Revue du Contrôle de la Comptabilité et de l'Audit
ISSN: 2550-469X
Volume 6 : Numéro 4

MONEY DEMAND STABILITY IN MOROCCO AND THE EFFECTIVENESS OF MONETARY POLICY: AN ECONOMETRIC STUDY WITH THE CO-INTEGRATED VAR MODEL

LA STABILITÉ DE DEMANDE DE MONNAIE AU MAROC ET L'EFFICACITÉ DE LA POLITIQUE MONÉTAIRE : UNE ÉTUDE ÉCONOMÉTRIQUE AVEC LE MODÈLE VAR CO-INTÉGRÉ

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Date submitted : 30/07/2022

Date of acceptance : 19/11/2022

To cite this article:

EL HASSNI. H & OUALI. I (2021) «Money demand stability in morocco and the effectiveness of monetary policy: An econometric study with the co-integrated var model», Revue du contrôle, de la comptabilité et de l'audit « Volume 6 : Numéro 4 » pp : 23 - 46

Abstract

The main objective of this paper is to study the stability of the demand for money in Morocco and its implication on the conduct of monetary policy. Our data were extracted from the World Bank and the High Commission for Planning database and consist of annual data covering the period from 1990 to 2018. We adopt an approach based on the concept of cointegration. After studying the stationarity of the variables, the VAR econometric specification suitable for our study is that of the cointegrated VAR model.

In light of the results of the empirical study on the Moroccan case, we can conclude that the currency demand function in Morocco is stable over the period studied, and the demand for M3 currency in Morocco is predictable and can be used for the effective implementation of monetary policy.

Keywords: Monetary policy; demand for money; inflation; cointegrated VAR; Stationarity test.

Résumé

Cet article a pour objectif principal l'étude de la stabilité de la demande de monnaie au Maroc et son implication sur la conduite de la politique monétaire. Nos données sont annuelles et couvrent la période allant de 1990 à 2018, elles ont été extraites depuis la base des données de la Banque Mondiale et du Haut-commissariat au plan. Nous adoptons une approche basée sur le concept de la cointégration, après l'étude de la stationnarité des variables, la spécification économétrique VAR adéquate avec notre étude est celle du modèle VAR cointégré.

À la lumière des résultats de l'étude empirique consacrée au cas marocain, nous pouvons conclure que la fonction de la demande de monnaie au Maroc est stable sur la période étudiée et la demande de monnaie M3 au Maroc est prévisible et peut être utilisé pour la mise en œuvre effective de la politique monétaire.

Mots-clés : Politique monétaire ; demande de monnaie ; inflation ; VAR cointégré ; Test de stationnarité.

Introduction

Economists and the scientific community still debate the conduct of monetary policy. At the origin of this debate is the object of its control, namely the currency, which is a permanent subject of controversy. Indeed, "the examination of the relationship between money and economic activity from the perspective of the theory of demand is fundamental in the formulation of economic policies." (Zejli, 1990).

In Morocco and until the end of the 1980s, most of the monetary policy was framed by the banking law of June 1967 and was based on regulation by quantities (supervision and selectivity of credit). However, the phenomenon of financial liberalization, which marked the same period, considerably modified the speed of circulation of money and consequently made the intermediate objective of growth of the money supply insufficient to guarantee price stability. This is how far-reaching financial reforms have been undertaken by Morocco and aim to ensure the development of Moroccan financial markets and to assign to the central bank (which became autonomous in 2006) one of the essential roles, which consists in carrying out an effective monetary policy capable of ensuring price stability (low and stable inflation) and managing economic fluctuations.

The action of targeting monetary aggregates to achieve the final objective of price stability is based on the monetarist theory, which stipulates the existence of a close link between the money supply and inflation. Indeed, Friedman (1956) considers that the demand for money is stable and that the random fluctuations in demand for cash are weak, and their evolution can be predicted with precision by means of the money demand function.

The importance of the money demand function has led many economists and scholars to study the relationship between money demand and its determinants empirically, as it has important implications for the conduct of monetary policy. Indeed, "the stability of the demand for money constitutes a fundamental element in the strategic mechanism of central banks" (Avom et al., 2020).

Thus, a stable money demand function is necessary for exerting a predictable influence on the economy so that the control of monetary aggregates can be an effective instrument of economic policy. However, if this function turns out to be unstable, then we can speak neither of a credible monetary policy nor of monetary targeting. In the Moroccan case, several empirical studies have focused on the stability of the demand for money. One could cite as an example the works of (Zejly, 1990), (M'Kaddem, 1997), (El hafidi, & al., 2006), and (Moudine, & al., 2013). The results differ between validation and rejection of this stability.

The objective of this research work is to contribute to deepening the reflection around the theme of the stability of the demand for money through an analysis of the cointegrated VAR model in order to answer the following questions:

- Is the money demand function stable in Morocco?

- Is targeting the M3 aggregate effective for the conduct of monetary policy?

In order to answer the research questions, this work is organized as follows. In the first axis, we present in a synthetic way the various theoretical approaches to the theory of the demand for money. The second axis will deal with changes and financial reforms in Morocco. The third axis will be devoted to the empirical study and presents the main implications.

1. Some theoretical considerations

In a broader conception, money is defined based on three fundamental functions: unit of account, store of value, and medium of exchange. There is a historical debate between these different functions; the different theoretical reflections proposed below explain the demand for money.

For the authors of the classical school, money is only a means of exchange, and the only reason for its possession is the reason for the transaction. "For liberal economists, money is only a veil that hides real wealth, that of products, and is only a lubricant that reduces the friction of generalized barter" (Castex, 2003).

According to J.-B. Say (1767-1832), money is a veil, in the sense that it does not modify the exchange in any monetary exchange (goods against money, or services against money) real exchange of goods and services. Thus, "There is no demand for holding money for itself" (Hamdi et al., 2021).

For the classics, the currency has no effect on real activity, so there is no relationship between the real sphere and the monetary sphere; a rise in the currency results in a rise in prices of the same importance.

The quantitative theory of money was approached for the first time in the work of the economist Bodin (1568) in his memoir entitled "Responses to the paradoxes of M. de Malestroit touching the increase of things", where he notes the rise in the price level following the influx of precious metals from the new world. The quantity theory of money will be formulated and finalized by the economist Fisher (1912) via the trade equation **M * V = P * T** With :

- M: The stock of money present in the economy;

- V: The speed of circulation of money;
- P: The general price index ;
- T: Total volume of transactions carried out over the period.

According to the Fisher hypothesis, money moves at a fixed speed and is only a medium of exchange and determines the general price level. Indeed, an increase in the quantity of money in circulation results in an increase in aggregate demand. Since the supply has remained stable, the price level will increase.

On the other hand, the followers of the school of Cambridge Pigou (1917), Marshall (1923), consider that money is also a store of value, that it can be desired for itself, and whose circulation or not depends in part on the desire of economic agents to hold liquidity. Agents express a demand for money proportional to total resources, the equation proposed by the Cambridge school is as follows: $M = k P Y$

With :

- K: proportion of cash desires
- P: the price level
- Y: real national income

It can be seen that the Fischer equation is placed in a macroeconomic angle, while the neoclassical equation has an individualistic vocation. This is the difference between Fisher's TQM and the Cambridge monetary equation; however, the analysis leads to the same conclusion: the volume of monetary circulation and prices vary proportionally.

The economist Keynes (1936), inspired by the work of the Cambridge school, shows that in addition to the transaction motive, agents hold money to protect themselves from unpredictable and unexpected expenses (precautionary motive). For him, in addition to the two reasons already mentioned, the agents also hold the currency for a motive of speculation. It assumes that the amount of money held for speculative purposes is proportional to income and the interest rate. Keynes distinguishes two types of assets that can only be used as a store of value: Money and securities.

According to Keynes, the increase in the quantity of money in circulation does not lead to inflation because demand, once stimulated, stimulates supply. Thus, the interest rate will invariably decrease if the money supply increases. The increase in the money supply will first increase the liquidity of all economic agents. The surplus money thus created will be spent by economic agents on bonds to take advantage of interest rates. This demand causes market prices to rise, leading to lower interest rates. Once interest rates fall too low, there will be an increase

in the demand for money for liquidity reasons. Moreover, if interest rates fall, the demand for investment increases.

Friedman (1956) suggests a reformulation of the quantity theory of money. For him, the demand for money comes under the theory of demand for assets. It depends on the wealth of individuals and the expected returns of other assets compared to that of money. At Keynes, the choice was a trade-off between money and titles. At Friedman, the choice of asset is wider since the arbitrage concerns various assets but also real assets (real estate and human capital). For Friedman, the demand for money from economic agents will depend on three factors:

- The total wealth that can be held in various forms (such as monetary and financial)
- The price and rate of return of each form of holding wealth: possible substitution between different assets that can make up the assets of agents
- The agents' preferences and, in particular, their attitude vis-à-vis the risk

Monetarists also explain that the demand for money depends on agents' permanent income (not on their current income, which is not perpetual). Agents base their decisions on what they have at a given moment and on what they can anticipate (expected future income). Hence, fluctuations in current income in the short term have no effect on agents, and variations in current income do not modify the demand for money. Milton Friedman explains that the goal of monetary policy is to maintain inflation at a stable and moderate level over the long term by controlling the money supply. The money supply must increase in relation to the expected growth of production in order to avoid inflationary slippage.

Several theories have tried to explain the role of money in the economy of a country. The classics and the neoclassical support, through the quantitative theory of money, the idea of the neutrality of money and assume the dichotomy between the monetary and real spheres. Keynes, for his part, rejected this dichotomy and explained that one could resort to "money creation" to revive the economy. The monetarists, led by Milton Friedman, considered that changes in the stock of money had an impact on the general price level and that the money supply should increase at a rate equal to the long-term growth rate of the economy to avoid inflationary pressures.

2. Financial reforms and changes in Morocco

Monetary policy is all the means available to states or monetary authorities to act on economic activity through the monetary offer. Indeed, "monetary policy is understood to be the action by

which monetary authority acts on the supply of money in order to achieve the objectives of economic policy (price stability, growth, full employment and external balance)" (Dabal, 2021).

In Morocco, until the end of the eighties and in the early nineties, the financial system was subject to strong regulatory constraints, and the conduct of monetary policy was mainly based on direct instruments such as credit supervision, administered interest rates and compulsory jobs. On the other hand, the capital market played a marginal role because the financial instruments were little diversified and the number of stakeholders in this market was restricted. In this context, we see that the public authorities widely controlled financial activity. This situation resulted in low competition between financial institutions, especially since banking activity was concentrated between a limited number of establishments.

With the start of the financial liberalization process in the early 1980s, the monetary authorities began to move towards indirect approaches; it is in this context that Morocco embarked on a vast reform of its financial system, intending to relax the regulation of interest rates gradually, and ensuring the abandonment of quantitative constraints on bank loans. The main reforms are summarized in the following:

- The gradual liberalization of interest rates: the main objective of this reform was to stimulate competition between banks based on market mechanisms and to ensure a better allocation of financial resources. The process of liberalizing interest rates, the effective start of which dates back to 1990, was completed in 1996 with the removal of the ceilings set for lending rates as well as the preferential rates which still benefited certain privileged credits (Moudine et al. .,2013);

-The significant reduction in minimum reserve requirements;

- The reform of the financial capital market through:

- The adoption in 1993 of three laws relating to the Casablanca Stock Exchange (BVC), OPCVM and CDVM;
- The adoption of two new laws in 1997 emphasized the strengthening of the role of the central market, the creation of a second market for SMEs and finally, the improvement of investor protection. The second text of the law introduced the institution of a new regime for the holding of securities listed on the official list (registration in a current account) and the creation of a central depositary (Maroclear);

-The reform of the monetary market by making the auction market more dynamic and the creation in 1995 of the negotiable claims market (TCN) in order to develop alternative funding sources for businesses;

In 2006, with the adoption of a new central bank statute, BAM became an independent institution in charge of monetary policy, with the primary mission of ensuring price stability. "BAM now has autonomy in the choice of its monetary policy instruments. Within the framework of its prerogatives, Bank Al-Maghrib conducts its monetary policy by acting, among other things, on liquidity and relying on various tools relating to the injection and withdrawal of liquidity, fine-tuning operations (Open Market, foreign exchange swaps) and, finally, the monetary reserve requirement" (Moumni & al., 2016).

Following the advent of the 2008 financial and economic crisis, the Moroccan financial system has shown a certain resilience to the repercussions of the crisis. However, the real economy was impacted through several channels, including foreign demand and the transfers of Moroccans residing abroad. In this context and to strengthen the solidity of the financial system, Bank Al-Maghrib has undertaken several major reforms. Thus, in 2015, a new banking law entered into force with the objectives:

- Broadening the scope of banking supervision;
- The Introduction of the Provisions Governing Participatory Banks;
- Strengthening Rules Relating to Banking Governance and Customer Protection;

Likewise, BAM's information system has experienced a gradual expansion of monetary statistics coverage in addition to implementing several new regular surveys. These are in particular surveys on:

-Debtor rates,

-Credit conditions and inflation expectations.

With the advent of the COVID-19 crisis and to deal with the repercussions of the pandemic (the sudden judgment of economic activity and the associated cash problems), the Moroccan central bank has reduced the rate of monetary policy From 25 base points to 2 % then to 1.5 % in June 2020 and announced a series of monetary measures to maintain access to credit for companies and households, this is in particular:

-Postponement of credit maturities;

-The establishment of « Damane oxigène and Damane relance »;

In an international context of deregulation and liberalization, Morocco has been engaged since the 1990s in significant reforms of its financial system, marked by the modernization of financial markets and the liberalization of the banking system as well as the autonomy granted in 2006 to the central bank of Morocco in the conduct of monetary policy. All of these measures were aimed at ensuring the development of Moroccan financial markets and assigning to the central bank one of the essential roles of conducting an effective monetary policy that ensures price stability (low and stable inflation) and managing economic fluctuations in addition to its contribution to growth and employment.

3. Empirical study

As part of our empirical study, we will first specify the model to be estimated and define the variables used. Thereafter, we will present a descriptive analysis, which allows us to present the evolution of the variables and the econometric method, which will be done in four stages: unit root tests, multivariate cointegration test of Johansen, estimation and validation of the model with Correction of Error (MCE), Granger causality test.

3.1 Basic theoretical model

The choice of our variables of interest is based on the Keynesian theory and the quantitative approach in its classical form of I. Fisher and the post-Keynesian form of M. Friedman. Thus, we retain the following function expressing the demand for money as a function of the motives of the transaction (Y=GDP) and speculation (interest rate = r) [Keynesian approach] and motives of physical substitutes (inflation: CPI) [M Friedman's approach], so we define the functional relationship of money demand as follows:

$$\frac{\mathrm{M3}}{\mathrm{CPI}} = f\ (\mathrm{y}, \mathrm{r}, \mathrm{inf})$$

With:

y: Current GDP.

r: Interbank interest rate.

inf: Inflation rate.

CPI: Consumer Price Index.

M3/ CPI= MD: Demand for money.

→ In the rest of this work, we have opted for the use of the money demand function in logarithmic form.

3.2 The variables used and their evolution

3.2.1 Data presentations

Our annual data covers the period from 1990 to 2018 (See appendix N°1, page 20à). They were extracted from the database of the World Bank and the High Commission for Planning and include:

- Current GDP: Gross domestic product is the economic indicator that expresses the total value of the annual "wealth production" carried out by economic agents residing within a territory. Current GDP is measured at the prices prevailing during the year studied.

- The interbank money market rate: is the rate at which banks borrow and lend money to each other. It plays an essential role in financial activity and fluctuates according to inflation, unemployment, and economic situation.

- The M3 aggregate: this aggregate corresponds to the money supply in the broad sense and includes, in addition to M2[1], other less liquid monetary assets (term accounts and bonds with a fixed maturity, foreign currency deposits, securities given in repos, certificates of deposit with a residual term of less than or equal to 2 years, money market UCITS securities, term deposits opened with the public treasury.

- **The Consumer Price Index (CPI):** is the index that measures the change in the average price level of goods and services consumed by households, weighted by their share in average household consumption.

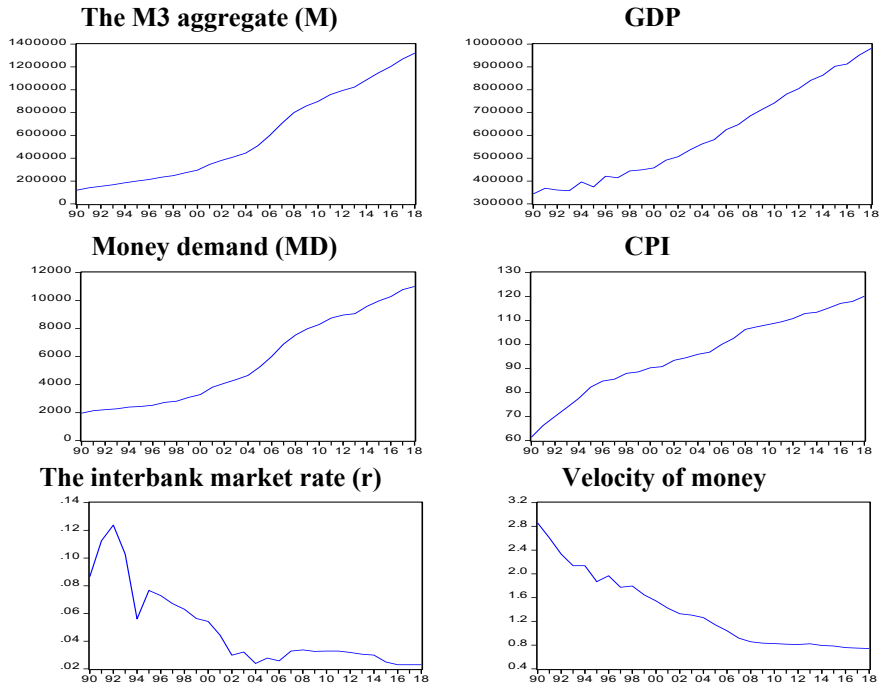
- Inflation rate: this is the rate of loss of purchasing power of money, characterized by a general and constant increase in prices. The consumer price index (CPI) is used in calculating inflation rate.

The graphs in figure N°1 allow us to observe the behaviour of the different variables of our model in addition to the indicator (velocity of money, GDP/M3) throughout the study period for Morocco (1990-2018).

[1] The M2 aggregate also includes banknotes and coins and sight deposits, interest-bearing sight investments

3.2.2 Graphs

Figure N° 1: Evolution of variables for the period (1990-2018)



Source: Calculations based on HCP and World Bank data.

From the graphs in Figure 1, we see that the variables MD, CPI, M and CPI have an upward trend over the entire period studied. For their part, the variables, interbank market rate (r) and the indicator (velocity of money circulation), have a downward trend. The downward trend in the variable (r) is explained by the de-fragmenting of credits introduced in 1992. While the evolution of the velocity of money informs us that the evolution of the money supply is more important than the growth of real activity.

Thus, we can anticipate in our analysis to say that the different variables are non-stationary according to their graphic visualization. This finding will be systematically tested later through the ADF and PP tests.

3.2.3 Descriptive statistics

Table N° 1: statistics of the variables studied

Elements	M3	CPI	GDP	r
Mean	**592713.0**	**95.91724**	**604314.9**	**0.048534**
Median	445883.0	95.90000	562875.0	0.032900
Maximum	**1320624.**	**120.1000**	**981146.0**	**0.123800**
Minimum	**120395.0**	**61.40000**	**343880.0**	**0.023000**
Observations	29	29	29	29

Source: Authors' calculation.

Table 1 shows that over the period studied:

- The average value of **the money supply (M3)** is 592713.0 MDHs. The maximum value recorded is 1320624 MDHs, while the minimum value is 120395.00 MDHs.
- The average **GDP** value is 604314.90 MDHs. The maximum recorded value is 981146.00 MDHs, while the minimum value is 343880.00 MDHs.
- The average value of the **CPI** is 95.91 MDHs. The maximum value recorded is 120.1000 MDHs, while the minimum value is 61.40 MDHs.
- The average value of **the interbank market rate** (r) is 4.8%. The maximum value recorded is 12.3%, while the minimum value is 2.3%.

We calculated the correlation matrix to deepen our analysis in terms of description.

Table N°2: Correlation matrix

Elements	MD	GDP	r	INF
MD	**1.000000**			
GDP	**0.994664**	**1.000000**		
r	**-0.733776**	-0.750630	**1.000000**	
INF	**-0.543164**	-0.566922	0.751218	**1.000000**

Source: Authors' calculation.

The correlation matrix (Table 2) shows that the demand for real money is strongly correlated with the explanatory variables, especially with the variables (gross domestic product and the interbank market rate).

After the description, the next step is to study the individual stochastic properties of the different variables. Especially the stationarity tests.

3.3 Unit root tests

Unit root tests allow for detecting the presence or not of a unit root in a series. Two-unit root tests are commonly used: the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The principle is to estimate the equations (ADF) and (PP) by determining the optimal lag, which ensures the whiteness of the residues. The null hypothesis of non-stationarity is rejected when the calculated statistic is lower than the critical value considering a given threshold.

The application of the non-stationarity tests (ADF) and (PP) to the different series in level gave the following results (see table n°3):

Table N°3: Results of the tests (ADF) and (PP) on the series in level

Variables	Test ADF			Test PP		
	Lag	Stat-ADF	Conclusion	Lag	Stat-PP	Conclusion
Lm	1	-0.92	I (1)	3	-1.8	I (1)
Lmd	1	-0.59	I (1)	3	-0.65	I (1)
Lgdp	5	-1.30	I (1)	1	0.35	I (1)
Lcpi	0	-6,77	I (1)	3	-4.9	I (1)
Linf	0	-2.76	I (1)	1	-3.64	I (1)
Lr	2	-2.22	I (1)	8	-0.9	I (1)
With I (1): the series is not stationary, and it is integrated of order 1 (it contains a single unit root).						

Source: Authors' calculation.

According to (Table N°3), we see that all the series are non-stationary in level. Hence, we applied the same tests on the differentiated series of order 1. The result is that the different variables become stationary after their first differentiation in view of the tests (ADF) and (PP) as shown in the table (Table N°4) and the graphs appearing in (appendix n°2, page 21):

Table N°4: Results of (ADF) and (PP) tests in first difference

Variables	Test ADF			Test PP		
	Lag	Stat-ADF	Conclusion	Lag	Stat-PP	Conclusion
Dlm	0	-2.72	I (0)	1	-2.80	I (0)
Dlmd	0	-2.84	I (0)	2	-2.90	I (0)
Dlgdp	4	-2.23	I (0)	2	-10.79	I (0)
Dlcpi	1	-2.76	I (0)	1	-3.64	I (0)
Dlinf	0	-8.45	I (0)	2	-8.73	I (0)
Dlr	1	-4.34	I (0)	2	-6.34	I (0)
With I (0): the series is stationary.						

Source: Authors' calculation.

The econometric methodology of cointegration teaches us that when the variables are not stationary and integrated in the same order, the appropriate VAR econometric specification is the cointegrated VAR model, also called the constrained VAR model or the error correction model. Thus, we must first test whether the variables under study are cointegrated. This is the subject of the next point.

3.4 Johansen multivariate cointegration tests

The Johansen cointegration test is based on the maximum likelihood method and involves two statistics: the trace statistic and the maximum eigenvalue statistic.

In the first step, we will determine the optimal lag to consider using the following information criteria:

- **Informational criteria for the selection of the optimal lag for a VAR model**

Critères	Programme	Calcul du critère
FPE	FPE(p) = min{FPE(j)/j =1,...,q}	$FPE(j) = \left(\frac{T+jk+1}{T-jk-1}\right)\Sigma_{u,j}$
AIC	AIC(p) = min{AIC(j)/j =1,...,q}	$AIC(j) = Ln\ \Sigma_{u,j} + \frac{2kj}{T}$
BIC	BIC(p) = min{BIC(j)/j =1,...,q}	$BIC(j) = Ln\ \Sigma_{u,j} + \frac{kj\,LnT}{T}$
HQ	HQ (p) = min{HQ(j)/j =1,...,q}	$HQ(j) = Ln\ \Sigma_{u,j} + \frac{2kj\,LnLnT}{T}$
SIC	SIC(p) = min{SIC(j)/j =1,...,q}	$SIC(j) = \Sigma_{u,j}\left(1+2\frac{kj+1}{T}\right)$

-

Source: Cited by AIT OUDRA (2006)

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The results obtained are presented in the following table (Table No. 5):

Table N°5: Determination of the optimal lag

Lag	LogL	LR	FPE	AIC	SC	HQ
0	173.5113	NA	4.66e-12	-14.74011	-14.54264	-14.69045
1	208.9654	55.49336	8.83e-13	-16.43177	**-15.44439***	-16.18345
2	231.2108	**27.08139***	5.95e-13	-16.97485	-15.19756	-16.52787
3	254.8607	20.56510	**4.68e-13***	-17.64006	-15.07286	-16.99442
4	280.5448	13.40040	5.90e-13	**-18.48216***	-15.12504	**-17.63785***

Source: Authors' calculation.

The results indicate that the calculated optimal lag is 4 for the AIC and HQ criteria, 3 for the FPE criterion and 1 for the SC criterion.

Johannsen's cointegration test can detect the existence of long-term relationships through trace statistics and the maximum eigenvalue. The results are given in the following two tables:

Table N°6: The statistics of the Johansen trace

Hypothesized		Trace	0.05	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None *	0.742861	79.16662	47.85613	0.0000
At most 1 *	0.588374	45.21316	29.79707	0.0004
At most 2 *	0.546759	23.02214	15.49471	0.0030
At most 3	0.121513	3.238865	3.841466	0.0719

Source: Authors' calculation.

Table N°7: The maximum eigenvalue statistic

Hypothesized		Max-	0,05	
No. of CE(s)	Eigen value	Statistic	Critical Value	Prob.**
None *	0.742861	33.95346	27.58434	0.0066
At most 1 *	0.588374	22.19101	21.13162	0.0354
At most 2 *	0.546759	19.78328	14.26460	0.0061
At most 3	0.121513	3.238865	3.841466	0.0719

Source: Authors' calculation.

We can see that the number of cointegration relationships for both statistics is 3. For the rest of our work, we have opted for the use of a single cointegration relationship. It is the one that involves all the variables of the study. It is estimated as follows:

1 Cointegrating Equation(s): Log likelihood 257.3608

Normalized cointegrating coefficients (standard error in parentheses)

LMD	LINF	LGDP	Lr
1.000000	-7.817672	-3.224295	-0.898294
	(2.41165)	(0.22768)	(0.16394)

After studying the cointegration relationships, the following error correction model was estimated :

$$\Delta m_t = \alpha ECM_{t-1} + \sum_{i=1}^{p} \partial_{1;i}\, \Delta m_{t-i} + \sum_{i=0}^{q} \partial_{2.i} \Delta LGDP_{t-i} + \sum_{i=0}^{h} \partial_{3,i} \Delta Lr_{t-i} + \sum_{i=0}^{s} \partial_{4,i}\, \Delta LINF_{t-i} + \emptyset DUM_t + \varepsilon_t$$

With:

- ECM_{t-1} : The long-run relationship for the money demand M3 of lag 1.
- α : The adjustment coefficient.
- $\partial_{s;i}$ et ϕ : The coefficients of the explanatory variables of the model.
- DUM : Any "dummy" variables.
- ε_t : The residual of the equation.
- p, q, h et s : Lags

After several simulations, the models presented, by the ordinary least squares method, and retained are the following (Table N°8):

Table N°8: Estimated error correction model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.119821	1.236729	6.565564	0.0000
ECM(-1)	-0.251895	0.038486	6.545062	0.0000
DLMD(-2)	-0.444584	0.258909	-1.717144	0.1116
DLMD(-3)	-0.649000	0.200369	-3.239025	0.0071
DLGDP(-2)	-0.772521	0.178624	-4.324837	0.0010
DLINF	-1.635685	0.529758	-3.087610	0.0094

DLINF(-1)	1.029825	0.526731	1.955124	0.0743
DLINF(-2)	1.275483	0.535389	2.382346	0.0346
DLINF(-3)	0.504028	0.387256	1.301535	0.2175
DLr(-1)	0.156833	0.029187	5.373452	0.0002
DLr(-2)	0.108765	0.032591	3.337301	0.0059
DLr(-3)	0.127582	0.045650	2.794780	0.0162

R-squared	0.880541	**Mean dependent var**	0.063601
Adjusted R-squared	0.771037	**S.D. dependent var**	0.039194
S.E. of regression	0.018755	**Akaike info criterion**	-4.807903
Sum squared resid	0.004221	**Schwarz criterion**	-4.218876
Log likelihood	69.69484	**F-statistic**	8.041164
Durbin-Watson stat	1.638222	**Prob(F-statistic)**	0.000566

Source: Authors' calculation

❖ **Interpretation:**

-The estimated model is well specified since the coefficient of the error correction term is negative. Moreover, it is significant. It indicates that there is a long-term causality and that the speed of adjustment is 25.19%.

- The model's predictive capacity is quite high since the coefficient of determination is 88%. That is to say, a correlation coefficient equal to 94%.

- The estimated model is quite stable in view of the CUSUM, CUSUM-squared, and stability of the coefficients stability tests (see stability tests in appendix N°3, page 22). This means that the money demand function in Morocco is stable over the period studied. It is concluded that the demand for money in Morocco is predictable and can be used for the effective implementation of monetary policy. The control of the monetary aggregate M3 constitutes an effective means for the formulation of monetary policy.

- The model successfully passes all the diagnostic tests (See diagnostic test results in Appendix 4, page 24).

The detection of long-term causality in our model prompted us to study short-term causality in the sense of Granger. The principle is as follows:

Consider two Variables Xt and Yt assumed to be stationary. The Granger causality test is based on the following bivariate VAR representation:

$$\begin{cases} X_t = a_0 + \sum_{i=1}^{i=p} \alpha_i X_{t-i} + \sum_{j=0}^{j=q} \beta_j Y_{t-j} + \varepsilon_{1t} \\ Y_t = b_0 + \sum_{i=0}^{i=p} \alpha_i' X_{t-i} + \sum_{j=1}^{j=q} \beta_j' Y_{t-j} + \varepsilon_{2t} \end{cases}$$

Xt is said not to cause Yt, in the Granger sense, if whatever i = 0; 1; 2;…; p : $\alpha_i' = 0$.

The Eviews software provides direct access to the results of this test and the interpretation based on the calculated threshold and the tabulated one. If we formulate the null hypothesis as follows: H0: "Xt does not cause, in the Granger sense, Yt", then H0 is rejected if the calculated threshold is lower than the tabulated threshold. The latter is chosen by the modeler according to the nature of the study. Note that in practice, we can tolerate up to a tabulated threshold of 10%.

- **The results of the test are presented in table N°9:**

Table N° 9: Granger causality test

Null Hypothesis	Obs	F-Statistic	Probability
DLMD does not Granger Cause DLINF	**23**	**3.58140**	**0.03271**
DLINF does not Granger Cause DLMD		0.20220	0.93296
DLGDP does not Granger Cause DLINF	23	1.80660	0.18369
DLINF does not Granger Cause DLGDP		0.55530	0.69863
DLR does not Granger Cause DLINF	23	1.47027	0.26366
DLINF does not Granger Cause DLR		1.63912	0.21969
DLGDP does not Granger Cause DLMD	**24**	**2.83076**	**0.06225**
DLMD does not Granger Cause DLGDP		**4.84671**	**0.01038**
DLr does not Granger Cause DLMD	24	1.47646	0.25862
DLMD does not Granger Cause DLR		0.89330	0.49197
DLr does not Granger Cause DLGDP	24	1.42067	0.27507
DLGDP does not Granger Cause DLR		0.83974	0.52117

Source: Authors' calculation.

Significant results that indicate the existence of a causal effect are shown in bold (see Table N°9).

According to the test of causality in the sense of Granger, we note the existence of the unidirectional causal effect between the variable demand for money (MD) and inflation rate (r) for a threshold of **5%,** also of after the same test and for a threshold of **10%,** the results obtained show the existence of the bidirectional causal effect between the demand for money (DM) and the gross domestic product (GDP).

Conclusion

As part of this research work, we sought to empirically verify the stability of the demand for money in Morocco through an empirical analysis of the cointegrated VAR model in order to know if the use of the targeting policy of inflation by controlling the money supply is effective for the conduct of monetary policy.

The results of the empirical study show that the model presented in this work is based on a cointegration relationship of the variables M, GDP, CPI and r, whose economic meaning is theoretically well established. The econometric technique adopted assumes a long-term equilibrium relationship. The estimated model, as a system, is sufficiently validated statistically.

The money demand function in Morocco (1990-2018) is statistically significant. It is also in perfect coherence with the theoretical lessons and the results established in previous empirical work carried out for the case of Morocco. This research highlights some aspects of the money demand function in Morocco:

- The money demand function in Morocco, estimated in the model, presents an appreciable stability.

- The non-neutrality of the currency approved by the statistical tests shows that price stability should remain the major objective of monetary policy.

-The demand for M3 money in Morocco is predictable and can be used to effectively implement monetary policy.

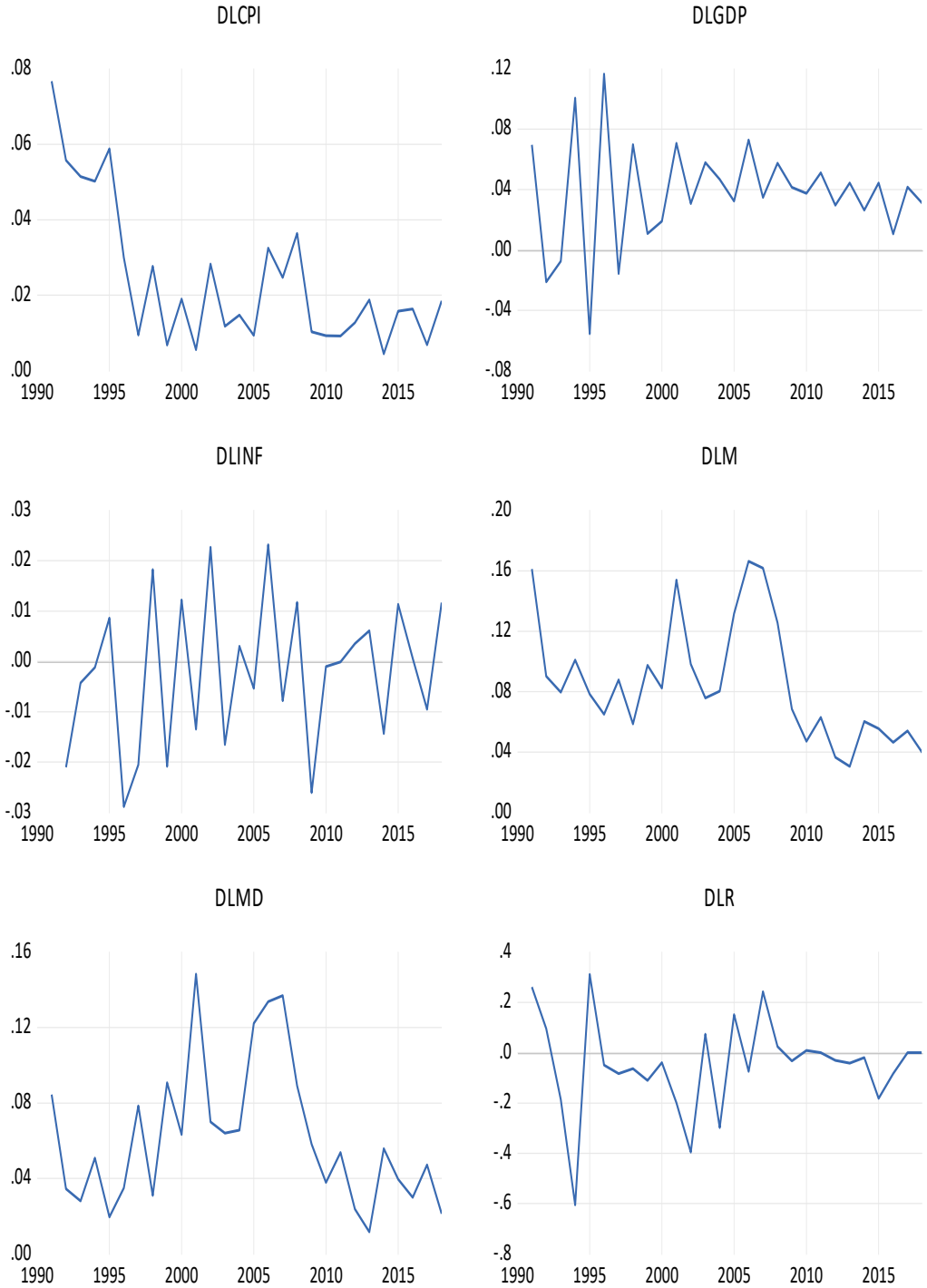
It should be noted that the results of this study may have limitations due mainly to the small number of observations and the consideration of a limited number of explanatory variables. Accordingly, to obtain more accurate results, further research could include other monetary aggregates, such as M1 and M2, in addition to the money supply M3. It would also be interesting to integrate other variables likely to better explain the demand for money in Morocco, such as the exchange rate.

APPENDICES

Appendix No. 1: Database

Year	Current GDP (In millions of dirhams)	Interbank money market rate	CPI (Base 2006)	Aggregate M3 (In millions of dirhams)
1990	343880	8,66%	61.4	120395
1991	368695	11,25%	66.3	141463
1992	360961	12,38%	70.1	154816
1993	358288	10,28%	73.8	167621
1994	396223	5,61%	77.6	185432
1995	374805	7,66%	82.3	200526
1996	421180	7,29%	84.8	213964
1997	414606	6,71%	85.6	233609
1998	444618	6,30%	88.00	247713
1999	449426	5,64%	88.6	273077
2000	458022	5,42%	90.3	296481
2001	491550	4,44%	90.8	345823
2002	506893	2,99%	93.4	381497
2003	537110	3,22%	94.5	411507
2004	562875	2,39%	95.9	445883
2005	581403	2,78%	96.8	508570
2006	625442	2,58%	100.00	600563
2007	647530	3,29%	102.5	705944
2008	685885	3,37%	106.3	800381
2009	714992	3,26%	107.4	857019
2010	742274	3,29%	108.4	898339
2011	781212	3,29%	109.4	956661
2012	804726	3,19%	110.8	992176
2013	841224	3,06%	112.9	1022816
2014	863680	3,00%	113.4	1086227
2015	902860	2,50%	115.2	1148039
2016	912429	2,30%	117.1	1202414
2017	951198	2,30%	117.9	1269097
2018	981146	2,30%	120.1	1320624
Sources	**world Bank**	**High Commission for Planning**	**High Commission for Planning**	**High Commission for Planning**

Appendix No. 2: Evolution of variables in first differences



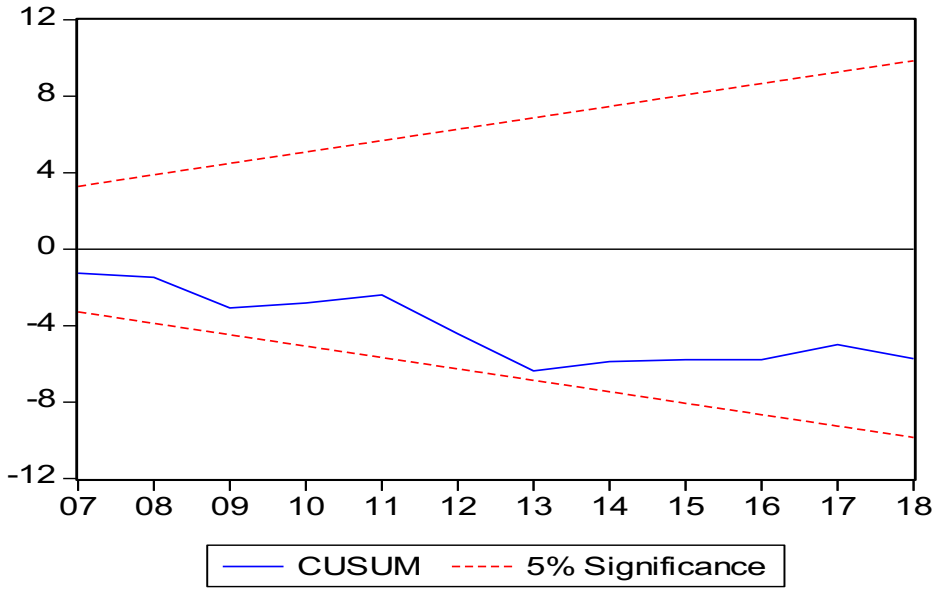
Source: Authors' estimates.

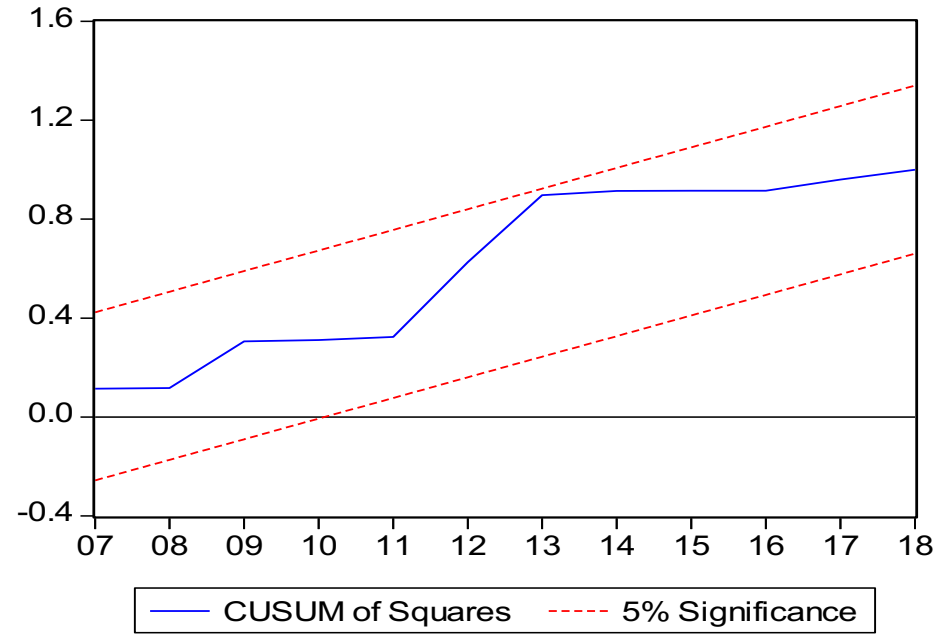
Appendix No. 3: Stability test

1. Ramsey reset test

F-statistic	1.363309	Probability	0.299526
Log likelihood ratio	5.786653	Probability	0.055392

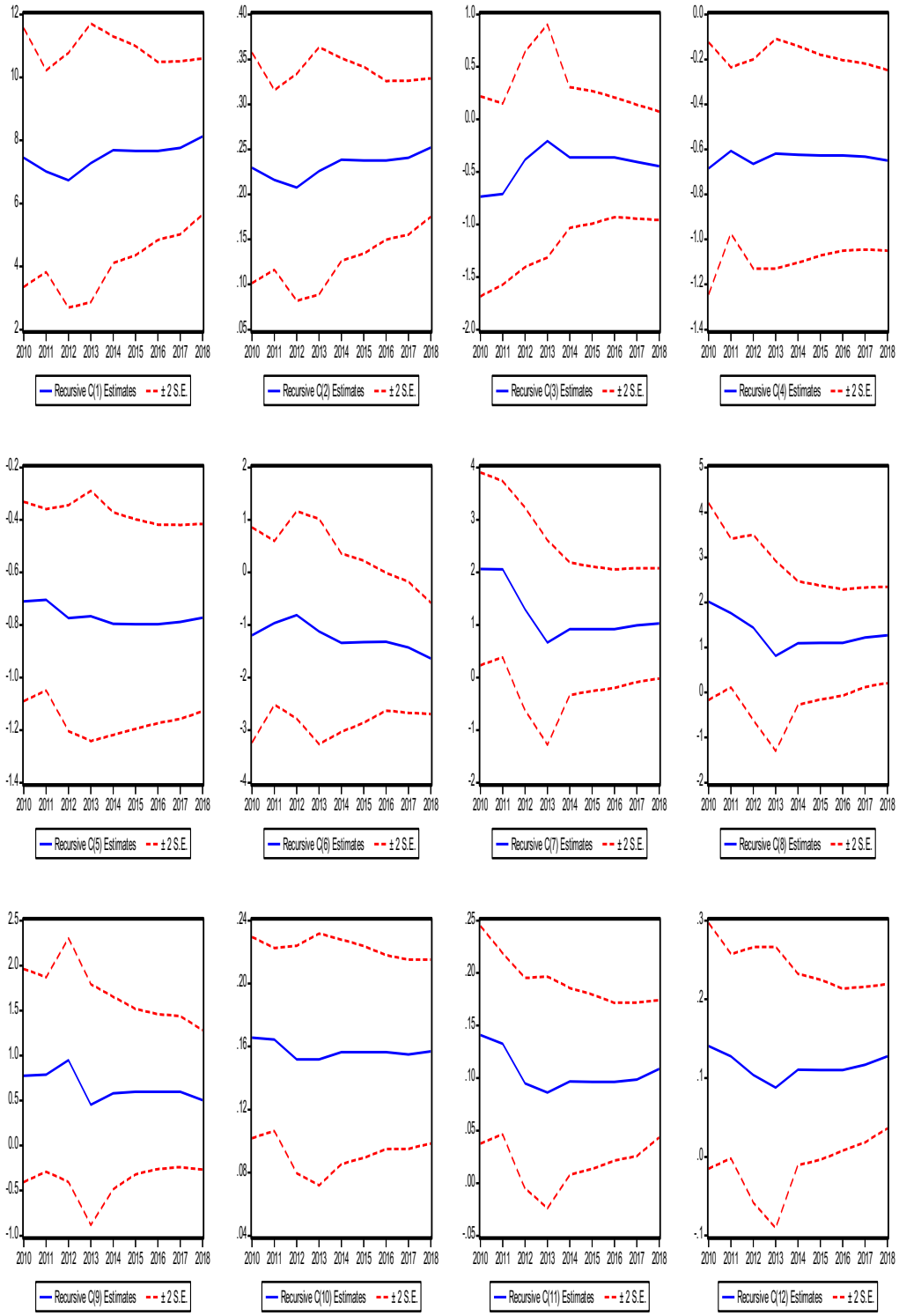
2. CUSUM and CUSUM-SQUARE stability test





Source: Authors' estimates

2. Coefficient stability



Source: Authors' estimates

Appendix No. 4: Diagnostic tests

1. Diagnostic tests

The purpose of various diagnostic tests is to validate the quality of a model. The table below summarizes the definition of each test and its hypothesis (H0). The hypothesis is rejected when the critical probability—called the "p-value" (calculated probability) in the Anglo-Saxon—is very low.

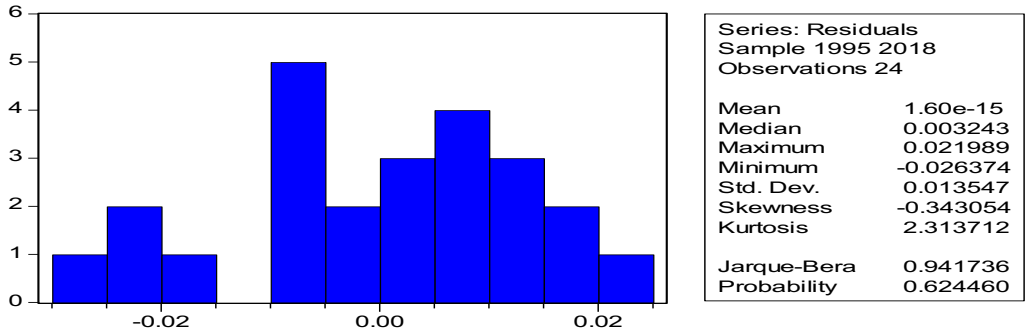
Table N° 10: Diagnostic tests

Testing	Null hypothesis(H0)
Ljung-Box test	The residuals are white noises up to the order considered
Jarcque-Berra normality test	Residuals are normally distributed
Breusch-Godfrey serial correlation test	No autocorrelation of residuals up to the order considered
Engle's ARCH test	No ARCH effect until the order considered
Ramsey's RESET linearity test	The specification considered is linear
White's heteroscedasticity test	Residuals are not heteroscedastic

Source: AIT OUDRA M. (2006), pp 136.

Below are the results of the various diagnostic tests according to the authors' calculations:

1. Normality



2. Serial correlation lm(2)

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.044207	Probability	0.387394
Obs*R-squared	4.146279	Probability	0.125790

3. ARCH LM(2) effect

ARCH Test:

F-statistic	0.843257	Probability	0.445789
Obs*R-squared	1.793599	Probability	0.407873

4. Heteroscedasticity

White Heteroskedasticity Test:

F-statistic	44.60446	Probability	0.117659
Obs*R-squared	23.97557	Probability	0.348511

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