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THE EFFECT OF INFLATION RATES ON STOCK MARKET RETURNS IN SUDAN: THE LINEAR AUTOREGRESSIVE DISTRIBUTED LAG MODEL

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ABSTRACT

This study investigates the effect of the inflation rate in Sudan on stock returns on the Khartoum Stock Exchange. The linear autoregressive distributed lag (ARDL) model was applied to monthly data over the period from September 2003 to December 2019, with the exchange and money supply growth rates, and Murabaha profit margin as control variables. As no previous studies have studied the effect of inflation on stock returns by means of the ARDL approach, this study intends to fill this gap in the current body of literature. The results show that the inflation rate exerts a significantly negative effect on stock returns in both the short and long term, which is crucial to the understanding of all, but especially developing, economies, such as Sudan. First, policymakers must formulate strategies to control inflation and stabilize the stock market; second, any decision-making on short- and long-term investments should take account of these findings.

Contribution/Originality: This study offers two contributions to the existing literature with regard to the effect of inflation rates on stock returns. First, only two similar studies undertaken in Sudan are known to exist. Second, neither of these studies adopted the linear ARDL model, which is regarded as the most reliable analysis technique.

1. INTRODUCTION

Investigating the relationship between the inflation rate and stock returns in different countries has been undertaken by a large number of theoretical and empirical studies since the early 1930s. Understanding this relationship is vital for researchers and policymakers in both developed and developing economies, but there is still no consensus among researchers on how the relationship works: some studies report a positive relationship between inflation and stock returns, while others conclude the opposite. For instance, Fisher (1930) suggested that nominal stock returns hedge against inflation; therefore, an increase in current and expected inflation rates should lead to an increase in expected nominal dividends. In contrast, Fama (1981) argued that an increase in inflation rates negatively affected corporate profits and stock prices due to reduced real economic activity.

According to the Central Bank of Sudan, the national inflation rate reached 81.6% in March 2020, following decades of very high inflation. It is of evident importance that the relationship between inflation and other

macroeconomic indicators, especially stock returns, is studied if Sudan is to establish an effective economic policy. However, very few studies have been conducted to date (Ahmed and Abdalla, 2013; Amin, Elbeel, and Banga, 2014).

Thus, this study aims to examine the relationship between the inflation rate and stock returns on the Khartoum Stock Exchange, extracting monthly data and applying the linear autoregressive distributed lag (ARDL) model developed by of Pesaran et al. (2001). Using such a recent analytical approach to test this relationship in Sudan is the main contribution of this study to the existing literature, within which no similar studies are currently known.

The paper is organized as follows: Section 2 presents a review of the current literature; Section 3 outlines the model and explains the research methodology; Section 4 reports the results and analyzes how a change in the inflation rate affects stock returns; and finally, Section (5) draws conclusions from the findings and offers recommendations to researchers and policymakers.

2. LITERATURE REVIEW

Although, researchers as well as policymakers have paid a great deal of attention to the impact of inflation rates on stock returns, it has not been widely investigated with regard to the Khartoum Stock Exchange. The current study intends to bridge this gap in the literature, but existing studies that have examined the relationship, both in general and in Sudan.

Fisher (1930) was the first such study, which was based on the assumption that the monetary and real sectors of the economy are largely independent, and the expected returns on physical or real assets, such as stocks, to move one-for-one with inflation rates, thus hedging against inflation. However, Modigliani and Cohn (1979) introduced the money (or inflation) illusion hypothesis that states investors fail to take into account the effect of fluctuations in inflation on the real value of their stock returns. Furthermore, Fama (1981) argued that stock returns are negatively affected by inflation due to the deleterious effect of inflation rates on real economic activity.

More studies have been undertaken over the last two decades, starting with Choudhry (2001) investigation into the relationship between stock returns and inflation in four high-inflation countries: Argentina, Chile, Mexico and Venezuela; the findings showed a positive relationship between current stock returns and current inflation, confirming that the former acts as a hedge against the latter. Ioannides, Katrakilidis, and Lake (2005) later studied the same relationship in Greece, using the ARDL cointegration technique and Granger causality test to identify possible long-run and short-run effects and causal direction between variables; the results revealed a negative long-run causal relationship between inflation and stock returns. Ozbay (2009), however, widened the investigation into the relationship between stock returns and macroeconomic variables (i.e., inflation, exchange, money supply growth, and interest rates, and the real economy) in Turkey. According to the results from monthly data between 1998 and 2008, inflation, exchange, and money supply growth rates, and industrial production proved not to be statistically significant.

More recently, Eldomiaty, Saeed, Hammam, and AboulSoud (2019) examined the effect of both inflation and interest rates on stock prices. Analyzing quarterly data with the linearity, normality, Johansen cointegration, cointegration regression, Granger causality, and vector error correction model tests, the results showed that inflation rates were negatively associated with stock prices. The ambiguity remains, though, as Alqaralleh (2020), taking a nonlinear autoregressive distributed lag (NARDL) approach, identified the generally asymmetric responses of stock returns to inflation rates. Reviewing other literature according to the geographical region in which the studies were undertaken over the last 10 years, the following discussion focuses on Southeast and South Asia, the Arab States, and West and South Africa, before concluding with Sudan.

With regard to Southeast Asia, Geetha, Mohidin, Chandran, and Chong (2011) tested the relationship between stock returns and inflation, which was divided into expected and unexpected inflation, in Malaysia, China, and the USA. They revealed a long-run relationship between both types of inflation and stock returns; however, no short-run relationship existed in Malaysia and the USA, although it did in China. In Vietnam, Bui (2019) applied the

ARDL approach adopted for the current study and found inflation to exert a significantly negative impact on stock returns in both the long and short run. Meanwhile, in South Asia, Chakravarty and Mitra (2013) used the alternative vector autoregression (VAR) to analyze monthly data on the wholesale price index and determine the relationship between inflation and stock prices in India, concluding that it tended to be negative. Likewise, Saleem, Zafar, and Rafique (2013) also showed a negative long-run relationship, with the Granger causality test—also used in this study—between inflation and stock returns in Pakistan between 1996 and 2011. Moreover, Mahmood, Fiyaz, and Muhammad (2014) also found a negative relationship between inflation and stock returns in Pakistan, using VAR. In contrast to these other Asian countries, though, Hemamala and Jameel (2016) demonstrated a positive relationship between inflation and stock returns in Sri Lanka.

Moving to the Arab States, Al-Sharkas and Al-Zoubi (2013) applied cointegration methods to study the 2000–2009 monthly stock and goods price indices for Jordan, Saudi Arabia, Morocco, and Kuwait. Their findings not only confirmed a long-run relationship between the two indices but also revealed that stock prices had a long memory with respect to inflation shocks, meaning stock returns act as reasonably good hedge against inflation in the long term. Specifically in Jordan, Al-Abbadi and Abdul-Khaliq (2017) discovered a short- as well as a long-run relationship over the longer period of 1978–2015 between inflation and stock market trading value. In addition, long- and short-run negative relationships were shown between inflation and stock returns in Iraq by the ARDL approach taken by Battal and Matar (2017).

Finally, three studies investigated the relationship between inflation and stock returns in Nigeria: Omotor (2010) analyzed monthly data and discovered that stock returns could provide effective hedging against inflation, while Ibrahim and Agbaje (2013) found short- and long-run relationships after performing an ARDL analysis of data from 1997 to 2010, and Uwubanmwen and Eghosa (2015) showed a weak, negative impact of inflation on stock returns following an analysis 1995–2010 monthly data. Also in West Africa, Kwofie and Ansah (2018) applied the ARDL model to data on inflation and exchange rates compared to inflation rates between 2000 and 2013 in Ghana. The results revealed a significant long-run relationship between inflation and stock; however, the short-run relationship proved not to be significant. With regard to South Africa, Ndlovu, Faisa, Resatoglu, and Türsoy (2018) tested the impact of macroeconomic variables—inflation, money supply growth, interest, and exchange rates—on stock prices for the Johannesburg Stock Exchange South Africa, and found a positive relationship between inflation and stock prices.

It is evident that not only has considerable attention been paid worldwide to the effect of inflation rates on stock returns by empirical studies but also no consensus has been reached on whether that relationship is positive or negative. It is also unfortunate that Sudan is rarely included in these empirical studies. The first known study for Sudan, which also included Saudi Arabia, was conducted by Ahmed and Abdalla (2013), who examined the impact of inflation rates on stock returns and volatility during the period 2003—2012, reporting inflation's negative effect on both returns and volatility. The only other study, by Amin et al. (2014), explored the correlation and causality between the stock price index and selected macroeconomics variables: money supply growth, exchange, and inflation rates, and the Murabaha profit margin. Their results indicated a positive, weak correlation between the index and the money supply growth and inflation rate variables, with a negative, weak one between the index and the Murabaha profit margin and exchange rate ones.

The studies in Sudan employed the generalized autoregressive conditional heteroskedasticity (GARCH) symmetric and symmetric models to investigate the effects of inflation rates on stock returns. A more recent and reliable analysis tool is available, however, which is applied in this study: the linear autoregressive distributed lag (ARDL) model.

3. METHODOLOGY

This study sourced secondary monthly data for the period September 2003–December 2019 from the Central Bank of Sudan (CBS), Khartoum Stock Exchange (KSE), and the Central Bureau of Statistics, which was then analyzed with the ARDL model. First, the linear error correction model (ECM) was applied:

$$LKSE_t = a + \beta_1 LINF_t + \beta_2 LEX_t + \beta_3 LM2_t + \beta_4 LMPM_t + \varepsilon t \qquad (1)$$

Where: KSE represents the Khartoum stock returns, INF the inflation rate, EX the official monthly nominal exchange rate per USD, M2 the nominal money supply growth rate, and MPM the Murabaha profit margin. It should be noted that by definition, a positive change in the exchange rate will lead to depreciation and a negative change to appreciation a multivariate model was applied to account for other variables mentioned by previous studies as affecting stock returns. The intention was to add a proxy for economic activity as well, but, the monthly data required was unavailable in Sudan.

The current study was based on certain predictions derived from previous research results:

- An increase in inflation leads to a negative effect on stock returns. As an increase in money supply leads to an increase in inflation, it is expected that the same effect on stock returns will be seen. This prediction is based on Fama (1981): rises in inflation rates negatively affected corporate profits and stock prices due to a reduction in real economic activity.
- As Sudanese firms are import-oriented and the exchange rates show a depreciation in the Sudanese pound, it is expected that Khartoum stock returns decline. This prediction is based on Bahmani and Saha (2015): stock returns can respond to changes in the exchange rate either positively or negatively, according to whether a country's private sector is export- or import-based.
- It is expected that a negative correlation will exists between the Murabaha profit margin and stock returns. This prediction is based on Amin et al. (2014): the Murabaha profit margin is negatively correlated stock returns in Sudan.

Following the bounds testing approach of Pesaran et al. (2001), Equation 1 can be rewritten as:

$$\begin{aligned}\Delta LKSE_t = a + &\sum_{k=0}^{n} \beta_1 \Delta LKSE_{t-k} + \sum_{k=0}^{n} \beta_2 \Delta LINF_{t-k} + \sum_{k=0}^{n} \beta_3 \Delta LEX_{t-k} + \sum_{k=0}^{n} \beta_4 \Delta LM2_{t-k} \\ &+ \sum_{k=0}^{n} \beta_5 \Delta LMPM_{t-k} + \lambda_1 LKSE_{t-1} + \lambda_2 LINF_{t-1} + \lambda_3 LEX_{t-1} + \lambda_4 LM2_{t-1} \\ &+ \lambda_5 LMPM_{t-1} + \mu_t \qquad (2)\end{aligned}$$

This linear ARDL model is then applied to identify short- and long-run relationships.

4. EMPIRICAL RESULTS AND DATA ANALYSIS

First, unit root tests were conducted for each variable is the first task of doing this analysis. The augmented Dickey–Fuller (ADF) test was used to determine stationarity at level and first difference, taking into account that cointegration requires I(0) or I(1) variables. The ADF statistics in Table 1 indicate that all the variables satisfied the required condition.

Using the, A maximum of 10 lags were then imposed on each first-difference variable and Akaike's information criterion (AIC) was used to select an optimum specification.

Second, short- and long-run estimates, in addition to diagnostic statistics, were calculated using the linear ARDL model.

Table-1. Levels and first differences.

Variable	Level		First Difference	
	ADF Statistics	Result	ADF Statistics	Result
LKSE	0.013551	Nonstationary	-12.12460	stationary**
LINF	-1.932106	Nonstationary	-8.385250	stationary**
LEX	1.214701	Nonstationary	-13.77344	stationary**
LM2	1.822354	Nonstationary	-4.728542	stationary**
LMPM	-3.214768	stationary*	-25.64813	stationary**

Note: ** = significant at 1%.
* = significant at 5%.

Table-2. Short-run coefficient estimates.

Variable	Coefficient	Std. Error	t-Statistic	Probability
Constant	1.255588	0.384908	3.262049	0.0015
LKSE (-1)	-0.121974	0.029885	-4.081490	0.0001
LM2	-0.010604	0.023553	-0.450230	0.6535
LMPM (-1)	-0.057504	0.098749	-0.582328	0.5616
LEX (-1)	0.126830	0.035503	3.572331	0.0005
LINF (-1)	-0.070445	0.022972	-3.066588	0.0027
Δ(LKSE (-1))	0.095678	0.069654	1.373627	0.1724
Δ(LKSE (-2))	0.182378	0.069299	2.631741	0.0098
Δ(LKSE (-3))	0.049256	0.085021	0.579341	0.5636
Δ(LKSE (-4))	-0.030321	0.085265	-0.355603	0.7228
Δ(LKSE (-5))	-0.044968	0.084610	-0.531475	0.5962
Δ(LKSE (-6))	0.071759	0.081985	0.875268	0.3834
Δ(LKSE (-7))	0.083362	0.082371	1.012023	0.3138
Δ(LKSE (-8))	0.096997	0.083590	1.160393	0.2485
Δ(LKSE (-9))	-0.372862	0.084290	-4.423581	0.0000
Δ(LMPM)	0.073339	0.104557	0.701431	0.4846
Δ(LMPM (-1))	0.210904	0.130806	1.612349	0.1098
Δ(LMPM (-2))	0.118495	0.132601	0.893623	0.3735
Δ(LMPM (-3))	0.110166	0.127101	0.866761	0.3880
Δ(LMPM (-4))	0.190009	0.118206	1.607445	0.1109
Δ(LMPM (-5))	0.177720	0.107267	1.656807	0.1005
Δ(LMPM (-6))	0.011762	0.099862	0.117781	0.9065
Δ(LMPM (-7))	0.089854	0.095856	0.937384	0.3507
Δ(LMPM (-8))	0.140144	0.092987	1.507136	0.1347
Δ(LMPM (-9))	0.242611	0.077033	3.149421	0.0021
Δ(LEX)	0.126381	0.073725	1.714229	0.0894
Δ(LEX (-1))	-0.042906	0.071375	-0.601139	0.5490
Δ(LEX (-2))	-0.0188□6	0.071771	-0.262443	0.7935
Δ(LEX (-3))	-0.102052	0.067928	-1.502355	0.1360
Δ(LEX (-4))	-0.060989	0.069530	-0.877159	0.3824
Δ(LEX (-5))	-0.094614	0.069702	-1.357404	0.1775
Δ(LEX (-6))	0.611564	0.068994	8.864035	0.0000
Δ(LINF)	-0.086167	0.030265	-2.84□136	0.0053
Δ(LINF (-1))	0.087074	0.036463	2.388017	0.0187
Δ(LINF (-2))	-0.003160	0.036348	-0.086945	0.9309
Δ(LINF (-3))	0.128200	0.037778	3.393502	0.0010
Δ(LINF (-4))	0.021800	0.035778	0.609306	0.5436
Δ(LINF (-5))	0.049504	0.034028	1.454790	0.1487
Δ(LINF (-6))	0.046534	0.030979	1.502136	0.1360
Δ(LINF (-7))	0.069024	0.032045	2.153988	0.0335

The short-run estimates reported in Table 2 indicate that only changes in LINF significantly affect stock returns at the 1% significance level, while the other variables, except for LM2, exert significant effects once lags are imposed.

Table-3. Long-run coefficient estimates.

Variable	Coefficient	Std. Error	t-Statistic	Probability
LM2	-0.086937	0.199778	-0.435168	0.6643
LMPM	-0.471447	0.810854	-0.581421	0.5622
LEX	1.039813	0.288782	3.600689	0.0005
LINF	-0.577542	0.177310	-3.257249	0.0015

With regard to the long-run estimates, cointegration had to be established first using the ARDL bounds test, which the F-statistic of 5.097143 being higher than the upper-bound critical value of 3.52 at all significance levels did suggest. Table 3 clearly shows that LINF still significantly affects stock returns in the long run, along with LEX, but none of the other variables exert a significant effect.

Several conclusions can be drawn from the diagnostic statistics reported in Table 4. The significant negative coefficient for ECM (t−1) confirms the existence of cointegration in the long run and implies that the estimate will adjust to its long-run equilibrium by 12% within one month. Meanwhile, the Lagrange multiplier (LM), although not significant at a 5% significance level, indicates the absence of any serial correlation problems. Moreover, Ramsey's regression equation specification error test (RESET), which, with a t-value of 0.300453, is also not significant, shows the model to be correct in its assumptions. Furthermore, the 56% coefficient of determination (Adj. R^2) demonstrates the goodness of fit for the model. Finally, the cumulative sum (CUSUM) test found the estimates to be stable.

Table-4. Diagnostic statistics.

F-Bounds Test	ECM (t−1)	LM	RESET	Adj. R^2	CUSUM
5.097143**	-0.121974**	0.7902	0.7645	0.556593	Stable**
	(-5.141834)	(0.236039)	(0.300453)		

Notes:
- ECM: error correction model.
- LM: Lagrange multiplier.
- RESET: regression equation specification error test.
- Adj. R^2: coefficient of determination.
- CUSUM: cumulative sum test.
- Numbers inside parentheses are expected (E) values of the t-statistics.
- The upper bound critical value at the 5% significance level is 4.01 (when there are four exogenous variables) for the F-statistic (Pesaran et al., 2001).
- The upper bound critical value at the 5% and 10% significance levels are −3.99 and (−3.66), respectively (when there are four exogenous variables) for the t-statistic (Pesaran et al., 2001). These values are usually used to determine the significance of ECM (−1).
- ** significance at the 5% level.

Figure 1 plots the break points (i.e., significant changes). As the CUSUM statistics remain within the 5% significance level, the estimated coefficients are regarded as stable.

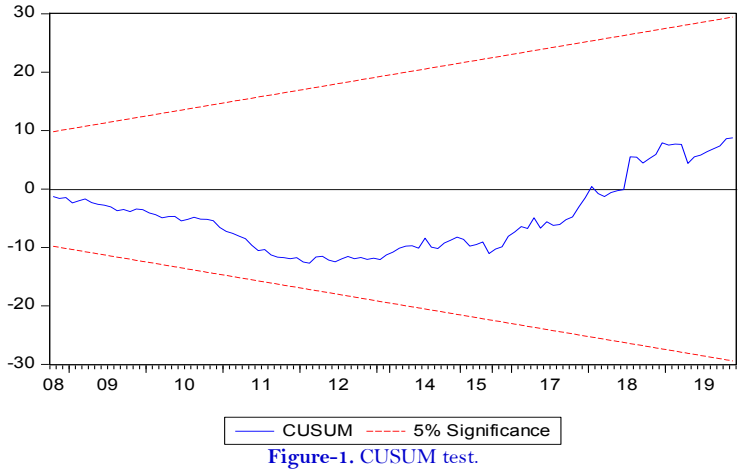

Figure-1. CUSUM test.

In conclusion, inflation rates in Sudan exert short- and long-run effects on stock returns, which agree with not only the results reported by Fama (1981) but also most of the other results of studies conducted in Sudan.

5. CONCLUSION

This study adopted the linear ARDL model to investigate the short- and long-run effects of the inflation rate on stock returns in Sudan, which the findings showed to be significantly negative in both the short and long term. This is of crucial importance to all economies, especially those developing like Sudan: policymakers must formulate strategies to control inflation to maintain a stable stock market. These findings are also of consequence for wiser decision-making on short- and long-term investments.

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