

# The Shorter- and Longer-Term Impacts of Moroccan Central Bank Interventions on Exchange Market

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## Abstract

This study explores the influence of Bank Al-Maghrib's interventions on exchange rate behavior in Morocco from 1990 to 2024. With an ARDL model integrating key macroeconomic factors (inflation, interbank rate, liquidity, and foreign reserves), the research goal is to observe the short- and long-run relationships between monetary policy and the dirham's appreciation. Apparently, the results reveal the presence of a long-run correlation of the studied variables, meaning that the exchange rate demonstrates a sustained-in-time response to monetary fundamentals. Notably, the money supply and foreign exchange reserves appear as the most influential determinants, thereby confirming the supremacy of interventions and withdrawal in foreign exchange markets. The analysis also shows there exists a major impact of the interest rate, which exemplifies the role of the financial channel in the Moroccan setting. The findings also establish that there is a quick adjustment of the exchange rate to its long-term equilibrium, and a strong structural stability of the model. Thus, the study enhances the knowledge about Morocco's exchange rate policy and stresses the importance of policy coordination among reserve management, monetary discipline, and specific central bank operations to boost the dirham's stability during the transitional economy times.

**Keywords:** Central Bank Interventions, Exchange Rates, Foreign Exchange Reserves, Inflation, Interest Rates, Monetary Policy, Money Supply, ARDL Model.

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## 1. INTRODUCTION

Currency stability can be considered as one of the fundamental components of macroeconomic policy. This is especially true for developing and emerging markets exposed to regular external shocks, limited capital market liquidity, and structural imbalances. In this regard, the acquisition of newer challenges remains a key task for central banks (Carstens, 2021). The foreign exchange interventions constitute their primary instrument. Such interventions involve smoothing excessive volatility, defending the domestic currency, and enhancing the credibility of the macroeconomic regime. Such a multiple role was underscored in a variety of studies, including the ones by Sarno & Taylor (2001), Ishii *et al.*, (2006), Basu (2012), and Drut (2022). The functions of these interventions range from correcting spatial imbalances in the exchange of currency to the adjustment of economic agents' expectations.

In Morocco, recent decades, the question of dirham stability has been set amid a situation of gradual trade openness, global inflationary pressuring, as well as a gradual evolution toward a flexible exchange rate regime since 2018 (Amraoui *et al.*, 2025). The Moroccan central Bank named Bank Al-Maghrib (BAM) regularly intervenes on the foreign exchange market, thereby preserving macroeconomic equilibrium, ensuring foreign currency liquidity provision, as well as limiting fluctuations that could influence external competitiveness or internal stability. Nevertheless, the channels through which these interventions act on the exchange rate are entirely unexplored in the Moroccan context, despite their essential role.

International literature draws attention to the heterogeneity of the effects of interventions. Fratzscher *et al.*, (2019), for instance, conclude that interventions are generally useful, especially when transparent and

large in scale. Such studies as those by Edison *et al.*, (2006) or de Dominguez (1998), on the other hand, indicate that, depending on the schedule, the adopted strategy, and its nature, it may occasionally increase volatility. This heterogeneity of the results demonstrates that the effectiveness of interventions depends primarily on the institutional context, the exchange rate regime, and the specific macroeconomic fundamentals of the country.

While Bank Al-Maghrib reports on its foreign currency reserves, monetary policy actions, and liquidity operations; there are few empirical studies that examine the interactions between these tools and their impacts upon the exchange rate (Lamrani & Bennis 2022). Understanding the nature of such relationships will be critical given the ongoing shift toward increased flexibility for the Moroccan Dirham, and an increasingly unstable global economic environment.

Against this backdrop, the present study empirically investigates the impact of Bank Al-Maghrib's interventions on exchange rate dynamics in Morocco using an ARDL modeling framework applied to annual data spanning the period 1990–2024. The analysis integrates a set of core macroeconomic variables namely; inflation, interest rates, foreign exchange reserves, and money supply, to identify the main transmission channels through which monetary policy actions influence the exchange rate, both in the short run and over the long term.

Accordingly, this research pursues a dual objective. First, it seeks to address a gap in the domestic literature by providing a structured and comprehensive empirical assessment of Morocco's exchange rate policy. Second, it aims to offer policy-relevant insights for economic decision-makers, particularly at a time when exchange rate management is becoming an increasingly strategic component of macroeconomic stabilization in a context of greater flexibility and heightened external uncertainty.

## 2. LITERATURE REVIEW

Throughout recent decades, central bank interventions in the foreign exchange market have remained a critical component of monetary policy, particularly in emerging economies where the exchange rate tends to fluctuate significantly. Their actions primarily aim to rectify the distortions that occur in the exchange rate, restrict extra volatility, and support foreign reserves (El Kadri *et al.*, 2025; Ishii *et al.*, 2006). Despite the fact that it has been discussed for the past few decades, the academic literature has not presented a univocal interpretation of their effectiveness. Different opinions exist concerning the channels through which these interventions function and their impact on the macroeconomic level, mirroring a debate on the actual importance of these policies in the light of the increased global financial background.

The objectives and mechanisms of intervention are subject to the influences of economic and institutional contexts. Ishii *et al.*, (2006), point out that the central banks in emerging economies are more active in their interventions than those of developed countries, especially to address external imbalances and stabilize financial markets. However, the effectiveness of these interventions depends on their coordination with other macroeconomic policy instruments. Basu (2012) puts forward a strategic approach, which enables the avoidance of over-accumulation of foreign reserves in the appreciation process of the currency, through regulating purchase and sale operations according to the exchange rate level. According to Durán-Vanegas (2015), in the case of Colombia, interventions also do posit a signaling role in the context of promoting agents' expectations whenever the exchange rate differs from its equilibrium value. This is supported by the theory of Sarno & Taylor (2001), according to which, central bank operations can regulate speculative activities and restore market stability by correcting them.

Empirical conclusions about intervention success present a more layered account. Fratzscher *et al.*, (2019), working with a generous set of 33 countries, conclude that interventions are effective in over 80% of situations, especially if they are public, coordinated among multiple parties, and large enough. Some other papers make the opposite case: Edison *et al.*, (2006) and Dominguez (1998) infer that secretive action, harmful timing, and a disequilibrium condition may dually influence volatility instead of mitigating it. For instance, Edison *et al.*, (2006) prove that some Reserve Bank of Australia interventions delayed devaluation temporarily but produced heightened uncertainty and compromised discovery potential. Similarly, Roy Trivedi & Apte (2016) observe the situation for India: Spot market interventions may inflate sensitivity, but interventions in the forward market can help how speculative pressures — Rincón-Castro *et al.*, (2020) show — combine interim capital-flow management and foreign-exchange intervention actions that are more successful than operating exclusively through a single instrument chosen by the authorities, who can thereby stabilize the currency at contestable costs. Considerations of instrument choice, transparency, and coordination proved essential.

Another segment of the literature looks at how interventions succeed or fail. Chang *et al.*, (2017) identify that Asian economies with treated foreign-exchange markets deploy interventions more successfully if they engage in supporting strategies, coordinated cross-institutional actions, and fast responses to speculative episodes. Uz Akdogan (2020) emphasizes fundamentals — such as take balances, domestic conditions for growth, and the stance of policy demands for sterilization — as causative considerations that influence intervention processing. B & Deo (2025) explore the BRICS economies and show that interventions show strong asymmetric potential:

interventions in Russia, India and China appear broadly successful, while outcomes for Brazil and South Africa are weaker or even negative. Economic structure and institutional credibility shape the transmission mechanism.

Recent studies emphasize an increasing complexity in the role of interventions, particularly after the global financial crisis and the COVID-19 pandemic. Katusiime (2023), studying Uganda, observes that interventions have had mixed effects on exchange rate volatility, mitigating certain shocks while generating uncertainty at other times. Viziniuc (2021), using a DSGE model, shows that these interventions may have distributive effects, creating winners and losers depending on debt structure and the nature of shocks. Löffler *et al.*, (2016) warn against excessive reserve accumulation, particularly in Asia, which may constrain monetary policy autonomy and generate liquidity or price stability risks. Delli Gatti *et al.*, (2025), using multi-agent models, confirm that the impact of interventions depends largely on speculative behavior and the rules adopted by the central bank.

Contemporary approaches now consider foreign exchange interventions as a complementary instrument to unconventional monetary policies. Musthaq (2023) highlights that interventions not only influence the exchange rate but also help preserve financial system liquidity and strengthen investor confidence. In inflation-targeting regimes, Krušković (2022) shows that they can mitigate depreciation pressures and reduce the need for monetary tightening, thereby indirectly contributing to price stability. Finally, Yildiz & Aydin (2020) demonstrate that mechanisms such as the Reserve Option Mechanism can act as automatic stabilizers, reducing uncertainty and promoting more transparent and predictable reserve management.

Overall, recent scientific research tends to view central bank interventions as a flexible and multifunctional instrument, whose effectiveness depends closely on the macroeconomic context, institutional framework, and coordination with other economic policies. They now form part of a broader vision of financial stability, integrating interactions among markets, expectations, and public policies.

### 3. METHODOLOGY

#### 3.1 Data Description

The selection of variables in this study is grounded in established theoretical frameworks that explain the functioning of foreign exchange markets and the role of monetary policy. These approaches underline the existence of interactions between central bank interventions and key macroeconomic indicators, notably inflation, the exchange rate, foreign exchange reserves, and interest rates. Nevertheless, the nature and strength of these relationships may vary according to the structural characteristics of each economy.

In the Moroccan context, the analysis aims to assess how these variables interact with one another and to determine whether the channels through which monetary policy influences the foreign exchange market operate smoothly or display certain rigidities.

To examine these response mechanisms within the Moroccan setting, the analysis draws on annual data spanning the period between 1990 and 2024, yielding a total of 35 observations. This time frame was selected to capture the major economic and institutional changes that have shaped the Moroccan economy, particularly the reforms of the exchange rate regime and the evolving role of Bank Al-Maghrib in the foreign exchange market.

**Table 1: Description of Variables**

Variable	Notation	Source	Description
Exchange rate	<b>TCH</b>	<b>WB</b>	The central variable of the research, reflecting the value of the Moroccan dirham relative to foreign currencies.
Inflation rate	<b>INF</b>	<b>WB</b>	Measures the overall rise or decline in prices and reflects macroeconomic stability.
interbank interest rate	<b>TINT</b>	<b>BAM</b>	An indicator reflecting the liquidity of the banking sector, influencing interest rates applied in an economy.
Money supply growth rate	<b>TMM</b>	<b>WB</b>	Included to assess the liquidity effect on exchange rate dynamics.
Foreign exchange reserves	<b>RCH</b>	<b>WB</b>	They reflect foreign currency purchases and sales made by the central bank in order to adjust foreign currency liquidity and to stabilize the currency exchange rate.

**Source:** Constructed by the author

The selection of the variables is justified not only by their theoretical importance but also by the quality and accessibility of the data obtained from official sources, primarily Bank Al-Maghrib (BAM) and the World Bank (WB). These institutions offer reliable

and consistent statistical series, which helps ensure the robustness of the empirical results.

#### 3.2 Model Specifications

To analyze the link between central bank interventions and the key macroeconomic factors

shaping the foreign exchange market in Morocco, this study employs an autoregressive distributed lag (ARDL) framework. This approach is particularly well suited to the analysis, as it makes it possible to capture both short-

term adjustments and long-run relationships between variables, even when they exhibit different orders of integration, namely I(0) and I(1).

ARDL models generally take the following form:

$$\Delta TCH_t = \alpha_0 + \sum_{i=1}^p \beta_i \Delta TCH_{t-i} + \sum_{j=1}^{q_1} \delta_j \Delta INF_{t-j} + \sum_{k=1}^{q_2} \gamma_k \Delta RCH_{t-k} + \sum_{l=0}^{q_3} \Delta TINT_{t-l} + \sum_{m=0}^{q_4} \phi_m$$

The ARDL framework offers a key advantage in that it allows both short-run and long-run relationships between variables to be examined within a single specification. In the short run, the dynamics are captured through the coefficients associated with first differences ( $\Delta$ ), which measure the immediate response of the dependent variable to changes in the explanatory variables. These coefficients therefore reflect how the economic system reacts in the presence of temporary or cyclical shocks.

On the other hand, the model also makes it possible to assess long-run effects through lagged variable coefficients ( $\lambda_i$ ). These parameters provide information on whether a stable equilibrium relationship exists between the exchange rate and the set of macroeconomic variables under consideration. By combining these two perspectives, the ARDL approach offers a comprehensive view of the interactions among the series, allowing a clear distinction between short-term adjustments and long-term structural relationships.

The estimation of the model is carried out using the ordinary least squares (OLS) method across different lag structures in order to identify the optimal specification. The selection of the appropriate number of

lags is guided by the Akaike Information Criterion (AIC), which helps determine the most suitable dynamic configuration.

Ultimately, this specification seeks to empirically evaluate how the interventions of the Central Bank of Morocco, captured through the selected monetary and financial variables, affect exchange rate movements and contribute to the stability of the foreign exchange market.

## 4. RESULTS

Correlation and stationarity play a fundamental role in time series analysis. Correlation helps identify the strength and direction of linear relationships between variables, offering a first indication of possible linkages within the data. Stationarity, in contrast, refers to the stability of a series' statistical properties, such as its mean and variance, over time, which is a necessary condition for sound econometric modeling. Addressing these issues at an early stage is essential, as it ensures the reliability of subsequent analyses and provides valuable insights into the underlying behavior of the time series.

### 4.1. Descriptive Analysis of Variables

**Table 2: Statistical and normality results**

Indicator	TCH	INF	RCH	TINT	TMM
Mean	9.204751	2.651702	52.20340	4.175143	9.009707
Median	9.202715	1.803917	50.51767	3.250000	7.966025
Maximum	11.30298	7.986166	118.8423	10.00000	21.47846
Minimum	7.750325	0.303386	9.340226	1.500000	3.088163
Standard deviation	0.851950	2.173556	31.13328	2.237240	4.878913
Skewness	0.509129	0.990835	0.601687	1.072229	1.037387
Kurtosis	2.772830	2.692409	2.461327	3.043285	2.962646
Jarque-Bera	1.587332	5.864877	2.534985	6.709172	6.279698
Probability	0.452184	0.053267	0.281537	0.034924	0.043289
Sum	322.1663	92.80957	1827.119	146.1300	315.3397
Sum Sq. Dev.	160.6278	32955.56	24.67786	170.1783	809.3290
Observations	35	35	35	35	35

**Source:** Constructed by the author

Table 2 reports the descriptive statistics for the main variables included in the model. These indicators provide useful information on the central tendency, dispersion, and normality of data.

The statistics reveal noticeable differences in both the level and variability of the variables, reflecting the heterogeneity of the underlying economic dynamics. Foreign exchange reserves (RCH), for instance, record

the highest mean 52.20 and a relatively large standard deviation 31.13, pointing to substantial fluctuations over the period under study. By contrast, the interbank interest rate (TINT) and inflation (INF) display much lower mean values, equal to 4.17 and 2.65 respectively, which suggests a relatively stable monetary environment over the sample period.



All variables present positive skewness, indicating moderately right-skewed distributions, where observations tend to extend toward higher values. In addition, the kurtosis measures are generally close to the benchmark value of 3, implying that most series exhibit distributions that are approximately normal.

Finally, Jarque- Baera test assesses the normality of the series based on skewness and kurtosis values. The corresponding probability values indicate that some series, notably TINT ( $p = 0.0349$ ) and TMM ( $p = 0.0432$ ), deviate from normality at the 5% significance level. In contrast, TCH, INF, and RCH appear closer to a normal distribution. These results

suggest that the normality assumption is not fully satisfied across all variables, thereby supporting the use of robust econometric techniques such as the ARDL approach, which remains appropriate in the presence of non-normal and non-stationary data.

## 2.4. Correlation

Figure 1 displays the correlation matrix for the main variables included in the model. It offers a graphical overview of both the direction and intensity of the relationships between pairs of variables, thereby highlighting potential linkages and interdependencies relevant to the analysis of central bank interventions in the foreign exchange market.



**Figure 1: Correlation Matrix**  
Source: Constructed by the author

First, foreign exchange reserves (RCH) display a negative correlation with both the exchange rate (TCH) and the interbank interest rate (TINT), with coefficients of -0.28 and -0.63. This suggests that the accumulation of foreign exchange reserves is generally associated with stabilization or exchange rate appreciation, while an interest rate hike tends to reduce reserves, reflecting monetary policy adjustments aimed at supporting the domestic currency.

Inflation (INF) is positively correlated with the interbank interest rate and the growth rate of money supply (TMM), with correlation coefficients of 0.65 and 0.29, respectively. This relationship indicates that periods of rising inflation are often accompanied by tighter monetary conditions and, at the same time, changes in liquidity dynamics within the economy. In the same vein, the positive association between money supply growth and interest rates (0.48) reflects close

interactions between liquidity conditions and monetary policy actions.

Overall, the correlation coefficients remain below 0.8, demonstrating the absence of significant multicollinearity between the explanatory variables. Consequently, the selected variables are statistically consistent and appropriate for estimating the ARDL model.

## 4.3. Stationarity

To assess the stationarity properties of the time series employed in this study, the Augmented Dickey-Fuller (ADF) unit root test is applied. This procedure makes it possible to determine whether a series is stationary, that is, whether its key statistical characteristics, such as the mean, variance, and autocorrelation structure, remain stable over time.

**Table 3: Results of stationarity tests (ADF)**

Variable	ADF Statistic	Critical Value 1%	Critical Value 5%	Critical Value 10%	p-value	Decision
TCH	-2,075946	-3,639407	-2,951125	-2,614300	0,2551	Non-stationary
INF	-2,704714	-3,653730	-2,957110	-2,617434	0,0843	Non-stationary
RCH	-2,462431	-3,653730	-2,957110	-2,617434	0,1338	Non-stationary
TINT	-3,962572	-3,639407	-2,951125	-2,614300	0,0044	Stationary
TMM	-3,764003	-3,639407	-2,951125	-2,614300	0,0073	Stationary

Source: Constructed by the author

**Table 4: Summary stationarity tests and integration order variables**

Variable	Level	1st Difference	Final Decision	Order of Integration
TCH	Non-stationary	Stationary	Becomes stationary after differencing	I(1)
INF	Non-stationary	Stationary	Becomes stationary after differencing	I(1)
RCH	Non-stationary	Stationary	Becomes stationary after differencing	I(1)
TINT	Stationary	—	Stationary at level	I(0)
TMM	Stationary	—	Stationary at level	I(0)

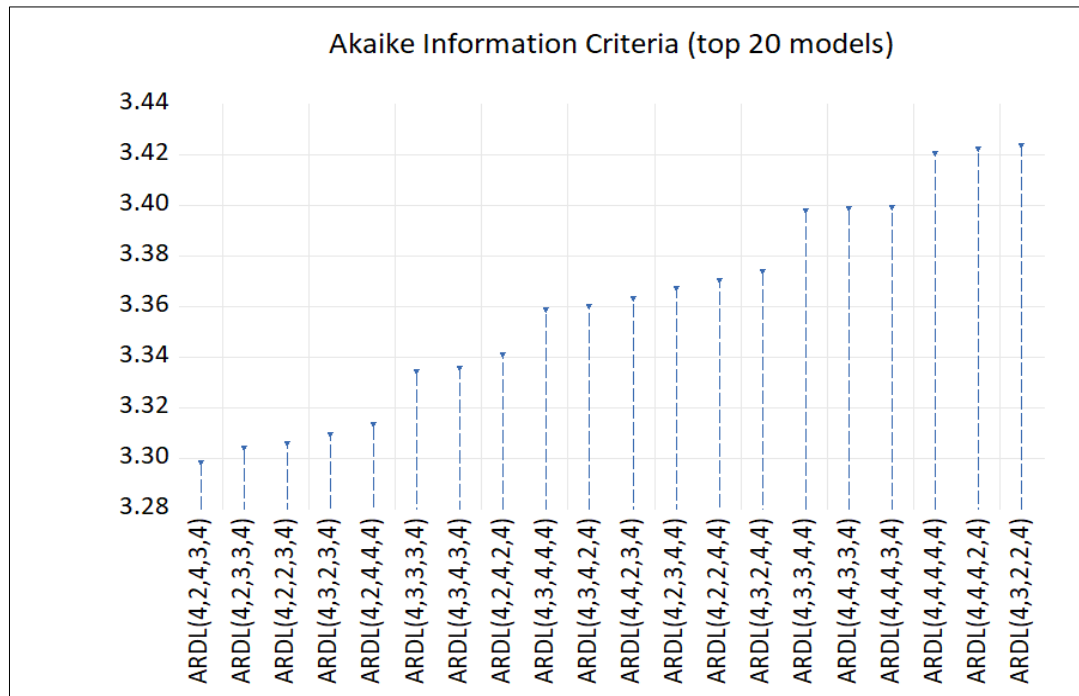
Source: Constructed by the author

The ADF unit root test results presented in table 2 show the series to be mixed-order integrated. More specifically, the TINT and TMM variables become stationary in levels, which indicates that they are zero-order integrated, I(0). In contrast, the TCH, INF, and RCH variables only turn stationary after a first differentiation, which suggests that they are first-order integrated, I(1).

Combining I(0) and I(1) variables, as summarized in table 3, rules out the presence of second-order integrated series and justifies using the ARDL model, which is known to be appropriate when explanatory variables have mixed integration orders.

#### 4.4. ARDL Modeling

##### 4.4.1. Determination of the Optimal Number of Delays for the ARDL Model


**Figure 2: AIC – ARDL Model Classification**

Source: Constructed by the author

Figure 2 presents a comparison of the 20 best ARDL models according to the Akaike information criterion (AIC), taking into account both the explanatory power and complexity of the individual models. Lower AIC values indicate better models, as they offer a good balance between data fit and parameter parsimony.

The results show that the ARDL (4,2,4,3,4) model has the lowest AIC value, indicating that it is the most appropriate model among those tested.

##### 4.4.2. Pesaran Cointegration Test: Boundary Test

**Table 5: Results of the Boundary Test (Pesaran *et al.*, 2006)**

F-statistic	5.844					
Sample Size	10% I(0)	10% I(1)	5% I(0)	5% I(1)	1% I(0)	1% I(1)
30	2.525	3.560	3.058	4.223	4.280	5.840
35	2.460	3.460	2.947	4.088	4.093	5.532
Asymptotic	2.200	3.090	2.560	3.490	3.290	4.370

Source: Constructed by the author

As shown in Table 5, we used Pesaran's bounds test to determine if a long-term relationship exists between the model variables. The calculated F statistic ( $F = 5.8444$ ) exceeded the upper bound  $I(1)$  at the conventional significance levels (1% and 5%). This result leads to the rejection of a null hypothesis of absence of cointegration, confirming the existence of a long-term relationship between the TCH and the

explanatory variables (inflation, interest rates, money supply, foreign exchange reserves). Consequently, we proceed to estimate the ECM model in order to assess the short-term dynamics and the speed of the adjustment towards long-term equilibrium.

#### 4.4.3. Short-Run Estimation

**Table 6: Short-Term Estimation Results**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<b>TCH(-1)</b>	-1.248732	0.253429	-4.927346	0.0005
<b>INF(-1)</b>	-0.474928	0.140312	-3.384813	0.0061
<b>RCH(-1)</b>	-0.064652	0.012076	-5.353585	0.0002
<b>TINT(-1)</b>	-0.505663	0.188133	-2.687797	0.0211
<b>TMM(-1)</b>	0.316699	0.080518	3.933256	0.0023
<b>C</b>	15.37904	2.960181	5.195303	0.0003
<b>D(TCH(-1))</b>	0.610494	0.210080	2.906010	0.0143
<b>D(INF)</b>	-0.113157	0.066547	-1.700417	0.1171
<b>D(INF(-1))</b>	0.319463	0.117368	2.721881	0.0199
<b>D(INF(-2))</b>	0.398837	0.109659	3.637064	0.0039
<b>D(RCH)</b>	-0.029839	0.013792	-2.163440	0.0534
<b>D(RCH(-1))</b>	0.038700	0.017327	2.233492	0.0472
<b>D(RCH(-2))</b>	0.024953	0.013950	1.788713	0.1012
<b>D(RCH(-3))</b>	0.018126	0.013257	1.367330	0.1988
<b>D(TINT)</b>	0.091948	0.277929	0.330832	0.7470
<b>D(TINT(-1))</b>	0.661366	0.255828	2.585201	0.0254
<b>D(TMM)</b>	0.038838	0.027747	1.399693	0.1892
<b>D(TMM(-1))</b>	-0.195947	0.052272	-3.748621	0.0032
<b>D(TMM(-2))</b>	-0.131782	0.037019	-3.559864	0.0045
<b>D(TMM(-3))</b>	-0.121094	0.035242	-3.436027	0.0056
<b>R-squared</b>	0.858469	Meandependent var		0.020763
<b>Adjusted R-squared</b>	0.614007	S.D. dependent var		0.574386
<b>S.E. of regression</b>	0.356856	Akaike info criterion		1.031263
<b>Sum Squared Resid</b>	1.400809	Schwarz criterion		1.956416
<b>Log likelihood</b>	4.015429	Hannan-Quinn criter.		1.332839
<b>F-statistic</b>	3.511667	Durbin-Watson stat		2.594081
<b>Prob(F-statistic)</b>	0.018618			

**Source:** Constructed by the author

The short-run estimation makes it possible to analyze the immediate dynamics of the exchange rate (TCH) in response to changes in the selected macroeconomic variables. The results show that the error-correction term  $TCH(-1)$  is negative, significant, and of large magnitude (-1.2487), confirming a rapid adjustment toward the long-run equilibrium following a shock.

In the short run, inflation exhibits a mixed effect: the contemporaneous change in inflation is not significant, but its one- and two-period lags positively affect the change in the exchange rate, indicating that past inflationary pressures contribute to a short-term depreciation of the dirham.

Foreign exchange reserves display a dual behavior: the immediate variation  $D(RCH)$  has a negative effect, helping stabilize the exchange rate,

whereas the lagged terms exhibit positive but moderate effects. This pattern suggests that adjustments in reserves take some time before influencing the foreign exchange market.

Regarding the interest rate, only its first lag  $D(TINT(-1))$  is significant and positive, implying that a past increase in the policy rate contributes temporarily to the appreciation of the dirham, likely through short-term capital inflows.

Finally, money supply shows significant negative effects at several lags, indicating that monetary expansion quickly puts downward pressure on the value of the dirham. This result is consistent with short-run monetarist mechanisms.

Overall, the significant coefficients reflect short-run dynamics that align with theoretical

foundations. The model exhibits good explanatory power ( $R^2 = 0.8585$ ) and no residual autocorrelation ( $DW \approx 2.59$ ). These findings confirm the relevance of the ARDL

approach for modeling fluctuations in the Moroccan exchange rate.

#### 4.4.4. Long-Term Relationship of the ARDL Model

**Table 7: Results of the long-term estimation**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-1.248732	0.174847	-7.141834	0.0000
D(TCH(-1))	0.610494	0.144955	4.211619	0.0007
D(INF)	-0.113157	0.049411	-2.290105	0.0359
D(INF(-1))	0.319463	0.069235	4.614152	0.0003
D(INF(-2))	0.398837	0.068366	5.833874	0.0000
D(RCH)	-0.029839	0.009525	-3.132600	0.0064
D(RCH(-1))	0.038700	0.013855	2.793217	0.0130
D(RCH(-2))	0.024953	0.010294	2.424043	0.0276
D(RCH(-3))	0.018126	0.009125	1.986407	0.0644
D(TINT)	0.091948	0.176256	0.521671	0.6090
D(TINT(-1))	0.661366	0.177028	3.735947	0.0018
D(TMM)	0.038838	0.016701	2.325452	0.0335
D(TMM(-1))	-0.195947	0.037040	-5.290091	0.0001
D(TMM(-2))	-0.131782	0.024499	-5.379143	0.0001
D(TMM(-3))	-0.121094	0.026645	-4.544637	0.0003

Source: Constructed by the author

According to Table 7, the results of the ARDL(4,2,4,3,4) model reveal the presence of a long-run relationship between the exchange rate and its macroeconomic determinants included in the study. The long-run adjustment coefficient (COINTEQ = -1.2487) is negative and highly significant ( $p < 0.01$ ), indicating a stable cointegrating relationship among the variables. Its absolute value, greater than one, implies that the return to equilibrium following a shock is rapid, reflecting a strong adjustment capacity of the Moroccan exchange rate in response to macroeconomic imbalances.

The long-run results show that inflation (INF) has a negative impact on TCH: a sustained increase in the general price level leads to a depreciation of the dirham. Indeed, high inflation reduces the purchasing power of the domestic currency, which results in a deterioration of its external value. Foreign exchange reserves (RCH) also exhibit a negative and significant effect. This indicates that an increase in foreign reserves by the central bank strengthens monetary credibility and helps stabilize or appreciate the dirham, reflecting the effectiveness of its interventions in the foreign exchange market.

With regard to the interest rate (TI), the effect is positive in the long run. An increase in the policy rate makes dirham-denominated assets more attractive to investors, thereby encouraging foreign capital inflows and contributing to the appreciation of the exchange rate.

Finally, money supply (TMM) exerts a negative influence on TCH: excessive monetary expansion increases overall liquidity and puts downward pressure on the value of the dirham. This relationship is fully consistent with monetarist theory, which posits that excessive money creation leads to a deterioration in the value of the national currency.

Overall, these results show that the Moroccan exchange rate is determined in the long run by monetary and external fundamentals. They also highlight that central bank interventions, through the management of foreign reserves, the policy rate, and money supply, play a key role in maintaining the stability of the dirham. Thus, the observed dynamics reflect a relatively effective monetary policy in preserving external balance and controlling inflationary pressures.

#### 4.5. Diagnostic Tests of Optimal model ARDL

**Table 8: Results of diagnostic tests of the optimal ARDL model**

Test Hypothesis	Tests	Values (p-value)
Autocorrélation	« <i>Breusch-Godfrey</i> »	3.44 (prob. 0.07)
Heteroskedasticity	« <i>Breusch-Pagan-Godfrey Arch</i> »	1.09 (prob. 0.45)
Normality	« <i>Jarque-Bera</i> »	0.49 (prob. 0.78)

Source: Constructed by the author

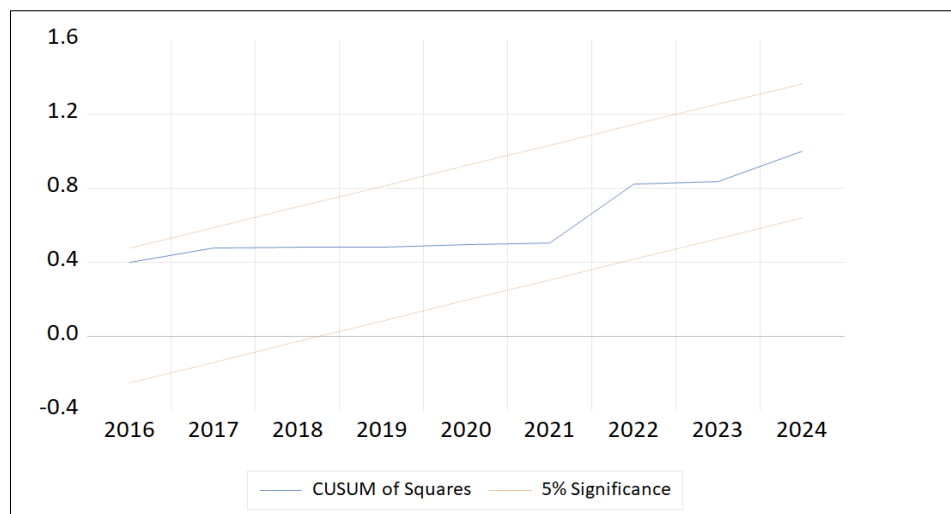
As shown in Table 7, diagnostic tests confirmed the validity of ARDL model. The Breusch–Godfrey test

( $p = 0.07$ ) indicates the absence of autocorrelation, the Breusch–Pagan–Godfrey/ARCH test ( $p = 0.45$ ) shows



that the error variance is constant, and the Jarque–Bera test ( $p = 0.78$ ) confirms the normality of the residuals.

Thus, the model is well specified and econometrically robust.



**Figure 3: Stability test**  
Source: Constructed by the author

Figure 3 illustrates the results of the CUSUM of Squares stability test applied to the residuals of the ARDL model. This test is used to evaluate whether the estimated coefficients remain stable throughout the sample period, which in this case extends from 2016 to 2024. Ensuring parameter stability over time is a crucial requirement for the validity of econometric results.

In the figure, the blue line represents the cumulative sum of squared residuals, while the red lines indicate the 5% critical confidence bounds. When the plotted curve stays within these limits, it suggests the absence of structural breaks and confirms the stability of the estimated relationships. Here, the CUSUM of Squares curve remains fully contained within the confidence bands and does not cross the critical thresholds, pointing to stable coefficients over the period considered.

These results confirm the dynamic robustness of the ARDL model, indicating that no significant changes in the relationships among the variables were detected over time. Thus, the model retains its validity for analyzing short- and long-term relationships between the studied variables. In summary, the CUSUM test of squares validates the structural stability of the model, reinforcing the reliability of the resulting econometric estimates and inferences.

## 5. DISCUSSION

The empirical analysis carried out in this study sheds light on the interactions between central bank interventions, key monetary variables, and exchange rate dynamics in Morocco over the period 1990–2024. Several key conclusions emerge from the econometric investigation based on the ARDL model.

First, the results confirm that monetary fundamentals are a key factor in exchange rate movements. In particular, the study shows that inflation, money supply, foreign exchange reserves, and interest rates have significant short- and long-term effects on the behavior of the dirham. This conclusion is in line with the work of Ishii *et al.*, (2006) and Basu (2012), who emphasize that price stability, monetary credibility, and reserve management are the main channels through which central banks influence foreign exchange markets.

Foreign exchange reserves have a particularly significant impact. Our results indicate that the accumulation of reserves contributes significantly to exchange rate stabilization, thereby reducing downward pressure on the dirham. This finding is consistent with the conclusions of Fratzscher *et al.*, (2019), who show that large and credible interventions are effective in more than 80% of cases. It is also consistent with the findings of (Durán-Vanegas 2015; Mnatsakanyan 2024; Sarno & Taylor 2001), who argue interventions act as a signaling mechanism capable of shaping agents' expectations and correcting disorderly speculative behavior.

With respect to inflation, the estimations point to a negative and statistically significant long-run relationship between the general price level and the value of the dirham. Sustained inflationary pressures are associated with a depreciation of the domestic currency, in line with monetarist theory. These observations are consistent with the studies of El-Khodary (2024), Viziniuc (2021) and Löffler *et al.*, (2016), which highlight how internal macroeconomic imbalances can weaken a currency and reduce the effectiveness of interventions when monetary policy lacks coherence.

Money supply also exerts a negative effect, indicating that periods of monetary expansion tend to weaken the dirham. This dynamic is consistent with the conclusions of Musthaq (2023), who argues that liquidity management is a central component of intervention effectiveness, and that the absence of monetary discipline can neutralize their positive effects.

With regard to the interbank interest rate, results show that it has a significant influence on exchange rates, particularly in the long term. An increase in the interest rate strengthens dirham by attracting foreign capital. This interest rate arbitrage mechanism confirms the analyses of Chang *et al.*, (2017), which highlight the importance of coordinated policies, particularly in emerging economies where financial markets are sensitive to interest rate differentials.

These empirical findings also highlight the essential role of the Moroccan institutional framework. The presence of a negative and highly significant adjustment coefficient indicates that the return to equilibrium after a shock is rapid. In other words, Bank Al-Maghrib succeeds in maintaining the structural stability of the exchange rate despite external disturbances. This observation echoes the conclusions of Katusiime (2023), who identifies similar effects in the Ugandan case, where interventions play an active role in absorbing external shocks.

Another important result is the stability of the model's coefficients, demonstrated by the CUSUM test. This stability suggests that Moroccan monetary policy has remained coherent over time, despite the recent exchange rate regime reforms initiated in 2018. This aligns with the work of Yildiz & Aydin (2020), who show that predictable and transparent institutional mechanisms, such as the Reserve Option Mechanism strengthen the effectiveness of interventions by stabilizing expectations.

Ultimately, this study shows that Bank Al-Maghrib's interventions cannot be interpreted in isolation, but rather form Teil of a broader set of monetary and financial policies. The effectiveness of interventions depends heavily on their consistency with reserve management, liquidity policy, and the institutional framework. This integrated approach is consistent with the findings of Delli Gatti *et al.*, (2025), who argue that market reactions depend not only on the interventions themselves, but also on the behavior of agents and the policy rules followed by the central bank.

## 6. CONCLUSION

This study aimed to examine the influence of measures taken by Bank Al-Maghrib on exchange rate developments in Morocco, based on an ARDL model using annual data covering the period 1990-2024. The results clearly show that the exchange rate in Morocco is largely determined by a set of monetary and external

indicators, including inflation, the interbank interest rate, money supply, and foreign exchange reserves.

The empirical analysis first confirms the existence of a long-run relationship among these variables, indicating that the exchange rate evolves around an equilibrium determined by macroeconomic fundamentals. This finding is consistent with the international literature, which suggests that foreign exchange interventions are more effective when implemented within a coherent macroeconomic framework. In Morocco, the presence of a fast adjustment coefficient highlights the system's ability to quickly correct imbalances, reflecting the credibility of monetary policy.

Foreign exchange reserves appear as the main operational instrument enabling the central bank to stabilize the dirham. Their negative and significant impact on the exchange rate confirms that BAM's interventions help reduce depreciation pressures. Inflation and money supply also play a decisive role: their negative effects on the exchange rate illustrate that monetary discipline remains essential for preserving the value of the dirham. As for the interest rate, its impact confirms the relevance of the financial transmission channel, strengthening the attractiveness of dirham-denominated assets.

Diagnostic and stability tests confirm the robustness of the model, while the absence of structural breaks suggests that the estimated relationships remain valid despite economic transformations and exchange rate regime reforms. These results attest to the strength of the Moroccan institutional framework and the coherence of the central bank's actions over the past decades.

Overall, this research shows that Bank Al-Maghrib's interventions in the foreign exchange market are generally effective, provided they are accompanied by prudent liquidity management, credible monetary policies, and close monitoring of macroeconomic fundamentals. In a context of gradual dirham liberalization, the findings highlight the importance of strengthening transparency, predictability, and policy coordination to consolidate exchange rate stability.

This study also opens the way for future research focusing on the impact of external shocks, the role of domestic financial markets, and the integration of volatility and uncertainty indicators. Such research avenues would help deepen the understanding of transmission mechanisms and better support Morocco's transition toward greater exchange rate flexibility.

## 7. Limitations

It's important to recognize some limitations of this study. First, it's based on annual data covering only 35 observations, which limits the ability to capture long-

term fluctuations and reduces the statistical power of the tests. Second, the choice of variables remains limited: although relevant, inflation, interest rates, money supply, and foreign exchange reserves represent only some of the factors influencing the exchange rate. Variables such as capital flows, external shocks, the current account balance, or agents' expectations could have provided a more comprehensive perspective.

Furthermore, using foreign exchange reserves as an indicator of Bank Al-Maghrib interventions is a simplification, as it does not distinguish between different types of operations (sterilized, discretionary, spot, or forward interventions).

These limitations do not call into question the relevance of the results, but rather highlight the need to diversify methodological approaches and enrich future research in order to better understand the complexity of central bank interventions in the Moroccan currency market.

## REFERENCES

- Amraoui, K., Alami Harrak, S. & El-Khodary, M. (2025). Asymmetric Effects of Exchange Rate Volatility on Trade and Investment: A Nonlinear Approach. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi* 9(4). doi:10.22437/jiituj.v9i4.43964
- B, A., & Deo, M. (2025). A Study of the Effectiveness of Central Bank Intervention in BRICS Countries. *International Economics and Economic Policy* 22(1). doi:10.1007/s10368-024-00649-1
- Basu, K. (2012). How to Devalue Exchange Rates, without Building up Reserves: Strategic Theory for Central Banking. *Economics Letters* 117(3):758–61. doi:10.1016/j.econlet.2011.12.069
- Carstens, A. (2021). Les Banques Centrales s'adaptent à de Nouveaux Défis. *Revue d'économie Financière* 144(4):33–46. doi:10.3917/ecofi.144.0033
- Chang, M.C., Suardi, S. & Chang, Y. (2017). Foreign Exchange Intervention in Asian Countries: What Determine the Odds of Success during the Credit Crisis? *International Review of Economics and Finance* 51:370–90. doi:10.1016/j.iref.2017.06.007
- Delli Gatti, D., Ferraresi, T., Gusella, F., Popoyan, L., Ricchiuti, G. & Roventini, A. (2025). The Complex Interplay between Exchange Rate and Real Markets: An Agent-Based Model Exploration. *Journal of Economic Behavior and Organization* 238. doi:10.1016/j.jebo.2025.107252
- Dominguez, K.M. (1998). Central Bank Intervention and Exchange Rate Volatility. *Journal of International Money and Finance* 17(1):161–90. doi:10.1016/S0261-5606(97)98055-4.
- Drut, B. (2022). Banques Centrales: Les Nouveaux Outils de Politique Monétaire. *De Boeck Supérieur* 196
- Durán-Vanegas, J. D. 2015. Do Foreign Exchange Interventions Work as Coordinating Signals in Colombia? *Ensayos Sobre Política Económica* 33(78):169–75. doi:10.1016/j.espe.2015.05.001.
- Edison, H., Cashin, P. & Liang, H. (2006). “Foreign Exchange Intervention and the Australian Dollar: Has It Mattered?” *International Journal of Finance and Economics* 11(2):155–71. doi:10.1002/ijfe.299
- El Kadri, A., El-Khodary, M. & Rifki, O. (2025). Combining ARDL and Tree-Based Machine Learning Methods to Assess the Impact of Exchange Rate Volatility on Moroccan Foreign Trade. *11th International Conference on Optimization and Applications (ICOA), Kenitra, Morocco* 1–6. doi:10.1109/ICOA66896.2025.11236930
- El-Khodary, M. (2024). The Impact of Money Supply, Interest Rate and Inflation Rate on Economic Growth: A Case of Morocco. *Journal of Economics, Finance, and Accounting Studies* 6(2):132–142. doi:https://doi.org/10.32996/jefas.2024.6.2.10
- Fratzscher, M., Gloede, O., Menkhoff, L., Sarno, L. & Stöhr, T. (2019). When Is Foreign Exchange Intervention Effective? Evidence from 33 Countries. *American Economic Journal: Macroeconomics* 11(1):132–56. doi:10.1257/mac.20150317
- Ishii, S., Canales-Kriljenko, J.I., Guimarães, R. & Karacadag, C. (2006). “Official Foreign Exchange Intervention.” *IMF Occasional Papers* (249):1–47
- Katusiime, L. (2023). COVID-19 and the Effect of Central Bank Intervention on Exchange Rate Volatility in Developing Countries: The Case of Uganda. *National Accounting Review* 5(1):23–37. doi:10.3934/NAR.2023002
- Krušković, B.D. (2022). Central Bank Intervention in the Inflation Targeting. *Journal of Central Banking Theory and Practice* 11(1):67–85. doi:10.2478/jcbtp-2022-0003
- Lamrani, K. & Bennis, L. (2022). Intervention Des Banques Centrales Sur Le Marché Des Changes et Leurs Contributions à La Stabilité Financière. *Revue Française d'Economie et de Gestion* 3(3):143–57
- Löffler, A., Schnabl, G. & Schobert, F. (2016). Limits of Monetary Policy Autonomy of East Asian Central Banks. *Applied Economics Quarterly* 62(3):187–204. doi:10.3790/aeq.62.3.187
- Mnatsakanyan, R. (2024). The Impact of Reserve Requirements on Macroeconomic and Financial Stability in a Small Open Economy. *SN Business & Economics* 4(12):164. doi:https://doi.org/10.1007/s43546-024-00758-8
- Musthaq, F. (2023). Unconventional Central Banking and the Politics of Liquidity. *Review of International Political Economy* 30(1):281–306. doi:10.1080/09692290.2021.1997785

- Rincón-Castro, H., Rodríguez-Niño, N. & Toro-Córdoba, J.H. (2020). Are Capital Controls and Central Bank Intervention Effective? *Investigacion Economica* 79(313):31–50. doi:10.22201/FE.01851667P.2020.313.76064
- Roy Trivedi, S., & Apte, P.G. (2016). Central Bank Intervention in USD/INR Market: Estimating Its Reaction Function and Impact on Volatility. *Asia-Pacific Financial Markets* 23(3):263–79. doi:10.1007/s10690-016-9218-6
- Sarno, L. & Taylor, M.P. (2001). Official Intervention in the Foreign Exchange Market: Is It Effective and, If so, How Does It Work? *Journal of Economic Literature* 39(3):839–68. doi:10.1257/jel.39.3.839
- Uz Akdogan, I. (2020). Understanding the Dynamics of Foreign Reserve Management: The Central Bank Intervention Policy and the Exchange Rate Fundamentals. *International Economics* 161:41–55. doi:10.1016/j.inteco.2019.11.002
- Viziniuc, M. (2021). Winners and Losers of Central Bank Foreign Exchange Interventions. *Economic Modelling* 94:748–67. doi:10.1016/j.econmod.2020.02.016
- Yildiz, S.N. & Aydin, Ü. (2020). Analysis of Reserve Option Mechanism Applied for Providing Financial Stability. Pp. 165–81 in *Evolution of Money, Banking and Financial Crisis: History, Theory and Policy*.