total educational attainment by population 25 years old and over as a proxy of higher education. It is covered "the number of population ages 25 and older who attained or completed primary education by the total population of the same age group in Bangladesh. A relatively high concentration of the adult population in a given level of education reflects the capacity of the educational system in the corresponding level of education. Educational attainment is closely related to the skills and competencies of a country's population" (WDI, 2019). T is total internet user as a proxy of digital technology. Digital technology denotes Fixed broadband subscriptions. "It mentions fixed subscriptions to high-speed access to the public Internet. This comprises cable modem, fiber-to-the-home/building, other fixed (wired)-broadband subscriptions, satellite broadband, and terrestrial fixed wireless broadband. It also comprises both residential subscriptions and subscriptions for organizations" (WDI, 2019).

Y denotes real gross domestic product (GDP) in $US (constant 2011) of Bangladesh. Also, GDP is the sum of gross value added by all resident producers in the economy plus any product"(WDI, 2019). Hereafter, the functional form of the VECM model can be written by the following equation:

$LE_t = \alpha_0 + \beta_1 LT_t + \beta_2 LY_t + \varepsilon_t$……………………………………………………………………………………… (2)

Where α_0 denotes intercept term, β_1 & β_2Are the coefficients of explanatory variables, t indicates the period, and ε means the error correction term of the model.

Before applying the VECM estimator, the study analyzes the descriptive analysis for characteristics of the data and correlation metrics for avoiding the multicollinearity of the series. Table 1 demonstrates the descriptive analysis of the data. The statistics explain that the mean and maximum of LE is 2.9225 and 3.4192. Similarly, the mean and maximum of LT is 2.9545 and 3.2032. Hence, the mean and maximum of LY is 25.1163 and 25.9919.

Table 1: The Descriptive Analysis

Variable	Observation	Mean	Standard Deviation	Minimum	Maximum
LE	31	2.9225	0.2959	2.4364	3.4192
LT	31	2.9545	5.0177	-11.6450	3.2032
LY	31	25.1163	0.4835	24.3882	25.9919

Source: Authors Calculations

After that, the study will try to check the augmented Dickey-Fuller unit root tests (Dickey & Fuller, 1979), which can fix the spurious regression results from the series (Pedroni, 1999). Then, the study will proceed with the vector autoregressive (VAR) estimator for finding the optimal lag length. Conversely, the study will also run the Johansen cointegration tests for finding the rank and long-run connection between variables (Johansen, 1988; Johansen & Juselius, 1990). However, if the variables exist cointegration in the long-run, then, there necessities to test the error correction metrics (ECM) representations by the VECM (Engle & Granger, 1987). After confirming the long-run associations, the study will employ the VECM procedure for long and short-run analyses. The study applies serial correlation, heteroscedasticity, Jarque-Bera, CUSUM, and CUSUM square tests to identify the robustness of the VECM process.

Findings and Discussions

The technological efficiency and higher education show the convergence with the level of economic development, and the "Catch-up effect" promotes the improvement of technological capability and achieves catch-up with higher education in developing countries. Here, the study employs the ADF unit root test. Hereafter, table 2 states that all the variables depict stationarity in the first difference, which meets the restriction of Johansen cointegration and VECM estimator.

Table 2: ADF Unit Root Test

Variable	At Level		First Difference	
	T-statistic	**Probability Value**	**T-statistic**	**Probability Value**
LE	-0.108	0.9487	-3.929	0.0018*
LT	-1.542	0.5129	-2.899	0.0454**
LY	-6.838	1.0000	-2.813	0.0565***

Notes: Δ denotes Significant at * 1% level, ** 5% level and 10% level; ADF test defined by Mackinnon (1996) formula

Source: Authors Calculations

Now, we check the lag length criterion by the VAR model. Table 3 implies that the optimal lag is 6. The study will apply lag length by Akaike information criterion (AIC) for running the Johansen cointegration and VECM estimator. The appropriate lag is crucial for running any regression model, which can provide correct results.

Table 3: Lag length Criterion

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-14.1831		.000794	1.37465	1.41522	1.52091
1	125.614	279.59	2.3e-08	-9.08908	-8.92681	-8.50402
2	132.545	13.863	2.8e-08	-8.92359	-8.63962	-7.89974
3	141.028	16.966	3.2e-08	-8.88224	-8.47656	-7.41959
4	152.043	22.029	3.3e-08	-9.0434	-8.51602	-7.14196
5	168.022	31.959	2.8e-08	-9.60178	-8.9527	-7.26154
6	199.624	63.204*	9.2e-09*	-11.4099*	-10.6391*	-8.6309*

Notes: * indicates lag order selected by the criterion; LR: Sequentially modified LR test statistic (each test at 5% level); FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information; HQ: Hannan-Quinn information criterion

Source: Authors Calculations

The study employs the Johansen cointegration tests (Johansen, 1988). The results represent the rank of "Trace and Maximum" value. The "Trace and Maximum Eigenvalue" suggests that there is one (1) cointegrating equations in the series (see table 4). Hence, Johansen's cointegration outcomes recommend that all the variables are cointegrated in the long-run. Now, the study would apply for the VECM long and short-run procedures.

Table 4: Johansen Cointegration Rank Test (Trace and Maximum Eigenvalue)

Trace Test					**Maximum Eigenvalue Test**				
Maximum Rank	LL	Eigenvalue	Trace Statistic	0.05Critical Value	Maximum Rank	LL	Eigenvalue	Max-Eigen Statistic	0.05Critical Value
0	142.82404		30.0089	29.68	0	142.82404		16.9230	20.97
1	151.28555	0.46569	13.0859*	15.41	1	151.28555	0.46569	10.9251	14.07
2	156.74809	0.33278	2.1608	3.76	2	156.74809	0.33278	2.1608	3.76
3	157.82851	0.07691			3	157.82851	0.07691		

Johansen cointegration tests (Trace and Maximum Eigenvalue) indicate one (1) cointegrating equation using MacKinnon et al. (1999) p-values

Source: Authors Calculations

Table 5 recommends that digital technology (LT) and GDP (LY) provoke higher education (LE) in the long-run. Because ECM is negative (-1.510) and statistically significant, the ECM coefficient (-1.510) confirms that the speed of adjustment corrects 100% in the current year and 51% corrects in the past year of this economy. It means that the economic development is very fast by higher education and digital technology of Bangladesh.

Table 5: VECM Long-run Representations: Exports as a Dependent Variable

	Coefficient	Std. Error	t-Statistic	Probability Value
ECM	-1.510	0.568	-2.66	0.008*

Significant at * 1% level

Source: Authors Calculations

Therefore, the VECM long-run equation can be expressed after analysis as follows:

$$ECM_{t-1} = [1.000LE_{t-1} - 0.032657LT_{t-1} - 0.189352LY_{t-1} + 1.986198] \quad \text{……..(3)}$$

The long-run equation suggests that if digital technology (LT) increases 1%, the higher education (LE) increases by 3.26%, this results in support by Newby et al. (2013) and Donou-Adonsou (2019). Similarly, if GDP (LY) increases 1%, the higher education increases (LE) by 18.93% in the long-run of Bangladesh, as Katircioğlu, Fethi, & Kilinç (2010) and Tsamadias & Prontzas (2012).

Table 6: VECM Short-run Representations: Wald Test

Variables	Chi-square Value	Probability Value
LT	7.47	0.0584***
LY	6.59	0.0863***

Significant at ***10% level

Source: Authors Calculations

Likewise, Table 6 implies that LT and LY probability is significant at the 10% level. Hence, there exists a short-run relationship running from digital technology (LT) and GDP (LY) to higher education (LE) whereas, LT and LY probability value are significant at the 10% level. Also, the results suggest that digital technology is a blessing for higher education and economic growth as well for Bangladesh. Technological transformation does not only help an approach to develop the country's economy but also provides the people's capability to do many things that people did not do further. However, novelty means whether the quality of people's lifestyles will positively or negatively grow (Freeman & Soete, 2003). This title for twisting up higher education in the kind of digital technology that effectively contributes to educational institutions and countries to remain long-term response. Bangladesh must be beneficial by growing technological development in higher education.

Table 7: Diagnostic test.

	Jarque-Bera	F-statistic	Probability Value*
Normality	3.264		0.19549
Serial Correlation: Breusch-Godfrey LM test		14.0303	0.12125
Heteroscedasticity: Breusch-Pagan-Godfrey		0.37474	0.8582

Source: Authors Calculations

For the robustness check of said model, the series does not bear serial correlation problem, because the Breusch-Godfrey LM test provides insignificant probability value, i.e., 0.12125 (see table7). However, the Jarque-Bera probability value also shows insignificant probability value, i.e., 0.19549, which depicts that the series is normally distributed (see table7). Table 6 also illustrates; the series has not existed a heteroscedasticity problem. Figure 1 also states that the cumulative sum (CUSUM) plot is inside the parameter of stability. Overall tests show the VECM estimator is the best and robust model of this study.

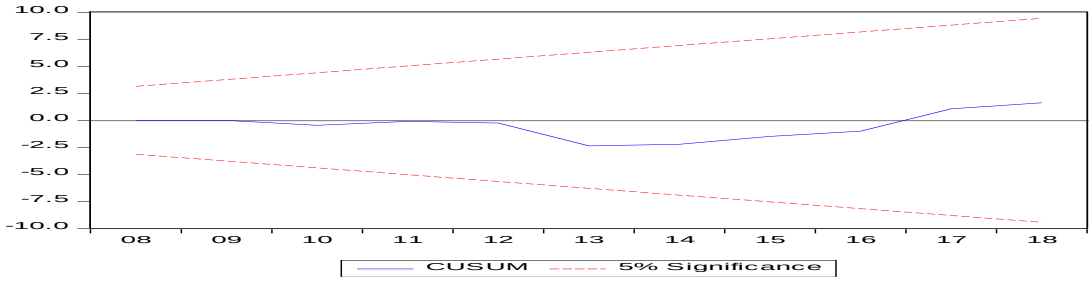

Figure 1: CUSUM

Conclusions

This research replicates on the growing importance of digital technology in higher education over the period 1988-2018 of Bangladesh. The paper uses the Johansen cointegration and VECM estimator for econometric analysis, which dynamically stipulates the robust results of the series. Furthermore, the nature of digital technology and its linkage to higher education have extensively conversed in the long-run and short-run. The outcomes suggest that digital technology can positively stimulate higher education in both the long and short-run, where learners, educators, and nations are consistently gainer of this country. The study also highlights that higher education consistently contributes to the GDP of Bangladesh both long and short period. The outcomes confirm that digital technology might contribute positively to higher education with better access to Bangladesh. The results also suggest that digital technology is a blessing for higher education and economic growth as well for Bangladesh. Technological transformation does not only help an approach to develop the country's economy but also provides the people's capability to do many things that people did not do further. However, novelty means whether the quality of people's lifestyles will positively or negatively grow (Freeman & Soete, 2003). This title is for twisting up higher education in the kind of digital technology that effectively contributes to educational institutions and countries to remain long-term response. Based on the exceptional experience of the higher education in Bangladesh,

our country should establish the legal status of the apprenticeship system, put forward legal constraints for the standards of modern apprenticeships, build a service-oriented government, establish a national vocational qualification system and develop professional ability standards, and collaborate the top position of organizations in the teaching of talents. In this way, Bangladesh must be beneficial by growing technological development in higher education. In this aspect, future research is necessary for access to digital technology for the higher education of this country.

Consequently, the policymakers should emphasize more budgets in advanced technology and higher education to increase more economic development of Bangladesh. For the rapid changes in higher education, the research is advocated that the successful execution of digital technology needs to concentrate on interconnecting structures for transformation: the educator, the educational institutions, and the policymakers. Likewise, public policies would make educational changes in the use of digital technology as well.

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