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Determinants of Inflation in the Democratic Republic of Congo: An Application of ARDL Modelling

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Abstract

The objective of this study is to estimate the short- and long-term determinants of inflation in the DRC for the period from 1981 to 2017. To achieve our objective, we used cointegration techniques based on Autoregressive Staggered Lag (ARDL) modelling. The estimated model is derived from Irving Fisher's quantitative equation of money, into which we have incorporated other variables such as the exchange rate, the budget deficit, gross domestic product, the demographic dependency ratio, public spending and household final consumption expenditure. The results show that, in the short and long term, inflation in the DRC is positively influenced by the nominal exchange rate and demographic dependency, unlike money supply, final household consumption expenditure and the budget deficit, whose effects are only significant in the long term. As for gross domestic product and public spending, estimates have shown that inflation reacts negatively to their shocks. In addition, the nominal exchange rate remains the most important determinant due to its short and long term elasticities (0.86 and 0.89) followed by the demographic dependency ratio (0.43% and 0.46%) and finally the budget deficit with a long term elasticity of 0.59%.

Keywords: Inflation, ARDL Modelling, DRC.

1. Introduction

Characterized by a failing production system, the economy of the Democratic Republic of Congo (DRC) went through a period of sad memory (the 1990s) crowned by negative growth rates, unprecedented hyperinflation coupled with endemic depreciation, a severe public debt crisis, recurrent very high budget deficits, persistent macroeconomic vulnerability due to the economy's heavy dependence on primary export products devoid of added value (Kabuya and Tshiunza, 2006; Kabuya and Tsasa, 2018). In an attempt to put an end to the crisis of the lean period (the 1990s), several monetary reforms were implemented (the monetary reform of October 1993 and the monetary reform of May 1997)[1], but these only succeeded in amplifying hyperinflation

[1]The monetary reform of October 1993 saw the issue of a new currency unit, the "new Zaire" (NZ), at the official rate of 1 US dollar = 3NZ (the internal parity used was 1NZ = 3,000,000 Z). The monetary reform of May 1997 marked a return to the Congolese franc. This reform benefited from long and meticulous technical preparations. Several preliminary actions were carried out between May 1997 and June 1998, with a view to stabilizing the currency and restoring its convertibility and the range of banknotes and coins.

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(Kabuya and Tshiunza, 2000). It was only in 2002 that the Congolese economy returned to positive growth rates (-2.1% in 2001 and 3.5% in 2002) and broke with the series of three-figure hyperinflation rates, 135.1% in 2001 and 15.8% in 2002 (i.e. 119.3% disinflation), the result of the "Programme Intérimaire Renforcé" (PIR) decreed in 2001 to halt the deterioration, break the hyperinflation and liberalize the economy and the market. The significant improvement in fundamental imbalances observed in the DRC between 2002 and 2015 can be attributed in particular to the progress made in complying with budgetary rules. Above all, the adoption of a budget anchor based on non-recourse to monetary financing, which was implemented from 2010 until the end of December 2015, has made a significant contribution to macroeconomic stability, as a result of the government's considerable efforts (Matata, 2018).

Despite the performance achieved as a result of the efforts made, the low and stable level of inflation continues to overshadow the success of economic policies and is therefore a major constraint on the proper management of economic performance. In view of the above, it would be imperative to study scrupulously the influence of the variables that are supposed to determine changes in the general level of prices in the DRC, with a view to protecting consumers against the erosion of their purchasing power. This exercise is of the utmost importance for those responsible for economic policy when making decisions as part of the implementation of policies aimed at reducing poverty. This is because inflation, when reduced and stabilized at low levels, is likely to reduce inequality and hence poverty (Kabuya, 2009). The aim of this study is to estimate the short- and long-term determinants of inflation in the DRC. To achieve our objective, we use cointegration techniques based on Autoregressive Staggered Lag (ARDL) modelling. Unlike the econometric techniques used in most studies on the same subject as ours, which require variables to be integrated of the same order (SVAR, VAR, Engel and Granger cointegration, Johannsen, etc.), the ARDL approach of Pesaran, Shin and Smith (PSS approach) is an alternative approach with fewer constraints (variables can be of different order and estimates produce good results even with a small sample size).

The rest of the article is structured as follows: the second section describes the literature review. The methodology is presented in the third section. The fourth section is devoted to the results, and the fifth concludes the study.

2. Related literature

Studies on inflation share a common view of the sources of inflation, with the literature focusing first on monetary variables and then on non-monetary factors. Monetarist approach asserted that "inflation is always and everywhere a monetary phenomenon in the sense that it is and can only be generated by an increase in the quantity of money faster than that of output" in the sense that any increase in the quantity of money put into circulation is accompanied by a rise in prices. This idea is based on the existence of a global economic relationship known as the "quantitative equation of money", which shows that an increase in the quantity of money mechanically causes an increase in the general price level. It thus helps to justify the monetarist golden rule developed by Friedman, namely that changes in the money supply must be correlated with changes in output. But in the short term, the immediate variation in prices as a function of changes in the

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money supply is not obvious. In his work entitled The General Theory of Employment, Interest and Money, Keynes (1936) sets out the theory of prices, i.e. the analysis of the relationship between the quantity of money in circulation and the price level, which aims to determine the elasticity of prices in response to changes in the quantity of money. According to this theory, inflation results from two processes. On the one hand, when factors are fully employed in an economy, output volume becomes inelastic and prices rise in proportion to M×V. On the other hand, as output grows, the economy successively reaches bottlenecks that act as brakes on the supply of products and where prices rise in order to divert demand towards other goods. Keynesian analysis is opposed to monetary theory because it opts for an increase in the money supply to stimulate employment. However, the author recognizes that there are limits to the use of money to promote economic growth.

According to Duchêne et al(2009), changes in the exchange rate can have a significant effect on inflation: a depreciation of the currency raises the price of imported goods, while an appreciation of the currency reduces the price of imported goods. This is known as the pass-through effect, meaning that movements in the exchange rate are passed on to prices. According to the theory of structural inflation, the fundamental causes of inflation are, by nature, structural and that the underlying sources of inflation in less developed countries are to be found in the fundamental problems of economic development and in the structural characteristics of the production system of these countries. Berthomieu(2004) assert that inflation is not a monetary phenomenon, but the result of the interaction of two components, namely the structural factors at the origin of price rises and the propagation mechanisms. In a study by Goodhart and Pradhan (2017), the link between demography and inflation was explained by one of the most convincing arguments highlighting the supply and demand of goods and services, the reasoning of which can be summarized as follows: Children and pensioners participate only in the demand for goods (through consumption), while the working population participates in both demand and supply of goods (through consumption and production of goods). Children and pensioners participate only in the demand for goods (through consumption), while the working population participates in both the demand and supply of goods (through consumption and production of goods). The "dependent" population (children and pensioners) therefore imprints an inflationary movement on the economy, while the active population tends to have a deflationary effect.

Using a structural autoregression model (SVAR), Jørgensen and Ravn (2022) evaluated the response of inflation to public spending shocks. Their results showed that, contrary to standard Keynesian models predicting that expansionary fiscal policy is inflationary, prices do not rise in response to a positive public spending shock. Instead, the price response is flat or even negative. Estimates by Juselius and Takats (2015) based on a panel of 22 countries covering the period from 1955 to 2010 have shown that there is a significant and economic relationship between demographics and inflation. The proportion of dependent people is positively correlated with inflation, while the proportion of independent people (working population) is deflationary. Fischer et al (2013) estimate a vector error correction model and conclude that inflation in the DRC is essentially explained in the long term by the nominal exchange rate followed by the monetary base, with respective elasticities of 0.80 and 0.31. To identify the determinants of

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inflation in the CEMAC, Bikai et al, (2016) estimated a panel VAR model over the period 1990 to 2014. The results show that the money supply and imported inflation explain inflation better than the oil price, the fiscal balance and the output gap.
According to Leeper (2018), if central banks are given a clear mandate to control inflation and stabilize the real economy without coming under pressure from the fiscal authorities, and fiscal policy is given the task of stabilizing debt (sustainable fiscal policy), then the effects of fiscal policy on inflation would be small or even non-existent. Empirically analyzing the determinants of inflation in Algeria, Ouafaa (2018) used a vector error correction model for a period from 1990 to 2015. The empirical results showed that inflation in Algeria is determined by the import price, government expenditure and the level of gross domestic product with a dominant effect of the external variable; the elasticities being 0.791%, 0.329% and 0.315% respectively. A negative relationship was found between inflation and the price of oil. Recently, Mahamat and Mohammadou (2022) estimated a dynamic panel for 39 Sub-Saharan African countries using the generalized method of moments for data covering the period from 1982 to 2017. Information from the estimation results indicated that external and domestic debt positively influence inflation in Sub-Saharan Africa while the economic growth rate (the increase in output) has negative effects on inflation.

The literature review shows that most studies on the determinants of inflation have produced divergent results for some and convergent results for others. Inflation does not always react in the same way to the shocks to its determinants highlighted in the review, and estimates have mainly been based on traditional cointegration, VAR and SVAR models, and cointegration on panel data. In terms of inflation explanatory variables, the review provides us with variables such as the money supply, the exchange rate, the budget deficit, gross domestic product, final consumption expenditure, demographic dependency and public expenditure. To distinguish ourselves from our predecessors, we use cointegration techniques based on staggered lag autoregressive modelling (PSS approach). In addition, the model estimated incorporates demographic dependency and takes account of both public spending and the budget deficit.

3. Methodology

Classical estimation methods require the series used to be stationary, as the inference procedures of classical econometrics are no longer valid in the presence of series containing stochastic trends. The question is why not eliminate the trend by differentiation. The answer is that this approach leads to a reduction in information insofar as the series is deprived of long-term movements. Hence the interest in working with non-stationary series using the theory of co-integration. This theory sets out the conditions under which it is legitimate to work with non-stationary series (Araujo et al, 2008). The most commonly used co-integration approaches are the two-stage approach of Engle and Granger (1987) and the approach of Johansen (1991, 1995). These co-integration techniques recommend the use of integrated series of the same order I (0) or I (1). Given the constraints associated with the application of the aforementioned traditional co-integration tests, the co-integration technique based on Autoregressive Staggered Lag (ARDL) modelling developed by Pesaran and Shin (1999) and extended by Pesaran et al (2001) is used as an alternative. This approach, known as the PSS approach (Pesaran, Shin and Smith), makes it

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possible to test long-term relationships on series that are not necessarily integrated of the same order, and to obtain better estimates on small samples (Cheung and Lai, 1993). Generally, the autoregressive model with staggered delays takes the following form:

$$Y_t = \pi_0 + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=0}^{q} \beta_i X_{t-j} + \mu_t \quad (1)$$

Where μ_t is white noise which is uncorrelated with the X_t, nor with the past values of X_t and not with the lagged values of Y_t. The explained variable Y_t depends not only on the present values of and its past values but also on its own past values. The maximum values of p and q are chosen according to the AIC (Akaike Information Criterion) or the SBC (Schwarz Bayesian Criterion) criterion, based on the principle of parsimony. In this model, the staggered lag implies that the long-term response of Y_t for a unit change in X_t is different from the immediate short-term response of Y_t in reaction to a shock X_t. To estimate the long-run and short-run effects between inflation and its various determinants, the ARDL representation of equation (1) is given by:

$$\Delta lnIPC_t = \pi_0 + \sum_{i=1}^{p} \alpha_i \Delta lnIPC_{t-i} + \sum_{j=0}^{q} \beta_i \Delta X_{t-j} + \sum_{i=1}^{7} \theta_i X_{t-1} + u_t \quad (2)$$

With X_{t-j} the vector of exogenous variables in difference; X_{t-1} is the vector of exogenous variables in level. Δ is the difference operator, π_0 is the constant; $\mu_t \sim iid\ (0, \delta)$ is the error term (a white noise); $\beta_i = \{\beta_1, \beta_2, \dots, \beta_7\}$ the short-term effects and $\theta_i = \{\theta_1, , , , , \theta_7\}$ the long-term effects. The vector of exogenous variables in difference and the vector of exogenous variables in level are given by equations (3) and (4) as follows:

$$X_{t-j} = \{lnM_{t-j}, lnXCHN_{t-j}, lnGDP_{t-j}, lnPS_{t-j}, lnHFC_{t-j}, lnBD_{t-j}, lnRDD_{t-j}\} \quad (3)$$

$$X_{t-1} = \{lnM_{t-1}, lnXCHN_{t-1}, lnGDP_{t-1}, lnPS_{t-1}, lnHFC_{t-1}, lnBD_{t-1}, lnRDD_{t-1}\} \quad (4)$$

With $XCHN$ the nominal exchange rate; GDP the gross domestic product; PS the public spending; HFC is the household final consumption expenditure; BD the budget deficit and RDD the demographic dependency ratio. By virtue of Granger's representation theorem, an Error Correction Model (ECM) is inevitable in the case of co-integrated variables. Thanks to the PSS procedure, an error correction model can help to confirm the existence or otherwise of co-integration between variables. In our case, the MCE we estimate is as follows:

$$\Delta lnCPI_t = \pi_0 + \sum_{i=1}^{p} \alpha_i \Delta lnIPC_{t-i} + \sum_{j=0}^{q} \beta_i \Delta X_{t-j} + \lambda \mathrm{ECM}_{t-1} + u_t \quad (5)$$

Where CPI is the consumer price index. λ is the error correction coefficient, which must be significantly negative. It indicates the speed of adjustment of the endogenous variable to return to long-term equilibrium following a short-term shock. And MCE represents the residuals obtained from estimating the equation of the cointegrated model. This modelling is made possible by two data sources. On the one hand, we use data from the Central Bank of Congo, and on the other, the data are taken from World Development Indicators and cover the period from

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1981 to 2017. In addition, the choice of variables is guided by the empirical literature and makes it possible to retain monetary and non-monetary variables. These are the Consumer Price Index (the dependent variable) and the explanatory variables, namely the nominal exchange rate, gross domestic product, government expenditure, household final consumption expenditure, the budget deficit and the demographic dependency ratio. The definitions of the variables used are given in Table 1.

According to the quantitative theory of money, the money supply has a positive influence on inflation, i.e. any increase in the money supply leads to an increase in the general price level. This relationship is only valid in the long term because prices are rigid in the short term (Fischer et al, 2013). It is captured by currency in circulation and sight deposits in commercial banks (M1) given its direct link with the consumer price index. The nominal exchange rate has a positive influence on the level of prices. In other words, any increase in the exchange rate (quoted at uncertain values) leads to an increase in the general level of prices. Empirical studies rank it first in the explanation of inflation. (Atabaev et Gamyev, 2013; Fischer et al, 2013). It is used to capture the effects of (i) frequent recourse to imports (ii) the value of the national currency against the dollar (depreciation) (iii) the international environment on domestic prices. Similarly, the budget deficit has a positive influence on inflation (Mahamat et al, 2020). Any increase in the budget deficit gives rise to inflation, regardless of how it is financed.
According to Leeper (1991), deficit shocks cause inflation to rise, now or in the future. This is captured by a dummy variable which takes the value 1 for all years in which the balance is negative and the value 0 for all years in which the balance is positive or zero, unlike previous studies which used the budget balance variable (Langwemy et Saidi, 2022; Naeem et al, 2011).

Table 1. Variables definition

Variables	Definition	Expected sign	Sources
MS	Money Supply	+	Central Bank of Congo
XCHN	Nominal exchange rate	+	Central Bank of Congo
PE	Public expenditure	+/-	Central Bank of Congo
BD	Budget deficit	+	Central Bank of Congo
GDP	Gross Domestic Product	+/-	Central Bank of Congo
RDD	Demographic dependency ratio	+	World Development Indicators
HFC	Household final consumption expenditure	+	World Development Indicators
CPI	Consumer price index		World Development Indicators

Source: Author.

We also use GDP as an indicator of economic performance. It provides information on the volume of production achieved over a period. It is assumed to be negatively correlated with inflation because, theoretically, increasing output in an economy makes it possible to contain the effects of inflation. However, it is positively correlated with inflation in the case where the increase in production (GDP) is accompanied by an increase in income, i.e. demand (demand greater than supply). Public spending influences the general price level positively or negatively depending on whether its effect is on supply or demand (Jørgensen and Ravn, 2022). In other

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words, when the increase in public spending favours an increase in production (supply), inflation reacts negatively, whereas when it does not, it reacts positively. Public spending is taken as a whole in this study. The Household Final Consumption Expenditure variable is used to check how the use of resources held by households affects inflation. It has a positive influence on the general price level through aggregate demand (Nubukpo, 2002). Finally, the Demographic Dependency Ratio is an indicator for assessing the weight of the financially dependent population in relation to the financially independent population. It has a positive influence on inflation, meaning that any increase in the dependent population relative to the independent population has inflationary effects (Juselius and Takats, 2015). This is explained by the degree of participation in supply, which remains lower than that of demand.

4. Results and discussion

- Statistical evidence

The results of the statistical analyses reported in the appendix (Table A.1) and in Table 2 show that all the variables with a unit root are made stationary at first difference, i.e. they are all integrated of order 1. We therefore record I (1) and I(0) variables. These results justify the use of the PSS approach. Table 2 shows that the nominal exchange rate is the most volatile, followed by the consumer price index and the demographic dependency ratio. The other variables appear less volatile in view of their almost zero standard deviations (Std. Dev). The probability associated with the Jarque-Bera statistic indicates that Gross Domestic Product, the demographic dependency ratio and public spending are normally distributed, unlike the other variables.

Table 2. Descriptive statistics for the variables used in the regression

	CPI	XCHN	GDP	RDD	BD	HFC	PE	MS
Mean	309.2891	2807.622	2.12E+10	94.50184	-3.18E+08	9.99E+09	3.06E+09	1.21E+09
Median	1.107454	4.020687	2.16E+10	94.49596	-1.14E+08	6.76E+09	2.70E+09	1181584.
Maximum	10000.00	92600.00	3.33E+10	97.65972	6.35E+08	3.08E+10	6.60E+09	1.99E+10
Minimum	5.56E-12	1.46E-11	1.34E+10	91.04011	-2.04E+09	3.76E+09	3.14E+08	785.0000
Std. Dev.	*1638.172*	*15177.33*	*5.53E+09*	*2.054927*	*6.35E+08*	*7.66E+09*	*1.87E+09*	*4.50E+09*
Skewness	5.824609	5.826646	0.389394	0.013603	-1.262168	1.653172	0.303209	3.843560
Kurtosis	34.96168	34.97709	2.235112	1.871606	4.049423	4.320479	1.974887	16.00754
Jarque-Bera	1784.099	1785.764	1.836998	1.964102	11.52174	19.54151	2.187005	351.9438
Probability	*0.000*	*0.000*	*0.399118*	*0.374542*	*0.003148*	*0.000057*	*0.335041*	*0.000*
Sum	11443.70	103882.0	7.85E+11	3496.568	-1.17E+10	3.70E+11	1.13E+11	4.46E+10
Sum Sq. Dev.	96609874	8.29E+09	1.10E+21	152.0182	1.45E+19	2.11E+21	1.26E+20	7.29E+20
N (obs)	37	37	37	37	37	37	37	37

Source: Computed by the author.

- Econometric evidence

Performing the Pesaran Cointegration test requires first specifying a general ARDL model and then selecting the reduced form of the model based on one of the lowest Schwartz-Bayesian Criteria (BIC) and Akaike Information Criterion (AIC). As our series are adapted to proceed with the PSS approach, the information criterion used to determine the optimal delay (values of p and

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q) is that of the Akaike Information Criterion (AIC). The information in Table A.2 shows that the null hypothesis of the absence of a possible cointegration relationship between the variables under consideration is rejected at the various thresholds. This is justified by the superiority of the value of the Fisher statistic in relation to the various critical values of the upper bound. Thus, there is cointegration between inflation and its various determinants. This conclusion is supported by the results in Table A.3, which show that the estimates are valid and optimal. As a result, the errors are neither autocorrelated nor heteroscedastic (they are rather homoscedastic) and, moreover, they are normally distributed. Furthermore, the Ramsey test confirms that the estimated model is well specified. We therefore conclude with certainty that the estimated ARDL model is valid for the various diagnostic tests performed.

Table 3 provides information on the determinants of short-term inflation and suggests that the money supply, household final consumption expenditure, public spending and the budget deficit are not statistically significant, i.e. their short-term influence on the inflation rate is insignificant. On the contrary, the nominal exchange rate, the Gross Domestic Product and the demographic dependency ratio have a significant influence on inflation in the short term. Furthermore, as the error correction coefficient (restoring force) is negative and significant, we confirm that there is indeed an error correction mechanism. This error correction coefficient shows how quickly equilibrium is restored once the model is out of equilibrium. It is 0.94 in absolute terms, which means that once the model has deviated from equilibrium, it would adjust by 94% over the same period. This adjustment would take place within one year and three weeks.

Tableau 3. The determinants of short-term inflation

Variables	Coefficients	t-statistics
D(LMS)	-0.0111	-1.073
D(LXCHN)	0.8662	21.529***
D(LXCHN(-1))	-0.0762	-2.242**
D(LGDP)	-2.0014	-4.981***
D(LPE)	0.1329	1.650
D(LHFC)	0.0583	0.371
D(LDHFC(-1))	-0.3897	-2.344**
D(RDD)	0.4277	4.745***
D(DUMMY)	0.0957	1.665
D(DUMMY(-1))	-0.1768	-2.761**
ECM(-1)	-0.9374	-6.436***
N(obs)	37	

Source: Computed by the author. ***p<0.01, **p<0.05, *p<0.1 are 1%, 5% and 10% levels of significance, respectively.

However, over the long term, all the variables are statistically significant. The expected signs are consistent with economic theory. Table 4 shows that the money supply, the nominal exchange rate, the demographic dependency ratio, household final consumption expenditure and the budget deficit have a positive influence on the inflation rate in the long term. In contrast, public spending and gross domestic product have a negative impact on inflation.

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Table 4. The determinants of long-term inflation

Variables	Coefficients	t-statistics
LMS	0,0258	2,8048**
LXCHN	0,8974	43,9822***
LGDP	-2,1351	-4,3930***
LPE	-0,1848	-2,2154**
LHFC	0,3829	3,1597***
RDD	0,4562	4,1033***
DUMMY	0,4627	4,0936***
N(obs)	37	

Source: Computed by the author. ***p<0.01, **p<0.05, *p<0.1 are 1%, 5% and 10% levels of significance, respectively.

The fact that, in the short term, the money supply does not influence inflation, but in the long term the relationship is positive and significant, is in line with economic theory and reality, since the use of the quantity of money held by economic agents can be shifted over time depending on the quality of the macroeconomic environment. In the DRC, the money supply obviously influences prices, but this influence is exerted via several variables such as the exchange rate, the dollarization rate and import prices. These variables thus constitute indirect channels for the money supply, diverting the pass-through mechanism from its influence on inflation. The influence of the nominal exchange rate on inflation is significant in both the short and long term. These results corroborate those obtained by Atabaev et Gamyev (2013) and Fischer et al (2013). This could be explained by the extent of dollarization on the one hand, and food dependence on the outside world and the failure of the production system on the other. In both the short and long term, the demographic dependency ratio has a positive influence on inflation in the DRC. This is explained by the fact that those who do not work do not participate in production but consume, whereas those who do work consume and participate in the production process and put in more effort, creating an imbalance between supply and demand. As the degree of participation in supply is lower than that of demand, the imbalance can only be restored by an increase in inflation (Juselius and Takats, 2015).

Conversely, in the long term, there is a negative relationship between public spending and inflation. This is true when output grows faster than spending, and the effect on the price level can only be negative. Likewise, if the increase in public spending is covered by public revenues due, for example, to a commodity boom, the impact that public spending could have had would be offset by that of public revenues. This would create disinflationary effects for the periods concerned. This result contrasts with standard Keynesian teachings that fiscal expansion is inflationary, but corroborates with those obtained by Jørgensen and Ravn (2022). Finally, the negative and significant correlation found between GDP and inflation in the short and long term is in line with some empirical evidence from African countries.

5. Conclusion

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In this study, we used co-integration techniques based on ARDL modelling to analyze the determinants of inflation in the DRC. The results show that inflation in the DRC is positively influenced by the exchange rate (in the short and long term), demographic dependency (in the short and long term), money supply (in the long term), the budget deficit (in the long term) and household final consumption expenditure (in the long term). Public spending (in the long term) and gross domestic product (in the short and long term) have a negative impact on inflation. The exchange rate remains the most decisive variable in explaining inflation in the DRC (the pass-through effect predominates), due to the high degree of dollarization and the frequent recourse to imports to compensate for the failure of domestic production. Thus, there is a need for better coordination of fiscal and monetary policy, focused primarily on improving the quality and efficiency of public spending and on the gradual de-dollarization of the economy.

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Appendix

Table A.1. Stationarity tests

	Level stationarity test			Difference stationarity test		
Variables	P-P Stat Test	Critical Value	Decision	P-P Stat Test	Critical Value	Decision
LCPI	1.439506	-2.945842	NS (type DS)	-7.709763	-1.951	I(1)
LMS	-2.924602	-2.945842	NS (type DS)	-16.14978	-1.951	I(1)
LXCHN	-1.486562	-2.945842	NS (type DS)	-9.125188	-1.951	I(1)
LGDP	0.568109	-1.950394	NS (type DS)	-5.668869	-1.951	I(1)
LHFC	-1.08378	-3.540328	NS (type TS)	-4.234601	-1.950394	
LPE	-0.109449	-1.950394	NS (type DS)	-32.49687	-1.951	I(1)
LRDD	4.449713	-1.950394	NS (type DS)	-3.30468	-1.950687	I(1)
SLB (DUMMY)	-4.116909	-1.950394	S			I(0)

Source: Computed by the author. NS: Non Stationary; S: Stationary; DS: Difference Stationary; TS: Trend Stationary.

Table A.2. Terminal Co-Integration Test

Diagnostics	Tests	Statistics
Autocorrelation test	B-G Serial LM Test	F-Stat : 0.623036 (0.5481)
Normality test	Jarque-Bera	B-G stat: 0.823217 (0.662584)
Heteroscedasticity test	Breusch-Pagan-Godfrey	F-Stat: 1.375920 (0.2555)
Specification test	Ramsey RESET	T-Stat: 0.245079 (0.8092)

Source: Computed by the author.

Table A.3. Diagnostic test summaries

Diagnostics	Tests	Statistics
Autocorrelation test	B-G Serial LM Test	F-Stat: 0.623036 (0.5481)
Normality test	Jarque-Bera	B-G stat: 0.823217 (0.662584)
Heteroscedasticity test	Breusch-Pagan-Godfrey	F-Stat: 1.375920 (0.2555)
Specification test	Ramsey RESET	T-Stat: 0.245079 (0.8092)

Source: Computed by the author.