


# Study of the Standard Relationship between the Money Supply and the Exchange Rate in Algeria during the Period (1990/2020)

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**Abstract:** *This study aims to examine the relationship between the money supply and the exchange rate in Algeria between 1990 and 2020. We analyze the economic conditions that characterized this period, including the shift from a directed economy to a market economy, as well as Algeria's participation in the International Monetary Fund and World Bank programs. To understand the impact of the exchange rate on the money supply in the short and long term, we utilize the Engel-Granger co-integration method. We employ (Auto Regressive Distributed Lag/ARDL) model to measure the relationship between the two variables. Our findings indicate that there is a statistically significant positive effect of the money supply on the exchange rate at a 1% significance level ( $P=0.001 < 0.01$ ). The limits tests for co-integration through F-statistic also indicate co-integration between the exchange rate and money supply, aligning with economic theory. During the post-reform period (2000-2014), we observe that net foreign assets played a marginal role in covering the monetary mass compared to state and economy loans, which continuously increased, particularly since 2009. It is important to note that our study relies on comprehensive and reliable data from official sources that collect economic data in Algeria. Additionally, economic assumptions may impact our results and may not be applicable in all cases. Nonetheless, our study contributes to the existing literature on the relationship between the money supply and the exchange rate and sheds light on the specific case of Algeria.*

**Keywords:** money supply, exchange rate, directed economy, market economy, Autoregressive distributed lag (ARDL) model, the course of monetary policy, the development of the monetary mass, Algeria.

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## Introduction

Money is a critical aspect of any economy, as it serves as a medium of exchange and a unit of measurement for goods and services. However, its significance extends far beyond these basic functions (Friedman, M. 1956). Monetary policy is a vital tool for achieving both internal and external stability by impacting macroeconomic variables and having widespread implications for the economy. Many countries, including Algeria, place great emphasis on managing the money supply and organizing its issuance in line with macroeconomic objectives. The monetary authority closely monitors the money supply, along with other

factors that can influence it. Algeria, like other nations, is vulnerable to various economic crises, particularly those related to the hydrocarbon sector. A drop in oil prices can lead to a decline in the value of the dinar against the dollar, resulting in a noticeable impact on macroeconomic indicators. In certain stages, the money supply in Algeria has experienced continuous growth, with the Monetary and Credit Law 90/10 serving as a significant milestone in the evolution of monetary policy in 1990 (Talahite, F. 2000). The Algerian government has implemented several economic programs over the years to address the challenges facing the country's economy. The first program, the Economic Recovery Program, ran from 2001 to 2004. The second program, the Supplementary Program to Support Growth, was implemented from 2005 to 2009. The third program, called the Economic Growth Promotion Program, was launched in 2010 and continued until 2015. The primary objective of the program was to revitalize the national economy, reduce unemployment, inflation, and other economic problems, and improve the financial situation in the country. To achieve these objectives, the government focused on ensuring economic stability by controlling the money supply and analyzing its impact on macroeconomic variables. The implementation of these mechanisms helped improve the financial situation in Algeria and promote sustainable economic growth (Talahite, F. 2010).

In recent years, Algeria has experienced acceleration in inflation, despite a lack of corresponding increase in monetary mass expansion. However, in 2017, there was a relative rise in monetary expansion, particularly in the non-fuel monetary mass, even though the overall price index increased at a higher rate, especially in non-food consumer goods. This increase was not in line with expected changes based on certain factors, such as exchange rate and collection. It should be noted that Algeria has undergone significant monetary reforms, resulting in the development of both narrow and broad monetary mass, making it a major factor in influencing various macroeconomic variables from 1990 to 2020. This leads us to ask ***about the impact of the money supply on the exchange rate in Algeria for the period between (1990-2020)?*** The main hypothesis that we seek to test can be identified as follows: *There is an effect of increasing the money supply on the exchange rate in Algeria during the period (1990-2020).*

The significance of this study lies in its ability to diagnose the current state of macro variables in the Algerian economy, providing an overview of the prevailing economic situation. The aim is to equip decision-makers with the knowledge necessary to create effective policies for controlling the money supply, by identifying its impact on the exchange rate. The study accomplishes this by monitoring the development of key variables, such as the money supply and exchange rate in Algeria and assessing the impact of various monetary reforms on the country's aggregate indicators. Standard methods are employed to analyze the relationship between the variables under study and determine their impact on one another. By doing so, this study seeks to provide insights that can inform effective economic decision-making in Algeria.

## Literature Review

The tools employed in implementing monetary policy are designed to exert a direct influence on the money supply and volume of credit, which in turn impact the foreign exchange rate. Conversely, the exchange rate affects monetary policy through the interest rate channel, where a reduction in the money supply results in an increase in the real interest rate in the domestic economy. In terms of foreign capital inflows, an increase in demand for the local currency can drive up its value, negatively impacting exports, and the current account situation. As such, it is essential to carefully balance the impact of monetary policy tools and the exchange rate to avoid undesirable consequences in the economy. The adoption of expansionary monetary policy leads to an increase in the money supply, which in turn results in a surge in demand for foreign exchange units. Like any other commodity, scarcity of foreign exchange units coupled with increased demand drives up their price, causing an increase in the exchange rate. Conversely, when the money supply contracts, the exchange rate decreases as the number of units required to purchase one unit of foreign exchange decreases. It is evident that the money supply and exchange rate share a direct and strong relationship. This relationship is reciprocal, as a decrease in the money supply leads to a decrease in the exchange rate, and vice versa. If the foreign exchange supply changes in proportion to the domestic money supply, the exchange rate is expected to remain relatively stable, or at least change marginally, based on the principles of supply and demand. In Algeria, the course of monetary policy has undergone various phases depending on the prevailing economic conditions. The first phase, which spanned from 1990 to 2000, was characterized by a focus on specific objectives. The second phase, covering the period between 2000 and 2020, saw a shift in focus towards more comprehensive and integrated policies.

## **The course of monetary policy in Algeria during the period (1990-2000)**

### **➤ Money and loan law 90/10**

During the period between 1990 and 2000, Algeria underwent several reforms, including the adoption of the Monetary and Loan Law 90/10 and its entry into negotiations with the International Monetary Fund. The Monetary and Loan Law 90/10 is considered a key legislative framework in Algeria, outlining the role of money and monetary policy in advancing development. The law aimed to achieve two primary objectives. The first was to address the financial environment of the national economy by utilizing traditional monetary policy tools and activating market forces. The second is represented in the management of foreign loans through the good management of foreign liabilities and ensuring the good functioning of the exchange market by controlling the budget market. The second objective of the Monetary and Loan Law 90/10 was to manage foreign loans effectively by ensuring the proper management of foreign liabilities and promoting the efficient functioning of the exchange market by controlling the budget market. The law also introduced the principle of separation between the real and monetary circles. This means that monetary decisions were no longer based on quantitative decisions made by the Planning Commission. Instead, the monetary authority set specific monetary goals based on the prevailing monetary situation, which it evaluated internally. This approach represented a significant shift in the way monetary policy was managed in Algeria. The Monetary and Loan Law 90/10 also introduced a clear separation between the monetary department and the state budget department. Prior to this law, the public treasury played a crucial role in securing necessary financing, often by resorting to loan currency, or resources generated through the issuance of new cash. However, this created an overlap between the powers and goals of the treasury and the monetary authority, which were not always aligned (Talahite, F. 2000).

The law helped to address this issue by clearly separating the responsibilities of each department, minimizing overlap, and promoting more effective management of monetary policy. The Monetary and Loan Law 90/10 also established the principle of separation between the budget department and the loan department, where the public treasury used to be responsible for financing public institution investments, and the banking system was limited to recording the funds. The law regulated the financing process by removing the treasury's role in granting loans to the economy and limiting its role to financing strategic state-planned investments, while the banking system became responsible for granting loans as part of its traditional tasks. The law also established a single and independent monetary authority, which was previously dispersed across multiple levels. Before the law was issued, the Ministry of Finance acted as the monetary authority, while the treasury and central bank also acted as if they were the monetary authority. Therefore, the Monetary and Loan Council was established as a single and independent monetary authority, with the independence to develop and implement monetary policy.

### **➤ The management of the Bank of Algeria in accordance with the law of money and credit 90/10**

According to the Monetary and Loan Law 90/10, the appointment of the governor and his deputies is made by a presidential decree for a period of 6 and 5 years, respectively, and is renewable for one term. Their duties may be terminated by presidential decrees, in addition to health disability or a fatal error. The decree of appointment determines a rank for each deputy, and this rank changes every year automatically according to the order. The governor has the authority to specify the tasks and powers of each deputy and may seek the assistance of advisors who are not members of the bank's management. The functions of the governor and his deputies are inconsistent with any legislative representation, governmental tasks, or any public position. During their term of office, the governor and his deputies cannot practice any activity or profession or assume any position except for representing the state in international public institutions of a financial or economic monetary nature. The governor of the Central Bank enjoys significant powers, which allow him to manage the affairs of the Central Bank and take all executive measures within the framework of the law. He signs all agreements and minutes related to the financial years, year-end results, and profit and loss accounts in the name of the Central Bank. The governor regulates the interests of the Central Bank and defines its functions. The Basic Law Council collaborates with the governor to establish the conditions for the employees of the Central Bank specified in the law. Under Article 30 of the Monetary and Loan Law 90/10, the Governor of the Central Bank can seek the assistance of technical advisors from outside the Central Bank's departments and appoint special agents from among them to meet the work needs for a specific period. The governor determines the powers and responsibilities of his deputies (Talahite, F. 2010).

➤ **The Monetary and Loan Council in accordance with the Monetary and Loan Law 90/10**

The Monetary and Loan Council, established by the Monetary and Loan Law 90/10, is composed of members of the Board of Directors and two members chosen by the Prime Minister for their expertise in finance. The Council convenes at least once a month, with the Governor serving as the Chairman and the three Deputy Governors as members. Additionally, three employees are appointed by a presidential decree based on their scientific capabilities in economic and financial affairs, and three successors are designated to replace them if necessary. The Council is responsible for managing and overseeing the Bank of Algeria, and has the authority to issue laws related to money issuance, discounting, and mortgage of public and private bonds. It also has the power to authorize credit from foreign banks and financial institutions operating in Algeria, as well as to deliberate on the organization of the central bank and agreements at the Governor's request. As a monetary authority, the Council has the right to issue currency and establish conditions for the implementation of central bank operations with banks and financial institutions. It is also responsible for conducting monetary policy, setting rules for managing banks and financial institutions with customers, regulating the exchange market, and enforcing exchange controls. The Council may authorize foreign banks and financial institutions to open branches and representative offices in Algeria, subject to its rules and regulations (Talahite, F. 2010).

➤ **Monetary policy under agreements with international monetary institutions**

In response to the severe crisis at the end of the 1980s, Algeria entered into international monetary agreements with the International Monetary Fund (IMF). The specific agreements are outlined below (Zaid, H. 2013):

**First Credit Standby Agreement (1989):** This agreement, signed on May 31, 1989, covered the period from May 31, 1989, to May 30, 1990. Its objective was to address the deficit in Algeria's balance of payments caused by the decline in hydrocarbon export revenues. Under the agreement, Algeria received 115.7 million special drawing rights units as financial assistance. Additionally, Algeria was granted a compensatory facility of 315.2 million special drawing rights units. In return, the IMF imposed certain obligations on the Algerian government, including the implementation of a strict monetary policy, which involved the devaluation of the dinar, and a reassessment of the state's involvement in economic activities.

**The Second Credit Standby Agreement (1991):** This agreement, signed on March 6, 1991, encompassed the period from March 1991 to March 1992. Its primary objective was to achieve economic stability in Algeria. Under the agreement, the IMF committed to providing a loan of \$400 million in exchange for the continuation of economic reforms. These reforms included the liberalization of prices and the freezing of wages, the implementation of positive interest rates, measures to limit inflation and devalue the dinar, the liberalization of foreign trade, and the facilitation of foreign capital inflows. Furthermore, the agreement called for the elimination of the budget deficit and the reform of the tax and customs systems. The loan amount was divided into four installments, with each installment set at \$75 million. However, Algeria only withdrew three installments, while the fourth installment was not disbursed and remained frozen. This occurred because the government of Sayed Ahmed Ghazali did not adhere to the terms and conditions outlined in the agreement.

**The Third Credit Standby Agreement (1994):** This marked Algeria's third request for assistance from the International Monetary Fund (IMF). The agreement was implemented as part of a structural adjustment program, with the following objectives: Restrict the expansion of the money supply ( $M_2$ ); Achieve stable and satisfactory growth in the gross domestic product (GDP); establish the necessary conditions for the liberalization of foreign trade; Increase the rediscount rate by 15%. These measures were aimed at addressing Algeria's economic challenges and promoting stability and growth. The agreement sought to implement policies that would control the money supply, stimulate economic activity, facilitate international trade, and strengthen the financial sector through the adjustment of the rediscount rate.

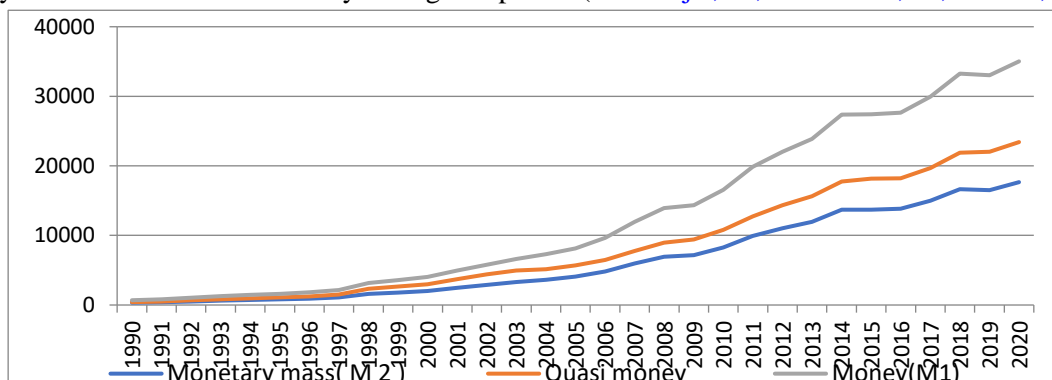
**Expanded Financing Agreement (January 3, 1995, to January 4, 1998):** In light of previous agreements, Algeria embarked on a path of liberalizing foreign trade and facilitating the growth of the private sector as part of its transition towards a market economy. However, the escalation of external debt servicing and the nation's heavy reliance on oil exports led to significant economic crises. Consequently, the Algerian government found it necessary to once again seek assistance from the International Monetary Fund (IMF) to implement a medium-term structural adjustment program aimed at deepening stabilization measures. Under this agreement, Algeria secured a loan of \$1.8 billion, which was complemented by the rescheduling of long and medium-term debts with the Paris Club. This financial support was essential to meet Algeria's estimated

financing needs of \$4.7 billion for the period between 1995 and 1996, \$3.7 billion for the period between 1996 and 1997, and \$3 billion for the period between 1997 and 1998. These funds were crucial in addressing the economic challenges faced by the country during that period, including debt servicing obligations and financing requirements.

**Continuation of Reforms (1998-2000):** During this period, the Algerian authorities made concentrated efforts to achieve macroeconomic stability through the implementation of financial and monetary tools. Their main objectives were to revive economic growth, reduce indebtedness, and create a favorable environment for foreign direct investment. To achieve a comprehensive restructuring of the production apparatus, the government implemented various measures to address budget imbalances. Notably, a national fund was established to effectively manage revenues, utilizing funds generated from high oil prices. These initiatives aimed to control and optimize the utilization of resources. In the monetary sphere, a stringent monetary policy was adopted to strengthen the economy. This policy allowed for the buildup of foreign exchange reserves, estimated to cover approximately 15 months' worth of imports. This strategic move was intended to safeguard against potential oil price shocks and ensure stability in the face of external economic challenges.

### The development of the monetary mass and its counterparts in Algeria for the period (1990-2020).

The monetary mass experienced a significant expansion during the period from 1990 to 1994, increasing from 342.9 billion dinars in 1990 to 723.4 billion dinars in 1994. This expansion was primarily a result of the expansionary monetary policy implemented by the government, which aimed to finance the budget deficit. The growth rate of the monetary mass during this period was approximately 20.5%. The increase was largely driven by the growth of paper and book money. Conversely, the liquidity of the economy underwent a notable decline, decreasing from 61.8% in 1990 to 48.6% in 1994. This indicates a decrease in the proportion of liquid assets in relation to the total money supply. The decline in liquidity suggests a tightening of the overall availability of funds within the economy during that period (Bouteldja, A., Benameur, A., Maliki, S. 2013).



**Figure 1: The evolution of the monetary mass during the period (1990-2020)**

Source: Prepared by the Researchers.

During the period from 1995 to 2000, there was a decrease in the growth rate of the monetary mass in Algeria. The average growth rate of the monetary mass from 1995 to 1997 was approximately 14.3%. Furthermore, the liquidity of the economy declined slightly from 39.8% in 1995 to 38.8% in 1997. The implementation of the Third Credit Standby Agreement played a role in controlling the expansion of the monetary mass and achieving stable and acceptable growth in the gross domestic product. This was accomplished through the adoption of austerity measures. In 1998, the growth rate of the monetary mass surged to 46%, reaching a value of 1579.7 billion dinars, compared to 1081.4 billion dinars in 1997. This increase was attributed to the implementation of debt rescheduling programs through the expanded loan agreement with the International Monetary Fund. Examining the structure of the monetary mass, it is evident that quasi-money, representing exchanges facilitated through the banking system, witnessed significant growth compared to previous years. Its contribution to the monetary mass ranged between 21.2% and 48% from 1990 to 1998. This indicates that individuals and institutions increasingly conducted transactions through the banking system. The rise in quasi-money can be attributed to the impact of banking reforms on the behavior of savers, as well as the strict monetary policy that aimed to absorb excess cash circulating outside the banking system as part of the structural adjustment efforts. In 2001, the monetary mass in

Algeria underwent a notable expansion, reaching a total of 2470.6 billion dinars, representing a growth rate of 22.5%. However, from 2002 to 2005, there was a decrease in the growth rate of the monetary mass. It declined from 17.4% in 2002 to 11.6% in 2005. This decrease in growth explains the corresponding decline in the liquidity of the economy, which dropped from 63.9% in 2002 to 54.2% in 2005.

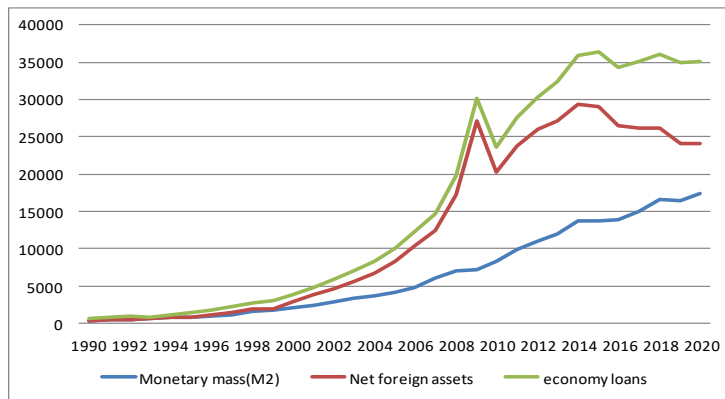
Regarding the structure of the monetary mass, it is worth noting that in 2002 ; a new monetary phenomenon emerged that had a positive impact on the development of the monetary situation. The central bank's holdings exceeded the M1 money supply. From 2006 to 2010, the monetary mass experienced fluctuations. In 2006, its value reached approximately 4827.6 billion dinars, compared to around 4070.4 billion dinars in 2005. The growth rate of the monetary mass hit its lowest level in 2009, standing at 3.1%, with a value of 7178.7 billion dinars. Two main factors contributed to this decline. Firstly, the global economic crisis and the slow increase in foreign assets had an impact. Secondly, there was a decrease in demand deposits, which dropped from 3424.9 billion dinars in 2008 to 3120.5 billion dinars in 2009. This reduction affected the ability of banks to create credit (quasi-money) and subsequently affected the monetary mass. In terms of the structure of the monetary mass, there was a noticeable decline in the percentage contribution of quasi-money to its formation, starting from 2004 when its value amounted to 1478.7 billion dinars. This decline was in favor of the M1 money supply, which amounted to 2165.6 billion dinars. The increase in the M1 money supply can be attributed to a higher growth rate in electronic or digital money compared to physical currency. In 2004, the value of electronic money was approximately 1291.3 billion dinars, which increased to 3424.9 billion dinars in 2008. However, in 2009 and 2010, the percentage contribution of quasi-money to the monetary mass increased, reaching 2524.3 billion dinars or 30.4% of the monetary mass in 2010, compared to 28.6% in 2008 (Wladimir, A. 2009).

During the period from 2011 to 2014, there was an increase in the growth rate of the monetary mass in Algeria, reaching 19.9%. This growth was primarily driven by the increase in demand deposits and time deposits (semi-money). In 2011, the value of the monetary mass was approximately 9929.2 billion dinars. However, the growth rate of the monetary mass declined in 2012 and 2013, reaching 10.9% and 8.4%, respectively. The monetary mass reached a value of 11015.4 billion dinars in 2012 and 11941.5 billion dinars in 2013. This decline in growth explains the decrease in the liquidity level of the economy from 68.3% in 2011 to 62.5% in 2013. Subsequently, the growth rate of the monetary mass rebounded to 14.6%, reaching 13687 billion dinars, while the liquidity of the economy reached a rate of 79.4%. In 2015 and 2016, the monetary mass remained relatively stable. However, in 2017, it increased by 8.4%, and in 2018, it increased by 11.1%. This increase was mainly attributed to the rise in demand deposits at the bank level, which experienced a growth rate of 19.0% in 2017. Time deposits increased by 11.1%, and the circulation of paper money increased by 4.5%. The period from 2018 to 2020 also witnessed an increase in the monetary mass, reaching 16636.7 billion dinars, 16506.6 billion dinars, and 17659.6 billion dinars in 2018, 2019, and 2020, respectively. This increase was primarily driven by the growth in demand deposits, particularly those related to the fuel sector, surpassing the levels of previous years.

### **Interviews on the monetary block in Algeria during the period (1990-2020)**

The monetary aggregates in Algeria comprise net foreign assets (also known as exchange reserves), domestic credit, and government debt. The graph below illustrates the changes in monetary aggregates during the period from 1990 to 2020 . Please note that as an AI text-based model, I am unable to generate or display visual content directly. However, you can refer to official reports, publications, or statistical sources from reliable sources to obtain the specific graph and data on the developments of monetary aggregates in Algeria during the mentioned period (Bouteldja, A., Benameur, A., Maliki, S., 2013).

By examining the development of net foreign assets, we observe fluctuations influenced by changes in oil prices. In 1991, net foreign assets increased by 272.3% due to the rise in oil prices from \$21.5 per barrel in 1990 to \$28.85 per barrel in 1991. However, negative growth was recorded in 1992 and 1993, followed by an increase in 1996 and 1997. Overall, it can be concluded that net foreign assets played a minor role in covering the monetary mass during the period of 1990-1999. Regarding economy loans, they grew at a rate of 26.7% from 1990 to 1995, despite experiencing negative growth in 1993. The growth rate reached 46.5% as institutions addressed their financial situations, prompting the banking system to provide this financing. The treasury also repurchased these loans. On the other hand, state loans exhibited a negative growth rate of approximately -4.8% in 1991 due to the agreement with the International Monetary Fund, which emphasized fiscal policy strictness. This trend continued in the years 1994, 1995, and 1996, with growth rates of -11.2%, 14.2%, and 30.1% respectively (Souissi, M., 2017).



**Figure 2. The development of monetary exchange counters in Algeria during the period (1990-2020)**

Source: Prepared by the Researchers.

At the end of the structural adjustment program period, a significant decline in net foreign assets was observed in 1998 and 1999, by 19.8% and 39.5% respectively. This decline was a result of the decrease in oil prices, leading to a reduction in the coverage of the money supply. Conversely, both state and economy loans experienced an increase, by 22.2% and 70.7% respectively, becoming the main source of covering the monetary mass. From 2000 to 2008, the Bank of Algeria successfully accumulated high levels of net foreign assets, driven by the rise in oil prices. The value of net foreign assets increased from 775.9 billion dinars in 2000 to 10,247 billion dinars in 2008, highlighting the significance of foreign assets as a counterpart to the monetary mass. The percentage of net foreign assets relative to the monetary mass reached 38.4% in 2000, rose to 85.5% in 2004, and exceeded 100% from 2005, reaching 147.3% in 2008. This increase can be attributed to the rise in fuel revenues and the subsequent growth of exchange reserves. During this period, there was a continuous expansion in loans provided to the economy as another component of the monetary mass. It grew by 17.5% in 2002 compared to 2001, when it stood at 1266.7 billion dinars, reaching 2615.5 billion dinars in 2008. However, the percentage contribution of these loans to the monetary mass experienced a consistent decrease, dropping from 49.3% in 2000 to 37.5% in 2008. The role of the treasury in financing declined significantly, with negative values recorded in 2004 (-20.5%) and 2008 (-3627.3%) (Bouteldja, A., Benameur, A., Maliki, S. 2013).

The loans provided to the economy continued to increase, reaching 6504.6 billion dinars in 2014, with a growth rate of 26.1%. This indicates a strong demand for bank loans and highlights the significant role of investments financed through bank loans. Additionally, credit facilities approved by certain banks, including financing for small and medium-sized enterprises and consumer loans for family expenses, particularly in real estate and automotive sectors, contributed to this growth. On the other hand, state loans experienced relatively low and stable growth rates from 2009 to 2013, not surpassing -3.8%. This was influenced by the role of the public treasury in financing consumer goods and providing loans to young individuals for job creation during this period. However, in 2014, state loans witnessed a negative growth rate of -38.45%.

The period from 2016 to 2020 witnessed developments in the interviews of the monetary mass, indicating that loans provided by the banking system to the state, particularly those granted by the Bank of Algeria, contributed to the expansion of M2 money supply. The monetary mass increased during the years 2016, 2017, and 2018, reaching approximately 9467.0 billion dinars, 10266.1 billion dinars, and 11404.2 billion dinars, respectively. However, it decreased in 2019 to 10975.2 billion dinars before experiencing a rapid increase in 2020. During this period, assets experienced a continuous decline, decreasing from 12596.0 billion dinars in 2016 to 6706.5 billion dinars in 2020. This decline was a result of the increase in receivables of the Bank of Algeria from the public treasury. The receivables increased from 1967.4 billion dinars at the end of 2017 to 3857.8 billion dinars at the end of 2018, as part of cash financing. This amount includes 900 billion dinars allocated to cover the financing needs of the public treasury for 2018 and 2471.2 billion dinars allocated to finance both the internal public debt and the National Investment Fund. By the end of 2020, the receivables reached 11082.6 billion dinars.

## The exchange rate of the Algerian dinar after 1990

The exchange rate of the Algerian dinar has undergone several stages due to Algeria's shift away from the socialist management style it adopted before 1990 and its transition towards a market economy. Let's summarize these stages as follows (Tahraoui, F., Benelbar, M. 2015):

**a) The first stage (1990-1998):** Is known as the dynamic management stage of the exchange rate, which marked a crucial period in the history of the Algerian dinar. During this stage, several measures were implemented based on the elasticity's method. After the issuance of the monetary and loan law in 1990 and the initiation of agreements with international monetary institutions, significant devaluations of the Algerian dinar took place, aiming to align its value with market conditions. In March 1994, the dinar was devalued by 7.3%, followed by an additional devaluation of 40.17% in April of the same year. These devaluations were intended to narrow the gap between official exchange rates and rates prevailing in the parallel market. The approach adopted was a flexible devaluation model, which allowed for adjustments based on market dynamics. Furthermore, restrictions that were previously imposed on institutions were lifted, and they assumed responsibility for their external sector obligations. The prior exchange control system, which governed agreements between public economic institutions and foreign entities, was abolished. It was replaced by a system known as the hard currency budgets, which aimed to enhance the management of foreign currency transactions. These measures aimed to introduce flexibility and adaptability in the exchange rate regime, aligning it with market forces and reducing the disparities between official and parallel market rates. This stage laid the foundation for subsequent developments in the Algerian dinar's exchange rate management. Please note that while this summary provides an overview of the first stage, it may not encompass all the intricacies and details of the period. For a comprehensive understanding, it is recommended to consult additional sources that delve into the specific policies and economic context of that time.

**b) The second stage (1999 to the present day):** Is known as the stage of exchange rate attraction. During this stage, the exchange rate policy implemented, particularly after the implementation of structural adjustment policies, included gradual devaluations of the Algerian dinar. These devaluations aimed to reduce the disparity between the official exchange rate and the rate in the parallel market. As a result of these policies, the exchange rate in the parallel market declined, and various institutions, including private institutions, were able to access foreign exchange through the regular market. This facilitated their ability to import necessary goods, subject to specific controls, and allowed for the annual allocation of foreign exchange to individuals and designated missions. These measures significantly reduced the demand for foreign exchange from the parallel market. Consequently, this contributed to the relative stability of the exchange rate in the parallel market, bringing it closer to the official rate. The French franc, being the most commonly demanded currency, particularly before 2002, held a significant position. The average exchange rate in the equilibrium market was around 16 Algerian dinars (DZD) to one French franc, especially during the mid-nineties. This rate was nearly double the official rate. It's important to note that this summary provides an overview of the second stage, but it may not encompass all the intricacies and details of the period. To gain a comprehensive understanding, it is advisable to refer to additional sources that delve into the specific policies, economic context, and developments in the exchange rate regime during that time. This led to: A large mass of hard currencies is in the hands of people, especially Algerian immigrants; Preference of foreigners coming to Algeria to exchange their currencies in the parallel market instead of the official market (Mehibel, S. and Belarbi, Y. 2018).

## Methodology

To conduct our applied study, we utilized the annual data provided by the World Bank for the period between 1990 and 2002. Our analysis was based on the following standard model:

- **Dependent Variable:** We identified a specific variable as our dependent variable, which represents the main focus of our study and is influenced by other factors in the model.
- **Independent Variables:** We selected a set of independent variables that we believed could have an impact on the dependent variable. These variables were chosen based on their theoretical relevance and availability in the World Bank data for the specified time frame.
- **Econometric Model:** We employed an econometric model to establish the relationship between the dependent variable and independent variables. The specific model used depended on the nature of the data



and the research question being addressed. Commonly used models include regression analysis, time series analysis, or panel data analysis.

- **The null hypothesis:** We formulated hypotheses regarding the expected direction and significance of the relationships between the dependent and independent variables. The null hypothesis states that there is no significant relationship between the dependent variable “The exchange rate” and the independent variables “The money supply”. In other words, any observed associations or correlations between these variables in the data are purely due to chance or random variation. This null hypothesis will be tested using appropriate statistical methods to determine if there is sufficient evidence to reject it in favor of the alternative hypotheses. These hypotheses were derived from economic theory, existing literature, and our research objectives.
- **Statistical Analysis:** We conducted rigorous statistical analysis to estimate the parameters of the model and test the hypotheses. This involved techniques such as hypothesis testing, parameter estimation, goodness-of-fit measures, and assessing statistical significance.
- **Interpretation of Results:** Based on the statistical analysis, we interpreted the estimated coefficients of the independent variables in relation to the dependent variable. We assessed the significance and direction of these coefficients and discussed their implications in the context of our research question.

It's important to note that the specific details and intricacies of the model used, as well as the variables and hypotheses, were not provided in the original text. Therefore, the above summary provides a general framework for conducting an applied study using the World Bank data for the specified period.

### Econometrics model of the Study

We employed an econometrics model to establish the relationship between the dependent variable and independent variables. The specific model used depended on the nature of the data and the research question being addressed. Commonly used models include regression analysis, time series analysis, or panel data analysis (Pesaran, M.H., Shin, Y., and Smith, R.J. 2001).

$$\ln EX_i = \alpha_0 + \alpha_1 \ln M2_{1i} + \mu_i \quad (1)$$

$i$  : The number of observations, which reflects the years of the period (1990-2020).

$\ln EX$  : The logarithm of the exchange rate.

$\ln M2$  : Logarithm of the money supply in its broadest sense.

$\mu_i$  : Random Error

$\alpha_0$  : Fixed limit

$\alpha_1$  : The response parameter represents the dependent variable of the explanatory variable

### A study of the stability of the chains under study

In order to assess the stability of the variables and determine the degree of stability, we employed several tests, including the unit root test, the Dickey-Fuller test (DF), the Augmented Dickey-Fuller test (ADF), and the Phillips- Perron test (PP). These tests enable us to examine the properties and characteristics of the time series for the variables under investigation. The results of these tests are summarized in the following table:

Table 1. Results of the unit root test for the study variables

UNIT ROOT TEST TABLE (PP)			
At Level			
		LNEX	LN M2
With Constant	t-Statistic	-5.8221	-2.7941
	<b>Prob.</b>	<b>0.0000</b> ***	<b>0.0711</b> *
With Constant & Trend	t-Statistic	-5.4011	0.3334
	<b>Prob.</b>	<b>0.0007</b> ***	<b>0.9979</b> n0
Without Constant & Trend	t-Statistic	1.5406	6.4412
	<b>Prob.</b>	<b>0.9666</b> n0	<b>1.0000</b> n0

Table 1 (cont.). Results of the unit root test for the study variables

At First Difference			
		D (LNEX)	D (LNM2)
With Constant	t-Statistic	-6.2846	-4.0326
	<b>Prob.</b>	<b>0.0000</b> ***	<b>0.0042</b> ***
With Constant & Trend	t-Statistic	-6.0586	-4.9694
	<b>Prob.</b>	<b>0.0001</b> ***	<b>0.0021</b> ***
Without Constant & Trend	t-Statistic	-5.8062	-1.8395
	<b>Prob.</b>	<b>.0000</b> ***	<b>0.0634</b> *
UNIT ROOT TEST TABLE (ADF)			
At Level			
		LNEX	LNM2
With Constant	t-Statistic	-6.2080	-2.8718
	<b>Prob.</b>	<b>0.0000</b> ***	<b>0.0606</b> *
With Constant & Trend	t-Statistic	-5.7784	0.1688
	<b>Prob.</b>	<b>0.0003</b> ***	<b>0.9966</b> <sup>n0</sup>
Without Constant & Trend	t-Statistic	2.3180	8.1668
	<b>Prob.</b>	<b>0.9937</b> <sup>n0</sup>	<b>1.0000</b> <sup>n0</sup>
At First Difference			
		D (LNEX)	D (LNM2)
With Constant	t-Statistic	-6.2846	-4.0589
	<b>Prob.</b>	<b>0.0000</b> ***	<b>0.0040</b> ***
With Constant & Trend	t-Statistic	-6.0586	-4.9847
	<b>Prob.</b>	<b>0.0001</b> ***	<b>0.0020</b> ***

Notes: (\*) Significant at the 10%; (\*\*) Significant at the 5%; (\*\*\*) Significant at the 1%. and (no) Not Significant \*MacKinnon (1996) one-sided p-values.

Source: Prepared by the Researchers.

Based on Table 1, we observed that one variable reached a stationary level, indicating it is integrated at zero degrees, denoted as  $CI \sim (0)$ . This implies that the variable does not require differencing to achieve stationary. On the other hand, another variable attained stability and stationary characteristics after taking the first difference, with significant levels of 1%, 5%, and 10%. This suggests that the variable is integrated of the first order, denoted as  $CI \sim (1)$ . The first-order integration indicates that differencing the variable once is necessary to achieve stationary. The identification of the integration order (0 or 1) for each variable provides valuable insights into their time series properties and the appropriate modeling techniques to be applied. It's important to note that the actual variables and their specific results from Table 1 were not provided in the original text. Therefore, the above statement provides a general interpretation of the integration orders based on the given information.

### Econometrics model estimation

The bounds test method can be applied regardless of whether the underlying variables are integrated at different degrees:  $CI \sim (0)$  (integrated of degree zero),  $CI \sim (1)$  (integrated of degree one), or jointly integrated  $CI \sim (1)$ . However, it is important to ensure that none of the variables are integrated at the second degree  $CI \sim (2)$ . Based on the analysis, it was concluded that the variables in our model are integrated at degree  $CI \sim (0)$  and degree  $CI \sim (1)$ . This implies that they either do not require differencing or need to be differenced once to achieve stationary. The integration properties of the variables being  $CI \sim (0)$  and  $CI \sim (1)$  allow us to apply the bounds test method. This method helps determine the existence and magnitude of a long-term equilibrium relationship between the variables in the model. By applying the modern boundary tests, we can investigate the extent of this long-term equilibrium relationship and gain insights into the dynamics between the variables. It's important to note that the specific variables and their integration properties were not provided in the original text. Therefore, the above statement provides a general understanding of the integration degrees and the applicability of the bounds test method based on the given information (Kuma, K. 2018).

### Determine the optimal deceleration period for the unconstrained error-correction model

To determine the optimal deceleration period for the unconstrained error correction model, we employ three criteria: (Log L), (LR), (FPE), (AIC), (SC), and (HQ). These criteria help in selecting the deceleration length that yields the lowest value across all of them. It's worth mentioning that the regression model includes a fixed constant.

Referring to Table 2, we can observe the optimal deceleration period as  $p = 1$  based on the mentioned criteria. In order to estimate the model, multiple attempts were made, and the model that exhibited the best performance was selected according to both economic and statistical criteria (Harris, D., McCabe, B., and Leybourn, S. 2002).

Table 2. UECM Test Results

VAR Lag Order Selection Criteria						
Endogenous variables: LNX LNM2						
Exogenous variables: C						
Date: 05/19/23 Time: 23:35						
Sample: 1990 2020						
Included observations: 28						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-37.12441	NA	0.056073	2.794601	2.889758	2.823692
1	66.58269	185.1913*	4.53e-05*	-4.327335*	-4.041863*	-4.240063*
2	70.07991	5.745423	4.73e-05	-4.291422	-3.815634	-4.145969
3	73.10358	4.535512	5.14e-05	-4.221684	-3.555582	-4.018050
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Source: Prepared by the Researchers.

Furthermore, Figure 3 Displays the optimal deceleration periods as per the AIC criterion for the specific model  $ARDL(P \cdot q_1)$  of interest, which is:  $ARDL(1 \cdot 1)$ . It's important to note that the specific details, variables, and results from Table 2 and Figure 3 were not provided in the original text. Therefore, the above statement offers a general explanation of the criteria used and their implications for determining the optimal deceleration period.

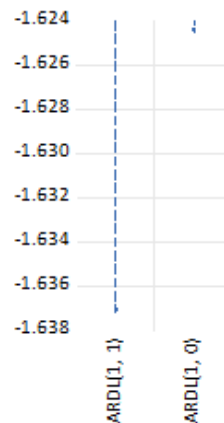


Figure 3. Results of the best model according to the Akaike Information criteria

Source: Prepared by the Researchers

The actual values and specific interpretations should be filled in with the relevant data and results from the analysis.

### Cointegration test using ARDL method

This step aims to assess the presence of a long-term equilibrium relationship between the exchange rate and the money supply, as depicted in Table 3. upon examining the results, we observe that the calculated (F) value of 17.76 exceeds the critical value at various significance levels. Therefore, the null hypothesis cannot be accepted. This outcome strongly suggests the existence of a co-integration relationship between the variables under study in the long run. Co-integration signifies that the exchange rate and the money supply are linked in the long term and tend to move together in a stable equilibrium relationship. It's important to note that the

specific variables, their data, and the critical values were not provided in the original text. Thus, the above statement provides a general understanding of the significance of the (F) value exceeding the critical value and the confirmation of a co-integration relationship. The actual values and specific interpretations should be filled in based on the actual analysis and results from Table 3 (Maddala, G.S. and Kimi, M. 1998)

Table 3. The results of the application of the co-integration test of the F statistic of the (ARDL) method

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic : n=1000				
F-statistic	17.76014	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 Researchers.

### Long-run and short-run model estimation using the ARDL method

The ARDL (Autoregressive Distributed Lag) method is employed to estimate both the long-run and short-run models. This method allows us to analyze the relationship between the variables over both the long-term and short-term periods. The long-run model captures the equilibrium relationship among the variables, while the short-run model focuses on the dynamics of adjustment to any short-term deviations from this equilibrium. By estimating both models, we gain a comprehensive understanding of the relationship between the variables in different time horizons (Si Mohammed, K. 2016).

Table 4. Results of estimating the long and short term model using the ARDL method

ARDL Long Run Form and Bounds Test				
Dependent Variable: D (LNEX)				
Selected Model: ARDL (1, 1)				
Case 2: Restricted Constant and No Trend				
Date: 05/19/23 Time: 23:45				
Sample: 1990 2020				
Included observations: 30				
Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.429576	0.679526	0.632170	0.5328
LNEX (-1)*	-0.271268	0.058253	-4.656691	0.0001
LN2 (-1)	0.028370	0.029305	0.968114	0.3419
D (LN2)	-0.333108	0.258450	-1.288867	0.2088
* p-value incompatible with t-Bounds distribution.				
Levels Equation				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN2	0.104584	0.090490	1.155755	0.2583
C	1.583587	2.747434	0.576388	0.5693
EC = LNEX - (0.1046*LN2 + 1.5836)				

Source: Prepared by the Researchers.

## Results

### Long-term model evaluation

Based on the results presented in Table 4, we can observe several key findings. Firstly, the estimated parameter for the constant term indicates that in the absence of independent variables, the exchange rate is approximately 3.74. This provides a baseline level for the exchange rate when other factors are not considered. Furthermore, we observe a positive effect of the money supply on the exchange rate. Specifically, when the money supply increases by one unit, the exchange rate tends to increase by 0.10 in the long term. This positive relationship is supported by a probability value of 0.25, which is lower than the 5% significance level. Consequently, we reject the null hypothesis and conclude that the parameter for the money supply is statistically significant.

This suggests that the money supply has a meaningful impact on the exchange rate. These findings highlight the strength of the influence of the money supply on the exchange rate and provide valuable insights into the relationship between these variables. It's important to note that the specific variables, their units, and the regression model were not provided in the original text. Therefore, the above statement provides a general interpretation of the results from Table 4. Based on the given information. The actual values, specific variables, and units should be filled in based on the specific analysis and context.

### Evaluation of the standard and statistical quality of the short-term model

The error correction model (ECM) assumes that there exists a long-run equilibrium relationship among the variables in question, as determined by the nature of the variables themselves. In the long run, the variables are expected to settle into a balanced state. However, in the short run, the variables may deviate from this equilibrium due to various factors. The ECM captures these short-term imbalances and incorporates an error correction term to measure the speed at which the variables adjust and return to their long-run equilibrium. The error correction term in the ECM serves as a mechanism to correct any deviations from the equilibrium relationship. It captures the disequilibrium in the short run and guides the adjustment process toward the long-run equilibrium. The coefficient of the error correction term provides insights into the speed of adjustment and how quickly the variables respond to deviations.

Table 5. Error Correction Form

ARDL Error Correction Regression				
Dependent Variable: D(LNEX)				
Selected Model: ARDL (1, 1)				
Case 2: Restricted Constant and No Trend				
Date: 05/19/23 Time: 23:52				
Sample: 1990 2020				
Included observations: 30				
ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNM2)	-0.333108	0.156591	-2.127250	0.0430
CointEq(-1)*	-0.271268	0.035811	-7.574888	0.0000
R-squared	0.642826	Mean dependent var		0.088331
Adjusted R-squared	0.630070	S.D. dependent var		0.158964
S.E. of regression	0.096685	Akaike info criterion		-1.770382
Sum squared resid	0.261742	Schwarz criterion		-1.676969
Log likelihood	28.55573	Hannan-Quinn criter.		-1.740498
Durbin-Watson stat	1.475112			
* p-value incompatible with t-Bounds distribution.				

Source: Prepared by the Researchers.

From the table, we can observe several important findings. Firstly, the parameter for the money supply variable at the first difference has a negative effect of 0.33. The probability value associated with the money supply  $P = 0.04 < 0.05$  leads us to reject the null hypothesis and conclude that the parameter is statistically significant. This indicates the strength of the money supply's influence on the exchange rate. Furthermore, the error correction term coefficient is -0.27, which is significant at a 1% level  $P = 0.00 < 0.05$ . This suggests the existence of an integration relationship between the exchange rate and the money supply. When a shock occurs, it takes approximately four years ( $0.27/1$ ) for the exchange rate to reach equilibrium in the long term. This reflects a relatively high adjustment rate. The correction rate indicates that around 27% of exchange rate imbalances are corrected annually in the long term. This signifies the speed at which the exchange rate adjusts to restore equilibrium. Moreover, the corrected coefficient of determination  $Adj. R^2 = 0.64$  has reached a value of 0.64. This percentage represents the explanatory power of the model, indicating that the independent variable can account for 64% of the variation in the exchange rate. The remaining 37% is influenced by factors not included in the model and random variables. It's important to note that the specific variables and their functional form were not provided in the original text. Therefore, the above statement provides a general interpretation of the results from the table based on the given information. The actual values, specific variables, and units should be filled in based on the specific analysis and context.

## Results and Discussion

To assess the efficiency of a model, it is crucial to verify that the residuals conform to natural patterns and display consistent variance. Additionally, the model itself should exhibit stability.

### Compare real values with estimated values

When comparing the actual values with the estimated values generated by the model shown in Figure 4, a distinct convergence between the two becomes apparent. This convergence is a clear indicator of the excellent quality of the estimated model, solidifying its dependability for interpreting and analyzing the results.

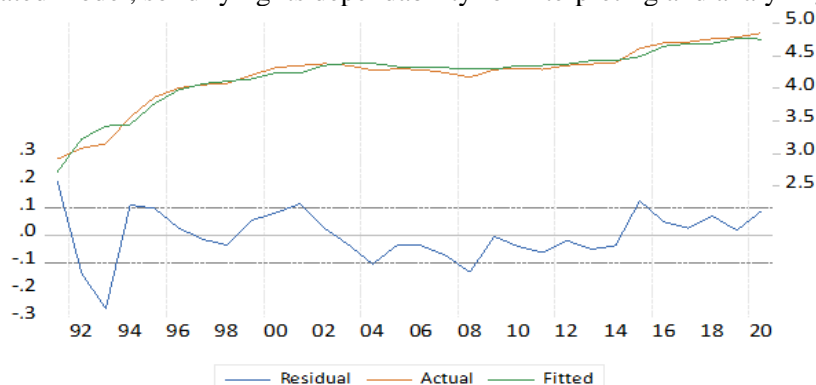


Figure 4. Comparison of real values with estimated values

Source: Prepared by the Researchers.

### Test the normal distribution condition for the estimated model residual

To verify whether the residuals of the estimated model conform to a normal distribution, the Jarque-Bera test was utilized. The test yielded a value of 1.77 with a probability greater than 5%, resulting in a P-value of 0.41. This non-significant result leads us to accept the null hypothesis, which states that the residuals of the estimated model adhere to a normal distribution.

### Residual variance stability test for the estimated model

To examine the assumption of homogeneity in error variances, we performed an ARCH test. The results revealed a test statistic value of 2.27, with a corresponding probability greater than 5% ( $p = 0.13 > 0.05$ ). These findings support the acceptance of the null hypothesis, indicating homogeneity in the error variances. These results align with the information presented in Table 5.

Table 6. Results of the condition of constant variance of error limits for the estimated model

Heteroskedasticity Test: ARCH			
F-statistic	2.295770	Prob. F(1,27)	0.1413
Obs*R-squared	2.272592	Prob. Chi-Square(1)	0.1317

Source: Prepared by the Researchers.

### Test the independence condition of the error bounds of the estimated model:

We utilized the Breusch-Godfrey serial correlation LM test to investigate the hypothesis of non-correlation in errors, specifically, the autocorrelation of errors. The test yielded a value of ( $N \cdot R\text{-squared} = 1.02$ ), with a p-value of 0.31, which is greater than the significance level of 5%. These results indicate the acceptance of the null hypothesis, suggesting the absence of autocorrelation in the estimated residuals of the model. Detailed information can be found in Table 6.

Table 7. Results of testing the condition of independence of error limits for the estimated model

<b>Breusch-Godfrey Serial Correlation LM Test:</b>			
Null hypothesis: No serial correlation at up to 1 lag			
F-statistic	0.881527	Prob. F(1,25)	0.3568
Obs*R-squared	1.021803	Prob. Chi-Square(1)	0.3121

Source: Prepared by the Researchers.

### Structural stability test:

To assess the stability of the model, we conducted tests on the cumulative sum of squares of Recursive Residuals (TEST) and the cumulative sum of squares of Recursive Residuals. The results indicated that the model demonstrated stability across the majority of the study periods, as depicted in Figure N<sup>o</sup> (5).

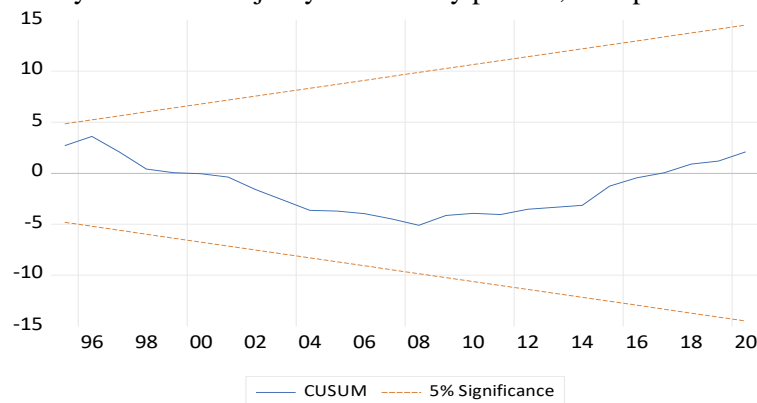


Figure 5. Model Stability Test (ARDL-ECM)

Source: Prepared by the Researchers

### Conclusion

Through this study, we successfully addressed the main question concerning the relationship between money supply and the exchange rate in Algeria from 1990 to 2020. Our findings highlighted the significant reforms that took place in the Algerian economy, most notably the Monetary and Loan Law 90/10. This law granted the Central Bank complete independence in drawing and implementing monetary policy, free from intervention by the Ministry of Finance. In the quantitative aspect of our study, we employed the F-statistic to test for co-integration, which confirmed the presence of co-integration between the exchange rate and money supply. Consequently, we utilized the Autoregressive Distributed Lag (ARDL) model to measure the short-term and long-term relationship between the variables. The model revealed a statistically significant positive effect of money supply on the exchange rate, with a significance level of 0.001, indicating a direct relationship. Specifically, a 1% increase in the money supply led to a 0.006% increase in the exchange rate, aligning with economic theory.

Furthermore, our study demonstrated the existence of a long and short-term equilibrium relationship between money supply and the exchange rate in Algeria throughout the study period. The error correction coefficient was negative, significant at 5%, and amounted to -0.12. This suggests the presence of an error correction mechanism from the short term to the long term. Therefore, we can conclude that the estimated model is statistically valid and acceptable.

### Authors Contributions

**Conceptualization:** Aid, L.; **data curation:** Benelbar, M.; **formal analysis:** Benelbar, M.; **investigation:** Aid, L.; **methodology:** Aid, L.; **project administration:** Aid, L.; **resources:** Benelbar, M.; **software:** Benelbar, M.; **supervision:** Aid, L.; **validation:** Aid, L.; **visualization:** Benelbar, M.; **writing – original draft:** Aid, L.; **writing – review & editing:** Aid, L.

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