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Money growth and inflation rate: evidence from Angola from 2014 to 2023[1]

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Abstract: This paper investigates the impact of the money supply on inflation in Angola from 2014 to 2023, by assessing the effect of money supply on inflation in Angola and to examine how the effects of money growth on inflation rate has evolved over time. For this purpose, we use money aggregate M2, and national price index data published by Banco Nacional de Angola (BNA, hereafter), that it is analysed using Vector Autoregressive model (VARM, hereafter) and rolling VARM. The results suggest that firstly, money supply does affect inflation in Angola and its impact is positive, in other words, a 1% increase in money supply leads inflation to rise by 0.11%. Thus, the greater the money supply the greater the inflation. Secondly, money supply and past inflation may explain nearly 67% of current inflation in Angola. Third, the time-varying elasticity of inflation rate with respect to money supply has changed dramatically over time and its value per period is mostly positive, confirming that throughout the period money growth affect constantly inflation. These findings have considerable implications for the role of monetary policy in the short term to control inflation rate in Angola once it reinforces the views to BNA deliver a discretionary monetary policy during the periods of increase in government activity. For the future, further analyses is requires, using a set of data much more robust and oil markets impacts on inflation through exchanges rates.

Keywords[3]: money growth; money supply; inflation; VAR; time-varying analysis.

Crescimento monetário e taxa de inflação: evidências de Angola de 2014 a 2023

Resumo: Este artigo investiga o impacto da oferta de moeda na inflação em Angola de 2014 a 2023, avaliando o efeito da oferta de moeda na inflação em Angola e examinando como os efeitos do crescimento da moeda na taxa de inflação evoluíram ao longo do tempo. Para esse propósito, usamos o agregado monetário M2 e os dados do índice nacional de preços publicados pelo Banco Nacional de Angola (BNA, a seguir), que são analisados usando o modelo Vector Autoregressivo (VARM, a seguir) e o VARM contínuo. Os resultados sugerem que, em primeiro lugar, a oferta de moeda afeta a inflação em Angola e seu impacto é positivo, em outras palavras, um aumento de 1% na oferta de moeda leva a inflação a aumentar em 0,11%. Assim, quanto maior a oferta de moeda, maior a inflação. Em segundo lugar, a oferta de moeda e a inflação passada podem explicar quase 67% da inflação atual em Angola. Terceiro, a elasticidade variável no tempo da taxa de inflação em relação à oferta de moeda mudou drasticamente ao longo do tempo e seu valor por período é principalmente positivo, confirmando que ao longo do período o crescimento da moeda afeta constantemente a inflação. Essas descobertas têm implicações consideráveis para o papel da política monetária no curto prazo para controlar a taxa de inflação em Angola, uma vez que reforça as visões de que o BNA deve entregar uma política monetária discricionária durante os períodos de aumento da atividade governamental. Para o futuro, análises adicionais são necessárias, usando um conjunto de dados muito mais robustos e os mercados de petróleo impactam a inflação por meio de taxas de câmbio.

Palavras-chave: crescimento monetário; oferta de moeda; inflação; VAR; análise de variação temporal.

Crecimiento monetario y tasa de inflación: datos de Angola de 2014 a 2023

Resumen: *Este trabajo investiga el impacto de la oferta monetaria sobre la inflación en Angola desde 2014 hasta 2023, evaluando el efecto de la oferta monetaria sobre la inflación en Angola y examinando cómo los efectos del crecimiento del dinero sobre la tasa de inflación han evolucionado con el tiempo. Para este propósito, utilizamos el agregado monetario M2 y los datos del índice de precios nacionales publicados por el Banco Nacional de Angola (BNA, en adelante), que se analizan utilizando el modelo vectorial autorregresivo (VARM, en adelante) y el VARM móvil. Los resultados sugieren que, en primer lugar, la oferta monetaria afecta la inflación en Angola y su impacto es positivo, en otras palabras, un aumento del 1% en la oferta monetaria hace que la inflación aumente un 0,11%. Por lo tanto, cuanto mayor sea la oferta monetaria, mayor será la inflación. En segundo lugar, la oferta monetaria y la inflación pasada pueden explicar casi el 67% de la inflación actual en Angola. En tercer lugar, la elasticidad variable en el tiempo de la tasa de inflación con respecto a la oferta monetaria ha cambiado drásticamente con el tiempo y su valor por período es mayoritariamente positivo, lo que confirma que a lo largo del período el crecimiento del dinero afecta constantemente a la inflación. Estos hallazgos tienen implicaciones considerables para el papel de la política monetaria en el corto plazo para controlar la tasa de inflación en Angola, ya que refuerzan la opinión de que el BNA debe aplicar una política monetaria discrecional durante los períodos de aumento de la actividad gubernamental. Para el futuro, se requieren más análisis, utilizando un conjunto de datos mucho más robustos y los impactos de los mercados petroleros en la inflación a través de los tipos de cambio.*

Palabras clave: *crecimiento monetario; oferta monetaria; inflación; VAR; análisis variable en el tiempo.*

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Introduce

Highly volatile inflation in Angola since 2016 has forced profound changes in the path of monetary and exchange rate policies in the country. Available evidence suggests that the more volatile the inflation, the greater the effect of money supply on the inflation rate (Papadia and Cadamuro 2021). However, it is unclear if it is true for Angola, particularly in last 9 years characterized by great inflation, combined either with low economic growth or economic depression. To the best of my knowledge, there is no public published evidence of how money supply has affected inflation in Angola in last 9 years, and whether its effects have changed dramatically throughout the last 9 years.

Available evidence in the literature suggests that there is a positive relationship between money supply and inflation, that is, as money supply increases, inflation increases, but it may not be entirely true when inflation is less volatile (Papadia and Cadamuro, 2021). In SSA economies, such as South Africa, Nigeria and Tanzania is observed similar patterns, that is, money supply has a strong positive relationship with inflation (Mpofu, 2011; Mbongo et. al., 2014; Evans, 2019). Evidence for Angola is lacking, but theoretically, is argued that money supply is correlated with inflation. However, the following question remains uncertain: how money supply has affected inflation in Angola and how its effects has changed dramatically over time?

This paper aims to bridge this gap by assessing the effect of money supply on inflation in Angola and to examine how the effects of money growth on inflation rate have evolved over time. To do so, the following hypotheses are tested: H1 - money growth does affect inflation rate in Angola; H2 - money growth does not affect inflation rate in Angola; H3 - money growth effect on inflation rate in Angola has changed dramatically over time and; H4- money growth effect on inflation rate in Angola has not changed dramatically over time.

For this purpose, money aggregate M2, and national price index data published by Banco Nacional de Angola (BNA, hereafter) are used, that it is analysed using Vector Autoregressive model (VARM, hereafter) and rolling VARM. The rationale to study Angola's case is given by the following reasons. First, availability of new economic facts provided by the new exchanges rates regime and discretionary monetary policy since 2018. Second, its massive economic reliance on oil revenue brings several challenges to monetary authorities.

The rest of the paper proceeds as follows. Section 2 reviews literature review. Section 3 presents an overview of inflation in Angola, and recent developments. Section 4 present empirical strategy, data, and presents and discusses our empirical results, respectively. Section 5 summarizes the paper and draws policy implications.

Literature review

Available evidence from the impact of money supply on inflation rate is generally supportive that money supply does affect levels of prices, although there might exist differences in the degree of its effects between developing countries, commodity-rich countries, and developed countries. Borio et., al. (2023) examines the link between money growth and inflation using a cross-country analysis (United States, Euro area, United Kingdom, Canada, Brazil, and Thailand) and their study indicates that, for the period 2015-2022, money growth and inflation have been closely linked, despite the absence of robust empirical evidence. This result reached by Borio et., al. (2023) is in line with what was found years ago in a study carried out by Roffia and Zaghini (2007) focusing on 15 industrialised economies, and by Bozkurt (2014) focusing on Turkiye.

A study carried out by Papadia and Cadamuro (2021) concluded that in countries in which inflation is volatile, money supply does help to explain inflation, but when inflation is not volatile, there is no evidence of money supply effects on inflation. Thus, this result implies that the relationship between money supply and inflation is no constant or may change over time. For

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instance, Roshan (2014) examines the inflation and money supply growth in Iran, using VAR models and finds evidence a bidirectional causality between money supply and inflation, concluding that inflation may have a feedback impact on money growth which generates more inflation.

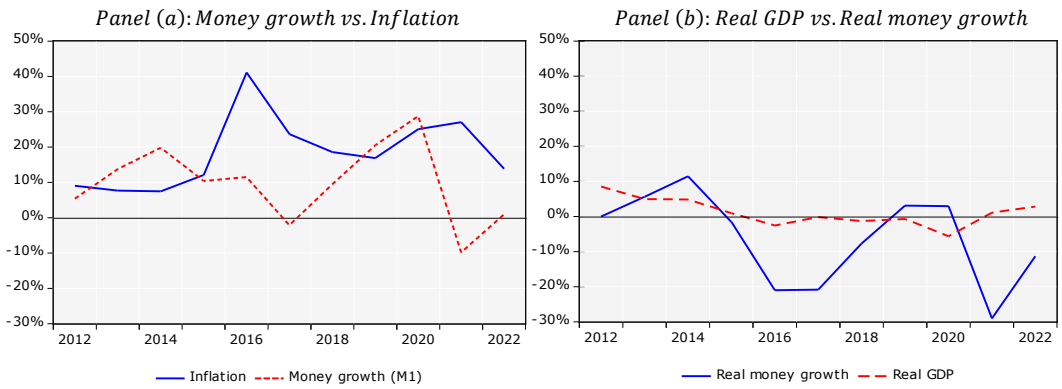
Many other studies are supportive to impact of money supply on inflation. However, recently, there has been some controversy about it. There is a debate about money exogeneity versus money endogeneity and it has gained force around the world (Tobin, 1970; Fontana and Setterfield, 2009; Thwaini and Hamdan, 2017; Sieron, 2019). Some defendthat money is indeed endogenously created (Fontana and Setterfield, 2009), in contrast to monetary view (money exogeneity). This may explain why central banks have been using massively quantitative easing to boost economic growth.

Inflation in Angola

Before we proceed, it seems necessary to explain the main characteristics of Angola's economy. Angola experienced a strong economic growth between 2002 and 2014, with average growth rates around 10%, and in 2022 it grew only 2.8%, after reached nearly 0% in 2021 and five (2016-2020) years of economic recession (IMF, 2023b). The oil sector has been the engine of economic growth accounting for about 29% of GDP and about 95% of exports in 2022 (BNA, 2023). Government accounts is also dependent heavily on oil sector. For instance, non-oil fiscal deficit in percentage of GDP, is estimated in -7.7% in 2022, while in 2014 it was -25.4%. (MINFIN, 2022).

From the monetary side, specifically inflation, it is valuable to explain that historically, Angola economy has faced periods of great problem of price level instability. Inflation has fluctuating, mainly around a double digit throughout recent Angolan economic history. The exception is only for the years 2012, 2013 and 2014 in which inflation rate was 9%, 7.7% and 7.5%, respectively, as illustrated in Fig 1, panel a (IMF, 2023b). High volatility is one of the issues of Angolan inflation over the years. As shown in the Fig. 1 panel (a), while from 2012 to 2014 the economy faced a relative price stability, from 2015 to 2022 it was profoundly volatile wherein reached a peak of 41% in 2016.

Figure 1. Money supply, GDP, and inflation (year-on-year, in percentage)



(Source: BNA, 2023; IMF, 2023b)

In terms of economic context, a relative price stability between 2012 and 2014 was due to a favourable oil sector (and responsible for nearly 95% of Angolan exports) which permitted a monetary policy anchored on foreign reserves to control inflation through exchanges rates

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manipulation[4]. Conversely, since 2015, the economy has performed poorly, Angolan oil market fell considerably due to continuing decline in oil production and constant negative shocks in oil prices. For a country heavily dependent on oil sector to gain foreign reserves, exchanges rates pressures take place and directly affect price level. Monetary authority starts to liberate exchanges rates markets in 2018 and reached a full flexible exchanges rate in 2020, and inflation responded positively dropping to nearly 14% in 2022. Panel (a) also shows that money growth (measure as year-to-year banknotes and coins held by the public and transferable deposits) was highly volatile in the period.

There are three major trends in money growth in Angola. Firstly, is observed a significant year-to-year growth from nearly 5% in 2012 to 20% in 2014. Secondly, it fell profoundly until reach a minus growth of about 2% in 2017. Third, it increased consistently, reaching a peak of nearly 29% in 2021. Before 2015, monetary authority in Angola was less cautious in controlling money supply in the economy once to control inflation was much more effective using exchanges to control price level burning foreign reserves. After that, BNA starts to deliver a tight monetary policy. Despite some exceptions fig. 1 tells us that there might exist a positive correlation between money growth and inflation in Angola, which is in line with hypothesis 1. This assumption is mainly true during the periods of less volatile inflation rate.

Considering that money growth was highly volatile between 2012 and 2022, a real money growth using national consumer price index to convert it from nominal to real (taking 2012 as basic year) shows that real money growth in 2013, 2014, 2019 and 2020 was higher than real GDP, as observed in Fig. 1 panel (b), which might have contributed to accelerate inflation rate, particularly in 2019 and 2020.

Search Results

To assess the impact of money growth on inflation rate in Angola this studiey use a Vector Autoregressive Model (VARM). A VARM is used when there is no confidence that a variable really is exogenous, each variable has to be treated symmetrically (Asteriou and Hall, 2011). In other words, some variables are not only explanatory variables for a given dependent variable, but are also explained by the variables that they are used to determine[5].

As pointed out by Asteriou and Hall (2011), the VARM approach has some very insightful characteristics. Firstly, it is very simple, once an econometrician does not have to worry about which variables are endogenous or exogenous. Secondly, estimation is also very simple, in the sense that each equation can be estimated separately with the usual ordinary least squares method. Finally, forecasts obtained from VARM are in most situations better than those obtained from the far more complex simultaneous equation models (Mahmoud, 1984; McNees, 1986).

The VAR model was implemented with two key variables has been imposed. The variables are national consumer price index and money supply (M2). To study the evolution of relationship

[4] Considering that Angolan imports its main goods and services, it was able to control inflation supplying foreign currencies to artificially appreciate local currency and consequently deliver a stable price level (lower inflation).

[5] For instance, the imagine the time series y_t that is affected by current and past values of x_t and, simultaneously, the time series x_t to be a series that is affected by current and past values of the y_t series. Thus, VARM is given by:

$$y_t = \beta_{10} + \beta_{12}x_t + \delta_{11}y_{t-1} + \delta_{12}x_{t-1} + \mu_{yt}$$

$$x_t = \beta_{20} + \beta_{21}y_t + \delta_{21}y_{t-1} + \delta_{22}x_{t-1} + \mu_{xt}$$

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between money growth and inflation rate over time and/or assess whether money growth has affected differently inflation rate through time we use time-varying estimates of our VAR. This is justified by the presence of structural breaks on the data, which might affect the intensity of money growth effect on inflation.

The general form of our VAR can be illustrated by the following expression:

$$\Delta z_t = c_0 + \sum_{i=1}^{n-1} \Gamma_i z_{t-i} + u_t \qquad (1)$$

Where z_t denotes a vector of variables. In our case, $z_t = (CPI_t, M_t)$, where CPI_t is (log) national consumer price index and M_t is (log) money supply M2. Further detail such as data definitions and sources are provided below in Table 1. c_0 is a vector of constant terms. n denotes the VAR lag-order. The short-run dynamics of the model are captured by the matrix of coefficients Γ_i, this includes the coefficients for CPI_t and M_t. u_t is a vector of error terms, Normally and Independently Distributed (NID).

The empirical strategy proceeds in four steps. The first two are aimed at understanding the properties of our data and model it appropriately. First, a test for unit roots in z_t using the standard unit-root stationary test (Augmented Dickey-Fuller and Phillips-Perron) and KPSS[6] test. Due to the presence of large shocks in the sample a unit-root test with breaks Zivot and Andrews (1992) is used. We test if cointegration vectors exist among z_t variables by testing for the rank (r) of the matrix Π using the Engle-Granger approach.

Second, we estimate a VAR model focusing on CPI_t equation for the full-sample and use our estimates of Γ_i to assess the effects of money growth on inflation rate in Angola. The coefficients for the lags of M_t contained in Γ_i, provides the elasticities of CPI_t to money growth. Considering the underlying economic theory, we expect a positive relationship between CPI_t and M_t. Three, to examine how the effects of money growth on inflation has evolved over time we re-estimate CPI_t equation using rolling windows. In our case, after experimenting with several window-sizes, we find that a window of 12 observations (quarterly data), that provides 24 rolling estimations or subsamples, is statistically satisfactory and economically meaningful. And lastly, we complement this evidence with estimates of impulse response functions of inflation for innovations on money supply.

Table 2 provides definitions and sources for each variable in z_t. Data expands over the period 2014:Q4-2023:Q2. This covers the post-global 2007/2008 financial crisis and the era of significative monetary policy reforms in Angola. It is well suited to study money growth and inflation rate as it contains periods of fixed exchange rates regime, as well as flexible exchange rate after.

Fig. 2, presents the evolution of variables in z_t over the sample period. As we can see, in the panel (a), CPI_t follows an upward trend, but from 2016 it accelerates considerably, reflecting the effect of lower capability to deliver discretionary monetary policy by National Bank of Angola to stabilize prices through exchange rates manipulation before the implementation of a fixed exchanges rates regime. Angola depends entirely on oil sector to accumulate foreign reserves and it imports majority of all essentials goods and services needed thereafter, constant oil prices shocks and reduction in oil production since late 2014 imposed a huge restriction on country's capability to accumulate foreign reserves to support external demand. Thus, with less foreign reserve, monetary policy is less effective and need to be restrictive. Panel (b), M_t, exhibits an upward-trend that fell

[6] We run, KPSS, firstly, to cross-check results from ADF, PP tests, which have a unit-root null hypothesis, against those of a test where the null is of stationarity (Kwiatkowski, et al., 1992). Secondly, it appears that, CPI_t might not be normally distributed. As noted by Hadri (2000), KPSS test is not affected by the non-normality of variables, as in our case. Hence, it seems appropriate to use this test.

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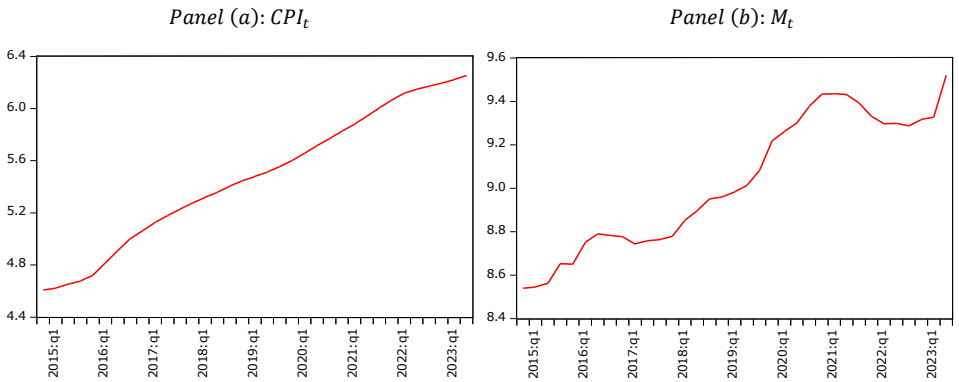
profoundly from mid of 2017, reflecting a week economic performance in that period in Angola. And in 2022 it turns down sharply in consequence of National Bank of Angola response to counter inflation rate. We seasonally adjusted CPI_t and M_t to deal with monetary and seasonal effects using X-13-ARIMA, as proposed by Balcilar et al. (2013).

Figure 2. Evolution of CPI_t and M_t 2014: q4 - 2023: q2



(Source: Banco Nacional de Angola, 2023)

Table 1. Data

Variable	Description	Data period	Source
CPI_t	National consumer price index (in logs).	Quarterly	[1]
M_t	Money supply M2 (in logs).		[2]

[1] IMF (2023a). [2] BNA (2023)

We use M2 (which is the entire stock of currency and other liquid instruments, that includes cash, coins and balanced held in checking and saving accounts) as measured to money supply growth because it contains more than just physical money and it is prominent instrument to measure money growth, and it is frequently used to evaluate liquidity.

Unit-roots

We start our analysis by testing the unit-root properties of our variables, $z_t = (CPI_t, M_t)'$. Table 2 presents the results of tests without breaks, i.e., ADF, PP and KPSS tests. Overall, comparing the results for ADF and PP suggests some contradictions once it is not possible to assume stationarity and/or non-stationarity jointly in each one of the tests. Thus, we run a KPSS which is much more robust than ADF and PP. KPSS tests rejects stationarity at level and concludes that CPI_t and M_t are stationary when imposed I(1).

Zivot-Andrews's test, reported in Table 3, does not reject the null of a unit-root on the first differences for all three specifications of the test. Further, Zivot-Andrews's test identifies significant structural breaks for CPI_t in 2016q1 coinciding with massive currency depreciation and consequently an inflation peak in Angola. In sum, evidence from Table 2 suggests that we should treat variables in z_t as $I(1)$ and that there are breaks in the data, which justify our time-varying VAR approach.

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Table 2. *Unit-root tests*

Variables	ADF		Phillips-Perron test		KPSS test	
	Const.	Const. & trend	No Const.	Const. & trend	Const.	Const. & trend
Level						
CPI_t	1.48	-2.17	7.99**	-1.07	1.39**	0.16*
M_t	0.13	-3.83*	-2.65*	-2.00	1.34**	0.13
1st diff.						
ΔCPI_t	-2.07	-2.18	-0.61	-2.75	0.16	0.07
ΔM_t	-2.79	-2.46	-2.29*	-2.91	0.07	0.07

Note: The number of lags selected by AIC are 8 CPI_t, 5 M_t and 1 IR_t . ADF critical values at 1% and 5% with intercept are: [-3.74/ -2.99], and with intercept and trend: [-4.37/ -3.60]. Phillips-Perron critical values at 1% and 5% with intercept are: [-2.65/ -1.95]. KPSS test critical values at 1% and 5% with intercept are: [0.74/ 0.46], and with intercept and trend: [0.22/ 0.15].

* Rejection of the null hypothesis at the 5% level/ ** Rejection of the null hypothesis at the 1% level.

Table 3*. Unit-root tests with breaks, Zivot-Andrews's test*

Variables	Zivot-Andrews's test					
	Model A, with break in const.		Model B, with break in trend		Model C, with break in const. and trend	
	Break	*t-statistic*	*Break*	*t-statistic*	*Break*	*t-statistic*
Levels						
CPI_t	2016q1	-5.64**	2015q2	-4.83*	2016q1	-5.48*
M_t	2019q3	-4.28*	2016q1	-3.45	2019q3	-4.17
1st Diff.						
ΔCPI_t	2015q4	-4.40	2016q1	-4.40	2015q4	-4.40
ΔM_t	2021q1	-3.36	2022q4	-3.30	2021q3	-3.81

Note: Critical values for A at 1% and 5% are: [-5.34/ -4.80]. For B at 1% and 5%: [-4.93/ -4.42]. For C at 1% and 5%: [-5.57/ -5.08]. * Denotes rejection of null hypothesis at 5% level and ** at 1%.

Next, we test if our variables are cointegrated using Engle-Granger cointegration approach. Table 4 reports our results for the full sample. The result indicates that there is not long-run relationship among our key variables at the 5% between CPI_t and M_t. In sum, considering the results from cointegration analysis, we should employ a VAR model in first differences to assess the effect of money growth on inflation rate in Angola to avoid a spurious regression.

Table 4. *Engle-Granger Cointegration test between CPI_t and M_t*

	Test statistic	*Critical value*		
z(t)		1%	5%	10%
	-3.16	-4.75	-4.01	-3.64

Money growth impact on inflation rate

Next, we evaluate the effect of money growth on inflation rate in Angola for the whole sample in our selected model and focusing the analyses on ΔCPIt equation. Following the appropriate standard selection criteria (AIC/SBC), it delivers n=1 for our VAR model, see Appendix A. Conversely, to resolve autocorrelation problems, we adopt a VAR model with two lags (n=2). Table 5 presents our results. Our regression for ΔCPI_t, explains a large proportion of the

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variation in the data, and the adjusted R-squares ($\bar{R}^2$) is 67.3%. For ΔM_t, the fitted values explain 32.9% in this variable. All regressions pass the corresponding serial correlation, homoscedasticity, and fell slightly the normality diagnostic tests, at the 5% significance level. Further, Eigenvalue stability condition is satisfied suggesting that the model is stable and satisfactorily specified, see Appendix B.

***Table 5**. VAR estimations*

	Equation (1): ΔCPI_t	Equation (2): ΔM_t
ΔCPI_{t-1}	0.968***	0.159
	(6.30)	(0.26)
ΔCPI_{t-2}	-0.313**	-1.626***
	(-2.06)	(-2.69)
ΔM_{t-1}	0.003	0.080
	(0.06)	(0.42)
ΔM_{t-2}	0.108**	0.265
	(2.31)	(1.42)
C_0	0.014***	0.094***
	(2.61)	(4.26)
R^2	0.715	0.415
$\bar{R}^2$	0.673	0.329
$\hat{\sigma}$	0.011	0.043
P-value	[0.000]	[0.000]

Observations=32 in all regressions. ( ) stands for *t*-statistics. * Indicates significance at 10%, ** at 5% and *** at 1%. $\hat{\sigma}$ Stands for the standard error of the residuals.

In equation (1), we find that lagged inflation rates do affect current inflation in Angola as the corresponding elasticities at lag 1 and 2 of ΔCPI_t are significant at the 5% test. This result is expected and in line with the inertial inflation principle. The results also indicates that the coefficients of ΔM_t on ΔCPI_t equation have the correct sign, implying that the greater the money supply the greater the inflation. Note that current inflation is not only affected by its previous levels but that lagged money supply movements have significative impact on current inflation rate in Angola. At lag 2 (ΔM_{t-2}), a 1% increase in money supply leads inflation to rise by 0.11%. At lag 1 (ΔM_{t-1}), the underlying coefficient (0.003%) on ΔCPI_t is not significantly different from zero.

To sum up, the result from VAR indicates firstly, that money supply does affect inflation in Angola and its impacts is positive. Secondly, there is inertial inflation once past inflation does affect current inflation rate. And finally, money supply and past inflation may explain nearly 67% of current inflation. These results are in line with what was found by Roshan (2014), and Papadia and Cadamuro (2021) wherein countries whose inflation is volatile, money supply does help to explain inflation, and considering that inflation in Angola is highly volatile, the evidence suggests that money supply does affect inflation in Angola. Thus, hypothesis 1 - money growth does affect inflation rate in Angola is not rejected

Time-varying analysis: money growth impact on inflation rate

Following our results, we can argue that money growth does affect inflation rate in Angola. Additionally, it is important to assess how money growth has affected inflation rate throughout the period and to do so, Fig 3 below presents the time-varying coefficient of money growth on inflation using rolling windows in our VAR model. Panel (a) and (b) in Fig. 2 shows that time varying elasticity of ΔCPI_t with respect to ΔM_{t-i} have changed dramatically over time and its value per period is mostly positive (excepting at the end of 2018 and beginning of 2019, and end of 2021), confirming the hypothesis 3.

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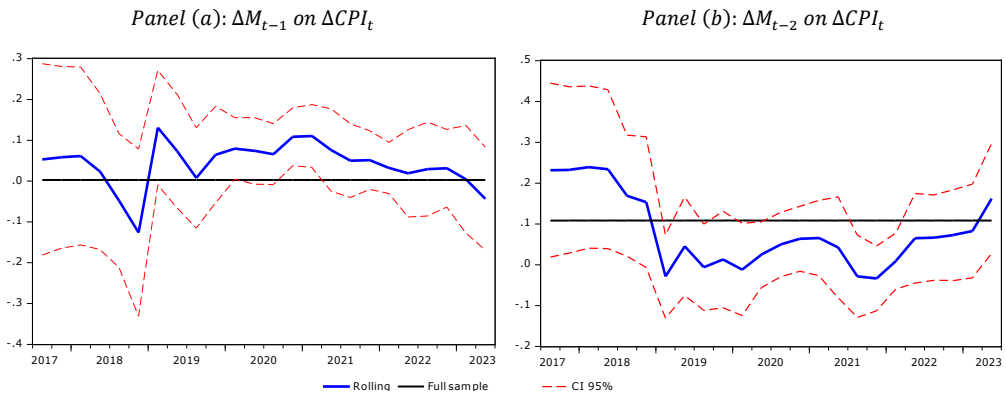
Figure 3. *Rolling elasticity of* ΔCPI_t *with respect to lags of* ΔM_t.



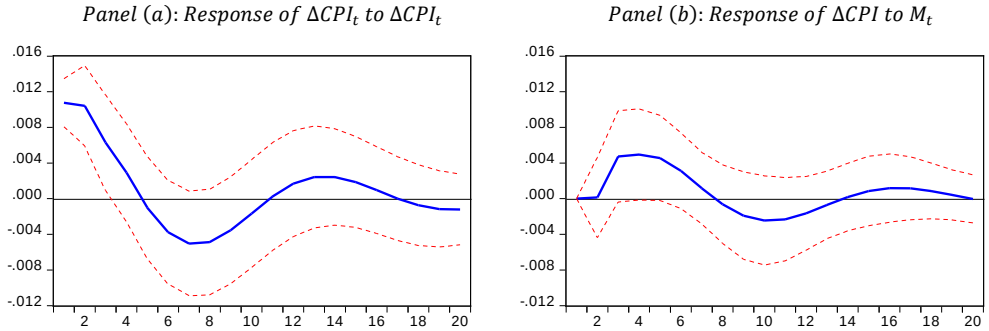
Note: Windows size=12 obs. (24 subsamples) dates in x-axis denote last quarter of estimation window.

Observing Fig 3 panel (b), whose full sample elasticity of ΔCPI_t with respect to ΔM_{t-2} is significantly different from zero it indicates that there are three different patterns for money growth effects on inflation. Firstly, from 2014 to 2019 the elasticity of ΔCPI_t with respect to ΔM_{t-2} shows a declining trend. Secondly, from 2019 to 2021 shows a stable trend, and finally, after the last quarter of 2022 indicates an increasing trend. There could be several reasons behind such behavior, but it is certain that the following ones may help to understand what happened in each period. The reason for declining trend before 2019 may be linked to the use of foreign reserves to guarantee artificially local currency value and consequently prices levels stability once majority of essential goods and services consumed in Angola are imported. Thus, in that period, the exchange rates position played a key role in controlling inflation. The stable trend between 2019 and 2021 can be explained by a tight monetary policy to control inflation combined with introduction of flexible exchanges rates regime in Angola, whereas an increasing trend from 2022 might be linked to government expenditures growth (general election in 2022) and oil prices increment.

Impulse response function

This section presents the impulse response function of inflation for innovations on money supply. As illustrated in Fig. 4 panel (b), a standard deviation shock on money supply does not affect inflation at the beginner, but in the following period the inflation rises profoundly during two quarters and then starts to decelerate slightly throughout the period. However, it appears that the effects of money supply shocks on inflation does disappear completely after sixteen quarters.

Figure 4. Impulse response function of ΔCPI_t with respect to shocks in ΔCPI_t and ΔM_t.



The results from impulse response functions tend to support the view that, money supply shocks in Angola does affect systematically inflation rate and it may last for at least 4 years if a

discretionary monetary policy is not introduced to control its spreads effect throughout the period.

Conclusion

The purpose of this study was firstly to assess the effect of money supply on inflation in Angola, secondly, to examine how the effects of money growth on inflation rate has evolved over time. To do so, a vector autoregressive model was used, after assessing the underlying mythological conditions.

The findings suggest that money supply does affect inflation in Angola and its shocks may last a certain period. And finally, the time-varying elasticity of inflation rate with respect to money supply has changed dramatically over time and its value per period is mostly positive. These findings have considerable implications for the role of monetary policy in the short term to control inflation rate in Angola once it reinforces the views to BNA deliver a discretionary monetary policy during the periods of increase in government activity.

Moreover, it is required, in the future, further analyses about the effect of money supply on inflation under a set of data much more robust in order to take into consideration the role of oil market sector on inflation through exchange rates.

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Appendix A. Selection-order

Table A1. *Lag-order selection criteria*

Lag	LR	AIC	SBIC
1	43.169	-10.3722*	-10.0796*
2	7.7816	-10.3634	-9.87587
3	.32127	-10.0563	-9.3737
4	2.3809	-9.83151	-8.95392
5	5.4582	-9.72983	-8.65722
6	5.3195	-9.62261	-8.35498
7	.88769	-9.33812	-7.87547
8	11.056	-9.46035	-7.80268
9	28.557*	-10.2826	-8.42993

Appendix B: VAR Post-estimation tests

ΔCPI_t fails the normality test. This persisted despite experimenting with several alternatives, e.g., using more lags and correcting outliers with dummies. Hence, given that this issue invalidates the *t*-test statistics but has no impact on the efficiency of estimates, we decided to proceed acknowledging that we cannot use the *t*-test to validate results when observation is larger.

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Table B1. Lagrange-multiplier test for serial correlation

Lag	Chi2	df.	Prob. > chi2
1	3.5349	4	0.47249
2	1.6960	4	0.79144

We conclude that residuals are not serially correlated.

Test for normally distributed disturbances, reported in Table B2. The null hypothesis is that disturbances are normally distributed. When p-value higher than 5% we do not reject null and rejected otherwise

Table B2. Test for Normality of residuals

Jarque-Bera test

Equation	Chi2	df.	Prob. > chi2
ΔCPI_t	19.621	2	0.00005
ΔM_t	6.334	2	0.04214
All	25.954	4	0.00003

Skewness test

Equation	Skewness	Chi2	df.	Prob. > chi2
ΔCPI_t	1.225	8.003	1	0.00467
ΔM_t	0.87183	4.054	1	0.04407
All		12.057	2	0.00241

Kurtosis test

Equation	Kurtosis	Chi2	df.	Prob. > chi2
ΔCPI_t	5.9518	11.617	1	0.00065
ΔM_t	4.3076	2.280	1	0.13107
All		13.897	2	0.00096

Table B3. Homoscedasticity of residuals

Sample: 35

Included observations: 32

Joint test:

Chi-sq	df	Prob.
26.6477	24	0.3211

Individual components:

Dependent	R-squared	F(135,23)	Prob.	Chi-sq(135)	Prob.
res1*res1	0.436033	2.222819	0.0641	13.95307	0.0830
res2*res2	0.154649	0.525954	0.8248	4.948764	0.7630
res2*res1	0.264701	1.034975	0.4392	8.470438	0.3889

White heteroscedasticity test indicates that we cannot reject the null hypothesis i.e., we have reasons to believe that the data is homoscedastic once the p-value for the joint test are higher at the 5% test level.

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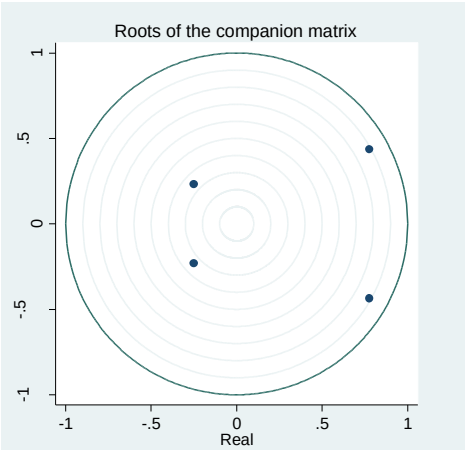
Figure B1. Eigenvalue Stability Condition Test



Eigenvalue Stability condition test yields that all roots lie inside the unit circle, thus the VAR system is stable.