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Article

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DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

The dynamic interactions of economic growth, foreign direct investment, and exchange rates in Ghana

Benedict Arthur^{1*} and Bismark Addai²

Abstract: This study examines the dynamic interactions among foreign direct investment (FDI), economic growth (GDPG), and real exchange rate (RER) in Ghana using time series data over the period 1996 to 2018, and two econometric models: a trivariate VAR and the ARDL bound test. The results reveal that no long-run relationship exists among the variables. However, a positive causal shock flows from both FDI and RER to GDPG. Also, the response of FDI to the shock in RER is positive. Therefore, it is recommended that the government implements policies that will ensure optimal balance in this nexus since a close and inter-reliant link exists among the variables.

Subjects: Economics; Macroeconomics; Finance; Investment & Securities

Keywords: Economic growth; FDI; exchange rate; trivariate VAR; ARDL bound test

JEL Codes: E22; E43; E52; F21

1. Introduction

Developing economies are branded with minimal savings, which is one of the major challenges to their earnest quest for substantial economic growth. Thus, since the exposition of the foreign direct investment-led growth notion, nations across the globe, particularly governments in developing economies, have prioritized foreign direct investment as a significant source of development funding to solve economic issues and stimulate growth. Many developing nations have aggressively implemented liberal and preferential market-oriented policies to attract more foreign direct investment (FDI) into their nations (UNCTAD, (2018).)

Before implementing the economic reforms and trade liberalization, most developing nations, mainly African countries, maintained policies that kept their economies impoverished, stagnant, unproductive, and disproportionately isolated from the global economy (Goldberg and Pavcnik 2007). The dread of recolonization partly contributed to the erection of those trade barriers and the communism doctrine in the region (Benedict et al., 2021).

However, many African countries apparently have done a lot and continue to create a broad favorable business climate to attract more foreign investors by ensuring long-term political and economic stability. Many of these nations have now reduced legislative barriers and institutions to allow external investors access to all sectors of their economies. Privatization projects and brilliant progressive initiatives, such as 100 percent foreign ownership of a firm and the ability to use remote management, specialist, and unskilled employees, have been implemented to boost external investors' trust level (Adams and Opoku, 2015). Specifically, Ghana, an African front-runner in the mid-1990s in terms of attracting FDI (UNCTAD, (2003).), has instituted various policy

reforms to achieve adequate growth and development rates on the ticket of FDI, among other key macroeconomic variables like the exchange rate. Since its independence. From a period of rapid industrialization in the 1960s to the present redenomination or introduction of two higher denominations of the local currency in 2019. The outcome of these tireless political and investment efforts is evident as the nation was named the largest receiver of FDI in West Africa in 2018 (UNCTAD, (2019)).

Despite the continuous growth of FDI in Ghana, the Ghanaian economy is still oscillating with a high level of unemployment, extreme poverty, and other insignificant growth of GDP, like issues that foreign direct investment is hypothetically expected to help mitigate. Coupled with this striking challenge is the country's recent currency crisis, evidenced by the cedi's continuous depreciation over the years and the introduction of the higher denomination in 2019 (Arthur et al., 2022), which has ignited argument on the determinants of economic growth and most importantly the cost-benefit of FDI on the host economy at the various policy front in the country. Notably among the various arguments is whether the surge in FDI inflows is of any substantial growth impact on the Ghanaian economy. Theoretically, with increased access to global and domestic capital markets, FDI inflows are often more productive and lucrative and are projected to have significant growth impacts. As a result, they may aid in mitigating the adverse consequences of exchange rate shocks and currency crises in developing nations (Agyeman et al., 2021). Yet the Ghanaian economy seems to portray a different picture.

Consistent with the above discussions, some researchers also hold the view that a significant increase in capital inflows might destabilize the financial system by reducing maturity and causing currency mismatches between financial institution's assets and liabilities. Large capital inflows may possibly erode the country's competitiveness by pushing the exchange rate over its balance (Agenor, 1998; Mensah et al., 2017). Thus, it is advisable to investigate the strength of causality between the country's exchange rate, economic growth, and FDI variables.

Moreover, the exchange rate has been among the cornerstones of the Ghanaian government's economic policies to accelerate economic growth. This is because the exchange rate is critical for FDI movements and economic growth. The rise and fall of the exchange rate generate consequences for both the international and local economies. Thus, domestic currency appreciation may negatively or positively influence FDI and economic growth. The connection between FDI and exchange rate has long been argued in literature; however, there still exists disagreement on the path of the effect. Previous research (Jeanneret, 2007; Coleman & Tettey, 2008; Wafure & Nurudeen, 2010; Ang, 2008; Goldberg, 2007) submit that a domestic country's currency depreciation draws FDI.

Nonetheless, other studies (e.g., Thomas & Grosse, 2001; Schmidt & Broll, 2009; Stevens, 1998; Waldkirch, 2003; Chakrabarti, 2003; Kiyota and Urata, 2004; Mensah et al., 2015) reveal that the appreciation of the domestic currency draws FDI. Thus, an empirical assessment of the causal connections between the exchange rate, economic growth, and FDI turns out to be imperative. Hence, in light of the above knowledge, the study empirically examines the dynamic relationship between economic growth, FDI, and exchange rate in Ghana.

This study adds to the existing literature in the following ways. First, this study contributes to the literature by examining the causality between economic growth, FDI, and exchange rate in a trivariate VAR and trivariate ARDL framework. In spite of the pool of studies on FDI in developing economies, just a handful of empirical studies capture the dynamic interaction among economic growth, FDI, and exchange rate simultaneously in a dynamic multivariate framework. As such, this study adds to the little to no existing literature on the concurrent associations between the variables under consideration. Thus, the findings of this study will help bridge the gap in the related literature, especially on Africa.

Second, the study sheds light on the long-standing debate on the FDI-Growth nexus using current data from Ghana, one of the major recipients of Sub-Saharan Africa's FDI inflow. The impact of FDI inflows has been under significant contention over the past decades (Kose et al., 2006). The bone of contention is whether FDI is imperative for economic growth. Despite the indispensability of FDI for growth amongst varied theoretical and empirical views (Begum et al., 2018; Caesar et al., 2018; Simionescu, 2016), there are also abundant empirical studies that depict the negative and ambiguous impact of FDI on growth (Agenor, 1998; Agosin & Machado, 2005; Adams 2009, Jilenga et al., 2016;). For example, a substantial upsurge in inwards capital could deteriorate a host country's financial system by impairing maturity and creating currency disparities between the liabilities and assets of financial intermediaries. Also, inflows of huge foreign capital could reduce the competitiveness of the host countries by catapulting the exchange rate beyond its equilibrium (Agenor, 1998). The contradictions in the results open up further dialogue on the nexus.

Lastly, this study also throws light on the inconclusive argument on the connection between the exchange rate and FDI. Furthermore, the study will illuminate the direction of the causality link between the variables. Although the relationship between FDI and exchange rate has long been debated in the literature, there is still a dispute on the direction of the effect. While some researchers (Jeanneret, 2007; Coleman & Tettey, 2008; Wafure & Nurudeen, 2010; Ang, 2008; Goldberg, 2007) posit that local currency depreciation upthrust more FDI inflows, other hand researchers like (Thomas & Grosse, 2001; Schmidt & Broll, 2009; Stevens, 1998; Waldkirch, 2003; Chakrabarti, 2003; Kiyota and Urata 2004; Mensah et al. 2015) show that domestic currency appreciation rather attracts FDI. Hence, the outcome of this study will help smooth these inconsistencies in the literature.

The rest of the study is organized as follows. The subsequent section shows the literature review. Section 3 describes the research methodology, including the empirical model, sources, and data sampling. The research observations are presented in Section 4, and the final section captures the conclusion and recommendation.

2. Literature review

There exists an extent of literature on the nexus of FDI-Economic growth, Exchange rate—FDI, and Exchange rate and Economic growth. However, little to no exist on associations among the three variables simultaneously in a multivariate framework (FDI-Economic growth-Exchange rate nexus) which this study, among other things, seeks to add on. Thus, the existing related studies are reviewed under four sub-sections: FDI and Growth; Exchange rate and FDI; Exchange rate and growth; and FDI, Growth, and Exchange rate.

2.1. FDI and growth nexus

FDI can stimulate economic growth in a variety of ways. Earlier traditional neoclassical models, for example, argue that FDI funds wealth creation and expands the capital base, hence increasing growth. In such models, foreign investment has the same consequence as national capital investments in that FDI has a short-run growth effect due to declining returns to capital. The new growth hypothesis, in contrast, emphasizes technological progression and implies that FDI has a beneficial influence on economic growth in both the short and long run. This is because FDI-related technology externalities may counterbalance the effect of declining returns on capital and enable the economy to thrive in the long term, rendering FDI more productive than national investment (Herzer et al., 2008; Solow, 1956).

Generally, the empirical evidence of the nexus suggests that FDI has a favorable influence on economic growth. For instance, Dinh et al. (2019), using data from some selected developing economies, examined the connection between FDI and economic growth in both the short-run and long-run periods. The study finds that FDI aids in kindling economic growth in the long run, though it has a resultant negative effect on economic growth in the short-run period for the selected or

underlying nations in this study. Also, Silajdzic and Mehic (2015) studied the bearing of FDI on economic growth in some particular transition economies in East and Central Europe. The study shows that FDI in a unidirectionally upsurges the economies by adding to the fixed capital formation and indirectly via knowledge stock. Similarly, a study was conducted by Gherghina et al. (2019) on eleven Central and Eastern European countries. The observation from the panel vector error-correction model Granger causalities shows a short-term one-way causal connection running from foreign direct investment to economic growth and a two-way causal link between FDI and growth. Equally, examining the interaction between FDI, economic growth, and foreign aid in Southern and South-Eastern Asia from 1980–2016, Rao et al. (2020) find that FDI positively impacted economic growth. Khan et al. (2020) document a similar finding of FDI spurring economic growth in Pakistan though it has an adverse effect on the biosphere of Pakistani by fueling carbon emission in the region.

Sakyi et al. (2015) also examined the impact of FDI and trade openness on Ghana's economic growth. The authors used ARDL to examine time-series data from 1997 to 2011. Their study findings show that there is a positive association between GDP growth and FDI inflows in the long run. Thus, a soar in FDI inflows will lead to an upsurge in GDP, affirming the premise that FDI operates as a chariot of global technology transport. Also, Antwi et al. (2013) utilized time-series yearly data from Ghana for the duration of 1980 to 2010 and found a favorable outcome of FDI on growth in an OLS model. In another study, Afolabi and Bakar (2016), Muhammed et al. (2010), Edoumiekumo (2009), and Keho (2015) on the Nigerian and South African nations, respectively, find a bi-directional causality between FDI and economic growth. Moreover, Loesse (2010) scrutinized the linkage and causality trail between FDI and growth of ten Sub-Saharan African nations utilizing annual time series data from 1970 to 2007. The study finds a one-way directional causality linkage and a positive significant long-run connection between FDI and GDP growth in South Africa, Liberia, Kenya, and Angola.

Notwithstanding, several other empirical studies show contrary conclusions on the FDI-led growth assumption. Agosin and Machado (2005) studied the FDI-led growth hypothesis using the generalized method of moment (GMM) for 12 developed economies using data from 1971–2000. Studying the influence of FDI on economic growth, they observe an adverse connection between economic growth and FDI. This relationship infers that an increase in FDI inflows leads to a decline in economic growth. Similarly, Herzer et al. (2008) analyzed the FDI-led growth theory in 28 developing economies. They adopted the Engle-Granger cointegration and error correction model to conclude that there is no causality between economic growth and FDI. Hence, FDI inflows do not substantially add value to the growth of the various economies studied. Acaravci and Ozturk (2012) arrived at the same conclusion using yearly data from the period of 1994–2008 to examine the consequence of foreign direct investment on the economic growth of 10 selected OECD nations. Furthermore, in the studies of Yalta (2013), Belloumi (2014), Jilenga et al. (2016), Saibu et al. (2011), and Frimpong and Oteng-Abayie (2006) on the economies of China, Tunisia, Turkey, Tanzania, Nigeria, and Ghana respectively, they establish that FDI does not have a significant impact on economic growth. Moreover, Adams and Opoku (2015) appraised the influence of foreign and local investment on the economic growth of 42 Sub-Saharan countries from 1990 to 2003. The authors find that foreign direct investment negatively affects domestic growth. They interpreted it as a net crowding out effect. In the same vein, Agbloyor et al. (2014) establish that FDI negatively influences the growth of 14 African nations' economies based on the generalized method of movement estimators.

2.2 Exchange rate and FDI nexus

Copious researchers have scrutinized the exchange rate-FDI-growth nexus for both advanced and emerging economies using a wide range of approaches. However, there are few generally agreed results. Jaratin et al. (2014), Chong and Tan (2008), Ang (2008), Goldberg (2007), and Froot and Stein (1991), among other research, established in their study that depreciation of the host country currency fuels FDI. They attributed this phenomenon to the imperfection in the capital market.

Similarly, Wafure and Nurudeen (2010) investigate the factors responsible for Nigeria's FDI inflow using yearly data over the era 1970 to 2008. The study, upon utilizing the ordinary least square and error correction method, finds that exchange rate depreciation is a chief cause for the inflows of foreign direct investment in Nigeria.

On the other hand, other studies (e.g., Thomas & Grosse, 2001; Schmidt & Broll, 2009; Stevens, 1998; Waldkirch, 2003; Chakrabarti, 2003; Kiyota and Urata, 2004) advance weight on the opinion that a real appreciation in a host country's currency boosts FDI. Jaratin et al. (2014) examined the exchange rate movements and foreign direct investment (FDI) relationship. The study utilized yearly data on ASEAN nations, namely Malaysia, the Philippines, Singapore, and Thailand. The study establishes that the appreciation of the Malaysian ringgit, Philippine peso, and the Singapore dollar positively affects inward FDI. Moreover, using the ECM-based ARDL method for the causality test, both Singapore and the Philippines display a long-run two-way directional causality between the exchange rate and FDI, while long-run one-way directional causality emanates from the exchange rate to FDI in Malaysia. Yet, the study also establishes that short-run one-way directional causality emanates from the exchange rate to FDI in Singapore. Benson et al. (2019), scrutinized the impression of exchange and interest rates on Nigeria's foreign direct investment. The study employed secondary data attained from the financial statement of the monetary authority of Nigeria for the period of 2000 to 2018. A positive connection was found between the exchange rate and foreign direct investment, which implies that a probable increase in the real exchange rate in Nigeria could lead to an increase in foreign direct investment. Moreover, the study of Mensah, Godfred, and Hene (2015) also finds a positive connection between the exchange rate and FDI in Ghana.

2.3. Exchange rate and growth nexus

According to Thapa (2002), the linkage between the behavior of real exchange rate (RER) and economic improvement is repeatedly regarded as robust in most developing countries such as Asia, Latin America, and Africa, among others. As such, according to Eichengreen (2008), nations in the Asian continent, for instance, Taiwan, Japan, Singapore, South Korea, China, and Hong Kong, among others, have had great accomplishments with some theories geared towards RER as an effective development key policy instrument. Some empirical exchange rate results show an adverse implication on economic growth upon depreciation, while others positively impact growth upon depreciation or undervaluation of currency. A study conducted by Huong (2019), Stracca et al. (2016), Akinbobola and Oyetayo (2010), and Kogid et al. (2012) in the economies of Vietnam, United States, Nigeria, and Malaysia, respectively, to examine the association between economic growth and real exchange rate in the region document a positive association on economic growth as exchange rate depreciates. Furthermore, Okonkwo et al. (2017) and Mwinlaaru and Ofori (2017) examined the linkage between exchange rates and economic growth in Nigeria and Ghana, respectively. The authors conclude that the real exchange rate exercises a positive and statistically significant consequence on economic growth in both the long and short-run.

Conversely, Su and Wu (2017) conduct a similar study in China and find a different outcome using the VAR estimation method to investigate the relationship between the movement in Chinese currency and real GDP. The study results display no clear evidence for associations between changes in the value of the Chinese currency and real GDP. Likewise, Cakrani (2014) utilized a vector error correction method (VECM) in a study in Southeast Europe on a small open economy. The study finds no statistically significant level of influence of the real exchange rate on economic growth. Atkins (2000), Kamin and Rogers (2000), and Bahmani-Oskooee and Miteza (2006) establish in their respective studies that exchange rate devaluation significantly leads to a reduction in economic growth or triggers a detrimental consequence on economic growth.

2.4. Economic growth, FDI, and exchange rate nexus

The only available related study at the time of writing this current study is Ahmad F et al. 2016. They undertook a study to explore the prospective connection between exchange rates, economic growth, and foreign direct investment (FDI) concurrently in some chosen emergent Asian

nations. The researchers document a long-run association via the ARDL bounds testing technique using yearly data that spans from 1981 to 2013. The shreds of evidence from their study endorse that depreciation of the exchange rate influences the capacity of FDI inflow into the regions, which in turn stimulates economic growth in the long run. The results further indicate that economic expansion and FDI inflows are also linked with exchange rates. The causality test results also reveal a long-run inter-reliant connection among these three underlying variables.

In summary, it is evident from the aforementioned prevailing literature that little to no available empirical literature exists on the nexus of economic growth, foreign direct investment, and foreign exchange rate simultaneously, particularly in Africa, even though, extent studies exist on the separate foreign exchange-growth nexus, foreign exchange—FDI nexus, and FDI-Growth nexus. Furthermore, most of the studies are carried out outside the region of Africa, while the few collections of empirical evidence on African nations remain inconclusive. Lastly, it is obvious from the reviewed literature that most of the studies either fail to test the direction of causality or make provision for the case of reverse causality among the variables, which has partly led to inconsistent conclusions. Hence, this current work attempts to seal the gaps in the literature by using a trivariate VAR and ARDL system to study the economic growth -FDI—exchange rate nexus in Ghana. As such, this study will contribute to the literature by examining simultaneously the economic growth -FDI—exchange rate nexus in Africa, particularly Ghana. The outcome of this study sheds light on the query of whether the exchange rate and FDI meaningfully influence economic growth and also on the connection between the exchange rate and FDI. Furthermore, this study will equally shed light on the imperative link between economic growth and the exchange rate. Finally, the study will elucidate the direction of causality link among the variables under review.

3. Research methodology

3.1. Data and study variables

The data for the study were extracted from the database of the Economist Intelligence Unit (EIU). Annual time-series data on the real exchange rate, real gross domestic product (GDP) growth, and foreign direct investment (FDI) inflows in Ghana from the period 1996 to 2018 were utilized in the study. Time series annual data basis were collected owing to the lack of availability of higher frequency data, for instance, the monthly and quarterly time series data basis. Nevertheless, the data span is sufficient to reach adequate degrees of freedom for the estimation of the dynamic nexus between the variables under consideration. Economic growth for this study was measured using the real GDP growth rate. The exchange rate for the study was also measured by the first difference of the log of the real exchange rate index. Similarly, foreign direct investment was measured by the first difference of inward FDI capital by non-locals into the country as a percentage of gross fixed investment. Table 1 below provides a summary of the variables' definitions and measurement scales.

3.2. The empirical model

The dialogs from the literature review show that the theoretical models that explain the nexus under consideration offer varied conclusions. Therefore, an empirical model, the Vector Autoregressive (VAR), was utilized to investigate the dynamic interactions among FDI, economic growth, and exchange rate. The VAR model has myriad advantages over most theoretical and econometric models. First and foremost, the VAR model does not involve any stringent economic theory within which the model is anchored. Also, the VAR method helps to overcome endogeneity since all variables are endogenously determined, which might have resulted in spurious regression and hence false judgments. Furthermore, the VAR framework permits explained variables to be expressed as a function of their lag in addition to lag values of other variables when variables are strongly affected by each other (Enders, 2004). This helps the prediction of each variable more accurately. Thus, we deployed the “p” order of the VAR model in matrix form below, following the

Table 1. Measurement of variables

VARIABLE	NOTATION	MEASUREMENT SCALE	SOURCE
Economic growth	GDPG	Percentage change in real GDP	Economist Intelligence Unit (EIU)
Inflows of foreign direct investment	FDI	First difference inward foreign direct investment capital by non-locals into the country, as a percentage of gross fixed investment	Economist Intelligence Unit (EIU)
Real exchange rate index (Real effective exchange rate)	RER	First difference of log of Trade-weighted basket of currencies transformed to an index and adjusted for relative price movements.	Economist Intelligence Unit (EIU)

Table 2. Summary statistics of the variables

Variables	Mean	Std. Dev.	Minimum	Maximum
RER	1.566250	1.367371	0.163667	4.584967
GDPG	6.101130	2.519187	2.178000	14.04700
FDI_GFI	24.18513	21.80253	2.800000	68.18300

underlying economic assumption of FDI as catalysts of growth since the innovation accounting is highly sensitive to the order of causal arrangement in the VAR model.

$$Y_t = \Psi + \varphi_1 + Y_{t-1} + \dots + \varphi_p Y_{t-p} + V_t; \quad = 1, \dots, N \quad (1)$$

$$\text{Where } Y_t = \begin{bmatrix} GDPG_t \\ FDI_t \\ RER_t \end{bmatrix} \quad \Psi = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \end{bmatrix} \quad \varphi_i = \begin{bmatrix} 11_i & \dots & 13_i \\ 21_i & \dots & 23_i \\ 31_i & \dots & 33_i \end{bmatrix} \quad \text{and } V_t = \begin{bmatrix} v1_{,t} \\ v2_{,t} \\ v3_{,t} \end{bmatrix}$$

Note that Ψ and $(i = 1 \dots p)$ are VAR parameters to be estimated, and V_t represents random errors with zero mean and finite variance. This VAR matrix for the three endogenous variables can be further expressed as follows:

$$GDPG_{1,t} = + \sum_{i=1}^p \theta_{11,i} GDPG_{1,t-1} + \sum_{i=1}^p \theta_{12,i} DFDI_{t-1} + \sum_{i=1}^p \theta_{13,i} DI_n RER_{t-1} + \varepsilon_{1,t} \quad (2)$$

$$DFDI_{2,t} = \partial_2 + \sum_{i=1}^p \theta_{21,i} GDPG_{1,t-1} + \sum_{i=1}^p \theta_{22,i} DFDI_{t-1} + \sum_{i=1}^p \theta_{23,i} DI_n RER_{t-1} + \varepsilon_{2,t} \quad (3)$$

$$DRER_{3,t} = \partial_3 + \sum_{i=1}^p \theta_{31,i} GDPG_{1,t-1} + \sum_{i=1}^p \theta_{32,i} DFDI_{t-1} + \sum_{i=1}^p \theta_{33,i} DI_n RER_{t-1} + \varepsilon_{3,t} \quad (4)$$

Where D is the first difference operator and ε_t the represents errors term. $\theta_{1,i}, \theta_{2,i}, \theta_{3,i}$ are the parameters to be estimated.

The empirical methodology comprehensively addresses the main objective of the study. That is, it determines the relationship between the variables and also examines how all variables within the framework respond to shock from one another. Thus, the variance decomposition and the impulse response functions, which are collectively known as innovation accounting, will elucidate the short-run dynamic interactions among economic growth, FDI, and exchange rate variables within the VAR framework. The impulse response functions can be utilized to trace how every single variable responds to shocks from other variables within the framework after some time. Also, the forecast error of variance decomposition estimate facilitates the categorization of the portion of the movement in order owing to its shocks as opposed to shocks from other variables in the framework. As part of the robustness check of results, a cointegration test (autoregressive distributed lag model), ARDL Bound Test, is adopted to further investigate whether a long-run relationship exists between the variables.

The empirical estimation of the ARDL bounds test technique to cointegration is expressed as follows:

$$\Delta GDPG_t = \alpha_{01} + b_{11}GDPG_{t-1} + b_{21}FDI_{t-1} + b_{31}RER_{t-1} + \sum_{i=1}^P \alpha_{1j} \Delta GDPG_{t-i} + \sum_{i=1}^{q_1} \alpha_{2j} \Delta FDI_{t-i} + \sum_{i=1}^{q_2} \alpha_{3j} \Delta RER_{t-i} + e_{1t} \quad (5)$$

$$\Delta FDI_t = \alpha_{02} + b_{12}GDPG_{t-1} + b_{22}FDI_{t-1} + b_{32}RER_{t-1} + \sum_{i=1}^P \alpha_{1j} \Delta FDI_{t-i} + \sum_{i=1}^{q_1} \alpha_{2j} \Delta GDPG_{t-i} + \sum_{i=1}^{q_2} \alpha_{3j} \Delta RER_{t-i} + e_{2t} \quad (6)$$

$$\Delta RER_t = \alpha_{03} + b_{13}GDPG_{t-1} + b_{23}FDI_{t-1} + b_{33}RER_{t-1} + \sum_{i=1}^P \alpha_{1j} \Delta RER_{t-i} + \sum_{i=1}^{q_1} \alpha_{2j} \Delta GDPG_{t-i} + \sum_{i=1}^{q_2} \alpha_{3j} \Delta FDI_{t-i} + e_{3t} \quad (7)$$

Where GDPG, FDI and RER are the vectors of the specifications indicated already in the other equations. P and q are the lag orders for the dependent variables and the regressors, respectively. e_t is the vector of the error term. α and b are the parameters to be estimated.

To ensure the appropriate specification of the VAR model to accurately examine the dynamic nexus between the variables, we employed a step-by-step estimation procedure. The approach begins with the stationary test, followed by the test for lag structure, diagnostic checks of the VAR model, innovation accounting function, and finally, the cointegration test to establish the long-run relationship between the variables.

4. Results and discussion

4.1. Descriptive statistics

Over the period under study, GDP growth is averaged 6.1%. By an emerging country standard, this figure is considered relatively high. The rate of inward foreign direct investment into the country was averaged to be 24.2%. The real exchange rate, conversely, was averaged 1.6% over this period. The average rate of the exchange rate index was relatively high. The relatively low value of the Ghana cedis might have accounted for the relatively high growth of GDP and FDI. The highest growth rate of GDP was 14.04, whereas the minimum was 2.18. The highest flow of foreign direct investment into Ghana was 68.18, whereas the minimum was about 2.80. The maximum real exchange rate over the whole period was 4.58% as against the minimum of 0.16%. The skewness of GDP growth of 1.30 implies that more high values of GDP dominated growth. Foreign direct investments were positively skewed, meaning that FDI flow into the economy has been on the rise. The real exchange rate was also positively skewed, with a skewness of 1.10; this means

that there were many years of a relatively high level of exchange rate. The Jarque-Bera for GDP, FDI, and RER presented that the data were not normally distributed; that is, the null hypothesis that the variables are normally distributed was rejected.

4.2. Unit root test

Non-stationary time series regression leads to spurious or misleading judgments which nullify standard empirical outcomes. As such, the stationary features of the variables were tested with the Augmented Dickey-Fuller (ADF) test and double-checked with the Phillips-Perron (PP) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). The results are presented in Table 2 and 3.

These tests were undertaken concomitantly to ensure the variables enter their conforming frameworks in a non-explosive nature and are robust. The outcome from the test indicates the presence of unit roots in the variables in their level form for all the variables under review since the probabilities level of the variables is more than 5%. This implies that the variables (GDP, FDI & RER) are non-stationary at the level. However, upon the first difference, all the variables GDP, FDI & RER becomes stationary with their probabilities less than 5%. Hence, the variables are found to be integrated of order one at either 1% or 5% level of significance, which satisfies the prerequisite for the VAR model estimation.

4.3. Tests for cointegration

The ARDL cointegration test was implemented basically to double-check as to whether long-run relationships exist between GDPG, FDI, and RER. The results of the Bounds test are offered in Table 4.

The bound test results show that all the F-statistic values estimated from equations 2, 3, and 4, respectively, are less than the lower bounds at 5% and 10%. Thus, the null hypothesis of no cointegration cannot be rejected for all three equations. This connotes that these variables are not cointegrated and do not have a long-run relationship. That is, all three variables, namely, In GDP,

Table 3. Result for unit root test in the variables

Variables	ADF		PP		KPSS
	t-statistic	p-value	Adj. t-statistic	p-value	LM-Statistic
GDP	-2.318	0.5896	-3.007	0.3387	0.184
FDI	-2.204	0.2105	-1.531	0.4993	0.169
RER	2.469	0.9999	2.479	0.8999	0.964
D(GDP)	-3.008***	0.0247	-3.007***	0.0297	0.089***
D(FDI)	-3.291***	0.0285	-3.280***	0.0292	0.077***
D(RER)	-4.494***	0.0020	-4.491***	0.0015	0.059***

Note: ***, **, and * indicates significant levels of 1%, 5% and 10%. D indicates the first-order difference of the variables. The critical values are obtained from MacKinnon (1991).

Table 4. Bound test for cointegration results

Dependable Variable	F-statistic For Three Variables	5%		10%	
		I(0)	I(1)	I(0)	I(1)
GDPG	2.74	3.79	4.85	3.17	4.14
FDI	1.00	3.79	4.85	3.17	4.14
RER	0.93	3.79	4.85	3.17	4.14

*, ** denotes that the null hypothesis of no cointegration is rejected at 5% and 10%, respectfully.

lnFDI, and lnRER, do not converge to the long-run equilibrium route when they diverge from it in the short run.

4.4. VAR Optimum lag-length selection

In order to ascertain the optimum lag length, we take up to 4 lags. The optimal lag length is then carefully chosen based on diverse criteria. According to the results from the lag length collection criteria in Table 5, the criteria test of FPE (Final prediction error), LR (sequential modified LR test statistic), and SC (Schwarz information criterion) each at the 5% level of significance discloses that the lag order optimal must be 1. Thus, the model is a VAR (1) model.

4.5. VAR Estimation result

The results from Table 6 show that a positive relationship exists between FDI, economic growth, and the exchange rate of Ghana. That is, foreign direct investment has a strong positive impact on GDP growth at a significance level of 5 percent. Thus, a percentage increase in FDI may expand GDPG by 0.439877 percent. This result is in agreement with Antwi et al. (2013) study, Sackey et al. (2012), and Dinh et al. (2019), who postulated that FDI is favorably connected to growth. However, the findings oppose the research of Agosin and Machado (2005), who found an adverse connection between FDI and Growth.

Similarly, real exchange rate is strongly related to foreign direct investment inflows. Thus, a percentage surge in the real exchange rate or local currency depreciation in real terms might lead to a 30.38698 percentage increase in inward FDI. The result between FDI and RER is consistent with the study of Froot and Stein (1991), Jaratin et al. (2014), and Chris-Ejiogu et al. (2019), who found a positive connection between exchange rates and foreign direct investment. A feeble host country's currency tends to upsurge inward FDI within an imperfect capital market theory as depreciation makes the host country's assets less expensive compared to assets in the foreign country.

In addition, the coefficient of lag one of the real exchange rate is established to be statistically significant at 5 percent (0.0051). This suggests that the real exchange rate strongly influences the growth in gross domestic product. By implication, if RER increases by 1 percent, this may result in

Table 5. Optimum VAR lag-length selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-93.78740	NA	9.401490	10.75416	10.90255	10.77462
1	-78.42946	23.89013*	4.743185*	10.04772	10.64130*	10.12956
2	-74.18940	5.182295	8.958273	10.57660	11.61537	10.71983
3	-62.41486	10.46626	8.843136	10.26832	11.75227	10.47293
4	-43.75607	10.36599	6.182990	9.195119*	11.12426	9.461121*

Note: * indicates lag order selected by the criterion (each test at 5%level)HQ: Hannan-Quinn information criterion SC: Schwarz information criterion

Table 6. Estimated standard VAR results

Variables	GDPG	FDI	RER
GDPG (-1)	0.357137*** (0.20598)	-1.877136 (0.70243)	-0.011099 (0.01144)
FDI (-1)	0.439877** (0.16979)	0.439877*** (0.16979)	0.001842*** (0.00277)
RER (-1)	4.065804** (1.39034)	30.38698** (14.5371)	0.009285 (0.23677)

, *: statistical significance at 5% and 10% respectively Standard errors in brackets.

4.07% increase in GDPG, all things being equal. This outcome is line with the results from other work by Huong (2020), Okonkwo et al. (2017), and Mwinlaaru & Ofori (2017).

4.6. Diagnostic test results

In order to assess the validity of the VAR model estimated, the residual diagnostic tests, which include serial correlation, normality and heteroscedasticity were undertaken. Also, the inverse root of the characteristic AR polynomial was performed to check the stability of the VAR model. The results estimated for residual diagnostics test are presented in Table 7

Table 7 reports that all models have gone through a threshold of diagnostic tests. The Lagrange Multiplier test (LM test) is utilized to test for higher-order ARMA errors, which is useful to assess whether there are lagged dependent variables or not. The null hypothesis of the LM test is that there is no serial correlation in the residuals. As such, from Table 7, it is evident that the computed LM test on 1 and 2-order autocorrelation of the residuals cannot reject the null hypothesis of white noise residuals of 5% significance levels. Therefore, it points out that the residuals are white noise, and there is no autocorrelation in the residuals. Also, per the White heteroscedasticity test results, it is evident that the null hypothesis of no heteroscedasticity cannot be rejected. This result implies that there is no indication of residual heteroscedasticity effects in the estimated model. Moreover, the probability value from the normality test indicates that the errors in the VAR system are normally distributed. Hence, the residuals of the VAR framework is serial correlation and heteroscedasticity free.

4.6.1. Inverse root of characteristic AR Polynomial

The estimated VAR is deemed stable (stationary), conditional on the fact that all roots have modulus less than one and fall within the unit circle. An unstable estimated VAR might produce invalid impulse response function results. Thus, to avoid biased results that might arise from inaccurate impulse response function, the study utilized the Graph form of Inverse Root of Characteristic AR Polynomial to certify the stationarity of the estimated VAR. Figure 1 below presents the result for inverse root AR characteristic polynomial.

From Figure 1, it is evident that all the root lies within the unit circle, stipulating that the estimated VAR is stationary. Hence, the impulse response and variance decomposition errors result from this model will be valid and free from bias. To this effect, we proceed to estimate the impulse response function and the variance of decomposition forecast error.

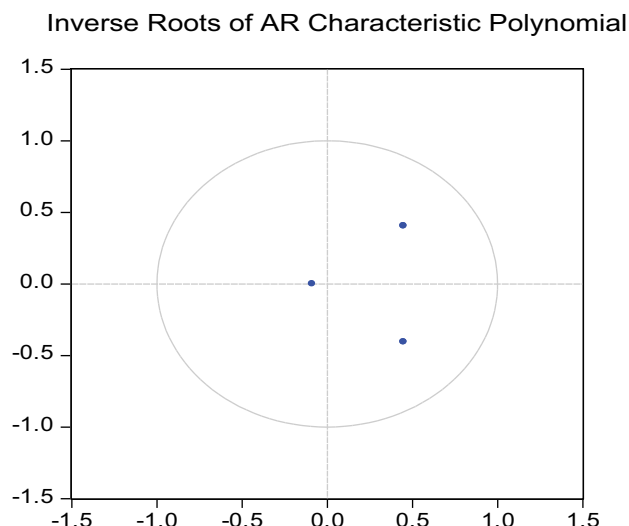
Table 7. Residual diagnostic test

Residual Test	Statistic value		Probability value
Serial correlation: Lags 1	LM-Stat	2.549257	0.9795
Lags 2	LM-Stat	6.634501	0.6751
Heteroscedasticity	Chi-square	42.35124	0.2159
Normality	Jarque-Bera	8.449907	0.2105

Table 8. Granger causality test

Variable	Chi-sq	Prob. value
RER does not cause FDI	6.871328**	0.0343
FDI does not cause RER	1.038731	0.1488
GDPG does not cause FDI	1.552470	0.4601
FDI does not cause GDPG	8.729382***	0.0049
GDPG does not cause RER	1.678756	0.2620
RER does not cause GDPG	4.850354**	0.0458

Figure 1. Inverse root of characteristic AR polynomial.



4.7. Granger causality test

It is evident from the results reported in [table 8 and 9](#) below that unidirectional causality runs from FDI to GDP, from RER to FDI, and from RER to GDP, respectively. Thus, the null hypotheses, which indicate no causality in those regards, are rejected. This implies that there is a causal link flowing from foreign direct investment to economic growth but no causality link from economic growth to foreign direct investment. This outcome is contrary to the study of Ahmed et al. (2016), who documents a bi-directional link between FDI and growth. Also, there is no causality flowing from foreign direct investment to the real exchange rate, but causality flows from the real exchange rate to foreign direct investment. There is no causal link from the gross domestic product to the real exchange rate, yet a causality link flows from the real exchange rate to the gross domestic product in Ghana. This finding is consistent with the study of Huong (2019), who also documents a unidirectional causal impact from exchange rate to economic growth.

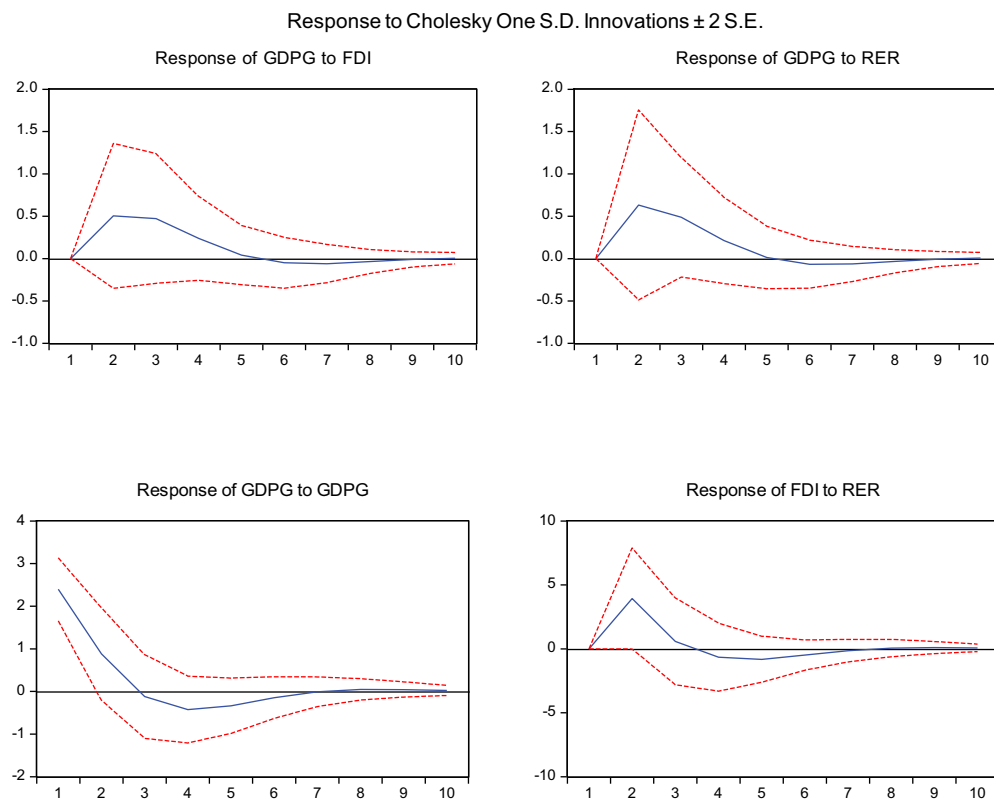
4.8. Impulse response function

From the figures below, we can trace out the time path of numerous shocks and define how each variable reacts over time to shocks from other variables. The impulse response function was plotted from a one standard deviation Cholesky shock, and the dynamic responses are captured within a time interval with ten periods. It is evident from all the graphs that among these self-response, all variables have a lasting impact on their innovations. Meaning the variables resume to their preceding equilibrium value of zero after some period when no additional shocks occur.

The first graph in [Figure 2](#) shows the response of economic growth to the shock of FDI inflows. The shocks of an impulse in FDI are positive on GDPG variable. Meaning as the inflow of FDI increases, the gross domestic product also increases. It is obvious from the graph that GDPG increases sharply at the earlier periods, then remains relatively stable along the way and gradually converges back to the origin zero where no extra shock from FDI can be felt. Thus, the impact only lasts during the first five periods or at lag one rather than at later periods which means that the response of GDPG to FDI is merely short-term. The outcomes defined above are consistent with the earlier neo-classical growth models, which submit that FDI only has a short-run impact on growth because of the diminishing returns to capital., emphasizing that an increase in FDI inflows will lead to an increase in economic growth but only in the short run (Herzer et al., 2008).

Also, the response of FDI to the shock from RER indicates a positive impact. Thus, an appreciation in the real exchange rate leads to an increment of FDI inflow in the region. This finding is consistent with the study of Chris-Ejiogu et al. (2019), who found a positive causal effect from the

Figure 2. Impulse response function.



exchange rate to FDI. From the graph, the extent of the reaction FDI to the shock of RER only lasts during the first four periods but not higher periods of lags, and therefore, the response of FDI to RER is only short-period.

Similarly, the response of GDPG to the shock of RER also shows a positive effect. This implies that depreciation in the domestic currency leads to an increase in the growth of the economy. These findings are consistent with the recent work of Huong (2019). Parallel to the above variable reactions to shock, the impact of GDPG on RER also lasts in the short term. In addition, the response of GDPG to the shock of GDPG, the response of RER to the shock of RER, and the response of FDI to the shock of FDI have a positive impact at the earlier stages which then declines, attains the negatives, and rises again until it converges at the origin respectively. The impact of GDPG has a short-run negative impact on RER and FDI. Likewise, FDI shock has a declining positive short-run impact on itself (FDI), which later quickly converges to zero. A summary of all the impulse response function results other than that which is presented in figure 4 is summarized in appendix A.

4.9. Variance decomposition forecast error

The variance decomposition points out the percentage of contribution in each variable that can be credited to innovations in other variables over the ten-year period (Enders,). The stated results within a 10-year horizon are offered in Table 8 and 9.

The decomposition of the GDPG discloses that 84.69% proportion of GDPG value is explained by shocks of its own innovation over the entire 10 years duration. The influence of FDI on the GDPG value is 6.72%, whereas innovative shocks to RER account for 8.58% of the GDPG value. The significant impact of both FDI and RER on the GDPG proves the close link among the variables, therefore confirming the findings from the impulse response functions analysis, which also points out the short-run connection among the variables. The results signpost

Table 9. Variance decomposition percentage of ten-year error variance results
Variance Decomposition of GDPG:

Period	S.E.	GDPG	FDI	RER
1	2.395718	100.0000	0.000000	0.000000
2	2.677229	90.87467	3.538073	5.587260
3	2.764710	85.39819	6.247144	8.354666
4	2.815179	84.62819	6.740458	8.631350
5	2.835521	84.82524	6.664885	8.509871
6	2.840534	84.79273	6.672580	8.534692
7	2.841899	84.71222	6.710461	8.577320
8	2.842677	84.69163	6.722172	8.586199
9	2.843042	84.69388	6.721628	8.584488
10	2.843143	84.69426	6.721357	8.584386

Variance Decomposition of FDI:

1	8.169793	5.375755	94.62425	0.000000
2	10.64748	20.34500	65.98217	13.67283
3	11.61635	32.08774	56.17538	11.73688
4	11.86907	34.51878	53.93576	11.54546
5	11.92812	34.31215	53.78424	11.90361
6	11.95753	34.28566	53.69884	12.01550
7	11.97304	34.41775	53.58351	11.99873
8	11.97798	34.46970	53.53961	11.99069
9	11.97908	34.47012	53.53466	11.99522
10	11.97953	34.46841	53.53393	11.99767

Variance Decomposition of RER:

1	0.133062	5.144179	0.042337	94.81348
2	0.137143	9.563466	1.174940	89.26159
3	0.138344	11.12301	1.158241	87.71875
4	0.138638	11.34106	1.213577	87.44537
5	0.138729	11.32703	1.273966	87.39901
6	0.138782	11.36293	1.290608	87.34646
7	0.138805	11.39123	1.290977	87.31779
8	0.138811	11.39720	1.291402	87.31139
9	0.138813	11.39704	1.292333	87.31062
10	0.138813	11.39739	1.292690	87.30992

Cholesky Ordering: GDPG FDI RER

that real exchange rate and foreign direct investment inflow play a critical role in the growth of the economy; nevertheless, the influence of real exchange rate on growth is greater than of foreign direct investment.

The results for the variance decomposition of FDI show that aside from the past realization of FDI inflow which accounts for 53.53% of its value, GDPG and RER also significantly contribute to the variation in FDI inflow. GDPG is the second contributor to the variation in FDI at around 34.46 percent, and RER is the third-most imperative influence accounting for 11.99 percent. Equally, the results of RER decomposition assert that the innovation in the RER is mainly explained by its own movement (87.3%), followed by GDPG (11.39%) and then FDI (1.29%).

4.10. Robustness test

The study utilized an alternate indicator for foreign direct investment to check whether our main findings are robust to different indicators. Foreign direct investment as a percentage of gross domestic product, in this case, was employed. Also, a foreign exchange rate (RER) was substituted with trade openness (TO) to study whether the results of the study are still robust to alternate specifications of control. The robustness test results are consistent with the study's main findings and not substantially different from it. Hence, the conclusions from the study's main findings are robust even to the inclusion of different indicators and control specifications. The results of the robustness check are accessible in the appendix as Tables A1, A2.

5. Conclusion and recommendations

This study examined the dynamic interactions of FDI, economic growth, and real exchange rate in Ghana using yearly time series data over the epoch of 1996 to 2018 and two econometric models: a trivariate VAR and the ARDL bound test. The data's empirical analysis reveals significant connections between economic growth, foreign direct investment, and foreign exchange rates in Ghana. Most importantly, the relationship between economic growth and foreign direct investment is positive, which implies that an increase in FDI leads to a corresponding increase in economic growth. Also, a positive relationship exists between the real effective exchange rate and foreign direct investment, which signifies that if the real effective exchange rate increases or the actual domestic currency depreciates, it will result in a corresponding increase in the inflow of foreign direct investment to the country. Furthermore, it was found that the response of GDPG to the causal shock in FDI and RER are both positive. Similarly, the response of FDI to the causal shock in RER was also found to be positive. The results posit that a depreciation of the local currency upsurges the level of inflows of foreign direct investment into the country, which in turn enhances the level of economic development. However, the impact of foreign direct investment on the economy of Ghana was found influential only in the short run, which clearly mirrors the earlier neo-classical growth models. Consequently, the following recommendations are made to help achieve a sustainable spillover impact of FDI on the economy: First, the absence of the long-run relationship between FDI and economic growth indicates a lack of sustainability of the impact of foreign direct investment on growth, so policymakers should elevate human capital development to fully assimilate the transfer of foreign knowledge to grasp the long run spillover effect. Second, policymakers should strive to maintain a competitive exchange rate to attract more foreign direct investment inflows because the results show a positive shock of a real effective exchange rate on both growth and foreign direct investment. For instance, policymakers can come up with pragmatic monetary and fiscal policies, such as an exchange rate targeting strategy that will help stabilize and make the exchange rate more competitive to increase FDI. Lastly, the study shows significant interactions among the three variables; therefore, a balanced policy should be implemented to attain optimal results from the study of this nexus since a close and inter-reliant link exists between these three variables.

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Appendix

Table A1. Robustness checks result—replaced RER with TO

Variables	GDPG	FDI	TO
GDPG (−1)	0.391747*** (0.21047)	−1.663659 (0.70401)	−0.002524 (0.01108)
FDI (−1)	0.177171** (0.05218)	0.414080*** (0.17454)	0.003050 (0.00275)
TO (−1)	1.457375** (3.60251)	13.54525** (12.0499)	0.654122 (0.18973)

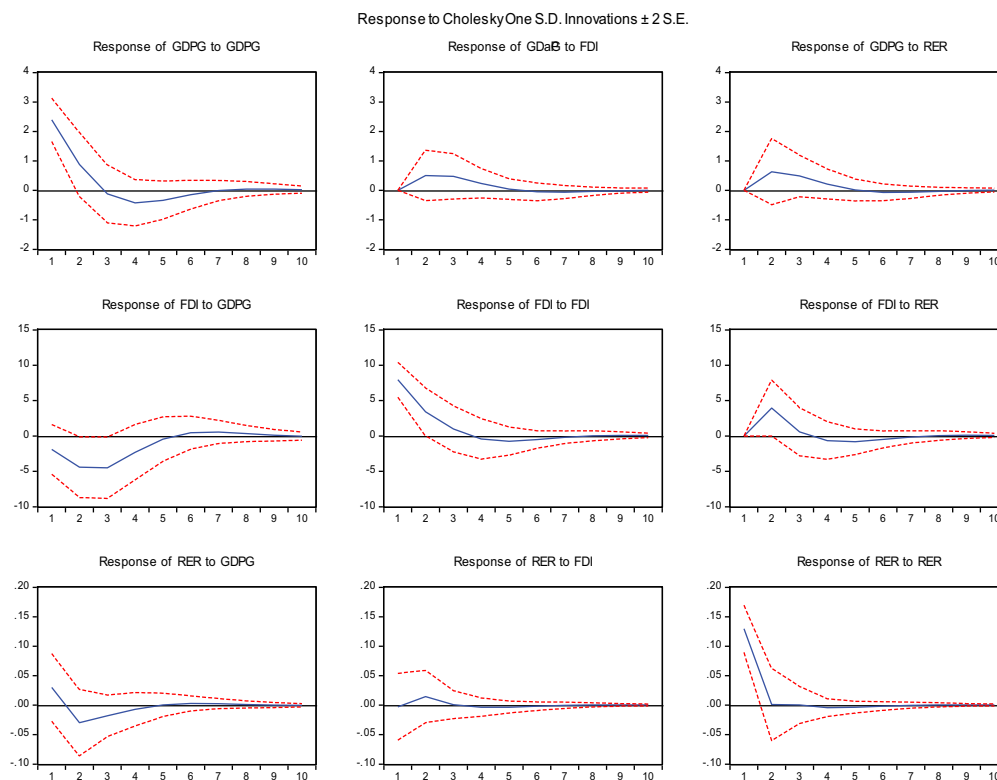
, *: statistical significance at 5% and 10% Standard errors in brackets.

This table reports the robustness check results with trade openness (TO) substituted for real effective rate (RER). The coefficient estimates of the main underlying variables remain the same and statistically significant even upon substitution of RER for TO. Thus, upon the increment of trade openness, it leads to an increase in FDI inflows which also results in a corresponding increase in economic growth. In conclusion, the main results of the study are robust.

Table A2. Robustness checks result – an alternative proxy for FDI

Variables	GDPG	FDI	RER
GDPG (−1)	0.245052*** (0.21735)	−0.051013 (0.12224)	−0.012370 (0.01204)
FDI (−1)	0.228320** (0.17993)	0.912156*** (0.10120)	0.001235 (0.00997)
RER (−1)	3.145548** (4.18462)	23.682824** (2.35348)	0.038588 (0.23186)

, *: statistical significance at 5% and 10% Standard errors in brackets. This table reports the robustness check results for alternative proxy for FDI. The study employed FDI as a percentage of the gross domestic product as an alternate proxy for FDI as a percentage of gross fixed investment. The coefficient estimates of the main underlying variables remain the same and statistically significant even upon utilizing different indicator measures of FDI. Juxtaposing these results with the main findings reveals that the conclusion or results of the main study is robust.





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