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Effects of Insecurity on Inflation in Burkina Faso

Abdoulaye SIRY[1*] and Inoussa TRAORE[2]

[1]*Thomas Sankara University, University Center of Dori, 03 P.O.box 7210 Ouagadougou 03, CEDRES, Burkina Faso*

[2]*Joseph Ki-Zerbo University, Burkinabe Institute of Arts and Crafts (IBAM)*

[*]**Corresponding author:** Abdoulaye SIRY, Thomas Sankara University, University Center of Dori, 03 P.O.box 7210 Ouagadougou 03, CEDRES, Burkina Faso.

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Abstract

The price increase has been exacerbated in Burkina Faso compared to other member countries of the West African Economic and Monetary Union. According to the existing literature, plausible explanations for this galloping inflation include the recent health crisis and the economic policy measures taken. However, inflation persists, although the health crisis has subsided. This paper highlights persistent insecurity's effects on inflation in Burkina Faso. ARDL modeling on monthly data from January 2019 to April 2022 was used. The analysis results show that the influx of internally displaced persons (IDPs) and deteriorating agro-climatic conditions drive inflation in Burkina Faso in the short and long term. The marginal effects of IDPs on inflation are about 0.09640, 0.08917, 0.1043, and 0.07827 percent after three, two, one month, and at the current time, respectively. It is recommended that short-term actions support IDPs, such as food allocations and long-term actions. Actions to improve agro-climatic conditions, such as irrigation techniques, should be supported. Indeed, any anti-inflationary policy should take into account non-monetary and monetary factors.

Keywords: Inflation, Humanitarian Crisis, Agro-Climatic Conditions, Burkina Faso

JEL Classification : E31, J15, J61, Q15

Introduction

Relatively low and stagnant during the 2009-2019 decade, inflation has risen, reaching 6.72 percent in the first half of 2022 on average in the West African Economic and Monetary Union [1]. This cumulative increase in the general price level has been exacerbated in Burkina Faso, a member of the Union. In the first half of 2022, inflation averaged 13.17 percent, up from an average of 0.72 percent over the 2009-2020 period in the country [1].

In most situations, the factors that drive the inflationary process are country-specific [2]. However, this author finds that the forces of globalization, sustained and higher global demand, and solid global competitiveness, have helped central banks in their efforts to keep inflation low and stable. Nevertheless, there are still exogenous factors, notably health and security crises, whose effects on inflation have been partially studied [3, 4]. These authors estimate that the shock of the coronavirus disease positively affected the consumer price index in the West African Economic and Monetary Union. Government policies have mitigated the impact of the shock on the consumer price index in the Union [3].

However, inflation remains worrying in some countries, such as Burkina Faso, with a strong security challenge. Kinda et al. (2020) have already estimated the significant impacts of the coronavirus disease at the macroeconomic and sectoral levels as well as on household welfare [4]. They indicated that the increase in consumer prices is expected to weigh heavily on household purchasing power for all socio-professional categories in Burkina Faso.

Burkina Faso has been going through an unprecedented security crisis since the beginning of the last decade. This crisis has had repercussions on social life and is reminiscent of similar crises, notably famine [5]. Very few empirical estimates have been made of insecurity's effects on Burkina Faso's inflation. Does not the increase in the general price level in Burkina Faso stem from exogenous non-monetary factors? First, is inflation in Burkina Faso the result of the humanitarian crisis? Second, do agro-climatic conditions explain the increase in the general price level in Burkina Faso?

The main objective of this study is to identify mechanisms by which non-monetary factors affect inflation in Burkina Faso. This macroeconomic analysis seeks to consider inflation resulting from changes in production costs and the confrontation between supply and demand in the markets. Specifically, the first step is to show how the humanitarian crisis increases the general price level in Burkina Faso. Second, it is necessary to highlight how agro-climatic conditions generate inflation in Burkina Faso.

The study's central hypothesis is that inflation in Burkina Faso results from insecurity. In Burkina Faso, insecurity has two main characteristics. Structural insecurity is linked to the deterioration

of agro-climatic conditions, and cyclical insecurity is linked to the humanitarian crisis. Indeed, the first specific hypothesis is linked to supply and demand, according to which the humanitarian crisis increases the general price level in Burkina Faso. In addition, a second specific hypothesis related to production costs stipulates that agro-climatic conditions affect prices in Burkina Faso.

Following the introduction, the second section presents the literature review. The third section is devoted to stylized facts. The fourth section presents the methodology of the study. The results are presented in the fifth section, followed by discussions. Finally, the last section is devoted to the conclusion and recommendations.

Review of the Literature

The theories and empirical determinants generally mobilized to explain the general price level are related to (i) demand-side inflation, (ii) cost-push inflation, and (iii) the monetarist explanation of inflation [6-8].

Beyond these theoretical considerations, it is essential to consider insecurity upstream. Fig. 1 describes two main channels through which insecurity can lead to inflation. The first is the mechanism by which insecurity linked to the humanitarian crisis simultaneously leads to increased demand and decreased production of goods and services. The influx of internally displaced persons (IDPs) increases the demand for goods and services in the host localities and creates a production vacuum in the localities of origin. The socio-professional integration of IDPs is only sometimes guaranteed in the host localities so this situation may lead to pressure on prices. On the other hand, the drop in the production of goods and services following a deterioration in agro-climatic conditions puts upward pressure on prices.

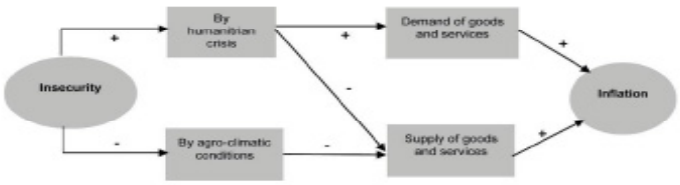

Figure 1: Transmission mechanism from insecurity to inflation. Source: Author's construction

Overall, inflation can result from economic structures [6]. If consumers anticipate a price increase, they will buy today to avoid it tomorrow, thus driving demand-side inflation. Similarly, inflationary expectations fuel income demands, leading to cost-push inflation and an inflationary spiral. For this reason, anti-inflation policies emphasize "breaking" inflationary expectations [9, 6].

Empirical studies have been conducted on the determinants of inflation, particularly in developing and middle-income countries. So, agro-climatic conditions are other important factors beyond the significant influence of fiscal and monetary policies on inflation in Nigeria [10]. External shocks can destroy the consistency between fiscal programs and inflation targets, leading to reserve losses, exchange rate changes, and higher inflation [11]. It is in this sense that authors such as Armantier et al. (2021), Coulibaly (2021), and Kinda et al. (2020) estimate that the shock of the coronavirus disease positively affected the consumer price index [9, 3, 4]. The pandemic led to an immediate and substantial increase in inflation uncertainty and disagreement in the medium and even more so in the short term [9]. Besides, the authors find that other households initially expected the pandemic to lead to low inflation or deflation.

With the health crisis, the WAEMU monetary authorities have, like those of developed countries, adopted accommodated policies, some of which are unconventional [12-15]. These include quantitative easing, which aims to increase the amount of liquidity available to banks, and qualitative easing, which aims to encourage the provision of credit to the economy. This policy is not without inflationary consequences. Thus, authors such as Coulibaly (2021) and Kinda et al. (2020) draw attention to the fact that there are risks that developing countries will experience inflationary pressure in their efforts to contain the spread of COVID-19 [3, 4].

In the long run, real GDP, the real effective exchange rate, and the lending rate are positive and significant determinants of inflation. In contrast, money supply, real GDP, population growth, gross national savings, and imports in the previous year are the drivers of inflation in the short run [16, 17]. On the other hand, world food and oil prices positively impact the consumer price index [3]. Oil prices increase inflation in the WAEMU zone in the long run but not in the short run [18]. Strong (2021) estimates that higher turnover rates lead to higher inflation and that central bank autonomy does not affect inflation for CFA zone countries. Instead, inflation is driven by other variables, such as the fixed exchange rate regime or commodity price shocks.

While Keho (2016) finds that budget deficits are not inflationary in WAEMU countries, Guy and Kouadio (2018) show a positive and significant relationship between the budget deficit and monetary expansion and the price level in Burkina Faso and Niger [19, 18]. The contribution of monetary expansion to inflation in the CFA monetary union was much smaller than in flexible exchange rate regimes [20]. Moreover, Lim and Sek (2015) estimate that GDP growth and imports of goods and services significantly impact inflation in low-inflation countries like WAEMU countries [17]. However, they indicate that money supply, imports of goods and services, and GDP growth have a significant relationship with inflation in these countries. Inflation in Ghana, one of the high-inflation countries, is explained by a combination of structural and monetary factors consistent with prior studies [21]. Given the limitations of previous work, some exogenous factors, notably insecurity, are not considered in explaining inflation in Burkina Faso. It is, therefore, important to establish the facts about these types of determinants.

Stylized Facts

The variable explained is the year-on-year change inflation rate. Fig. 2 shows that the cumulative increase in the general price level has been exacerbated in Burkina Faso over the last three quarters compared to the other WAEMU countries.

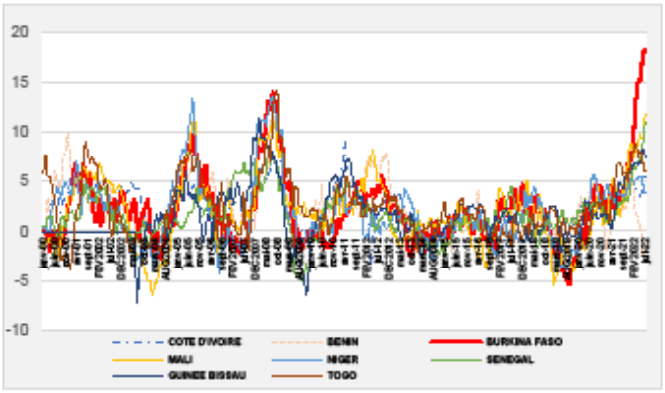

Figure 2: Inflation trends in WAEMU member countries, January 2000-July 2022, year-on-year, in percent. Source: Constructed from BCEAO (2022b) [22].

Despite the overall upward trend in the general price level in the WAEMU, inflation has remained moderate in some countries, such as Mali and Niger, which are also affected by the security crisis (Fig. 2). Therefore, the case of Burkina Faso remains atypical, and the factors explaining this galloping inflation may vary.

The potential explanatory factors for this phenomenon in Burkina Faso are the seriousness of insecurity, which has led to population movements, and the deterioration of agro-climatic conditions (Fig. 3 and 4). The evolution of rainfall in Burkina Faso is punctuated by cycles from January 2019 to April 2022 (Fig. 4).

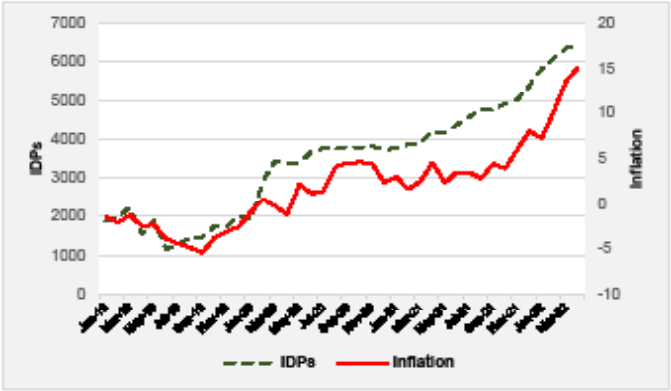

Figure 3: Number of IDPs and inflation trends, Burkina Faso, January 2019-April 2022. Source: Author's construction from Centre for humdata (2022) and BCEAO (2022b) [23, 22].

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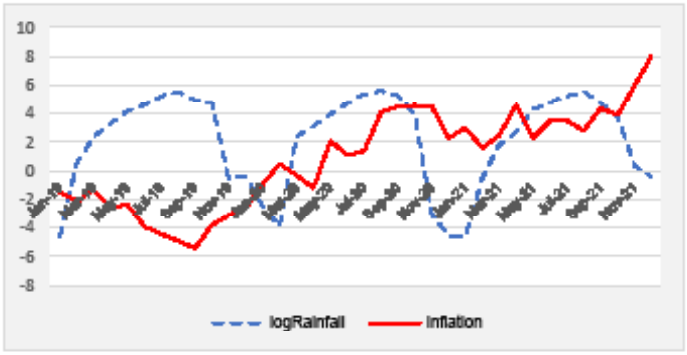

Figure 4: Rainfall and inflation trends, Burkina Faso, January 2019-April 2022. Source: Author's construction from World Bank (2022) and BCEAO (2022b) [24, 22]

At the same rate as inflation, the number of IDPs has increased from January 2019 to April 2022 (Fig. 3). The increase in IDPs is linked to the security crisis, particularly the humanitarian crisis. The correlation coefficient between the average number of internally displaced persons (IDPs) and inflation is about 0.93 [23, 22].

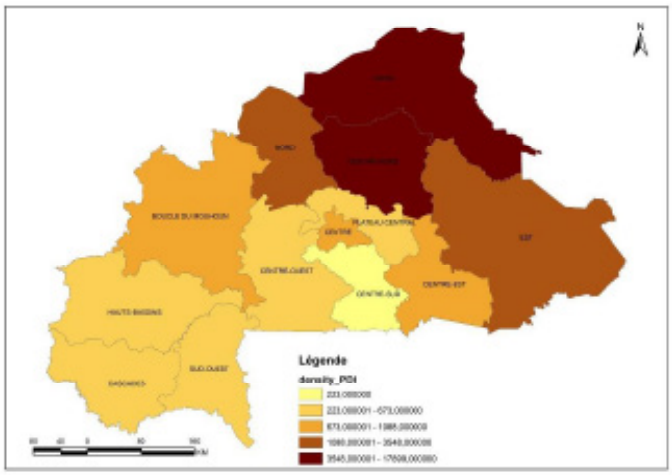

Figure 5: Average number of IDPs, Burkina Faso regions, January 2019-April 2022. Source: Author's construction from Centre for humdata (2022) [23]

All regions of the country are affected by the flows of internally displaced persons, which vary across the different regions (Fig. 5). Thus, the regions of Sahel (Dori), Centre Nord (Kaya), Est (Fada N'Gourma), and Boucle du Mouhoun (Dédougou) recorded the highest number of IDPs over the period from January 2019 to April 2022. These regions have been the most affected by violence and terrorist attacks. From the literature review and the stylized facts, the determinants of inflation related to insecurity should be modeled.

Materials and Methods

This section presents the empirical strategy, namely econometric modeling, the ARDL model to be estimated, and the data source.

Econometric Modeling

This paper aims to highlight the effects of insecurity on inflation in Burkina Faso. To this end, an econometric model to detect the

determinants of the general price level is formulated in equation (1) as follows:

$$INF_t = \beta_0 + \beta_1 logIDP_t + \beta_2 logRainf_t + \beta_3 X_t + \mu_t$$

Where INF_t is the general price level, log IDP_t is the logarithm of the number of Internally Displaced Persons, $logRainf_t$ is the agro-climatic shocks estimated by the logarithm of rainfall and X_t is the vector of control variables at time t. The parameters β_1, β_2 and β_3 are the coefficients associated with the inflation explanatory variables to be estimated, with β_0 a constant term. μ_t is the error term of the model. Before estimating the parameters, unit root tests were first performed to check the stationarity of the time series. Indeed, the Augmented Dickey-Fuller test and the Phillips and Perron (1988) test were performed [25, 26].

ARDL Model and Bounds Test to Cointegration

The autoregressive distributed lag (ARDL) cointegration test developed by Pesaran et al. (2001) is used to examine the existence of a long-run relationship between the variables [27]. The ARDL method has advantages over other alternative methods [27]. First, the technique allows using integrated variables of order zero (0), one (1), or both orders. Second, the problem of endogeneity of the explanatory variables and the inability to test hypotheses on the estimated coefficients, in the long run, are resolved. Furthermore, while other techniques, the ARDL model is statistically better at determining the cointegration relationship between variables when the sample size is small [28, 27]. Finally, the ARDL procedure does not require that the variables necessarily have the same optimal lags [16].

The general form of the ARDL model ARDL (m,n,p,q,…,q) is specified in equation (2) as follows :

$$\Delta INF_t = \theta_0 + \theta_1 INF_{t-1} + \theta_2 logIDP_{t-1} + \theta_3 logRainf_{t-1} + \theta_4 X_{t-1} + \\ + \sum_{i=1}^{m} \emptyset_{1i} \Delta INF_{t-i} + \sum_{i=1}^{n} \emptyset_{2i} \Delta logIDP_{t-i} + \sum_{i=1}^{p} \emptyset_{3i} \Delta logRainf_{t-i} + \\ + \sum_{i=1}^{q} \emptyset_{4i} \Delta X_{t-i} + \mu_t$$

The presence of cointegration is tested by restricting all estimated coefficients of lagged-level variables equal to zero. Then the null hypothesis of no cointegration is that θ_1=θ_2=θ_3=θ_4=0. This hypothesis is tested using a F-test. Asymptotic critical values are provided by Pesaran et al. (2001) [27]. The lag length of each variable (m,n,p,q,…,q) was selected using the general-specific approach with a maximum lag set to five [29].

Before implementing the cointegration test at the bounds, different ARDL models (m,n,p,q,…,q) are estimated, followed by a diagnosis and stability tests of the estimates. The cointegration test serves as a bridge between the specification of a long-run model, a short-run model, or only the latter. If the cointegration test leads to the conclusion that there is a long-term relationship between the variables, both models must be estimated.

Identified Drivers of Inflation

Based on the facts and the recent literature review, the potential explanatory factors and variables of inflation in Burkina Faso are listed in Table 1.

Table 1 : Description of factors and variables. Source: Author's construction

Factors	Variables	Description of variables	expected sign	Data source
To be explained	Inflation	Year-on-year change inflation rate - overall index (%)	-	BCEAO (2022b)
Explanatory				
Dynamic	$Inflation_{t-i}$	Lagged inflation rate of order i	+/-	Author, BCEAO (2022b)
Insecurity and Agro-climatic conditions	LogIDP	Internally Displaced Persons (in logarithm)	+ /-	Author, Centre for humdata (2022)
	$LogIDP_{t-i}$	Internally Displaced Persons lagged by order i	+ /-	Author, Centre for humdata (2022)
	LogRainf	Precipitations (in logarithm)	-	World Bank (2022)
	$LogRainf_{t-i}$	Precipitation delayed of order i	+/-	Author, World Bank (2022)
Controle	COVIDR	Government Response Index to COVID-19	-	GitHub (2022)
	$COVIDR_{t-i}$	Government response index lagged by order i	-	Author, GitHub (2022)
	IPI	Industrial Production Index	+	BCEAO (2022a)
	IPI_{t-i}	Industrial production index lagged by order i	+	Author, BCEAO (2022a)
	ISF	Financial sector index	+	BCEAO (2022a)
	ISF_{t-i}	Financial sector index lagged i	+	Author, BCEAO (2022a)
	TxD	Policy rate (monthly weighted average rate)	-	BCEAO (2022a)
	TxD_{t-i}	Policy rate lagged i	+ /-	Author, BCEAO (2022a)

Overall, insecurity is expected to affect the general price level. There are different ways of conceiving insecurity [30-33]. As demonstrated by Vornanen et al. (2009), insecurity is defined by young people by external realities, such as socio-economic ill-being, violence, and war [33]. In the present work, cyclical insecurity is estimated by the flows of internally displaced persons. Agro-climatic conditions, notably rainfall, approximate structural insecurity.

The influx of internally displaced persons (IDPs) can pressure prices through demand-side and/or costs-push sides. However, with rapid and adequate socio-professional integration of IDPs, their flow can even inhibit price increases. Agro-climatic conditions (Rainf) can also affect the overall price level. Harvests can be highly dependent on rainfall across different regions of the country. Poor harvests following a drop in rainfall can lead to higher prices. Hefty rainfall could cause damage and limit harvests, and this may increase prices.

Government responses (COVIDR), including central bank policy rate (TxD) adjustments due to coronavirus disease, may dampen inflation. In response to the coronavirus, monetary authorities have lowered policy rates and generally in the WAEMU. This policy should have an impact on inflation.

The Industrial Production Index (IPI) can lead to higher inflation, as can GDP [16]. An increase in the financial sector index (ISF) can be a source of inflation. Indeed, Subramaniam and Masron (2022) find that financial deepening may be desirable or undesirable above the optimum financing level [34]. They believe that the effect of financial depth on inflation is characterized by being desirable to a certain extent and undesirable if over-financing is beyond the optimum level. Inflation can be self-sustaining, following a particular dynamic ($Inflation_{t-i}$). The different variables identified may act on inflation with a lag. Indeed, the expected signs of some variables may vary.

Data

The data used in this study are monthly and come from World Bank (2022), Centre for humdata (2022), BCEAO (2022a,b), and GitHub (2022) [23, 1, 22, 35]. Specifically, data on the humanitarian crisis, including internally displaced persons (IDPs), are from the Centre for humdata (2022) [23]. The average number of internally displaced persons (IDPs) is consolidated daily by commune across the thirteen regions of Burkina Faso. Data on agro-climatic conditions are from the World Bank (2022) and data on control variables are from BCEAO (2022a,b) and GitHub (2022) [24, 6, 7, 35]. Descriptive statistics on the different variables are given in table 2. Some variables contain missing observations, including four missing observations for logRainf and one missing observation for ISF and IPI, from January 2019 to April 2022.

Table 2 : Descriptive statistics. Source: Author

Variable	Obs	Mean	Std. Dev.	Min	Max
Inflation	40	1.918	4.700	-5.42	15.1
logIDP	40	8.056	.485	7.05	8.7
logRainf	36	2.181	3.347	-4.60	5.6
ISF	39	8.943	1.847	5.3	12.8
TxD	40	2.677	.872	2	4.5
$COVID_r$	40	21.317	17.108	0	56.3
IPI	39	4.094	4.642	-8.5	15.6

Empirical Results and Discussion

This section presents the results of the specification tests and estimations of the ARDL model. The results of the cointegration test are presented, followed by the results of the estimation of the long-run and short-run effects.

Results of the ARDL Model

The results of the correlation coefficients between the variables, the selection of the lag order of the variables, and the unit root tests are given, respectively, in Tables 7, 8, and 9 in the Appendix. The correlation coefficient between the average number of IDPs and inflation in Burkina Faso is 0.93 from January 2019 to April 2022.

d.Inflation	ARDL (3,2,3,3,3,3)		ARDL (2,3,0,3,2,1)		ARDL (3,3,1,0,3,2)	
	Coef.	*P>|t|*	*Coef.*	*P>|t|*	*Coef.*	*P>|t|*
$d.inflation_{t-1}$	-0.523101**	0.047	-0.990002***	0.001	-.3640814**	0.015
$d.inflation_{t-2}$	0.325950	0.131	-0.190494	0.204	.0487343	0.700
$d.inflation_{t-3}$	0.271467	0.214			.2814213*	0.066
$d.ogIDP_{t}$	10.944831***	0.005	9.640960***	0.001	5.347956**	0.014
$d.logIDP_{t-1}$	8.368911**	0.035	8.917188***	0.000	5.792355***	0.007
$d.logIDP_{t-2}$	6.802537**	0.020	10.435511***	0.000	10.95328***	0.000
$d.logIDP_{t-3}$			7.827759***	0.002	5.269654***	0.003
ISF_{t}	0.393952	0.150	0.698518***	0.001	.5013404***	0.010
ISF_{t-1}	-0.060990	0.830	1.011773**	0.010		
ISF_{t-2}	-0.475884	0.136	-0.021591	0.885		
ISF_{t-3}	0.261321	0.286	0.300145*	0.069		
$d.logRainf_{t}$	0.137664	0.251	-0.134299*	0.086	-.0292968	0.700
$d.logRainf_{t-1}$	0.185272	0.177			.0655279	0.372
$d.logRainf_{t-2}$	0.230601	0.109				
$d.logRainf_{t-3}$	0.357704**	0.022				
$d.IPI_{t}$	0.249248**	0.040	0.109198*	0.062	.2962529***	0.003
$d.IPI_{t-1}$	-0.187167	0.133	0.135540**	0.038	.0320028	0.468
$d.IPI_{t-2}$	-0.033892	0.776			.2019924**	0.018
$d.IPI_{t-3}$	-0.157671	0.243				
$d.COVIDr_{t}$	-0.161164**	0.026			-.0325435**	0.019
$d.COVIDR_{t-1}$	0.029226	0.578				
$d.COVIDR_{t-2}$	-0.151663**	0.039				
$d.COVIDR_{t-3}$	-0.119501*	0.072				
$d.TxD_{t}$			2.663022**	0.026	2.637004**	0.024
$d.TxD_{t-1}$			-2.633858***	0.002	-2.063678**	0.011
$d.TxD_{t-2}$			-3.365796**	0.025	-.1149145	0.863
$d.TxD_{t-3}$					-.869069	0.152
Constant	-1.123785	0.838	-17.954038***	0.001	-4.379663**	0.013
Observations	27		27		27	
R2 ajusted	0.7393		0.7750		0.8323	
Prob > F	0.0813		0.0023		0.0025	
AIC	54.03648		62.79781		52.84171	
BIC	83.84073		84.82704		77.46261	

Asterisks ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively

All variables are integrated I (1), except for the financial sector index, which is integrated I (0), following the ADF test (Table 9 in the Appendix). Following the specification tests, the results of the ARDL model estimates are presented in Table 3.

The estimates show that at lag order 1, inflation is not self-sustaining, but rather at lag order 3. Indeed, the coefficient associated with lagged inflation of order 1 is significant and positive, in contrast to the lagged effect of order 3 (table 3). Rigidities can explain this in the behavior of economic agents, particularly producers, who incorporate the increase in factor costs into prices with a delay. For example, increases in the general price level, including input costs, may be reflected later in the level of consumer prices.

The influx of IDPs generates inflation in Burkina Faso. The coefficients associated with the variable d.LogIDP are all significant and positive. The ARDL (2,3,0,3,2,1) model results indicate that increasing IDPs by 1 percent generates an increase in inflation of 0.09640***, 0.08917***, 0.1043***, and 0.07827*** percent after three, two, one month and at the current time respectively. This result is consistent with the theoretical understanding that the humanitarian crisis breeds inflation.

Relatively, the deterioration of agro-climatic conditions leads to inflation in Burkina Faso. The coefficient associated with the variable d.LogRainf is significant and negative at time t but positive after three months. Increased current rainfall by 1 percent reduces inflation by 0.001342* percent. Moser (1995) finds similar results in Nigeria [10]. Good rainfall and agricultural production increases, which lead to downward pressure on food prices and/or production costs, are an explanation. However, a 1% increase in rainfall generates an increase in inflation at the current time of 0.003577** percent after three months. This positive effect can be explained by the fact that increased rainfall can lead to devastating floods of crops. Another plausible explanation is that increased rainfall may induce economic agents to deplete their stocks in the hope of a promising harvest season. In the long run, this behavior may lead to pressure on prices.

Table 4: Diagnosis and stability testing of estimates. Source: Author's estimate

ARDL (3,2,3,3,3,3) model								
Type of the tests	**Lags(p)**	**F**	**χ^2**	**df**	**Prob > F**	**Prob > χ^2**	**Diagnostic**	**Threshold**
Breusch-Godfrey	1	0.118		F (1, 3)	0.7539		No auto-correlation of errors	1 %
Durbin-Watson	1	0.013		F (1, 3)	0.9159		No auto-correlation of errors	1 %
Ramsey RESET		152.69		F (3, 1)	0.0594		No omitted variables	5%
Heteroscedasticity (ARCH)	1		0.875	χ^2 (1)		0.3496	No heteroscedasticity	1 %
Heteroscedasticity (ARCH)	2		1.021	χ^2 (2)		0.6002	No heteroscedasticity	1 %
Heteroscedasticity (ARCH)	3		0.956	χ^2 (3)		0.8118	No heteroscedasticity	1 %
ARDL (2,3,0,3,2,1) model								
Type of the tests	Lags(p)	F	χ^2	df	Prob > F	Prob > χ^2	Diagnostic	Threshold
Breusch-Godfrey	1	5.019		F (1, 9)	0.0518		No auto-correlation of errors	5%
Durbin-Watson	1	2.055		F (1, 9)	0.1855		No auto-correlation of errors	1 %
Ramsey RESET		0.83		F (3, 7)	0.5179		No omitted variables	1 %
Heteroscedasticity (ARCH)	1		0.011	1		0.9148	No heteroscedasticity	1 %
Heteroscedasticity (ARCH)	2		2.202	2		0.3325	No heteroscedasticity	1 %
Heteroscedasticity (ARCH)	3		2.552	3		0.4659	No heteroscedasticity	1 %
ARDL (3,3,1,0,3,2) model								
Type of the tests	Lags(p)	F	χ^2	df	Prob > F	Prob > χ^2	Diagnostic	Threshold
Breusch-Godfrey	1	3.566		F (1, 7)	0.1009		No auto-correlation of errors	1 %
Ramsey RESET		0.72		F (3, 5)	0.5835		No omitted variables	1 %
Heteroscedasticity (ARCH)	1		0.316			0.5739	No heteroscedasticity	1 %
Heteroscedasticity (ARCH)	2		0.769			0.6807	No heteroscedasticity	1 %
Heteroscedasticity (ARCH)	3		0.622			0.8914	No heteroscedasticity	1 %

The financial sector index (ISF) and the industrial production index (IPI) have significant and positive effects on inflation. These effects are common and dynamic at orders 1, 2, and 3 over time. These results are consistent with Subramaniam and Masron (2022) estimates relative to financial deepening [34]. Overall, the coronavirus disease response policy contributes to curbing inflation in Burkina Faso, in line with Coulibaly (2021) estimates [3]. Indeed, the coefficients associated with the variable d.COVIDR are significant and negative. In addition, the downward adjustments of the Central bank key rate contribute to curbing inflation in Burkina Faso. The coefficients associated with the lagged d.TxD variable are significant and negative. However, the policy rate is inflationary in the short run. This result is consistent with the estimates of Tolasa et al. (2022), who estimate that, in the long run, this monetary policy is inflationary [16].

The diagnosis and stability tests (Table 4) show no serial self-correlation of errors for all the ARDL models estimated. Indeed, the p-values of the Fisher statistic of the Breusch-Godfrey test are above the critical threshold of 5 percent, and even 1 percent for the ARDL (3,2,3,3,3,3) and ARDL (3,3,1,0,3,2).

Next, the Ramsey RESET test indicates an absence of omitted explanatory variables at the 5 percent statistical threshold or even 1 percent for the ARDL (2,3,0,3,2,1) and ARDL (2,3,0,3,2,1) models. The absence of heteroscedasticity is confirmed by the ARCH test of heteroscedasticity at the 1 percent threshold (Table 4).

Results of long-run and Short-run Effects

The results of the cointegration test at the bounds for the ARDL (2,3,0,3,2,1) model estimated in the previous section are shown in Table 5. Variables are cointegrated, and there is a long-run relationship between inflation and the explanatory variables. The estimated values of the Fisher statistic are all below the critical value of the statistic (7.890) at the integration orders I (0) and I (1). In addition, the calculated values of the t-statistic are all greater than the critical value of the statistic (-5.953) at the integration orders I (0) and I (1).

Table 5: Bounds cointegration test. Source : Author's estimate

ARDL (2,3,0,3,2,1) model		I (0)		I (1)	
Statistic	Critical Value	F Value	t Value	F value	t value
Statistic-F	7.890	2.26 < 7.890	-2.57 > -5.953	3.35 < 7.890	-3.86 > -5.953
Statistic-t	-5.953	2.62 < 7.890	-2.86 > -5.953	3.79 < 7.890	-4.19 > -5.953
K	6	2.96 < 7.890	-3.13 > -5.953	4.18 < 7.890	-4.46 > -5.953
		3.41 < 7.890	-3.43 > -5.953	4.68 < 7.890	-4.79 > -5.953

Reassured of a long-run relationship, the long-run and short-run effects are estimated and presented in Table 6. The ECM (-1) and ECM error correction estimators estimated the lagged and level long-run effects, respectively.

Table 6: ARDL model giving long-run and short-run effects. Source: Author's estimate

ARDL (2,3,0,3,2,1) model		ECM			ECM (t-1)	
d.Inflation		Coef.	P>|t|		Coef.	P>|t|
ADJ	$d.inflation_{t-1}$	-1.894885***	0.000	$d.Inflation_{t-1}$	-1.894885***	0.000
	$d.logIDP_t$	16.664494***	0.000	$d.logIDP_{t-1}$	16.66449***	0.000
Long-term	$d.logRainf_t$	-0.095447**	0.040	$d.logRainf_{t-1}$	-.0954472**	0.040
	ISF_t	0.714891***	0.008	ISF_{t-1}	.714891***	0.008
	$d.TxD_t$	-0.985865	0.253	$d.TxD_{t-1}$	-.985865	0.253
	$d.IPI_t$	0.117236**	0.022	$d.IPI_{t-1}$	.1172365**	0.022
	$d.inflation_{t-1}$	0.062535	0.703		.062535	0.703
	$d.logIDP_t$	-22.759382***	0.001		8.817925***	0.005
	$d.logIDP_{t-1}$	-14.324286***	0.002		-14.32429***	0.002
	$d.logIDP_{t-2}$	-5.805662**	0.019		-5.805662**	0.019
	$d.logRainf_t$				-.1808615*	0.052
	ISF_t	-0.617809	0.159		.7368273***	0.002
Short-term	ISF_{t-1}	-0.046831	0.827		-.0468312	0.827
	ISF_{t-1}	-0.185924	0.302		-.185924	0.302
	$d.TxD_t$	4.766038**	0.020		2.897937**	0.039
	$d.TxD_{t-1}$	2.009844	0.185		2.009844	0.185
	$d.IPI_t$	-0.114387	0.125		.1077623	0.118
	Constant	-12.340104**	0.013		-12.3401**	0.013
	Observations	28			28	
	R2a	0.8548			0.8548	

Asterisks ***, ** and * denote statistical significance at the 1%, 5% and 10% levels respectively

The results show that the influx of IDPs causes inflation in Burkina Faso in both the short and long run. However, the sign of the short-run influence is unstable. The ECM regressions give a negative marginal effect of IDPs of -0.2275*** percent, while the ECM (-1) regressions give a positive marginal effect of 0.0881*** percent on inflation. ECM ARDL model (2,3,0,3,2,1) results show that a 1 percent increase in short-term IDPs reduces current inflation by 0.2275***; 0.1432*** and 0.0580** percent, after the current month, one and two months, respectively. The long-run marginal effect of IDPs on inflation is positive and of the order of 0.1666*** percent.

The short-run negative marginal effect may be explained by the delay in the expression of demand from IDPs due to the existence of survival stocks or food endowments in the short run. In the long run, the depletion of stocks leads to price pressure. This result implies that food allocations to IDPs reduce inflation in the short run but not in the long run.

Moreover, in the short-term and long-term, the improvement in agro-climatic conditions is favorable to the decline in inflation. The marginal effects of rainfall are -0.001808* percent in the short run and -0.00095** percent in the long run. An increase in rainfall is beneficial and limits inflation. However, as it depends on the vagaries of nature, actions to improve agro-climatic conditions, such as irrigation techniques, should be supported.

In the short-term and long-term, financial deepening is inflationary. The associated marginal effects are about 0.007368*** percent in the short run and 0.007148*** percent in the long run. These results provide a better understanding of the influence of financial development than work such as that of Subramaniam and Masron (2022) [34]. Monetary policy through the policy rate is also inflationary, but in the short run, with a marginal effect of 0.04766** percent by the ECM model. In the long run, this policy is inflationary, but the effect is statistically insignificant. These results are similar to Keho's (2016) finding that money supply and price are positively related in Burkina Faso, even if he does not find a causality from money supply to inflation in the short run [19]. The industrial production index influences inflation with a significant marginal effect of 0.001172** percent in the long run. Inventory changes can explain this result, and studies using GDP as a determinant of inflation find similar results [16, 17].

Conclusion and Policy Implications

This paper has studied the effects of the insecurity estimated by the humanitarian crisis and the deterioration of agro-climatic conditions on inflation in Burkina Faso. ARDL modeling was used, giving long-run and short-run effects. The hypotheses put forward are valid. There is evidence that non-monetary exogenous factors affect inflation. Indeed, the empirical results reveal that the humanitarian crisis proxied by the number of internally displaced persons (IDPs) causes inflation in Burkina Faso in both the short and long run. However, the sign of the effect of IDPs on inflation remains ambiguous in the short run. Indeed, an influx of IDPs with survival stocks or food allocations may mitigate inflation in the short run but not in the long run. It is recommended that actions to support IDPs should be short-term actions, such as food allocations, and long-term actions. These actions can aim at the return of IDPs or their socio-professional integration in the host areas. These types of actions can alleviate upward pressure on prices.

On the other hand, improving agro-climatic conditions mitigates short and long-term inflation. An increase in rainfall is beneficial and limits inflation. As rainfall depends on nature's vagaries, actions to improve agro-climatic conditions, such as irrigation techniques, should be supported.

It is also clear that inflation is not self-sustaining. However, financial deepening in the short and long term, monetary policy through the policy rate in the short term, and the index of industrial production, a proxy of GDP, in the long term are inflationary. Therefore, any anti-inflationary policy must control non-monetary as well as monetary factors.

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Appendix

Table 7: Correlation coefficient between variables. Source: Author's estimate

	Inflation	LogIDP	LogRainf	ISF	TxD	COVIDR	IPI
Inflation	1.0000						
LogIDP	0.9257	1.0000					
LogRainf	-0.1183	-0.0505	1.0000				
ISF	0.2079	0.0030	-0.0368	1.0000			
TxD	-0.7930	-0.8064	-0.1859	-0.0124	1.0000		
COVIDR	0.7300	0.8245	0.2220	-0.1093	-0.8194	1.0000	
IPI	-0.1388	-0.2209	0.0586	0.2490	0.0867	-0.3618	1.0000

Table 8 : Selection of the order of delay of the variables. Source: Author's estimate

	Lag	LL	LR	df	P-Value	FPE	AIC	HQIC	SBIC
	0	-103.867	23.4426	3.0974	3.0974	3.0974			
Inflation	1	-63.1852	81.364	1	0.000	2.42811	.829846	.845186*	.874285*
	2	-62.806	.75837	1	0.384	2.51654	.865321	.896002	.954198
	3	-62.736	.14003	1	0.708	2.65544	.918463	.964484	1.05178
	4	-59.6109	6.2502*	1	0.012	2.35406*	.797029*	.858389	.974783
	5	-58.8392	1.5434	1	0.214	2.38843	.810076	.886776	1.03227
	0	-22.9273	.22979	-1.52775	-1.52775	-1.52775			
logIDP	1	24.1881	94.231	1	0.000	.016479	-4.16291	-4.14757	-4.11847*
	2	25.0845	1.7929	1	0.181	.016582	-4.15699	-4.12631	-4.06812
	3	27.0447	3.9204*	1	0.048	.015706*	-4.21186*	-4.16584*	-4.07855
	4	27.3367	.58386	1	0.445	.01637	-4.1714	-4.11004	-3.99365
	5	27.8144	.95549	1	0.328	.016891	-4.14156	-4.06486	-3.91937
	0	-80.9858	11.6064	2.38701	2.38701	2.38701			
	1	-68.3656	25.24	1	0.000	5.48502	1.63733	1.6524	1.68358
	2	-65.1516	6.428	1	0.011	4.75697	1.49449	1.52464	1.587
logRainf	3	-63.0414	4.2205*	1	0.040	4.43186	1.42286	1.46809	1.56163*
	4	-61.5957	2.8913	1	0.089	4.31226*	1.39411*	1.45442*	1.57914
	5	-61.5174	.15662	1	0.692	4.5861	1.45357	1.52896	1.68486
	0	-58.1917	3.47064	1.17535	1.17535	1.17535			
ISF	1	-49.2169	17.95	1	0.000	2.00279*	.625357*	.640123*	.672505*
	2	-49.1094	.21495	1	0.643	2.13106	.686911	.716443	.781207
	3	-48.2552	1.7084	1	0.191	2.1548	.696964	.741263	.838409
	4	-48.0468	.41675	1	0.519	2.27961	.751559	.810624	.940152
	5	-45.7739	4.5458*	1	0.033	2.09342	.663773	.737604	.899514
	0	-38.1444	.548242	-.658197	-.658197	-.658197			
TxD	1	9.5821	95.453*	1	0.000	.037968	-3.32828	-3.31294	-3.28384*
	2	11.2903	3.4164	1	0.065	.036473*	-3.36875*	-3.33807*	-3.27987
	3	11.5523	.52396	1	0.469	.038066	-3.32658	-3.28056	-3.19326
	4	12.1141	1.1237	1	0.289	.039069	-3.30154	-3.24018	-3.12379
	5	12.7691	1.31	1	0.252	.039905	-3.28183	-3.20512	-3.05963
	0	-146.426	266.795	5.52932	5.52932	5.52932			
	1	-119.233	54.385	1	0.000	59.7318	4.0326	4.04794	4.07704
	2	-116.067	6.333	1	0.012	52.7922	3.9088	3.93948	3.99768
Covid_r	3	-113.711	4.7119*	1	0.030	48.8846	3.83132	3.87734*	3.96463*
	4	-112.527	2.3687	1	0.124	48.419*	3.82078*	3.88214	3.99854
	5	-112.259	.53472	1	0.465	50.5624	3.86265	3.93935	4.08484
	0	-88.3423	27.7626	3.2547	3.2547	3.2547			
	1	-75.6378	25.409	1	0.000	12.3873	2.44749	2.46225	2.49464
IPI	2	-73.64	3.9956*	1	0.046	11.5696*	2.37867*	2.40821*	2.47297*
	3	-73.5634	.15327	1	0.695	12.343	2.44235	2.48665	2.5838
	4	-73.5167	.09322	1	0.760	13.2044	2.50811	2.56717	2.6967
	5	-72.6765	1.6805	1	0.195	13.3852	2.51912	2.59295	2.75486

* indicates the order of delay selected by the criterion

Table 9: Unit root test. Source: Author's estimate

		Level test (Constant and trend included)		First difference test (Constant and trend included)		
Tests	**Variables**	**Z(t) Statistic**	**P-value**	**Z(t) Statistic**	**P-value**	**Integration Order**
	Inflation	-0.832	0.9629	-4.472	0.0017***	I (1)
Augmented	LogIDP	-2.060	0.5685	-3.832	0.0150**	I (1)
Dickey-	LogRainf	-3.005	0.1308	-3.237	0.0773*	I (1)
Fuller	ISF	-3.212	0.0820*	-6.634	0.0000***	I (0)
(ADF)	TxD	-2.430	0.3638	-4.275	0.0034***	I (1)
	IPI	-2.286	0.4418	-4.414	0.0021***	I (1)
	COVIDR	-1.947	0.6301	-3.311	0.0644*	I (1)
Philips-	Inflation	-1.380	0.8666	-6.907	0.0000***	I (1)
Perron	LogIDP	-2.574	0.2919	-8.010	0.0000***	I (1)
Test	LogRainf	-3.055	0.1173	-4.507	0.0015***	I (1)
(PP)	ISF	-2.873	0.1715	-7.553	0.0000***	I (1)
	TxD	-2.038	0.5808	-5.037	0.0002***	I (1)
	IPI	-2.705	0.2340	-5.865	0.0000***	I (1)
	COVIDR	-1.784	0.7125	-4.049	0.0075***	I (1)

Asterisks ***, **, and * denote the level of significance at the 1%, 5%, and 10% thresholds, respectively