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Nexus Among Innovations, Financial Development and Economic Growth in Developing Countries

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Abstract

Studying the level of economic growth remains a topic of discussion among economists and policymakers. As economic growth further impacts the socioeconomic development of the country. The present study has investigated the impact of innovations and financial development on economic growth in case 58 developing counties from 2000 to 2020. To analyze the stationarity of the variables LLC, ADF-Fisher, IPS, and PP-Fisher unit roots have been used. This study uses a panel autoregressive distribution lag co-integration approach and a vector error-correction model for short-run dynamics of the model. For investigating the causal relationship among the variables variance decomposition and impulse response function have been applied. The outcomes of the study show that innovations, availability of physical capital, and trade have a positive and significant impact on economic growth. The results show that financial development has a negative and significant impact on economic growth. It is suggested that for higher economic growth, developing countries improve the threshold level of financial development and use an innovative process of production. Urbanization and inflation hurt economic growth. Thus, developing countries should promote a stable inflation rate with liberalized trade, innovation, and physical capital to enhance economic growth.

Keywords: economic growth, financial development, inflation rate, innovations

JEL Codes: O40, G20, E31, O30

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1. Introduction

In this globalized era, innovations have become the part and parcel of economic growth (Solow, 1956; Romer, 1986). Innovations have been considered an inherent tendency for humans to think differently and better as compared to their forefathers. Despite their obvious importance, innovations have not always received the deserved attention from developing countries since the early 2000s (Fagerberg and Srholec, 2008). Although innovations are considered complex and multidimensional processes, researchers highlight their contribution to economic growth, competitiveness, and quality of life. In general, the creation and adoption of new knowledge to improve the value of products, processes, and services. New product development has become the most important factor in this competitive environment (Tidd, 2006). Being the driving force of economic growth, innovations have gained much importance in developed countries since the 18th century (Schumpeter, 1939). In 1960, Some developing countries recognized the role of technological change in the process of economic growth (Solow, 1956; Denison, 1962), but still, most of the developing countries lag (Audi et al., 2021; Audi et al., 2022). Presently, the modern economy is often called "the innovative economy" which is emphasizing the role of innovations and modernization of the economy. Several core conditions enable innovations and encourage economic growth, such as innovations are crucial for value creation, growth, and employment, at both regional and national levels. Innovations will also lead to new businesses as well as increase the competitiveness of existing enterprises (Gerguri and Ramadani, 2010).

The link between innovations and economic growth has been emphasized in numerous theoretical and empirical studies (Solow, 1956; Mansfield, 1972; Romer, 1986; Raimuni and Nadir, 1993). Most of these studies have been conducted in the case of developed economies because developing countries lack data related to innovations and politically manipulated economic growth (Mazzucato, 2013). Over the last two decades, new information technology has been responsible for rising economic activities and enhanced productivity (Gerguri and Ramadani, 2010; Audi et al., 2021). According to Gurbiel (2002) innovations have the potential to influence the economy, at both macro and micro levels. But still, the number of developing countries does not provide the true picture of the relationship between innovations and economic growth. So, it is fair to say that the question of how technology and innovations influence economic growth is still a controversial issue and needs to be studied (Fagerberg & Srholec, 2008).

A financial market is a key factor in deciding the strong process of economic growth because an efficient financial market diver finances and funds from unproductive to productive uses. The role of efficient financial markets may be traced back to the seminal work of Schumpeter (1911). The relationship between financial development and economic growth has been a subject of great interest among economists since the late 1950s (De Gregorio and Guidotti, 1995). This discussion has traditionally revolved around two issues: the first relates to whether development in the financial system results in faster economic growth and the second relates to how financial development affects economic growth. The financial system can acquire and process financial information effectively to increase the level of investment and enhances the allocative efficiency of investment as well (Ghirmay, 2004).

The relationship between financial development and economic growth has been extensively studied in the previous literature. Now, it is well-recognized that financial development is crucial for economic growth (McKinnon, 1992; King and Levine, 1993; Neusser and Kugler, 1998). Most empirical studies have indicated that well-developed financial markets, enhance the efficiency of resource allocation and faster long-run economic growth via two channels: the capital accumulation channel and the total factor productivity channel. The first channel, also known as the quantitative channel, is rather straightforward. Economic growth depends on capital accumulation through both domestic and foreign capital. To mobilize savings and channel them to capital accumulation, an efficient financial system is essential. In this way, financial development and economic growth are linked. The total factor productivity channel refers to as the qualitative channel, it suggests that an efficient financial system facilitates the adoption of modern technology to boost the development of knowledge and technology-intensive industries, through the provision of efficient credit facilities and other financial services (Ang, 2008). The financial systems of developing countries have led to the common adoption of innovations, as financial innovations with a focus on technology are influencing the supply and demand of money in the economy and affecting economic growth (von Schönfeld & Ferreira, 2021; Ali and Rehman, 2015; Ali, 2015). To study the relationship between financial liberalization and innovation is not an old one (King & Levine, 1993). But the relationship between economic growth and financial development has well-established theoretical and empirical roots (von Schönfeld & Ferreira, 2021).

Presently, with the fastest process of globalization, the relationship between an advanced financial system, innovations, and economic growth has become one of the most debated issues. The financial system plays an important role in the overall success levels of the economy (Allen et al., 2007). The rapidly changing nature of economies with industrialization, this change even more rapidly with innovations and technology. Today, the financial sector has become the backbone of the dynamics of economic growth. In addition, the increasing integration among countries has led to many socioeconomic, technological, and behavioral changes (O'Rourke and Lollo, 2015). Modern economic policies and development strategies have turned into an open economy model. Moreover, with globalization, the concept of the world economy converted into a global village (Ali and Audi, 2016; Audi et al., 2022).

In the process of economic growth, innovations and financial development are considered the most important indicators (Jedidia et al., 2014). The creation and adoption of new knowledge have improved the value of products, processes, and services (Tidd, 2006). This study has empirically investigated the link between innovations, financial development, and economic growth in the case of developing countries. Previous studies have linked financial development and economic growth but innovations have been ignored (Posner, 1961; Bell and Pavitt, 1993; Schumpeter, 1939; Kahneman and Tversky, 2013). Moreover, previously, credit to the private sector has been considered a measure of financial development, this study has constructed an index of financial development with the help of money supply, interest rate, and credit to the private sector. Previous studies have used R&D expenditures as a measure of innovations (Rogers and Rogers, 1998), this study has constructed an index with the help of R&D expenditures, education level, and use of computers. These indices are hardly available in the existing literature. This research is useful to explain and understand how innovations and financial development affect economic growth in the case of developing countries. So, this study is a healthy contribution to the respective literature.

2. Literature Review

The part of the study is comprised of the literature review and here most recent and relevant studies have been selected for this purpose. Following existing literature, we know that, in the process of economic growth, innovations are considered the most important indicators (Cavdar and Aydin, 2015). The creation and adoption of new knowledge have improved the value of products, processes, and services, as product development has become the most important factor in the competitive environment (Tidd, 2006). The contribution of technological innovations to national economic growth has been emphasized in numerous theoretical and empirical studies (Solow, 1956; Romer, 1986). The relationship between innovations, entrepreneurship, and economic growth has been the mainstream discussion among many empirical studies (Porter, 1990; Baumol, 1993; Lumpkin and Dess, 1996). Audi and Ali (2021) investigate the impact of advancement in information and communication technologies (ICT) on economic development. The results of this study show that advancement in information and communication technologies has an insignificant relationship with economic development and plays a positive and significant role in economic development in the case of developing countries. The findings of this study strongly show that developing countries should introduce new and advanced information and communication technologies (ICT) for competing with developed countries in the process of economic development.

Many studies have found links between financial development and economic growth (Schumpeter, 1939; Posne, 1961; Kahneman and Tversky, 2013; Bell and Pavitt, 1993). Financial development constitutes the promotion of financial products and services, the development of new financial processes as well as the interaction with customers, and the development of new structures for financial institutions (Mention, 2011). Innovations continue to play a key role in economic growth and reduce the gap of competitiveness and uneven knowledge gap between developed and developing countries (Salas-Guerra and Cesar, 2021).

Jung (1986) investigates international evidence on the causal relationship between financial development and economic growth. The results of this study show that the monetization variable exhibits the reverse causal pattern among LDCs and provides moderate support for the Patrick hypothesis. Levine et al., (2000) examine the effect of financial intermediary development on economic growth. The findings show a strong positive relationship between financial development and output growth. But finance development partly explains economic growth. The results support the idea of the growth-enhancing hypothesis of financial development. Halifa Al-Yousif (2002) empirically examines the relationship between financial development and economic growth. The empirical results of this study toughly support the opinion that financial development and economic growth are equally causal. Results also indicate that there is bidirectional causality between financial development and economic growth. Ali and Rehman (2015) empirically examine the impact of macroeconomic instability detrimental to the gross domestic product in the case of Pakistan. The results of the study also show that macroeconomic instability has a deep-rooted and detrimental impact on the gross domestic product of Pakistan. The findings of this study are that government should make appropriate policies for raising the pace of economic growth in Pakistan.

3. Background to Empirical Model

This section is comprised of the theoretical background to the empirical model of our article. The main purpose of theory is to construct models that define the behavior of an individual and society as a whole. Normally, a model represents real situations of different units in the presence of some assumptions and abstractions. These abstractions depend on the purpose for which the model has been constructed. The basic objective behind the construction of the model is to analyze and predict. The predicting power, provided information, realism, and simplicity of assumptions and generality would decide the validity of the model (Nagel, 1963).

Theoretically, the link between innovations, knowledge and economic growth is established by Marshall (1890) and Solow (1956) later it is augmented and strengthened by Kuznets (1971), Mansfield (1972), Romar (1986), Nadiri (1993). These studies have been recognizing the direct and indirect impact of knowledge on economic activities. Moreover, from a broader perspective, innovations attempt to improve products, processes, or ways to think people about economic activities (Schumpeter, 1939; Bell and Pavitt, 1993). Many studies have described how innovations and entrepreneurship affect the economy (Porter, 1990; Baumol, 1993; Lumpkin and Dess, 1996).

The new growth model begins with Solow (1980), this model has three basic components for measuring economic growth, i.e. labor (L) capital (K), and technology (A).

$$Y=AK^{\alpha} L^{(1-\alpha)} \qquad (1)$$

Y=Economic growth

Romer (1986) and Lucas (1988) extended the Solow model by including human capital; as they believe that human capital can lead to captivate technology and stimulate economic growth. The form of the economic growth model become as:

$$Y=K^{\alpha} (AH)^{1-\alpha} \qquad (2)$$

H=Human Capital

Since the endogenous growth model allows us to include some additional variables for the determination of economic growth. The studies, e.g., Anaman (2004) and Kogid et al., (2010) incorporate government expenditure, exchange rate, inflation, labor, consumption expenditure, foreign aid, corruption, financial development, education, population growth, and life expectancy as determinants of economic growth. Since, the total productivity factor has an indirect relationship with total output, which depends on technology and efficiency. This means that the total productivity factor productivity impacts economic growth via the transfer of technology (Takumah and Iyke, 2017). This study is examining the impact of innovations and financial development on economic growth in the case of selected developing countries. Following the basic Cobb-Douglas production function, and empirically tested by (Pendharkar et al., 2008; Miller, 2008; Ali and Rehman, 2015; Ali 2015), the model of this study can be formulated as follows:

$$ECOG_{it} = F\,(FIN_{it}, CAPITAL_{it}, INN_{it}, TRADE_{it}, URB_{it}, INF_{it}) \qquad (3)$$

ECOG=Economic Growth (measured with the help of GDP growth rate)

FIN=Financial development (an index has been constructed with the help of money supply, interest rate, credit to the private sector, etc.)

CAPITAL=Available physical capital (measured with the help of capital formation)

INN=Innovations (an index has been constructed with the help of R&D expenditures, level of education, use of the computer, etc.)

TRADE=Merchandised trade (measured with the help of merchandised trade among countries)

URB=Urbanization (measured with the help of urban population)

INF=Inflation rate (GDP deflator has been used as inflation rate)

i= the country (58 developing countries have been selected for this empirical analysis)

t= time period (data from 2000 to 2020 has been selected)

For checking the responsiveness of the dependent variable for the independent variables, the equation can be written as:

$$ECOG_{it} = AFIN^{\beta 1}{}_{it}\ CAPITAL^{\beta 2}{}_{it}\ INN^{\beta 3}{}_{it}\ TRADE^{\beta 4}{}_{it}\ URB^{\beta 5}{}_{it}\ INF^{\beta 6}{}_{it}\ U_{it} \qquad (4)$$

The econometric model of the study becomes as:

$$ECOG_{it} = A+\beta_1 FIN_{it}+\beta_2 CAPITAL_{it}+\beta_3 INN_{it}+\beta_4 TRADE_{it}+\beta_5 URB_{it}+\beta_6 INF_{it}+U_{it} \qquad (5)$$

All the variables explained above except A and U,

A= constant intercept

U= Error term (supposed to be white noise)

Data of selected variables have been taken from World Development Indicators (WDI), online databases maintained by the World Bank.

4. Econometric Methodology

The application of econometric tools to macroeconomic models is one of the most important aspects of quantitative economic analysis. This section is comprised of econometric methodologies which are used for empirical analysis.

4.1. Panel Unit Root

The article uses the unit root tests to check the stationary of the panel. Panel data unit root tests have been used following the recent literature to adjust the difference in mean and variance within a variable. Various tests can be used to identify a unit root problem in panel data, namely those of Maddala and Wu (MW) (1999), I'm, Pesaran and Shin (IPS) (2003); Levin, Lin and Chu (LLC) (2002) and Hadri's (2000). Levin, Lin & Chu t*, ADF - Fisher Chi-square, Im, Pesaran, and Shin W-stat, and PP Fisher Chi-square unit root tests have been used for investigating the issue of stationarity in the data. The methodology follows as:

$$\Delta y_{i,t} = \gamma_{0i} + py_{it-1+} \sum_{i-1}^{pi} \gamma_{1i} \Delta y_{i,t-j} + u_{i,t} \qquad (6)$$

"γ_{0i} is the constant parameter in the eq. (6), this has exceptional properties for the cross-sectional units and p is the same for all the coefficients of autoregressive, however, γ_i presents the selected order of lags for the model, $u_{i,t}$ is the disturbance term, it is normally considered to be autonomous for all of the selected across of panel units. This eq. (6) is based on the Autoregressive Moving Average (ARMA) stationary procedure for respective cross-sections, then eq. can be presented as:

$$u_{i,t} = \sum_{j-0}^{\infty} \gamma_{1i} \Delta y_{i,t-j} + \varepsilon_{i,t} \qquad (7)$$

Based on eq. (7), null and alternative hypotheses would be tested as:

H_0: $p_i = p = 0$

H_a: $p_i = p < 0$ for all i

the t-test can be utilized for the LLC model, where p is supposed to be fixed for the across and units, by following, the null and alternative hypothesis.

$$t_p = \frac{\hat{p}}{SE(\hat{p})} \qquad (8)$$

Throughout this process, it has been assumed that the error series is following all properties of white-noise error. Moreover, the panel eq. for regression has t_p test statistics, it shows the convergence of all selected standard normally distributed series, for example, N and $T \to \infty$ $\sqrt{\frac{N}{T}} \to 0$. On the opposite sideways, if some units of the section are not independent of each other, then the residual of the selected series would be corrected, as this raises the chances of auto-correlation. Because of such conditions LLC test assumes an alternative test statistic:

$$t_p = \frac{t_p - N\tilde{T}\hat{S}_N \hat{\sigma}^{-2}(\hat{p})\mathrm{u}_m^*}{\sigma_m^*} \qquad (9)$$

where u_m^* and σ_m^* are supposed to be augmented by the residual series, and its standard deviation, the coefficients of these estimates can be calculated with the support of Monte Carlo Simulation, our unit test LLC (2002) also followed this value.

Im et al., (2003) introduced another panel stationary test, under such conditions when the panel data have heterogeneity. This method has followed the procedures of ADF unit root, but this method had used a modest mean of all series, the main eq. of this test can be written as:

$$\Delta y_{i,t} = \bar{w}_i + py_{it-1+} \sum_{i-1}^{pi} \gamma_{1i} \Delta y_{i,t-j} + v_{i,t} \qquad (10)$$

The IPS test permits the unit root process when we have heterogeneity in v_i values, then the IPS unit root test eq. would be written as:

$$\bar{t}_T = \frac{1}{N} \sum_{i-1}^{N} t_{1,i}(\mathrm{p}_i) \qquad (11)$$

where $t_{i,t}$ is the test statistic for ADF, lag order can be presented by p_i. The main procedures for the analysis would be followed as:

$$A_t - = \frac{\sqrt{N(T)}[\bar{t}_T - \mathrm{E}(\mathrm{t}_T)]}{\sqrt{Var(\mathrm{t}_T)}} \qquad (12)$$

4.2. Panel Co-Integration

After checking the stationary of data and confirming that each series is integrated in the same order, the next step is to check whether these series can be combined into a single series, which itself must be non-stationary, which is known as co-integration. Co-integrated series move in the same direction in the long run and are in equilibrium relationship-integration tests have been developed by Granger (1981) and extended by Engle and Granger (1987). To overcome the problem, scholars introduce panel co-integration, which pools both time series and cross-sectional data to analyze the relationship between the non-stationary variables I (1). This study employed the Padroni (1999) panel co-integration test. This test is the extension of Engle-Granger (1987) in the context of panel data. It is employed to examine the impact of trade openness and economic growth. Padroni introduced seven co-integration tests which are categorized into two dimensions which are: within dimension-based statistics, referred to as co-integration statistics containing four test panels: v-statistics, panel p statistics, panel t- statistics (non -parametric), and panel t-statistics (parametric). The other is between- dimension based statistics, which are referred to as group mean panel co-integration statistics. The tests are divided into three: group p- statistics, group t-statistics (non -parametric), and group t-statistics (parametric). The test is defined as follows:

1. Panel v statistic:

$$Z_v = \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\ell}_{i,t-1}^{2} \right)^{-1} \qquad (13)$$

2. The panel t statistic:

$$Z_p = \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\ell}_{i,t-1}^{2} \right)^{-1} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{\ell}_{i,t-1} \Delta \hat{\ell}_{i,t} - \hat{\lambda}_{i} \right) \qquad (14)$$

3. The panel t statistic (Non-parametric):

$$Z_i \equiv \left(\tilde{\sigma}_{N,T}^{2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \hat{\ell}_{i,t-1}^{2} \right)^{-1\backslash 2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}_{11i}^{-2} \left(\hat{\ell}_{i,t-1} \Delta \hat{\ell}_{i,t} - \hat{\lambda}_{i} \right) \qquad (15)$$

4. The panel t statistic (parametric):

$$\overset{*}{Z}_t \equiv \left(\tilde{S}^{*2}_{N,T} \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}^{-2}_{11i}\, \hat{\ell}^{*2}_{i,t-1} \right)^{-1\backslash 2} \sum_{i=1}^{N}\sum_{t=1}^{T} \hat{L}^{-2}_{11i} \left(\hat{\ell}^{*}_{i,t-1}\, \Delta \hat{\ell}^{*}_{i,t} \right) \quad (16)$$

5. The group t statistic (parametric):

$$\tilde{Z}_P \equiv TN^{-1\backslash 2} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{\ell}^{2}_{i,t-1} \right)^{-1} \sum_{t=1}^{T} \left(\hat{\ell}_{i,t-1}\, \Delta \hat{\ell}_{i,t} - \hat{\lambda}_i \right) \quad (17)$$

6. The group t statistic (non-parametric):

$$\tilde{Z}_t \equiv N^{-1\backslash 2} \sum_{i=1}^{N} \left(\hat{\sigma}^{2}_{i} \sum_{t=1}^{T} \hat{\ell}^{2}_{i,t-1} \right)^{-1\backslash 2} \sum_{t=1}^{T} \left(\hat{\ell}_{i,t-1}\, \Delta \hat{\ell}_{i,t} - \hat{\lambda}_i \right) \quad (18)$$

7. The group t statistic (parametric):

$$\tilde{Z}^{*}_t \equiv N^{-1\backslash 2} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{S}^{*2}_{i}\, \hat{\ell}^{*2}_{i,t-1} \right)^{-1\backslash 2} \sum_{t=1}^{T} \left(\hat{\ell}^{*}_{i,t-1}\, \Delta \hat{\ell}^{*}_{i,t} \right) \quad (19)$$

Where $\lambda\, \hat{}_i$ is a consistent estimator of the long-run variance?

$$\hat{L}^{2}_{11} = \frac{1}{T} \sum_{t-1}^{T} \hat{\eta}^{2}_{i,t} + \frac{2}{T} \sum_{s=1}^{ki} \left(1 - \frac{S}{K_1 + 1} \right) \sum \hat{\eta}_{i,t}\, \hat{\eta}_{i,t-s,}\ \ \sigma^{\wedge 2}_{i} = S_i + 2\hat{\lambda}_i, \hat{S}_i = \frac{1}{T} \sum_{t=1}^{T} \eta_{it,}$$

$$\sigma^{2}_{N,T} = \frac{1}{N} \sum_{t=1}^{N} \hat{L}_{11} \hat{\sigma}^{2}_{i}\, \hat{S}^{*2}_{i} = \frac{1}{t} \sum_{t=1}^{T} \hat{\eta}^{-2}_{i,t}\, \tilde{S}^{*2} \quad (20)$$

And the residuals $\eta^{\wedge}{}_{I,t,}$ and $\eta^{\wedge *}{}_{I,t}$ and $\eta^{\wedge}{}_{I,t}$ are obtained from the following regression:

$$\hat{\ell}_{i,t} = \hat{\gamma}_i\, \hat{\ell}_{i,t-1} + \eta_{i,t}, \ell^{\wedge *}_{i,t} \hat{\gamma}_i\, \ell_{i,t-1} + \sum_{k=1}^{ki} \hat{\gamma}_{i,k} \Delta \hat{\ell}_{i,t-k} + \hat{\eta}^{*}_{i,t}, \gamma_{i,t} = \sum_{M-1}^{N} \hat{b}_{mi}\, x_{mi,t} + \hat{\eta}_{i,t} \quad (21)$$

Therefore, the null hypothesis of no co-integration is said to take place when residuals are non-stationary. On the other hand, when the residuals are stationary, there is co-integration. Given there is panel co-integration between the results, the long-run relationship can further be estimated using panel co-integration estimation namely Ordinary Least Square, Fully modified OLS (FMOLS) estimator. It was developed by Phillips and Moon and Padroni in 1999, 1995, and 2000 respectively, and Dynamic OLS (DOLS) was developed by Kao and Chiang in 2000. Unfortunately, Kao et al., (1999) found that the OLS estimator is biased in analyzing non-stationary data. Fully modified OLS was then developed to correct the serial correlation and endogeneity of the OLS estimator. The test was developed by Philips and Hansen (1990), and extended to the context of heterogeneous panels by Pedroni (1999).

4.3. Variance Decomposition

In applied Econometrics number of causality tests are available, but among them, Vector Error Correction Method (VECM) is used in most cases. The drawback of this test is that it only finds the causal relationship of variables within the sample period and does not give information about the future relationship. Moreover, VECM is unable to detect the feedback impact of one variable on other variables. For finding the exact feedback points and the impact of shocks of one variable on other variables, variance decomposition, and impulse response functions are used. Variance decomposition finds the magnitude of shocks of one variable to other variables within the selected period and beyond the selected time zone. Whereas the impulse response gives us details about the feedback impact of one variable on another variable within and beyond the selected period. Variance decompositions are a slightly different approach for exploring the SVAR system dynamics. The variance decomposition approach explains how many unanticipated changes are explained by different shocks. Variance decompositions indicate the percentage of the forecast error variance in one variable that is due to errors in forecasting itself and each of the other variables (Alami, 2001). From the variance decompositions, it is possible to learn if the corresponding effects of one variable upon another are important in a relative sense. Of particular concern in this study is the percentage variation in the social progress explained by macroeconomic instability with some control variables. Silvey (1969) presented the method of variance decomposition he decomposes a coefficient variance into a sum of terms each of which is associated with a singular value and Belsely et al., (1980) extended his work.

For reviewing the OLS under the model

$$E_m(\mathrm{X}) = Y\beta \qquad (22)$$

and $Var_m(X) = \sigma^2 I_n$ where I_n is the $n \times n$ identity matrix.

$$\hat{\beta} = (Y^t Y)^{-1} Y^t X$$

And its $Var_m(\hat{\beta}) = \sigma^2 (Y^t Y)^{-1}$

Using the singular-value decomposition $Y = UDV^t$ and the $\mathrm{Var}_m(\hat{\beta})$ can be written as

$$\mathrm{Var}_m(\hat{\beta}) = \sigma^2[(UDV^t)^t (UDV^t)]^{-1} = \sigma^2 V D^{-2} V^t \qquad (23)$$

And the k^{th} diagonal element $\mathrm{Var}_m(\hat{\beta})$ is the estimated variance for the k^{th} coefficient $\hat{\beta}_k$. So using the eq. (23) $\mathrm{Var}_m(\hat{\beta}_k)$ can be expressed as:

$$\mathrm{Var}_m(\hat{\beta}_k) = \sigma^2 \sum_{j=1}^{p} \frac{v_{kj}^2}{\mu_j^2} \qquad (24)$$

Where $V = (V_{kj})_{p \times p}$

Let $\phi_{kj} = v_{kj}^2 / \mu_j^2, \phi_k = \sum_{j=1}^{p} \phi_{kj}$

And $Q = (\phi_{kj})_{p \times p} = (VD^{-1}).(VD^{-1})$

The variance decomposition proportions are $\pi_{jk} = \phi_{kj} / \phi_k$ which is the proportion of the variance of the k^{th} regression coefficient associated with the j^{th} component of its decomposition in eq. (24). Denote the variance decomposition proportion matrix as

$$\prod = (\pi_{jk})_{p \times p} = Q^t \bar{Q}^{-1} \qquad (25)$$

Where $\bar{Q}$ is the diagonal matrix with the row sum of Q on the main diagonal and 0 elsewhere, Since at least one v_{kj} must be non-zero in eq. (24), this implies that a high proportion of any variance can be associated with a large singular value even when there is no co-linearity. The standard approach is to check a high condition index associated with a large proportion of the variance of two or more coefficients when diagnosing co-linearity since there must be two or more columns of Y involved to make a near dependency. Belsely et al., (1980) suggested showing the matrix $\prod$ and the condition indexes of Y in a variance decomposition table as

Condition Index	Proportions of variance			
	$Var_M(\hat{\beta}_1)$	$Var_M(\hat{\beta}_2)$	$\cdots$	$Var_M(\hat{\beta}_p)$
η_1	π_{11}	π_{12}	$\cdots$	π_{1p}
η_2	π_{21}	π_{22}	$\cdots$	π_{2p}
$\vdots$	$\vdots$	$\vdots$		$\vdots$
η_p	π_{p1}	π_{p2}	$\cdots$	π_{pp}

4.4. Impulse Response Function

The impulse response function has a special interpretation in applied macroeconomic modeling because it describes the reaction of an economy in response to different shocks over time. The impulse response function helps us to trace out the time path of the impacts of shock on variables in the VAR. These shocks can be modeled with the help of a standard Vector Autoregressive (VAR) process and impulse response analysis follows the nonlinear methodology. Hamilton (1994) mentions that the impulse response function is used for examining the reaction of endogenous macroeconomic variables at the time of the shocks and over the subsequent points in time. Mörling (2002) explains that impulse response analysis illustrates the response of a system to one-standard deviation shocks to one of the variables. This method is best for finding the causal relationship between variables as compared to the Granger Causality test (Lin and Bever, 2006). Impulse response analysis can also separate the impact of positive impulses from negative impulses (Lanne and Lutkepohl, 2008; Hatemi-j, 2014). This method is best for estimating the overall interdependence among the variables of the models.

Let X_t be a k-dimensional vector series that is generated by following the autoregressive process

$$X_t = a_1 X_{t-1} + ... + a_p X_{t-p} + \varepsilon_t \qquad (26)$$

$$= \phi(b)\varepsilon_t = \sum_{i=0}^{\infty} \phi_i \varepsilon_{t-i} \qquad (27)$$

$$I = (\mathrm{I} - a_1 b - a_2\, \mathrm{b} - .... - a_p b^p)\phi(\mathrm{b}) \qquad (28)$$

Here $\mathrm{cov}(\varepsilon_t) = \Sigma, \phi_i$ are the MA coefficients which measure the impulse response. Generally, $\phi_{jk,i}$ explains the response of variable *j* to a unit impulse in variable *k* occurring in the *i-th* period ago.

By using these coefficients impulse response analysis can evaluate the effectiveness of policy change.

Usually $\sum$ is non-diagonal and it explains how a dependent variable is fixed by the possible shocks of the independent variable. For its better understanding, a simple transformation is required. The most famous transformation used in literature is Cholesky decomposition. Let P is a lower triangular matrix such as $\sum = PP'$. Then the eq. (28) can be written as

$$X_t = \sum_{i=0}^{\infty} \theta_i \omega_{t-i} \qquad (29)$$

Where $\theta_i = \phi_i P, \omega_t = P^{-1}\varepsilon_t$ and $E(\omega_t, \omega_t') = \mathrm{I}$.

Let D be a diagonal matrix with the same diagonals as P and $W = PD^{-1}, \Lambda = DD'$ after some manipulation we get,

$$X_t = b_0 X_t + b_1 X_{t-1} + ... + b_p X_{t-p} + \mu_t \qquad (30)$$

Where $b_0 = I_k - W^{-1}, W = PD^{-1}, b_i = W^{-1} a_i$.

Here b_0 it represents the lower triangular matrix with *0* diagonals. Simply now we conclude that Cholesky decomposition shows the causal reaction between the variables of the model. For getting the required results the following two conditions are necessary.

For a k –dimensional stationary VAR (p) process

$\phi_{j,k,i} = 0$ And for $j \neq k, \mathrm{i} = 1, 2, 3, 4, ...$

It is equal to

$\phi_{j,k,i} = 0$ And for $i = 1, 2, ..., p(k-1)$

It means that if the first $\phi_{j,k,i} = 0$ and for $pk - p$ response to variable *j* to an impulse in variable *k* is zero, then all the following responses are zero.

Variable *k* does not cause variable *j* if and only if $\phi_{j,k,i} = 0$ and for $\mathrm{i} = 1, 2, 3, 4, ...$

5. Estimated Results and Discussions

This article has conducted a nexus among innovations, financial development, and economic growth in the case of developing countries from 2000 to 2020. This section presents the empirical results and discussion on estimated results and tries to answer our basic question that how financial development, innovations, and economic growth are interlinked with each other.

The appendix table-A provides the descriptive statistic of the selected variables, all the variables of the model have been analyzed with help of mean, median, maximum, minimum, and standard deviation, Skewness, Kurtosis, and Jarque-Bera. The descriptive statistic also helps to test the normality of the data. The overall results of table-A disclose that financial development, physical capital, innovations, merchandised trade, urbanization, and inflation rate are positively skewed and all variables have positive Kurtosis. The values of Skewness and Kurtosis reveal that all the variables are statistically insignificant which means the variables are normally distributed. The estimated values of the Jarque-Bera indicate that all the variables have zero mean and finite covariance, this also confirms that all variables are normally distributed.

The results of the correlation between the variables are presented in table-B. The overall results of pairwise correlation show that economic growth being the dependent variable of the model has a significant correlation with most of the independent variables i.e. financial development, physical capital, innovations, merchandised trade, and urbanization. Overall results show that most of the variables have a significant correlation with each and selected explanatory variables for the regression line do have not a high correlation which generates the issue of multicollinearity for the model.

The results of panel unit root tests have been given in table-C, covering the period from 2000 to 2020, this study has to check the unit root issue of the data series, LLC, IP&S W-stat, ADF-Fisher, and PP Fisher Chi-square unit root tests have been used for this purpose. for investigating the issue of stationarity in the data. The results of LLC show that all variables are stationary at level, the results of IP&S, ADF-Fisher, and PP-Fisher unit root tests show that except financial development and availability of physical capital, all variables are stationary at level. But the first difference outcomes of the LLC, IP&S W-stat, ADF-Fisher, and PP Fisher Chi-square unit root tests show that all the variables become stationary. This shows that there is a mixed order of integration among the selected variables of the model which is a suitable condition for applying the panel ARDL co-integration approach.

By keeping this in view, the number of observations and variables of the model lag order can be selected. The lag order selection criteria are reported in table-D; a maximum of 3 lags are allowed for Vector Auto-Regressive process. The results show that all criteria allow optimal lag length 3. Thus, following the sequentially modified LR test statistic, FPE (Final prediction error), SC

(Schwarz information criterion), and HQ (Hannan-Quinn information criterion) lag length 3, is used for the variables of this model.

The estimated long-run and short-run results of the study have been presented in table 1. The level of economic growth of an economy requires a strong financial sector. The development of the financial sector needs the establishment of financial institutions, markets, and instruments that sustain huge investments and economic growth (Levine, 1996; Demirguc-Kunt, 2008). Financial development provides better information about possible profitable investments and promotes the optimum allocation of resources (Greenwood and Jovanovic, 1990; Ehigiamusoe and Samsurijan, 2021). The emergence of financial institutions helps in curtailing the cost of acquiring information and effective implementation of contracts and execution of transactions (Kidwell et al., 2016). The expanding financial access inculcates dynamic efficiency in the system by bringing about a structural change through innovation and welfare gain the entire economy (Guru and Yadav, 2019). A developed financial system can easily operationalize the domestic savings of the economy into profitable investments (Stiglitz and Weiss, 1983; Diamond, 1984), and there is less information cost thus better resource allocation can be attained (Greenwood and Jovanovic, 1990). Moreover, the developed financial system is attached with less corporate governance cost too (Bencivenga and Smith, 1993). According to Levine (1997), financial systems can also assist in trading, risk amelioration and hedging, and diversification, rather than only facilitation in the transactions of services and goods. The allocation of credit through the financial system works as a channel between financial and real sectors, which can be used to finance working capital requirements and investment in fixed capital; the former is used to raise production whereas the latter enhances productivity in the real sector (Das and Guha-Khasnobis, 2008). In the case of developing countries, there may be an inverse relationship between financial development and economic growth, as according to Lucas (1988), financial markets play less role in the process of economic growth. Our estimated results show that in long run, financial development has a negative and significant impact on economic growth. But financial development has a positive and insignificant impact on economic growth in the short run. Shan (2005) mentions that the financial markets of developing countries, especially, Asian countries are unable to allocate a large inflow of funds into profitable ventures. Guru and Yadav (2018) also find the same type of relationship between financial development and economic growth in the case of BRICS.

The availability of physical capital refers to as income or output-producing capacity of a country (Islam and Alam, 2019). These are gross savings out of income that make a possible portion of gross investment portion out of national income. Gross investment offsets capital consumption and adds to productive capacity for future periods. Neoclassical growth theory and endogenous growth theories starightwardly mention that the accumulation of physical capital and human capital play important role in determining economic growth (Solow 1956; Romer 1986; Lucas 1988). Our estimated long-run and short-run results show that the availability of physical capital has a positive and significant impact on economic growth in the case of developing countries. These findings are consistent with the finding of Easterly and Levine (1997), Chen and Feng (2000), Bleaney et al., (2001), Freire-Seren (2002), Anaman (2004), Acikgoz and Mert (2005), Bayraktar (2006), Asheghian (2009), Checherita-Westphal and Rother (2012), Ali (2015), Ali and Rehman (2015), Fetahi-Vehapi et al., (2015), and Ali and Audi (2018).

Innovations are one of the driving forces of economic growth (Solow, 1956; Mansfield, 1972; Romar 1986; Nadiri, 1993; Cameron, 1996; Andergassen et al., 2009; Santacreu, 2015; Bae and Yoo, 2015), and these have become a pervasive indicator of our lives and lifestyle as well. In the last few years, economists and policymakers have paid much attention to examine the link between innovations and regional economic output (Howells 2005; Wang et al. 2009; Malerba and Brusoni 2007; Grossman et al., 2017; Galindo and Mendez-Picazo 2014; Tsvetkova 2015). Unlike natural resources, innovations are man-made resources with continuously increasing abundance (Starr and Rudman, 1973). Innovations can impact an economy in multiple ways, i.e., employment, trade openness, quality of life, financial systems, global competitiveness, economic growth, and infrastructure development, and hence, spawns high economic growth. Our long-run results show that innovations have a positive and significant impact on economic growth in the case of developing countries. Lichtenberg (1992) highlights the positive impact of innovations on productivity and growth, our long-run findings are consistent with these studies. But in the short-run innovations have a negative and insignificant impact on economic growth in developing countries. These findings show that the relationship between innovations and economic growth is a long-run phenomenon rather than a short-run (Silverberg and Verspagen, 1994; Wang, 2013).

Historically, the relationship between trade and economic growth remains controversial (Grossman and Helpman, 1991; Rivera-Batiz and Romer, 1991; Barro and Sala-i-Martin, 1992; Edwards, 1998). Some researchers recommend that lowering trade restrictions raises the level of international trade through the reduction of transaction costs which further raises the level of economic growth. Likewise, it can be argued that developing countries that have opened their economy to the rest of the world have a greater ability to absorb the advanced technologies of the developed countries. Whereas, some economists argue that some forms of protection are necessary for the survival of the country, i.e., infant industry and local employment burden, etc, which are responsible for the economic growth of the country. Rodríguez and Rodrik (2000) mention that the positive and negative effects of trade are related as a matter of course but pose conceptually distinct questions and different qualitative and quantitative outcomes. Trade policies can be seen as responses to market imperfections or as a mechanism of rent-seeking. Thus, rising trade is attached to the higher economic growth of the nation. Our estimated results show that trade has a positive and significant impact on economic growth in the long run and short run. These findings are consistent with Ben-David (1993), Sachs and Warner (1995), Edwards (1998), Warner (2003), Dollar and Kraay (2004), Barro and Sala-i-Martin (2004), Noguer and Siscart (2005), Manole and Spatareanu (2010), and Squalli and Wilson (2011).

21^{st} century is attached to rising urbanization throughout the world, although, this urbanization varies across regions and countries. In the last few years, the relationship between rising urbanization and economic growth has got much importance among policymakers and economists. The link between urbanization and economic growth is often portrayed as inevitable and automatic, like some sort of universal law governing an immutable historical process. Some studies find a positive relationship between urbanization and economic growth (Ali and Rehman, 2015; Ali, 2015; Nguyen, 2018), but some studies find an inverse relationship between urbanization and economic growth (Nathaniel, 2020). Our results show that urbanization has a negative and insignificant impact on economic growth in the long run, but in the short run, urbanization has a negative but significant impact on economic growth. There numerous studies (Henderson, 2003; Al-Mulali et al., 2015) mention that urbanization has an insignificant impact on economic growth in the case of developing countries.

The relationship between inflation and economic growth is of great interest in macroeconomics and monetary policy modeling (Batini and Nelson, 2001). Although the relationship between the inflation rate and economic growth has been studied extensively, nevertheless the exact relationship is not well defined (Friedman, 1956; Wai, 1959; Dorrance, 1966; Sidrauski, 1967; Stockman, 1981; Barro, 1995; Bruno & Easterly, 1998). Our results show that inflation has a negative and significant impact on economic growth in the long run. These findings are consistent with Risso and Carrera (2009), Kasidi and Mwakanemela (2013), and Majumder (2016). But in the short run inflation has a positive and significant impact on economic growth in developing countries.

The value of ECT is theoretically correct, with a negative and significant value. This reveals that short deviations in the economic growth of developing countries need one year, and one month to converge in the long run. This also shows that 90 percent of short-run deviations in economic growth are corrected very next year in the case of developing countries.

Table 1: Long and Short Run Coefficients

Dependent variable: Economic Growth: ARDL(1,0,1,1,0,1)				
	Long Run Outcomes		Short Run Outcomes	
Variable	Coefficient	Std. Error	Coefficient	Std. Error
FIN	-0.044858***	0.007589	0.074825	0.048951
CAPITAL	0.027571*	0.018648	0.435960***	0.090016
INN	0.037903**	0.015657	-0.007264	0.081786
TRADE	0.028474***	0.006611	0.092058***	0.030754
LURB	-0.315087	0.480339	-100.4953*	65.19627
INF	-0.048575***	0.017017	0.095795***	0.032891
ECT	-	-	-0.905800***	0.045307
Note: The asterisks ***, ** and * denote the significant at 1%, 5% and 10% levels, respectively				

The results of variance decomposition have been given in Table-2. The results reveal that 95.59% as a part of economic growth is explained by its own created shocks. Whereas shocks of financial development contribute to Economic growth by 0.63%. The results show that the availability of physical capital, innovations, trade, urbanization, and inflation contribute to economic growth by 1.20%, 2.29%, 0.088495%, 0.08%, and 0.10%, respectively. The results show that 11.10% of shocks in financial development are due to economic growth, whereas 87.13% percent of shocks in financial development is explained by their own created shocks. The results show that the availability of physical capital, innovations, trade, urbanization, and inflation contribute to shocks of financial development by 0.63%, 0.32%, 0.61%, 0.05%, and 0.12%, respectively. The results show that 15.68% of shocks in the availability of physical capital are due to economic growth, whereas 82.85% of shocks in the availability of physical capital are explained by their own created shocks. The results show that financial development, innovations, trade, urbanization, and inflation contribute to shocks of availability of physical capital by 0.73%, 0.21%, 0.33%, 0.15%, and 0.01%, respectively. The results show that 0.30% of shocks in innovations are due to economic growth, whereas 98.78% of shocks in innovations are explained by their own created shocks. The results show that the availability of physical capital, financial development, trade, urbanization, and inflation contribute to shocks of availability of physical capital by 0.14%, 0.63%, 0.12%, 0.007%, and 0.007%, respectively. The results show that 2.47% of shocks in trade are due to economic growth, whereas 92.83% of shocks in trade are explained by their own created shocks. The results show that the availability of physical capital, financial development, innovations, urbanization, and inflation contribute to shocks of trade by 0.86%, 0.73%, 0.42%, 0.04%, and 2.62%, respectively. The results show that 2.47% of shocks in urbanization are due to economic growth, whereas 96.31% of shocks in urbanization are explained by their own created shocks. The results show that the availability of physical capital, financial development, innovations, trade, and inflation contribute to shocks of urbanization by 0.03%, 0.48%, 0.006%, 1.40%, and 0.16%, respectively. The results show that 2.47% of shocks in inflation are due to economic growth, whereas 85.34% of shocks in inflation are explained by their own created shocks. The results show that the availability of physical capital, financial development, innovations, trade, and urbanization contribute to shocks of urbanization by 0.15%, 9.04%, 0.56%, 3.88%, and 0.36%, respectively. Overall, the feedback effects the results show that financial development, availability of physical capital, innovations, trade, urbanization, and inflation play important roles in determining economic growth in developing countries.

Table 2: Variance Decomposition

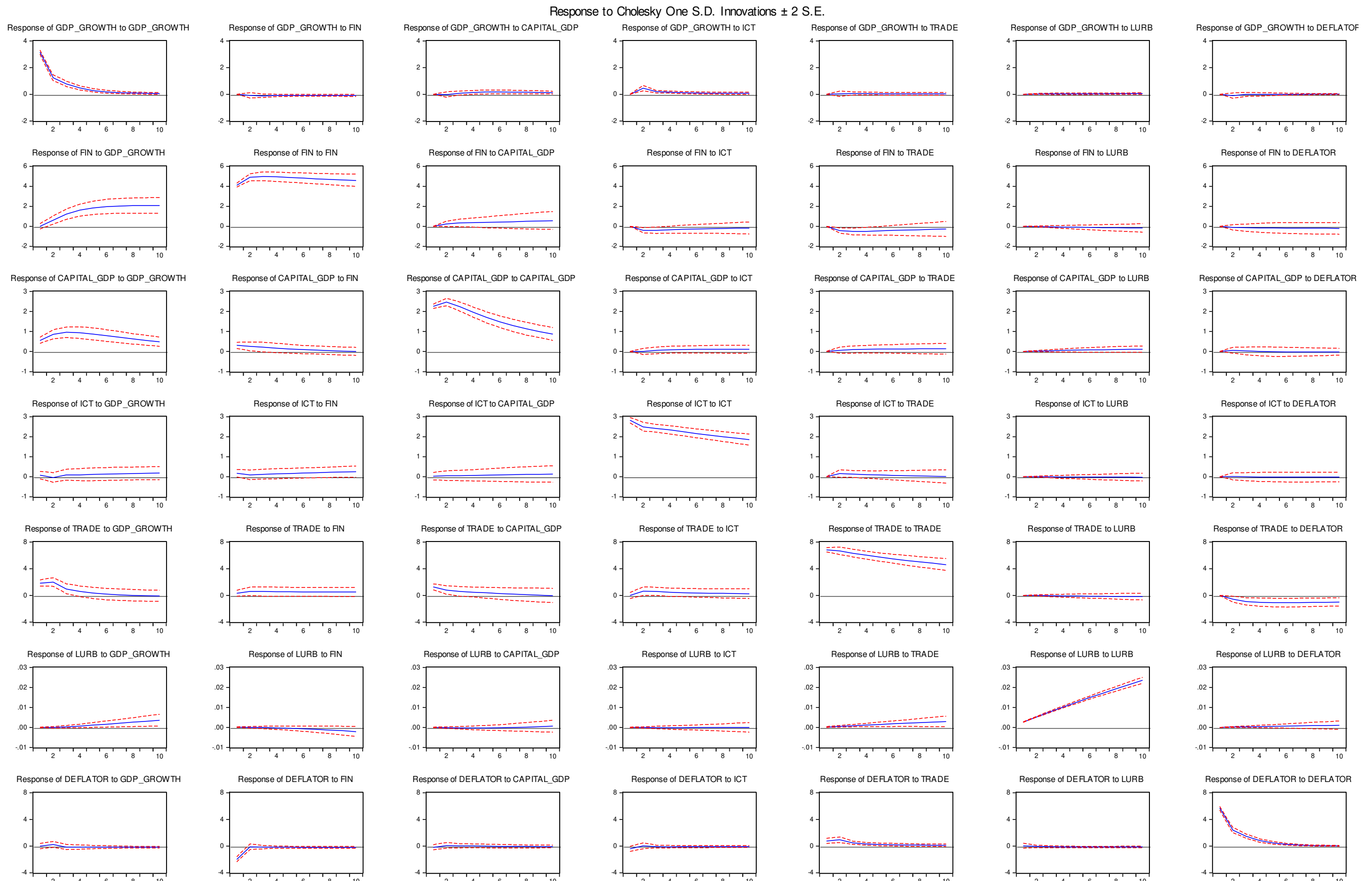
Variance Decomposition of ECOG								
Period	S.E.	ECOG	FIN	CAPITAL	INN	TRADE	LURB	INF
1	3.156189	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
2	3.420741	98.08206	0.066116	0.007026	1.725905	0.005019	0.002485	0.111386
3	3.516303	97.71412	0.194575	0.051997	1.898586	0.024458	0.007685	0.108581
4	3.554006	97.32978	0.269349	0.194740	2.043796	0.038330	0.015090	0.108913
5	3.571774	96.96301	0.335352	0.398038	2.121627	0.049448	0.024320	0.108205
6	3.582722	96.61827	0.394904	0.612945	2.172402	0.058938	0.034945	0.107600
7	3.590563	96.30746	0.452673	0.808257	2.210472	0.067325	0.046684	0.107132
8	3.596684	96.03443	0.510685	0.972263	2.241569	0.074957	0.059324	0.106771
9	3.601685	95.79649	0.569820	1.103915	2.268605	0.081988	0.072698	0.106487
10	3.605895	95.58844	0.630403	1.206825	2.292909	0.088495	0.086672	0.106260
Variance Decomposition of FIN								
Period	S.E.	ECOG	FIN	CAPITAL	INN	TRADE	LURB	INF
1	4.105278	0.000502	99.99950	0.000000	0.000000	0.000000	0.000000	0.000000
2	6.447890	0.892824	98.06526	0.113957	0.423045	0.469410	0.002790	0.032719
3	8.270313	2.648661	95.84954	0.222054	0.519091	0.700837	0.007461	0.052358

4	9.791639	4.562815	93.78387	0.293784	0.508880	0.770514	0.013106	0.067028
5	11.11185	6.265929	92.03934	0.348256	0.472815	0.775149	0.019364	0.079143
6	12.28413	7.672178	90.62306	0.399806	0.435412	0.753953	0.026080	0.089512
7	13.34149	8.809271	89.47995	0.454199	0.402308	0.722500	0.033176	0.098598
8	14.30621	9.729082	88.54957	0.512618	0.374007	0.687366	0.040603	0.106758
9	15.19424	10.48004	87.78167	0.574324	0.349846	0.651543	0.048323	0.114253
10	16.01743	11.10069	87.13826	0.637974	0.329028	0.616481	0.056305	0.121266
Variance Decomposition of CAPITAL								
Period	S.E.	ECOG	FIN	CAPITAL	INN	TRADE	LURB	INF
1	2.339974	5.612682	1.673061	92.71426	0.000000	0.000000	0.000000	0.000000
2	3.512021	8.366232	1.267673	90.30878	4.33E-06	0.029019	0.002100	0.026192
3	4.278384	10.62073	1.108342	88.16015	0.015624	0.066942	0.007528	0.020679
4	4.800769	12.23119	1.003520	86.58656	0.042294	0.103150	0.016847	0.016433
5	5.171094	13.38305	0.926650	85.43321	0.072356	0.139770	0.030263	0.014703
6	5.440548	14.19978	0.867458	84.59001	0.102992	0.177483	0.047779	0.014501
7	5.640187	14.77809	0.820889	83.96739	0.132875	0.216494	0.069240	0.015026
8	5.790030	15.18776	0.784113	83.49967	0.161589	0.256643	0.094385	0.015839
9	5.903610	15.47780	0.755414	83.14054	0.189031	0.297608	0.122879	0.016728
10	5.990399	15.68243	0.733691	82.85774	0.215206	0.339004	0.154340	0.017594
Variance Decomposition of INN								
Period	S.E.	ECOG	FIN	CAPITAL	INN	TRADE	LURB	INF
1	2.828994	0.076566	0.341047	0.007304	99.57508	0.000000	0.000000	0.000000
2	3.772334	0.059044	0.243686	0.017311	99.51955	0.159146	0.000184	0.001082
3	4.482182	0.084703	0.242300	0.023831	99.45777	0.189743	0.000697	0.000951
4	5.057592	0.098852	0.265966	0.031881	99.41039	0.189186	0.001397	0.002329
5	5.536654	0.123272	0.304028	0.043809	99.34366	0.179361	0.002232	0.003641
6	5.947189	0.152771	0.353865	0.059058	99.25970	0.166587	0.003155	0.004863
7	6.304543	0.186144	0.412997	0.077053	99.16024	0.153613	0.004130	0.005823
8	6.619398	0.222821	0.480311	0.097231	99.04638	0.141583	0.005130	0.006545
9	6.899352	0.262272	0.554994	0.119101	98.91944	0.130991	0.006133	0.007068
10	7.150074	0.304123	0.636454	0.142253	98.78059	0.122026	0.007120	0.007439
Variance Decomposition of TRADE								
Period	S.E.	ECOG	FIN	CAPITAL	INN	TRADE	LURB	INF
1	7.183104	6.498596	0.175369	3.059499	0.001998	90.26454	0.000000	0.000000
2	10.07066	7.168564	0.427771	2.178311	0.370121	89.50402	0.001086	0.350123
3	12.00058	5.686318	0.520538	1.769797	0.494679	90.69059	0.003176	0.834899
4	13.49858	4.682380	0.571854	1.522828	0.499597	91.46190	0.006240	1.255204
5	14.72827	3.983694	0.610599	1.343317	0.491407	91.94611	0.010203	1.614675
6	15.76815	3.487741	0.640831	1.201956	0.477634	92.26938	0.015056	1.907405
7	16.66403	3.124639	0.666659	1.087676	0.463307	92.49229	0.020838	2.144595
8	17.44556	2.850952	0.690011	0.995243	0.449637	92.64948	0.027605	2.337073
9	18.13361	2.639556	0.712113	0.921241	0.436913	92.76041	0.035418	2.494353
10	18.74361	2.472967	0.733743	0.862910	0.425147	92.83682	0.044341	2.624076
Variance Decomposition of LURB								
Period	S.E.	ECOG	FIN	CAPITAL	INN	TRADE	LURB	INF

1	0.002635	0.092240	0.030293	0.095101	0.078323	0.206225	99.49782	0.000000
2	0.005847	0.029409	0.008805	0.133902	0.062013	0.647456	99.05865	0.059765
3	0.009704	0.081864	0.019560	0.133830	0.047114	0.907717	98.71541	0.094506
4	0.014092	0.256160	0.045913	0.114365	0.033532	1.066424	98.36886	0.114743
5	0.018933	0.486184	0.086232	0.087213	0.024210	1.172420	98.01514	0.128599
6	0.024168	0.732277	0.139792	0.061066	0.017782	1.247426	97.66271	0.138952
7	0.029752	0.973550	0.206368	0.040958	0.013303	1.302768	97.31576	0.147292
8	0.035648	1.199858	0.285855	0.029324	0.010131	1.344862	96.97558	0.154387
9	0.041825	1.406660	0.378222	0.026939	0.007843	1.377608	96.64206	0.160667
10	0.048259	1.592393	0.483472	0.033588	0.006164	1.403513	96.31448	0.166391
Variance Decomposition of INF								
Period	S.E.	ECOG	FIN	CAPITAL	INN	TRADE	LURB	INF
1	6.104330	0.000480	10.80172	0.119964	0.515705	1.521882	0.001894	87.03836
2	6.627365	0.113015	9.206159	0.115802	0.439416	3.258316	0.014102	86.85319
3	6.807589	0.162899	8.807159	0.110747	0.438553	3.545013	0.043732	86.89190
4	6.869024	0.227841	8.718917	0.109005	0.463193	3.686187	0.086434	86.70842
5	6.895108	0.299383	8.734556	0.109038	0.486119	3.760722	0.135549	86.47463
6	6.909822	0.369983	8.786208	0.112802	0.506136	3.806618	0.186500	86.23175
7	6.920759	0.438035	8.850067	0.120581	0.523419	3.836796	0.236503	85.99460
8	6.930273	0.503486	8.916826	0.131567	0.538633	3.857882	0.284081	85.76752
9	6.939070	0.566224	8.982760	0.144772	0.552303	3.873407	0.328546	85.55199
10	6.947352	0.626201	9.046341	0.159374	0.564761	3.885342	0.369660	85.34832
Cholesky Ordering: ECONOMIC GROWTH FIN CAPITAL INN TRADE LURBANIZATION INFLATION								

Normally, the impulse response function is considered an alternative to the variance decomposition, and granger causality test. It can provide the causality between variables among different time horizons. The results of the impulse response function are given in figure 1. The results show that the response of economic growth in financial development remains minimal and constant throughout the whole time horizon. The figures explain that the response of economic growth in explaining physical capital, innovations, merchandised trade, urbanization and the inflation rate is constant and minimal throughout the whole time horizon. The overall results of the impulse response function show that most of the selected variables are causing economic growth in the case of developing countries.

Figure 1



6. Conclusions

Based on the results and discussion, this study has major conclusions and policy suggestions. The present study has investigated the impact of innovations and financial development on economic growth. A sample of 58 developing countries has been selected for this purpose and data from 2000 to 2020 is used for empirical analysis. The results of unit root tests show that there is mix order of integration among the variables of the model. The results of the study show that financial development has a negative and significant impact on economic growth. This shows that developing countries are unable to get the true benefits of financial development, so, with rising financial development, the economic growth of the developing countries is depressed. The results show that the availability of physical capital has a positive and significant impact on economic growth. Economic growth is directly related to economic and business activities, and these activities are directly linked to the availability of physical capital. Therefore, to raise the level of economic growth, developing countries arrange a sufficient amount of physical capital. Innovations have a positive and significant impact on economic growth. Innovations raise the productivity of the country with the help of sufficient utilization of resources, so developing countries should promote innovation to raise the level of economic growth. Trade has a positive and significant impact on economic growth. Thus, there is a dire need to promote trade to enhance economic growth in developing countries. Urbanization and inflation hurt economic growth. So, to promote economic growth developing countries should encourage stable inflation with a rise in urbanization, in this way negative effects of urbanization can be overcome. Overall, this study suggests that developing countries should encourage the availability of physical capital, innovations, and trade to raise economic growth.

References

Acikgoz, S., & Mert, M. (2014). Sources of Growth Revisited: The importance of the nature of technological progress. *Journal of Applied Economics*, *17*(1), 31-62.

Alami, T. H. (2001). Variance decomposition analysis of the demand for foreign money in Egypt. *Journal of Economic studies*.

Ali, A. (2015). *The impact of macroeconomic instability on social progress: an empirical analysis of Pakistan*. (Doctoral dissertation, National College of Business Administration & Economics Lahore).

Ali, A., & Audi, M. (2016). The Impact of Income Inequality, Environmental Degradation and Globalization on Life Expectancy in Pakistan: An Empirical Analysis. *International Journal of Economics and Empirical Research*, 4 (4), 182-193.

Ali, A., & Audi, M. (2018). Macroeconomic environment and taxes revenues in Pakistan: an application of ARDL approach. *Bulletin of Business and Economics (BBE)*, *7*(1), 30-39.

Ali, A., & Rehman, H. U. (2015). Macroeconomic instability and its impact on the gross domestic product: an empirical analysis of Pakistan. *Pakistan Economic and Social Review*, 285-316.

Allen, F., Qian, J., & Qian, M. (2007). China's financial system: past, present, and future. *Present, and Future (March 28, 2007)*.

Al-Mulali, U., Ozturk, I., & Lean, H. H. (2015). The influence of economic growth, urbanization, trade openness, financial development, and renewable energy on pollution in Europe. *Natural Hazards*, *79*(1), 621-644.

Al-Yousif, Y. K. (2002). Financial development and economic growth: another look at the evidence from developing countries. *Review of financial economics*, *11*(2), 131-150.

Anaman, K. A. (2004). Determinants of economic growth in Brunei Darussalam. *Journal of Asian Economics*, *15*(4), 777-796.

Andergassen, R., Nardini, F., & Ricottilli, M. (2009). Innovation and growth through local and global interaction. *Journal of Economic Dynamics and Control*, *33*(10), 1779-1795.

Ang, J. B. (2008). A survey of recent developments in the literature of finance and growth. *Journal of economic Surveys*, *22*(3), 536-576.

Asheghian, P. (2009). Determinants of economic growth in Japan: The role of foreign direct investment. *Global Economy Journal*, *9*(3), 1850171.

Audi, M., Ali, A., & Al-Masri, R. (2022). Determinants of Advancement in Information Communication Technologies and its Prospect under the role of Aggregate and Disaggregate Globalization. *Scientific Annals of Economics and Business*.

Audi, M., Ali, A., & Roussel, Y. (2021). The Advancement in Information and Communication Technologies (ICT) and Economic Development: A Panel Analysis. *International Journal of Innovation, Creativity and Change*, 15(4), 1013-1039.

Bae, S. H., & Yoo, K. (2015). Economic modeling of innovation in the creative industries and its implications. *Technological forecasting and social change*, *96*, 101-110.

Barro, R. J. (1995). Inflation and economic growth.

Barro, R. J., & Sala-i-Martin, X. (1992). Convergence. *Journal of political Economy*, *100*(2), 223-251.

Barro, R., & Sala-i-Martin, X. (2004). Economic growth second edition.

Batini, N., & Nelson, E. (2001). The lag from monetary policy actions to inflation: Friedman revisited. *International Finance*, *4*(3), 381-400.

Baumol, W. J. (1993). Formal entrepreneurship theory in economics: Existence and bounds. *Journal of business venturing*, *8*(3), 197-210.

Bayraktar, N., & Wang, Y. (2006). Banking sector openness and economic growth. *World Bank Policy Research Working Paper*, (4019).

Bell, M., & Pavitt, K. (1993). Technological accumulation and industrial growth: Contrasts between.

Belsley, D. A. (1980). On the efficient computation of the nonlinear full-information maximum-likelihood estimator. *Journal of Econometrics*, *14*(2), 203-225.

Bencivenga, V. R., & Smith, B. D. (1993). Some consequences of credit rationing in an endogenous growth model. *Journal of economic Dynamics and Control*, *17*(1-2), 97-122.

Ben-David, D. (1993). Equalizing exchange: Trade liberalization and income convergence. *The Quarterly Journal of Economics*, *108*(3), 653-679.

Bleaney, M., Gemmell, N., & Kneller, R. (2001). Testing the endogenous growth model: public expenditure, taxation, and growth over the long run. *Canadian Journal of Economics/Revue canadienne d'économique*, *34*(1), 36-57.

Bruno, M., & Easterly, W. (1998). Inflation crises and long-run growth. *Journal of Monetary economics*, *41*(1), 3-26.

Cameron, G. (1996). *Innovation and economic growth* (No. 277). Centre for Economic Performance, London School of Economics and Political Science.

Cavdar, S. C., & Aydin, A. D. (2015). An empirical analysis about technological development and innovation indicators. *Procedia-Social and Behavioral Sciences*, *195*, 1486-1495.

Checherita-Westphal, C., & Rother, P. (2012). The impact of high government debt on economic growth and its channels: An empirical investigation for the euro area. *European economic review*, *56*(7), 1392-1405.

Chen, B., & Feng, Y. (2000). Determinants of economic growth in China: Private enterprise, education, and openness. *China Economic Review*, *11*(1), 1-15.

Das, P. K., & Guha-Khasnobis, B. (2008). Finance and growth: An empirical assessment of the Indian economy. In *Financial development, institutions, growth and poverty reduction* (pp. 120-140). Palgrave Macmillan, London.

De Gregorio, J., & Guidotti, P. E. (1995). Financial development and economic growth. *World development*, *23*(3), 433-448.

Demirguc-Kunt, A. (2008). Finance, financial sector policies, and long-run growth.

Denison, E. F. (1962). Education, economic growth, and gaps in information. *Journal of Political Economy*, *70*(5, Part 2), 124-128.

Diamond, D. W. (1984). Financial intermediation and delegated monitoring. *The review of economic studies*, *51*(3), 393-414.

Dollar, D., & Kraay, A. (2004). Trade, growth, and poverty. *The economic journal*, *114*(493), F22-F49.

Dorrance, G. S. (1966). Inflation and growth: the statistical evidence. *Staff Papers*, *13*(1), 82-102.

Easterly, W., & Levine, R. (1997). Africa's growth tragedy: policies and ethnic divisions. *The quarterly journal of economics*, 1203-1250.

Edwards, S. (1998). Openness, productivity and growth: what do we really know?. *The economic journal*, *108*(447), 383-398.

Ehigiamusoe, K. U., & Samsurijan, M. S. (2021). What matters for finance-growth nexus? A critical survey of macroeconomic stability, institutions, financial and economic development. *International Journal of Finance & Economics*, *26*(4), 5302-5320.

Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: journal of the Econometric Society*, 251-276.

Fagerberg, J., & Srholec, M. (2008). National innovation systems, capabilities and economic development. *Research policy*, *37*(9), 1417-1435.

Fetahi-Vehapi, M., Sadiku, L., & Petkovski, M. (2015). Empirical analysis of the effects of trade openness on economic growth: An evidence for South East European countries. *Procedia Economics and Finance*, *19*, 17-26.

Freire-Seren, M. J. (2002). On the relationship between human capital accumulation and economic growth. *Applied Economics Letters*, *9*(12), 805-808.

Friedman, L. (1956). A competitive-bidding strategy. *Operations research*, *4*(1), 104-112.

Gerguri, S., & Ramadani, V. (2010). The impact of innovation into the economic growth.

Ghirmay, T. (2004). Financial development and economic growth in Sub-Saharan African countries: evidence from time series analysis. *African Development Review*, *16*(3), 415-432.

Granger, C. W. (1981). Some properties of time series data and their use in econometric model specification. *Journal of econometrics*, *16*(1), 121-130.

Greenwood, J., & Jovanovic, B. (1990). Financial development, growth, and the distribution of income. *Journal of political Economy*, *98*(5, Part 1), 1076-1107.

Grossman, G. M., & Helpman, E. (1991). Trade, knowledge spillovers, and growth. *European economic review*, *35*(2-3), 517-526.

Grossman, G. M., Helpman, E., Oberfield, E., & Sampson, T. (2017). Balanced growth despite Uzawa. *American Economic Review*, *107*(4), 1293-1312.

Gurbiel, R. (2002). Impact of innovation and technology transfer on economic growth: the central and Eastern Europe experience. *Warshaw School of Economics*, *162*, 1-18.

Guru, B. K., & Yadav, I. S. (2019). Financial development and economic growth: panel evidence from BRICS. *Journal of Economics, Finance and Administrative Science*, *24*(47), 113-126.

Hadri, K. (2000). Testing for stationarity in heterogeneous panel data. *The Econometrics Journal*, *3*(2), 148-161.

Hamilton, J. D., & Susmel, R. (1994). Autoregressive conditional heteroskedasticity and changes in regime. *Journal of econometrics*, *64*(1-2), 307-333.

Hatemi-j, A. (2014). Asymmetric generalized impulse responses with an application in finance. *Economic Modelling*, *36*, 18-22.

Henderson, V. (2003). The urbanization process and economic growth: The so-what question. *Journal of Economic growth*, *8*(1), 47-71.

Howells, J. (2005). Innovation and regional economic development: A matter of perspective?. *Research policy*, *34*(8), 1220-1234.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of econometrics*, *115*(1), 53-74.

Islam, M. T., & Alam, M. J. (2019). The relationship between informal economy and GDP growth: a study on south-asian developing countries. *Can. J. Bus. Inf. Stud*, *1*(5), 01-09.

Jedidia, K. B., Boujelbène, T., & Helali, K. (2014). Financial development and economic growth: New evidence from Tunisia. *Journal of Policy Modeling*, *36*(5), 883-898.

Jung, W. S. (1986). Financial development and economic growth: international evidence. *Economic Development and cultural change*, *34*(2), 333-346.

Kahneman, D., & Tversky, A. (2013). Prospect theory: An analysis of decision under risk. In *Handbook of the fundamentals of financial decision making: Part I* (pp. 99-127).

Kao, C., Chiang, M. H., & Chen, B. (1999). International R&D spillovers: an application of estimation and inference in panel cointegration. *Oxford Bulletin of Economics and statistics*, *61*(S1), 691-709.

Kasidi, F., & Mwakanemela, K. (2013). Impact of inflation on economic growth: A case study of Tanzania. *Asian Journal of empirical research*, *3*(4), 363-380.

Kidwell, D. S., Blackwell, D. W., Sias, R. W., & Whidbee, D. A. (2016). *Financial institutions, markets, and money*. John Wiley & Sons.

King, R. G., & Levine, R. (1993). Finance and growth: Schumpeter might be right. *The quarterly journal of economics*, *108*(3), 717-737.

Kogid, M., Mulok, D., Beatrice, L. F. Y., & Mansur, K. (2010). Determinant factors of economic growth in Malaysia: Multivariate cointegration and causality analysis. *European Journal of Economics, Finance and Administrative Sciences*, *24*(24), 123-137.

Kuznets, S. (1971). 8. Notes on Stage of Economic Growth as a System Determinant. In *Comparison of economic systems* (pp. 243-268). University of California Press.

Lanne, M., & Lütkepohl, H. (2008). Identifying monetary policy shocks via changes in volatility. *Journal of Money, Credit and Banking*, *40*(6), 1131-1149.

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics*, *108*(1), 1-24.

Levine, R. (1996). Foreign Banks, Financial Development, and Economic. *International financial markets: Harmonization versus competition*, *224*.

Levine, R. (1997). Financial development and economic growth: views and agenda. *Journal of economic literature*, *35*(2), 688-726.

Levine, R., Loayza, N., & Beck, T. (2000). Financial intermediation and growth: Causality and causes. *Journal of monetary Economics*, *46*(1), 31-77.

Lichtenberg, F. R. (1992). *R&D investment and international productivity differences* (No. w4161). National Bureau of Economic Research.

Lin, C. J. C., & Bever, T. G. (2006). Subject preference in the processing of relative clauses in Chinese. In *Proceedings of the 25th west coast conference on formal linguistics* (Vol. 25, pp. 254-260).

Lucas Jr, R. E. (1988). On the mechanics of economic development. *Journal of monetary economics*, *22*(1), 3-42.

Lumpkin, G. T., & Dess, G. G. (1996). Clarifying the entrepreneurial orientation construct and linking it to performance. *Academy of management Review*, *21*(1), 135-172.

Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and statistics*, *61*(S1), 631-652.

Majumder, S. C. (2016). Inflation and its impacts on economic growth of Bangladesh. *American Journal of Marketing Research*, *2*(1), 17-26.

Malerba, F., & Brusoni, S. (Eds.). (2007). *Perspectives on innovation*. Cambridge University Press.

Manole, V., & Spatareanu, M. (2010). Trade openness and income—A re-examination. *Economics Letters*, *106*(1), 1-3.

Mansfield, E. (1972). Contribution of R&D to economic growth in the United States. *Science*, *175*(4021), 477-486.

Marshall, A. (1890). " Some aspects of competition." The address of the president of section F--Economic Science and Statistics--of the British Association, at the Sixtiet Meeting, held at Leeds, in September, 1890. *Journal of the Royal Statistical Society*, *53*(4), 612-643.

Martín, M. Á. G., & Picazo, M. T. M. (2014). "All´ idea di quel metallo": Ideas económicas en algunas óperas de comienzos del XIX. *Studies of Applied Economics*, *32*(1), 139-152.

Mazzucato, M. (2013). Financing innovation: creative destruction vs. destructive creation. *Industrial and Corporate Change*, *22*(4), 851-867.

McKinnon, R. I. (1994). Financial growth and macroeconomic stability in China, 1978-1992: implications for Russia and other transitional economies. *Journal of Comparative Economics*, *18*(3), 438-469.

Miller, E. (2008). *An assessment of CES and Cobb-Douglas production functions* (pp. 2008-2005). Washington, DC: Congressional Budget Office.

Mörling, T. (2002). Evaluation of annual ring width and ring density development following fertilisation and thinning of Scots pine. *Annals of Forest Science*, *59*(1), 29-40.

Nadiri, M. I. (1993). Innovations and technological spillovers.

Nagel, E. (1963). Assumptions in economic theory. *The American Economic Review*, *53*(2), 211-219.

Nathaniel, S. P. (2020). Modelling urbanization, trade flow, economic growth and energy consumption with regards to the environment in Nigeria. *GeoJournal*, *85*(6), 1499-1513.

Neusser, K., & Kugler, M. (1998). Manufacturing growth and financial development: evidence from OECD countries. *Review of economics and statistics*, *80*(4), 638-646.

Nguyen, H. M. (2018). The relationship between urbanization and economic growth: An empirical study on ASEAN countries. *International Journal of Social Economics*.

Noguer, M., & Siscart, M. (2005). Trade raises income: a precise and robust result. *Journal of international Economics*, *65*(2), 447-460.

O'Rourke, D., & Lollo, N. (2015). Transforming consumption: from decoupling, to behavior change, to system changes for sustainable consumption. *Annual Review of Environment and Resources*, *40*(1), 233-259.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and statistics*, *61*(S1), 653-670.

Pendharkar, P. C., Rodger, J. A., & Subramanian, G. H. (2008). An empirical study of the Cobb–Douglas production function properties of software development effort. *Information and Software Technology*, *50*(12), 1181-1188.

Phillips, P. C., & Hansen, B. E. (1990). Statistical inference in instrumental variables regression with I (1) processes. *The Review of Economic Studies*, *57*(1), 99-125.

Porter, M. E. (1996). Competitive advantage, agglomeration economies, and regional policy. *International regional science review*, *19*(1-2), 85-90.

Posner, M. V. (1961). International trade and technical change. *Oxford economic papers*, *13*(3), 323-341.

Raimuni, A., & Nadir, H. The Effect of Exports on Economic Growth in Developing Countries: The Case of Jordan, 1970-1993.

Risso, W. A., & Carrera, E. J. S. (2009). Inflation and Mexican economic growth: long-run relation and threshold effects. *Journal of Financial Economic Policy*.

Rivera-Batiz, L. A., & Romer, P. M. (1991). Economic integration and endogenous growth. *The Quarterly Journal of Economics*, *106*(2), 531-555.

Rodriguez, F., & Rodrik, D. (2000). Trade policy and economic growth: a skeptic's guide to the cross-national evidence. *NBER macroeconomics annual*, *15*, 261-325.

Rogers, M., & Rogers, M. (1998). *The definition and measurement of innovation* (Vol. 98). Parkville, VIC: Melbourne Institute of Applied Economic and Social Research.

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of political economy*, *94*(5), 1002-1037.

Sachs, J. D., Warner, A., Åslund, A., & Fischer, S. (1995). Economic reform and the process of global integration. *Brookings papers on economic activity*, *1995*(1), 1-118.

Salas-Guerra, D., & Cesar, R. (2021). Impact of digital economic activity on regional economic growth: A Case study from northern Minas Gerais between 2009 To 2018. *arXiv preprint arXiv:2105.02849*.

Santacreu, A. M. (2015). Innovation, diffusion, and trade: Theory and measurement. *Journal of Monetary Economics*, *75*, 1-20.

Schumpeter, J. A. (1911, 2008). *The theory of economic development: an inquiry into profits, capital, credit, interest and the business cycle* (R. Opie, Trans.). New Brunswick, U.S.: Transaction Publishers.

Schumpeter, J. A. (1939). *Business cycles* (Vol. 1, pp. 161-174). New York: Mcgraw-hill.

Shan, J. (2005). Does financial development ‘lead'economic growth? A vector auto-regression appraisal. *Applied Economics*, *37*(12), 1353-1367.

Sidrauski, M. (1967). Inflation and economic growth. *Journal of political economy*, *75*(6), 796-810.

Silverberg, G., & Verspagen, B. (1994). Learning, innovation and economic growth: a long-run model of industrial dynamics. *Industrial and Corporate Change*, *3*(1), 199-223.

Silvey, S. D. (1969). Multicollinearity and imprecise estimation. *Journal of the Royal Statistical Society: Series B (Methodological)*, *31*(3), 539-552.

Solow, R. M. (1956). A contribution to the theory of economic growth. *The quarterly journal of economics*, *70*(1), 65-94.

Solow, R. M. (1980). On theories of unemployment. *The American Economic Review*, *70*(1), 1-11.

Squalli, J., & Wilson, K. (2011). A new measure of trade openness. *The World Economy*, *34*(10), 1745-1770.

Starr, C., & Rudman, R. (1973). Parameters of technological growth. *Science*, *182*(4110), 358-364.

Stiglitz, J. E., & Weiss, A. (1983). Incentive effects of terminations: Applications to the credit and labor markets. *The American Economic Review*, *73*(5), 912-927.

Stockman, A. C. (1981). *Effects of inflation on the pattern of international trade* (No. w0713). National Bureau of Economic Research.

Takumah, W., & Iyke, B. N. (2017). The links between economic growth and tax revenue in Ghana: an empirical investigation. *International Journal of Sustainable Economy*, *9*(1), 34-55.

Tidd, J. (2006). A review of innovation models. *Imperial College London*, *16*.

Tsvetkova, A. (2015). Innovation, entrepreneurship, and metropolitan economic performance: empirical test of recent theoretical propositions. *Economic Development Quarterly*, *29*(4), 299-316.

von Schönfeld, K. C., & Ferreira, A. (2021). Urban planning and european innovation policy: Achieving sustainability, social inclusion, and economic growth?. *Sustainability*, *13*(3), 1137.

Wai, U. T. (1959). The relation between inflation and economic development: a statistical inductive study. *Staff Papers (International Monetary Fund)*, *7*(2), 302-317.

Wang, C. (2013). The long-run effect of innovation on economic growth. *School of Economics UNSW, Sydney*, *2052*.

Wang, M., & Sunny Wong, M. C. (2009). What drives economic growth? The case of cross-border M&A and greenfield FDI activities. *Kyklos*, *62*(2), 316-330.

Warner, A. (2003). Once more into the breach: Economic growth and integration. *Center for global development working paper*, (34).

Yadav, S., Baliyan, S., Guru Prasad, V., & Sibi, G. (2018). Future of vinyl banners: chemical composition, toxicity, environmental impact and degradation. *International Journal of environmental sciences and nature resources*, *15*(4).

Appendixes

Table A: Descriptive Statistics

Variables	ECOG	FIN	CAPITAL	INN	TRADE	URB	INF
Mean	4.382807	41.67684	22.96623	10.85873	62.48933	15.78623	7.028862
Median	4.401768	33.77283	22.10346	5.685005	55.82179	15.57848	5.248794
Maximum	34.50000	160.1248	57.71025	93.84192	192.1234	20.50456	185.2908
Minimum	-14.75855	2.268144	11.19994	0.009781	7.780557	11.39391	-25.12813
Std. Dev.	3.628761	31.39135	6.147391	15.01073	29.54775	1.665575	9.671773
Skewness	0.325826	1.380227	1.154403	3.166741	1.004724	0.240451	7.752427
Kurtosis	11.60444	4.636309	5.272110	13.57369	4.126743	3.499369	121.2794
Jarque-Bera	3239.051	447.9463	456.4486	6608.341	230.8734	20.90765	619022.8
Sum	4575.651	43510.63	23976.74	11336.51	65238.86	16480.82	7338.132
Sum Sq. Dev.	13734.12	1027790.	39415.41	235010.8	910611.6	2893.427	97565.55

Table B: Correlation Matrix

Variables	ECOG	FIN	CAPITAL	INN	TRADE	URB	INF
ECOG	1.000						
FIN	-0.083***	1.000					
CAPITAL	0.306***	0.159***	1.000				
INN	0.077**	0.379***	0.100***	1.000			
TRADE	0.079**	0.252***	0.163***	0.253***	1.000		
URB	0.108***	0.149***	0.076**	0.346***	-0.331***	1.000	
INF	0.022	-0.207***	-0.044	-0.090***	0.080**	0.080***	1.000

Note: The asterisks ***, ** and * denote the significant at 1%, 5% and 10% levels, respectively

Table: C Outcomes of Panel Unit Root

Variables	LLC	IP&S W-stat	ADF-Fisher	PP-Fisher
	At Level			
ECOG	-8.61971***	-7.97016***	256.159***	448.558***
FIN	-3.29621***	1.97223	100.296	74.4363
CAPITAL	-2.42225***	-0.64962	113.470	113.994
INN	-3.91841***	-3.61834***	172.978***	241.687***
TRADE	-3.37147***	-1.85748**	131.831	135.967*
URB	-14.4943***	-2.28109**	653.895***	2590.75***
INF	-7.14452***	-7.56858***	250.657***	544.012***
At First Difference				
DECOG	-17.4045***	-20.2337***	576.028***	4052.91***
DFIN	-7.30779***	-8.25351***	271.495***	535.928***
DCAPITAL	-11.6420***	-10.1446***	309.672***	569.547***
DINN	-14.3665***	-14.2431***	412.087***	1310.07***
DTRADE	-15.4846***	-13.3656***	394.929***	723.964***
DURB	-7.70458***	-11.6263***	338.877***	291.590***
DINF	-18.3916***	-22.0337***	629.827***	3460.85***

Note: The asterisks ***, ** and * denote the significant at 1%, 5% and 10% levels, respectively

Table D: Var Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-14134.25	NA	3.5512	48.76294	48.81560	48.78347
1	-7955.716	12186.63	2348.377	27.62661	28.04786	27.79084
2	-6813.460	2225.429	54.14689	23.85676	24.64662	24.16470
3	-6645.829	322.5462*	35.97414*	23.44769	* 24.60614*	23.89933*
4	-6605.016	77.54459	37.01640	23.47592	25.00298	24.07127
5	-6567.705	69.99021	38.55949	23.51622	25.41188	24.25528
6	-6518.489	91.13391	38.56125	23.51548	25.77974	24.39824
7	-6441.658	140.4152	35.07099	23.41951	26.05237	24.44598
8	-6405.597	65.03383	36.72450	23.46413	26.46559	24.63431

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