Kasdi Merbah University, Ouargla

Faculty of Economic Sciences,

Commercial Sciences and Management Sciences

Department of Economic Sciences

Memoire submitted as part of the requirements for obtaining a Master's degree Specialization: Quantitative Economics

Impact of Foreign Direct Investment on Economic Growth in Algeria During the Period (1990-2023) Using ARDL Models.

Prepared by Student: GARBI Fatima Batoul

Discussed and Approve in: 15/06/2025

Members of the Examination Committee

Pr.Haddadi Nour El Hoda (assistant professor - Kasdi Merbah University, Ouargla) President

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إهداء

قال تعالى: {وَمَا تَوْفِيقِي إِلَّا بِاللَّهِ عَلَيْهِ تَوَكَّلْتُ وَإِلَيْهِ أُنِيبُ} [هود من الآية : 88]

*إلى الطفل الذي كنتُهُ، والحالم الذي لم يخذلني.

*إلى أسمى آيات العطاء البشري، وإلى من لا توفيهم الكلمات حقهما: أمي وأبي.

*إلى الذين هم ملاذي ورمز فخري واعتزازي: أخي وأخواتي.

*إلى أولئك الذين يفرحهم نجاحي ويحزنهم فشلي، وإلى الأقارب قلباً ودماً ووفاء.

*إلى الأيدي الصغيرة التي تطرق بابي زائرة، لتدخل الأنس والحياة إلى أيامي: أولاد أختي.

*إلى زينة حياتي وبهجتها ورفيقة عمري: ميمة.

*إلى رفيقات المشوار، شكراً لكونهنّ الوطن حين ابتعدت عن كل شيء يشبهه.

*إلى من حملوا مشعل الفكرة في دروب الظلام، وإلى من علموني أن السؤال لا يقل قداسة عن الجواب، وأن الشك هو أول الطريق إلى اليقين: أساتذتي الكرام.

*شكر وتقدير لأستاذي المشرف هتهات السعيد على دعمه المتواصل في كل مرحلة من مراحل المذكرة.

*إلى من علمني أن الصمت قد يحمل كل الحروف، وأن الدعم لا يحتاج صوتاً بل قلباً حاضراً.

*إلى كل من ظنّ أنني لن أنجح، شكراً لكونهم وقود العناد الذي أوصلني إلى خط النهاية.

*إلى كل من ذكرتهم ذاكرتي، ولم تنكرهم مذكرتي.

* أُهديكم عملي المتواضع هذا.

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Abstract:

This thesis, conducted in Algeria, investigates the impact of Foreign Direct Investment (FDI) on real GDP growth over1990–2023. The core methodology utilizes the ARDL frame work to extract both short-run and long-run effects,with an Error Correction Model (ECM) employed to measure the annual speed of adjustment back to equilibrium .

the results show a significant positive relationship between FDI and GDP in both the short-and long-run, and the ECM indicates that Algeria's economy corrects approximately 7.35% of any disequilibrium each year, reflecting a relatively slow transmission of shocks . These outcomes highlight Algeria's strategic North African position and its attractiveness for foreign capital—particularly in the energy sector, which has accounted for the majority of FDI over the past three decades

Keywords: Economic Growth, Foreign Direct Investment (FDI),ARDL

الملخص

انطلقت هذه الدراسة في الجزائر لتقيم أثر تدفقات الاستثمار الأجنبي المباشر (FDI) على نمو الناتج المحلي الإجمالي خلال الفترة 1990-2023 وإعتمدنا منهجية ARDL لاستنباط اليات تأثير في مدين القصير و الطويل و معالجة أي إنحراف عن توازن عبر نموذج تصحيح الخطأ (ECM) لتقدير سرعة العودة الى مسار التوازن السنوي أظهر التحليل وجود علاقة إيجابية معنوية بين FDI و GDP في مدى القصير و الطويل مع إمكانية تصحيح أي خلل بنسبة تقارب 7.35% سنويا ما يعكس بطئ انتقال أثار الصدمات ضمن إقتصاد الجزائري تظهر هذه النتائج أن الجزائر بوضعها الجغرافي و موقعها في شمال إفريقيا كانت محطة ترحيب للمستثمرين الأجانب ، لاسيما في قطاع الطاقة الذي أستحوذ على الجزء الأكبر من FDI خلال العقود الماضية .

الكلمات المفتاحية: النمو الاقتصادي، الاستثمار الأجنبي المباشر ، ARDL

Introduction

Introduction

Foreign direct investment (FDI) is considered one of the most important drivers contributing to economic growth globally, as it provides new capital, transfers modern technologies, and contributes to creating job opportunities and increasing productivity. In developing countries, in particular, this type of investment is a crucial factor for bridging financing gaps, stimulating innovation, and building institutional capacities. In Algeria's case, FDI has been one of the fundamental pillars of the economic openness policy since the 1990s. It has played a significant role in financing infrastructure projects, diversifying the economy, and improving the performance of both oil and non-oil sectors. However, the sustainability of this impact requires the completion of institutional reforms and the development of the business environment to ensure the attraction of more foreign capital in the long term.

In this thesis, I have chosen my country, Algeria, and the thesis represents two main axes: the first is theoretical, highlighting the basic concepts of foreign direct investment and its relationship with economic growth, reviewing the literary developments and economic theories that explain its role in technology transfer and the development of productive capacities. As for the second axis, it is applied, translating these theoretical foundations into practical econometric analysis through the ARDL model, which reveals the dynamics of the relationship between foreign investment flows and GDP growth in Algeria during the period 1990–2023, and provides conclusions based on real data that help decision-makers formulate more effective investment policies.

Main Problem:

How does foreign direct investment (FDI) contribute to promoting economic growth in Algeria during the period 1990-2023?

Sub-questions:

1. What is foreign direct investment and what is its role in achieving economic growth?
2. What is the importance off foreign direct investment in achieving economic growth?
3. What are the competitive advantages that make Algeria an attractive destination for foreign direct investment, and what are the obstacles that prevent its attraction?

Study Hypotheses:

1. There is a long-term relationship between foreign direct investment and economic growth in Algeria.
2. Foreign direct investment positively affects the acceleration of economic growth in Algeria.

Research Objectives:

- Measure the impact of foreign direct investment on growth indicators to verify the validity of the hypotheses.
- Use the ARDL model to measure the quantitative relationship between FDI and economic growth.
- Provide a new addition by comparing national results with international studies.

Importance of the Study:

- Understanding the impact of foreign direct investment helps redirect economic policies to support an attractive environment for capital.
- It clarifies the role that FDI plays in technology transfer, productivity improvement, and human resource development.

Research Limits:

- Spatial scope: The Algerian Republic.
- Time frame: From 1990 to 2023.

Methodology Used:

- Applying the ARDL autoregressive model after testing the stationarity of the time series variables.
- Using cointegration and causality tests to analyze the nature of the relationship.
- Descriptive analytical approach to support the qualitative interpretation of the results.

Research Difficulties:

- Scarcity of specialized local references.
- Difficulties in collecting consistent statistical data over the specified time period.

Research Structure:

- Chapter One: Theoretical Framework: Basic concepts, theories, and review of previous studies.
- Chapter Two: Econometric Aspect: ARDL analysis to measure the impact of FDI on economic growth

Chapter One: The Theoretical Framework for Foreign Direct Investment as a Supporter of Economic Growth

Preamble:

Foreign direct investment (FDI) is considered one of the most important drivers of economic growth in developing countries, as it provides additional financing sources and transfers modern technology and expertise. In Algeria, there has been increasing interest in attracting foreign investments as a means to boost economic development and reduce reliance on oil revenues. However, the relationship between FDI and economic growth remains a subject of extensive debate among researchers, with some seeing a clear positive impact and others considering it limited by certain conditions. Therefore, understanding this Relationship requires a return to the theoretical frameworks that explain how the flow of foreign capital affects local economic growth.

Chapter One: The Nature of Foreign Direct Investment, Economic Growth, and Their Relationship

In this chapter, we define foreign direct investment and economic growth, considering the former as a source of capital and technologies, and the latter as a measure of production expansion.

Section One: Introduction of foreign Direct Investment

Subsection One: The Essence and Types of Investment

1- Definition of Investment:

1.1-Net Addition to Society's Capital Stock: Investment is defined as expenditure on capital assets over a specific period. This implies an addition to the assets of an enterprise (buildings, machinery, equipment), as well as fundamental improvements that extend the lifespan of these assets. This represents the net increase in the real capital of society [1].

1.2- Sacrificing Present Funds for Future Returns: Investment is also regarded as the sacrifice of a specific amount of financial resources today (initial outlay) with the objective of achieving future monetary results or returns distributed over defined time periods. This enhances

[1]Bakri, K. (1987). *Principles of Economics*. Beirut: Al-Dar Al-Jami'iya, p. 295

The investor's ability to obtain payments exceeding the original expenditure value[2].

2-Types of Investment:

1.2-According to the Legal Nature of the Activity:

Real Investment: Expenditure on long-term tangible assets such as buildings, factories, and machinery, for the purpose of expanding or modernizing production capacity. **Financial Investment:** The purchase of securities (stocks and bonds) with the aim of achieving financial returns with out direct involvement in the management of the enterprise [3].

2.2 - According to Nationality Domestic Investment: Financing economic activities in a specific country by resident individuals or institutions, where the ownership of capital and assets belongs entirely to residents. **Foreign Investment:** The undertaking by individuals or institutions from outside the host country to finance economic activities within it, either through establishing new entities or increasing the capital of existing companies [4].

Subsection Two: Generalities on Foreign Direct Investment:

1- Definition of Indirect Foreign Investment This type represents investment in the securities of existing companies in a foreign country,

2-Al-Hunaini, M. Al-Saleh. (1997). *Fundamentals of Investment in Securities*. Cairo: Al-Dar Al-Jami'iya, p. 2.

3-Meloudi, B. (1988). *Investissement et stratégie de développement*. Algiers: OPU, p. 4

4-Amer, H. (1991). *The Economic Encyclopedia*. Cairo: Al-Dar Al-Jami'iya, p. 40

whereby foreign investors – whether individuals or institutions – purchase shares (stocks or bonds) in these companies without demanding the right to participate in the management or control of the project[5].

2- Different Definitions of Foreign Direct Investment

2.1. Definition by the Organization for Economic Co-operation and Development (OECD)

Foreign Direct Investment (FDI) is defined as an investor's acquisition of a stake that enables effective influence over the management of a foreign enterprise, typically specified as not less than 10% of the issued capital or voting power[6].

2.2. Definition by the United Nations Conference on Trade and Development (UNCTAD)

Direct investment is defined as a long-term partnership relationship between a parent company and its affiliate in another country, reflecting lasting interests and granting the parent company administrative and supervisory authority beyond merely providing financing[7].

2.3. Definition by Raymond Bertrand

5-International Monetary Fund. (2000). *Balance of Payments Manua*

[6]OECD Benchmark Definition of Foreign Direct Investment,1996.

[7]UNCTAD,World Investment Report,2003.

Bertrand views FDI as the injection of capital into another country through the establishment of a new branch or an increase in the capital of an existing company, along with the transfer of real and technical resources, and granting the investor the right to control and supervise the project's management[8].

2.4. Definition by Abdel Aziz Heikal

Heikal defines it as the investment of resident companies in a country into entities in foreign countries, either by establishing new branches or by increasing the capital of existing companies, with the foreign investor retaining the right to full direction and control[9].

3- Types of Foreign Direct Investment: Different classifications of FDI types have been developed based on the motives and incentives that lead to their occurrence, and they can be classified according to the following determinants:

3.1- Resource-Seeking Foreign Investment: This type of investment aims to exploit the comparative advantage of countries, especially those rich in raw materials such as oil, gas, and agricultural products, as well as benefiting from low labor costs or the availability of skilled and trained labor.

3.2- Market-Seeking Foreign Investment: This type of investment usually aims to meet consumer demands in the markets of recipient

[8]Bertrand,R.(1997).Économie financière internationale.PUF.
[9]Heikal, A. A. (1985). *Encyclopedia of Economic and Statistical Terms*. Beirut: Dar Al-Nahda Al-Arabiya, p. 956.

countries, including local, neighboring, and regional markets, especially those that were previously exported to.

3.3- Efficiency-Seeking Foreign Investment: This type of investment occurs between developed countries and integrated regional markets such as the European market or North America.

3.4- Asset-Seeking Foreign Investment: This strategy involves companiesundertakingacquisitionsorpartnershipstoservetheir strategic objectives.

In a parallel context, there are numerous classifications of foreign direct investment (FDI) types, whether from the perspective of investing (source) countries or from the perspective of recipient (host) countries. From the perspective of the source country, FDI can be classified into three types: horizontal, vertical, and conglomerate. The first type aims at investment expansion in recipient countries for the purpose of producing the same goods or goods similar to those produced domestically. The second type aims at exploiting raw materials (backward vertical investment) or getting closer to consumers through ownership or distribution channels (forward vertical investment). The mixed foreign investment, on the other hand, includes both types mentioned[10].

From the perspective of the recipient country, foreign direct investment can be divided into three types based on their objective: import-

[10]Abou Qahf, A. S. (2005). *International Business Management*. Alexandria: Al-Dar Al-Jami'iya, p. 267

substituting investments, export-promoting investments, and government-initiated foreign direct investments.

Generally, there are three main forms of foreign direct investment: a- Private Investment: This primarily occurs in the primary products sector in developing countries, especially in the oil sector. This type of investment has generated huge profits due to the depletion of natural resources in developing countries with minimal oversight.

b- Bilateral Investment: This type of investment emerged as a result of nationalistic tendencies and independence movements that swept developing countries after gaining their independence. Bilateral investment means the participation of developing countries with foreign investors in economic projects established on their territories. It is a mixture of local and foreign capital. This type of investment reduces the financial burdens borne by the national economy to the extent that the local investor benefits from their participation in the project.

c- Foreign Direct Investment in the form of Multinational Corporations: These companies represent more than 80% of total global FDI. They have gained complete control over some high-technology industries, such as electronic computers and certain industrial machinery and equipment. Additionally, these companies operate in developing countries in the production of raw materials, agriculture, and the services sector, including banking, insurance,

tourism, fast-food, soft drinks, and the execution of some utility projects[11].

Section Two: The Importance of Foreign Direct Investment in Supporting Economic Growth and Its Measurement Tools

Subsection One: The Importance of Foreign Direct Investment in Supporting Economic Growth:

- The importance of Foreign Direct Investment (FDI) lies in its pivotal role in driving growth and development, serving as a primary means to achieve desired growth rates, transfer production technology to local sectors, modernize industrial facilities, enhance export competitiveness, and optimize the utilization of limited resources. The performance of a country's economic system has come to be measured by its ability to attract foreign capital and establish projects that create employment opportunities and stimulate export activity.
- In addition, FDI is an effective tool to compensate for deficiencies in domestic savings and accelerate GDP growth. Establishing productive projects across various industrial, agricultural, and service sectors enables the production of goods and services with a competitive advantage for export. Furthermore, the availability of foreign capital permits the

[11]Abd Mohamed, N. (2012). *The Impact of Foreign Investment on the Future of Arab Domestic Investment: An Analytical and Econometric Study for Selected Gulf Countries (1992–2010)* [PhD Dissertation, St. Clements University]. p. 42.

Expansion of production lines and product diversification. DI is also a fundamental driver of export operations, bringing with it modern technology that helps improve product quality and reduce costs, in addition to new management and marketing expertise.

- Moreover, its importance stems from a set of fundamental factors, including:
- Transfer of Modern Technologies: It is considered one of the most effective means of bringing in advanced technology and developing management and control systems

- **Contribution to Unemployment Reduction:** By creating direct and indirect job opportunities and enhancing the skill levels of the local workforce.

- **Improvement of the Balance of Payments:** Through the inflow of foreign currencies into the host country, which increases demand for the local currency to finance imports, and opens up opportunities for increased exports while reducing reliance on imports.

- **Exchange Rate Stability and Inflation Control:** As a result of capital inflows, which strengthens price stability and limits currency fluctuations.

- **Addition of Long-Term Financing Source and Technical Knowledge:** Increases foreign exchange reserves and introduces

the necessary knowledge for the success and sustainability of invested projects.

In the same context, the investment environment requires adopting a set of policies, the most prominent of which are:

- **Improving the Investment Climate:** The inflow of FDI depends on the prevailing economic, social, and political landscape in the host country. It is defined as an environment characterized by a slight budget deficit and a potential balance of payments deficit that can be financed by regular flows of foreign aid and internationalloans,along with low inflation rates, stable exchange rates, and a transparent and predictable institutional environment.
- **Developing and Supporting the Financial Sector:** The financial sector in most countries needs to strengthen its components and activities to attract more foreign investments through policies including:
    - **Banking Sector:** Raising the level of transparency and supervision, developing accounting systems, and encouraging the merger and privatization of some financial institutions to ensure their readiness to face the challenges of globalization.
- **Stock Markets:** Activating their role in attracting FDI by addressing obstacles such as the small relative size of markets, weak liquidity, high price volatility, inadequate regulatory and

legislative frameworks, and scarcity of diversification opportunities. In addition to the above, FDI relies on important components, including investment in productive projects and service sector projects, integrating foreigners into companies' capital shares, converting outstanding foreign debts to finance tools and equipment into fixed capital, and converting foreign technical assistance into convertible investments[12].

Subsection Two: Foreign Direct Investment Measurement Tools:

Accurate quantitative indicators are relied upon to measure and interpret the role of Foreign Direct Investment (FDI) in economic growth. The following are the most important adopted tools with a precise description of each tool and a reliable Arabic source:

1. **Net FDI Inflows:**
   - **Definition:** The net amount of FDI flowing in to a country annually, measured in U.S. dollars.
   - **Calculation:** FDI inflows minus FDI outflows[13].
2. **Cumulative FDI Stock:**
   - **Definition:** The total value of al inflows over previous years, representing the accumulated volume of foreign capital[14].
   - **Calculation:** The annual sumofnet inflows.
3. **FDI to GDP Ratio (FDI/GDP):**
   - **Definition:** The ratio of cumulative stock or annual flows to the GDP for the same year.
   - **Importance:** Illustrates the degree of economic openness to foreign investors[15].

[12]Belhassan, M. H., & Saleh, A. O. Y. (2020). *Analysis of the Foreign Direct Investment Environment in Libya: Obstacles and Challenges; Case Study of the Libyan Iron and Steel Company (2011–2018). Third Scientific Conference on Oil and Gas*, Ajdabiya University, Libya, p. 375.

[13]Algerian National Office of Statistics (ONS). (2022). *Foreign Direct Investment Bulletin* (pp. 12–15). Retrieved May 3, 2025, at 17:30 from http://www.ons.dz

[14]Algerian Ministry of Commerce. (2021). *Annual Foreign Investment Report 2021* (Table 3). Retrieved May 4, 2025, at 18:20 from http://www.commerce.gov.dz

[15]Arab Economic Publishing Center. (2020). *Arab Economic Indicators* (pp. 78–80).

4. **FDI per Capita:**
    - **Definition:** The cumulative stock or annual flows per individual (total divided by population).
    - **Usage:** Allows for comparing the relative impact of investment among different countries[16].
5. **Sectoral FDI Distribution:**
    - **Definition:** The distribution of FDI percentages across key sectors: industry, services, and agriculture.
    - **Benefit:** Reveals attractive sectors and allows for modeling the sectoral impact of FDI[17].
6. **Business Climate Indices:**
    - **Definition:** Indicators such as "Ease of Doing Business" and "Quality of Governance," used as control variables.
    - **Measurement:** The country's ranking in these indices among Arab countries[18].
7. **Stationarity and Cointegration Tests (ADF,PP,Johansen, Bound Test):**
    - **Definition:** Statistical tests used to confirm the stability of time series and the presence of a cointegrating relationship.
    - **Usage in Models:** Essential before estimating ARDL/ECM models[19].
8. **Error Correction Models (ECM):**
    - **Definition:** Models that integrate long-term relationships with short-term adjustments.
    - **Main Equation:** $\Delta GPt=\alpha(GDPt-1-\beta FDIt-1)+\Sigma\gamma\Delta FDI+\epsilon t$.

By utilizing these standard tools and tests, a researcher can construct accurate models to measure the impact of foreign direct investment on various economic variables and analyze their temporal dynamics[20].

Chapter Two: Previous Studies on the Topic

[16]Arab Organization for Agricultural Development. (2019). *Arab Development Report* (pp. 42–45).
[17]Algerian National Investment Authority. (2020). *Sectoral Report on Foreign Investment* (pp. 33–36). Retrieved May 4, 2025, at 19:00 from http://www.invest.dz
[18]Arab World Bank. (2021). *Ease of Doing Business in the Arab World* (pp. 19–22).
[19]Al-Ali, A. R. (2019). *Applied Econometrics*. Cairo: Dar Al-Fikr Al-Arabi, pp. 210–220.Al-Masri, S. (2020). *Theories of International Finance*. Beirut: Lebanon Library, pp. 145–150.

In this chapter, we will discuss studies similar to and different from our current study, and analyze their similarities and differences.

Section One: ARDL Studies in Measuring the Impact of Foreign Direct Investment on Economic Growth

SubsectionOne:Presentation of ARDL Studies in Measuring the Impact of Foreign Direct Investment on Economic Growth

1. Study: The Impact of Foreign Direct Investment on Economic Growth in Algeria (1990–2022)

This thesis, prepared by researcher Asmaa Belmihoub at Belhadj Bouchaib University – Ain Temouchent in 2024, is a prominent example of applying the Autoregressive Distributed Lag (ARDL) methodology within the Algerian context. The study began by reviewing the theoretical framework of foreign investment and its relationship to growth, before precisely formulating the problem that questioned the extent to which Foreign Direct Investment (FDI) flows contributed to enhancing Gross Domestic Product (GDP) in both the short and long term. The researcher relied on two hypotheses: the first assumed a positive long-term relationship between FDI and GDP, and the second predicted that government policies implemented during the 1990–2022 period contributed to reducing the response time of GDP to changes in FDI. The methodology included testing the stationarity of the series using ADF and PP tests to verify integration levels I(0) and I(1),followed by employing the Bounds Test to determine the

presence of a cointegrating relationship between the variables. Subsequently, the ARDL model was estimated to determine the relationship coefficients in the short and long term, and an Error Correction Model (ECM) was included to measure the speed of return to the equilibrium path aftershocks. The results showed that a 1% increase in FDI corresponded to an approximate 0.4% increase in GDP in the long term, while the Algerian economy took approximately one year to absorb two-thirds of the shock's impact, confirming the effectiveness of foreign stimulus and highlighting the need to improve the investment environment to accelerate shock absorption.

2. Study: The Impact of Foreign Direct Investment on Sustainable Development in Algeria (1995–2018)

This study, conducted by Iman Fartas, Soumia Nabta, and Hadjer Fadl at the University of Echahid Hamma Lakhdar – El Oued in 2020, presented a comprehensive analysis of the impact of FDI on the dimensions of sustainable development in Algeria, represented by the economic dimension (GDP), the environmental dimension (CO_2 emissions), and the social dimension (unemployment rate - UNE). The study started from the hypothesis of a long-term cointegrating relationship between FDI and each of the three dimensions, meaning that investment flows affect not only growth but also the reduction of emissions and the promotion of employment. The researchers used ADF and PP tests for

stationarity, and then employed the Bounds Test to detect the presence of cointegration. This was followed by the estimation of the ARDL and ECM models to present the short- and long-term impact coefficients and the speed of correction after shocks. The results revealed that a 1% increase in FDI was associated with an estimated 0.2% reduction in CO_2 emissions, a 0.3% increase in GDP, and a0.1% decrease in unemployment in the long term, with the social impact taking longer to appear compared to the economic and environmental impacts.

The researchers utilized ADF and PP tests for stability, followed by the Bound Test to detect the presence of cointegration. This was succeeded by the estimation of the ARDL and ECM models to present the short- and long-term impact coefficients and the speed of correction after shocks. The results revealed that a1% increase in FDI is accompanied by an estimated 0.2% reduction in CO_2 emissions, a 0.3% increase in GDP, and a 0.1% decrease in unemployment in the long term, with the social impact taking longer to appear compared to the economic and environmental impacts.

3. Study: The Impact of Foreign Direct Investment on GDP Per Capita and Unemployment Rate in Algeria (1991–2021)

This thesis, prepared by Ben Alamoudi Nesreen and Al-Aagoun Aida at Kasdi Merbah University – Ouargla in 2023, is renowned for applying the ARDL approach to two applied variables: Gross Domestic Product per capita (GDPP) and the Unemployment Rate (UEMP). The researchers started with a hypothesis that foreign inflows have a dual impact, boosting per capita income and reducing unemployment through knowledge transfer and

technology localization. After performing the ADF test for series stationarity, they applied the Bound Test to confirm the presence of a cointegrating relationship with FDI.ECM results showed that a 1% increase in FDI boosts GDPP by about 0.5% and reduces unemployment by 0.15% in the long term, with an adjustment speed reaching 40% annually. This indicates the Algerian market's ability to absorb mechanisms for utilizing foreign inflows to improve economic and social indicators.

4. Study: The Impact of Foreign Direct Investment on Economic Growth in Algeria and Singapore (1990–2018)

Bashir Haroun presented his doctoral thesis at Hadj Lakhdar University – Batna 1 in 2022, undertaking a structural comparison between Algeria and Singapore in absorbing FDI flows and their reflection on GDP during the period 1990–2018. The research problem was based on shock absorption and the differing speeds of response between the two countries: Algeria is characterized by traditional exchange policies and a rentier economy, while Singapore boasts a developed institutional and legislative environment. The researcher employed the ADF test for series stationarity, followed by the Bound Test within the ARDL framework for distributed lags, and subsequently ECM to measure short and long-term effects. The results indicated that Singapore absorbs 70% of the shock during the first year compared to 45% for Algeria, which confirms the importance of

The quality of the investment environment and the speed of implementing accompanying policies.

Subsection Two: Studies that Used Models Other Than ARDL

1. Study: The Impact of Foreign Direct Investment and Local Investment on Economic Growth in Algeria (1990–2011)

In a master's thesis at Kasdi Merbah University – Ouargla in 2013, Bilal Moumou investigated the interaction between foreign capital (FDI) and local capital (INV_local) and their combined effect on Gross Domestic Product (GDP). The study was based on the hypothesis that local investment amplifies the effect of FDI through technical and knowledge linkages, while foreign inflows represent an essential external resource. The researcher applied a multivariate VAR model after testing for series stationarity using the ADF test, then utilized Impulse Response functions and Variance Decomposition in EViews 7. The study found that a 1% shock in FDI led to a 0.3% short-term increase and a 0.5% long- term increase in GDP, while a 1% shock in INV_local contributed to a 0.2% short-term increase and a 0.4% long-term increase, noting the importance of policy coordination to support positive interaction.

2. Study: Cobb–Douglas Function for Measuring the Impact of Foreign Direct Investment on Economic Growth in Algeria (2000–2018)

Researchers Taher Kasri and Ahmed Dahoumane prepared a master's thesis at Mohamed Boudiaf University–MSila in 2019, applying the Cobb–Douglas production function to production factors: local capital (K), foreign capital (FDI), and imports (IMP), and their impact on Gross Production (GP). The problem originated from the differential roles of foreign and local capital in generating growth, especially in an import-dependent economy. The researchers used OLS after testing the validity of classical assumptions (residual stationarity, absence of multicollinearity), and they found an elasticity of 0.25for FDI, compared to 0.40 for local capital and 0.15 for imports, which indicates the importance of supporting local investment and diversifying imports.

3. Study: The Impact of Foreign Direct Investment on Economic Development in Algeria (1999–2019)

In a 2021 master's thesis at Mohamed El Bachir El Ibrahimi University – Bordj Bou Arréridj, researchers Mona Zraiya and Hasna Drardja studied the relationship between FDI, GDP, and CF using the Johansen approach for unit root testing and the Vector Error Correction Model (VECM). The problem addressed ways to ensure long-term integration between variables and the impact of foreign investment shocks on growth. The results showed that about 30% of shocks are corrected in the first year, which indicates the robustness of the cointegration relationship in the Algerian economy

4. **Study: The Impact of Foreign Direct Investment on GDP Per Capita (1990–2017)**

   A master's thesis at Kasdi Merbah University – Ouargla in 2019 discussed the impact of FDI on GDP per capita (GDPP) using a multivariate OLS model via EViews 10, with control variables such as government spending. The study indicated that a 1% increase in FDI boosts GDPP by approximately 0.35% annually, with gradual repercussions in reducing internal disparities.

Section Two: Similarities and Differences Between Previous Studies and the Current Study

Differences These can be summarized in the following table (1.1):

Study Name	Main Problem	Hypotheses	Variables	Quantitative Tools	Methodology	Time Period	Country/ Countries
FDI Growth Algeria (1990–2022)	Extent of FDI flows' contribution to enhancing GDP in the short and long term	Positivelong-term relationship between FDI and GDP; Governmentpolicy reducesGDP response time	FDI, GDP	ADF, PP, BoundTest ,ECM	ARDL+ ECM	1990–2022	Algeria
FDI Sustainable Algeria(1995–2018)	Impact of FDI on GDP, CO_2, UNE in the short and long term	Long-term cointegration relationship between FDI and each of the three dimensions	FDI, GDP, CO_2, UNE	ADF, PP, Bound Test, ECM	ARDL+ ECM	1995–2018	Algeria
FDI GDPP & UEMP (1991–2021)	Relationship of FDI with GDPP and UEMP in the long and short term	FDI boosts GDPP by 0.5% and reduces UEMP by 0.15%	FDI, GDPP, UEMP	ADF, Bound Test, ECM	ARDL+ ECM	1991–2021	Algeria
FDI Algeria vs SG(1990–2018)	Comparison of shock absorption between Algeria and Singapore from FDI	Response speed of 70%in SG vs.45% in Algeria	FDI, GDP, GNE, LEER, ER	ADF, Bound Test, ECM	ARDL+ ECM	1990–2018	Algeria, Singapore
FDI & INV VAR (1990–2011)	Interaction of FDI and INV_local on GDP	FDI +0.3% GDP short-term and +0.5% long-term; INV +0.2% and +0.4%	FDI, INV_local, GDP	ADF, VAR, Impulse Response, Variance Decomp	VAR	1990–2011	Algeria
Cobb–Douglas (2000–2018)	Distinguishing the role of K,FDI,IMP in GP	Elasticity of 0.40 for K, 0.25 for FDI, 0.15 For IMP	K, FDI,IMP, GP	OLS, OLS Validity tests	Cobb–Douglas+ OLS	2000–2018	Algeria

VECM FDI Algeria (1999–2019)	Long-term cointegration relationship between FDI, GDP, CF	Cointegrating relationship exists;30% annual correction	FDI, GDP, CF	Johansen, VECM	Johansen VECM	1999–2019	Algeria
OLS GDPP (1990–2017)	Impact of FDI on GDPP with control variables	1% increase in FDI boosts GDPP by 0.35%	FDI, GDPP, GovExp	OLS, OLS Validity tests	Multivariate OLS	1990–2017	Algeria
Thestudy current	The effect of FDI on GDP	When foreign investment increases by one unit (one m.d) the GDP icreases by 0.000147	FDI; GDP	ADF, PP, Bound Test, ECM	ARDL	1990-2023	Algeria

Source: Prepared by the student based on previous studies

As for the similarities:

All previous studies, which covered time periods extending between 1990 and 2023 and focused on Algeria (with the exception of one comparative study with Singapore), share common ground in addressing the central question of the impact of Foreign Direct Investment (FDI) flows on variables related to economic growth or sustainable development dimensions. They all adopted hypotheses assuming a positive and long-term relationship and utilized common quantitative tools such as ADF/PP tests for stationarity, Bound Test or Johansen for cointegration testing, and Error Correction Models (ECM) to measure the speed of return to equilibrium after shocks.

Conclusion of Chapter One:

Foreign Direct Investment (FDI) provides essential external financing sources for major projects and infrastructure. It contributes to creating new job opportunities and reducing unemployment rates by attracting capital and expanding productive activities. It also facilitates the transfer of advanced technology and builds national human resource capabilities through technical partnerships and training programs, which enhances the efficiency and productivity of local institutions, alleviates financial burdens on the state, and stimulates economic growth. These advantages have prompted the government to improve Legoland legislative frameworks and streamline investment procedures to protect investors, confirming that FDI is an effective tool for achieving sustainable development in Algeria.

Chapter Two: Measuring the Impact of Foreign Direct Investment on Economic Growth in Algeria During the Period (1990/2023) Using ARDL Models

Introduction:

Chapter Two of this study transitions to the empirical aspect, applying econometric tools to measure the impact of foreign direct investment on economic growth in Algeria. This chapter will first provide a brief overview of the evolution of foreign investment flows and GDP indicators, then review the statistical methodology of the ARDL model and its detailed stages, leading to estimation results and their discussion. This chapter relies on annual data spanning three decades, focusing on evaluating the dynamic relationship between the two main variables and exploring the Algerian economy's adjustment speed to investment shocks. Finally, practical recommendations based on the econometric analysis results will be presented to economic policymakers.

Chapter One: Evolution of Foreign Direct Investment and its Impact on Economic Growth in Algeria

This chapter reviews the developments in foreign direct investment flows and gross domestic product in Algeria between 1990 and 2023. It then introduces the ARDL methodology and its fundamental statistical tools for identifying cointegration relationships.

Section One: Evolution of Foreign Direct Investment in Algeria

First and foremost, at the beginning of this chapter, the basic parameters of the study must be defined: the population (i.e., the scope of the study), the main variables, and the time period covered by the data. These can be summarized as follows:

- Population (Scope of Study): The statistical population is the Algerian economy as a whole, with a focus on national indicators of capital quantities and foreign capital flows.
- Time Period: The study extends over annual data from 1990 to 2023, allowing for monitoring the effects of economic openness, institutional reforms, and global shocks on the relationship between foreign investment and growth.
- Main Variables:
    - Independent Variable: FDI (Foreign Direct Investment) – the volume of foreign direct investment flows in U.S. dollars (millions).

- Dependent Variable: GDP (Gross Domestic Product) – the gross domestic product in U.S. dollars (millions).

Presentation of Time Series for Study Variables:

Table(1.2): Foreign Direct Investment Flows and Gross Domestic Product

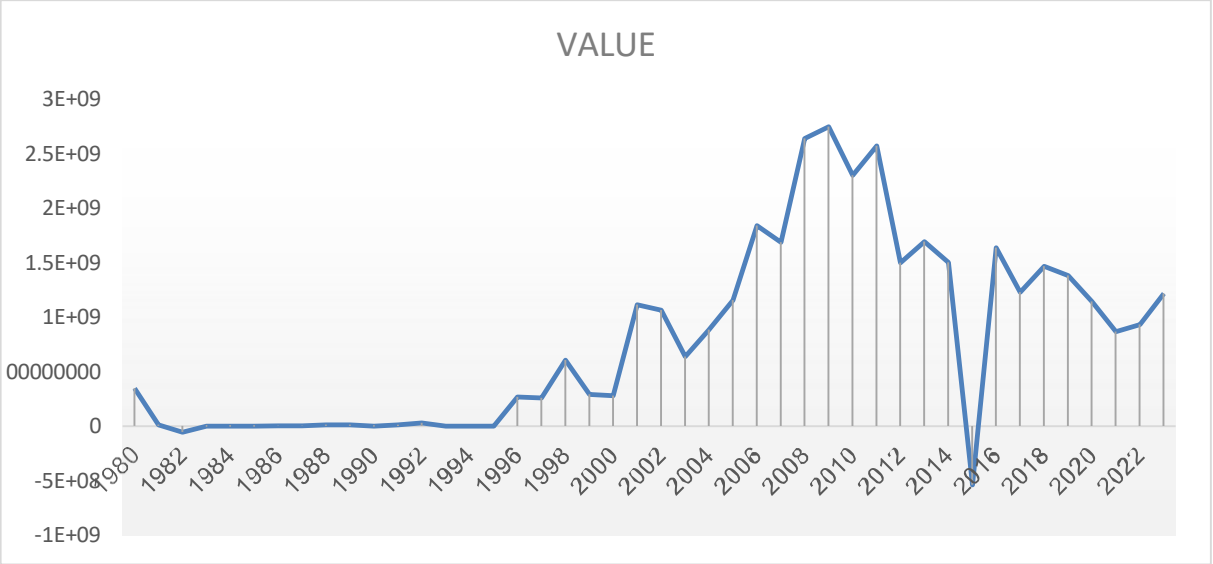
DATE	VALUE	GDP	DATE	VALUE	GDP
1980	348669038	42347,2	2002	1064960000	56759,6
1981	13207259,4	44364,5	2003	637853030	67864,1
1982	-53569193	45197,6	2004	884749030	85332,9
1983	417641,163	48815,3	2005	1156000000	103081
1984	802668,874	52945,9	2006	1841000000	117027
1985	397788,297	57995,8	2007	1686736540	134815
1986	5316528,38	63065,2	2008	2638607034	171001
1987	3711537,9	64642,1	2009	2746930734	137235
1988	13018265	58791,6	2010	2300369124	161197
1989	12091646,8	55470,7	2011	2571237025	200242
1990	334914,564	61840,5	2012	1500402453	210514
1991	11638686,5	46684,5	2013	1691886708	209722
1992	30000000	49136,4	2014	1502206171	213947
1993	1000	50951,2	2015	-537792921	166461
1994	1000	42430,3	2016	1638263954	159951
1995	1000	42078,5	2017	1230243451	170056
1996	270000000	46943,6	2018	1466116068	174900
1997	260000000	48203,5	2019	1381200050	171557
1998	606600000	48190,8	2020	1143918160	144983

1999	291600000	48641,9	2021	869194073	186173
2000	280100000	54792,5	2022	932987842	225625
2001	1113105540	54709,6	2023	1216010864	247618

Source: Prepared by the student based on data from the World Bank and ONS.

Subsection One: Evolution of Foreign Direct Investment in Algeria

Figure1:Curve of the Evolution of Foreign Direct Investment Flows in Algeria 1990-2023



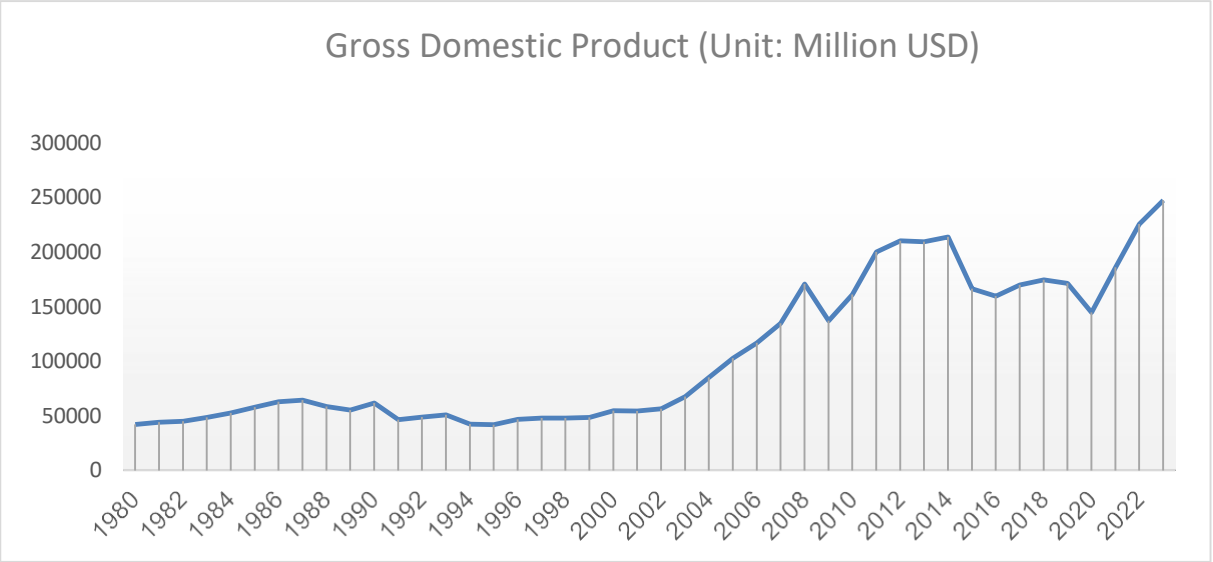
Source: Prepared by the student based on World Bank data.

From the curve, and according to my research, Algeria experienced a real transformation after the mid-1990s. The average annual FDI rose from less than 50million USD in the early 1990s to approximately 270 million USD in1996, then exceeded 1,000 million USD by 2001–2002. It peaked before the global financial crisis at 2,639 million USD

in 2008, driven by legal reforms and high oil prices. It remained high (2,746 million USD in 2009) despite the crisis.The oil price collapse in 2015 led to a decrease to 1,150 million USD, before gradually recovering to reach 1,216 million USD in 2023, with continuous improvement in the investment climate and limited sectoral diversification.

Subsection Two: Evolution of Economic Growth in Algeria

Figure 2: Curve of Gross Domestic Product Evolution 1990-2023



Source: Prepared by the student based on ONS data.

We also observe in the second graph the growth of Algerian GDP from 42,347 million USD in 1980 to approximately 63,065 million USD in the mid-1980s. It then declined due to crises in the early 1990s, falling to 42,430 million USD in 1994. With the turn of the millennium, growth accelerated to 85,333 million USD in 2004, and reached 171,001 million USD in 2008, coinciding with the oil boom and increased FDI. It decreased to 137,235 million USD in 2009, then recovered to 210,514 million USD in 2012, and stabilized around 213,947 million USD in 2014. After the 2015 shock, it dropped to

166,461 million USD, then gradually increased to 247,618 million USD in 2023, with ongoing efforts to diversify the economy and improve the business environment.

Section Two: Presentation of Methods and Tools Used in the Study

Definition of the Auto Regressive Distributed Lag (ARDL) Model

The ARDL model is an econometric framework that allows for studying the long-run and short-run relationship between a dependent variable and a number of independent variables in time-series data. It is characterized by its ability to handle variables with different orders of integration (I(0) or I(1)) without requiring second-order integration, making it suitable for cointegration testing in many econometric cases[21].

Stages of ARDL Model Application:

1. **Unit-Root Tests:**
   - Perform the Augmented Dickey-Fuller (ADF) test for each variable to ensure it is I(0) or I(1), and that I(2) is not present.
2. **Lag Selection:**
   - Determine the optimal number of lag periods for the dependent and independent variables using information criteria such as Akaike (AIC) or Schwarz (SBC).
3. **Bounds Test for Cointegration:**
   - Estimate the Unrestricted Error Correction Model (UECM) and calculate the F-statistic to test for the absence of a long-run equilibrium relationship, by comparing the F-value to the lower and upper bounds.
4. **Estimation of Long-Run Coefficients:**

- Extracting the regression coefficients that express the permanent effect of each independent variable on the dependent variable.

2. Error Correction Model (ECM):

[21]EViews Blog. (2025, May 10, at 08:00). *[Econometric Modeling and ARDL Applications]*.

- Including the long-term error term within the time difference equation to measure the speed of short-term adjustment towards equilibrium.

3. Diagnostic Tests:

- Ensuring that the model residuals are free from auto correlation (Breusch–Godfrey), heteroscedasticity (White), that they follow a normal distribution (Jarque–Bera), and that coefficients are stable (CUSUM).

Software Tool Used

The ARDL model will be applied using EViews 12, by:

- Loading FDI and GDP data.
- Opening the Equation Object and selecting "ARDL" fromthe Method menu.
- Specifyingthedependentandindependentvariables.
- Choosingthenumberoflagsvia AIC/SBC.
- Executing the Bound Test, then estimating the long-term equations and ECM.
- Running diagnostic tests from the VIEW >Coefficient Diagnostics tab[22].

Through this, we will have clearly distinguished between the long-term and short-term relationships, and provided a precise analysis of the Algerian economy's adaptation to foreign investment flows.

22EViewsBlog(2025, May 10, at 08:30)

Chapter Two: Modeling the Impact of Foreign Direct Investment on Economic Growth in the Short and Long Runs Using ARDL Models in Algeria

To answer the main research question and measure the impact of foreign direct investment on economic growth, represented by gross domestic product, in both the short and long runs, we use auto regressive distributed lag (ARDL) models, which were explained in the previous chapter, to measure the short-run relationship and test for a long-run equilibrium relationship. However, before doing so,we will first conduct a statistical study of the study variables, specifically the volume of foreign investment and gross domestic product during the study period.

Section One: Statistical Study of Study Variables

Descriptive statistics and applied statistics tools can be used to describe both study variables.

Subsection One: Descriptive Statistical Indicators

Table (2.2) presents the most important descriptive statistical indicators for both the volume of foreign investment and gross domestic product during the study period.

	FDI	GDP
Mean	**8.35E+08**	**105552.3**
Median	**7.20 E+08**	**63853.65**
Maximum	**2.75 E+09**	**247618.0**
Minimum	**-5.38E+08**	**42078.50**
Std. Dev	**8.23E+08**	**65519.90**
Skewness	**0.643215**	**0.629788**
Kurtosis	**2.611931**	**1.865224**

Jarque-Bera	**3.310084**	**5.269456**
Probability	**0.191084**	**0.071738**
Sum	**3.67E+10**	**4644301**
Sums. Dev	**2.91E+19**	**1.85E+11**
Observations	**44**	**44**

Source: Prepared by the student using EViews software.

From the table, the following can be observed:

- The average foreign direct investment (FDI) during the study period is 8.35×1080 with a median value of 7.20×1080. This means that for half of the period or half of the years, Algeria achieved an FDI volume greater than 7.20×1080. The FDI values ranged between −5.38×1080 and 2.75×109, with a standard deviation of 8.23. The probability value of the Jarque-Bera test indicates that the distribution of these values is normal, as the Probability is 0.191084, which is greater than 0.05.
- The Gross Domestic Product (GDP) during the study period is 105552.3, with a median value of 63853.65. This means that for half of the period or half of the years, Algeria achieved a GDP greater than 63853.65. The GDP values ranged between 247618.0 and 42078.50, with a standard deviation of 65519.90. The probability value of the Jarque-Bera test indicates that the distribution of these values is normal, as the Probability is 0.071738, which is greater than 0.05.

Subsection Two: Nature of Linear Correlation Between Foreign Investment and GDP in Algeria

Before estimating the impact of foreign investment on GDP in Algeria, we can here study the nature and strength of the linear correlation between the two variables using Pearson's coefficient, which measures

the nature of the inverse and direct relationship between the variables, as well as the strength of the relationship and the linear correlation ratio.

Table (3.2) Matrix of Linear Correlation

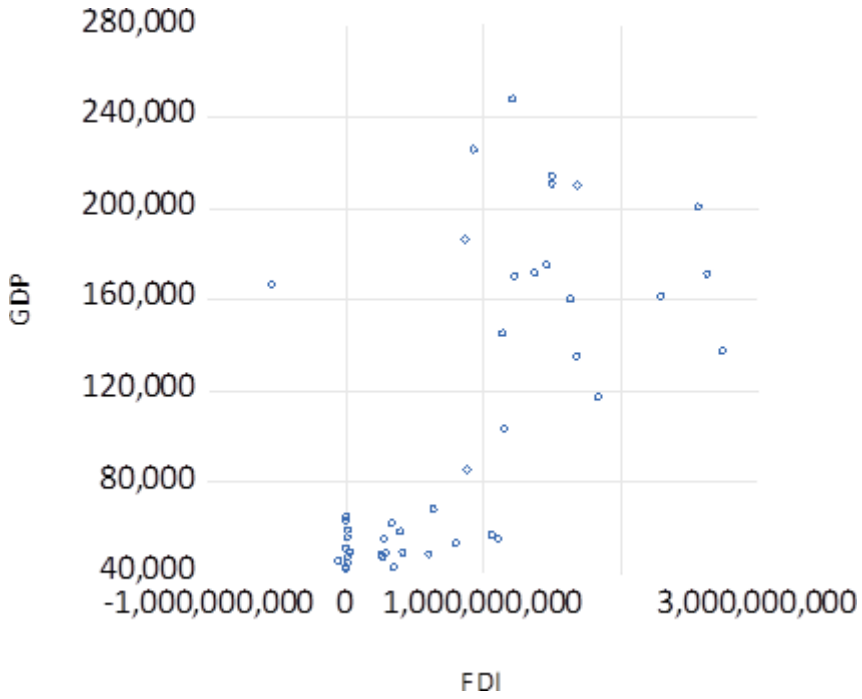
Covariance Analysis: Ordinary
Date: 05/23/25Time: 18:16
Sample: 1980 2023
Included observations:44

Correlation Probability	FDI	GDP
FDI	1.000000 ---	
GDP	0.670369 0.0000	1.000000 -----

Source: Prepared by the student using Eviews software.

It appears from the probability value of the linear correlation coefficient that it equals 0.0000, which indicates the statistical significance of the correlation coefficient between foreign direct investment and GDP in Algeria. A correlation ratio of 67.03% is recorded, which is a positive relationship. This demonstrates the importance of the relationship between economic growth in Algeria and the volume of foreign direct investments. This linear correlation can be shown through the following linear representation:

Figure3: Scatter Plot of the Relationship Between GDP and Foreign Direct Investment



Source: Prepared by the student using EViews software.

The figure indicates that the points generally form an increasing straight line or a cluster resembling an increasing straight line with a high slope, which confirms the existence of a linear correlation between the two study variables.

Section Two: Proposing an ARDL Model for the Impact of Foreign Investment on GDP in Algeria

In the section, we attempt to apply the methodology of Autoregressive Distributed Lag (ARDL) models to the two variables, GDP and Foreign Direct Investment, after testing the stationarity condition for the time series under study.

Subsection One: Testing the Stationarity Condition for the Time Series Under Study

As previously stated, applying the ARDL model requires that the time series for the dependent variable (GDP) be integrated of order 1. In contrast, the time series for the independent variable (Foreign Direct Investment) must not exceed an integration order of one (I(0) or I(1)), and there must be a sufficient volume of data to estimate various forms of the ARDL model.

Table (4.2) Summary of ADF and PP Stationarity Tests

UNIT ROOT TEST TABLE(PP)

	At Level	GDP	FDI
With Constant	t-Statistic	0.2979	-2.3090
	Prob.	***0.9755*** n0	***0.1738*** n0
With Constant& Trend	t-Statistic	-1.6981	-3.2650
	Prob.	***0.7350*** n0	***0.0859*** *
Without Constant& Trend	t-Statistic	1.7090	-1.2361
	Prob.	***0.9771*** n0	***0.1954*** n0
	At First Difference	d(GDP)	d(FDI)
With Constant	t-Statistic	-5.4843	-9.8072
	Prob.	***0.0000*** ***	***0.0000*** ***
With Constant& Trend	t-Statistic	-5.6069	-9.7052
	Prob.	***0.0002*** ***	***0.0000*** ***
Without Constant& Trend	t-Statistic	-5.1890	-9.8971
	Prob.	***0.0000*** ***	***0.0000*** ***

UNIT ROOT TEST TABLE (ADF)

	At Level	GDP	FDI
With Constant	t-Statistic	0.2979	-1.7250
	Prob.	***0.9755*** n0	***0.4117*** n0
With Constant& Trend	t-Statistic	-1.5664	-3.1950
	Prob.	***0.7897*** n0	***0.0990*** *
Without Constant& Trend	t-Statistic	1.7090	-0.8613
	Prob.	***0.9771*** n0	***0.3369*** n0
	At First Difference	d(GDP)	d(FDI)
With Constant	t-Statistic	-5.4843	-9.6644
	Prob.	***0.0000*** ***	***0.0000*** ***
With Constant& Trend	t-Statistic	-5.6069	-9.5584
	Prob.	***0.0002*** ***	***0.0000*** ***
Without Constant& Trend	t-Statistic	-5.1816	-9.7578
	Prob.	***0.0000*** ***	***0.0000*** ***

*MacKinnon (1996)one-sided p-values.

This Result is The Out-Put of Program Has Developed By:

Dr. Imadeddin AlMosabbeh

College of Business and Economics

Qassim University-KSA

Source: Prepared by the student using EViews software.

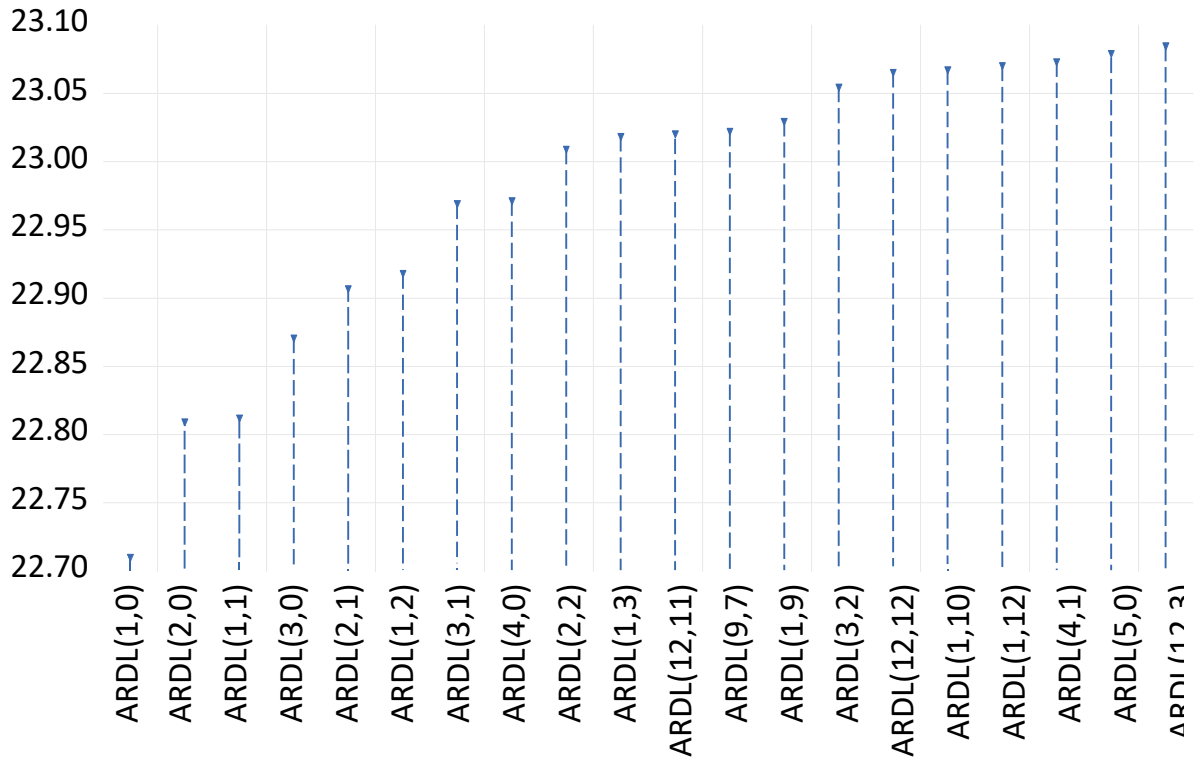
It appears from the table that for both series (GDP and FDI series), the Phillips-Perron test showed that all probability values for testing the null hypothesis of a unit root at the original level are greater than 0.05 across the three defined unit root test models. Therefore, we accept the hypothesis of a unit root at the original level for both series .However,

after first differencing, these series demonstrated stationarity through probability values less than the 0.05 significance level in the three defined models, which holds true for both series (GDP and foreign investment). These results were consistent when using the Augmented Dickey-Fuller (ADF) test, thus both the Phillips-Perron and Augmented Dickey-Fuller tests confirm that the integration order of all-time series (dependent and independent) is one, which allows for the use of the ARDL model.

Subsection Two: Selecting the Optimal Specification for the Autoregressive Distributed Lag Model

In this section, we aim to compare all possible specifications for the Autoregressive Distributed Lag (ARDL) model to define the relationship of GDP as a function of foreign investment. This comparison is based on varying values of P and Q for the distributed lags of the dependent and independent variables in the ARDL model, as shown in Appendix 1.

Figure 4:Top Twenty Models According to Schwarz Criterion



Source: Prepared by the student using Appendix 1 and EViews software.

The figure indicates that the best model to explain the impact of foreign investment on GDP is of the form ARDL (1,0), meaning with a time lag of 1 for the dependent variable and 0 for the independent variable.

The general form of this model can be written as follows:

$$GDP_t = a_0 + \sum_{i=1}^{p} \psi_i GDP_{t-i} + \sum_{j=0}^{q} B_j FDI_{t-j} + \varepsilon_t$$

Where P=1and Q=0, the optimal equation is as follows:

$$GDP_t = a_0 + \psi_1 GDP_{t-1} + B\ FDI_t + \varepsilon_t$$

Subsection Three: Estimating the Optimal ARDL Model Specification

The previously mentioned optimal specification for interpreting the impact of foreign investment on GDP in Algeria shows that Algeria's GDP in the current year is affected by both its value from the previous year and the volume of foreign investments in the same year. The following are the estimation results for the studied relationship:

Table (5.2) Estimation Results of the ARDL Model for the Studied Relationship

Dependent Variable: GDP
Method: ARDL
Date: 05/23/25 Time: 18:34
Sample (adjusted):19812023
Included observations: 43 after adjustments
Maximum dependent lags:12(Automatic selection)
Model selection method: Schwarz criterion (SIC)
Dynamic regressors (12 lags, automatic): FDI
Fixed regressors: C
Number of models evalulated:156
Selected Model: ARDL(1, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.926451	0.049262	18.80653	0.0000
FDI	1.08E-05	3.71E-06	2.919465	0.0057
C	3126.634	4707.946	0.664119	0.5104

R-squared	0.943596	Mean dependent var	107022.2
Adjusted R-squared	0.940776	S.D.dependent var	65557.15
S.E.of regression	15954.01	Akaike info criterion	22.26002
Sum squared resid	1.02E+10	Schwarz criterion	22.38290
Log likelihood	-475.5905	Hannan-Quinncriter.	22.30533
F-statistic	334.5847	Durbin-Watson stat	1.730240
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Source: Prepared by the student using EViews software.

From the table, the ARDL equation for the relationship studied in our research can be written as follows:

GDP=0.926450609616*GDP(-1) + 1.08377037793e-05*FDI + 3126.63384271

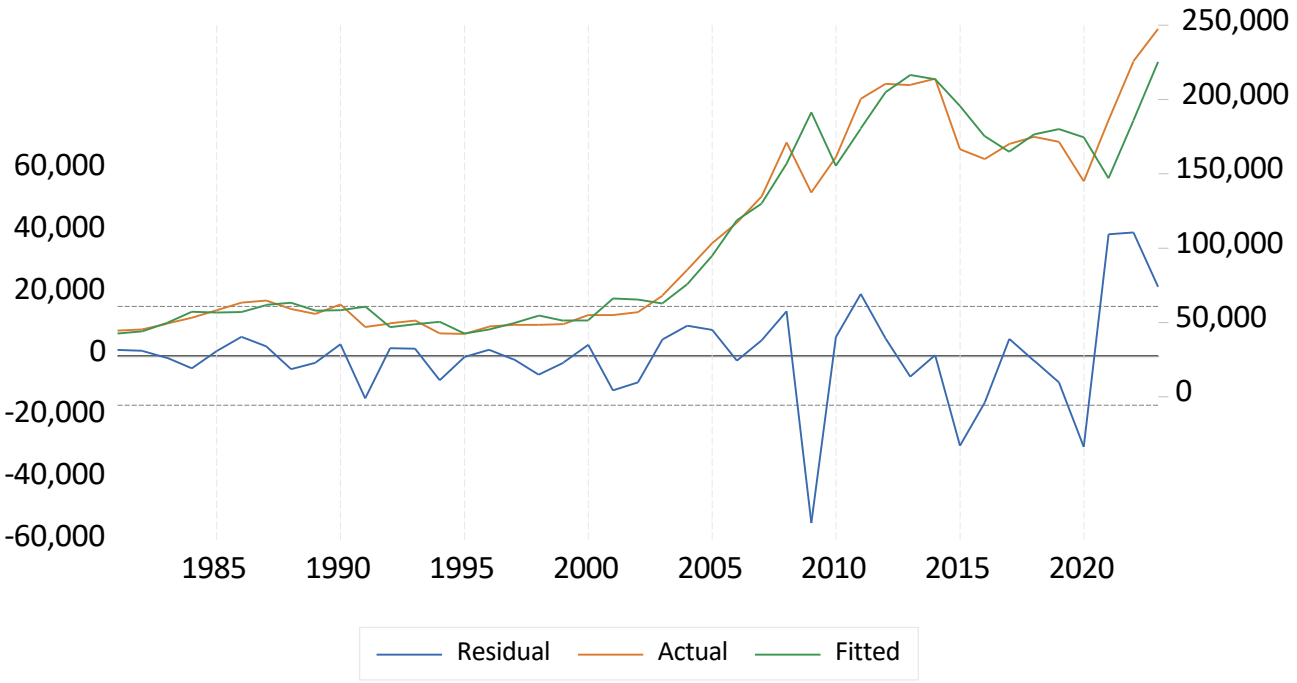
This equation reveals the following:

- The value of GDP in the current year is directly affected by its value in the previous year. Specifically, if GDP increases by one unit, its value increases by 0.926450609616 million USD after one year.
- Similarly, the current year's GDP is directly affected by the volume of foreign direct investments in the same year. An increase in investment volume by one unit (million USD) leads to a GDP increase of 1.08×10−5, indicating a positive relationship and the significance of investment volume in determining Algeria's economic growth. The constant C=3126 represents the estimated GDP value in the absence of foreign investment.

This model demonstrates good statistical power through the following points:

1. **Statistical Significance of Regression Coefficients:** Both the coefficients for GDP_{t-1} and FDI are statistically significant, except for the constant, as their Prob values are 0.0000 and 0.0057, respectively. Thus, there is statistical significance for the GDP_{t-1} and FDI coefficients.
2. **Explanatory Power:** The coefficient of determination is 0.94, meaning this model explains 94.3% of the total changes in economic growth in Algeria.
3. **Overall Statistical Significance:** The probability value of the Fisher test is 0.000000, which is less than 0.05. Therefore, we accept the hypothesis of statistical significance for the equation and the value of R. These points, along with other assumptions fulfilled by the residuals (which will be examined later), all demonstrate the statistical importance and power of this model in interpreting the studied relationship, as shown in the following representation:

Figure5: Comparison Between Actual GDP Values and Values Estimated by the ARDL Model



Source: Prepared by the student using EViews software.

The curve indicates that the actual GDP values in Algeria almost perfectly match the curve of the values estimated by the Autoregressive Distributed Lag (ARDL) model. This highlights the importance of this specification in interpreting the impact of foreign investment on Algeria's GDP.

Section Three: Estimating the Long-Run Equilibrium Relationship and the Error Correction Model

In this section, we will focus on testing for a long-run equilibrium relationship governed by cointegration between foreign investment and GDP. For this purpose, we will use the Bounds Test for cointegration.

Subsection One: Bounds Test for Cointegration

The Bounds Test for cointegration requires that the residuals of the previously estimated ARDL model satisfy certain assumptions.

1- Diagnostic Tests for ARDL Model Residuals:

1-1- Testing the Homoscedasticity Assumption of Errors:

Table (6.2) ARCH Test for the Homoscedasticity Assumption of Errors

Heteroskedasticity Test: ARCH

F-statistic	2.695018	Prob.F(1,40)	0.1085
Obs*R-squared	2.651147	Prob.Chi-Square(1)	0.1035

Test Equation:
Dependent Variable:RESID^2
Method: Least Squares
Date: 05/23/25 Time: 18:39
Sample (adjusted):19822023
Included observations:42after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.84E+08	92395744	1.995375	0.0528
RESID^2(-1)	0.251370	0.153120	1.641651	0.1085

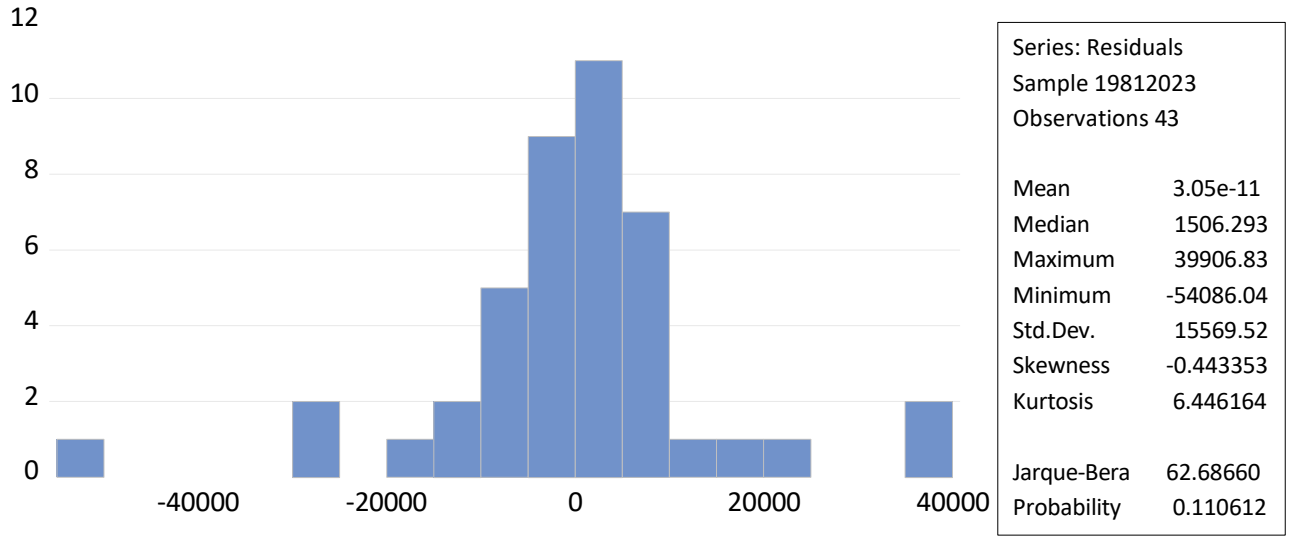
R-squared	0.063123	Mean dependent var	2.42E+08
Adjusted R-squared	0.039701	S.D. dependent var	5.65E+08
S.E.of regression	5.53E+08	Akaike info criterion	43.14732
Sum squared resid	1.22E+19	Schwarz criterion	43.23007
Log likelihood	-904.0937	Hannan-Quinncriter.	43.17765
F-statistic	2.695018	Durbin-Watson stat	2.039205
Prob(F-statistic)	0.108503		

Source: Prepared by the student using EViews software.

The table shows that the probability values for Fisher and Lagrange multiplier tests are 0.1085 and 0.1035, respectively. These values are greater than the 0.05 significance level, thus we accept the hypothesis of homoscedasticity for the estimated errors of the ARDL model.

1-2- Normality Distribution Test:

Figure 6: Statistical Measures of Residuals



Source: Prepared by the student using EViews software.

It appears from the probability values of the Jarque-Bera test that it equals0.1106, whichisgreaterthan0.05. Therefore, reaccepted hypothesis of the normal distribution of residuals.

1-3- Test for Autocorrelation of Errors:

Table (7.2) Breusch-Godfrey Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.475152	Prob.F(2,38)	0.2415
Obs*R-squared	3.097976	Prob.Chi-Square(2)	0.2125

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date:05/23/25 Time:18:40
Sample: 1981 2023
Included observations: 43
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	-0.004020	0.050137	-0.080183	0.9365
FDI	1.64E-07	3.72E-06	0.044091	0.9651
C	-58.32927	4736.131	-0.012316	0.9902
RESID(-1)	0.124873	0.164834	0.757570	0.4534
RESID(-2)	-0.273404	0.176638	-1.547823	0.1300
R-squared	0.072046	Mean dependent var		3.05E-11

Adjusted R-squared	-0.025633	S.D.dependen tvar	15569.52
S.E.of regression	15767.80	Akaike info criterion	22.27827
Sum squared resid	9.45E+09	Schwarz criterion	22.48306
Log likelihood	-473.9828	Hannan-Quinncriter.	22.35379
F-statistic	0.737576	Durbin-Watson stat	1.959947
Prob(F-statistic)	0.572196		

Source: Prepared by the student using EViews software.

From the probability values of Fisher and Lagrange multiplier tests, we have 0.2415 and 0.2125 respectively, which are both greater than the 0.05 significance level. Therefore, we accept the null hypothesis (H0) that the residuals are not serially correlated after lag 2.

Based on the three preceding points, it appears that the three conditions regarding the residuals are met for applying the Bounds Test. This is further illustrated by the partial autocorrelation function in the following figure:

Figure7: Autocorrelation Function and Partial Autocorrelation Function

Correlogram of Residuals

Date: 05/23/25 Time: 18:39
Sample (adjusted): 1981 2023
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.110	0.110	0.5608	0.454
		2	-0.213	-0.228	2.7045	0.259
		3	-0.079	-0.027	3.0097	0.390
		4	0.023	-0.012	3.0361	0.552
		5	-0.063	-0.094	3.2352	0.664
		6	-0.037	-0.019	3.3078	0.769
		7	-0.017	-0.046	3.3229	0.854
		8	-0.116	-0.142	4.0676	0.851
		9	-0.120	-0.115	4.8871	0.844
		10	0.078	0.041	5.2462	0.874
		11	0.257	0.188	9.2500	0.599
		12	-0.212	-0.294	12.058	0.441
		13	-0.173	-0.041	13.978	0.375
		14	-0.015	-0.103	13.993	0.450
		15	0.060	-0.017	14.245	0.507
		16	-0.032	-0.072	14.320	0.575
		17	0.042	0.007	14.451	0.635
		18	0.216	0.212	18.056	0.452
		19	0.013	-0.027	18.070	0.518
		20	-0.101	-0.052	18.926	0.527

*Probabilities may not be valid for this equation specification.

Source: Prepared by the student using EViews software.

The two functions indicate that they form white noise and meet the necessary conditions for using the F-bounds test.

2:F-boundstest:

Table (8.2) Results of the Bounds Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.759391	10%	3.02	3.51
k	1	5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58
			Finite Sample: n=45	
Actual Sample Size	43			
		10%	3.19	3.73
		5%	3.877	**4.46**
		1%	5.607	6.193
			Finite Sample: n=40	
		10%	3.21	3.73
		5%	3.937	4.523
		1%	5.593	6.333

Source: Prepared by the student using EViews software.

We have the F-statistic value of 4.75, which is greater than the upper bound of I(1) using n=45 at a 5% significance level, where this bound is 4.46. Therefore, we reject the null hypothesis (H0) and accept the alternative hypothesis (H1) of a cointegrating relationship between GDP and FDI in the long run.

Subsection Two: Estimation of the Error Correction Model and Speed of Disequilibrium Correction

The previous test proved the existence of a long-run equilibrium relationship for GDP and economic growth in Algeria in terms of foreign direct investment. We will now study this relationship in the following sections:

2- Estimating the Long-Run Relationship:

Table (9.2) Long-Run Equilibrium Relationship of GDP in terms of Foreign Investment

Levels Equation Case2:Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
FDI	0.000147	7.94E-05	1.855212	0.0709
C	42510.67	49672.69	0.855816	0.0972
EC=GDP-(0.0001*FDI+42510.6697)				

Source: Prepared by the student using EViews software.

The long-run equilibrium relationship between the study variables can be written as follows:

GDP=0.000147*FDI+42510.6697

This equation shows that in the long run, foreign direct investment (FDI) has a direct impact with a coefficient of 0.000147. Therefore, the relationship between GDP and FDI will stabilize in the long run as follows: an increase of one unit (million USD) in foreign investment leads to a 0.00147 increase in GDP, and the autonomous long-run GDP value is 42510.67. Both of these coefficients are statistically significant at the 10% level because their probability value is less than 0.10.

3- Estimation of the Error Correction Model (ECM):

The importance of the Error Correction Model lies in estimating the mechanism by which the relationship between foreign investment and GDP transitions from the short run to the long run, and how the error is corrected if the equilibrium relationship is disturbed in the short run.

Table (10.2) Error Correction Model

ARDL Error Correction Regression
Dependent Variable(GDP)
Selected Model: ARDL(1, 0)
Case2:Restricted Constant and No Trend
Date: 05/23/25 Time: 19:02
Sample:19802023
Included observations: 43

ECM Regression
Case2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Cintiq(-1)*	-0.073549	0.020319	-3.619680	0.0008

R-squared	0.177434	Mean dependent var	4773.740
Adjusted R-squared	0.177434	S.D.dependent var	17166.81
S.E.of regression	15569.52	Akaike info criterion	22.16700
Sum squared resid	1.02E+10	Schwarz criterion	22.20796
Log likelihood	-475.5905	Hannan-Quinn criter.	22.18210
Durbin-Watson stat	1.730240		

*p-value in compatible with-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.759391	10%	3.02	3.51
k	1	5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58

Source: Prepared by the student using EViews software.

The table shows that the error correction coefficients 0.073549. The statistical conditions for this coefficient are met: it is negative and statistically significant, with a probability value of 0.0008. This formula indicates that if there is a disequilibrium in the current year, or if the equilibrium relationship between GDP and foreign investment is disturbed, then 7.35% of this error will be corrected after one year. Therefore, this model demonstrates the mechanism by which the error is corrected from the short run to the long run. This means that if the equilibrium relationship increases, decreases, or becomes imbalanced, 7.35% of it will be corrected after one year.

Economic Interpretation:

Finally, after conducting the standard diagnostic tests for the model, we can conclude that the model is relatively acceptable statistically and econometrically, and thus can be relied upon for analysis and

study. Its results indicate that the current year's GDP is positively influenced by its value in the previous year. Specifically, a one-unit increase in GDP (e.g., million USD) in the previous year leads to a 0.926450609616 million USD increase in GDP after one year.

Similarly, the current year's GDP is positively affected by the volume of foreign direct investments in the same year. A one-unit increase in investment volume (million USD) leads to a $1.08\times10-5$ increase in GDP. This demonstrates a positive relationship and highlights the importance of investment volume in determining economic growth in Algeria, which is consistent with economic theory.

Chapter Summary:

In Chapter Two, the study collected annual data on Foreign Direct Investment (FDI) flows and Gross Domestic Product (GDP) in Algeria (1990–2023). It then examined the stationarity of both series using ADF and PP tests before verifying the existence of a long-term cointegration relationship through the Bounds test. The results indicated a stable equilibrium relationship between FDI and GDP. Flows gradually increased until 2008, then declined around 2015 before recovering, while GDP grew at an accelerated pace. The researcher used the ARDL model to extract short-term and long-term dynamics. It was found that any increase in FDI positively impacts GDP, but the economy corrects its deviations from the equilibrium path slowly (approximately 7.35% annually), which reflects the slow transmission of foreign investment effects in the absence of sufficient structural diversification.

Conclusion:

The study's findings revealed that Algeria's economy, throughout the 1990–2023 period, witnessed significant developments in both Foreign Direct Investment (FDI) flows and Gross Domestic Product (GDP). FDI gradually increased from modest levels in the early 1990s, peaking by 2008, then significantly declined following the 2015 oil price collapse before gradually recovering until 2023. Meanwhile, GDP grew at an accelerated pace, reflecting the national economy's recovery phases after each crisis. According to the Bounds test, a long-term equilibrium relationship was observed between FDI and GDP, with the F-statistic value exceeding the upper bound at a 5% significance level. This confirms the existence of cointegration, reflecting the Algerian economy's reliance on attracting foreign capital, especially in the energy sector, as a strategic lever for growth.

Within the optimal ARDL (1,0) model framework, it was found that the previous year's GDP value explains approximately 92.6% of its current year's value. This indicates a high degree of self-reliance for annual output and a strong accumulation of capital and past outputs in the formation of current economic activity. The short-term impact of FDI was statistically significant, despite its small numerical size, which illustrates that every additional inflow of foreign capital reflects on the quarterly or annual standard output through increased investments in infrastructure and partial technological transformation. However, this impact only gains its full momentum in the long run. The estimation of the long-term equation confirms that the general level of FDI plays a positive role in increasing GDP overtime, as the cumulative relationship linking the accumulation of foreign capital and the national production structure is evident. Through the Error Correction Model (ECM), it appeared that any deviation from the long-term equilibrium path is corrected annually by only approximately 7.35%. This reflects the slow response of the Algerian economy to external shocks or changes in the volume of foreign

investment. This slowness is partly attributed to bureaucratic challenges, insufficient diversification of the production base, and the reliance on foreign capital injections in limited areas, particularly oil and gas, without easily transitioning to other transformative sectors. The study also showed that shocks affecting the local economy, whether resulting from energy price fluctuations or global crises such as the coronavirus pandemic, take longer for full recovery due to the slow capacity of non-oil sectors to absorb foreign investments and employ them efficiently. This highlights the need for better structuring that encourages investments in higher value-added areas. Consequently, both study hypotheses—the first asserting a long-term equilibrium relationship between FDI and GDP, and the second positing a positive impact of FDI on Algerian economic growth—were statistically and practically validated. The degree of impact varied between the short and long term, reflecting the nature of the Algerian economy as a country largely dependent on the energy sector as the main gateway for foreign capital, and it needs to enhance diversification in other sectors to achieve a faster transfer of investment gains to GDP.

Recommendations: Some recommendations can be provided as follows:

1. Diversifying Targeted Sectors for Foreign Investment: Efforts to attract FDI should be directed towards manufacturing, sustainable agriculture, and the digital economy, moving away from the traditional focus on the energy sector. The aim is to create a broader production base that contributes to reducing oil dependency.
2. Improving the Institutional and Administrative Climate: This requires accelerating administrative procedures for granting investment licenses, simplifying regulatory laws, and reducing bureaucracy and corruption. Additionally, it involves

strengthening the role of commercial courts and dispute resolution bodies to protect the rights of foreign investors and ensure the continuity of their capital.

3. Enhancing Technology Transfer and Capacity Building: Effective partnerships between foreign and local companies should be mandated to enable the transfer of knowledge and modern technologies. Joint training programs should be supported to raise the efficiency of the local workforce and ensure practical technology transfer.
4. Establishing a Specialized Economic Monitoring Body: It is advisable to establish a national center for monitoring and evaluating the impact of FDI on key economic variables (suchas GDP, unemployment, and productivity) and providing periodic reports based on reliable data. This would assist policy makers in continuously adjusting investment policies.
5. Focusing on Digital Infrastructure and the Green Economy: With global technological shifts, FDI investments should be encouraged in digital projects (e-government, telecommunications infrastructure) and renewable energies. This would drive sustainable growth and attract quality capital with the aim of building a more resilient and competitive economy.

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Appendix1: Best-estimated ARDL formula as for the studied relationship

Model Selection Criteria Table

Dependent Variable: GDP
Date:05/23/25 Time: 18:35
Sample: 1980 2023
Included observations:43

Model	LogL	AIC	BIC*	HQ	Adj.R-sq	Specification
156	-358.166772	22.57292322.71033622.618472			0.924181	ARDL(1, 0)
143	-358.020375	22.62627322.80949022.687005			0.922188	ARDL(2, 0)
155	-358.066198	22.62913722.81235422.689869			0.921965	ARDL(1, 1)
130	-357.271332	22.64195822.87098022.717872			0.922997	ARDL(3, 0)
142	-357.846190	22.67788722.90690822.753801			0.920180	ARDL(2, 1)
154	-358.025352	22.68908422.91810622.764999			0.919281	ARDL(1, 2)
129	-357.110989	22.69443722.96926222.785534			0.920832	ARDL(3, 1)
117	-357.146418	22.69665122.97147722.787748			0.920657	ARDL(4, 0)
141	-357.748910	22.73430723.00913222.825404			0.917612	ARDL(2, 2)
153	-357.901480	22.74384323.01866822.834939			0.916823	ARDL(1, 3)
2	-325.003459	21.87521623.02032222.254786			0.960471	ARDL(12, 11)
45	-337.164227	22.19776423.02224122.471055			0.957736	ARDL(9, 7)
147	-347.680218	22.48001423.02966522.662207			0.942917	ARDL(1, 9)
128	-356.745408	22.73408823.05471822.840368			0.919526	ARDL(3, 2)
1	-323.993284	21.87458023.06549122.269333			0.956705	ARDL(12, 12)
146	-346.550273	22.47189223.06734722.669269			0.944010	ARDL(1, 10)
144	-343.131581	22.38322423.07028822.610966			0.949461	ARDL(1,12)
116	-357.041599	22.75260023.07323022.858880			0.918022	ARDL(4, 1)
104	-357.138931	22.75868323.07931322.864963			0.917522	ARDL(5, 0)
10	-339.896871	22.30605423.08472722.564162			0.953207	ARDL(12, 3)
32	-336.474825	22.21717723.08745722.505650			0.956404	ARDL(10, 7)
9	-338.430165	22.27688523.10136222.550176			0.954256	ARDL(12, 4)
131	-341.950026	22.37187723.10474522.614802			0.950125	ARDL(2, 12)
140	-357.576179	22.78601123.10664122.892291			0.915237	ARDL(2,3)
36	-343.811727	22.42573323.11279722.653475			0.947267	ARDL(10, 3)
44	-336.932290	22.24576823.11604922.534242			0.955140	ARDL(9, 8)
6	-333.626201	22.16413823.12602722.482977			0.956881	ARDL(12, 7)
152	-357.894813	22.80592623.12655622.912205			0.913532	ARDL(1, 4)
7	-335.376595	22.21103723.12712222.514693			0.955904	ARDL(12, 6)
134	-347.609637	22.53810223.13355822.735479			0.940177	ARDL(2, 9)
19	-335.538977	22.22118623.13727122.524842			0.955455	ARDL(11, 7)
11	-342.641175	22.41507323.14794122.657998			0.947924	ARDL(12, 2)
115	-356.622763	22.78892323.15535722.910385			0.916813	ARDL(4, 2)
127	-356.667126	22.79169523.15812922.913158			0.916582	ARDL(3, 3)
149	-353.245250	22.70282823.16087122.854656			0.926520	ARDL(1, 7)
47	-343.057180	22.44107423.17394222.683999			0.946552	ARDL(9, 5)
145	-346.524453	22.53277823.17403822.745338			0.940994	ARDL(1, 11)
133	-346.541832	22.53386523.17512422.746424			0.940930	ARDL(2,10)
109	-346.579526	22.53622023.17748022.748780			0.940791	ARDL(4, 8)
103	-357.041494	22.81509323.18152722.936556			0.914607	ARDL(5, 1)
91	-357.137983	22.82112423.18755822.942586			0.914090	ARDL(6, 0)

31	-336.363071	22.27269223.18877722.576348	0.953100	ARDL(10, 8)
4	-331.237391	22.13983723.19333522.489042	0.954608	ARDL(12, 9)
121	-346.961338	22.56008423.20134322.772643	0.939361	ARDL(3, 9)
108	-345.337289	22.52108123.20814422.748823	0.941991	ARDL(4,9)
8	-338.406759	22.33792223.20820322.626396	0.950810	ARDL(12, 5)
35	-343.609180	22.47557423.20844222.718499	0.944676	ARDL(10, 4)
34	-341.882097	22.43013123.20880322.688239	0.947026	ARDL(10, 5)
33	-340.196260	22.38726623.21174322.660557	0.948918	ARDL(10, 6)
118	-341.949980	22.43437423.21304622.692482	0.946800	ARDL(3, 12)
139	-357.576132	22.84850823.21494222.969971	0.911705	ARDL(2, 4)
151	-357.584772	22.84904823.21548222.970511	0.911657	ARDL(1, 5)
150	-355.889581	22.80559923.21783722.942244	0.917084	ARDL(1, 6)
23	-343.764997	22.48531223.21818022.728237	0.944134	ARDL(11, 3)
5	-333.389188	22.21182423.21951822.545846	0.953266	ARDL(12, 8)
43	-336.856418	22.30352623.21961122.607182	0.951632	ARDL(9, 9)
123	-350.727836	22.67049023.22014122.852683	0.930939	ARDL(3, 7)
46	-342.079174	22.44244823.22112122.700556	0.946369	ARDL(9, 6)
122	-349.160273	22.63501723.23047222.832394	0.934089	ARDL(3, 8)
105	-340.677784	22.41736223.24183822.690652	0.947357	ARDL(4, 12)
18	-335.508930	22.28180823.24369722.600647	0.951496	ARDL(11, 8)
114	-356.349361	22.83433523.24657322.970980	0.914666	ARDL(4, 3)
96	-345.971282	22.56070523.24776922.788447	0.939646	ARDL(5, 8)
78	-356.487851	22.84299123.25522922.979636	0.913925	ARDL(7, 0)
120	-346.103643	22.56897823.25604122.796720	0.939145	ARDL(3, 10)
110	-349.602474	22.66265523.25811022.860031	0.932242	ARDL(4, 7)
136	-353.076638	22.75479023.25863722.921801	0.923828	ARDL(2, 7)
102	-356.604184	22.85026123.26250022.986907	0.913296	ARDL(5, 2)
3	-330.638082	22.16488023.26418222.529268	0.950811	ARDL(12, 10)
126	-356.664823	22.85405123.26629022.990697	0.912967	ARDL(3, 4)
148	-353.231854	22.76449123.26833822.931502	0.923085	ARDL(1, 8)
39	-351.658282	22.72864323.27829422.910836	0.926804	ARDL(10, 0)
132	-346.504672	22.59404223.28110622.821784	0.937601	ARDL(2, 11)
30	-336.182829	22.32392723.28581622.642766	0.949410	ARDL(10, 9)
138	-356.999097	22.87494423.28718223.011589	0.911130	ARDL(2, 5)
90	-357.037015	22.87731323.28955223.013959	0.910919	ARDL(6, 1)
79	-337.999219	22.37495123.29103622.678607	0.948051	ARDL(6, 12)
83	-344.940245	22.55876523.29163322.801690	0.939876	ARDL(6, 8)
124	-353.758542	22.79740923.30125622.964420	0.920511	ARDL(3, 6)
137	-355.536207	22.84601323.30405522.997841	0.915208	ARDL(2, 6)
107	-345.205348	22.57533423.30820222.818259	0.938872	ARDL(4, 10)
21	-341.771707	22.48573223.31020822.759022	0.943632	ARDL(11, 5)
22	-343.551815	22.53448823.31316122.792596	0.941199	ARDL(11, 4)
95	-345.300293	22.58126823.31413622.824193	0.938508	ARDL(5, 9)
42	-336.638837	22.35242723.31431622.671266	0.947947	ARDL(9, 10)
20	-340.106119	22.44413223.31441322.732606	0.945297	ARDL(11, 6)
17	-334.969603	22.31060023.31829422.644622	0.948414	ARDL(11, 9)
65	-355.775518	22.86097023.31901223.012798	0.913931	ARDL(8, 0)
52	-354.141186	22.82132423.32517122.988335	0.918587	ARDL(9, 0)
70	-343.746999	22.54668723.32536022.804795	0.940477	ARDL(7, 8)
50	-350.703383	22.73146123.32691722.928838	0.927416	ARDL(9, 2)
92	-340.555220	22.47220123.34248222.760675	0.943740	ARDL(5, 12)
125	-356.195494	22.88721823.34526123.039047	0.911641	ARDL(3, 5)
77	-356.303067	22.89394223.35198423.045770	0.911045	ARDL(7, 1)
101	-356.312152	22.89451023.35255223.046338	0.910995	ARDL(5, 3)
113	-356.348208	22.89676323.35480523.048591	0.910794	ARDL(4, 4)

29	-335.624269	22.35151723.35921022.685539	0.946260	ARDL(10, 10)
41	-335.659990	22.35374923.36144322.687771	0.946140	ARDL(9, 11)
119	-346.062077	22.62888023.36174822.871805	0.935509	ARDL(3, 11)
49	-349.551980	22.72199923.36325822.934558	0.928703	ARDL(9, 3)
40	-333.972869	22.31080423.36430222.660009	0.946144	ARDL(9, 12)
97	-349.577961	22.72362323.36488222.936182	0.928587	ARDL(5, 7)
135	-353.065976	22.81662323.36627422.998817	0.920073	ARDL(2, 8)
89	-356.552287	22.90951823.36756023.061346	0.909649	ARDL(6, 2)
26	-351.528274	22.78301723.37847222.980394	0.923575	ARDL(11, 0)
37	-349.800645	22.73754023.37880022.950100	0.927586	ARDL(10, 2)
38	-351.551655	22.78447823.37993422.981855	0.923464	ARDL(10, 1)
82	-344.648498	22.60303123.38170322.861139	0.937027	ARDL(6, 9)
13	-349.933268	22.74582923.38708922.958389	0.926984	ARDL(12, 0)
111	-353.451616	22.84072623.39037723.022920	0.918123	ARDL(4, 6)
66	-337.922377	22.43264923.39453822.751488	0.943599	ARDL(7, 12)
106	-345.167097	22.63544423.41411622.893551	0.934952	ARDL(4, 11)
94	-345.177810	22.63611323.41478522.894221	0.934909	ARDL(5, 10)
69	-343.448313	22.59052023.41499622.863810	0.937405	ARDL(7, 9)
57	-343.503879	22.59399223.41846922.867283	0.937187	ARDL(8, 8)
16	-334.872496	22.36703123.42052922.716236	0.943029	ARDL(11, 10)
64	-355.751314	22.92195723.42580423.088968	0.909968	ARDL(8, 1)
112	-355.843402	22.92771323.43155923.094724	0.909449	ARDL(4, 5)
51	-354.137126	22.88357023.43322123.065764	0.914539	ARDL(9, 1)
84	-348.967926	22.74799523.43505922.975738	0.927215	ARDL(6, 7)
28	-335.234840	22.38967723.44317522.738882	0.941725	ARDL(10, 11)
76	-356.081092	22.94256823.44641523.109579	0.908093	ARDL(7, 2)
27	-333.638493	22.35240623.45170822.716793	0.940665	ARDL(10, 12)
88	-356.179366	22.94871023.45255723.115721	0.907527	ARDL(6, 3)
100	-356.307925	22.95674523.46059223.123756	0.906781	ARDL(5, 4)
15	-333.847299	22.36545623.46475822.729844	0.939886	ARDL(11, 11)
68	-342.540777	22.59629923.46657922.884772	0.936307	ARDL(7, 10)
48	-349.551807	22.78448823.47155223.012230	0.924510	ARDL(9, 4)
24	-349.557219	22.78482623.47189023.012568	0.924484	ARDL(11, 2)
25	-351.449709	22.84060723.48186623.053166	0.919725	ARDL(11, 1)
12	-349.789450	22.79934123.48640423.027083	0.923380	ARDL(12, 1)
81	-344.643446	22.66521523.48969222.938506	0.932550	ARDL(6, 10)
98	-353.426809	22.90167623.49713123.099052	0.913947	ARDL(5, 6)
53	-337.918613	22.49491323.50260722.828935	0.937974	ARDL(8, 12)
63	-355.431539	22.96447123.51412223.146665	0.907337	ARDL(8, 2)
75	-355.485429	22.96783923.51749023.150033	0.907025	ARDL(7, 3)
56	-343.375407	22.64846323.51874422.936936	0.932896	ARDL(8, 9)
93	-345.165455	22.69784123.52231722.971132	0.930313	ARDL(5, 11)
71	-348.715203	22.79470023.52756823.037625	0.923878	ARDL(7, 7)
67	-341.786398	22.61165023.52773522.915306	0.934177	ARDL(7, 11)
99	-355.792440	22.98702723.53667823.169221	0.905223	ARDL(5, 5)
14	-333.354062	22.39712923.54223522.776699	0.933384	ARDL(11, 12)
87	-356.164618	23.01028923.55994023.192482	0.902993	ARDL(6, 4)
85	-352.807613	22.92547623.56673523.138035	0.912614	ARDL(6, 6)
55	-342.416531	22.65103323.56711822.954689	0.931533	ARDL(8, 10)
80	-344.636442	22.72727823.59755823.015751	0.927393	ARDL(6, 11)
86	-355.068919	23.00430723.59976323.201684	0.904646	ARDL(6, 5)
60	-351.617740	22.91360923.60067223.141351	0.914105	ARDL(8, 5)
62	-355.095189	23.00594923.60140523.203326	0.904489	ARDL(8, 3)
74	-355.242933	23.01518323.61063923.212560	0.903603	ARDL(7, 4)
58	-348.375062	22.83594123.61461423.094049	0.920511	ARDL(8, 7)

73	-353.591366	22.97446023.61572023.187020	0.908227	ARDL(7, 5)
54	-341.764492	22.67278123.63467022.991620	0.928291	ARDL(8, 11)
59	-350.839156	22.92744723.66031523.170372	0.913072	ARDL(8, 6)
72	-352.730838	22.98317723.67024123.210920	0.907917	ARDL(7, 6)
61	-354.805286	23.05033023.69159023.262890	0.900993	ARDL(8, 4)