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The impact of foreign direct investment on economic growth: Empirical evidence in G20 countries

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ABSTRACT

This study investigates how foreign direct investment (FDI) affects economic growth in G20 countries. It uses annual panel data from 19 countries for the years 2001 and 2022. In addition to FDI as the main independent variable, the study includes control variables such as exchange rates, trade balance, inflation, government effectiveness, and gross fixed capital formation. The relationship between economic growth and FDI is analyzed using Johansen's cointegration method and a vector error correction model. First, unit root tests were conducted using the Augmented Dickey-Fuller (ADF) test. Granger causality tests were also applied to identify the direction of causality between FDI and economic growth. To ensure the reliability of the results, three different panel linear regression models were used to confirm the robustness of the findings. The results from all econometric models consistently show that FDI has a positive and statistically significant effect on the economic growth of G20 countries. Additionally, gross fixed capital formation and exchange rate appreciation were found to have positive and significant effects on economic growth. On the other hand, inflation and trade openness negatively impacted economic growth. Government effectiveness was found to be insignificant, and its moderating role was not further analyzed. Based on these findings, the study recommends that governments implement policies to attract FDI, as it promotes technology transfer, increases market competition, and introduces new expertise, all of which contribute to economic growth. Additionally, governments should create a stable economic environment by implementing strict monetary policies to control inflation and support long-term economic development.

1. Introduction

Economic growth is closely connected to living standards. While population growth often makes it difficult to maintain high living standards, economic growth can support or even improve these standards despite more people. By increasing productivity, creating better job opportunities, and raising incomes, economic growth can help manage the impact of a growing population, ensuring that people's quality of life remains stable or even improves. Economic growth means a rise in total consumption, investment, government spending, and net exports. Higher economic growth leads to an increase in real GDP and national income, allowing more resources to be allocated to enhance healthcare and education for citizens (Chang et al., 2017).

In today's global economy, foreign direct investment (FDI) has become a vital factor in supporting economic growth in various countries. FDI not only provides financial capital but also introduces advanced technology, increases competitiveness, and encourages innovation, which are essential for economic development. This impact of FDI on economic growth has been a major topic among researchers, academics, and professionals. FDI transfers technology and skills, which significantly boost growth in recipient countries, allowing them to benefit even with population growth. One way FDI affects growth is through the "spillover effect," where multinational companies interact with local firms, facilitating the transfer of technology and knowledge (Khan, 2007). This technology transfer creates more jobs, improves production processes, and, consequently, leads to higher economic growth. Developed nations,

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particularly G20 countries, significantly support the economic development of emerging economies (Zamani and Tayebi, 2022).

Alongside FDI, trade balance is also important to consider. While international trade often promotes economic growth, a negative trade balance can harm growth in recipient countries. This study, therefore, examines both FDI and trade balance. Furthermore, many studies emphasize the exchange rate as a key factor for economic growth. When a local currency appreciates, it can make local products less appealing to foreign buyers. However, if it depreciates, these products become cheaper and more attractive in foreign markets, potentially fostering economic growth. Many countries strategically adjust their exchange rates to encourage growth (Blavasciunaite et al., 2020).

While economic growth has been studied in many contexts, there is still a need to understand how countries use FDI and other growth factors within various governance environments. This study is unique in applying a range of econometric methods to investigate the relationship between economic growth and FDI in G20 countries. Unlike previous studies that often focus on single countries or use time series data for developing economies, this research uses panel data from G20 countries. By combining traditional time series analysis with panel data models, it aims to clarify how factors such as FDI affect economic growth across countries. This research provides insight into how different levels of governance quality influence the FDI-growth relationship, answering several research questions through multiple econometric approaches (Tripathy et al., 2022).

The main question of this study is whether FDI influences economic growth in G20 countries. Additional questions include: How does the real exchange rate affect growth in these countries? What is the role of trade balance in economic growth? How does inflation influence growth in G20 countries? Does governance quality in these countries affect their economic growth? Finally, what impact does gross fixed capital investment have on growth? Together, these questions aim to give a comprehensive view of the factors driving economic growth in G20 countries.

The paper is organized as follows: Section 2 reviews the existing literature and key studies related to the topic. Section 3 describes the data sources and research model. Section 4 analyzes the results, providing insights from the findings. Section 5 concludes with a summary and discusses policy implications based on the study's conclusions.

2. Literature review

Research on the effects of FDI on economic development has yielded conflicting results. Both classical and endogenous growth models have examined the impact of FDI through four primary channels: (1) FDI as a determinant of economic growth, (2) economic growth as a factor influencing FDI, (3) the various channels through which FDI affects economic growth, and (4) the causal relationship between FDI and economic growth. These diverse perspectives underscore the complexity of FDI's role in economic development. Studies exploring the varied role of FDI in economic growth include the works of Al Nasser (2010), Borensztein et al. (1998), Hansen and Rand (2006), de Mello (1997), and Balasubramanyam et al. (1996, 1999). These studies examine FDI from four critical perspectives: its role as a determinant of economic growth, its interplay with economic growth, the channels through which it impacts growth, and the causal relationship between the two variables. A significant factor affecting the return on investment for foreign investors is the exchange rate, which can convert profits into losses and vice versa, thereby influencing economic growth. Razzaque et al. (2017) found that a 10 percent local currency depreciation can lead to a 3.2 percent increase in economic growth. The trade balance, reflecting a country's economic connectivity with the global market, also impacts growth. Blavasciunaite et al. (2020) examined the effects of trade balance on economic growth through both linear relationships and dummy variables for trade deficit periods, finding that trade balance negatively affects growth, regardless of whether there is a surplus or deficit. Additionally, the inflation rate, often seen as a proxy for economic uncertainty, affects real economic growth by influencing the perceived risk for foreign investors (Burlea-Schiopoiu et al., 2021; Ilyas et al., 2023).

Research on the relationship between FDI and economic growth has yielded varied and sometimes conflicting results. Some studies report no significant link between FDI and economic growth, while others highlight a positive and significant impact. For instance, Mwitta (2022) found that FDI positively affects economic growth. Similarly, Jehangir et al. (2020) documented a significant positive effect of FDI and labor force participation on economic growth. Given the critical role of economic growth, other researchers have explored how various explanatory variables influence it. For example, Gudaro et al. (2012) identified a positive relationship between economic growth and FDI but a negative relationship between economic growth and inflation. These discrepancies underscore the complexity of the FDI-growth nexus and suggest that additional factors and context-specific conditions may shape these relationships (Kumari et al., 2021; Yimer, 2022).

Given the critical role of economic growth in meeting basic human needs, researchers have explored various dimensions of how economic growth can be influenced by different factors and methodologies. A central focus in this exploration has been the manufacturing sector, which has been highlighted as a key driver of economic development. For example, Libanio and Moro (2006) conducted an in-depth study using panel data from numerous developing countries between 1985 and

2006. They found that improvements in productivity within the manufacturing sector—achieved by reallocating labor from less productive sectors to higher-productivity industries could significantly drive economic development. Similarly, Szirmai and Verspagen (2015) analyzed data spanning over 50 years and concluded that advancements in the manufacturing sector are crucial for economic growth. Their findings, supported by a comprehensive panel data analysis, reaffirmed the role of manufacturing as a vital engine of economic growth.

This notion was further reinforced by Szirmai et al. (2013), who argued that manufacturing continues to be a major contributor to economic growth, especially in developing nations. However, recent studies from the past seven years suggest a shift, indicating that the services sector may now be a more significant contributor to economic growth. Additionally, fair distribution of economic activities across different sectors and regions could enhance living standards and economic development. Guo et al. (2012) advocated that focusing on the manufacturing sector can lead to improvements in living standards by boosting economic growth and ensuring equitable distribution of economic benefits.

Despite substantial inflows of FDI into many countries over recent years, the anticipated improvements in economic growth have often not materialized. This suggests that the impact of FDI on economic growth might be significantly influenced by the effectiveness of recipient governments. Research by Awan et al. (2018) highlighted how variations in government effectiveness can affect the response of economic growth to changes in FDI. Furthermore, Nedanovski and Shapkova Kocevska (2023) demonstrated that adherence to the rule of law is a crucial determinant of economic growth, indicating that stronger rule of law practices can enhance the positive effects of FDI on economic growth.

Baiashvili and Gattini (2020) explored the mediating role of institutional factors in the relationship between FDI and economic growth. Their study revealed that the impact of FDI is neither automatic nor uniform; it varies significantly across countries, with low-income nations experiencing a stronger effect compared to middle-income countries. The literature on FDI and economic growth is extensive, showing mixed results. While some researchers, like Mahmood (2012), find a positive effect of FDI on economic growth, arguing that FDI has a greater impact compared to local investments, others present varying outcomes. Dirks and Schmidt (2023) investigated how political instability affects economic growth, using panel data from 34 countries over the period 1996 to 2020. Their findings indicate that GDP can decrease by 4 to 7 percent five years after a political shock. This view aligns with earlier studies, such as the IMF report from 2011, which documented that higher levels of political instability are linked to reduced economic activity and slower growth (Aisen and Veiga, 2013). Feyisa et al. (2022) employed both fixed and random effects estimations to examine the relationship between various governance indicators and economic growth. Their analysis revealed that government corruption, adherence to the rule of law, and government effectiveness positively influenced real GDP per capita. Conversely, political instability was found to have an insignificant impact on economic growth in their study.

3. Data and methodology

To investigate the impact of FDI on the economic growth of G20 countries, this research selects a panel of 19 member nations: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Republic of Korea, Mexico, Russia, Saudi Arabia, South Africa, Türkiye, United Kingdom, and United States. The study covers the sample period from 2001 to 2022.

3.1. Model specification

The current study employs the following general equation to measure the effect of foreign direct investment on economic growth alongside other control variables:

$$EG_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 ER_{it} + \beta_3 TB_{it} + \beta_4 INF_{it} + \beta_5 GOV_{it} + \beta_6 GFCF_{it} + \varepsilon_{it} \quad (1)$$

where, EG_{it} is the economic growth of a country i in year t. FDI_{it} is the foreign direct investment of a country i in year t. ER_{it} is the real effective exchange rate of country i in year t. TB_{it} is the trade balance of country i in year t, measured as ratio of GDP. INF_{it} is the inflation rate of country i in year t, measured by the first difference of the consumer price index. GOV_{it} is the measure of the governance quality of a country i in year t. $GFCF_{it}$ is the measure of gross domestic fixed investment of country i in year t

A cointegration approach is utilized to assess the long-term relationships among the variables. For cointegration analysis, the variables must be non-stationary at their levels and integrated of order 1. The step-by-step time series methodology applied in this research is detailed below.

3.2. Augmented Dickey-Fuller test

To test the stationarity of the variables, the Augmented Dickey-Fuller (ADF) test has been employed. The ADF test equation is as follows:

$$\Delta y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 \sum y_{t-1} + \mu_t \quad (2)$$

The null hypothesis of the ADF test is that the variable contains a unit root, indicating non-stationarity. The alternative hypothesis is that the variable is stationary.

3.3. Cointegration and vector error correction model

To examine the long-run cointegrating relationship among the selected variables, the current research employs the Johansen approach, which utilizes two statistics: trace statistics and maximum eigenvalue statistics. These tests help determine the number of cointegrating equations that explain the long-run relationships among the variables. Suppose the Johansen cointegration test confirms the existence of cointegrating equations. In that case, a Vector Error Correction Model (VECM) is then applied to measure the speed of adjustment in the event of short-run disequilibrium. The VECM not only assesses short-run relationships but also indicates how quickly short-run shocks are corrected over time. This model helps determine the number of years (assuming yearly data, as in our case) needed for the system to return to equilibrium.

$$\Delta x_t = \beta_0 + \beta_1 \sum x_{t-1} + \beta_2 \sum y_{t-1} + \mu_t \quad (3)$$

To ensure the robustness of the results, this study also employs linear panel data models. The three-panel data models used are the common effects model, the fixed effects model, and the random effects model. In the common effects model, every cross-sectional unit and each year share the same intercept and the same slopes for all explanatory variables. This model essentially applies ordinary least squares (OLS) to panel data, treating the data as if it were a single pooled dataset without accounting for individual-specific effects or time-specific variations. In contrast, the fixed effects model accommodates distinct intercepts for each cross-sectional unit and each period. This approach allows for the inclusion of unique individual and temporal effects, providing a more nuanced analysis by controlling for unobserved heterogeneity that might influence the dependent variable across different entities and over time. This model utilizes dummy variables to account for these individual and time-specific effects and is therefore also referred to as the Least Squares Dummy Variable (LSDV) model. However, in applying the fixed effects model, a common issue is the potential loss of degrees of freedom due to the large number of dummy variables used to capture individual and time-specific effects. To address this problem, the random effects model is employed as an alternative. Subsequently, the Hausman test is used to determine whether the fixed effects model is more appropriate than the random effects model, based on the nature of the individual effects and the suitability of each model for the data.

4. Results and analysis

This study begins its empirical analysis by presenting a descriptive summary of the chosen variables, including their means and standard deviations, as detailed in Table 1. It shows that the average growth rate among G20 countries during the sample period stands at 4.02 percent, reflecting a positive trend. This rate varies significantly, with a peak of 37 percent per year and a low of -33.7 percent. Considering that economic growth is measured by real GDP, the G20 nations have generally demonstrated commendable growth performance over the sample period. Moreover, on average, G20 countries have attracted FDI amounting to approximately 2 percent of their gross domestic product (GDP). This level of investment indicates that G20 countries are preferred investment destinations. The influx of FDI is expected to positively influence economic growth, as it brings not only capital but also technology and expertise that can further drive economic development to these nations. Over the sample period from 2001 to 2022, G20 countries have experienced an average inflation rate of 4.06%. This indicates that inflation levels have been relatively stable and under control during this period. Also, on average, gross fixed capital formation in the sample economies constitutes approximately 24% of GDP, which is a positive indicator of substantial investment in productive assets Table 1.

Table 1: Descriptive statistics

	EG	FDI	ER	TB	INF	GOV	GFCF
Mean	0.040	0.0192	725.740	0.041817	4.066681	0.509246	24.51815
Median	0.027	0.0114	96.772	0.009712	2.706236	0.312921	22.77769
Maximum	0.373	0.373	14849.85	2.568068	72.30884	1.984942	46.66012
Minimum	-0.337	-0.034	0.999	-0.653586	-2.093333	-1.141307	10.85391
Standard deviation	0.071	0.027	2542.040	0.211325	5.828863	0.920687	6.88669
Skewness	0.990	6.263	4.233	8.261558	6.548847	0.086015	1.106374
Kurtosis	9.580	69.617	19.912	87.64839	65.26129	1.650898	4.04749
Jarque-Bera	822.386	80025	6229	12955	70502	32.21511	104.3866
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	418	418	418	418	418	418	418

EG: Economic growth; FDI: Foreign direct investment; ER: Exchange rate; TB: Trade balance; INF: Inflation; GOV: Government expenditure; GFCF: Gross fixed capital formation

Table 2 presents the pairwise correlation coefficients for the selected variables, illustrating the degree of association between each pair. Correlation values range from -1 to +1, where -1 indicates a perfect negative relationship and +1 signifies a perfect positive relationship. The estimates in Table 2 show that no correlation coefficient exceeds 0.7, indicating there is no issue of multicollinearity among the variables. The GDP has a negative correlation with FDI, trade balance (TB), inflation rate (INF), and government effectiveness (GOV). In contrast, it has a positive correlation with the

exchange rate (ER) and gross fixed capital formation (GFCF). This suggests that a higher effective exchange rate is associated with higher economic growth. Similarly, a higher percentage of fixed capital investment correlates with a higher GDP. However, the negative correlation between GDP and FDI and GDP and governance quality (measured by government effectiveness) is contrary to expectations. This anomaly calls for the application of sophisticated econometric techniques to thoroughly investigate the relationship between the natural log of GDP and the explanatory variables, particularly FDI and government effectiveness. The highest correlation coefficients are found between the exchange rate, GDP, trade balance, and FDI, but these values are still below 0.8, thereby mitigating concerns about multicollinearity.

Table 2: Correlation matrix

	LGDP	FDI	ER	TB	INF	GOV	GFCF
LGDP	1.00	-0.15	0.64	-0.13	-0.06	-0.14	0.45
FDI	-0.15	1.00	-0.11	0.63	-0.07	0.16	-0.18
ER	0.64	-0.11	1.00	-0.01	0.06	-0.28	0.22
TB	-0.13	0.63	-0.01	1.00	-0.16	-0.17	-0.14
INF	-0.06	-0.07	0.06	-0.16	1.00	-0.34	0.07
GOV	-0.14	0.16	-0.28	-0.17	-0.34	1.00	-0.17
GFCF	0.45	-0.18	0.22	-0.14	0.07	-0.17	1.00

LGDP: Log of gross domestic product; FDI: Foreign direct investment; ER: Exchange rate; TB: Trade balance; INF: Inflation; GOV: Government expenditure; GFCF: Gross fixed capital formation

After analyzing the descriptive statistics and pairwise correlations, the current study proceeds with a stationarity test on the dataset to ensure the reliability of its modeling approach. The panel ADF test, a widely recognized method in econometrics analysis, is used to identify the presence of a unit root in the selected panel data. A unit root signifies non-stationarity in a selected variable, indicating that the statistical properties of the series, such as its mean and variance, are not constant over time. The results, presented in Table 3, show that most of the selected variables demonstrated stationarity at the first difference level.

If all variables are found to be non-stationary at their levels but become stationary after differencing, Johansen's cointegration method can be used to analyze the long-term relationship between them. When variables are cointegrated, they exhibit a long-term relationship. Table 4 presents the results of Johansen's cointegration test. Both the trace test and the maximum eigenvalue test indicate the presence of three cointegrating equations. This implies that economic growth and foreign direct investment share a long-run relationship when considering control variables. The p-values for the null hypotheses listed in the first column of Table 4 are shown in the last column. As the p-values for 'None,' 'At most 1,' and 'At most 2' cointegrating equations are significantly below the 5% significance level, it is concluded that the relationship between foreign direct investment, economic growth, exchange rate, trade balance, and government effectiveness can be described with three distinct equations. Our primary research question was to explore the relationship between foreign direct investment and economic growth. This objective has been met as Johansen's panel cointegration test confirms a long-run association between foreign direct investment and economic growth in G20 countries. These findings align with those of Mwitta (2022), who reported causality from foreign direct investment to economic growth. This result also supports the theoretical perspective that foreign direct investment brings technology and expertise to the recipient country, enhancing its operations and marketing strategies and ultimately leading to higher economic growth.

Table 3: Augmented Dickey-Fuller test

Variable		ADF statistics	P-value
GDP	Level	23.7792	0.9653
	First difference	167.747	0.0000
FDI	Level	47.9759	0.1288
	First difference	188.166	0.0000
ER	Level	32.9021	0.7039
	First difference	119	0.0000
TB	Level	51.3786	0.0723
	First difference	123.97	0.0000
INF	Level	74.146	0.0004
	First difference	154.689	0.0000
GOV	Level	22.9901	0.9739
	First difference	163.751	0.0000
GFCF	Level	63.6742	0.0056
	First difference	150.648	0.0000

GDP: Gross domestic product; FDI: Foreign direct investment; ER: Exchange rate; TB: Trade balance; INF: Inflation; GOV: Government expenditure; GFCF: Gross fixed capital formation

4.1. Vector error correction model

After confirming the cointegrating relationships, the next step involves estimating the VECM to assess both the short-run and long-run relationships among the selected variables. The VECM quantifies the speed at which the variables adjust towards long-run equilibrium following a short-run shock. The error correction term indicates how quickly deviations from equilibrium are corrected. Additionally, the

VECM captures the short-term dynamics by incorporating the lagged differences of the variables, enabling an understanding of how short-term changes in one variable affect the others. Table 5 presents the results of the VECM estimation. The results reveal three distinct cointegrating equations, each influencing different variables. The first equation (CointEq1) has a significant impact on the exchange rate. The second equation (CointEq2) highlights substantial adjustments in FDI, trade balance, and government effectiveness. Lastly, the third equation (CointEq3) demonstrates significant effects on both GDP and the exchange rate. This indicates that the long-term relationships among the variables are captured through these separate cointegrating equations, with each equation focusing on specific economic factors.

Table 4: Results of Johansen's cointegration test

Hypothesized No. of cointegrations	Trace test	Probability	Max-Eigen test	Probability
None	415.9	0.0000	299.2	0.0000
At most 1	188.6	0.0000	124.6	0.0000
At most 2	98.15	0.0000	72.45	0.0006
At most 3	59.32	0.0150	48.22	0.1238
At most 4	58.58	0.0176	58.58	0.0176

Table 5: Results of vector error correction model

Error correction	D(GDP)	D(FDI)	D(ER)	D(TB)	D(GOV)
CointEq1	0.003480	2.01E-12	1.11E-07***	-3.16E-12	2.16E-11
	(0.00706)	(3.1E-12)	(2.5E-08)	(1.7E-11)	(1.8E-11)
CointEq2	-3514440.0	-0.154276***	385.0166*	0.564487***	-0.431723***
	(6.3E+07)	(0.02728)	(220.749)	(0.14941)	(0.15702)
CointEq3	32771.75***	-1.87E-06	-0.092714***	2.77E-06	-1.60E-05
	(5370.01)	(2.3E-06)	(0.01887)	(1.3E-05)	(1.3E-05)
D(GDP(-1))	0.161544***	1.04E-11	1.41E-06***	-2.87E-11	4.01E-11
	(0.05244)	(2.3E-11)	(1.8E-07)	(1.2E-10)	(1.3E-10)
D(GDP(-2))	-0.260767***	7.33E-12	-7.29E-08	1.05E-11	9.73E-11
	(0.05577)	(2.4E-11)	(2.0E-07)	(1.3E-10)	(1.4E-10)
D(FDI(-1))	-73744320	-0.391318***	-380.5376	-0.030703	-0.818511**
	(1.4E+08)	(0.06093)	(492.964)	(0.33365)	(0.35065)
D(FDI(-2))	-56590932	-0.253486***	-396.7124	-0.083189	-0.394354
	(1.5E+08)	(0.06458)	(522.504)	(0.35364)	(0.37166)
D(ER(-1))	43724.60***	-3.41E-06	0.279734***	-1.20E-06	-3.31E-05
	(13715.9)	(6.0E-06)	(0.04820)	(3.3E-05)	(3.4E-05)
D(ER(-2))	-63001.91***	-3.17E-06	-0.296700***	6.35E-06	4.06E-05
	(12791.1)	(5.6E-06)	(0.04495)	(3.0E-05)	(3.2E-05)
D(TB(-1))	15852860	0.013869	51.76229	0.307590***	-0.218926**
	(3.5E+07)	(0.01508)	(121.989)	(0.08257)	(0.08677)
D(TB(-2))	20937583	0.013059	37.16800	0.502951***	-0.175357**
	(3.4E+07)	(0.01485)	(120.159)	(0.08133)	(0.08547)
D(GOV(-1))	40170530**	-0.028762***	121.6449	-0.049434	-0.170631***
	(2.1E+07)	(0.00914)	(73.9175)	(0.05003)	(0.05258)
D(GOV(-2))	726474.8	-0.002167	42.91367	0.025859	-0.062360
	(2.0E+07)	(0.00877)	(70.9577)	(0.04803)	(0.05047)
C	24760874***	0.002499**	-10.49970	0.000116	-0.006628
	(2563988)	(0.00111)	(9.00997)	(0.00610)	(0.00641)
R^2	0.827	0.3418	0.409	0.144	0.0971

***: p<0.01; **: p<0.05; * p<0.1; C: Constant term (intercept); R^2: R-squared

To further assess the causality between economic growth and foreign direct investment, we applied a pairwise Granger causality test. The results of this analysis are detailed in Table 6.

Table 6: Pairwise Granger causality test

Null hypothesis	Obs.	F-statistic	Prob.
EG does not Granger cause FDI	399	2.45102	0.1182
FDI does not Granger cause EG		7.12807	0.0079

Obs.: Observations; Prob.: Probability

The findings from the Granger causality test reveal that the null hypothesis, which posits that economic growth does not Granger cause FDI, is accepted with a p-value of 0.1182, indicating no significant causality in this direction. Conversely, the null hypothesis that FDI does not Granger cause economic growth is rejected, as the p-value of 0.0079 is below the 0.05 significance level. This suggests a significant causal relationship between foreign direct investment and economic growth in the G20 countries.

4.2. Robustness of results

Linear panel regression models have been employed to ensure the results' robustness. Unlike the cointegration analysis, which requires variables to be integrated of order 1, the panel regression approach allows for including variables such as inflation rate and gross fixed investment. Gross domestic product is measured logarithmic for consistency and ease of coefficient interpretation, as detailed in Table 7. The results from the linear panel regression models indicate that FDI has a positive and statistically significant impact on the economic growth of G20 countries. This relationship holds consistently across all the models employed in the analysis, reinforcing the robustness of the finding that FDI is a key driver of economic growth in these

nations. In addition, exchange rate appreciation positively influences the economic growth of G20 countries. Moreover, the appreciation of the exchange rate positively influences the economic growth of G20 countries. This means that as the local currency strengthens relative to foreign currencies, it tends to boost the economic performance of these nations. A stronger exchange rate can make imports cheaper and increase purchasing power, which can, in turn, stimulate economic growth. This finding highlights the importance of exchange rate policies in shaping the economic trajectory of G20 countries. Furthermore, an increase in gross fixed capital formation enhances the economic growth in the selected economies. This indicates that higher investments in physical assets such as infrastructure, machinery, and equipment contribute significantly to the economic development of G20 countries. Capital accumulation improves productivity and efficiency, fostering a more robust economic environment. Meanwhile, an increase in the inflation rate and trade openness negatively affects economic growth. High inflation erodes purchasing power and creates economic uncertainty, whereas greater exposure to international trade may introduce economic vulnerabilities or competitive pressures that can impede the economic growth of G20 countries. In addition, the role of governance quality positively affects the economic growth of G20 countries, though this relationship remains statistically insignificant across all the panel linear regression models.

Table 7: Panel regression models

Variable	GDP common effects	GDP fixed effects	GDP random effects
C	12.78103***	14.78636***	14.77286***
	0.373208	0.149960	0.468403
FDI	4.048626***	2.768490***	2.737587***
	4.457184	0.832898	0.832422
ER	0.000605***	6.34E-05**	7.94E-05***
	3.72E-05	2.91E-05	2.87E-05
TB	-1.632572***	-0.222295*	-0.223908**
	0.609717	0.117495	0.117441
INF	-0.059623***	-0.006714**	-0.006703**
	0.016991	0.003356	0.003355
GOV	0.014305	0.136919	0.110958
	0.119388	0.085536	0.084087
GFCF	0.120882***	0.042401***	0.043044***
	0.013552	0.006233	0.006205
R^2	0.53	0.98	0.21

***: p<0.01; **: p<0.05; * p<0.1; C: Constant term (intercept); FDI: Foreign direct investment; ER: Exchange rate; TB: Trade balance; INF: Inflation; GOV: Government expenditure; GFCF: Gross fixed capital formation; R^2: R-squared

Based on the econometric models used in the analysis, including cointegration, vector error correction model, Granger causality tests, and both fixed and random effects models, it is evident that FDI has a positive and significant impact on economic growth in G20 countries.

5. Conclusion

This study examines the impact of FDI on economic growth for a panel of G20 countries, using annual data spanning from 2001 to 2022. It employs variables such as economic growth and foreign direct investment along with five control variables such as exchange rate, trade balance, inflation rate, government effectiveness, and gross fixed capital investment. To assess the short-run and long-term relationship among the selected variables, this study employs panel Johansen's cointegration and vector error correction model. Three-panel linear regression models are also used to check the robustness of the results. All the models reveal a positive and statistically significant impact of foreign direct investment on the economic growth of G20 nations. Our estimates also reveal a positive and statistically significant impact on gross fixed capital formation and exchange rate appreciation. On the other hand, inflation rate and trade openness negatively affect the region's economic growth. This study provides critical insights into the relationship between FDI and economic growth among G20 countries, suggesting that policymakers should prioritize strategies that enhance FDI inflows. Creating a favorable investment climate by ensuring political stability, offering incentives, and reducing bureaucratic hurdles can attract more foreign investors and stimulate economic growth. Additionally, the study highlights gross fixed capital formation's positive and statistically significant role in driving economic growth. Governments should focus on increasing investments in infrastructure and capital assets, which are crucial for enhancing productivity and long-term economic development. Policies promoting public and private sector investments in critical infrastructure—such as transportation, energy, and communication—will support sustainable economic progress.

The findings also indicate that exchange rate appreciation positively influences economic growth. Policymakers should consider implementing measures to stabilize and strengthen their currency, which can boost investor confidence and economic stability. Effective exchange rate management can reduce market uncertainties and create a more predictable investment and economic planning environment. Conversely, the study finds that higher inflation rates and trade openness hurt economic growth. To address these issues, governments should implement policies to control inflation, such as adopting sound monetary policies and inflation-

targeting frameworks. While trade openness is generally beneficial, excessive openness can lead to trade imbalances that may harm economic stability. A balanced trade policy that supports competitive industries while managing trade deficits can help mitigate these negative effects. Finally, the role of governance quality, though positively related to economic growth, is statistically insignificant in this study. This suggests that improving governance remains essential but requires more targeted efforts. Enhancing transparency, reducing corruption, and strengthening institutional frameworks are crucial steps towards creating a robust environment conducive to domestic and foreign investment.

In summary, these findings highlight the importance of strategic policy interventions in fostering economic growth through effective management of FDI, capital formation, exchange rates, and inflation while also emphasizing the need for balanced trade policies and improved governance.

6. Limitations and future research

While this research primarily focuses on G20 countries, future studies could expand by examining various income groups to offer a more comprehensive analysis of how foreign direct investment affects economic growth across different regions and economic classifications. Additionally, this study utilizes linear models exclusively; future research could benefit from incorporating advanced methodologies to explore potential nonlinear relationships in the data.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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