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Is the Effect of the Exchange Rate on Stock Prices Symmetric or Asymmetric? Evidence from Sudan

Omer Ahmed Sayed Mohamed*, Faiza Omer Mohammed Elmahgop

Finance and Investment, University of Tabuk, Saudi. *Email: omer@ut.edu.sa

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ABSTRACT

This study investigates asymmetry in the effect of the exchange rate on the Sudanese stock market prices. We applied the nonlinear autoregressive distributed lag (ARDL) model by Shin et al. (2014) to monthly data for the period from September 2003 to September 2019, using inflation, money supply, and Murabaha profit margin as control variables. No study found that test the nonlinearity effect of the exchange rate on stock prices in Sudan. This study proposed to fill this gap by examining the impact of the exchange rate of Sudanese Pound nonlinearity on the stock prices in the Khartoum Stock Exchange. The results show that the exchange rate has asymmetric effects on stock prices in both the short run and long run. The policy implication of this paper is that modeling the exchange rate and stock prices symmetrically may affect negatively the effectiveness of economic planning. Thus, nonlinear autoregressive distributed lag emerges as a more suitable model than the ARDL model for investigating such a relationship.

Keywords: Exchange Rate, Stock Prices, Nonlinear Autoregressive Distributed Lag, Autoregressive Distributed Lag, Asymmetry, Symmetry
JEL Classifications: E31, E44, G2

1. INTRODUCTION

Investigating the relationship between exchange rate and stock prices is of great importance to researchers and policymakers in the developed and developing economies. Research on this relation includes a large number of studies that investigate the link for different countries since the early 1970s. Researching this link has gained substantial consideration with the development of financial markets, the appearance of flexible currency market policies, and the new systems of foreign exchange.

There are two theoretical approaches to test the relationship between exchange rate and stock prices. That is, the flow-oriented model and the stock-oriented model. While the former assumes that the casualty runs from the exchange rate to stock prices, the latter assumes the opposite. The majority of studies investigated this relation used symmetric models, such as Ajaz et al. (2017), Luqman and Rehana (2018), Kwofie and Richard (2018), Bala and Hassan (2018). With the increasing recognition of nonlinearity in the exchange rate effect recently, there are some studies based on asymmetric models, such as Shin et al. (2014), Cheah et al. (2017), Ahmet et al. (2018), Oyinlola and Tirimisyu (2018), Benli et al. (2019), Yacouba and Halil (2019), Habibi and Chin (2019).

Sudan, during the last decades suffering from a massive deterioration in the value of the domestic currency, so it is vital to investigate the interrelation between the exchange rate and the other macroeconomic indicators to establish an effective economic policy in Sudan. However, unfortunately, a few studies have been empirically analyzed for the Sudanese economy to investigate such interrelation, and they are Abdalla (2013), Amin et al. (2014), Abdalla (2017), Dawai and Saeed (2017).

The objective of this paper is to determine whether changes in the nominal exchange rate of the Sudanese Pound have asymmetric or symmetric effects on the stock prices in the Khartoum Stock Exchange. For this purpose, we use monthly data from Sudan and employ the nonlinear autoregressive distributed lag (NARDL) approach of Shin et al. (2014) beside the linear autoregressive distributed lag (ARDL) approach of Pesaran et al.'s (2001). The main contribution of this study is that the change in the nominal exchange rate is decomposed into the partial sum of positive changes and negative changes to determine whether the changes in exchange rates have symmetric or asymmetric effects on stock prices. To the best of my knowledge, similar studies are absent in the literature about Sudan.

We organize the remaining of our paper as follows; we review the related literature in section (2), outline our model and explain the methodology in Section (3). The results reported in Section (4), where we analyzed to reveal that exchange rate changes have asymmetric effects on stock prices. In section (5), we conclude the results and analysis for the sake of researchers and policymakers.

2. LITERATURE REVIEW

In the related literature, the interaction between stock market prices and exchange rate changes usually explained by two models. The flow-oriented model of exchange rate determination which assumes that the currency changes affect the real income and output of an economy through international competitiveness and the balance of trade position. Consequently, this will affects current and future cash flows of companies and their stock prices (Mundell, 1963, 1964; Dornbusch and Fisher, 1980, and Gavin, 1989). The second model is the stock-oriented model, which assumes that causality will run from stock prices to exchange rate changes. If there is an increase in the stock price, it will lead to a rise in the wealth of the country, which, in turn, will increase demand for domestic currency, and currency will appreciate as a result (Branson, 1983and Frankel, 1983). Other theories used to explain the impact of the exchange rate on stock prices include the Efficient Market Hypothesis, Malkiel and Eugene (1970), and the Arbitrage Pricing Theory, Ross (1976).

Many studies investigated the relationship between stock prices and exchange rates around the world. One of the earliest studies that investigated such a relationship was by Aggarwal (1981). He used an aggregate index of stock prices and an effective exchange rate for monthly data for the period (1974-1978) for the United States of America; he concluded that the two variables have a positive correlation. Soenen and Hennigar (1988) reached to findings opposite to the results by Aggarwal (1981). Bahmani-Oskooee and Sohrabian (1992) used monthly data for the period (1973-1988) and by using the Granger causality test and cointegration method. They found causality between stock prices and the effective rate of the United States of America in the short run and no relationship between the variables in the long run.

The majority of studies in the 1980s that investigate the relationship between exchange rate and stock prices focused on the determination of the direction of causality. While some investigate the causality between stock prices and exchange rates, some try to distinguish the long-run relationship from short-run effects by establishing cointegration between the two variables.

Going on the same lines of our analysis, we divide the literature broadly into two sub-groups. Firstly, studies assume an asymmetric relationship between exchange rate and stock prices. We review some of the studies that used Linear ARDL of Pesaran et al. (2001) in the Table 1.

Studies reviewed and listed in Table 1 have all assumed that the effects of exchange rate changes on stock prices are symmetric, that is to say, if depreciation has a negative impact on stock prices, appreciation has a positive effect. Secondly, studies which assume an asymmetric relationship between exchange rate and stock prices. In the Table 2, we review some recent studies from the literature that demonstrate how we can introduce asymmetry and run the test using nonlinear ARDL of Shin et al. (2014).

In the Table 3, we review some studies that carried out in Sudan.

No study was carried out to test the nonlinearity effect of the exchange rate on stock prices in Sudan. This study proposed to fill this gap by examining the impact of the exchange rate in Sudanese Pound nonlinearity on the stock prices in the Khartoum Stock Exchange.

Table 1: Studies using symmetric autoregressive distributed lag (ARDL) for detecting linearity

No.	Name of authors and Year	Variables		Data and country	Exchange rate and stock price relation
		Dependent	Independent		
1.	Wen and Tang (2010)	Stock returns	Exchange rates	Monthly (8, 2005-2010), Hong Kong, China Singapore, Taiwan and Malaysia	Varied according to exchange rate regimes and level of capital control
2.	Tian and Ma (2010)	Stock price	Exchange rates, money supply price index, industrial prod	Monthly (1995-2009), China	Positive correlation
3.	Lin (2012)	Stock price	Exchange rates, interest rates, foreign reserves	Monthly (1986-2010), India, Indonesia, Korea, Philippines, Taiwan, Thailand	Stronger during crisis periods, consistent with contagion or spillover between asset prices
4.	Kwofie and Richard (2018)	Stock returns	Inflation and exchange rate	Monthly (2000-2013), Ghana	Significant long- and short-run relationship
5.	Bala and Hassan (2018)	Share index	Exchange rate, growth, money supply	Annual (1985-2015)	Positive impact on the stock market

ARDL: Autoregressive distributed lag

Table 2: Studies using asymmetric autoregressive distributed lag (NARDL) for detecting nonlinearity

No	Name of authors and Year	Variables		Data and country	Response to exchange rate change
		Dependent	Independent		
1.	Veli and Bozoklu (2015)	Stock returns	Exchange rate	Monthly (2000-2011), Turkey	Asymmetric causalities
2.	Cuestas and Tang (2015)	Stock returns	Exchange rate market return	Monthly (2006-2015) China (1973-2014)	Short-run asymmetry effect, long-run effect minimal
3	Bahmani and Saha (2015)	Stock prices	Exchange rate price index, industrial index money supply	Monthly, USA, (1973-2014)	Asymmetry relationship
4.	Bahmani and Saha (2016)	Stock prices	Exchange rate price index, industrial index money supply	Monthly Brazil, and others, (1980-2014)	The short-run effect is asymmetry
5.	Ajaz et al. (2017)	Stock prices	Interest rate exchange rate	Daily (2001-2017), India	Asymmetric for the first period Symmetric for the second period
6.	Siew et al. (2017)	Stock prices	Exchange rate production, money supply, inflation	Monthly (1993-2015), Malaysia	Asymmetrically stock price
7.	Akanni and Kazeem (2018)	Stock prices	Exchange rate	Weekly, Nigeria	Symmetry relationship
8.	Oyinlola and Tirimisyu (2018)	Stock prices	Exchange rate	Monthly (1985-2017), Nigeria	Long run asymmetry no short-run effect
9.	Ahmet et al. (2018)	Stock returns	Production, money supply exchange rate	Monthly (1994-2017) Turkey	Asymmetric effects of on stock returns
10.	Benli et al. (2019)	Stock prices	Exchange rate price index, industrial index money supply	Monthly (2003-2016) Turkey	Incomplete pass-through effect both in the long- and short-run
11.	Yacouba and Halil (2019)	Stock returns	Exchange rate money supply interest rates	Monthly (2003-2017), Turkey	Asymmetrically effect in the short-run and long-run
12.	Habibi and Chin (2019)	Stock prices	exchange rate production index, Price Index, money supply	Monthly (1997-2016) G7 countries	Asymmetric effects in short-run, no long-run effect

NARDL: Nonlinear autoregressive distributed lag

Table 3: Studies carried out for Sudan

No.	Name of authors, Year and Country	Variables		Data and methods of analysis	Results
		Dependent	Independent		
1.	Amin et al., (2014)	KSE index	Money supply, inflation rate, Morabaha profit margin exchange rate	Monthly (2003-2012) Augmented dickey-fuller	Negative and weak correlation between KSE index and exchange rate
2.	Abdalla (2013)	Returns of KSE	Exchange rate	Daily (2008-2011) AR GARCH	The shock is originating from the exchange rate to increase stock price volatility
3.	Abdalla (2017)	KSE index	Exchange rate, inflation crude oil price	Daily (2008-2014) Monthly (2003-2014) VAR ARCH l	Short-term predictability in KSE index changes and significant effect of a one-period lagged of exchange rate on KSE
4.	Dawai and Saeed (2017)	Stock price	Exchange rate	2004- 2016 GARCH models ARMA approach	A significant and the GARCH model has a higher capability for exchange rate fluctuations forecasting

3. METHODOLOGY

The study will employ monthly secondary data covering the period from September 2003 to September 2019, sourced from the Central Bank of Sudan, Khartoum stock exchange, and National Bureau of Statistics. To accomplish the study objective, we use Linear ARDL and NARDL models. We will start with linear error-correction:

$$LnKse_t = a + \beta_1 LnEX_t + \beta_2 LnINF_t + \beta_3 LnM2_t + \beta_4 LnMPM_t + \varepsilon t \quad (1)$$

Where KSE denotes the stock prices in Khartoum financial market, EX is the official monthly nominal exchange rate per USD. By definition, a positive change in the exchange rate will mean depreciation. In contrast, a negative change will imply appreciation, PMP denotes Morabaha profit margin, INF is the level of inflation, and M2 is a measure of the nominal money supply. To account for the effects of other variables, we employ this multivariate model, which contains, besides the exchange rate, variables that affect stock prices, as mentioned by the literature on this topic. We intended to add a proxy for measuring economic activity to the model (following Bahmani-Oskooee and Saha (2015a). But, unfortunately, we could not add because of the unavailability of the monthly data in Sudan.

As found in the literature, the response of stock prices to changes in the exchange rate could be positive or negative, which depends, as Bahmani-Oskooee and Saha (2015b) illustrated, on whether the firms in the country are export or import oriented. Since the firms in Sudan are import oriented, we expect that due to depreciation in the Sudanese Pound, the stock prices in Khartoum Financial Market will decline.

Regarding the relationship between stock prices and inflation, according to Anari and Kolari (2001), while in the short-run, there is a negative correlation between stock prices and inflation, this relation could be positive in the long run. Since usually, an increase in the money supply leads to a rise in inflation, we expect the same relationship between stock prices and money supply. To determine the response of stock prices to change in the Murabaha profit margin, we follow Amin et al. (2014). They found a negative correlation between stock prices and the Murabaha profit margin In Sudan.

Following Pesaran et al.'s (2001) bounds testing approach we can rewrite equation (1) as error-correction model:

$$DLnKSE_t = a + \sum_{k=1}^{n1}\beta_1 \Delta LnKSE_{t-k} + \sum_{k=0}^{n2}\beta_2 \Delta LnEX_{t-k} + \sum_{k=0}^{n4}\beta_3 \Delta LnINF_{t-k} + \sum_{k=0}^{n5}\beta_4 \Delta LnM2_{t-k} + \sum_{k=0}^{n3}\beta_5 \Delta LnMPM_{t-k} + \lambda_1 LnKSE_{t-1} + \lambda_2 LnEX_{t-1} + \lambda_3 LnINF_{t-1} + \lambda_4 LnM2_{t-1} + \lambda_5 LnMPM_{t-1} + \mu_t \quad (2)$$

Then, we modify the Equation (2) to analyze asymmetric effects of the exchange rate on stock prices. To accomplish this task, we insert the negative and positive changes in LnEX following Shin et al. (2014) as below:

$$\Delta LnKSE_t = a + \sum_{k=1}^{n1}\beta_1 \Delta LnKSE_{t-k} + \sum_{k=0}^{n2}\beta_2 \Delta POS_{t-k} + \sum_{k=0}^{n3}\beta_3 \Delta NEG_{t-k} + \sum_{k=0}^{n5}\beta_4 \Delta LnINF_{t-k} + \sum_{k=0}^{n6}\beta_5 \Delta LnM2_{t-k} + \sum_{k=0}^{n4}\beta_6 \Delta LnMPM_{t-k} + \lambda_1 LnKSE_{t-1} + \lambda_2\ LnPOS_{t-1} + \lambda_3\ LnNEG_{t-1} + \lambda_4\ LnINF_{t-1} + \lambda_5\ LnM2_{t-1} + \lambda_6\ LnMPM_{t-1} + \mu_t \quad (3)$$

Shin et al. (2014) illustrate that we can apply Pesaran et al.' 2001 bounds testing approach to equation (3) so that we can judge short run symmetry or asymmetry as well as long run symmetry or asymmetry which is labeled non-linear ARDL model.

4. EMPIRICAL RESULTS AND ANALYSIS

This study tries to investigate the relationship between the nominal exchange rate and stock prices from the asymmetric perspective. We difficultly obtained monthly data from Sudan covering the period from September 2003 to September 2019 using linear ARDL and nonlinear ARDL.

Conducting unit root tests for the variables is the first task of doing this analysis. We tested stationary at the level and first difference using the Augmented Dickey-Fuller (ADF) test, putting in mind that the cointegration test procedure requires I (0) or I (1) variable only. We divided the results report and analysis into three divisions; firstly, we will outline unit root test results, then we will proceed to report linear ARDL estimates, and lastly, we will report nonlinear ARDL estimates.

4.1. Unit Root Test Results using ADF

The results presented in Tables 4 and 5 and the findings of the ADF test indicate that all variables in the model satisfied the required condition.

Using Akaike's information criterion (AIC) to select an optimum specification, we Impose a maximum of twelve lags on each first differenced variable. We estimated the model outlined in the previous section using ARDL and NARDL. The results reported in the following tables.

4.2. Estimates of the Linear Model

We will report here the results obtained by using the linear ARDL, which include both short and long-run results in addition to their diagnostic statistics.

The CUSUM test is plotted against the breakpoints. If the plot of CUSUM statistic stays within a 5% significance level, then estimated coefficients are said to be stable (Figure 1).

Using the linear ARDL to investigate the relationship between LnEX and LnKSE in Sudan, the short-run results (reported in Tables 6) indicate that only changes in the LnINF have significant effects on the stock prices at significance level 1%m While the other variables in the model have significant effects on the stock prices through their lags except for LnM2, which has no significant impact.

Regarding long run results (reported in Tables 7), we have first to establish cointegration using the bound test. Our calculated F statistic (8.27338) is higher than the upper bound critical value of 3.52 at all levels of significance**,** implying the existing of cointegration. However, in the long run, it clears that LnINF still has significant effects, while the other variables in the model have insignificant impacts on LnKSE.

Table 4: Level

Deterministic component	LnKSE	LnEX	LnINF	LnM2	LnMPM
Probability	0.9461	0.9989	0.3006	0.9998	0.0167[s]
t-Statistic	−0.104976	1.371760	−1.968501	1.855369	−3.290367

[s]Indicates that we reject the null of unit root, and the variable is stationary. All values are with and trend

Table 5: First different

Deterministic component	ΔLnKSE	ΔLnEX	ΔLnINF	ΔLnM2	ΔLnMPM
Probability	0.0000[s]	0.0000[s]	0.0000[s]	0.0001[s]	0.0000[s]
t-Statistic	−12.02284	−13.66953	−8.319238	−4.664598	−25.34679

[s]Indicates that we reject the null of unit root, and the variable is stationary. All values are with and trend

Table 6: Short-run coefficient estimates

Lag	$\Delta LnKSe_t$		$\Delta LnEX_t$		$\Delta LnINF_t$		$\Delta LnM2_t$		$\Delta LnMPM_t$	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
0			0.0290	0.3592	−0.0859	−3.1152**	0.5038	1.6253	0.1047	1.0699
1	0.0574	0.7237		−0.0939	0.0889	2.6136*			0.0828	0.8593
2	0.1570	1.980	0.05262	0.7800	0.0055	0.1605			0.0271	0.2637
3	0.0816	0.9284	0.0164	0.2500	0.1313	3.6807**			0.0091	0.0879
4	−0.0201	−0.2293	0.0279	0.4227	0.0304	0.8655			0.0782	0.7665
5	−0.1154	−1.3233	0.00095	0.0149	0.0713	2.1433			0.0580	0.5890
6	0.1440	1.8702	0.7177	11.301**	0.0534	1.7011*			−0.0875	−0.9273
7	0.2002	2.5881*	0.1999	2.7264*	0.0727	2.2979			0.0228	0.2578
8	0.2013	2.5882*	0.2067	2.8824*					0.1054	1.2391
9	−0.3268	−4.0426**	0.2086	2.7473*					0.2252	3.1221**
10			0.2298	3.0340*						
11			0.2563	3.5316**						

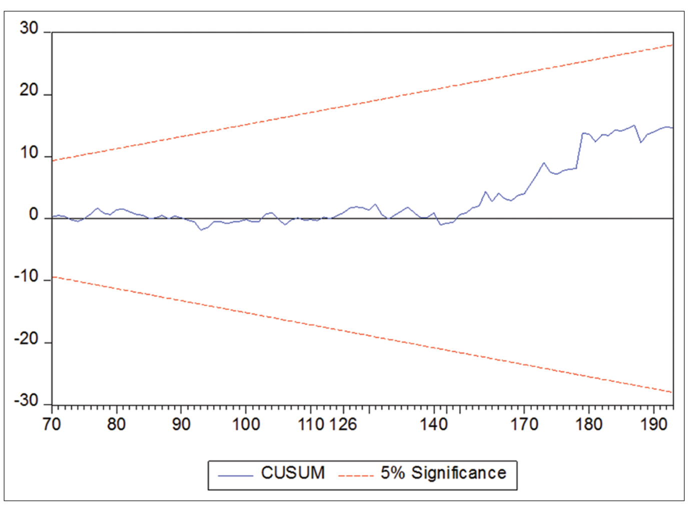
*Indicates that the parameter is significant at 5%. **indicates that the parameter is significant at 1%

Table 7: Long-run coefficient estimates

	ΔLnEX	ΔLnINF	ΔLnM2	ΔLnMPM
Coefficient	0.276492	−0.478263	0.13761	0.602134
t-Statistic	1.469378	−4.881844**	1.210623	1.292579

*Indicates that the parameter is significant at 1%. **Indicates that the parameter is significant at 5%

Figure 1: CUSUM test



In the diagnostic statistics (reported in Tables 8), a significant negative coefficient obtained for ECM_{t-1} that supports the existence of cointegration in the long run. The size of the coefficient itself implies that 22% of adjustment takes place within one month. Some other diagnostics also reported. We found that the Lagrange multiplier (LM) insignificant at a 5% level of significance, which implies the absence of serial correlation problems. We test Ramsey's RESET statistic to judge misspecification. Given its t-value of 0.3004, the RESET statistic is insignificant, supporting the excellent specification of the model. Depending on the CUSUM test, we found stable estimates. We also calculate Adjusted R2 to judge the goodness of fit, which found to be 56%. To conclude this section, we note that the exchange rate has short-run but not long-run effects on stock prices in Sudan. We have to compare these results with that obtained using the non-linear ARDL to attain the objective of this study.

4.3. Estimates of the Nonlinear Model

We will report here the results obtained by using the nonlinear ARDL, which include both short and long-run results in addition to their diagnostic statistics.

The CUSUM test state that If the plot of CUSUM statistic stays within a 5% significance level, then estimated coefficients are stable (Figure 2).

When we rely on nonlinear ARDL to investigate the relationship between LnEX and LnKSE in Sudan, the short-run results (reported in Tables 9), indicate that only changes in the LnINF have significant effects on the stock prices at significance level 5%, While LnEX-POS (currency appreciation) and LnMPM have significant effects on the stock prices through their lags. Nevertheless, LnEX-NEG (currency depreciation) and LnM2 have insignificant effects. This result implies that the exchange rate (LnEX) changes have an asymmetric effect on stock prices (LnKSE) in Sudan in the short run.

Regarding long run results (reported in Table 10), we must first establish cointegration using the bound test. Our calculated F statistic (8.093689) is higher than the upper bound critical value of 4.01 at all levels of significance, implying the existing of cointegration. However, in the long run, it clears that LnEX-NEG (currency depreciation) has significant effects on LnKSE while the other variables in the model, including LnEX-POS (currency appreciation), have insignificant effects on LnKSE. To conclude, LnEX-POS (currency appreciation) is insignificant and has a negative sign. At the same time, LnEX-NEG (currency

Table 8: Diagnostics statistics

F-Bounds test	ECM_{t-1}	LM	Reset	Adj. R^2	CUSUM
8.27338**	−0.218612** (−6.562983)	0.7082 (0.346269)	0.7645 (0.300453)	0.556593	Stable**

Numbers inside the parentheses are e values of the t-ratios. The upper bound critical value of the F-statistic at the 5% significance level is 4.01 (when there are four exogenous variables). This value comes from Pesaran et al. (2001, Table CI-Case III, p. 300). The upper bound critical value of the t-statistic at the 5% (10%) significance level is −3.99 (−3.66) when there are four exogenous variables. These come from Pesaran et al. (2001, Table CII-Case III, p. 303). These values usually used to judge the significance of ECM_{t-1}. *, ** and *** denote significance at the 1%, 5% and 10% levels, respectively

Table 9: Short-run coefficient estimates

Lag	$\Delta LnKSe_t$		$\Delta LnEX_{t-pos}$		$\Delta LnEX_t$-NEG		$\Delta LnINF_t$		$\Delta LnM2_t$		$\Delta LnMPM_t$	
	Coeff.	t-value	Coeff.	t-value	Coef	t-value	Coeff.	t-value	Coef	t-value	Coeff.	t-value
0			0.04499	0.7411			−0.0585	−2.266*			0.0740	0.8165
1	0.0102	0.1362	0.0175	0.2796			0.0369	1.1978			0.3074	3.3518*
2	0.0932	1.2402	0.0794	1.2675			−0.0551	−1.7827			0.2032	2.0914
3	0.0129	0.1544	0.06333	1.0042			0.0587	1.7386			0.1639	1.6809
4	−0.0900	−1.0848	0.0585	0.9438			−0.0106	−0.3190			0.2147	2.2241
5	−0.1500	−1.7852	−0.0192	−0.3179			0.06342	1.9833*			0.1329	1.4394
6	0.0476	0.6628	0.7371	12.373**			0.0280	0.9345			−0.0586	−0.6436
7	0.0964	1.3486	0.1840	2.7642*			0.0674	2.2777*			0.0191	0.2164
8	0.1506	2.0894	0.2113	3.1820*			−0.0387	−1.4091			0.0835	1.0243
9	−0.3745	−5.2037**	0.2160	3.0996*							0.2153	3.2073**
10			0.2254	3.2608**								
11			0.2349	3.4114**								

*Indicates that the parameter is significant at 5%. **Indicates that the parameter is significant at 1%

Table 10: Long-run coefficient estimates

	LnEX-POS	LnEX-NEG	LnINF	LnM2	LnMPM
Coefficient	−0.057332	3.676564	−0.141437	0.772481	−0.84386
t-Statistic	−0.233185	2.321727*	−0.968988	2.451904*	−0.953402

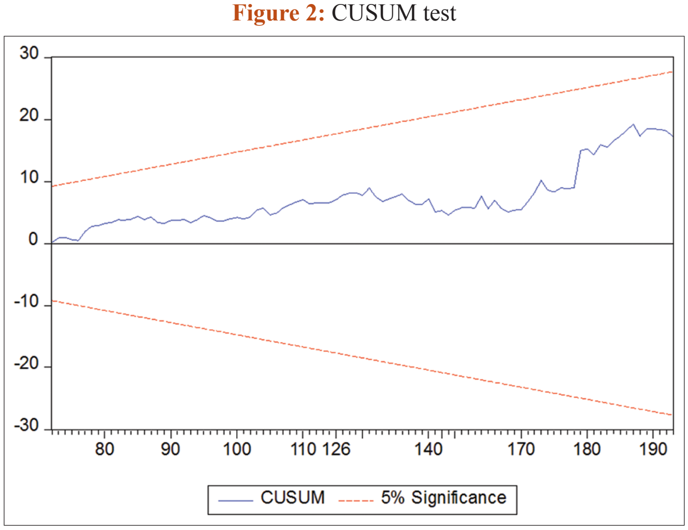
*Indicates that the parameter is significant at 1%. **Indicates that the parameter is significant at 5%

Table 11: Diagnostics statistics

F-Bounds test	ECM_{t-1}	LM	Reset	Adj. R^2	Custom
8.093689*	−0.199112* (−7.761062)	1.84151 (0.1643)	2.17091 (0.0325)	0.722739	Stable**

Numbers inside the parentheses are values of the t-ratios. The upper bound critical value of the F-statistic at the 5% significance level is 4.01 (when there are four exogenous variables). This value comes from Pesaran et al. (2001, Table CI-Case III, p. 300). The upper bound critical value of the t-statistic at the 5% (10%) significance level is −3.99 (−3.66) when there are four exogenous variables. These come from Pesaran et al. (2001, Table CII-Case III, p. 303). We use these values to judge the significance of ECM_{t-1}. *, ** and *** denote significance at the 1%, 5% and 10% levels, respectively

Figure 2: CUSUM test



depreciation) is the significance with a positive sign, which again implies that exchange rate (LnEX) changes have an asymmetric effect on stock prices (LnKSE) in Sudan in the long run also.

In the diagnostic statistic (reported in Table 11), a significant negative coefficient obtained for ECM_{t-1} that supports the existence of cointegration in the long run. The size of the coefficient itself implies that 20% of adjustment takes place within one month. We also reported some other diagnostics. We found that the LM insignificant at a 5% level of significance, which implies the absence of serial correlation problems. We test Ramsey's RESET statistic to judge misspecification. Given its t-value of (2.17091), the RESET statistic is significant, supporting the misspecification of the model. Depending on the CUSUM test, we found stable estimates. We calculate the adjusted R^2 to judge the goodness of fit, which found to be 61%. To conclude this section, we note that the exchange rate has short-run but not long-run effects on stock prices in Sudan.

5. CONCLUSION

This study employs Linear ARDL and Nonlinear ARDL models to analyze both symmetric and asymmetric effects in the short run and long run of exchange rate on stock prices in the Khartoum stock exchange. Our results show that the exchange rate has a asymmetric impact on stock prices in both the short run and long run. Hence, modeling the exchange rate and stock prices as a symmetric relation may lead to uneffective economic plans. Thus, NARDL emerges as a more suitable model than the ARDL model for investigating such a relationship.

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