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Macroeconomic determinants of Tunisia's trade balance: An ARDL approach (1990–2021)

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ABSTRACT

This study aims to examine the key macroeconomic determinants of Tunisia's trade balance over the period 1990 to 2021 by analyzing the dynamic interactions among broad money supply (M2), real effective exchange rate (EX), and real gross domestic product (GDP). The study employs the Autoregressive Distributed Lag (ARDL) Bounds Testing approach to assess both short-run and long-run relationships. The analysis is grounded in elasticity, absorption, and monetary theories, using annual time series data. Diagnostic tests for stationarity, residual behavior (including autocorrelation, normality, and heteroskedasticity), and model stability through the CUSUM test are also conducted to validate the model. The results indicate that GDP and M2 have significant effects on the trade balance in both the short and long run. An increase in M2 contributes to a worsening trade balance due to increased domestic consumption and import demand, while GDP growth enhances export performance and improves trade balance outcomes. The real effective exchange rate exerts a significant positive long-run impact, supporting the view that currency depreciation strengthens export competitiveness. The findings suggest that policymakers should adopt cautious monetary expansion, maintain a flexible and strategic exchange rate policy, promote export-led industrial development, and support investment-driven GDP growth to reduce persistent trade imbalances and enhance long-term external sector sustainability in Tunisia.

Contribution/Originality: This study contributes to the literature by integrating elasticity, absorption, and monetary approaches within an ARDL framework to assess Tunisia's trade balance. Unlike previous studies, it provides a comprehensive evaluation of short- and long-term effects, supported by diagnostic robustness, and offers policy insights tailored to Tunisia's macroeconomic structure.

1. INTRODUCTION

The trade balance is a fundamental component of a nation's external sector, serving as a key indicator of macroeconomic stability and international competitiveness. It represents the net difference between the value of exports and imports over a specific period. Understanding the determinants of the trade balance is crucial for economists and policymakers, as it sheds light on the structural strengths and vulnerabilities of a country's economy and informs the design of effective trade and macroeconomic policies (Chiu & Sun, 2016; Falk, 2008).

This study focuses on Tunisia, a developing economy in North Africa where trade plays a pivotal role in driving economic growth. Since the early 1990s, Tunisia has undergone significant structural and economic transformations, including trade liberalization, monetary reforms, and exchange rate adjustments. These changes, along with external shocks, have contributed to fluctuations in the trade balance, prompting the need for empirical analysis grounded in robust econometric methods (Tran & Dinh, 2014).

Previous research across various developing economies has highlighted the importance of exchange rates, national income, and monetary aggregates as primary drivers of trade imbalances (Shah, 2015; Shawa & Shen, 2013; Tran & Dinh, 2014). However, despite the growing body of literature, empirical studies specifically focused on Tunisia remain limited. This study seeks to fill that gap by employing the Autoregressive Distributed Lag (ARDL) Bounds Testing approach, as developed by Pesaran and Shin (1999), which is well-suited for analyzing the dynamic relationships between variables with different orders of integration over time.

The ARDL methodology is particularly advantageous in capturing both short-run fluctuations and long-run equilibrium among key macroeconomic variables. By incorporating lagged effects and the Error Correction Mechanism (ECM), the model provides insights into the speed of adjustment and the temporal dependencies that characterize trade balance behavior in small open economies like Tunisia (Pesaran & Shin, 1999).

The central objective of this research is to investigate the extent to which the money supply (M2), the real effective exchange rate (EX), and real gross domestic product (GDP) influence Tunisia's trade balance. These variables are selected based on their theoretical significance in the elasticity, absorption, and monetary approaches to the balance of payments (Alexander, 1952; International Monetary Fund, 1981). By integrating these perspectives, the study offers a comprehensive understanding of the trade balance determinants in Tunisia.

Furthermore, the findings are expected to inform the development of macroeconomic policies aimed at stabilizing trade performance, enhancing competitiveness, and achieving sustainable growth. The broader significance of this research lies in its methodological and empirical contributions, which can be extended to other emerging economies confronting similar external sector challenges (Gu, 2012; Kodongo & Ojah, 2013).

This study focuses on Tunisia, a North African developing economy that relies heavily on international trade to stimulate economic growth. Since the early 1990s, Tunisia's trade balance has experienced persistent fluctuations due to various domestic and global factors, including exchange rate volatility, income shifts, and monetary expansion. Existing literature has explored trade balance determinants across different countries, yet there remains a significant gap in empirically modeling Tunisia's trade dynamics using an integrated and updated econometric approach that captures both short- and long-term effects.

The principal contribution of this study lies in its application of the Autoregressive Distributed Lag (ARDL) Bounds Testing approach to investigate the long-term equilibrium and short-term adjustments in the Tunisian trade balance, incorporating the roles of money supply, income, and the real effective exchange rate. By integrating theoretical perspectives from the elasticity, income absorption, and monetary approaches, this study provides a holistic framework for understanding trade balance behavior in a developing economy context.

In addition to employing robust time series econometric techniques, the study extends the analytical framework to include policy-relevant interpretations of how monetary and exchange rate policies can influence trade performance. This dual emphasis on theoretical integration and empirical rigor positions the study as a valuable addition to the body of research on external balance determinants in emerging markets, particularly in the MENA region (Ibrahim, Saeed, & Ahmed, 2024).

The findings are expected to inform both academic discourse and practical policymaking by offering actionable insights on how Tunisia can enhance its trade competitiveness, control inflationary pressures, and maintain macroeconomic stability through effective policy coordination.

Furthermore, this study contributes to the existing literature by offering an empirical reassessment of the trade balance determinants in Tunisia, a country that has been underrepresented in the broader trade balance discourse. While prior studies have investigated trade dynamics in various African, Asian, and Latin American contexts, few have employed a comprehensive model combining the real effective exchange rate, money supply, and income within the ARDL framework specifically for Tunisia. By doing so, this research bridges a critical empirical gap and updates previous analyses using recent data spanning from 1990 to 2021, which includes key transitional economic phases, such as trade liberalization efforts, post-Arab Spring economic reforms, and monetary policy adjustments.

Additionally, this study advances methodological rigor in the field by employing a multidimensional diagnostic strategy to validate the model's robustness using unit root tests, residual diagnostics, and stability analysis through the CUSUM test. This methodological thoroughness ensures that the inferences drawn are statistically sound and policy-relevant. Unlike earlier studies that may have relied on single-equation models or overlooked structural breaks and adjustment dynamics, this study's use of the ARDL model and Error Correction Mechanism (ECM) captures both the long-run equilibrium and short-run fluctuations in trade balance behavior. This contributes not only to the empirical body of trade literature but also provides a replicable model that can be adapted for other developing economies facing similar macroeconomic challenges.

2. LITERATURE REVIEW

2.1. Theoretical Framework

2.1.1. The Elasticity Method (The Neoclassical Method)

Paradoxically, this view suggests that a nominal depreciation of the exchange rate can theoretically improve the trade balance. This perspective derives from the aforementioned Bickerdike-Robinson-Metzler Model, which is a static and partial equilibrium model that determines the effect of the exchange rate on specific export and import markets. In all markets, supply and demand are exclusively determined by the nominal price in terms of the currency of the country of origin and the country of destination, with no cross-market price effects. This model is defined by the following Equations: (1) to (5).

$$\mathrm{M}(P_m) = X^*(P_m^*) \quad (1)$$

$$\mathrm{X}(P_x) = M^*(P_x^*) \quad (2)$$

$$\mathrm{B} = P_x X - P_m \mathrm{M} \quad (3)$$

$$\mathrm{P}_m = \mathrm{P}_m^* e \quad (4)$$

$$\mathrm{P}_X = \mathrm{P}_X^* e \quad (5)$$

Where:

M, X = Imports and exports of domestic goods.

M*, X* = Imports and exports from abroad.

Local import and export prices in local currency = Pm, Px.

Equation 1 represents the equilibrium condition on the domestic imports market, while Equation 2 represents the equilibrium condition on the exports market. Equation 3 determines the original country's trade surplus in local currency. Through the exchange rate, Equations 4 and 5 link the local and foreign currency prices of products.

Figure 1 depicts the initial equilibrium at the intersection of the solid supply and demand curves drawn for the exchange rate e^0.

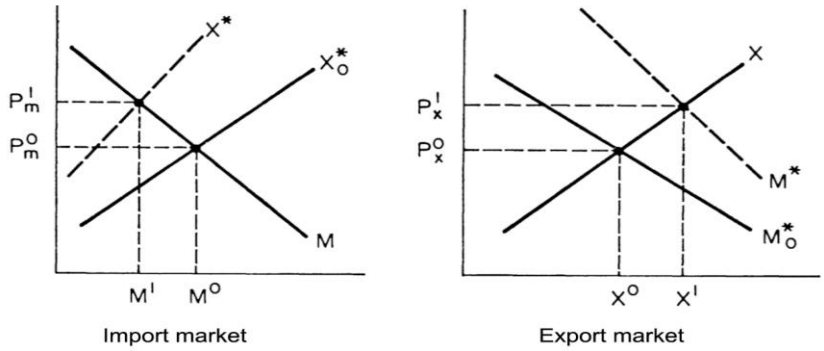

Figure 1. Initial equilibrium in the foreign exchange market at exchange rate e_0.

At this initial equilibrium, the import value P_m^0 equals the export value P_x^0, resulting in a balanced trade. In other words, the trade balance is balanced, and there is neither a trade deficit nor surplus.

Consider a scenario in which the home nation decides to devalue its currency, but domestic demand for imports and export supply are unaffected by the appreciation of its local currency. However, the foreign supply and demand schedules must alter in order to maintain the products' foreign currency prices. Consequently, the local currency must appreciate by the same proportion as calculated by Equations 4 and 5 and the exchange rate. Therefore, both the foreign supply and demand schedules increase by the same amount as the devaluation rate. This new equilibrium is reached because both markets are in equilibrium. Import and export prices in the local market rise to P_m^1 and P_x^1, respectively. Imports decline to M^1, while exports increase to X^1. In this paradigm, the impact of currency devaluation on the trade balance is ambiguous. Depending on the elasticity of demand, the value of imports may increase or decrease, whereas the value of exports may increase. Through the well-known BRM (Bickerdike-Robinson-Metzler) model, the condition for an improved trade balance is established. The Marshall-Lerner condition supports the positive influence of decreasing the absolute value of export and import demand elasticities. If the currency exchange rate is greater than the equilibrium point, there will be an excess of foreign currency. If it is below the equilibrium point, however, there will be an excess demand for foreign currency. Therefore, the Marshall-Lerner condition is an argument for those who advocate devaluing the currency to attain foreign exchange market stability and improve the trade balance (DORNBUSCH:1975).

2.1.2. The Income Absorption Method (Keynesian Method)

In Alexander (1952), the Income Absorption Approach was created. It describes the fundamental relationship between one of the components of the balance of payments and the trade balance, as well as the main aggregate variables involved. This was one of the initial approaches adopted by the International Monetary Fund (IMF). In economics, "absorption" refers to the aggregate of consumption and investment. The Income Absorption Approach defines the balance of payments as the difference between the total receipts of a country's residents, excluding the monetary authorities (or national income), and their total expenditures. Consequently, it is the disparity between national income and national expenditures. Accordingly, a deficit in this balance implies that expenditures exceed income, and vice versa for a surplus. In other words, a deficit in the income absorption balance indicates that a country is spending more than it earns. This method contributes to the analysis of a country's economic situation and external transactions by providing valuable insights into the relationship between domestic income, expenditure patterns, and the trade balance.

It is widely acknowledged that problems with the balance of payments result from an imbalance between domestic income and expenditure. Consequently, this method emphasizes the fact that current account imbalances can be viewed as the difference between domestic income and domestic expenditure (known as absorption).

Unlike the Elasticity Approach, the Income Absorption Approach is a development because it shifts focus away from the balance of trade, which is the difference between exports and imports, and towards the current account, which is the difference between national income and total expenditure. This approach is based on a model of accounts for the entire nation that includes the components of the current account, gross domestic product, and total domestic spending.

2.1.3. The Income Absorption Method's Assumptions: The Income Absorption Method is based on Certain Assumptions such as

1. It assumes different degrees of employment than those of the maximum employment level.
2. It is assumed that the rates of change of commodity prices and cash wages are lagged to be approximately the same.
3. Makes the balance of production costs and expenses constant.
4. Where applicable, it assumes that the country has foreign exchange reserves.

2.1.4. The Income Absorption Approach's Mathematical Formulation

The Income Absorption Approach is a more recent innovation than the Elasticity Approach. The analysis shifts from the trade balance, which is the difference between export and import values, to the current account, which is the difference between domestic income and total domestic expenditure. Therefore, this formula for determining national income is based on Keynesian principles.

$$Y = C + I + G + (X - M) \quad (1)$$

Where:

Y = National income.

C = Private consumption.

I = Net investment.

G = Government expenditure.

X = Exports.

M = Imports.

To determine the meaning of domestic absorption, rewrite Equation 1 as Equation 2.

$$Y = Cd + Id + Gd + X \quad (2)$$

The domestic attribute is represented by the letter "d" in this equation. According to the equation, domestic absorption (Ad), which comprises products produced and consumed locally, equals (Cd + Id + Gd), combined with the value of exports (X), which make up national income (Y).

Ad is substituted into Equation 2 to produce the following result.

$$Y = Ad + X \quad (3)$$

The following Equation 4 represents the total absorption (A), which includes both domestic absorption (Ad) and imports (M).

$$A + Ad + AM \quad (4)$$

Or alternatively

$$Ad = A - M \quad (5)$$

Equation 3 can be changed by Equation 5 to get the results shown below.

$$Y = A + X - M \quad (6)$$

Or alternatively

$$Y - A = X - M \quad (7)$$

The primary equation of the Income Absorption Approach is represented by Equation 7. Alexander, on the other hand, simplified this equation to take the following simplified form.

$$B = Y - A = \pm IF \quad (8)$$

It is clear from this equation's final form that the trade balance will be in surplus when gross national income is higher than domestic absorption, and it will be in deficit when the reverse is true. When domestic consumption reaches parity with gross domestic product, trade will be in a condition of equilibrium. In other words, a balance of payments deficit occurs when domestic consumption exceeds gross domestic product, and the discrepancy is covered by incoming capital flows.

When the gross national income exceeds domestic consumption, there is a trade surplus, and the gap generates capital outflows. This research shows that the difference between national income and total absorption causes the surplus or deficit in the trade balance. The levels of gross national income and total absorption must be brought back to their equilibrium values to repair the trade balance imbalance. This can be achieved by adjusting the levels of total spending upward or downward. Consequently, fiscal policy plays a crucial role in determining how to adjust the trade balance (Mokhtari, 2018).

2.1.5. Monetary Balance of Payments Approach (Polak Model)

Since the early 1950s, problems such as inflation and the balance of payments have emerged as concerns among economists and policymakers. This focus has led to the development of new methods for conducting financial analysis. The perspective on the payment balance from a financial standpoint has gradually evolved, with the two most prominent methods being the Flexible (New Classical) method and the Absorption of Income (New Keynesian) method.

The Polak model can be described as a system of four interconnected internal variables.

The relationship between these variables in the Polak model is that MO, Y, M, and ANFA can have different values, and these values occur where at least one of the following values changes.

The following are used as external variables in this model: change in net domestic credit (ΔNDC), capital movement (CM), and exports (X). The latter serves as a tool for controlling fiscal authorities and is treated as an external factor. Since the interest rate is not a factor in this model, it is less complicated and more suitable for developing nations. This is especially important for economies where there are few readily marketable financial assets and fluctuations in interest rates have little impact.

The following definitions describe the relationships in the Polak model.

$$Mt = mYt, 0 < m < 1 \quad (1)$$

$$Yt = \frac{1}{k} MOt, 0 < k < 1 \quad (2)$$

$$MO_t = \Delta NFA_t + \Delta NDC_t + MO_{t-1} \quad (3)$$

$$\Delta NFA_t = X_t + CM_t - M_t \quad (4)$$

According to the first relationship, which is a behavioral equation, nominal imports in the present period are fixed to be a certain percentage of nominal revenue in the same period. The average and marginal import propensity is the name given to the coefficient "m". Equation 2 entails a proportional connection between the money stock and nominal income, with the coefficient $^1/_k$ standing in for the average and marginal money velocity, or Y_t/MO_t This implies that the rise in income will be determined by multiplying the quantity of money in circulation by the rate of change.

The equations in relationships (3) and (4) define key terms. The first equation states that money at the end of the previous period (MO_t), plus changes in net foreign assets (ΔNFA_t)and net domestic credit of the banking system (ΔNDC_t) during the current period, the equals the money supply at the end of this period (MO_{t-1}). According to the second equation, changes in the banking system's net foreign assets correspond to the overall balance of payments surplus or deficit. The model's definition of money can be interpreted either broadly, as currency plus demand deposits plus quasi-money, or narrowly, as currency plus demand deposits only. Using the broad definition incorporates quasi-money in (MO_{t-1}) in Equation 3 and similarly affects the interpretation of the velocity of money, 1/k.

These two definitional equations are combined to provide the following conclusions.

$$\Delta MO_t = X_t + CM_t + \Delta NDC_t$$

After the definition

$$A_t = X_t + CM_t + \Delta NDC_t$$

The model, which includes all three external variables (including the policy variable), may be stated as follows:

$$Mt = mYt, 0 < m < 1 \quad (1)$$

$$Yt = \frac{1}{k} MOt, 0 < k < 1 \quad (2)$$

$$MO_t = A_t - M_t + MO_{t-1} \quad (3)$$

Changes in one or more of the external variables in the equations above will impact the internal variables M, Y, and MO. A change in A will affect M through changes in MO and Y since m and k are constant factors. However,

subsequent modifications to M will have the opposite impact on MO and Y, leading to a second set of effects, and so on.

All rounds of interactions can be taken into account when calculating the net impact. For each internal variable, expressed in terms of external and lagged internal variables, a simplified version of the model must be obtained. There are several uses for the model. For example, if there is excess demand for money in the country compared to what is supplied by the central bank, the trade balance can be improved through the inflow of foreign money. Conversely, if the central bank creates more cash than required, the excess cash can negatively affect the trade balance.

The model through which many analytical aims may be served facilitates the comprehension of the dynamic interplay between internal and external factors once these elements are considered (International Monetary Fund, 1981).

2.2. Review of the Literature

The determinant of the trade balance has been discussed in other papers. For example, Osoro (2013) conducted research on Kenya using yearly data spanning 50 years from 1963 to 2012. The cointegration results were obtained through the Johansen procedure, and the error correction model was examined for both short-term and long-term relationships. The study revealed a close and positive relationship between real exchange rates, trade balance, budget deficit, and foreign direct investment.

Along these lines, Tran and Dinh (2014) analyzed how FDI inflows impact and respond to external imbalances in Asian developing and transition economies. They found that recent FDI movements have contributed to increasing the trade imbalance, which has been observed to negatively affect the stability of the host country's economy. The inflows of foreign investment initially worsened the trade balance before improving it, as indicated by the calculated coefficient turning negative when a lagged variable was added to the foreign direct investment variable.

Shah (2015) used a regression model to conduct research on the factors affecting Pakistan's trade balance between 1975 and 2010. The analysis results indicated that the only significant factor influencing Pakistan's trade balance was the value of the rupee. Conversely, the impacts of the money supply, foreign investment, GDP, and consumption on the trade balance were statistically insignificant.

In a related context, Theodora and Emmanuel (2012) utilized the Ordinary Least Squares (OLS) technique to investigate the key factors influencing Tanzania's trade balance over the period 1980–2012. Their analysis revealed that trade openness, exploitation of natural resources, improvements in human development, and inflows of foreign direct investment (FDI) significantly contributed to enhancing the trade balance. In contrast, inflation, along with public and private consumption, negatively influenced trade performance. Although the real exchange rate was included in the model, its impact was statistically insignificant.

Similarly, Hailu (2011) assessed how foreign aid affected trade deficits across Sub-Saharan African countries between 1980 and 2007, applying the Generalized Method of Moments (GMM) with endogenous variables. The findings indicated that official development assistance (ODA) tended to increase imports while slightly reducing exports, although both effects lacked statistical significance. Moreover, while the real exchange rate adversely impacted both imports and exports, FDI was found to support trade flows positively. However, the lack of a significant relationship between FDI and trade balance outcomes cast doubt on the reliability of some of the conclusions.

In another study, Kollmann (1998) used a two-country real business cycle (RBC) framework to examine the behavior of the U.S. trade balance between 1975 and 1991. The model incorporated key variables such as total factor productivity, national output, government expenditure, and taxation. The analysis concluded that productivity shocks were a dominant driver of U.S. trade balance fluctuations during that period.

Baharumshah (2001) study aimed to identify the key macroeconomic factors affecting the trade balances of Malaysia and Thailand in their bilateral trade with the United States and Japan. Employing a Vector Autoregression (VAR) model based on extensive data spanning from 1980 to 1996, the analysis uncovered a persistent negative long-

term relationship between trade balance and three main variables: the exchange rate, domestic income, and income in partner countries. The actual effective exchange rate emerged as a pivotal factor, with currency depreciation found to enhance the trade balance over time for both nations.

Chiu and Sun (2016) examined the impact of savings rates on trade balances by analyzing data from 76 countries covering the years 1975 to 2010. Their analysis focused on the interactions between the trade balance, national savings, and real exchange rates. The results indicated that countries maintaining savings rates above 14.8% could improve their trade balances either by increasing savings or by devaluing their currencies. During economic expansion, investment tends to exceed savings, thereby reducing the current account surplus. Conversely, during recessions, investment contracts more sharply than savings, which tends to reduce trade deficits.

Kodongo and Ojah (2013) explored the relationship between real exchange rates, trade balances, and capital flows across African economies. Their findings aligned with conventional economic theory, suggesting that a devaluation of the domestic currency tends to improve a country's trade balance in the short term by enhancing its balance of payments position.

Falk (2008) employed panel data regression techniques to examine trade balance determinants across 32 industrialized and developing countries from 1990 to 2007. In this study, the trade balance was measured as the difference between a country's exports and imports, expressed as a proportion of its nominal GDP.

The real effective exchange rate, foreign income (defined as the average weighted GDP per capita of 40 main trade partners), real GDP per capita, and the beginning balance as a percentage of GDP were the independent variables utilized.

According to the study, the trade balance as a percentage of GDP is considerably positively connected with the individual's share of real foreign GDP of trading partners. The individual's proportion of real GDP, on the other hand, has a negative impact on the trade balance. Furthermore, a decrease in the actual exchange rate index improves the trade balance.

It has been shown that the consequences differ dramatically between nations with a favorable attitude toward foreign direct investment and those with a negative or limited attitude toward foreign direct investment. The trade balance is less vulnerable to variations in the real effective exchange rate for nations having a positive net position in terms of foreign direct investment.

Gu (2012) used economic, social, cultural, and political factors to undertake a thorough and extensive examination of China's trade balance between 1984 and 2008. The overall study estimates that China and the rest of the world should follow its lead, whereas the detailed analysis forecasts for China and its important trading partners. Data from 12 significant trading partners' bilateral trades were used.

Using the labor cost ratio, the real effective exchange rate, China's income, global income, and foreign direct investment inflows are the explanatory variables employed in the overall study. These factors, as well as the relative labor cost per hour between China and its trade partners, were also used in the more detailed analysis.

To estimate the long-term relationship between the trade balance and its determinants, the Dynamic Ordinary Least Squares and Fully Modified Ordinary Least Squares approaches were used. According to extensive research, labor costs and foreign direct investment are major factors influencing China's trade balance. Lowering labor costs has a greater impact than increasing foreign direct investment.

3. METHODOLOGY AND PROCEDURES

This study utilized the Autoregressive Distributed Lag Bounds Test (ARDL) model, as proposed by Pesaran and Shin (1999) and further developed by Pesaran, Shin, and Smith (2001).

Based on the aforementioned views, this study used a model that integrates the three perspectives to examine the trade balance in the Tunisian economy from 1990 to 2021.

$$X/M = F(M2, EX, GDP) \quad (1)$$

Where

X/M represents the trade balance, which is the ratio of exports to imports.

M2 represents the broad money supply (% of GDP).

EX represents the real effective exchange rate.

GDP represents the per capita real GDP.

The linear form of the equation is obtained by taking the natural logarithm of each independent variable.

$$LnX/M = Bo + B1\,LnM2 + B2\,LnEX + B3\,LnGDP + U \quad (1)$$

3.1. Test of Unit Root

The purpose of the unit root test is to assess the characteristics of time series data. Despite the availability of numerous unit root tests, the Augmented Dickey-Fuller test will be utilized. The dependent variable (LnX/M) is observed to be non-stationary at the level in the presence of a constant and a time trend in the model, as shown in Table 1. However, after taking its first difference, it becomes stationary. The same applies to the variables (EX, GDP): at the initial level, they are all non-stationary with a constant and trend, but they become stationary after the first difference. Regarding the variable M2, it remains at its initial level. The results of the mixed stability test for the variables allow us to employ the ARDL model methodology proposed by Pesaran et al. (2001), with the stipulation that the maximum order of integration for the variables must be attained after the first difference.

3.2. Rationale for Sample Period, Variables, and Methodology

The selection of the sample period from 1990 to 2021 is motivated by both economic and methodological considerations. This period captures significant structural changes and policy reforms in the Tunisian economy, including trade liberalization, currency devaluation episodes, and financial sector transformations following Tunisia's engagement with international institutions and its post-2011 economic transitions. The inclusion of over three decades of data ensures sufficient temporal coverage to detect both short- and long-term effects while avoiding bias arising from short-run economic volatility. Moreover, this period encompasses cyclical variations in global and regional economic conditions, providing a robust context for examining trade balance determinants.

The choice of explanatory variables broad money supply (M2), real effective exchange rate (EX), and real gross domestic product (GDP) is grounded in economic theory and empirical literature on trade balance behavior. The money supply (M2) serves as a proxy for monetary policy and domestic liquidity conditions, which influence import demand and inflationary trends. The real effective exchange rate reflects the relative price of domestic goods against foreign goods, capturing the competitiveness of Tunisia's exports. GDP, representing national income, is a measure of economic activity and purchasing power, affecting both export capacity and import demand. These variables are widely recognized in classical and Keynesian frameworks as key macroeconomic indicators affecting the trade balance, and their inclusion allows for a holistic assessment of internal and external sector interactions.

Methodologically, the Autoregressive Distributed Lag (ARDL) Bounds Testing approach was selected due to its suitability for small sample sizes and its flexibility in handling regressors that are integrated of different orders, i.e., I(0) and I(1), but not I(2). Unlike traditional cointegration methods such as Johansen or Engle-Granger, the ARDL model accommodates structural lags and allows for the simultaneous estimation of both short-run dynamics and long-run equilibrium relationships. Additionally, the inclusion of the Error Correction Mechanism (ECM) enables the analysis of the speed of adjustment toward equilibrium, which is crucial for understanding how Tunisia's trade balance responds to macroeconomic shocks over time. This methodological approach ensures robust, policy-relevant findings that contribute meaningfully to both academic research and economic decision-making.

4. RESULTS AND DISCUSSION

4.1. Long-Run Parameters

The table displays the results of the ARDL model for the long-term relationship between the trade balance deficit and various economic variables. It indicates that the relationship between all explanatory variables and the dependent variable is statistically significant, and their signs are consistent with economic theory.

Table 1. The following are the outcomes of the Augmented Dickey-Fuller test (applied to the logarithm of the variables) for testing unit roots.

Variables	Model	Statistics ADF	Number of lags
Ln (X/M)	Constant and trend	-2.308	1
Ln (EX)	Constant and trend	-2.947	1
Ln (GDP)	Constant and trend	0.301	1
Ln (M2)	Constant and trend	-3.808**	1
Ln(X/M)	Constant and trend	-5.836***	1
Ln (EX)	Constant and trend	-4.596***	1
Ln (GDP)	Constant and trend	-5.808***	1
Ln (M2)	Constant and trend		1

Note: The hypothesis assumes that the time series are non-stationary or have a unit root. The rejection of the null hypothesis is based on the critical values determined by and the lag length is selected according to the SIC criteria, extending from lag 0 to lag 9. At the 10%, 5%, and 1% significance levels, respectively, the significance levels **, and *** indicate rejection of the null hypothesis of non-stationarity. The symbol "!" denotes the uncertainty of the outcome.

Economic theory supports the positive relationship of the real effective exchange rate (EX) variable. It is anticipated that an increase in the exchange rate will result in a trade balance deficit, as it enhances the competitiveness of exports. Conversely, a decrease in the exchange rate is expected to reduce the trade deficit by increasing export competitiveness.

In addition, the long-term relationship between the money supply (M2) and the trade balance (X/M) is negative, indicating that a reduction in the money supply would decrease the trade deficit. This implies that local products become relatively more affordable for immigrants, highlighting the importance of monetary policy's objective to reduce inflation rates in order to promote sustainable economic growth.

According to the elasticity approach, exports are independent of the Gross Domestic Product (GDP), whereas imports have a positive relationship with GDP. Therefore, a rise in GDP will result in an increase in imports, which will negatively affect the trade balance and increase the trade deficit. Table 2 presents the results of the unit root tests for stationarity.

Table 2. The following describes the ARDL model for long-run parameters.

Variable	Coefficient	Std. error	t-statistic	Prob.
C	-3.309627	1.616347	-2.047597	0.0501
EX	0.305561	0.164585	1.856555	0.0739*
M2	-0.41594	0.175551	-2.369348	0.0249**
GDP	0.389762	0.095174	4.095258	0.0003***

Note: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

4.2. Short-Run Parameters

The results of the Error Correction Model (ECM) for the trade balance are presented in Table 4. In the ECM model, the coefficients of the lagged variables have statistically significant relationships with the trade balance variable. Approximately 82% of the fluctuations in the trade balance are explained by the ECM model.

The Error Correction Model (ECM) reveals the feedback or adjustment rates of short-term latent coefficients that converge to their long-run equilibrium in the model. According to Pesaran and Pesaran (1997) the ECM coefficient (-1) is statistically significant at the 1% level, indicating the existence of a cointegration relationship. The

coefficient of the error correction term is approximately -0.399265, indicating that the rate of adjustment towards the long-run equilibrium is 40%. Table 3 shows the estimated long-run coefficients from the ARDL model.

Table 3. The model for error correction (ECM).

Dependent variable: D(TB)				
ECM regression				
Variable	**Coefficient**	**Std. error**	**t-statistic**	**Prob.**
D(TB(-1))	-0.508614	0.151688	-3.35303	0.0073
D(TB(-2))	-0.200353	0.131185	-1.527259	0.1577
D(TB(-3))	-0.374622	0.153374	-2.442531	0.0347
D(EX)	-0.613327	0.242994	-2.524046	0.0302**
D(EX(-1))	0.698077	0.258246	2.703148	0.0222**
D(EX(-2))	-0.860062	0.219911	-3.910954	0.0029***
D(M2)	0.921196	0.198185	4.64815	0.0009***
D(M2(-1))	-0.628952	0.156469	-4.019659	0.0024***
D(M2(-2))	-0.710924	0.200819	-3.540118	0.0054***
D(GDP)	1.479253	0.259549	5.699317	0.0002***
D(GDP(-1))	3.020526	0.549932	5.492541	0.0003***
D(GDP(-2))	1.769646	0.401276	4.410049	0.0013***
D(GDP(-3))	0.4899	0.281654	1.739366	0.1126
ECM(-1)*	-0.399265	0.060324	-6.618707	0.0001***
R-squared	0.829927			
Adjusted R-squared	0.672003			
Durbin-Watson stat	1.482238			

Note: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

4.3. Diagnostic Tests

The outcomes of three diagnostic tests are presented in Table 4. The Breusch-Godfrey Serial Correlation LM test, the Jarque-Bera test, and the ARCH test.

The Breusch-Godfrey Serial Correlation (LM) test is used to determine the presence of autocorrelation in the residuals of a regression model. If the p-value of this test is less than 0.05, serial correlation is present. In this case, the p-value was 0.697417, which is greater than 0.05, indicating that the residuals do not show evidence of serial correlation.

The Jarque-Bera test is used to determine whether the residuals of a model follow a normal distribution. If the p-value of this test is less than 0.05, the residuals are not normally distributed. In this case, the test statistic was 4.453517, and the p-value was 0.107878, indicating that the p-value exceeds 0.05. This suggests there is not enough evidence to reject the null hypothesis, which implies that the residuals are normally distributed.

The ARCH test is used to detect heteroskedasticity (variable variance) in the error term. The test resulted in a value of 0.7006 and a p-value of 0.151304. The presence of heteroskedasticity is indicated by the p-value, which is greater than 0.05, suggesting no significant issue with fluctuating variance in the error term.

However, the p-value in this situation is larger than 0.05, indicating that there is no evidence of heteroskedasticity.

In general, the regression model met the requirements of no serial correlation, normality of residuals, and homoscedasticity of errors based on the results of these three tests.

Table 4. The results of diagnostic testing.

Normality (JB)=	4. 453517 (0.108)
Heteroskedasticity test: ARCH =	0.701 (0.151)

4.4. Model Stability Test

To evaluate the stability of parameters over the short and long term, the cumulative sum (CUSUM) approach is utilized. We compared the alternative hypothesis that both short-term and long-term parameters are unstable to the null hypothesis of stable parameters. Figure 2 CUSUM plots show that the estimated model and underlying transactions are stable at a significance level of 0.05 because they are inside the crucial boundaries.

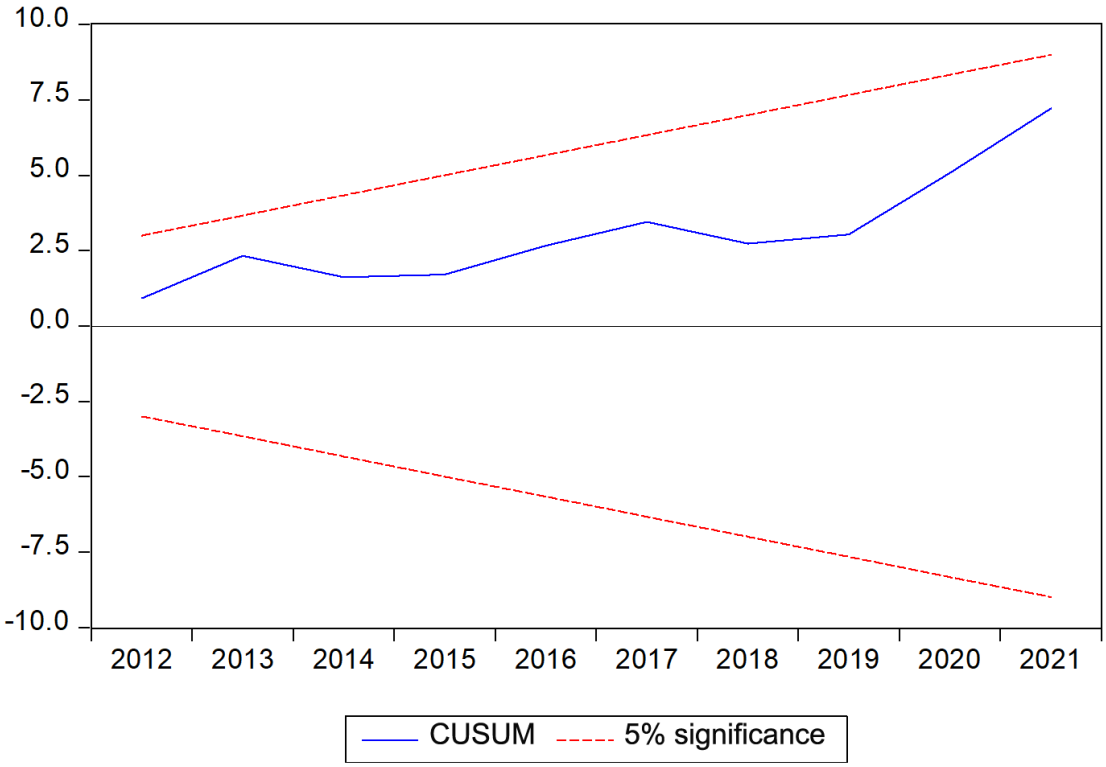

Figure 2. Illustrates the estimated model and underlying transactions.

4.5. Discussion

The ARDL model results revealed a significant long-term relationship between the trade balance and macroeconomic indicators: the exchange rate (EX), money supply (M2), and GDP. The positive coefficient (0.305561) indicates that a depreciation of the exchange rate improves the trade balance by making exports cheaper and imports more expensive. This is consistent with the elasticity approach in trade theory and supports the findings of Mokhtari (2018), who reported that exchange rate fluctuations directly impact the trade balance in developing countries. Similarly, Shah (2015) found that exchange rate devaluation in Pakistan led to improved export performance, although the effect was not immediate.

The negative coefficient (-0.415940) indicates that an expansionary monetary policy (increasing M2) worsens the trade balance. This result aligns with the Polak model (International Monetary Fund, 1981), which emphasizes the inflationary effects of an increased money supply, leading to higher imports and deteriorated trade balances. It also supports Dornbusch (1975)'s argument that monetary expansion under flexible exchange rates can fuel current account imbalances in the short to medium term.

The positive and significant coefficient for GDP (0.389762) indicates that economic growth is associated with increased import demand, contributing to a trade deficit. This aligns with Tran and Dinh (2014), who found that GDP growth in developing Asian countries often leads to wider trade deficits due to increased consumption and investment-driven imports. Shah (2015) also reported a positive relationship between GDP and import growth, resulting in a deteriorating trade balance in Pakistan.

The Error Correction Model demonstrates an effective adjustment mechanism. The ECM coefficient of -0.399265 is statistically significant, indicating a 40% correction toward equilibrium in each period. This moderate adjustment speed suggests that any shock to the trade balance is gradually corrected over time. Similar findings were reported by Tran and Dinh (2014), who observed a slow but significant rebalancing of trade disequilibria in developing Asia due to structural rigidities.

Lagged values of EX, M2, and GDP are statistically significant, indicating that past values of macroeconomic variables influence current trade balance movements. This temporal dependence is typical in small open economies, as reported by Shah (2015) and Mokhtari (2018). In particular, the mixed signs and varying lags of EX and M2 reflect exchange rate pass-through effects and delayed import-export reactions.

The residuals passed the Breusch-Godfrey and ARCH tests, indicating no serial correlation or heteroskedasticity. These results confirm the model's reliability and echo the robustness reported by Shah (2015), who applied similar diagnostic tests in his empirical assessment of Pakistan's trade determinants. The Jarque-Bera test showed that the residuals are normally distributed, satisfying a key OLS assumption and enhancing the credibility of statistical inferences. Regarding the CUSUM stability test, the stability of the model over time, as shown by the CUSUM plots, suggests that the estimated relationships are structurally stable. This aligns with findings from Tran and Dinh (2014), who confirmed the temporal robustness of their ARDL results through similar tests.

This study confirms several theoretical predictions and reinforces findings from empirical literature.

- It validates the Marshall-Lerner condition in the long term, as the real exchange rate positively affects the trade balance.
- It highlights the destabilizing effect of expansive monetary policy, consistent with classical and modern monetary trade models.
- It underscores the role of GDP-driven import growth, reflecting structural import dependence in developing economies.

The model's sound diagnostics and stability further enhance confidence in its policy implications. Policymakers should consider carefully managing exchange rate policy, avoiding excessive monetary expansion, and adopting strategies to promote import substitution as GDP rises.

5. CONCLUSION

This study aims to empirically assess the determinants of Tunisia's trade balance by integrating three major theoretical frameworks: the elasticity approach, the income absorption approach, and the monetary approach. Each of these perspectives offers unique insights into the macroeconomic dynamics affecting external balances. The elasticity and absorption models primarily emphasize the role of real-sector variables under conditions of resource underutilization, while the monetary approach focuses on the influence of monetary aggregates and their interaction with external accounts.

Utilizing the Autoregressive Distributed Lag (ARDL) Bounds Testing methodology, the study examined the long-run and short-run relationships between Tunisia's trade balance and key macroeconomic variables namely, money supply (M2), real effective exchange rate (EX), and real gross domestic product (GDP) over the period 1990 to 2021. The results confirm a statistically significant and dynamic interaction among these variables, providing robust empirical support for their inclusion in trade balance modeling.

The findings reveal that increases in the money supply tend to deteriorate the trade balance, consistent with the monetary approach's assertion that excess liquidity fuels imports and weakens external balances. Conversely, GDP growth contributes positively to trade performance by enhancing export potential and economic productivity. The real effective exchange rate was also found to have a favorable long-term effect, affirming the relevance of currency competitiveness in improving export-led growth, albeit with a more limited impact compared to GDP and M2.

Overall, the study underscores the complexity of trade balance dynamics in a developing economy like Tunisia. Policy implications drawn from this research suggest the necessity of maintaining prudent monetary policy to control inflation and manage import pressures, alongside efforts to foster economic growth through investment, industrialization, and export diversification. While exchange rate adjustments can support trade rebalancing, they must be complemented by structural reforms that enhance production capacity and attract foreign direct investment.

In sum, a multifaceted policy approach anchored in sound monetary management, sustained economic growth, and export-oriented development is essential for improving Tunisia's trade balance and ensuring long-term macroeconomic stability. These insights contribute to both academic literature and practical policy design for emerging economies facing similar trade and external sector challenges.

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