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Covid-19 and inflation targeting in the Alliance of Sahel States: ARDL approach

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Abstract

This article aims to identify the determinants of inflation trends in the ASS (Alliance of Sahel States) zone using the ARDL model, over the period 2019M1-2023M12. The main results of our analyses show that: (1) there is a short-term relationship between the explanatory variable and the explained variables. In fact, reading the adjustment coefficient of this information means that, when inflation is far from its short-term equilibrium and to reach long-term equilibrium, its annual speed of adjustment is 14.7%; (2). The results of the bounds cointegration test confirm the existence of a cointegrating relationship between the model's explanatory variables, thereby, confirming the long-term relationship between the series of study variables; (3) the long-term relationship between inflation and the money supply shows that a 1% increase in money supply generates a 0.60% increase in inflation. Therefore, the Covid-19 has a significant impact on inflation and economic activity in the long term in the ASS zone.

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1. Introduction

Health crises disrupt social and economic systems worldwide. However, their impacts are particularly more severe in fragile states (Mocia et al., 2020) due to various factors such as ineffective institutions, lack of resilience and precarious economies OECD (2021) (Organisation for Economic Cooperation and Development). For example, the Ebola crisis in Guinea, in 2013, highlighted gaps in resilience preparedness, which hampered crisis management (Boozary et al., 2014; Kekulé, 2015; Kruk et al., 2015). The World Health Organization (Mboussou and al 2019) recognises that epidemics and health emergencies have devastating global impacts. Currently, the global health crisis previously caused by Covid-19 has rapidly turned into an unprecedented economic crisis, threatening to jeopardise the global economy and undermine the progress made in development in the recent years (Zhu et al, 2020; World Bank, 2020; Anderson, 2021). The outbreak of the coronavirus pandemic has forced most African countries to implement preventive measures to limit further spread of the disease, such as temporarily suspending economic activities and imposing curfews (IMF, 2020; Ezeibe, C and al 2020). For instance, West African countries would suffer heavy consequences in terms of both loss of life and contraction of economic activity (Ouédraogo, I et al 2020; WAEMU (2020) (West Africa Economic and Monetary Union). The WAEMU Commission estimated that the Union's economic growth should be 2.7% in 2020, compared with an initial forecast of 6.6% BCEAO (2021) (Central Bank of the West African States). Economic growth in Economic Community of West African States (ECOWAS), forecasted before the crisis at 5.24% in 2020, was expected to be -1.73% following the effects of the disease (ADB), 2020) (African Development Bank). Like many other central banks, the BCEAO has taken initiatives to support governments in mobilising low-cost financial resources and ensuring bank liquidity (BCEAO, 2021). To this end, it has created a special refinancing window (BCEAO, 2020) for supporting member states to issue Treasuries known as 'Covid-19 Bonds' (BCEAO, 2021). According to the central scenario of the projections, the inflation rate in the Union should rise to 7.1% in 2022, then fall to 4.1% in 2023, after having been 3.6% in 2021. In a two-year timeframe, in the second quarter of 2024, the inflation rate is projected at 2.7%, placing it within the target zone from 1.0% to 3.0% defined for monetary policy (BCEAO, 2022).

Given this economic crisis and the nature of the ASS economy (Alliance of Sahel States created on 16/09/2023, which includes Burkina Faso, Mali and Niger), which is virtually import-dependent and mono exporter, the purpose of this article is to find out whether the Covid-19 health crisis has undermined the effectiveness of monetary policy in the ASS countries. In fact, this general question raises a number of issues: Is there a direct relationship between GDP and inflation as well as the money supply? Does covid-19 have a negative impact on inflation? This work is based on the hypothesis that the health crisis linked to covid-19 has a negative impact on the ASS zone economy.

To answer this question, this study uses the Auto Regressive Distributed Lag (ARDL) approach based on monthly macroeconomic data from ASS countries covering the period 2019M1-2023M12.

2. Literature review

Aizenman and Hutchison (2012) examine the impact of the United States' global financial crisis on emerging markets. For this purpose, they analyze whether the crisis primarily exerted pressure on external markets and whether countries mainly absorbed the shock either through

currency depreciation or loss of international reserves. The results show that emerging markets with large external liabilities were more vulnerable. In addition, those with higher liabilities relative to their reserves absorbed the shock by more depreciating their currencies and losing fewer reserves. Despite significant reserve accumulation prior to the crisis, countries primarily used currency depreciation to manage the crisis, which could be the result of either a deliberate strategy to protect their reserves or a rapid adjustment of exchange rates in open markets.

The aim of the study by (Bakouan et al., 2024) is to assess the medium-term macroeconomic and sectoral impact on West African economies. While empirical studies on the effects of international trade on income inequality are proliferating, little attention has been paid to the impacts of BioTrade. Their article fills this gap by exploring the impact of BioTrade on income inequality, highlighting the role of technological innovations. The analysis is based on a panel model covering 131 countries between 2010 and 2019, using two-stage least squares and smoothed quantile regression with instrumental variables. The results reveal a significant positive link between BioTrade and income inequality, with heterogeneous effects across sub-regions and levels of inequality. The key role of advanced technologies in mitigating these effects is demonstrated, underlining the importance of technological readiness. In fact, these findings, robust to various tests, encourage policymakers to promote technological innovations, such as Internet access and R&D, to sustainably reduce BioTrade-induced inequalities.

The aim of the study by Nkoa and Song (2020) is to analyze the effect of the pandemic risk on Franc Zone countries budget balance. Specifically, the study aims to assess financing mechanisms in health crises generally, with a focus on Covid-19 in particular. Empirically, they collected data from Franc Zone countries over the period 2000-2020. The results show that the global pandemic risk is increasing the budget deficit of Franc Zone countries. Despite revenues from natural resources, GDP growth, and a better democratic system, the global pandemic risk continues to increase the budget deficit in Franc Zone countries.

In their article, (Sanoussi et al., 2023) contribute to the recent literature on the effects of COVID-19 on poverty in WAEMU by potentially estimating them under three household income reduction scenarios of 5%, 10% and 25%, using the PovcalNet tool. The results show that the incidence of poverty could increase in WAEMU countries while the poverty reduction dynamic observed since the 2000s is likely to be disrupted by the pandemic.

(Gammadigbe, 2021) shows that the Covid-19 health crisis has threatened financial stability through the recession it has engendered. Several months after the outbreak of this health crisis, his study aims to make an initial empirical assessment of its impact on the activity and soundness of banks in the West African Monetary Union (WAMU) using both a panel VARX model and a network model over the period 2019M1 to 2021M2. Overall, the results of the estimates and simulations showed that despite the significant drop-in economic activity observed during the health crisis, the WAMU banking system remained stable and profitable, thanks to the reforms and measures taken by the Central Bank of West African States (BCEAO) before and also during Covid-19

3. Epidemiological situation of covid-19 in the ASS zone

Like other continents, Africa has not been spared by the virus, although it has been less affected in terms of confirmed cases number, despite alarmist predictions (Vigninou, 2021). As a matter of fact, out of 105,998,995 confirmed cases of Covid-19 worldwide (with 2,310,966

deaths) (worldometers, 2021), Africa recorded around 3.46%, i.e. 3,664,468 cases (with 94,321 deaths) on 6 February 2021 (WAEMU, 2021). South Africa, the most affected country, accounts for more than 40% of Covid-19 cases on the African continent. Morocco, Tunisia and Egypt come second, third and fourth respectively (WAEMU, 2021).

Table I: Distribution of confirmed cases of Covid-19 in the ASS and ECOWAS zones to 6 February 2021

	Burkina-Faso	Mali	Niger	CEDEAO
Case	**11143**	**8145**	**4589**	**340496**
Case/CEDEAO	**3.27%**	**2.39%**	**1.34%**	**Trace**

Source : authors, worldometers (2021)

To 6 February 2021, the epidemiological situation of the coronavirus pandemic showed 340,496 positive diagnoses in West Africa. ECOWAS, which sheltered 30% of the African population (ECOWAS, 2020), accounts for 9.3% of the positive cases detected in Africa. The incidence of the disease remains relatively low in the sub-region, although Burkina-Faso was the worst affected, with 3.27% of cases. In broader terms, West African countries were affected differently. Nigeria (40.42%) and Ghana (20.57%), at the head of the pack in the sub-region, ranked sixth and tenth, respectively, in Africa. Table 2 shows the spatial distribution of the pandemic scale in the WAEMU (Which brings together the three ASS countries and the five other countries in the BCEAO zone) zone during April 2024.

Table II: Epidemiological situation of Covid-19 in the ASS zone to 13 April 2024

Country	***Total cases***	***total number of deaths***	***recoveries***	***active cases***
World	**704 753 890**	**7 010 681**	**675 619 811**	**22 123 398**
WAEMU	**310 254**	**4 891**	**313 396**	**1 581**
ASS	65 209	1 455	62 818	936
Benin	28 036	163	27 847	26
Burkina-Faso	22 114	400	21 596	118
Côte d'Ivoire	88 384	835	87 497	52
Guinea-Bissau	9 614	177	8 929	508
Mali	33 164	743	32 332	89
Niger	9 931	312	8 890	729
Senegal	89 053	1 971	87 024	58
Togo	39 572	290	39 281	1

Source : Authors, worldometers (2024)

Based on these data, we can say that the ASS countries are less affected by the pandemic in the WAEMU zone, with a total of 21.02% of cases and 29.75% of deaths (worldometers, 2024).

4. Model

To assess the incidence, we estimate a dynamic panel model of the ARDL type with three monthly frequency variables: The inflation rate (INFL): To measure inflation, we use the consumer price index (CPI) following the example of Claus (1997), when he investigates the relationship between inflation and economic growth. The growth rate (PIBH): measured by real GDP per capita like Fischer (1993), Sarel (1996) and Mantsie (2003) when they determine a threshold at which inflation becomes vulnerable to the economy. The money supply (MM): measures the quantity of money in a country. The Covid variable has been added as a dummy variable. The statistics were obtained from the BCEAO Economic and Financial Database. These indicators cover the period from 2019M4 to 2023M12 (BCEAO, 2023). Assessing the impact of monetary policies, whether conventional or unconventional, is essential to understanding their effect on the economy, such as that of the AES zone. The use of the ARDL model makes it possible to include various economic and political factors in the analysis. By incorporating a dummy variable for COVID-19, (this variable generally takes the value 1 during the period affected by the pandemic (for example, from January 2020 to December 2023) and 0 otherwise), we can isolate the specific impact of the pandemic on inflation and the monetary policy response. This approach separates the effects of the pandemic from other economic factors, providing a more accurate view of the impact of monetary policy on price stability. This method allows for capturing the specific effects of the pandemic and better understanding how monetary policies need to be adapted to maintain price stability in the zone.

4.1. Study of the stationarity of variables

To test the stationarity of the variables in the model, the Phillips Perron/PP test is the most effective in the presence of errors auto-correlation. The results of the unit root test are shown in Table 3 below.

Table III: unit root test

Null hypothesis: the variable has a unit root

Variables	**Phillips Perron unit root test**		
	Level	**First difference**	**Integration order**
Inflation	-2.2487	**-3.4672*** (Stationary at 10%.)	First difference stationary I (1)
Pibh	-2.5054	**-3.4672***	First difference stationary I (1)
MM	-3.4669	**-3.4672***	First difference stationary I (1)
Covid	-3.4669	**-3.4672***	First difference stationary I (1)

Note that all the variables used are integrated of order I (1) (stationary after the first difference). This enhances the efficiency of the terminal cointegration test and the estimation of the ARDL model (Sebahi & Gana (2022))

4.2. Optimal ARDL and identification of the determinants of inflation in the short and long term

Hence, in the dynamic models family, if we consider the dependent variable 'inflation' and the exogenous variables (Pibh, mm and covid-19) noted Xt , the ARDL model formulation that we propose will be (Sebahi & Gana (2022))

$$INF_t = \forall + \sum_{i=1}^{n} \alpha_i INF_{t-i} + \sum_{j=0}^{q} d_j X_{t-j} + \varepsilon_{it}$$

Considering the long-run effect of exogenous variables on inflation, we define the long-run relationship as follows (Dalila Sebahi et al, 2022):

$$INF_t = m + \emptyset X_t + \mu$$

The calculation of the long-run effect of the model's independent variables on the dependent variable, denoted ∅, can be presented in the following form:

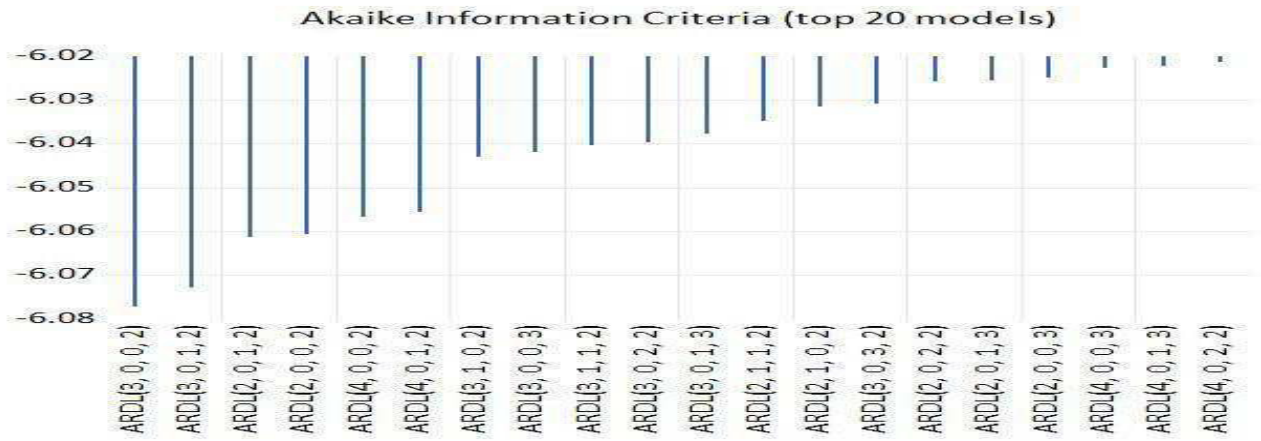
$$\emptyset = \frac{\sum d_k}{(1 - \sum \alpha_i)}$$

However, in order to perform the terminal cointegration test of (Pesaran ,2001), it is necessary to perform two preliminary steps for determining the optimal lag by referring to the AIC and SIC criteria. The Fisher test is, then, used for cointegration between series.

4.2.1. Selection of the optimal ARDL model

Before identifying the determinants, we first deduce the ARDL model that offers statistically significant results with optimum parameters. In our case, we will use the AIC (Akaike Information Criterion) to select this model. The results are shown in Graph 1 and Table 4 below. As can be seen from Graph 1, the AKAIKE criterion provides the information criterion values for the twenty best models. Thus, the optimal ARDL (3,0,0,2) is the best model since it offers the smallest AIC value.

Figure 1: Identification of the optimal model according to (AIC)



Source: produced by the authors

Table IV: Selecting the optimal parameter ARDL model

	model sélection : ARDL (3, 0, 0,2)			
Variables	Coefficient	Std. Error	t-Statistic	Prob. *
Inflation (-1)	1.099591	0.140096	7.848834	0.0000
Inflation (-2)	-0.054040	0.211947	-0.254968	0.7998
Inflation (-3)	-0.192912	0.129312	-1.491839	0.1423
PIBH	-0.000329	0.000592	-0.554894	0.5815
COVID	-0.004932	0.006651	-0.741628	0.4619
MM	-0.003906	0.048959	-0.079782	0.9367
MM (-1)	-0.021042	0.057014	-0.369073	0.7137
MM (-2)	0.114238	0.046575	2.452773	0.0179
C	-0.054494	0.125524	-0.434135	0.661

4.2.2. The determinants of inflation and their short-term impact

Based on the data presented in Table 4 and Graph 1, we developed an ARDL model (3.0.0.2) to study the relationship between the independent variable and a set of exogenous variables considered to be factors influencing the evolution of inflation in the ASS area. However, analysing the results in Table 4 does not allow us to identify any short- or long-term relationship between the variables in the model, hence, the need to carry out a bounds co-integration test. The results of this estimation are presented in tables 5 and 6 below.

Table V: Determinants of short-term inflation

Dependent Variable: D(INFLATION)				
Selected Model: ARDL (3, 0, 0, 2)				
Included observations : **57**				
Variables	Coefficient	Std. Error	t-Statistic	Prob
D (Inflation (-1))	0.246952	0.122544	2.015119	0.0495
D (Inflation (-2))	0.192912	0.120622	1.599305	0.1163
D(MM)	-0.003906	0.042535	-0.091831	0.9272
D (MM (-1))	-0.114238	0.044532	-2.565321	0.0135
CointEq (-1) *	**-0.147361**	0.035784	-4.118061	**0.0001**

As can be seen from the table above (Table 5), the adjustment coefficient (CointEq (-1)) has a negative sign and is statistically significant (prob =00) (Sebahi & Gana (2022)). Its characteristics express the existence of a short-term relationship between the study variables. This information means that, when inflation is far from its short-term equilibrium and to reach long-term equilibrium, its annual speed of adjustment is 14.73%. To be precise, during the COVID-19 crisis, inflation in the ASS zone was influenced by various factors linked to the pandemic: chain disruptions, fluctuations in raw material prices, variations in demand and production restrictions, as well as inflationary expectations. These factors interacted in complex ways, resulting in an unstable economic environment with varying effects on inflation in the ASS.

4.2.3. Bounds test and confirmation of long-term relationship

The results of the cointegration bounds test (Table 6) confirm the existence of a cointegrating relationship between the model's explanatory variables. This finding is confirmed by the Fisher statistic, which exceeds the upper bound statistic (3.1307 > 3), thus, confirming the long-term relationship between the series of study variables.

Table VI : test Bounds

F-Bounds Test		**Null hypothesis: No levels relationship**		
Test statistic	Value	Signif.	I (0)	I (1)
F-statistic	3.130786	10%	2.37	3.2
k	3	05%	2.79	3.67
		2.5%	3.15	4.08
		01%	3.65	4.66

4.2.4. The determinants of inflation and their long-term impact

There is a cointegrating relationship between the explanatory variables and the endogenous variable, which means that there is a long-term relationship between inflation, Pibh and MM_GDP. The coefficient has a positive sign for the variable MM and a negative sign for the variables Pibh and Covid with respective coefficients of (-0.0022 and -0.033). Table 7 below provides us with the estimated long-run coefficients.

In functional form, the estimated model is written as follows

$$\boldsymbol{INFL_t = -0.0022PIBh_t + 0.6059MM_t - 0.033COVID_t - 0.369}$$

In contrast, during the COVID-19 crisis, a 1% increase in GDP per capita was associated with a 0.002% decrease in inflation. This can be explained by several interconnected economic mechanisms: i) Inflation expectations: during a crisis, inflation expectations can be influenced by various factors. An increase in GDP per capita can boost economic confidence and reduce inflation expectations, which in turn can contribute to lower inflation. ii) Interventions and policies: economic policies, such as income support measures and accommodating monetary policies, play a crucial role in stabilizing prices. When effective, they can positively influence the relationship between GDP per capita and inflation, thereby, contributing to price stabilization. iii) The impact of COVID-19: The observed effect where a 1% increase in the dummy variable COVID-19 results in a 0.033 decrease in inflation can be attributed to a combination of factors. These include reduced demand, the effects of economic policies implemented during the crisis, changes in inflation expectations, and economic behavior specific to the crisis period. The 1% increase in the money supply had a significant impact on inflation of 0.606 over the COVID-19 period due to two main factors: the increase in aggregate demand, as a higher money supply, increases the liquidity available to consumers and businesses, and the supply disruptions caused by the pandemic, which limited production and supply chains, leading to increased pressure on prices.

Table VII: Determinants of long-term inflation

ARDL (3,0,0,2)

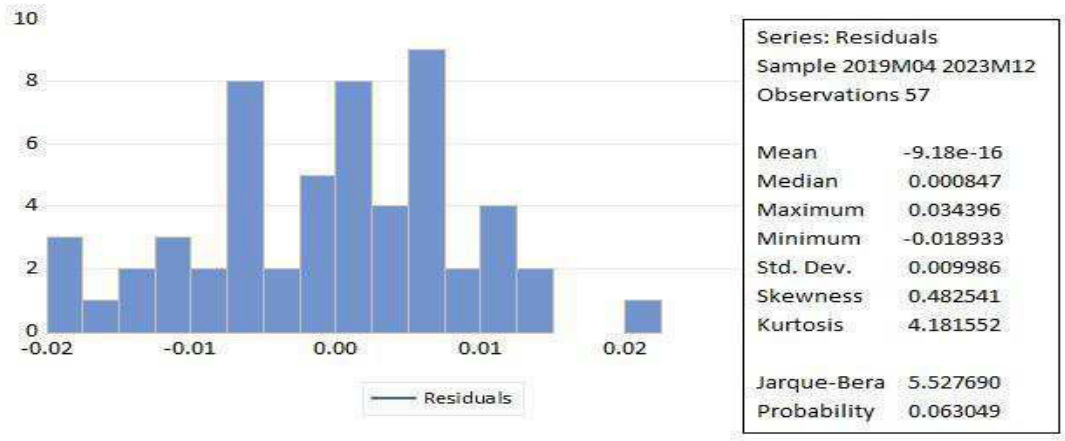
Variables	Coefficient	Std.Error	t-statistic	Prob.
Pibh	-0.002230	0.004019	-0.554895	0.5815
COVID	-0.033471	0.041592	-0.804765	0.4294
MM	0.605922	0.100892	6.005655	0.0000
C	-0.369801	0.832813	-0.444039	0.6590

EC = INFLATION – (-0.0022*Pibh +0.6059*MM -0.033*Covid – 0.369)

4.2.5. Testing the normality of residuals and the stability of the CUSUM model

In order to calculate predictive confidence intervals and carry out Student's tests on the parameters, it is necessary to check the normality of the errors. The Jarque-Bera test (1984), based on the notion of Skewness (asymmetry)and Kurtosis (flattening), is used to verify the normality of a statistical distribution (Abdelali 2022).

Figure 2: residue distribution histogram



Source: produced by the authors

The above results confirm that the residuals are Gaussian white noise (following a normal distribution), as the Jarque-Bera probability is greater than 5% (Abdelali Liticia, 2022).

Once the long-term dynamics of the variables under study have been identified, it is necessary to test the model's stability. We chose the CUSUM test, which is one of the best-known statistical tests for detecting anomalies in a dynamic model, such as the ARDL type estimate (Sebahi & Gana (2022)). The decision rule is interpreted using a graphical representation of CUSUM statistic (Sebahi & Gana (2022)). Thus, the model is structurally stable when this statistic is maintained between the critical bounds at a threshold of 5% margin of error (Kuma, 2018).

Figure 3: CUSUM test for variable stability

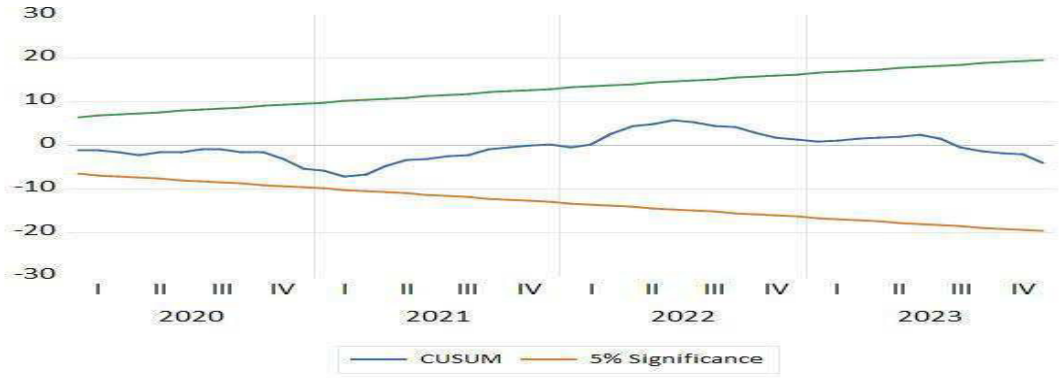


Figure 4: CUSUM SQ test for variable stability

5. Conclusion

The main idea of this article is to identify the main determinants and their impact on inflation trends, through a time series econometric study for the period 2019M1 to 2023M12. The ARDL econometric method enabled us to identify the variables that impact inflation both in the short and long term. The results reveal significant relationships in both time horizons. In the one hand, the expansionary monetary policies implemented to counter the economic effects of the pandemic led to an increase in inflation (BCEAO, 2021), in the short term, which illustrates the immediate effectiveness of monetary measures in supporting consumption and investment as in the study conducted by Gammadigbe (2021). On the other hand, there is a cointegrating relationship between the explanatory variables, in the long term, namely in the study conducted by (Christophe Bolt,2021) which confirms that the continued expansion of the money supply, without equivalent GDP growth, leads to sustained inflationary pressures rising from 2.4% in 2018 to 7.1% in 2022 (BCEAO, 2022).

The persistent increase in the money supply is fuelling inflation, in line with traditional economic theories on the relationship between money and prices as in the study conducted by

Ascari. G et al. (2024). In fact, the Covid-19 health crisis revealed the threats to financial stability in relation to the severe recession it globally caused (Gammadgibe,2021). In greater detail, ARDL modelling shows that, although monetary measures were crucial in mitigating the economic effects of Covid-19, this did not prevent the crisis from having long-term inflationary implications (Ascari, G and al (2024) . In conclusion, the results underline the importance of balanced monetary policy management. While monetary intervention has been essential in supporting the economy in the short term, it must be carefully adjusted to avoid inflationary imbalances in the long term. One of the first negative effects of the COVID-19 pandemic and the social and public health measures put in place by health authorities quickly became apparent, particularly at borders. To be more specific, the pandemic led to border closures and controls, disrupting the cross-border movement of healthcare, medical and pharmaceutical products, as well as food and basic supplies (Word Health Organization,2024). It also showed confusion and mistrust, which subsequently had a significant effect on inflation. Policymakers must, therefore, continue to monitor the effects of these policies and accordingly adjust measures to maintain price stability while promoting a sustainable economic recovery (BCEAO, 2021).

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