Universidade de Aveiro Departamento de Economia, Gestão, Engenharia Industrial e Turismo
2020

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Substituição de moeda e previsão da inflação em Angola: comparação entre diferentes agregados monetários

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Economia, realizada sob a orientação científica do Doutor António Miguel Amôedo Lebre de Freitas, Professor Auxiliar do Departamento de Economia, Gestão, Engenharia Industrial e Turismo da Universidade de Aveiro.

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agradecimentos

Ao professor Miguel Lebre de Freitas, por este ano desafiador e de aquisição de conhecimento.
Ao curso de Economia, por fazer de Aveiro a minha casa.
À professora Mara Madaleno, que forneceu as aulas essenciais para a metodologia neste trabalho e está sempre pronta a ajudar.
Ao Rúben, por ser um exemplo a seguir.
E à minha família, sem eles nada disto seria possível.

palavras-chave Procura de moeda, Angola, Substituição de moeda, Inflação

resumo O objetivo principal deste estudo é identificar uma função procura de moeda estável para Angola e comparar o poder de previsão de diferentes agregados monetários relativamente à inflação. Com dados mensais desde 2012:01 até 2019:01 foi estimado um Vector Error Correction Model onde foram utilizadas especificações alternativas no processo de estimação. Foi também estimado um modelo Autoregressive Distributed Lag para prever a inflação no curto prazo. Os resultados sugerem que existe substituição de moeda em Angola levando à instabilidade da função procura de moeda. No entanto, também é possível verificar que este problema pode ser superado através do uso de agregados monetários mais amplos que incluam depósitos em moeda estrangeira.

keywords Money Demand, Angola, Currency Substitution, Inflation

abstract The main purpose of this paper is to identify a stable money demand function for Angola. Using monthly data from 2012:01 until 2019:01, we run a Vector Error Correction model, for the long-run relationships experimenting with different monetary aggregates. Then, an Auto Regressive Distributed Lag model is used to access the forecasting power of the corresponding excess liquidities regarding the inflation rate. The results indicate that there is currency substitution in Angola, but instability of money demand can be overcome by using broader monetary aggregates that include foreign currency deposits.

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Acronym List

ADF – Augmented Dickey-Fuller

AIC – Akaike Information Criterion

ARDL – Auto Regressive Distributed Lag

BNA – National Bank of Angola

CPI – Consumer Price Index

CS – Currency Substitution

CUSUM – Cumulative Sum

CUSUMQ – Cumulative Sum of Squares

FCD – Foreign Currency Deposits

GDP – Gross Domestic Product

INE – National Statistics Institute

LR – Likelihood-ratio

LSM – Liquidity Services Model

PBM – Portfolio Balance Model

USA – United States of America

VAR – Vector Autoregressive

VECM – Vector Error Correction Model

1. Introduction

In 2018, Angola adopted a new monetary policy regime, where the National Bank of Angola (BNA) controls directly the growth of the national monetary base (as the operational variable) (Banco Nacional de Angola, 2019) and indirectly the monetary aggregate M2 (as the intermediate goal) to insure the stability of prices in the medium and long run. The main reasoning underlying this strategy is the fact that inflation and the quantity of money have a long run relationship (Banco Nacional de Angola, 2018). Nevertheless, this strategy will only be effective if money demand is stable (Hossain, 2010).

Due to history of high inflation rates, Angola is a dollarized economy. If the opportunity cost of holding domestic money depends on the return of holding another currency, then domestic money demand will become unstable depending on the size of substitutability between the currencies. By the literature, currency substitution (CS) may destabilize domestic money demand, consequently reducing the effectiveness of money targeting (Calvo & Vegh, 1992).

Based on this, a question arises in whether the national monetary base is the appropriate monetary aggregate to target, or should a broader monetary aggregate be used instead?

To answer this question we estimate a money demand function for Angola experimenting with alternative monetary aggregates. A vector error correction model (VECM) estimation is computed and, afterwards, by taking the excess liquidities, an autoregressive distributed lag (ARDL) and a forecast analysis are made in order to check which measure of excess liquidity has more power predicting the price level. Excess liquidity is defined as the difference between the observed and the equilibrium monetary aggregates (Dreger & Wolters, 2010). We find evidence of currency substitution when considering narrow real money balances, such as the national monetary base. The same does not happen when using broader monetary aggregates, suggesting that CS is internalized. In this way, the money demand function becomes more reliable when broader monetary aggregates are used in the monetary policy formulation (Miles, 1978, 1981). In the forecast analysis, the results suggest that the model using the real broader M2 has a better forecasting power than the others.

The remaining of this study is organized as follows. Section 2 presents a brief revision of the literature as well as the theoretical model that underlies our money demand specification for Angola. Section 3 describes the variables and the methodology used in the empirical analysis. The estimation results are examined in section 4. By last, the conclusion is in section 5.

2. Literature Review

2.1 Angola, Money Targeting and Currency Substitution

Although, nowadays, most developed countries achieves price stability by conventionally controlling the interest rate (Dalziel, 2002), in the 1970s many Central Banks were targeting money (Federal Reserve Bank, 2018). The idea underlying this was that Central Banks kept inflation low and steady by keeping the money supply growth low and steady as well (Hossain, 2010), this comes from the classical view in which Friedman stated “inflation is always and everywhere a monetary phenomenon” (as cited in Hossain, 2010). When the United States of America (USA) came across a two digits inflation, in the end of 1970s, the monetarism was seen as the only way to achieve price stability. In 1979, the Federal Reserve stopped controlling the interest rate and decided to implement a “monetarist experiment” (Samuelson & Nordhaus, 2010). This experiment had success in stabilizing output and reducing inflation, which in two years reduced 9 percentual points. Albeit these results seemed quite satisfactory, the velocity of money became very unstable in the 1980s and was no longer predictable as monetarists defended. All these events led to the discrediting of monetarism, making the Federal Reserve to implement, in 1990, the interest rate as the main instrument to obtain price stability (Samuelson & Nordhaus, 2010).

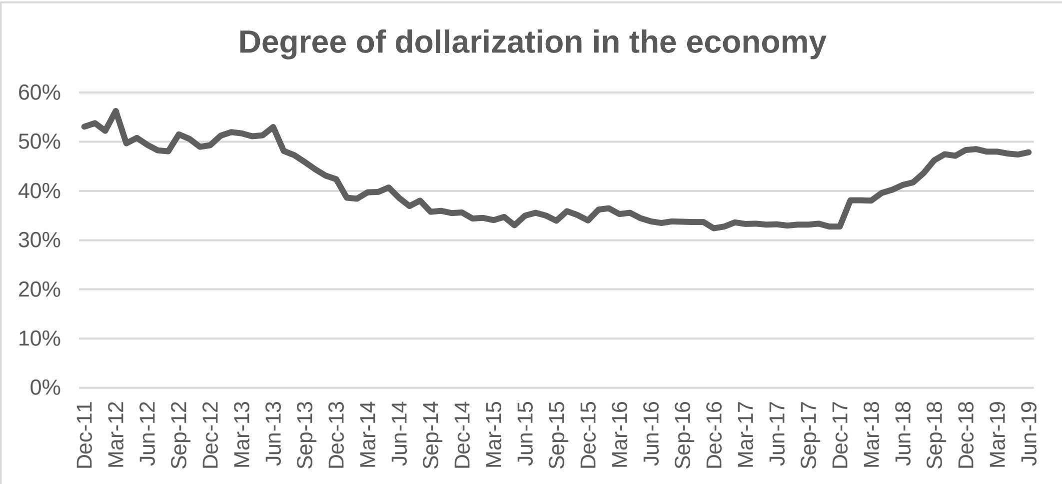
Setting the interest rate as the main tool of monetary policy would not work in Angola as it presumes a developed financial system (Banco Nacional de Angola, 2018). Still, a question arises concerning the stability of money demand in developing countries whereas the problem of money demand instability is even more severe, since there is a tendency for economic agents to partially replace domestic currency by foreign currency in the basic functions of money (Calvo & Vegh, 1992), particularly, as store of value and medium of exchange (Freitas & Veiga, 2006; Giovanni & Turtelboom, 1992). When this occurs the country is in the presence of currency substitution. Usually, what happens is that domestic money is no longer seen as safe and as a “safety precaution” individuals act in order to protect their purchasing power (Prock, Soydemir, & Abugri, 2003).

Currency substitution has an important role when it comes to conduct monetary policy (Batten & Hafer, 1984; Chaisrisawatsuk, Sharma, & Chowdhury, 2004; Cuddington, 1983; Genc, Sahin, & Erol, 2005; Owoye & Onafowora, 2007). As pointed out by Batten & Hafer (1984), this phenomenon may deliver an unstable domestic money demand, undermining the monetary authority’s role in maintaining an efficient and independent policy. If the opportunity cost of holding domestic money depends on the return of holding another currency (exchange rate depreciation), then domestic money demand will become unstable depending on the size of substitutability between the currencies. That is, if depreciation of exchange rate happens and individuals resort to foreign currency as substitute of domestic currency, then this will negatively impact the demand for domestic money (Calvo & Vegh, 1992; Mckinnon, 1982; Prock et al., 2003).

This phenomenon should be taken into account in the formulation of monetary policy. Miles (1978, 1981) argue that even that CS tend to deliver an unstable domestic money demand, if a broader monetary aggregate is applied in the monetary policy as the main instrument, the money demand function can become more reliable than by using a narrow monetary aggregate, since there is the possibility of the currency substitution effects to cancel out. Thus, if individuals can choose between national currency and foreign currency, then the real monetary aggregate that will determine prices is broader, including not only the national money, but as well the foreign money in the economy.

When it comes to Angola, in 2001, the deposits in foreign currency represented 82% of the total amount, leading the BNA to state a framework of effective financial dollarization of the economy (Banco Nacional de Angola, 2014). Even though the BNA started a de-dollarization process, the levels of dollarization are still quite high, the percentage of deposits in foreign currency in Angola represents, in April 2019, almost 50% of the total banking deposits (figure 1). This evidence is supportive of currency substitution in Angola, giving rise to some controversy regarding the monetary policy implemented in the beginning of 2018.

Figure 1 - Degree of dollarization in Angola



Notes: Own elaboration using data from Banco Nacional de Angola (2020).

2.2 Theoretical Background on Money Demand with CS

To derive money demand functions in light of currency substitution, two main models are usually discussed by the literature. One is the Portfolio Balance Model (PBM) (Branson & Henderson, 1984; Cuddington, 1983; Zervoyianni, 1992) and the other is the Liquidity Services Model (LSM) (Bergstrand & Bundt, 1990; Miles, 1978; Mizen & Pentecost, 1994; Smith, 1995; Thomas, 1985).

Cuddington (1983) extends the standard PBM integrating currency substitution. According to this approach, the economic agent is allowed to hold their wealth in the form of domestic money, domestic bonds, foreign bonds and foreign money. Gross substitutability is assumed, leading to money demand functions that depend positively on income and negatively on the return of each alternative asset. The focus of the PBM in light of CS is the coefficient of the exchange rate depreciation, since this is the one that will show the existence or not of CS (Smith, 1995).

This approach has been criticised, since the model does not explain why individuals hold money. The Liquidity Services Model is used as an alternative model, that distinguishes itself from the PBM, because it accounts for the specific role of money. Thomas (1985) presented an expected utility maximizing model contradicting the PBM by showing that exchange rate depreciation does not impact money demand. Instead, the only opportunity costs that impact money demand are the interest rates (both domestic and foreign), that represent user costs into the production of money services. Fundamentally, in the LSM, instead of a one-stage allocation of wealth, there will be a sequential allocation, with two-stages. In the first-stage, individuals divide their wealth between money and other assets, then, in the second-stage they divide it between different types of money or bonds (i.e. domestic and foreign) depending on the choices in the first stage (Mizen & Pentecost, 1994). This two-stage allocation happens because money has the same risk as bonds, but with bonds higher returns can be obtained. So bonds will dominate money, and they will not be perfect substitutes (Smith, 1995), making it necessary to first choose between one or another.

Authors such as Thomas (1985) and Bergstrand & Bundt (1990) studied CS in a context of unrestricted access to bonds and money. Nevertheless, some economies experience capital controls, as is the case of Angola. Freitas & Veiga (2006) extended the Thomas (1985) version to the case where there is no free availability on foreign bonds, what tends to happen in some developing countries. In this case the foreign interest rate would have to be dismissed. A PBM approach with restriction on foreign bonds holdings would give a domestic demand for money exactly the same as the LSM approach, in the estimation process (Freitas & Veiga, 2006). The following model illustrates this proposition.

2.3 Theoretical Model: Money Demand Function

In this section we present a deterministic version of the model used by Freitas & Veiga (2006) to determine the money demand function.

Consider an infinitely lived consumer that lives in a small open economy. The consumer maximizes the expected value of the discounted utility of the form:

$$Max\ U = \int_0^{\infty} e^{-\rho t} u(c_t) dt, \tag{1}$$

where $u(c_t) = ln(c_t)$, c_t denotes for real consumption at time t, ρ is a positive and constant subjective discount rate.

The individual can access to money denominated in domestic currency (kwanzas, M), money denominated in foreign currency (US dollar, F) and bonds denominated in domestic currency (B). The individual has no access to bonds denominated in foreign currency due to capital controls. So, following this, the individual's real wealth (w) is:

$$w = m + f + b \tag{2}$$

Where $\mathrm{m} = \frac{\mathrm{M}}{\mathrm{P}}, \mathrm{f} = \frac{\mathrm{EF}}{\mathrm{P}}, \mathrm{b} = \frac{\mathrm{B}}{\mathrm{P}}$, P is the domestic price level and E is the price of US dollars in kwanzas. It is assumed that domestic money and foreign money are the only ones that provide liquidity services.

As in Végh (1989), it is assumed that purchases of the consumption good imply a transaction cost (τ) that depends negatively on real money holdings. The transactions cost function is convex. These transaction costs are specified in the following form:

$$\tau = v\left[\frac{m}{c}, \frac{f}{c}\right], \tag{3}$$

$$with\ v(.) > 0, v_1; v_2 < 0, v_{11}; v_{22} > 0, v_{21;} v_{12} \geq 0\ and\ \Delta = (v_{11}v_{22} - v_{21}v_{12}) \geq 0$$ [1]

If the cross derivative is strictly positive then the domestic and foreign monies are substitutes as means of payment and, therefore, currency substitution exists. If $v_{12}; v_{21} = 0$, then there is no currency substitution.

[1] Where $v_k, k = 1{,}2$ is the first derivative of the k argument and $v_{kj}, j = 1{,}2$ is the second derivative of each argument or the cross derivatives.

The household's flow budget constraint is given by:

$$\dot{w} = y - c\big(1+\tau(.)\big) - \pi m + (\hat{e} - \pi)f + (i - \pi)b \qquad (4)$$

Where $\dot{w}$ is the variation of wealth, y is income, π is the inflation rate that represents the opportunity cost of holding domestic money, ê is the depreciation of the exchange rate and i is the interest rate. Imagining that an individual holds a certain amount of bonds, if the interest rate increases, the opportunity cost of holding domestic money will increase, individuals will carry on less money, leading to a higher transaction cost. The cost of holding domestic bonds is then represented as $(i - \pi)$. $(\hat{e} - \pi)$ is the cost of holding foreign money. Using (2), equation (4) becomes:

$$\dot{w} = y - c\big(1+\tau(.)\big) + (i - \pi)w - im + (\hat{e} - i)f \qquad (4.1)$$

The individual maximizes utility subject to the budget constraint. The current value Hamiltonian is:

$$\mathcal{H} = \ln c_t + \lambda[y - c\big(1+\tau(.)\big) + (i - \pi)w - im + (\hat{e} - i)f] \qquad (5)$$

The state-dynamics is given by $\frac{\partial \mathcal{H}}{\partial \lambda} = \dot{w}$ and the initial value for the state variable is $w(0) = w_0$. The remaining necessary and sufficient conditions for $t \geq 0$ are:

$$\frac{\partial \mathcal{H}}{\partial c} = 0 \qquad (6)$$

$$\dot{\lambda} = \rho\lambda - \frac{\partial \mathcal{H}}{\partial w} \Leftrightarrow \frac{\dot{\lambda}}{\lambda} = \rho - (i - \pi) \qquad (7)$$

Where (7) is the co-state dynamics. From the fisher equation we have that: $r = i - \pi$, $\frac{\dot{\lambda}}{\lambda} = \rho - r$ and the steady state is given by: $r = \rho$, where $\lambda = \bar{\lambda}$.

The first-order conditions in respect to m and f imply:

$$\begin{cases} \frac{\partial \mathcal{H}}{\partial m} = 0 \Leftrightarrow \lambda\left[-c * \frac{\partial \tau}{\partial m} - i\right] = 0 \Leftrightarrow -c * \frac{v_1}{c} - i = 0 & (8) \\ \frac{\partial \mathcal{H}}{\partial f} = 0 \Leftrightarrow \lambda\left[-c * \frac{\partial \tau}{\partial f} + (\hat{e} - i)\right] = 0 \Leftrightarrow -c * \frac{v_2}{c} + (\hat{e} - i) = 0 & (9) \end{cases}$$

The total differentiation of the following conditions, (8) and (9), gives:

$$\begin{cases} v_{11} * \frac{1}{c} dm + v_{12} * \frac{1}{c} df = -di & (10) \\ v_{21} * \frac{1}{c} dm + v_{22} * \frac{1}{c} df = d\hat{e} - di & (11) \end{cases}$$

Since we have a system of linear equations, we can use the Cramer's Rule, leading to the following specification:

$$\begin{bmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{bmatrix} \begin{bmatrix} dm \\ df \end{bmatrix} = \begin{bmatrix} -cdi \\ c(d\hat{e} - di) \end{bmatrix} \tag{12}$$

Solving the problem for domestic money demand one obtains:

$$dm = \begin{vmatrix} -cdi & v_{12} \\ c(d\hat{e} - di) & v_{22} \end{vmatrix} = c(-v_{22}di - v_{12}d\hat{e} + v_{12}di) \tag{13}$$

The coefficient matrix's determinant is given by the variation parameter already presented in (3):

$$\Delta = \begin{vmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{vmatrix} = (v_{11}v_{22} - v_{21}v_{12}) \tag{14}$$

Gathering (13) and (14):

$$\frac{dm}{\Delta} = \frac{c}{\Delta}(-v_{22}di - v_{12}d\hat{e} + v_{12}di) \tag{15}$$

From (15) we get that, the demand for domestic money takes the following form:

$$m = cL^m(i, \hat{e}) \tag{16}$$

$$with\ L_i^m = \frac{c(v_{12} - v_{22})}{\Delta} >< 0\ and\ L_{\hat{e}}^m = \frac{-cv_{12}}{\Delta} \leq 0$$

Since, from (3), $\Delta \geq 0$ and $v_{12} \geq 0$ then the domestic money demand will depend negatively on the depreciation of the exchange rate if there is currency substitution or it will be equal to zero if there is no currency substitution.

From here, as in Freitas & Veiga (2006), one obtains the following specification for money demand:

$$\frac{\mathrm{M}}{\mathrm{P}} = \mathrm{m}\ (\mathrm{i}, \hat{\mathrm{e}}, \mathrm{Y});\ \frac{\partial \mathrm{m}}{\partial \mathrm{Y}} > 0;\ \frac{\partial \mathrm{m}}{\partial \mathrm{i}} < 0; \frac{\partial \mathrm{m}}{\partial \hat{\mathrm{e}}} < 0, \tag{17}$$

Y is the real income[2]. Evidence of CS is assumed by the sign and significance of the exchange rate depreciation coefficient, that must be negative and statistically significant.

[2] Proxy for consumption.

3. Empirical Strategy and Data

From the discussion above, the research hypotheses to be tested are the following ones:

H1 The economy in Angola is affected by CS, but broader monetary aggregates cancel out these effects providing a stable domestic money demand.

H2 By using a broader monetary aggregate it is possible to obtain a better forecast of inflation rate.

To check for the presence of currency substitution, the stability of money demand and the efficiency of the monetary policy applied in Angola, twelve alternative models are estimated. Afterwards, excess liquidity given by the cointegrating relation in each estimation is used as explanatory variable in an ARDL model.

3.1 The Model

Following the theoretical model (17), an empirical long-run money demand for Angola can be written as:

$$m_t - p_t = \beta_0 + \beta_1 \hat{e}_t + \beta_2 i_t + \beta_3 y_t + \mu_{1t} \quad (18)$$

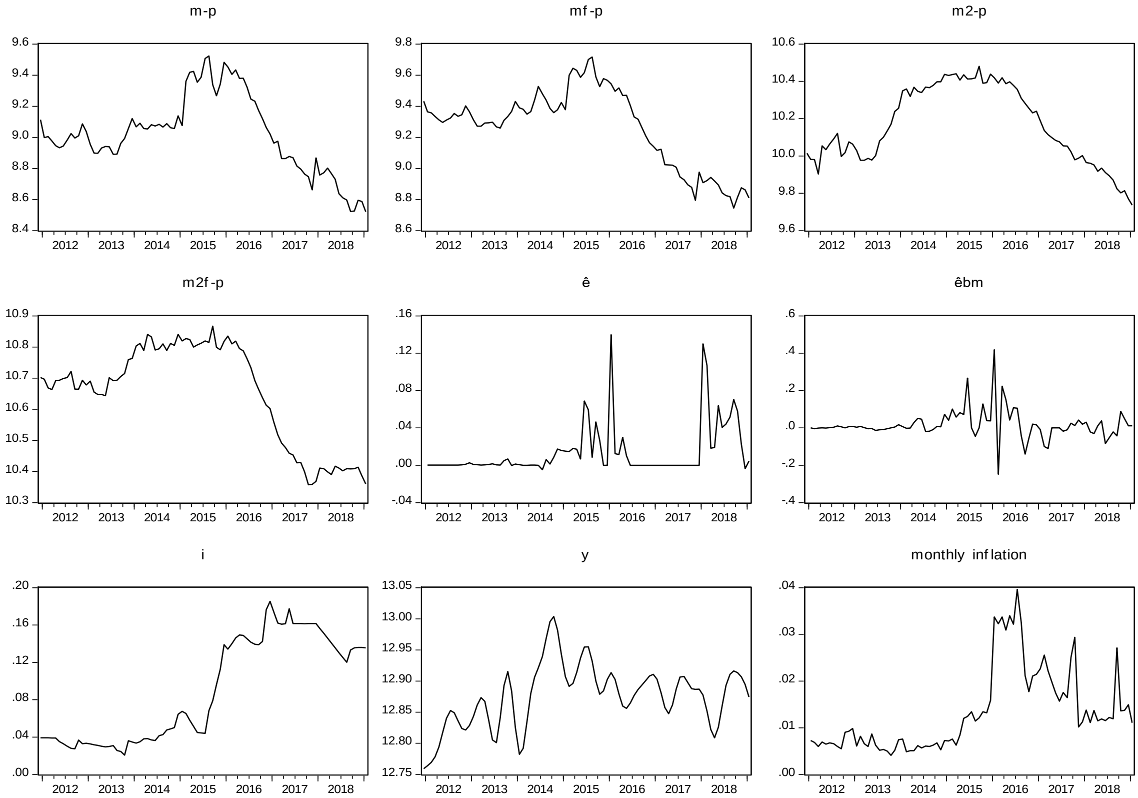
Where m is the logarithm of nominal money, p is the logarithm of the consumer price index, $\hat{e}$ is the depreciation of the exchange rate, i is the domestic interest rate and y is the logarithm of real income, that is a proxy for consumption. μ_{1t} represent the error term. The expected signs of coefficients are $\beta_1 < 0, \beta_2 < 0, \beta_3 > 0$. If $\beta_1 < 0$ and statistically significant then evidence of CS is found in this country.

3.2 Data

The empirical work in the subsequent sections uses monthly (time-series) data of Angola, from January 2012 until January 2019.

The variables used as proxies for real money are four alternatives: the log of the real national monetary base $(m - p)$, the log of real money base including foreign currency deposits (FCD) $(mf - p)$, the log of real M2 excluding FCD $(m2 - p)$ and the log of real M2 including FCD $(m2f - p)$. As explanatory variables we tried with two alternative measures of the exchange rate (the official $(\hat{e})$ and the black-market $(\hat{e}bm)$), the 91-days treasury-bills from the government of Angola is used as proxy for the interest rate (i) and the log of the real GDP is used as proxy for real income (y). For the short-run analysis the monthly inflation rate (π) becomes the dependent variable and the explanatory variables are the lagged monthly inflation rate and the excess liquidity (CIV), given by the residuals of the long-run relationship.

Figure 2 - Variables used in the empirical analysis



Notes: Own elaboration using data from Angola Forex (2019); Banco Nacional de Angola (2019); Instituto Nacional de Estatística (2019).

All data was collected from the BNA with few exceptions: the exchange rate of the black market that was collected from Angola Forex, the consumers price index (CPI) and the gross domestic product (GDP) that was collected from the National Statistics Institute (INE) of Angola. Since, GDP is only available in years and quarters, an interpolation procedure[3] was implemented to transform quarterly data into monthly data. To fulfil some gaps existing in the interest rate of treasury-bills, an interpolation procedure[4] was also used with the interest rate. Each money-demand system contains four variables. Real values are deflated by the consumer price index, with exception of the real income that was already collected in volume.

The graphs of the variables used in the empirical analysis are plotted in figure 2. In the beginning of 2016 a severe decline in oil prices and the following deceleration of global economic activity led to a sharp instability of prices in Angola. This can be seen in the graph of

[3] Through EViews, using the cubic method for low to high frequency data.

[4] Since, only some months were unavailable, the Microsoft Excel was used to do a linear interpolation procedure, using the following formula: $y = \frac{x_H - x_L}{LIN(x_H) - LIN(x_L)}$. Where x_H represents the value most recent between each gap of values, y is the value to be added.

monthly inflation rate where a clear instability is shown starting in December 2015. In this way the BNA executed contractionary monetary policies using open market and discount rate operations (Banco Nacional de Angola, 2017).

The high level of the official depreciation of the exchange rate in the beginning of 2016 is due to the intention of the BNA to reduce the difference between the official and black-market exchange rate (Banco Nacional de Angola, 2017). Nevertheless, the gap remains and due to the volatility of the exchange-market, the first semester of 2016 is marked by high volatility of the exchange rates, particularly, the black-market.

3.3 Unit Roots

To verify the stationarity of the variables, the Augmented Dickey-Fuller (ADF) test was implemented to see how many times a variable must be differenced to obtain stationarity. Table 1 shows the ADF test statistics and the equivalent p-values.

Table 1 - Unit Roots Test

ADF TEST	LEVELS		1ST DIFFERENCES		INTEGRATION ORDER
Sample: 2012:01-2019:01	ADF	Prob.	ADF	Prob.	
$(\mathrm{m}-\mathrm{p})$	-0,4511	0,8944	-9,2233***	0,0000	I(1)
$(\mathrm{mf}-\mathrm{p})$	-0,2593	0,9255	-8,9679***	0,0000	I(1)
$(\mathrm{m2}-\mathrm{p})$	-0,7691	0,9638	-5,5944***	0,0001	I(1)
$(\mathrm{m2f}-\mathrm{p})$	0,4562	0,9842	-3,8190***	0,0040	I(1)
$\hat{\mathrm{e}}$	-2,5213**	0,0122	-	-	I(0)
$\hat{\mathrm{e}}bm$	-2,0658**	0,0380	-	-	I(0)
i	-1,6943	0,7453	-6,8317***	0,0000	I(1)
y	-2,0920	0,2485	-4,4072***	0,0006	I(1)
π	-2,4210	0,1391	-8,0076***	0,0000	I(1)

Notes: *, **, *** represents significance levels of 10%, 5% and 1%, respectively. In each test the lag length is decided according to the Akaike Information Criterion (AIC). I(0) represents stationary in levels and I(1) stationary in first differences. The test equation included trend and intercept for the interest rate and the real M2 (excluding FCD), none for both exchange rates and only intercept for the rest of the variables.

The results of the unit roots test suggest that all variables are stationary in first differences, except for both the exchange rates that are stationary in levels. Although both $\hat{\mathrm{e}}$ and $\hat{\mathrm{e}}\mathrm{bm}$ are I(0) the vector autoregressive (VAR) systems will include these variables to enrich the short-run dynamics.

3.4 Estimation Method

To examine the stability of domestic money demand and to check for presence of currency substitution, a cointegration analysis is performed using the Johansen (1988) Cointegration Test and the VECM for the estimation procedure. Alternative combinations of variables are applied.

Due to presence of I(1) variables in the money demand function, the appropriate methodology to follow is based on cointegration analysis. To start the empirical process, in each model an unrestricted VAR is estimated in the reduced form, where for each of the variables there is an equation, where the regressors in all equations are lagged values of the lagged variables (Stock & Watson, 2016). The number of lags is chosen considering the AIC.

Using an error correction term, there is a removal of trend and in this way the problems created by stochastic trends will be eliminated (Stock & Watson, 2016). If cointegration is found the VECM must be applied. A simple VECM specification, can be exhibited as the following one:

$$\boldsymbol{\Delta y_t} = \boldsymbol{\sigma} + \boldsymbol{\Pi y_{t-1}} + \sum_{j=1}^{p-1} \boldsymbol{\Gamma_j \Delta y_{t-j}} + \boldsymbol{\mu_t},$$

where $\Delta \boldsymbol{y_t}$ is the vector of dependent variables, $\boldsymbol{\sigma}$ are the intercepts, $\boldsymbol{\Pi} = \boldsymbol{\alpha\beta'}$, where $\boldsymbol{\alpha}$ is the matrix of adjustment coefficients, measuring the velocity at which short-term deviations from the long-run relationship are reduced, and $\boldsymbol{\beta}$ is the cointegration matrix, both are $r * K$ matrices, where r is the number of cointegrating relations and K is the number of variables in the system, p is the optimal number of lags, $j = 1, \dots, p-1$, $\boldsymbol{\mu_t}$ it's a multivariate white noise.

The simple ARDL model has as dependent variable the monthly inflation rate and the explanatory variables are given by the lagged monthly inflation rate and the excess liquidity. Afterwards, the price level forecast is performed where the ARDL is computed but only from January 2012 until January 2018 to, afterwards, forecast the models in a horizon of one year (February 2018 until January 2019).

4. Empirical Results

4.1 Cointegration Analysis

Tables 2 and 3 show the estimation results. To facilitate the analysis, the tables are divided according to each alternative dependent variable. Columns (1)-(3) have as dependent variable the real national monetary base, and the real broader monetary base results are exhibited in columns (4)-(6). In table 3, columns (7)-(9) represent the results when the dependent variable is the real narrow M2 and in columns (10)-(12) the dependent variable is the real broader M2. In each table, Panel 1 exhibits the results of the trace test of the Johansen Cointegration Test. In Panel 2, the results of the cointegrating equation (long-run model) are displayed (VECM results) and in Panel 3, results of the short-run coefficients of the cointegration equation are exhibited, but only, when the dependent variable is the money demand, since it is the main focus of the paper. Panel 4 shows the results of the serial correlation test.

In table 4 we display the likelihood-ratio (LR) test and the estimation results.

The maximum number of lags included was 6 and the optimal lags, according to the AIC, vary from 4 to 6 through all the systems. In table 2, the trace-test shows that there is at least one cointegrating relationship in each system, if a 10% significance level is considered. Columns (2), (3) and (6) stand out, given that they have more than one cointegrating relation, as opposite to the others. The same did not happen in table 3 in which two of the six systems did not exhibit a cointegrating relationship. Among them are the $m2 - p, \hat{e}, i, y$ and $m2f - p, \hat{e}, i, y$. Both systems included the official depreciation of the exchange rate. Even though zero cointegration relationships were found, the VECM results for these systems were still computed, for comparative purposes[5].

Starting the analysis in table 2, a clear distinction is detected between the estimation results of the narrow money base and the broader money base. Both the estimations display relevant and statistically significant coefficients in columns (3) and (6), when the explanatory variables are just the interest rate and real income. This could lead to forejudge for a stable money demand, nevertheless, when the depreciation of the exchange rate is introduced these conclusion changes. In columns (1) and (2), both exchange rate depreciations exhibit negative and statistically significant coefficients at 5%, what is suggestive of currency substitution (Mizen & Pentecost, 1994). Nevertheless, in column (2) by including the black-market depreciation of exchange rate, the other outcomes are different from column (1): the interest rate, the real income and the adjustment coefficients are not statistically significant. What enhances the gap between the official and black-market exchange rates.

[5] Only 1 cointegrating equation was assumed in the estimation of the VECM.

Table 2 - Johansen Cointegration Test and VECM results (part 1)

DEPENDENT VARIABLES	NARROW MONETARY BASE, $m - p$			BROAD MONETARY BASE, $mf - p$		
SYSTEMS	(1)	(2)	(3)	(4)	(5)	(6)
EXPLANATORY VARIABLES	$\hat{e}, i, y$	$\hat{e}bm, i, y$	i, y	$\hat{e}, i, y$	$\hat{e}bm, i, y$	i, y
OBS. (after adjustments)	78	78	79	78	78	79
Lags (AIC)	6	6	6	6	6	6
PANEL 1 - Trace-test results						
NONE	47,4721*	56,8797***	38,5360***	45,8383*	51,8936**	37,8084***
AT MOST 1	24,6939	28,4936*	16,7264**	22,9969	27,0169	13,6245*
AT MOST 2	8,3751	6,7188	5,5439**	7,8690	6,8598	5,3784
AT MOST 3	1,9551	0,7539		1,7915	1,2573	
NO. OF CE(S)	1	2	3	1	1	2
PANEL 2 - Long-run coefficients						
REAL MONEY (-1)	-1,0000	-1,0000	-1,0000	-1,0000	-1,0000	-1,0000
Δ EXCHANGE RATE	-4,9677**	-3,7278**		-2,4398	0,7101	
	(-2,0372)	(-2,1457)		(-0,9541)	(0,6119)	
INTEREST RATE	-2,5597**	1,4961	-7,9630***	-5,9594***	-5,8768***	-7,1171***
	(-2,1066)	(1,0949)	(-4,23238)	(-4,7422)	(-6,2957)	(-6,1920)
REAL INCOME	4,2702***	1,4235	7,2358***	4,8875***	4,4137***	5,1297***
	(3,1458)	(0,8656)	(3,2676)	(3,6434)	(3,8434)	(3,7590)
PANEL 3 - Adjustment coefficients						
D(REAL MONEY)	0,1779***	-0,0026	0,1158***	0,1512***	0,1614***	0,1443***
	(3,6449)	(-0,0676)	(4,2524)	(3,8782)	(3,8212)	(4,4105)
PANEL 4 – LM Test						
LRE*stat						
LM (2)	14,2304	11,7192	16,8603	15,3880	23,9210	14,6531
	[0,5816]	[0,7631]	[0,0509]	[0,4964]	[0,0912]	[0,1009]
LM (6)	10,2781	10,7429	12,3081	9,7002	14,0009	11,0574
	[0,8517]	[0,8251]	[0,1965]	[0,8818]	[0,5986]	[0,2718]

Notes: *, **, ***: denote significance at 10%, 5% and 1%, respectively. T-statistics in () and p-value in []. Trace tests are evaluated with a constant in the cointegrating relation and in the error correction form. Real Money (-1) represents the real money with 1 lag. A restriction was imposed when estimating the VECM (the coefficient of the lagged dependent variable is equal to -1) to make it possible to read the signs of the coefficients directly. Own elaboration using EViews.

In columns (4) and (5) the coefficients of exchange rate depreciation are not statistically significant, suggesting that currency substitution has no direct impact. In column (3) the number of cointegrating relationships are excessive and the LM test shows that there is residuals serial correlation at 2 lags, suggesting a misspecification.

For robustness matters, to check if by using a broad monetary base the influence of this coefficient is eliminated, a restriction was imposed in columns (4) and (5) where exchange rate depreciation equals zero (in the long-run analysis). The results are displayed in columns (4.1) and (5.1) of table 4, and the conclusions remain the same: the effects of currency substitution cancel out when the real broader monetary base is used as dependent variable.

Table 3 - Johansen Cointegration Test and VECM results (part 2)

DEPENDENT VARIABLES	NARROW M2, $m2 - p$			BROAD M2, $m2f - p$		
SYSTEMS	(7)	(8)	(9)	(10)	(11)	(12)
EXPLANATORY VARIABLES	$\hat{e}, i, y$	$\hat{e}bm, i, y$	i, y	$\hat{e}, i, y$	$\hat{e}bm, i, y$	i, y
OBS. (after adjustments)	80	78	78	80	78	78
Lags (AIC)	4	6	6	4	6	6
PANEL 1 - Trace-test results						
NONE	38,7985	55,4334***	27,8953*	40,7675	53,3062**	30,8012**
AT MOST 1	20,9782	20,5607	13,2234	23,1553	24,5499	10,4773
AT MOST 2	12,1537	9,4095	4,8685	10,8393	8,8294	4,6171
AT MOST 3	4,7796	0,9891		4,7837	2,5433	
NO. OF CE(S)	0	1	1	0	1	1
PANEL 2 - Long-run coefficients						
REAL MONEY (-1)	-1,0000	-1,0000	-1,0000	-1,0000	-1,0000	-1,0000
Δ EXCHANGE RATE	-4,8748**	-0,9445		-448,7902***	-0,2324	
	(-2,3304)	(-1,2873)		(-3,5499)	(-0,4083)	
INTEREST RATE	0,9262	-0,9999	-0,8855	185,8670***	-2,9559***	-3,3480***
	(0,9447)	(-1,6126)	(-0,9435)	(3,4652)	(-7,0938)	(-6,5877)
REAL INCOME	4,7986***	5,0310***	4,4530***	31,3567	2,2222***	1,7458***
	(4,2922)	(6,8980)	(4,4111)	(0,5852)	(3,9857)	(2,8851)
PANEL 3 – Adjustment coefficients						
D(REAL MONEY)	0,0029	0,0405	0,0443	-0,0005	0,0986***	0,1022***
	(0,1022)	(1,1077)	(1,2660)	(-1,2128)	(2,7920)	(3,2783)
PANEL 4 – LM Test						
LM (2)	30,3216	17,0764	14,0061	39,2299	18,4753	14,7105
	[0,0164]	[0,3807]	[0,1221]	[0,0010]	[0,2968]	[0,0992]
LM (6)	22,3552	11,2545	10,4530	18,3551	19,6474	15,6224
	[0,1321]	[0,7935]	[0,3151]	[0,3035]	[0,2365]	[0,0752]

Notes: *, **, ***: denote significance at 10%, 5% and 1%, respectively. T-statistics in () and p-value in []. Trace tests are evaluated with a constant in the cointegrating relation and in the error correction form. Real Money (-1) represents the real money with 1 lag. A restriction was imposed when estimating the VECM (the coefficient of the lagged dependent variable is equal to -1) to make it possible to read the signs of the coefficients directly. Own elaboration using EViews.

It is important to have under consideration the two cases with no cointegrating relationship in table 3, for the reason that the results of the VECM estimation in both cases are odd: in column (7) the interest rate is not statistically significant and in column (10) the semi-elasticity of the interest rate is positive, and the real income is not statistically significant, what gives no trustable conclusions. Also, the loading factors do not exhibit statistically significance, pointing to the non-convergence of the real money balances to the equilibrium relationship. Hence, no further mention to these cases is made.

Comparing now the results of narrow M2 with the broader M2, once again, is clear the distinction between the estimation outcomes. First, no stable money demand equation is found when the dependent variable is the narrow M2 and the adjustment coefficients point to a non-convergence to the long-run relationship. The opposite happens when using the broader real M2. When the depreciation of the exchange rate is included in column (11) no statistically significant coefficient was found for this variable. When excluding the latter one from the system, column (12), a stable money demand is found where the semi-elasticity of the interest rate is negative, and the elasticity of real income is positive. In this situation, when we look to the LM test, both at 2 and 6 lags there is autocorrelation of the residuals if a 10% level is considered. So, since column (11) displays better results in the LM test, a restriction was imposed to the exchange rate depreciation coefficient in this column. From column (11.1), in table 4, we found a stable money demand for the broader M2 and there is no residual serial correlation. Leading us to conclude that even though depreciation of the exchange rate is not relevant in the long-run estimation, it should, at least, be included in the short-run system. According to the VEC residuals heteroskedasticity tests (no cross terms)[6], no heteroskedasticity was found.

Summing up, a pattern can be detected in here. The systems, that have as dependent variable the narrow real monetary aggregates, are more sensitive to the depreciation of the exchange rate, suggesting the presence of currency substitution and instability of domestic money demand. This goes according to Yildirim (2003), in which it is shown that when using a broader monetary aggregate, the domestic money demand function can become more reliable. Considering all said above, hypothesis 1 is confirmed.

The adjustment coefficients of short-run money demands are also reported in the tables. Since columns (2), (7), (8), (9) and (10) exhibit adjustment coefficients that are not statistically significant, pointing to a non-convergence of the real money balances to the equilibrium relationship, these systems are excluded from further analysis because no trustable conclusions could be taken if further computation was applied. System (3) is also excluded because it would allow for omitted variable bias in further analysis.

[6] Results of the heteroskedasticity test can be found in the annex (table 8).

Table 4 - Restrictions imposed to previous estimations

DEPENDENT VARIABLE	$mf - p$	$mf - p$	$m2f - p$
Observations (after adjustments)	78	78	78
System	(4.1)	(5.1)	(11.1)
Restrictions		$B(1,2) = 0$	
LR test for binding restrictions (rank=1):			
Chi-square (1)	0,5130	0,1523	0,0833
Probability	0,4739	0,6964	0,7729
REAL MONEY (-1)	-1,0000	-1,0000	-1,0000
Δ EXCHANGE RATE	0,0000	0,0000	0,0000
INTEREST RATE	-7,5692***	-5,6763***	-2,9453***
	(-5,4566)	(-5,9248)	(-7,4976)
REAL INCOME	5,6761***	4,4512***	2,1233***
	(3,4943)	(3,9022)	(4,3536)
Loading factors			
D(REAL MONEY)	0,1262***	0,1504***	0,1051***
	(3,8672)	(3,6006)	(2,8358)
Residual Tests			
LM (2)	16,8872	23,1835	18,0505
	[0,3929]	[0,1089]	[0,3209]
LM (6)	13,6529	14,0113	19,3324
	[0,6246]	[0,5979]	[0,2518]

Notes: ***, **, *: denote significance at 1%, 5% and 10%, respectively. T-statistics in () and p-value in []. Trace tests are evaluated with a constant in the cointegrating relation and in the error correction form. Real Money (-1) represents the real money with 1 lag. A restriction was imposed when estimating the VECM (the coefficient of the lagged dependent variable is equal to -1) to make it possible to read the signs of the coefficients directly. Own elaboration using EViews.

4.2 ARDL estimation and inflation forecast

The fact that we identify stable money demand relationships with the expected coefficients does not necessarily imply that these systems contain useful information to forecast the price level. Based on this, in the current section the main purpose is to complement the previous analysis in order to verify if departures from the long-run relationship (excess liquidity) help to predict the price level.[7] In order to do so, an ARDL model is estimated for monthly inflation rate experimenting with alternative excess liquidities as explanatory variables (from the previous estimations). Lag-lengths for each variable are automatically selected based on the AIC, that is

[7] In the annex the excess liquidity (cointegrating relations) graphs can be found in figure 3.

equal to 1 through all estimations. Table 5 summarizes the estimation results. Since all estimations exhibit heteroskedasticity, the Newey & West (1987) heteroskedastic consistent covariance estimator is used along with the ARDL estimation.

At a 10% significance level all excess liquidities are statistically significant in predicting inflation with exception of system (11.1). Nevertheless, only column (12) shows a 5% significance level for the coefficient on the excess liquidity (that corresponds to the estimates using the broader M2). This sustains the hypothesis enunciated in the beginning of this paper where broader monetary aggregates could have a better performance in forecasting inflation. No residual serial correlation was found.

For the tests on parameters stability, this study implemented the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMQ). If the plots stay within the 5 percent critical bound, it provides evidence that the parameters are stable. No breaks beyond the 5% level significance were found in the CUSUM test, but the same did not happen with the CUSUMQ, where all estimations exhibited a structural break.

Table 5 - ARDL estimation results of monthly inflation

DEPENDENT VARIABLE: MONTHLY INFLATION RATE						
SYSTEMS	(1)	(4.1)	(5.1)	(6)	(11.1)	(12)
CIV	$(m-p)-\ m^d$		$(mf-p)-\ m^d$		$(m2f-p)-\ m^d$	
MONEY DEMAND	$(\hat{e}, i, y)$	$(\hat{e}=0, i, y)$	$(\hat{e}bm=0, i, y)$	(i, y)	$(\hat{e}bm=0, i, y)$	(i, y)
SAMPLE	2012:01 – 2019:01					
OBS.	84	84	84	84	84	84
INFLATION RATE (-1)	0,8184***	0,7828***	0,7918***	0,7748***	0,7933***	0,7329***
	(11,7709)	(9,6158)	(10,3539)	(9,4686)	(10,1963)	(8,1281)
EXCESS LIQUIDITY (CIV)	0,003014*	0,0032*	0,0040*	0,0037*	0,0083	0,0120**
	(1,7404)	(1,7997)	(1,6912)	(1,8528)	(1,5879)	(2,0514)
CONSTANT (C)	0,0024***	0,0029**	0,0028***	0,0030***	0,0028**	0,0036***
	(2,6564)	(2,6132)	(2,6433)	(2,6713)	(2,5172)	(2,7752)
R^2	0,7672	0,7700	0,7706	0,7716	0,7719	0,7817
S.E. REGRESSION	0,0043	0,0043	0,0043	0,0043	0,0043	0,0042
DURBIN WATSON	2,2332	2,1221	2,1460	2,1218	2,1549	2,1242
CUSUM 5%	No break	No break	No break	No break	No break	No break
CUSUMQ 5%	Break	Break	Break	Break	Break	Break

Notes: ***, **, *: denote significance at 1%, 5% and 10%, respectively. T-statistics in parentheses. The "excess liquidity" was computed using the cointegrating vector (CIV) of the VECM estimations, where $CIV = real\ money\ balances - money\ demand\ estimations$. The lags were automatically selected using the AIC. Own elaboration using EViews.

This structural break can be eliminated by creating a dummy (D1512) that assumes a value equal to 0 before December of 2015 and 1 until the end of the sample. The Chow Breakpoint Test was also computed for this specific structural break. The results are displayed in the annex (table 9).

When the dummy variable is included in the estimation procedure (table 6) the excess liquidity on system (11.1) becomes statistically significant at a 5% level and the excess liquidities of system (4.1) and (6) are now statistically insignificant. The coefficient of excess liquidity computed using the monetary aggregate M2 including FCD remains statistically significant at a 5% level and with a higher influence (0,0108 and 0,0133) than the excess liquidity computed using the national monetary base (0,0038).

Table 6 - ARDL estimation results when a dummy variable is included

DEPENDENT VARIABLE: MONTHLY INFLATION RATE						
SYSTEMS	(1)	(4.1)	(5.1)	(6)	(11.1)	(12)
CIV	$(\mathrm{m}-\mathrm{p})-\mathrm{m}^{\mathrm{d}}$	$(\mathrm{mf}-\mathrm{p})-\mathrm{m}^{\mathrm{d}}$			$(\mathrm{m2f}-\mathrm{p})-\mathrm{m}^{\mathrm{d}}$	
MONEY DEMAND	$(\hat{e}, i, y)$	$(\hat{e}=0, i, y)$	$(\hat{e}bm=0, i, y)$	$(\hat{e}, i, y)$	$(\hat{e}=0, i, y)$	$(\hat{e}bm=0, i, y)$
SAMPLE	2012:01 – 2019:01					
OBS.	84	84	84	84	84	84
INFLATION RATE (-1)	0,6360*** (4,9828)	0,6751*** (6,0123)	0,6437*** (5,6219)	0,6629*** (5,8497)	0,5872*** (4,8376)	0,5493*** (4,5604)
EXCESS LIQUIDITY (CIV)	0,0038* (1,7983)	0,0024 (1,3998)	0,0040* (1,7398)	0,0030 (1,5473)	0,0108** (2,0590)	0,0133** (2,4280)
DUMMY (D1512)	0,0040** (2,2271)	0,0030** (2,0254)	0,0035** (2,2389)	0,0031** (2,0230)	0,0043** (2,5764)	0,0040** (2,5065)
CONSTANT (C)	0,0031*** (2,8201)	0,0030*** (2,8140)	0,0032*** (3,0417)	0,0031*** (2,8954)	0,0035*** (3,2060)	0,0042*** (3,5013)
R^2	0,7893	0,7824	0,7880	0,7845	0,7973	0,8040
S.E.	0,0041	0,0042	0,0041	0,0042	0,0040	0,0040
DURBIN-WATSON	2,0757	2,0030	2,0013	2,0008	1,9839	1,9775
CUSUM 5%	No Break	No Break	No Break	No Break	No Break	No Break
CUSUMQ 5%	No Break	No Break	No Break	No Break	No Break	No Break

Notes: ***, **, *: denote significance at 1%, 5% and 10%, respectively. T-statistics in parentheses. The "excess liquidity" was computed using the cointegrating vector (CIV) of the VECM estimations, where $CIV = real\ money\ balances - money\ demand\ estimations$. Own elaboration using EViews.

From these outcomes, the models that exhibited statistically significant coefficients were estimated in a subsample (2012:02 – 2018:01)[8]. Afterwards, a forecast evaluation was made

[8] The ARDL estimation results for the small sample are displayed in the annex (table 10).

for the price level (2018:02 – 2019:01)[9]. Both dynamic and static forecasts are examined to allow for comparison.

The main purpose is to find out what is the monetary aggregate that best forecasts inflation[10]. In order to do a more detailed analysis, this paper uses the root mean squared error and the mean absolute error as in Dreger & Wolters (2014). And, for robustness, the Theil inequality coefficient is also considered. Lower values represent lower errors between the forecasted model and the actual model. The Theil inequality coefficient varies from 0 to 1, where 0 represents a perfect fit of both the forecasted model and the actual model. The purpose is to see which model has better forecasting ability.

The results are displayed in table 7 where it is shown that not only $\mathrm{CIV}\ (12)$ exhibits the lower values compared to the other excess liquidities, but there is a clear conclusion that broader real money balances display a better performance in forecasting the price level, since $\mathrm{CIV}\ (5.1)$ and $\mathrm{CIV}\ (11.1)$ have lower values compared to $\mathrm{CIV}\ (1)$ as well. The difference between the forecasted models using $\mathrm{CIV}\ (12)$ and using $\mathrm{CIV}\ (11.1)$ is not significative, this would be expected since both use the broader M2 to calculate the excess liquidities. The static forecast has a better performance compared to the dynamic forecast, this happens because dynamic forecasting uses the forecasted value of the lagged dependent variable and static forecasting uses the actual value of the lagged dependent variable.

Table 7 – Forecast evaluation

Estimation subsample	2012:02 – 2018:01			
Forecast subsample	2018:02 – 2019:01			
	$\mathrm{CIV}\ (1)$	$\mathrm{CIV}\ (5.1)$	$\mathrm{CIV}\ (11.1)$	$\mathrm{CIV}\ (12)$
DYNAMIC FORECAST				
Root Mean Squared Error	0,0629	0,0451	0,0372	0,0302*
Mean Absolute Error	0,0576	0,0408	0,0340	0,0280*
Theil Inequality Coefficient	0,0058	0,0041	0,0034	0,0028*
STATIC FORECAST				
Root Mean Squared Error	0,0066	0,0059	0,0057	0,0056*
Mean Absolute Error	0,0057	0,0047	0,0044	0,0041*
Theil Inequality Coefficient	0,0006	0,0005*	0,0005*	0,0005*

Notes: In each line the best performance is marked with *.

Broader monetary aggregates can predict in a better way the price level compared to narrow monetary aggregates. Having this, hypothesis 2 is also confirmed.

[9] Using the ARDL forecast with EViews.

[10] The forecast is made using the $\ln(CPI)$, based on the estimation results of $[\ln(CPI_t) - \ln(CPI_{t-1})]$.

5. Conclusions

This study aims to find a stable domestic money demand in Angola using alternative monetary aggregates and, also, verifying the forecasting power of these monetary aggregates in predicting the inflation rate (from 2012:01 until 2019:01). Currency substitution is defined as the partial replacement of domestic currency by foreign currency in the basic functions of money, principally means of payment and store of value (Freitas & Veiga, 2006).

We identify a stable money demand for Angola when monetary aggregates contain FCD. This was verified in the long-run VECM estimation when using the narrow money base in which the coefficient of exchange rate depreciation was negative and statistically significant, which according to earlier studies gives an unstable money demand provided by the presence of currency substitution (Batten & Hafer, 1984; Calvo & Vegh, 1992; Cuddington, 1983; Mizen & Pentecost, 1994; Smith, 1995; Thomas, 1985). The opposite was observed when using the broader monetary aggregate M2, in which the depreciation of the exchange rate did not exhibit a statistically significant coefficient, hence, a stable money demand was found. Thus, the BNA, by using the national monetary base as the operational variable of the money targeting, is not taking into account the currency substitution phenomenon.

The fact that we identify stable money demand relationships with the expected coefficients does not necessarily imply that these systems contain useful information to forecast the price level, so using the excess liquidities of different models an ARDL estimation and a forecast evaluation was computed. Even though, none of the forecasts are perfectly fitted with the actual values, the better forecasting performance is from the broader M2.

When analysing and comparing this work with other studies it should be considered that there are some limitations in the data that can indeed change the results if more accurate data is provided by the BNA and other databases, in future years. Such limitations are that the CPI is from Luanda, instead as the whole country and the lack of data in the interest rate of treasury-bills. More data and more transparency are needed and to do so more studies in this country should be made. In future studies the expected depreciation of exchange rate should be used instead of the depreciation of exchange rate.

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Annex

Table 8 - VECM Heteroskedasticity test

VEC Residual Heteroskedasticity Test

	(1)	(2)	(3)	(4)	(5)	(6)
Chi-sq	485,8247	544,6161	215,1706	507,3752	509,681	229,6241
p-value	(0,6669)	(0,0820)	(0,7194)	(0,4001)	(0,3725)	(0,4574)
	(7)	(8)	(9)	(10)	(11)	(12)
Chi-sq	309,8346	500,1326	247,019	311,5519	479,401	223,4329
p-value	(0,8784)	(0,4899)	(0,1846)	(0,8637)	(0,7387)	(0,5730)

VEC Residual Heteroskedasticity Test (Restrictions)

	(4.1)	(5.1)	(11.1)
Chi-sq	508,4098	504,2668	477,6921
p-value	(0,3876)	(0,4382)	(0,7565)

Table 9 - Chow Breakpoint Test

Chow Breakpoint Test: 2015M12

Equation sample: 2012M02 2019M01

CIV	F-statistic	Prob. F (3,78)	Log likelihood ratio	Prob. Chi-Square (3)
(1)	3,6024	(0,0171)	10,8998	(0,0123)
(4.1)	3,1158	(0,0309)	9,5076	(0,0233)
(5.1)	4,2741	(0,0076)	12,7843	(0,0051)
(6)	3,3301	(0,0238)	10,1235	(0,0175)
(11.1)	7,5002	(0,0002)	21,2901	(0,0001)
(12)	6,8496	(0,0004)	19,6428	(0,0002)

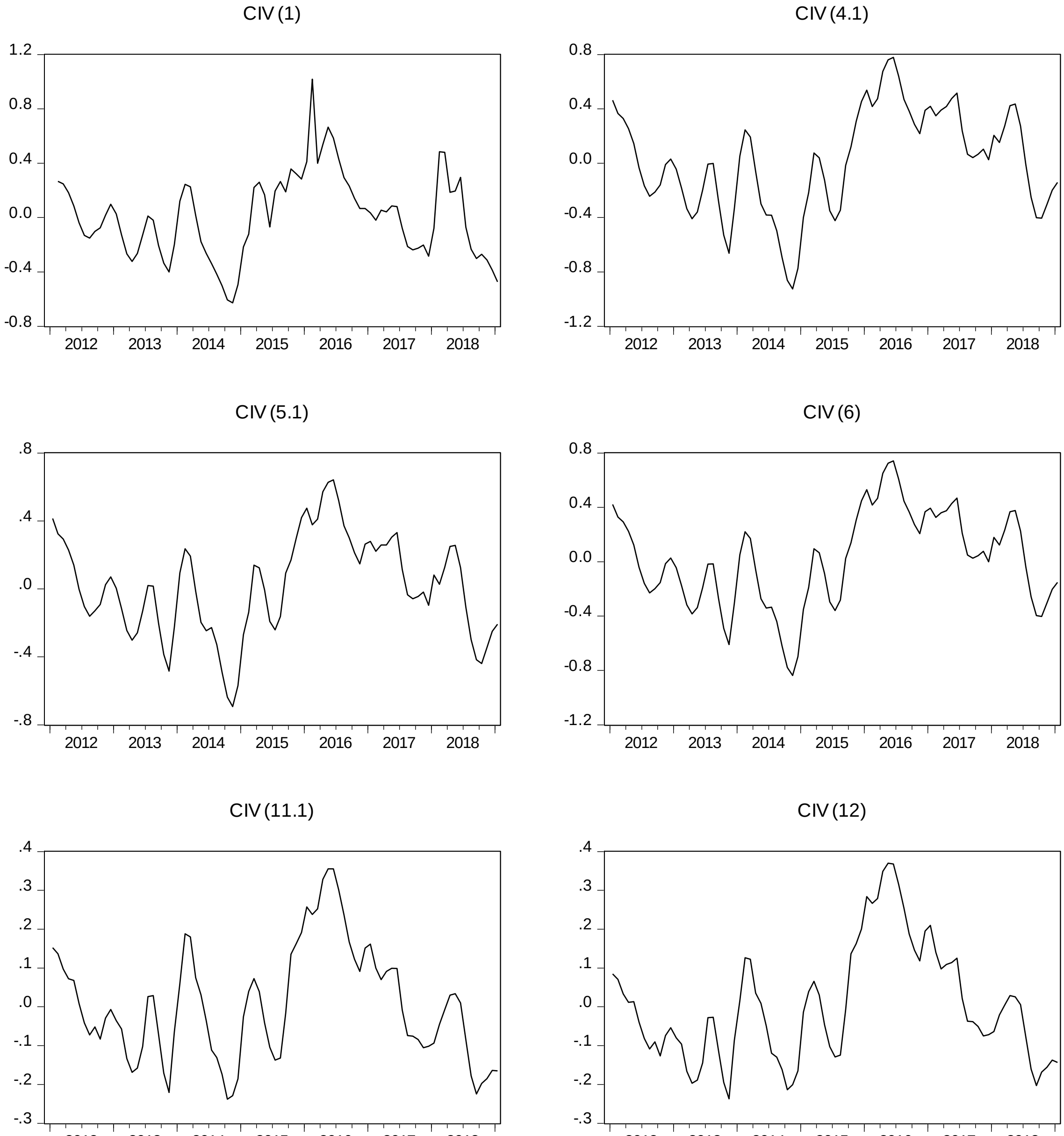
Notes: Chow Breakpoint test at the specified breakpoint in each monthly inflation equation using different excess liquidities. Own elaboration using EViews.

Table 10 - ARDL estimation results (small sample) for forecasting purposes

DEPENDENT VARIABLE: MONTHLY INFLATION RATE						
SYSTEMS	(1)	(4.1)	(5.1)	(6)	(11.1)	(12)
CIV	$(\mathrm{m}-\mathrm{p})-\mathrm{m}^{\mathrm{d}}$		$(\mathrm{mf}-\mathrm{p})-\mathrm{m}^{\mathrm{d}}$		$(\mathrm{m2f}-\mathrm{p})-\mathrm{m}^{\mathrm{d}}$	
MONEY DEMAND	$(\hat{e}, i, y)$	$(\hat{e}=0, i, y)$	$(\hat{e}bm=0, i, y)$	$(\hat{e}, i, y)$	$(\hat{e}=0, i, y)$	$(\hat{e}bm=0, i, y)$
SAMPLE	2012M02 - 2018M01					
OBS.	72	72	72	72	72	72
INFLATION RATE (-1)	0,5369 (4,3392)	0,6501 (6,0575)	0,6217 (5,6140)	0,6396 (5,8747)	0,5774 (4,6846)	0,5467 (4,3918)
EXCESS LIQUIDITY (CIV)	0,0052 (2,2408)	0,0022 (1,2509)	0,0039 (1,5254)	0,0028 (1,3743)	0,0102 (1,7100)	0,0130 (2,0157)
DUMMY (D1512)	0,0062 (3,2987)	0,0043 (2,4918)	0,0046 (2,6996)	0,0043 (2,4832)	0,0052 (2,9481)	0,0046 (2,8203)
CONSTANT (C)	0,0039 (3,5328)	0,0031 (2,9399)	0,0033 (3,1279)	0,0032 (2,9735)	0,0036 (3,1324)	0,0042 (3,2170)
R^2	0,8525	0,8388	0,8430	0,8403	0,8499	0,8551
S.E. OF THE REGRESSION	0,0037	0,0038	0,0038	0,0038	0,0037	0,0036
DURBIN-WATSON	1,9064	1,7841	1,7993	1,7872	1,7830	1,7875
CUSUM 5%	No Break	No Break	No Break	No Break	No Break	No Break
CUSUMQ 5%	No Break	No Break	No Break	No Break	No Break	No Break

Notes: *, **, ***: denote significance at 10%, 5% and 1%, respectively. T-statistics in parentheses. The "excess liquidity" was computed using the cointegrating vector (civ) of the VECM estimations, where $CIV = real\ money\ balances - money\ demand\ estimations$. The lags were automatically selected using the AIC. Own elaboration using EViews.

Figure 3 - Cointegration graphs



Notes: Relevant excess liquidities for forecasting inflation. Own elaboration using EViews.