European Journal of Government and Economics

Vol. 12, No. 2 (2023), pages 175-195
https://doi.org/10.17979/ejge.2023.12.2.9909
Submitted: Sep 3, 2023 Accepted: Nov 14, 2023 Published: Dec 5, 2023

Article

Long-term relationship between investment and economic growth: a cointegration analysis of OECD countries

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Abstract. This article investigates the impact of domestic investments on economic growth in OECD countries from 2000 to 2020. It identifies factors affecting economic growth and analyzes the relationship between domestic investments and economic growth using econometric models. Empirical data from the World Bank, IMF, and OECD reports supports the positive impact of domestic investments on economic growth in OECD countries. The study also finds a long-term causality between GDP and Gross Fixed Capital Formation (GFCF). These findings offer valuable insights into investment dynamics and their effects on economic growth, informing governments and policymakers in OECD countries.

Keywords: investments, economic growth, OECD countries
JEL classification: E2; G11; E42; F3; F43

1. Introduction

Investments are the process of engaging and mobilizing money or other productive resources at the present moment with the hope and expectation of securing some anticipated benefits in the future. In other words, investment is any expenditure that is made expecting benefits in the future. According to the well-known theorist Massé (1962), investments represent the exchange of a safe good, the consumption of which is given up, with the hope we have in the investment object. Similarly, Sharpe (1998) states that investment is the sacrifice of a present value for a possible future value. According to the same authors, the difference between investment and saving is made. Where saving is presented as giving up consumption, investment is made to increase output in the future.

Economic growth can be defined as an expansion in the potential GDP of a country. In other words, economic growth is defined as the ability of a country's economy to produce more and more goods and services that consumers want. It is one of the central macroeconomic stabilizing objectives because this fact is closely related to the standard of living of a country's population. An increase in the population's standard of living necessarily requires an increase in the production of goods and services.

The first theories of economic growth by Smith (1776) and Malthus (1820) started from the hypothetical situation when there was no private ownership of land and no capital accumulation, which implies that prices were formed only based on the labor consumed. The national product aligned with population dynamics, while the actual income per worker was constant. In particular, Malthus (1820) claimed that population pressures would break the economy to the point where the workers would find themselves at the minimum threshold of existence.

Therefore, the primary purpose of this research is to study the cointegration (causal relationship) between domestic investment and economic growth in OECD countries. Another goal of this study is to analyze other macroeconomic and macro-financial factors that influence the causal relationship between investment and economic growth. We suggest the following research hypotheses to investigate the relationship between investment and economic growth:

- **H1:** Capital investments (GFCF) positively impact economic growth in OECD countries.
- **H2:** Investments by sector positively impact economic growth in OECD countries.
- **H3:** Investments according to assets positively impact economic growth in OECD countries.

This study is divided into the following sections. The first section of the study contains a review of the literature on the effects of domestic investments on economic growth; the second section includes a meta-analysis of the relationship between investments and economic growth; the fourth and fifth sections cover the data methodology and empirical results and findings of the study; and the last parts contain the conclusions, discussions, and references.

2. Literature review

In the last decades, several studies have been carried out by different authors, who have analyzed and identified the impact and relationships of investments in the economic growth of a country or several countries, giving different views. Several studies from the empirical literature have found favorable correlations between investment and economic growth (Starker & Khan, 2020; Abbes et al., 2015; Klonowski, 2010; Islam et al., 2020; Fuente-Mella et al., 2019; Dinh et al., 2019; Almfraji et al., 2014; Brown & Ulijn, 2004).

An investment is an asset or item acquired to generate income or appreciation. Appreciation refers to an increase in the value of an asset over time. When an individual buys a good as an investment, the intention is not to consume the good but to use it in the future to create wealth. An investment is always about spending some capital today - time, effort, money, or an asset - hoping for a greater return in the future than what was initially put in (Hayes, Boyle & Rathburn, 2021). Specifically, an investment is the actual commitment of money for some time in order to obtain future payments that will compensate the investor for the time the funds are committed (Reilly, Keith, & Sanford, 2020).

According to Starker & Khan (2020), Foreign Direct Investment (FDI) is among the most critical factors influencing economic growth. In the absence of adequate domestic investment, FDI has been withdrawn from industrially advanced countries to accelerate the path of industrialization,

promote and maintain sustainable economic growth, and reduce unemployment. Furthermore, the effectiveness of FDI in host countries depends on the efficiency of domestic investment. Today, the importance of FDI has increased through technology transfer and market networks that can result in efficient production and sales globally.

Indeed, FDI is increasingly sought by both developed and developing countries and is no longer considered a factor of dominance but a significant channel for technology transfer and innovation. Thus, the global economy has been completely transformed in recent years. It operates in an increasingly confused environment as free trade and free movement of capital and goods become hallmarks, where FDI is increasingly seen as a new way of financing economic growth (Abbes, Mostéfa, Seghir, & Zakarya, 2015).

Developing new entrepreneurial ventures plays a crucial role in shaping any national economy. Entrepreneurial firms are a source of growth and innovation in the industry for owners and provide jobs for the local population. They are also believed to offset economic downturns and help restructure existing industries. Venture capital is generally defined as capital provided to private businesses to accelerate a firm's development through access to capital and a wide range of business support services (Klonowski, 2010).

Investments can arise for various reasons, but mainly, a company will invest to achieve a return on that investment in the form of profit shares or dividends (Collings, 2016).

Savings and investments are two macroeconomic aggregates that are important in GDP growth in the long run. These factors relate to the allocation of resources between different periods. One method of increasing future product productivity is to allocate current resources to increase the capital stock, which is achieved by saving a portion of their current income to finance investment to grow. However, there is evidence that capital accumulation increases productivity and a consensus that higher levels of investment accelerate economic growth. Increasing the capital stock increases productivity and accelerates GDP growth (Fuente-Mella, Vallina-Hernandez, & Fuentes-Solis, 2019).

The importance of savings in developing countries depends on the long-debated economic theory that the rate of economic growth is a function of the rate of investment and that the rate of domestic savings limits investment. Savings contribute to economic growth by freeing up resources that can then be used to increase the economy's productive capacity by increasing the amount of capital equipment, machinery, and buildings (Joshi, Pradhan, & Bist, 2019).

Foreign direct investment (FDI) has emerged as a significant economic linkage between developed and developed and developing economies (Strange, 2003). In theory, FDI directly affects growth through capital accumulation and incorporating new inputs and foreign technologies into the host country's production function (Almfraji, Mohammad, & Khalid, 2014).

Moreover, economic growth can be a source of foreign direct investment, a country's infrastructure development, and a solid tax base (Brown & Ulijn, 2004).

The relationship between foreign direct investment (FDI) and economic growth has attracted much attention from academics and governments of developing countries. Since economic growth is one of their main focuses, policies related to attracting FDI have been prioritized during economic growth and development. From another point of view, it can be affirmed that FDI is one of the decisive factors for economic integration, as it increases benefits and long-term ties between different countries (Dinh, Vo, The Vo, & Nguyen, 2019).

Foreign direct investment (FDI) is often seen as a massive economic boon. FDI has long been widely accepted as an enabler for the sustainable growth of an economy. Given the importance of FDI, economies – especially developing ones – should attract more FDI. Although many factors as attractors of FDI have been highlighted, financial development's (FD) impact has been the least explored in the finance and FDI literature. While financial development is valued as a country's increased provision of financial goods and services to its citizens and enterprises, a developed financial system primarily symbolizes confidence for foreign investors. Most importantly, the financial system functions as an allocative resource, provides information, and functions as a cost-reduction mechanism (Islam, Khan, Popp, Sroka, & Oláh, 2020).

3. Meta-analysis: Analysis of the Cointegration between Investment and Economic Growth

This section presents a comprehensive meta-analysis consolidating a substantial body of research conducted by various researchers concerning the relationship between investments and their impact on economic growth. Table 1 provides a concise overview of these studies, detailing the variables employed and the specific econometric methodologies utilized by the respective authors. The summary encapsulates the pivotal findings and results of each study, elucidating the nuanced dynamics between investments and economic growth. Furthermore, the subsequent section delves into an in-depth examination of select studies by other esteemed researchers, offering a detailed scrutiny of their findings and results within the context of this thematic domain. This critical analysis aims to provide a comprehensive understanding of the nuances and complexities inherent in the relationship between investments and economic growth as perceived by other scholars. By undertaking this meticulous review, this research seeks to contribute to the existing discourse and offer valuable insights that can inform future research directions and policy formulation in the field of economic development.

Table 1. Existing literature

Authors	Years	Variables	Methods	Findings
Dinh, Vo, The Vo, & Nguyen (2019)	2000-2014	Real GDP per capita, foreign capital flows, Domestic credit to the private sector, Total domestic Investments, Human capital	Panel-based unit root test, Johansen cointegration test, Vector error correction model (VECM), and fully modified OLS (FMOLS)	The results of this study show that FDI helps stimulate economic growth in the long run, although it has a negative impact in the short term for the countries in this study. Other macroeconomic factors also play an essential role in explaining economic growth in these countries.
Abbes, Mostéfa, Seghir, & Zakarya (2015)	1980-2010	GDP: Gross Domestic Product FDI: Foreign direct investment	Unit Root Tests in Panel Series, Cointegration Tests, Vector Long-Term Cointegration, and Panel Granger Causality Test	The results show a disparity in the relationship between panel study cointegration. The results also show a unidirectional causality from FDI to GDP, which can be an excellent tool to prioritize allocating resources across sectors to promote foreign direct investment.

Authors	Years	Variables	Methods	Findings
Szkorupová (2014)	2001-2010	GDP, Foreign Direct Investments and Exports.	Johansen test for cointegration, Vector error correction (VAR) model.	The results confirm the existence of long-term causal relationships between the studied variables in Slovakia. The study also reveals a positive impact of foreign direct investment and export on gross domestic product.
Sunde (2017)	1994-2013	GDP, Foreign Direct Investments and Exports.	Unit root tests, bounds test for cointegration and causality within ARDL modeling approaches.	The article confirmed the co-integration between economic growth, foreign direct investment, and exports. Causality analysis found unidirectional causality between economic growth and FDI, unidirectional causality between foreign direct investment and exports, and bidirectional causality between economic growth and exports.
Kumari & Sharma (2018)	1981-2013	Electricity consumption (ELC), foreign direct investment (FDI) and economic growth (GDP).	ADF unit root test, Johansen cointegration approach, Granger causality and VECM.	The study findings show that the three variables are stationary at the first difference level from the Johansen cointegration approach, confirming two cointegrated equations between the study variables. The Granger causality analysis confirms two unidirectional causalities, going from ELC to GDP and GDP on FDI, and a bidirectional causality between ELC and FDI.
Pegkas (2015)	2002-2012	Gross Domestic Product and FDI.	Descriptive statistics, stationary panel tests, panel cointegration tests, fixed and random effects methods.	Empirical results show a positive relationship between FDI and economic growth. The empirical analysis reveals a positive long-run cointegrating relationship between the stock of FDI and economic growth. Also, the fixed and random methods of assessing country effects show that foreign direct investment is an essential factor that positively affects economic growth.
Abdelhafidh (2013)	1970-2008	Domestic savings, foreign capital inflows and Economic growth.	Augmented Dickey–Fuller (ADF) test and Causality tests.	Based on the study's findings, growth performance can be directly enhanced by a more significant mobilization of various foreign capital inflows, ranging from grants, FDI, long-term loans, short-term loans, bilateral loans, multilateral loans, and bank loans.
Pece, Andreea, Oros & Olivera (2015)	2000-2013	GDP, number of patents, Number of trademarks, Research and development expenditure EUR/capita, Research and development expenditure.	Analysis was performed using multiple regression models.	The results show a positive relationship between economic growth and innovations. Furthermore, we found that foreign direct investment significantly impacts economic growth through the transfer of knowledge and the improvement of technological processes.

Authors	Years	Variables	Methods	Findings
Gobalet & Diamon (2014)	1950-1980	Economic development, Specialization in mining, Internal capital formation, Dependence on investment.	Panel regression.	From the research results, investment-dependent countries have tended to experience relatively less subsequent economic growth. The most substantial adverse effects depend on the period, and the negative consequences of FDI can lie in the structural distortions of the country's economy, which appear slowly but prove harmful in the long term.
Hong (2014)	1994-2010	Foreign direct investments (FDI), Economic growth (GDP).	System evaluation results – GMM.	Based on the generated research results, it was found that FDI has a positive impact on economic development. Moreover, economies of scale, human capital, infrastructure, wage levels, and regional differences actively interact with FDI and drive economic growth in China, while trade openness does not significantly drive FDI.
Ribaj & Mexhuani (2021)	2010-2017	Savings and Economic growth.	Augmented Dickey-Fuller tests, Johansen cointegration tests and Ganger causality test.	The regression results showed that deposits have a significant positive impact on the economic growth of Kosovo because savings stimulate investments, production, and employment and consequently generate more significant economic growth. In addition, loans and remittances also help grow Kosovo's economy through their direct impact on investment.
Joshi, Pradhan & Bist (2019)	1975-2016	Savings, Investments and Economic growth.	Johansen, Gregory–Hansen and ARDL cointegration tests.	The study's empirical results show a long-term stable relationship between savings, investment, and economic growth. Similarly, the long-run estimates of the ARDL model show that investment has a significant positive impact on economic growth.
Wigren & Wilhelmsson (2007)	1980-2004	GDP, Total investment, Residential, Buildings and Infrastructure.	Cointegration and error correction model.	From the research results, investments in the construction of housing or other types of buildings, together with investments in infrastructure, are assumed to have a direct and indirect effect on economic growth. Therefore, it is essential to analyze its effect on economic growth.
Meyer & Sanusi (2019)	1995-2016	Economic growth, Internal investments (gross fixed capital formation), Employment register and Export.	ADF and PP Unit Root Tests, Johansen Cointegration Tests, VEC Granger Causality Test and Pairwise Granger Causality Test.	Empirical research findings suggest a long-term relationship between domestic investment, employment, and economic growth, with causality from economic growth to investment and not vice versa. The results also show that investments have a positive long-term impact on employment. Empirical evidence further suggests bidirectional causality between employment and economic growth.

Long-term relationship between investment and economic growth

Authors	Years	Variables	Methods	Findings
Nguyen & Nguyen (2021)	2000-2020	Economic growth, public investment, private investment, FDI, regular expenditure, total value of imports and exports and employment.	Descriptive statistics, Correlation and Robustness test.	The study results show that factors such as labor and trade openness negatively impact economic growth in the short term. Public investment harms economic growth in the long run, while domestic private investment, foreign direct investment, trade openness, and labor positively affect economic growth.
Tabassum & Ahmed (2014)	1972-2011	Economic growth, foreign direct investment, domestic investment, import and export.	Multiple regression method.	The research results show that domestic investments positively impact economic growth, while foreign direct investments and trade openness are less critical.
Sothan (2015)	1980-2013	Foreign direct investment (FDI), export and Economic growth.	Panel Unit Root Tests, Panel Granger Causality, Panel Cointegration Analysis and the FMOLS Approach.	The study's findings strongly confirm a long-run steady-state relationship between the selected countries' FDI, exports, and GDP. Based on the Granger panel causality analysis, a long-run bidirectional causality exists between FDI and GDP and exports and GDP. From this, it can be concluded that FDI and exports have a causal impact on long-term growth.
Alshehry (2015)	1970-2012	Economic growth, foreign direct investment, gross fixed capital formation, and international trade.	Granger Causality Test, Johansen Cointegration Tests, Unit Root Tests and Descriptive Statistics.	The study's empirical results suggest the existence of long-term unidirectional causality and long-term relationship between FDI and economic growth, a bidirectional causal relationship between capital investment and economic growth in the long run, and the one-way causality flowing from FDI to domestic capital investment. Therefore, increased foreign and domestic investment promotes economic growth.
Owusu (2020)	1990-2016	Foreign direct investment, Credit to the private sector, Trade openness, Gross national expenditure and Economic growth.	ARDL method of cointegration and UECM and Granger causality test.	The study results find a solid bidirectional causal relationship between FDI inflows and economic growth in the short and long run. The study also finds that the flow of FDI, credit for private international trade, and national spending promote economic growth both in the short and long term.
Bila (2020)	2002-2018	Foreign Direct Investments (FDI) and Gross Domestic Product (GDP).	Descriptive statistics, Cross-sectional dependence test statistics, Panel cointegration tests (ARDL model) and Granger causality analysis.	The study results found evidence that there is a long-term balance between GDP and foreign direct investment. Also, the panel causality test showed that a relationship between GDP growth rate and FDI growth rate is only indirect. Finally, only weak evidence showed that FDI had a statistically significant impact on GDP.

Source: Own elaboration.

The meta-analysis reflected in Table 1 contains a summary of several papers by different authors on the topic of investments and their impact on economic growth. From the analysis of their empirical results, a conclusion is reached that investments positively impact economic growth and a long-term positive cointegrating relationship between them. However, these studies have analyzed other macroeconomic factors and have impacted economic growth, including domestic credit, export, domestic savings, import, and human capital, implying that these interact actively with investments and promote economic growth.

4. Research methodology and data

4.1 Research Methodology

The primary purpose of this research is to analyze the cointegration (causal relationship) between domestic investments and economic growth of OECD countries. So, the main focus of this study is to identify the fact that this relationship exists and what is the impact of investments on economic growth.

Authors such as Starker & Khan (2020), Abbes et al. (2015), Bayar (2014), Dinh et al. (2019), Trinh & Nguyen (2015), Omri & Kahouli (2014), Naz et al. (2015), Sunde (2017), and Pegkas (2015), as well as many other studies by other authors, have analyzed the impact of investments on the economic growth of OECD countries. The primary importance of carrying out this study lies in the fact that the OECD countries, taking into account that they are countries with a relatively developed economy, then investment can be considered as a vital component for the economic growth of these countries, but also for indirect effects that are caused in the economies of developing countries.

This research reflects how domestic investments (GFCF) have influenced economic growth in OECD countries. What is the impact of investments by sectors of the real economy on GDP in OECD countries, and what effect do investments by assets have on economic growth in OECD countries?
The main hypotheses of this study are:

- **H1:** Capital investments (GFCF) positively impact economic growth in OECD countries.

Auxiliary hypotheses:

- H_{1a}: A positive correlation exists between capital investment (GFCF) and economic growth.
- H_{1b}: A positive causal relationship exists between capital investment (GFCF) and economic growth.

- **H2:** Investments by sector positively impact economic growth in OECD countries.

Auxiliary hypotheses:

- H_{2a}: A positive correlation exists between sector investment and economic growth.
- H_{2b}: There is a positive causal relationship between investment by sector and economic growth.

- **H3:** Investments according to assets positively impact economic growth in OECD countries.

Auxiliary hypotheses:

- H_{3a}: A positive correlation exists between investment by assets and economic growth.
- H_{3b}: There is a positive causal relationship between investment by assets and economic growth.

Quantitative methods have been applied to test these hypotheses based on the secondary data of the OECD, the IMF, and the World Bank annual reports. These data are mainly annual data presented in time series and numerical data. To analyze the impact of the domestic investments on economic growth, it was necessary to consider many other factors that explain the causal relationship between these variables. Our econometric model is derived from various studies analyzing the impact of investments on the economic growth of OECD countries, conducted by different authors.

The analysis of this research includes data from 37 OECD countries for twenty years (2000 - 2020). The data are processed in the STATA program, and to test the validity of the hypotheses of this study, the following statistical tests were applied: VAR analysis (Vector Autoregression Model), Granger Causality Wald Test, Johansen Cointegration Test, multiple linear regression, effect random, fixed effect, Hausman – Taylor Regression, GMM Model – Arellano Bond Estimation and Generalized Estimating Equations (GEE Model) and Nelson's E-Garch.

Table 2. Description of the variables included in the econometric model

Variables	Acronym	Measure	Evidence	Data source
Gross Domestic Product	GDP	Total, US dollars/capita – OECD	(Abbes, Mostéfa, Seghir, & Zakarya, 2015), (Sunde, 2017), (Wigren & Wilhelmsson, 2007), (Meyer & Sanusi, 2019), (Bilas, 2020).	OECD Annual Reports (2000 – 2020)
Gross fixed capital formation	GFCF	Total quarterly growth rate – OECD	(Dinh, Vo, The Vo, & Nguyen, 2019), (Pegkas, 2015), (Abdelhafidh, 2013), (Gobalet & Diamond, 2014), (Meyer & Sanusi, 2019), (Ugochukwu & Chinyere, 2013) , (Alshehry, 2015).	OECD Annual Reports (2000 – 2020))
Investments by sectors	IS	Percentage of gross fixed capital formation – OECD	(Bouchoucha & Ali, 2019), (Bayar, 2014), (Naz, Sabir, & Ahmed, 2015), (Tabassum & Ahmed, 2014).	OECD Annual Reports (2000 – 2020)
Investments by assets	IA	Percentage of gross fixed capital formation – OECD	(Trinh & Nguyen, 2015), (Wigren & Wilhelmsson, 2007), (Joshi, Pradhan, & Bist, 2019), (Dinh, Vo, The Vo, & Nguyen, 2019).	OECD Annual Reports (2000 – 2020)
Inflation	INF	Annual growth rate – OECD	(Trinh & Nguyen, 2015), (Ugochukwu & Chinyere, 2013), (Naz, Sabir, & Ahmed, 2015).	OECD Annual Reports (2000 – 2020)
Interest rate	IR	Total, % per year – OECD	(Ugochukwu & Chinyere, 2013).	OECD Annual Reports (2000 – 2020)
Domestic credit	DC	Percentage of GDP – World Bank	(Owusu, 2020), (Dinh, Vo, The Vo, & Nguyen, 2019).	OECD and World Bank Annual Reports (2000 – 2020)

Source: Own elaboration

To test the validity of the hypotheses of this study, we have built this econometric model as follows:

$$GDP_{it} = \beta_0 + \beta_1 GFCF_{it} + \beta_2 IS_{it} + \beta_3 IA_{it} + \beta_4 INF_{it} + \beta_5 IR_{it} + \beta_6 DC_{it} + \gamma_{it},$$

where:

GDP – Gross Domestic Product
GFCF – Investments
IS – Investments by sectors.
IA – Investments by assets
INF – Inflation
IR – Interest rate
DC – Domestic credit for the private sector
γ – stochastic variables (other factors not considered in the model)
***i* –** code and ***t* –** time period**.**

4.2 Descriptive statistics

In this part of the econometric analysis, all the results of the descriptive statistics of the statistical tests for the variables that are part of the econometric model are presented. These descriptive statistics include minimum, maximum, mean, and standard deviation values. From the data generated from the descriptive statistics table (Table 3), we can conclude that variables such as GDP, Credit, and Investments have the highest standard deviation value. In contrast, the variables with the smallest standard deviation values are the Interest Rate, Inflation, Investments by assets, and Investments by sector. From this, we can conclude that the variables with a higher standard deviation value are more spread than the mean value. In comparison, the variables with a lower standard deviation value are considered to be distributed closer to the mean value.

Table 3. Variable definitions and descriptive statistics

Variables	Obs.	Minimum	Maximum	Mean	Std. Deviation
GDP	777	6709	117721	35184.76	16786.22
GFCF	772	-20.4	313.9	1.555052	12.75924
IS	709	3.11	51.23	24.1159	7.478691
IA	735	4.23	43.69	20.67887	7.249532
INF	777	-4.48	54.92	2.658443	3.892529
IR	713	-0.52	22.5	3.887363	2.640092
DC	689	0.2	304.6	96.28142	46.1832

Source: Own elaboration.

5. Empirical Results

Table 4 shows the regression analysis results using panel data and the assessment of the impact of investments on the economic growth of OECD countries. Table 4 uses a variety of econometric approaches or measures, with the study's findings reflecting the same results from almost all panel data models that estimate the investment effect or relationship with economic growth in these countries. Moreover, an essential element of this research is analyzing the causal relationship between investments and economic growth. Time series model approaches were also used to analyze and prove the validity of the proposed hypotheses. These results show that all the variables included in this econometric model are significant at the 0.05 and 0.10 levels. Therefore, we have based the results of the multiple linear regression model for interpretation purposes.

According to the data presented in Table 4, we can observe that some of the variables are statistically significant at the 95% and 90% confidence levels. The parameter coefficient b0= 39043.37 considers that if other factors are constant, the GDP value will be $39043.37 (unit). If the primary independent variable (GFCF) increases by 1 unit while keeping other independent variables constant, GDP will increase by 178.16 units. This statement is correct as the significance value (P-value = 0.000 < 0.05) is at a statistical significance level. Based on this result, we can observe that investments have positively influenced the economic growth of OECD countries. The primary hypothesis is rejected, and the alternative hypothesis is accepted. So, with the increase in investments, the OECD countries increase the capital stock, and according to this, the increase in the amount of capital available to an economy contributes to economic growth.

Table 4. Results of the regression analysis

Variables	Linear Regression	Random Effects – GLS Regression	Fixed – Effects Regression	Hausman Taylor Regression	GEE Model	GMM Model
GDP	-	-	-	-	-	0.978821*** (0.000)
GFCF	178.1594*** (0.000)	100.552*** (0.000)	97.92486*** (0.000)	98.89147*** (0.000)	100.3164*** (0.000)	2.766009 (0.548)
IS	269.7156** (0.025)	- 1468.535*** (0.000)	- 1681.159*** (0.000)	- 1551.936*** (0.000)	- 1486.855*** (0.000)	-34.95403 (0.607)
IA	-231.1823* (0.062)	1198.149*** (0.000)	1408.499*** (0.000)	1278.423*** (0.000)	1216.183*** (0.000)	11.72929 (0.864)
INF	257.3447 (0.521)	204.0757 (0.307)	200.3417 (0.310)	204.3697 (0.299)	203.8267 (0.355)	137.0001** (0.014)
IR	- 3592.182*** (0.000)	- 2469.269*** (0.000)	- 2387.309*** (0.000)	- 2439.206*** (0.000)	- 2462.165*** (0.000)	-100.3756* (0.065)
DC	90.86103*** (0.000)	89.22334*** (0.000)	85.03547*** (0.000)	87.80784*** (0.000)	88.87247*** (0.000)	- 25.87507*** (0.000)
Const.	39043.37*** (0.000)	47950.86*** (0.000)	49404.94*** (0.000)	51394.49*** (0.000)	48031.39*** (0.000)	
R Square	0.4258	0.6241	0.6253	-	-	-
Adj. R^2	0.4198	0.4174	0.3650	-	-	-

Note: * p < 0.1; ** p<0.05; *** p < 0.01. *Source*: Own elaboration.

If investments by sector increase by 1 unit while keeping other variables constant, then GDP will grow by 269.72 units. This statement is correct since the level of statistical significance is above 90% (0.025<0.05). Investment in different sectors includes portfolio diversification and risk management, where with risk management, investors tend to have a better performance in that investment, and this chain effect causes a positive impact on the economic growth of these countries. If investments according to assets increase by 1 unit while keeping other variables constant, then GDP will decrease by -231.18 units. This statement is correct since the significance value is below the level of statistical significance (0.062<0.10).

In order to explain even more the impact of investments on the economic growth of the OECD countries, the effect of the inflation rate, the interest rate, and domestic loans were also taken into account in the analysis. If the inflation rate increases by 1 unit, keeping other factors constant, GDP will increase by 257.34 units. This statement is incorrect, considering that the significance level is above the level of statistical significance (P-value = 0.521 > 0.05). Since we know that inflation is a continuous increase in the general level of prices, the increase in the inflation rate reduces the economic growth of the OECD countries. With higher inflation, employment in OECD countries decreases. Consumers need more money to buy goods and services, so the economy of these countries can be low.

If interest rates increase by 1 unit while keeping other variables constant, GDP will decrease by -3592.18 units. This statement is correct since the significance value is below the level of statistical significance (P-value = 0.000 < 0.01). Interest rates not only affect economic growth but also the level of investment since businesses and consumers will reduce their spending when they increase. Also, this will cause incomes to fall and thus affect the economic growth of these countries.

The last independent variable is internal credits, where we mean that with the increase in internal credits by 1 unit, keeping all other variables constant, GDP will increase by 90.86 units. This statement is correct since the significance value is below the level of statistical significance (P-value = 0.000 < 0.01).

In order to verify the validity of the hypotheses presented in this study and to give more support to the econometric results presented in the study's findings, we have reflected some additional analyses related to the analysis of the VAR model (Vector Autoregressive Model).
Initially, the results of the three statistical tests were reflected in this part as:

- Johansen Test for Cointegration;
- Vector Autoregressive Models (VAR);
- Wald tests of Granger causality.

The first test, the Johansen Test for Cointegration, analyzes whether the main variables in this study, such as "Gross Domestic Product" (GDP) and "Investment" in OECD countries, are integrated. In the second analysis, through the VAR method, we see whether the main variables explain each other. Finally, the "Granger Causality Wald Test" as part of the time series model is reflected to verify whether these variables have long-term or short-term causality.

Johansen test

- **H_0:** There is no dynamic correlation and co-integrating relationship between GDP and Investments
- **H_1:** There is a dynamic correlation and co-integrating relationship between GDP and Investments

Table 5. Johansen Tests for Cointegration

Trend: constant			**Number of OBS = 774**		
Sample: 4 – 777			Lags = 3		
Maximum rank	Parms	LL	Eigenvalue	Trace statistic	5% critical value
0	10	-11058.774	.	214.2017	15.41
1	13	-10972.572	0.19968	41.7974	3.76
2	14	-10951.673	0.05257		
Maximum rank	Parms	LL	Eigenvalue	max statistic	5% critical value
0	10	-11058.774	.	172.4043	14.07
1	13	-10972.572	0.19968	41.7974	3.76
2	14	-10951.673	0.05257		

Source: Own elaboration.

Table 5 reflects that the value of "trace statistics" is greater than the "Critical value 5%" for ranking 0. We can say there is a co-integration between these variables – Gross Domestic Product (GDP) and Investment (GFCF). So, in this case, the primary hypothesis is rejected, and the alternative hypothesis (H1) is accepted.

Also, since the value of the "max statistic" is greater than the "Critical value 5%", we can say that there is a co-integration between these two variables (GDP and GFCF). So, in this case, the alternative hypothesis (H1) is accepted.

Since the two main variables in this study are integrated, we can use the VAR model in the econometric analysis. Based on the fact that GDP and GFCF were integrated, we can conclude that there is a long-term causality between Gross Domestic Product and GFCF Investments in OECD countries.

Below, the analysis through the VAR model is reflected, which proves the validity of the hypotheses if GDP, in the long term, explains the GFCF.

Vector Autoregressive Model (VAR)

- **H_0:** There is no long-term causality between GDP and investments;
- **H_1:** There is a long-run causality between GDP and investment;

From Table 6, we can conclude that GDP depends on the values of this variable in the periods (lag_1) in the long term since the significance values are at the standard level of 5%.

- GDP-lag_1: (P-value = 0.000<0.05)
- GDP-lag_2: (P-value = 0.673 > 0.10)
- GDP-lag_3: (P-value = 0.124 > 0.10)

Table 6. Vector Autoregressive Model (VAR)

		Coef.	Std. Err.	Z	p > |z|	95% Conf. Interval	
GDP							
	GDP						
	L1.	.9772	.035899	27.22	0.000	.9068392	1.047561
	L2.	-.020772	.0492747	-0.42	0.673	-.1173486	.0758046
	L3.	-.0530826	.0345103	-1.54	0.124	-.1207217	.0145564
	GFCF						
	L1.	74.43553	20.46765	3.64	0.000	34.31967	114.5514
	L2.	-164.5353	21.5386	-7.64	0.000	-206.7502	-122.3205
	L3.	-.5613106	21.31825	-0.03	0.979	-42.34432	41.22169
	_cons	3576.681	598.8376	5.97	0.000	2402.981	4750.381

Source: Own elaboration.

Based on the coefficient values, we can conclude that if GDP (lag_1) in the previous year increases by 1 unit, then GDP in the current year will increase by 0.9772 units. This statement is correct since the significance value is below the level of statistical significance (0.000<0.05). Also, in (lag_2), if GDP increases by 1 unit, then actual GDP will decrease by -0.020772 units. This statement is incorrect, as the significance value is above the level of statistical significance (0.673>0.10). While in the period (lag_3), if the GDP will increase by 1 unit, then the current GDP will have a negative value of -0.05308 units. Also, this statement is incorrect since the P-value is above the level of statistical significance (0.124> 0.10). Meanwhile, the results of the VAR model show that GDP in OECD countries depends on the values of GFCF in the periods (lag_1) (lag_2) in the long term.

GDP–GFCF (Lag_1) is a significant variable, and this explains the dependent variable (GDP), as the significance value is less than 0.05 (p-value = 0.000 < 0.05). Likewise, the variables GDP-GFCF (lag_2) reflect a significant variable that explains the dependent variable (GDP), considering the level of significance, which has a value of less than 5% (p-value = 0.000<0.05). Such a result provides more empirical evidence for the integration of these two variables and the existence of causality in the long term. While for the variable GDP-GFCF (lag_3), there is no significant correlation since the significance level is above the standard level of 10% (p-value = 0.979 > 0.10).

We applied the Granger Causality Wald test to verify the hypothesis of any long-term causality between GDP and GFCF for OECD countries.

Granger Causality Wald Tests

- • **H_0:** There is no long-term causality between GDP and investments;
- • **H_1:** There is a long-term causality between GDP and investments;

Table 7. Granger Causality Wald Tests

Equation	Excluded	chi2	Df	Prob > chi2
GDP	GFCF	67.265	3	0.000
GDP	ALL	67.265	3	0.000

Source: Own elaboration

Based on the results of the Granger Causality Wald Tests (see Table 7), we can conclude that there is a long-run causality between GDP and investment – GFCF. So, we say there is a long-run causality between GDP and GFCF, so the primary hypothesis is rejected, and the alternative hypothesis is accepted (p-value = 0.000 < 0.05). The chi-square value between the two variables is 67.265. Also, from the Granger Causality Wald Test results, we can observe a long-term causality between GDP and other variables. So, we can say there is a long-term causality between GDP – ALL since the significance value is below the 5% level (0.000<0.05).

Based on the econometric results of statistical tests, Johansen Test for Cointegration, Vector Autoregressive Test, and Wald Causality Granger Test, it is proved that the two main variables of this study (GDP and GFCF) are integrated. Likewise, they are significant and explainable to each other, implying that there is an express causality between them in the long term. Such a result is consistent with the studies of the authors Bilas (2020), Owusu (2020), Alshehry (2015), Sothan (2015), Nguyen & Nguyen (2021), Meyer & Sanusi (2019), Pegkas (2015), Kumari & Sharma (2018), Sunde (2017).

Table 8 presents the econometric results of Nelson's E-Garch statistical test. This econometric model has analyzed whether capital investments (GFCF) have a positive or negative impact on the volatility of economic growth in OECD countries.

According to the econometric results of this statistical test, we can conclude that capital investments (GFCF) have positively influenced economic growth in OECD countries (P-value = 0.000 < 0.05). The effect of GDP is present in the independent variable (Capital Investments – GFCF) in the dynamic time lag L1.

Table 8. Econometric results of Nelson's E - Garch model between GDP and investments

GDP	Coef.	Std. Error	z	P > |z|	95% Conf. Interval	95% Conf. Interval
GFCF	246.1699	28.24278	8.72	0.000	190.815	301.5247
_cons.	37527.42	184.4446	203.46	0.000	37165.92	37888.93
ARCH L1.	.3175469	.1265185	2.51	0.012	.0695752	.5655187
EARCH L1.	1.282838	.246562	5.20	0.000	.7995853	1.766091
E-GARCH (L1)	.9120341	.1983063	4.60	0.000	.5233608	1.300707
E-GARCH (L2)	.0107963	.3079794	0.04	0.972	-.5928323	.6144248
E-GARCH (L3)	-.2087136	.2129475	-0.98	0.327	-.6260831	.2086559
E-GARCH (L4)	.2002932	.2046487	0.98	0.328	-.2008109	.6013974
E-GARCH (L5)	-.0500757	.1952083	-0.26	0.798	-.4326769	.3325255
_cons.	2.196741	1.178594	1.86	0.062	-.11326	4.506742

Source: Own elaboration.

In the constant (L1), we have a positive and significant correlation (P-Value = 0.000 < 0.05). So, when capital investment in 2019 increases by 1 unit, then GDP volatility in 2020 has increased by 0.912 units. This economic phenomenon shows that the OECD countries must follow an efficient strategy in managing these investments because the growth of these investments in 2020 has influenced the increase in the volatility of economic growth. An increase in volatility means that a sudden increase in the risk of these investments negatively affects the economic growth of these countries.

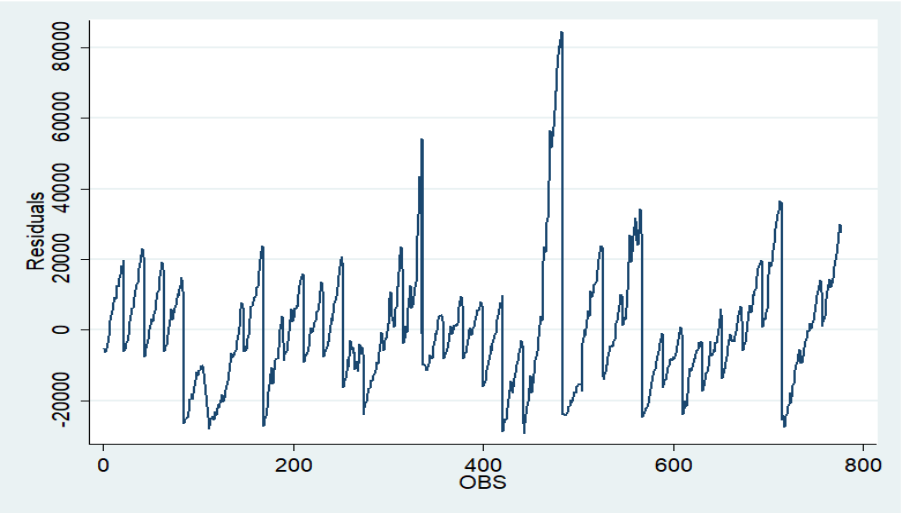

Figure 1. Volatility of time series data for GDP and investment variables. *Source*: Own elaboration.

In the constant (L2), we have a positive correlation, but not significant (P-Value = 0.972 > 0.05). Consequently, when capital investments in 2018 have increased by 1 unit, the volatility of economic growth has increased by 0.010 units. This statement is incorrect since the significance value is above the level of statistical significance. This economic phenomenon shows that these countries in the dynamic time delay (L2) can manage the risks that may occur in those investments. According to this result, the OECD countries, in the most extended periods, have carefully managed these risks in these investments, which has influenced the economic growth of these countries.

Referring to Figure 1, we can notice that the time series data for GDP and investments have an accumulation of volatility because the periods when OECD countries are associated with high risk of these investments, then in these periods, these countries are characterized by a high volatility of economic growth.

In continuation of Nelson's E-Garch analysis, it has been analyzed whether investments by sector have a positive or negative impact on the volatility of economic growth in OECD countries (Table 9).

Table 9. Econometric results of the Nelson's E - Garch model between GDP and investments by sector

GDP	Coef.	Std. Error	z	P > |z|	95% Conf. Interval	95% Conf. Interval
IS	129.9488	16.5479	7.85	0.000	97.51552	162.3821
_cons.	33450.66	437.8684	76.39	0.000	32592.46	34308.87
ARCH L1.	.4085706	.1727945	2.36	0.018	.0698997	.7472415
EARCH L1.	1.636798	.2993979	5.47	0.000	1.049989	2.223607
E-GARCH (L1)	.7671487	.2045074	3.75	0.000	.3663216	1.167976
E-GARCH (L2)	.0497486	.3463328	0.14	0.886	-.6290512	.7285484
E-GARCH (L3)	-.0028908	.2341155	-0.01	0.990	-.4617488	.4559672
_cons.	3.277742	1.218685	2.69	0.007	.8891627	5.666321

Source: Own elaboration.

According to the results of Nelson's E-Garch model, we can conclude that investments by sector influence GDP growth. So, with the increase in investments according to the sector, the economic growth in the OECD countries is positively affected. In the constant (L1), we have the presence of GDP and investments by sector. In the constant (L1), we have a positive and significant correlation.

Therefore, when investments by sector with a dynamic time lag (1) increase by 1 unit, the value of economic growth volatility will increase by 0.767 units. So, based on this econometric result, it can be concluded that the OECD countries have not effectively managed these investments because, as a result of the growth of these investments in various sectors, these countries have had an increase in the volatility of economic growth for one year.

Such an effect does not result in the constant (L2) and (L3). These constants have a positive and negative correlation but are not significant since the significance values are above the level of statistical significance. As a result, when investments by sector with a dynamic time lag (2) and (3) increase by 1 unit, the value of economic growth volatility will decrease by 0.0028 units. Based on this econometric result, the OECD countries have followed a policy on investment risk management in the three years because, despite the risks that these investments may have, they positively affect the economic growth of these countries.

Table 10. Econometric results of Nelson's E – Garch model between GDP and investments by assets

GDP	Coef.	Std. Error	z	P > |z|	95% Conf. Interval	95% Conf. Interval
IA	366.0884	18.49781	19.79	0.000	329.8834	402.3435
_cons.	28805.92	420.4492	68.51	0.000	27981.85	29629.98
ARCH L1.	.3944389	.1521463	2.59	0.010	.0962377	.6926402
EARCH L1.	1.798244	.2313236	7.77	0.000	1.344858	2.25163
E-GARCH (L1)	.8118304	.1609492	5.04	0.000	.4963757	1.127285
E-GARCH (L2)	.0006715	.2524377	0.00	0.998	-.4940972	.4954403
E-GARCH (L3)	.0204547	.1994363	0.10	0.918	-.3704333	.4113428
_cons.	2.696959	1.07553	2.51	0.012	.5889583	4.80496

Source: Own elaboration.

Based on the econometric results of Nelson's E-Garch model (see Table 10), we can conclude a positive correlation between investments according to assets and GDP. Therefore, if investment by assets increases by 1 unit, then the value of GDP will increase by 366.08 units.

The effect of GDP exists in the constant (L1). In the constant (L1), we have a positive and significant correlation. Therefore, when investments according to assets with a dynamic time delay (1) increase by 1 unit, the value of the volatility of economic growth will increase by 0.811 units. Based on this econometric result, the OECD countries have not effectively managed these investments, which has influenced these countries to have an increase in the volatility of economic growth for one year. Such an effect does not result in the constant (L2) and (L3). These constants have a positive correlation but are not significant since the significance values are above the level of statistical significance. As a result, when investments according to assets with a dynamic time lag (2) and (3) increase by 1 unit, the value of economic growth volatility will increase. The statement is incorrect since the significance value in the three years is above statistical significance. From this, we can conclude that in more extended periods, OECD countries manage investments more effectively according to assets.

6. Discussion

Researchers explore two hypotheses concerning the correlation between investments and economic growth, as investments essentially entail allocating a portion of existing capital, anticipating a

subsequent increase in value. The first hypothesis is that investments positively impact economic growth. The second is a positive correlation between investment and economic growth. Based on all the statistical tests we have presented, we can conclude that investments positively affect economic growth, from which the first hypothesis was verified. The support of this conclusion is also found in the author's research (Szkorupová, 2014), which, in order to prove the first hypothesis showing that investments have a positive impact on economic growth, used the data for the country of Slovakia during the period 2001-2010. The study examines whether investment is strongly linked to economic growth. The author identifies a positive influence between investments and economic growth.

Evidence that generally strongly supports the view that investments have a positive effect on economic growth includes research by authors such as (Pegkas, 2015; Dinh et al., 2019; Tabassum & Ahmed, 2014). Their data show a positive relationship between investments and economic growth, and they consider investments as one of the most critical factors that positively affect the economic growth of a country.

As for the second hypothesis, which reflected that there is a positive correlation between investments and economic growth. In its confirmation was the research of authors (Owusu, 2020) and (Sothan, 2015), where from the results obtained, they proved a two-way solid causal relationship between foreign direct investments and economic growth. In confirmation of this hypothesis, it shows that in addition to investments affecting economic growth, it is also a fact that economic growth affects investments, which means that the countries with a higher economic development attract more investors to invest in that country. The growth of more investments means a more significant reason for reducing unemployment in that country and its economic growth.

7. Conclusions and recommendations

In conclusion, the entire research provides a detailed summary regarding the impact of investments on economic growth. The empirical results of this study have reflected various statistical tests that have been applied to examine the impact of investments on economic growth for OECD countries. Based on OECD and World Bank time series data covering all 37 OECD countries for 20 years, the research concluded that capital investment (GFCF) has positively influenced the economic growth of OECD countries, as well as being integrated, are also significant, explainable and there is a causality expressed in the long term.

Considering the impact of investments by sector and investments by assets, the empirical findings of this study state that this category of investments positively affects the economic growth of OECD countries. Since these countries, through investments in different sectors, manage to diversify their portfolio and manage risks, the better risk management made the investors of these countries have a better performance in that investment, and from this chain, the effect has an impact on the economic growth of these countries.

Therefore, according to the findings, investments are a strong basis for a country's economy, especially countries that are still developing, and need to offer favorable conditions for investors not to hesitate or be reluctant to invest in those countries. Therefore, as a recommendation, it is

recommended that OECD countries implement policies to attract inflows of foreign direct investments, which will bring positive effects to the economic growth of these countries.

We recommend that the governments of the OECD countries work on creating good economic stability so that investments are adequate; as a result, this would reduce unemployment and provide new jobs. Also, the OECD countries would have to provide stability in price volatility, security in investments, fighting corruption, and other negative aspects that would hinder the economic development of a country.

Future research should focus on exploring the intricate dynamics between investments and economic growth within the evolving global market landscape and geopolitical climate. A more nuanced investigation into the impacts of different investment sectors and asset categories can provide valuable insights for policymakers and investors.

However, it is crucial to acknowledge the limitations of this study, such as the reliance on secondary data and constraints associated with the chosen econometric models. Additionally, the focus on OECD countries may restrict the generalizability of the findings. To address these limitations, future research should utilize diverse data sources and encompass a broader spectrum of economies, thereby enhancing our understanding of the complex relationship between investments and economic growth.

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