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Are Exchange Rate, Interest Rate, and Price level Pass-through to Stock Prices in Egypt Symmetric or Asymmetric?

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Abstract

This paper employs linear (ARDL) and nonlinear (NARDL) models to examine the short-run and long-run relationships between stock prices on one hand and each of the exchange rate, the interest rate and the price level in Egypt. Employing monthly time series variables from January 2000 until June 2022, the paper concludes that the exchange rate has a clear asymmetric impact on stock prices both in the short and long run. In the short run, the depreciation of the Egyptian currency (LE) has a very strong instantaneous impact in raising stock prices, in addition to a significant effect in raising stock prices in the long run. The opposite impacts do not materialize in the case of the appreciation of the LE. Results also revealed that there is a significant negative relation between the interest rate and stock prices in the short run, and between the inflation rate and stock prices in the long run. As the devaluation of the LE (which positively affects stock prices) was always a main cause behind inflation (which negatively affects stock prices), policymakers should consider, before devaluing the LE, the net cumulative effects of both variables on stock prices in the long run, especially since the magnitude of the negative impact of inflation exceedingly outweighs the positive impact of the devaluation on stock prices.

Keywords: Exchange rate, Interest rate, Inflation rate, Stock prices, Asymmetry, NARDL, Egypt

JEL classification: C22, E31, F31, G15, G44

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1. Introduction

The Egyptian stock market is considered amongst the oldest in the world. In 1883, the Alexandria Stock Exchange was established in Egypt's second-largest city, Alexandria, followed twenty years later, in 1903, by the inauguration of the Cairo Stock Exchange in the capital Cairo (The Egyptian Exchange - History, 2022). Nevertheless, the Egyptian stock exchange declined and remained somewhat latent during the Nasserite era due to the adoption of socialist policies. In 1974, the country changed its economic orientation with the adoption of a more liberal and market-oriented policy entitled the Open-Door Policy. A major step to invigorate the stock market again took place in 1997 through the public offering of state-owned enterprises as part of the government's Economic Reform and Structural Adjustment and Program (ERSAP) (African Markets – About Egyptian

Exchange, n.d.). Nevertheless, external and internal macroeconomic developments continued to have negative ramifications on the stock market, especially the global financial crisis in 2008 and the eruption of the January 25 revolution in Egypt in 2011, the latter resulting in the suspension of trading in the stock exchange from January 28, 2011, until March 23, 2011 (The Egyptian Exchange Annual Report, 2011). Stock prices accelerated again during the period 2016–2019 (The Egyptian Exchange Annual Report. 2019), but incurred losses in the first quarter of 2022 as a result of a multiplicity of internal and external events (Egypt Independent, 14 June 2022). Internally, Egypt's external debt has been mounting in recent years (Helmy, 2021) and the debt service payments in foreign currency have been increasingly becoming a burden, given the country's limited inflows of foreign currency. Externally, the eruption of the Russian–Ukrainian war drove prices of Egypt's extensive imports of wheat and energy upwards, further aggravating the foreign currency predicament. Consequently, the current government declared that it can no longer depend on hot money for external financing and revealed the government's intention on focusing more on foreign direct investment (Werr, 2022). One of the main routes by which foreign capital for investment can enter the Egyptian market is through the stock market. To stimulate the stock market, the government promulgated new public offerings of state-owned enterprises (The Egyptian Exchange Annual Report, 2019). Such offerings – if materialized – are intended to boost stock market prices as well. However, whether or not such measures will impact stock returns and prices is contingent on Egypt's macroeconomic environment. In recent years, Egypt's GDP has been growing, but so has inflation, while the LE has also been steadily depreciating. Such trends were at rare times interrupted with slight and minor opposite trends, with inflation and depreciation leveling off or decreasing. On the other hand, the interest rate has been fluctuating, rising at times of inflation – but most importantly at times of devaluation – and falling when such trends are moderated. Despite the importance of the various macroeconomic factors, the asymmetric impact of depreciation versus appreciation, interest rate rises versus interest rate falls, and price level rises versus price level falls, on stock prices in Egypt was mostly ignored by researchers, who have assumed only a symmetric reaction of stock prices to the aforementioned factors. Though important, linear modeling is expected to ignore a variety of potential investor reactions. The main motivation of our study is thus to explore a largely unaddressed area of research that has not been sufficiently elucidated, namely the asymmetric impact of depreciation versus appreciation, interest rate rises versus interest rate falls, and price level rises versus price level falls, on stock prices in Egypt.

The main research questions of our paper are therefore whether or not the exchange rate, interest rate, and the inflation rate have asymmetric impacts on the stock market prices in Egypt. We hypothesize that the three aforementioned variables have asymmetric impacts on the stock market prices in Egypt. The hypothesis of nonlinearity emanates from the fact that the nexus between stock prices and the three variables was previously supported in several studies conducted on countries other than Egypt; which justifies our assumption and use of a nonlinear relation – or a NARDL technique – on Egypt. Furthermore, the recent general downward trend in stock prices in Egypt cannot be fully explained by the fluctuations – or both rises and falls – in the variables, thereby raising questions on the efficiency of assuming and using a linear relation estimator – or the ARDL technique – to explain the causal relation among the tested variables.

Our paper makes a very important contribution in that it is the only paper that simultaneously tackles the asymmetric impacts of the exchange rate, interest rate, and inflation rate on the stock market prices in Egypt using multivariate time series econometric techniques.[1] Finding appropriate determinants of stock prices is of fundamental importance for policymakers, analysts, and investors. Furthermore, the importance of the paper also arises from the fact that Egypt has recently been identified by the International Monetary Fund as an emerging economy (International Monetary

1. We initially incorporated GDP per capita as one of our determinants of stock prices but due to its unsuitability for estimation using our econometric technique, and insignificance in some studies, we decided to exclude it as explained in section 3.

Fund, 2021). Hence, the findings of the paper are valuable for other emerging economies as well. Following this introduction, section 2 articulates a brief theoretical review of the evolution of stock prices theories and stock prices macroeconomic determinants which paves the way for our model selection; section 3 reviews the literature focusing on the asymmetric impacts of stock prices determinants on stock prices. The data and methodology are elucidated in section 4, followed by the empirical analysis and results in section 5, and finally the conclusion in section 6.

2. Theoretical review

To know how stock prices would react necessitates first looking at the main determinants of stock prices. Sections 2.1 and 2.2 briefly review the main theories and macroeconomic determinants of stock prices and returns.

2.1 Theories on stock returns

Theories on stock prices and returns evolved since the mid-twentieth century. A pioneer in stock market theories was Markowitz (1952) who postulated that an investor chooses a portfolio that decreases the total risk (as measured by the variance of the rate of return). Capital Asset Pricing Model (CAPM) was built on Markowitz's theory and using a simple mathematical equation assumed that the rate of stock return depends on the risk-free rate and the product of the *beta* coefficient multiplied by the market risk premium – or the difference between the market rate and the risk-free rate.[2] However, the problem is that the calculation of beta is contingent on the frequency of the data used in its estimation whether daily, monthly, or annual. Moreover, many macroeconomic variables may increase the risk of stock. Such factors – unaccounted for in the CAPM – induced the formulation of the Arbitrage Pricing Theory Model (APTM) by Ross (1976), which is based on the concept that an asset's returns can be forecasted using the linear relation between the asset's expected return and several macroeconomic variables that reflect systematic risk. As an extension of the CAPM, Merton (1973) introduced the Intertemporal Capital Asset Pricing Model (ICAPM) assuming that investors stay in the market for multiple years (hence intertemporal) and therefore attempt to protect their investments against market uncertainties and risk by constructing dynamic portfolios that change over time. Finally, Fama and French introduced their Three-Factor Model (known as the Fama-French Model) in 1992, which builds on the CAPM by adding new risk factors such as size and value to the market risk factor. Summing up, the evolution of such theories was based on the expansion of the conceptualization of the risk factor to incorporate a multiplicity of macroeconomic factors, besides the conventional microeconomic risk factors pertaining to the firms themselves.

2.2 Macroeconomic determinants of stock market prices

Exchange rate, interest rate, inflation rate, and real output have evolved in recent literature as fundamental determinants of stock prices. In 1980, Dornbusch and Fischer's seminal work posited that the exchange rate affects stock prices through the flow-oriented approach. According to their theory, currency depreciation would increase stock prices. Such results were supported by several researchers but also challenged by many others such as Bahmani-Oskooee and Saha (2016) who posited that such results would materialize only if a country had more export-oriented firms compared to import-oriented firms and vice versa.

On the other hand, interest rate remained integral in the explanation of stock prices ever since the introduction of models which explain stock prices determination such as the generalized dividend model, the Gordon growth model, the efficient market hypothesis, and others. Such theories imply that a reduction in the interest rate by the central bank would lower the return the investors are

2. is defined as the covariance (rate of stock, rate of market return) divided by the variance of the market return.

willing to accept (denominator in the Gordon model), thereby decreasing the price of stock. Said differently, if the discount rate increases (decreases), future cash flows of firms decrease (increase), causing stock prices to decrease (increase). Hence, there is an inverse relationship between interest rate and stock price. (Mishkin, 2010).

Finally, the impact of inflation or expansionary monetary policy on the economy is indeterminate, as high inflation may stimulate job growth and increase the overall level of economic activity thereby boosting stock prices (Patelis, 1997). Nevertheless, inflation may also decrease firms' profits and therefore reduce stock prices. As a result, most theories were inconclusive with respect to the impact of inflation on stock prices. Finally, some studies posited that an increase in real output may boost stock prices (Gurley and Shaw, 1967; Goldsmith, 1969; Garcia and Liu, 1999). Other less important and more controversial determinants included the saving rate, financial intermediary development, and macroeconomic volatility (Garcia and Liu, 1999).

3. The literature on the asymmetric impacts of stock market prices determinants

As the literature on the relation between the stock prices determinants and stock prices can least be described as gigantic, this section will focus primarily on two main themes; firstly, we will shed light on the recent articles examining the asymmetric relationship between stock market determinants (especially the exchange rate, interest rate and the price level) and stock prices in general. Secondly, we will have a closer look at the relatively few articles examining this relationship in Egypt in particular. Table 1 summarizes the major works falling mainly under the aforementioned criteria. In general, there is a dichotomy in the literature as to whether or not shocks in the exchange rate and the price level (or inflation) asymmetrically affect stock prices in both the short and long runs and on the direction of such impacts on the stock prices. A large group of studies identifies some evidence of long-run asymmetry regarding the impact of the exchange rate on stock prices, such as those by Alsamara, Yaghi, and Mrabet (2020) on Syria, Kassouri and Altıntaş (2020) on Turkey, Mohamed, and Sahin (2020) on Kuwait; while others identify short-run asymmetries, such as those by Nusair and Olson (2022) on the G7 countries (even though the findings are somehow conditional on the selected country) and Saidi et al (2021) on Indonesia. The third group reveals both short-run and long-run asymmetries, the most prominent of which are those by Bahmani-Oskooee and Saha (2016; 2018) on a group of developed and developing countries (yet again the long run asymmetries are contingent upon the country selected), and Aftab et al (2021) study on a sample of nine Asian countries. At the extreme end lies Phong et al. (2018) study that finds no significant relation (symmetric or asymmetric) from the exchange rate to stock prices in Vietnam whether in the short or long runs.

Similar to the disparities in the magnitude and timing of the effects of the shocks in the exchange rate on stock prices, studies also displayed discrepancies in the direction of causality. For example, Nusair and Olson (2022) find that the asymmetric relation is the other way round; that is, from stock prices to exchange rate prices in the G7 countries in the short run, a conclusion not supported by many studies, such as that by Ndlovo et al (2018) on South Africa and other studies that employed more conventional economic techniques such as VARs, VECMs, or Granger Causality tests, examples of which are listed in Table 1.

Results were also inconclusive on the effect of the rise in the price level (or some strategic commodities' prices) on stock prices. Many studies presumed long-run asymmetry of the impact of inflation on stock prices such as those by Phong et al (2018) on Vietnam, Batabyal, and Killins (2021) on Canada, Civcir, and Akkoc (2021) (between oil prices and stock indices) on Turkey, Badamvaanchig et al (2021) (between copper prices and stock prices) on Mongolia. The direction of causality was also unsettled, with some studies positing a positive impact on stock prices from a shock in inflation while others presuming the opposite effect (Eldomiaty et al., 2018).

Concerning Egypt, very few studies were conducted on the asymmetric response of some stock market determinants on stock prices, mostly mentioned among a panel of countries. For example,

the most recent study is conducted by Moussa and Delhoumi (2022) where Egypt's case is studied amongst a group of Middle Eastern and North African (MENA) countries. The authors conclude that, in the case of Egypt, there is evidence of an asymmetric response of stock return to exchange rate shocks in the short and long runs. Other conventional econometric methods such as VAR and Granger Causality tests revealed no long-run cointegration between exchange rate and stock prices in Egypt (El-Masry and Badr, 2021). However, El-Masry and Badr (2021) concluded that a relationship exists from exchange rate to most stock market indexes at the 10% significance level in the pre-2011 revolution period. In the post-2011 revolution period, there is no causal relation from the exchange rate to stock indexes or market capitalization, but a 10% significant relation exists the other way round. Abouwafia and Chambers's (2015) relatively older study on selected MENA countries used Johansen Cointegration tests and impulse response functions to assess the impact of the exchange rate on stock prices in those countries. They concluded that depreciation causes stock prices to fall (rather than rise) probably due to the high import component of goods used in production, thereby lowering the profitability of firms. Egypt is also one of the seven African countries selected by Adjasi et al (2011) in their study conducted several years before Abouwafia and Chambers's (2015). However, their conclusion is totally at odds with the latter as in their study posits that a depreciation of the LE drives down stock prices. Older studies by Omran and Pointer (2003) and Omran (2001) concluded that an inverse relation between inflation and stock market activity both in the short and long runs.

Our paper contributes to filling an important gap in the extant literature since it is the only paper that simultaneously tackles the asymmetric impacts of the exchange rate, interest rate, and the inflation rate on the stock market prices in Egypt using multivariate time series econometric techniques. Even though El-Masry and Badr's (2021) paper is important in linking the stock market and exchange markets, it does not capture the asymmetric effects of the shocks in both the exchange rate and – most importantly – the inflation rate, a limitation shared by Adjasi et al on some selected African countries including Egypt. On the other hand, Moussa, and Delhoumi's (2022) study on some MENA countries including Egypt does not incorporate the inflation rate in the model, an important determinant of stock market prices in Egypt nowadays. We believe that not incorporating the inflation rate with the exchange rate in the same model or not incorporating the inflation rate at all is one of the reasons for the contesting results that appeared on the impact of the exchange rate on stock prices in Egypt.

4. Data and Methodology

4.1 Data

Based on the theories of the stock returns and the previous literature, the most fundamental macroeconomic factors that can explain the changes in the stock market index are the exchange rate, the interest rate, monetary policy, and in some few cases real output production. To account for monetary policy, most studies incorporated money supply and/or the inflation rate. However, a preliminary examination of multicollinearity among the time series of these two variables in Egypt revealed that it is almost perfect (0.992) which necessitated dropping one of the two. We decided to retain the inflation rate and exclude the money supply variable as we believe it is more reflective of the outcome of the monetary policy rather than merely being a tool of it. Moreover, inflation is sometimes a substitute for investment in stocks as Egyptians tend during periods of high inflation to buy real estate to benefit from rising prices rather than invest in stocks. As for real output, we use the real per capita GDP.

To examine the relationship in Egypt among the exchange rate, the interest rate, and price level changes on one hand and stock prices on the other, we used monthly data starting 2000M1 until 2022M6. Specifically, LEX is the natural log of the monthly nominal exchange rate or the value of $1 in terms of LEs. LDR is the monthly discount rate stipulated by the Central Bank of Egypt with

Table 1. Review of Selected Studies on Determinants of Stock Market Prices

Study	Countries/ companies examined	Period estimated	Dependent variable and independent variables estimated	Methodology used	Main findings (with a focus on Egypt's results if the study is conducted on Egypt and other countries)
Abouwafia and Chambers (2015)	Selected MENA countries	Undefined	Dependent variable: stock prices. Independent variables: exchange rate and monetary policy	Johansen , cointegration test. Impulse response functions	No long-run cointegration exists between the exchange rate and stock prices. The real exchange rate and monetary policy shocks have a significant short-run impact on the stock prices in countries employing flexible exchange rates and having an independent monetary policy. Concerning Egypt, a 1% depreciation in the exchange rate causes stock prices to fall by 3.5%
Adjasi, Biekpe and Osei (2011)	Seven African countries	1992-2006	Dependent variable: stock prices. Independent variables: exchange rate	VAR and impulse response functions	Exchange rate depreciation drives down stock prices in Tunisia. Impulse response analyses show that stock returns in Ghana, Kenya, Mauritius, and Nigeria decrease when faced with exchange rate shocks, but increase in Egypt and South Africa.
Aftab, Ahmad, and Ismail (2015)	A sample of 1256 Chinese firms	2005 - 2012	Dependent variable: Dynamic conditional correlation between stock price returns and the exchange rate Independent variables: trade balance, interest rate, financial development and industrial production	DCC-GARCH	A negative relation exists between the exchange rate and stock prices
Aftab, Ahmad, Ismail, and Phylaktis (2021).	A sample of nine Asian countries	2005 –2016	Dependent variable: Dynamic conditional correlation between equity return differences and the real exchange-rate variations. Independent variables: Trade balance to GDP, real integration, real interest rate, financial integration, economic activity, financial development	DCC-GARCH, ARDL and NARDL	A negative association exists between the exchange rate and stock returns differentials in all selected countries with except for China. Real integration and financial integration have asymmetric impacts on the nexus between the two markets both in the long and short terms
Alsamara, Yaghi. And Mrabet (2020)	Syria	2010:Q1 – 2017:Q4.	Dependent variable: Damascus Securities Exchange Index (DSEI). Independent variables: real GDP, broad money supply, consumer price index, and parallel market exchange rate	ARDL and NARDL	The impact of exchange rate shocks on stock prices is asymmetric in the long run, as the stock market index responds more to currency appreciation rather than currency depreciation. The stock market index response to a negative shock in the parallel market exchange rate is greater than its response to a positive shock.
Badamvaanchig *et al.* (2021)	Mongolia	2007M1-2018M12	Dependent variable: index of stock prices. Independent variables: commodity prices especially coal and copper	NARDL	Asymmetric long-run relationships exist between stock prices and commodity prices. In particular, the analysis presents a positive relationship between copper price and stock price in the case of a positive shock on copper price, but no clear relationship in the case of a negative shock on copper price. A negative shock in coal prices leads to a positive relation between coal and stock prices.
Bahmani-Oskooee, and Saha (2016).	Nine developed and developing countries	1988 M1–2014 M3, but differed according to country	Dependent variable: index of stock prices. Independent variables: nominal effective exchange rate, index of industrial production, consumer price index, and nominal money supply	ARDL and NARDL	Exchange rate changes have asymmetric effects on stock prices. The long-run effects are found only in limited cases. The exchange rate had significant long-run effects on stock prices in Brazil and Korea. The inflation rate had significant long-run effects in Brazil, Mexico, and the U.K. , both in the short and long runs.

Table 1. Continue....

Study	Countries/ companies examined	Period estimated	Dependent variable and independent variables estimated	Methodology used	Main findings (with a focus on Egypt's results if the study is conducted on Egypt and other countries)
Bahmani-Oskooee, and Saha (2018).	24 developed and developing countries	Monthly data	Stock prices and nominal effective exchange rate (each variable is used once as the dependent variable and once as independent)	ARDL and NARDL	Most countries in the sample exhibit short-run asymmetric effects and short-run adjustment asymmetry. However, the long-run asymmetric effects are contingent upon the selected country.
Batabyal and Killins (2021)	Canada	1985-2015 Monthly	Dependent variable: S&P/TSX Toronto stock market index. Independent variables: Economic policy uncertainty, industrial production, rate of inflation, credit spread, and real effective (USD/CAD) exchange rate.	ARDL and NARDL	The short-run and long-run impacts are asymmetric. In the long-run, increased policy uncertainty convinces investors to move toward lower-risk investments, which tends to decrease asset prices; contrarily, decreased uncertainty prompts investors to take on risk for the chance of higher returns. Over the long-run, higher inflation can have a dampening effect on investment returns.
Cheah, Yiew, and Ng (2017).	Malaysia	1993M01 to 2015M12.	Dependent variable: Stock index. Independent variables: nominal effective exchange rate, money supply, consumer price index and industrial production index	ARDL	Stock prices asymmetrically respond to exchange rate movements in both the short and long runs. However, currency appreciation has a significant and positive short-run effect on stock prices, while currency depreciation does not have a significant effect in the short run. In the long run, only currency depreciation has a significant and positive effect on stock prices
Civcir and Akkoc (2021)	Turkey	Daily data 2009M1- 2019M5.	Dependent variable: The aggregate BIST100 index and sectoral stock indexes. Independent variables: exchange rate and oil prices	NARDL	Oil price rises have a negative impact on the Turkish stock market in the short-run. There is a long-term asymmetry between oil prices and sectoral indices in six sectors. Besides, in six sectors. Besides, in short-run impacts are more pronounced than the long-run impacts. Finally an increase in the exchange rate adversely affects sectoral stock indices in the short run.
Dahir, et al, (2017)	BRICS	Daily data, 1/1/2006 to 31/12/2016	Stock prices and exchange rate (each variable is used once as the dependent variable and once as independent)	Wavelet analysis	In Russia and Brazil, exchange rates lead stock; in India, the index pair has an inverse relation, while South Africa has a more bidirectional relationship; finally, the Chinese index pair did not show any correlation.
Eldomiaty, Saeed, Hammam, and AboulSoud (2020).	Non-financial firms listed in DJIA30 and NASDAQ100	Quarterly data for the period 1999-2016.	Dependent variable: Stock index. Independent variables: interest rate and inflation	Johansen cointegration test, Granger causality and VECM	Inflation negatively affects stock prices while real interest rates positively affect stock prices. There is cointegration among the three variables.
El-Masry, and Badr (2021)	Egypt	Daily from 07/09/2009 to 01/09/2016	Dependent variable: stock market performance which is measured by Egypt's three main stock and market capitalization. Independent variable: exchange rate	VAR model and Granger causality tests.	A causal relationship exists from the exchange rate to most stock market indexes at the 10% level in the pre-2011 revolution period. The same exists from the exchange rate to market capitalization during the same period. In the post revolution period, there is no causal relation from the exchange rate to stock indexes or market capitalization. However, there is no long-run cointegration between the two variables

Table 1. Continue....

Study	Countries/ companies examined	Period estimated	Dependent variable and independent variables estimated	Methodology used	Main findings (with a focus on Egypt's results if the study is conducted on Egypt and other countries)
Kassouri and Altıntaş (2020)	Turkey	2003M to 2018M12	Dependent variable: Share price index. Independent variables: real effective exchange rate, broad monetary aggregate, industrial production index, interbank interest rate	EnglE-Granger cointegration, TAR and M-TAR models, NARDL	Long-run cointegration exists with significant asymmetric adjustment between stock prices and real effective exchange rates in Turkey. While the Lira depreciation effect is statistically insignificant, the long-run effect of Lira appreciation negatively affects stock prices. Thus there is evidence of the incomplete exchange rate pass-through in Turkey.
Mohamed and Sahin (2020)	Kuwait	2002M6-2018M3	Dependent variable: Kuwait Stock Exchange Index (KSE) exchange rate, consumer price index, money supply, crude oil prices, discount rate	NARDL	Appreciation of the Kuwaiti Dinar hurts stock prices in the long-run, but depreciation is not statistically significant, so there is a case of long-run asymmetry. No short-run asymmetry exists between the exchange rate and stock prices
Moussa, and Delhoumi (2022).	Selected MENA	Daily data from June 1998 to June 2018.	Dependent variable: stock returns computed from the stock price index. Dependent variable: real exchange rate and real interest rates.	NARDL	For Egypt, there is no asymmetric impact of real interest rate in the short run; but the results indicate the asymmetric response of return to exchange rate shocks in return to exchange rate shocks in the short run. There is evidence of long run asymmetry running from the exchange rate to the index return.
Ndlovo et al, (2018)	South Africa	1981Q1 to 2016 Q4	Dependent variable: Johannesburg Stock Exchange. Independent variables: inflation, money supply growth, interest rates, and USD/ZAR exchange rate	Co-integration tests, VECM, variance decomposition and impulse response functions	In the long run, interest rates, money supply, and inflation vary directly with the share price, while the exchange rate changes inversely with stock prices. Unidirectional causality was found running from exchange rates and interest rates to stock prices
Nusair and Olson (2022)	G7 countries	Monthly data. Period differed as per country	Dependent variable: End-of-month closing prices for the seven national stock indexes Independent variables: Nominal effective exchange rate	ARDL, NARDL, Johansen Cointegration test, Granger Causality test	The flow-oriented approach - positing that exchange rates affect stock prices and the portfolio balance approach - assuming that stock prices affect exchange rates - are supported in the short run. Neither model is supported in the long run using linear ARDL models, but the nonlinear ARDL model shows evidence advocating the portfolio balance approach in some G7 countries
Omran, and Pointon (2001)	Egypt	1980-1998 Annual	Dependent variable: stock market activity and liquidity Dependent variable: inflation	Co-integration analysis through error correction mechanisms (ECM).	An inverse relationship between the inflation rate and both stockreturns in Egypt in the short and long runs.
Omran (2003).	Egypt	Annual 1980/81 to 1997/98	Dependent variable: stock price Dependent variables: real interest rate	Granger Causality tests, Error correction mechanisms (ECM).	Interest rates have an impact on stock market performance.
Phong et al. (2018)	Vietnam	2001M4 to 2017M10	Dependent variable: stock index of Vietnam (VNIndex) Dependent variables: exchange rate, interest rate, money supply and inflation	Error Correction Model (ECM) based on NARDL	Money supply has a positive impact on stock prices in the short and long runs. The exchange rate demonstrates insignificant effects on VNIndex. Also, inflation hinders VNIndex almost linearly.

Study	Countries/ companies examined	Period estimated	Dependent variable and independent variables estimated	Methodology used	Main findings (with a focus on Egypt's results if the study is conducted on Egypt and other countries)
Saidi, et al. (2021)	Indonesia	2006M1-2019M7	Dependent variable: stock index of Indonesia Dependent variables: exchange rate, volatility	ARDL and NARDL	The results showed that in the short term, the exchange rate has a symmetry effect on stock prices, while volatility lacks such a symmetric effect. Besides, in the long run, the exchange rate and the volatility lack symmetric and asymmetric impacts on stock prices.
Salisu and Vo (2021)	Nine high-interest rate and eight low-interest rate countries	January 9, 2011 to November 1, 2020 (data weekly and monthly)	Dependent variable: stock index. independent variables: exchange rate, interest rate, oil prices	Panel ARDL	There is a disparity between low and high interest rate environments in relation to short-run and long-run results of the relation between exchange rate and stock prices. Results show that the low-interest rate group displays long run positive relation while the high-interest rate group exhibits short-run negative relationship between exchange rate and stock prices
Sikhosana and Aye (2018).	South Africa	Monthly data from 1996 to 2016	Dependent variable: JSE All Share Index. Independent variable: real Rand/US$ exchange rate	EGARCH model, asymmetric GARCH models (GJR GARCH and APARCH)	A bi-directional volatility spillover effect exists between the two markets in the short-run. Negative shocks in the exchange rate market have a greater impact on volatility in the stock market, while positive shocks in the stock market have a greater impact in transmitting volatility to the exchange rate market.
Sui and Sun (2016)	BRICS	1999M1 – 2014M8 (but differs according to the BRICS country)	Dependent variable: stock returns. Independent variable: exchange rate, interest differential, S& P500	ARDL, VAR, Variance decomposition, Impulse response functions	Significant spillover impacts take place from foreign exchange rates to stock returns in the short-run, but not vice versa. U.S. S&P 500 shocks significantly influence stock markets in China, Brazil, and South Africa.

Source: Compiled by the author and listed in alphabetical order.

the variable also taken in natural logs.[3] The International Financial Statistics (IFS) of the International Monetary Fund (IMF) is the main source of the data. However, recent figures were obtained from the Central Bank of Egypt (CBE) website according to the end-of-month rate (as the rates are published daily). LCPI: is the natural log of the monthly consumer price index (CPI) in Egypt. Data was also gathered from both the International Financial Statistics (IFS) of the International Monetary Fund and the Central Bank of Egypt (CBE) (for the recent figures not recorded in the IFS). LGDPPC is the natural log of real per capita GDP with the raw data obtained from the World Bank World Development Indicators.[4] LEGX30 is the natural log of the end-of-month closing prices for Egypt's main stock price index – the EGX30 – obtained from the Egyptian Stock Exchange website.

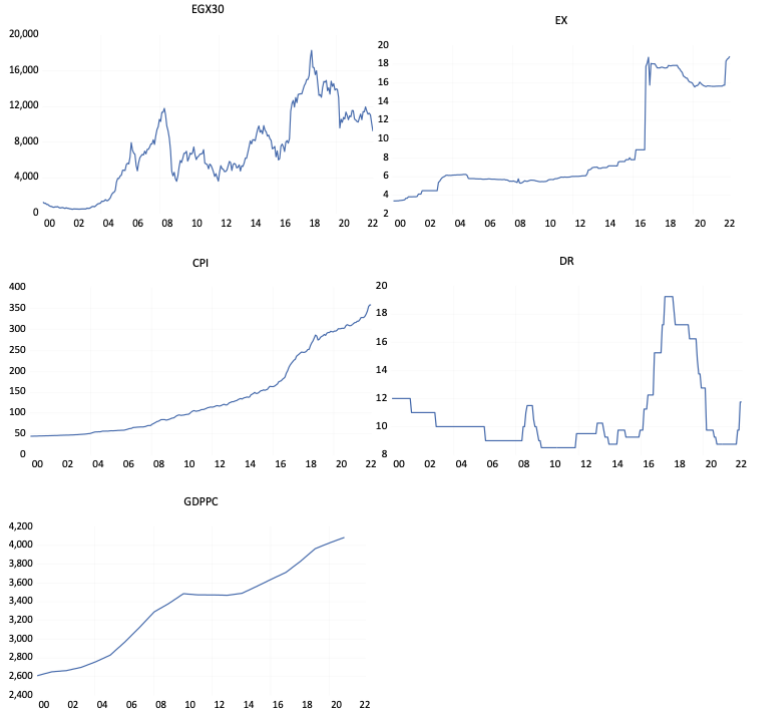
Visual inspection of the evolution of stock prices, exchange rate and consumer price index in Egypt in Figure 1 shows that there is a degree of co-movement among them. Besides, the time series of the exchange rate of the Egyptian Currency (LE) equivalent to one US dollar, and the main stock price index of the Egyptian stock exchange (EGX30) pinpoint how periods of harsh devaluations at the beginning of 2003 and the end of 2016 were accompanied by hikes in the stock index during or

3. Many studies in the literature incorporate real interest (lending interest rate adjusted for inflation) rather than nominal interest in the model. It is worth noting that we originally incorporated the real interest rate in our model. However, estimating the model highlighted the insignificance of the real interest variable both in the short run and long run. The redundant variable test also confirmed our results. Replacing the real interest with the nominal interest rate (represented by the discount rate) proved the significance of the variable in the short run in the ARDL model.

4. GDP per capita is defined as the "gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for the depreciation of fabricated assets or for the depletion and degradation of natural resources. Data are in constant 2015 U.S. dollars" (World Bank, n.d.). As the data is provided annually we converted it to monthly data through interpolation using Eviews software. Eviews provides several interpolating techniques for converting low-frequency data into high-frequency data. Our study used the linear interpolating method.

immediately after the devaluations.

Figure 1: Evolution of stock prices, exchange rate and consumer price index in Egypt 2000M1-2022M6



Sources: EGX30 is the end-of-month closing price for Egypt's main stock price index – the EGX30 – obtained from the Egyptian Stock Exchange website. EX is the monthly nominal exchange rate or the value of $1 in terms of LEs. DR is the monthly discount rate stipulated by the Central Bank of Egypt - obtained from The International Financial Statistics (IFS) of the International Monetary Fund (IMF) However, recent figures were obtained from the Central Bank of Egypt (CBE) website according to the end-of-month rate (as the rates are published daily). CPI: is the monthly consumer price index (CPI) in Egypt. Data was also gathered from both the International Financial Statistics (IFS) of the International Monetary Fund and the Central Bank of Egypt (CBE) (for the recent figures not recorded in the IFS). GDPPC is the real per capita GDP obtained from the World Bank World Development Indicators.

4.2 Methodology

We begin first by investigating the descriptive statistics of the variables in our model, followed by a correlation analysis. We then proceed by examining whether our variables are integrated of order I(0) or order I(I) using unit root tests (with and without structural breaks) to guarantee their appropriateness to the application of the ARDL estimation technique, which is unsuitable if any of the variables is integrated of order (2). To investigate the asymmetric links between stock prices and exchange rate, interest rate and the price level for Egypt, we first examine the short-run and long-run relationship between stock prices and the three aforementioned determinants using the linear autoregressive distributed lag (ARDL) model of Pesaran et al. (2001). Following this, we conduct a BDS independence test (created by Broock et al. in 1996) to check for the existence of a nonlinear relation among our variables. If nonlinearity is confirmed, we then adopt the nonlinear ARDL (henceforth NARDL) model of Shin et al. (2014) and allow for both short-run and long-run asymmetries in the relationship between stock prices and the three determinants. The asymmetries are introduced by differentiating between first, currency appreciations and depreciations, second, positive and negative changes in the interest rate, and third, positive and negative changes in the price level, all with respect to their impact on stock prices. As will be explained later in the next section,

LGDPPC was excluded from the model as the variable was only stationary at second differences. Besides, the exclusion of LGDPPC was further supported by the fact that a relatively high level of multicollinearity existed between LGDPPC and LCPI (Table 3); since per capita income appeared in much fewer studies as an important determinant of stock prices compared to inflation, we were reinforced to exclude the former rather than the latter. Based on the stock price theories in addition to the literature, our general model is constructed as follows:

$$LEGX30_t = a_0 + a_1 LEX_t + a_2 LDR_t + a_3 LCPI_t + \nu_t \quad (1)$$

where *LEX*30 is the Egyptian stock market index EGX30, LEX is the exchange rate of $1 in terms of the LE at time *t*, *LDR* is the monthly discount rate at time *t*, and CPI is the consumer price index at time *t* respectively (all variables in log forms as previously mentioned), while ν is the error term. It is worth clarifying that an increase in LEX represents a depreciation of the Egyptian pound or an appreciation of the dollar.

To distinguish between the short-run and the long-run equations, the previous equation can be written in an Error Correction Model (ECM) format. Specifically, the short-run equation can be written as:

$$\Delta LEGX30_t = \beta_0 + \sum_{k=1}^{n} \delta_k \Delta LEGX30_{t-k} + \sum_{k=1}^{n} \phi_k \Delta LEX_{t-k} + \sum_{k=1}^{n} \lambda_k \Delta LDR_{t-k} + \sum_{k=1}^{n} \gamma_k \Delta LCPI_{t-k}$$
$$+\beta_1 LEGX30_{t-1} + \beta_2 LEX_{t-1} + \beta_3 LDR_{t-1} + \beta_4 LCPI_{t-1} + \beta_5 DUMMY_t + \varepsilon_t \quad (2)$$

The short-run coefficients are those attached to the first differenced variables while the long-run coefficients are attached to the lagged-level variables. $DUMMY_t = (DUMMY_{1t} ..... DUMMY_{jt})$ is a dummy variable that takes the value 1 if the observation pertains to the j_n^{th} period and 0 otherwise. The addition of a dummy variable is explained fully in the next section. Variables are cointegrated if their linear combination is stationary and they have a common stochastic trend. According to Pesaran et al (2001), a standard F-test with lower and upper critical bounds is used to test for cointegration of the mixed I(0) and I(1) variables, which can either be endogenous or exogenous in the ARDL model. The linear combination of the lagged level variables can be replaced by the lagged Error Correction Term (ECT_{t-1}), (equation 3) which explains how the variables adapt in the long run as a reaction to divergence from the long run equilibrium resulting from short-run shocks.

$$\Delta LEGX30_t = \beta_0 + \sum_{k=1}^{n} \delta_k \Delta LEGX30_{t-k} + \sum_{k=1}^{n} \phi_k \Delta LEX_{t-k} + \sum_{k=1}^{n} \lambda_k \Delta LDR_{t-k} + \sum_{k=1}^{n} \gamma_k \Delta LCPI_{t-k}$$
$$+\beta_5 DUMMY_t + \omega_1 ECT_{t-1} \quad (3)$$

Nevertheless, a conventional linear ARDL assumes that the responses of the dependent variable to any changes from the independent variables are symmetric (Pesaran et al, 2001), meaning that opposite changes result in identically opposite responses, which is not always the case, especially concerning stock prices as evident from the previous literature. Accordingly, we employ the NARDL model introduced by Shin et al (2014), which expands the linear ARDL model to account for potential asymmetries in the response of the dependent variable to changes in the independent variables. Following Shin et al (2014), the asymmetric long-run relationship can be written as follows:

$$LEGX30_t = a_0 + \delta^+ LEX_t^+ + \delta^- LEX_t^- + \sigma^+ LDR_t^+ + \sigma^- LDR_t^- + \theta^+ LCPI_t^+ + \theta^- LCPI_t^- + \varepsilon_t \quad (4)$$

Where LEX_t^+ and LEX_t^- are partial sum processes of positive and negative changes in *LEX*; LDR^++are partial sum processes of positive and negative changes in *LDR*, while $LCPI_t^+$ and $LCPI_t$ are partial

sum processes of positive and negative changes in *LCPI*. They are calculated as follows:

$$LEX_t^+ = \sum_1^t \Delta LEX_t^+ = \sum_i^t \max(\Delta LEX_i, 0) \tag{5}$$

$$LEX_t^- = \sum_1^t \Delta LEX_t^- = \sum_i^t \min(\Delta LEX_i, 0) \tag{6}$$

$$LDR_t^+ = \sum_1^t \Delta LDR_t^+ = \sum_i^t \max(\Delta LDR_i, 0) \tag{7}$$

$$LDR_t^- = \sum_1^t \Delta LDR_t^- = \sum_i^t \min(\Delta LDR_i, 0) \tag{8}$$

$$LCPI_t^+ = \sum_1^t \Delta LCPI_t^+ = \sum_i^t \max(\Delta LCPI_i, 0) \tag{9}$$

$$LCPI_t^- = \sum_1^t \Delta LCPI_t^- = \sum_i^t \min(\Delta LCPI_i, 0) \tag{10}$$

Where $LEX^{++}$and $LEX_t^-$are positive and negative changes in the foreign exchange rate implying domestic currency depreciation and appreciation respectively; the LDR_A^+_and $LDR_t^-$are positive and negative changes in the interest rate respectively, while $LCPI^+$ and $LCPI_t$ are positive and negative changes in the consumer price index. The $\delta^+$and δ^- are long-run parameters that reflect the rise of the $US to the Egyptian LE (domestic currency depreciation) and fall (domestic currency appreciation) respectively; the $\sigma^+$and $\sigma^-$are long-run parameters that reflect interest rate rises and falls respectively, while θ^+ and $\theta^-$are long-run parameters that reflect domestic price level increases and decreases respectively. By replacing *LEX*, *LDR* and *LCPI* in the linear ARDL model of equation (2) by $LEX_t^+$and LEX_t^-(the partial sum processes of positive and negative changes in *LEX*) LDR^+_and LDR^-(the partial sum processes of positive and negative changes in *LDR*) and $L_{CPI^+}^+$and $LCPI_t$ (the partial sum processes of positive and negative changes in *LCPI*) respectively, we obtain the NARDL model:

$$\Delta LEGX30_t = \lambda_0 + \lambda_1 DUMMY_t + \sum_{k=1}^n \sigma_k \Delta LEGX30_{t-k} + \sum_{k=1}^n \eta^+ \Delta LEX_{t-k}^+ + \sum_{k=1}^n \eta^- \Delta LEX_{t-k}^-$$

$$+\sum_{k=1}^n \mu^+ \Delta LDR_{t-k}^+ + \sum_{k=1}^n \mu^- \Delta LDR_{t-k}^- + \sum_{k=1}^n \pi^+ \Delta LCPI_{t-k}^+ + \sum_{k=1}^n \pi^- \Delta LCPI_{t-k}^- + \rho_k LEGX30_{t-1}$$

$$+\psi^+ LEX_{t-1}^+ + \psi^- LEX_{t-1}^- + \varpi^+ LDR_{t-1}^+ + \varpi^- LDR_{t-1}^- + \tau^+ LCPI_{t-1}^+ + \tau^- LCPI_{t-1}^- + \varepsilon_t \tag{11}$$

According to Shin (2014), the positive and negative fractionalizations of the independent variable can display the nonlinearities in the long run and short run in the ARDL model. The nonlinear cointegration between the dependent and independent variables can be tested using the F-statistics with the null hypothesis assuming no cointegration $(\rho = \psi^+ = \psi^- = 0)$, $(\rho = \varpi^+ = \varpi^- = 0)$ and $(\rho = \tau^+ = \tau^- = 0)$ against the alternative hypothesis of cointegration. To test for the long-run asymmetric effect, we test for the long run-symmetric effect of rises and falls in the exchange rate, or whether or not $\psi^+ = \psi^-$where $\psi^+ = \psi^+/\rho$ and $\psi^- = \psi^-/\rho$; the existence of the null hypothesis of long run symmetric effect of rises and falls of the interest rate, or whether $\varpi^+ = \varpi^-$where $\omega^+ = \varpi^+/$

ρ and $\varpi^- = \varpi^-/\rho$; and the existence of the null hypothesis of long-run symmetric effect of rises and falls of the price level, or whether or not $\tau^+ = \tau^-$where $\tau^+ = \tau^+/\rho$ and $\tau^- = \tau^-/\rho$. Rejecting the null hypothesis in any or all indicates the existence of long-run asymmetries in the impact of the two variables on stock prices in Egypt.

On the other hand, to test for short-run asymmetries we test the null hypothesis of a short-run symmetric effect of our two explanatory variables. In other words, we test the null hypothesis of symmetry in short-run impact of the rise and fall in the US dollar relative to the Egyptian LE on Egypt's stock market prices; or

$$\sum_{k=1}^{n} \eta^+ = \sum_{k=1}^{n} \eta^-$$

and the null hypothesis of symmetry in short-run impact of the rise and fall in the interest rate on stock prices; or

$$\sum_{k=1}^{n} \mu^+ = \sum_{k=1}^{n} \mu^-$$

and the null hypothesis of symmetry in short-run impact of the rise and fall in the price level on stock prices; or

$$\sum_{k=1}^{n} \pi^+ = \sum_{k=1}^{n} \pi^-$$

Rejecting one or the three null hypotheses indicates that there are short run asymmetric effects in one or all variables. In addition, if the partial sum processes in one or the two independent variables take different lags, this will imply that there is an asymmetry in short-run adjustments toward the long-run equilibrium.

5. Empirical analysis

5.1 Descriptive statistics

We begin with a preliminary investigation of our time series by looking at the descriptive statistics (Table 2) which, as mentioned earlier, incorporated initially real GDP per capita.

Table 2. Descriptive statistics

	EGX30	EX	CPI	DR	GDPPC
Mean	6931.456	8.631667	138.4684	10.89032	3326.241
Median	6633.990	6.085000	107.6295	10.00000	3470.309
Maximum	18295.57	18.83000	359.0833	19.25000	4083.625
Minimum	448.0200	3.410000	44.56828	8.500000	2610.476
Standard deviation	4435.473	4.910935	93.85946	2.726919	445.1976
Skewness	0.241565	1.032539	0.865126	1.680458	-0.166820
Kurtosis	2.247287	2.345977	2.365096	4.875595	1.881429

Source: Author's calculations

As apparent from Table 2, there are considerable differences between the mean and the median concerning the exchange rate and the consumer price index, as in both cases the mean is remarkably larger than the median. This may sometimes imply that the mean is closer to the tail in these right-skewed distributions, reflecting the considerable increases in the price of the US$ relative to the LE, and Egypt's CPI, in recent months compared to the early months. The variation in the three variables is high as shown by the wide variety in their standard deviations, which supports taking

the natural logs of the variables to mitigate the large disparities. Kurtosis values are slightly less than 3 in all variables except for the discount rate, implying that the distributions of the three variables are somewhat flat with thinner-than-normal tails.

5.2 Correlation analysis

Testing for multicollinearity among the dependent variables (table 3) indicates that the variables do not display perfect multicollinearity. The correlation matrix also displays the importance of the explanatory variables in explaining stock prices in Egypt, as they all have a significant correlation with the dependent variable (stock price index).

Table 3. Correlation analysis

	EGX30	EX	CPI	DR	GDPPC
EGX30	1.0000				
EX	0.836161***	1.0000			
CPI	0.839350***	0.927036***	1.0000		
DR	0.537598***	0.745121***	0.561355***	1.0000	
GDPPC	0.865983***	0.766905***	0.902764***	0.331041***	1.0000

Source: Author's calculations

5.3 Unit root tests

Testing for the stationarity of the variables is fundamental prior to estimating our model using ARDL or NARDL, as such techniques are suitable only when the variables are stationary at levels or at first differences. Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests (table 4) both indicate that the variables are nonstationary at levels but stationary at first differences, except for GDPPC which is stationary only at second differences. Therefore we exclude that variable from our model especially since it has proved in previous studies to be relatively less significant compared to our other selected variables. Accordingly, we are confident that none of our remaining variables are I(2).

Table 4. Unit root tests

Variable	ADF test				PP test			
	Level		First difference		Level		First difference	
	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend	Intercept	Intercept and trend
LEGX30	-1.147559	-0.856755	−14.05181***	−14.06831***	-1.271194	-1.388879	−14.49931***	−14.48824***
LEX	-0.531808	-1.727922	−16.71467***	−16.68753***	-0.531886	-1.685782	−16.71152***	−16.68474***
LCPI	1.426109	-2.762552	−10.57529***	−10.76847***	1.670088	-2.761807	−10.52617***	−10.65334***
LDR	-1.372189	-1.570272	−9.090705***	−9.086545***	-1.812082	-2.050255	−15.68127***	−15.67290***
LGDPPC	-1.186696	-2.914648	-1.823042	-1.864817	-0.684351	-1.107836	-1.846088	-1.886607

Sources and notes: *, **, *** denotes rejection of the null hypothesis at the 1%, 5%, and 10% significance level. The number of lags is selected by the Schwarz info criterion with a maximum lag of 15. The bandwidth for the PP test is selected automatically by Newey-West Bandwidth, using the Barlett Kernel spectral estimation method. LEGX30, LEX and LCPI are stock price index, exchange rate, and the price level respectively. Variables are in logarithmic form. The 1%, 5%, and 10% critical values for the ADF and PP tests are -3.45, -2.87, and -2.57 for the test with an intercept only, and -3.99, -3.42, and -3.13 for an intercept and trend.

Since the graphical representations of our variables (fig. 1) reveal the possibility of structural breaks (especially during and after the severe devaluation of the LE in November 2016), we also test for unit roots with structural breaks. As Perron (1989) points out, conventional unit root tests can be biased toward a false unit root null when the data are trend stationary with a structural break. Results of breakpoint unit root tests appear in Table 5.

Table 5. Unit root tests with structural breaks

	Level	First difference
LEGX30	-4.419589	−15.38678***
LEX	−6.761516 ∗ ∗	−17.07325***
LDR	-4.194865	−17.17652***
LCPI	-4.350201	−11.91081***

Sources and notes: *, **, *** denotes rejection of the null hypothesis at the 1%, 5%, and 10% significance level. The trend specification was Intercept and trend, and the breaking was assumed in the Intercept and trend. The number of lags is selected by the Schwarz info criterion with a maximum lag of 15. Breakpoint selection was chosen according to the Dickey-Fuller min-t test. LEGX30, LEX, LDR, and LCPI are the stock price index, the exchange rate, the interest rate and the price level respectively. Variables are in logarithmic form. The 1%, 5%, and 10% critical values are -5.719, -5.175, and -4.893 for the test.

The breakpoint unit root test displayed a somewhat different result, with LEX stationary at levels. This result further advocates the use of the ARDL which as mentioned before is suitable when variables are integrated of order I(0) or I(1). The tests also confirm the date of the breakpoints that start in LEX and LCPI in November 2016. Accordingly, we construct a dummy variable which starts from that date and extends till 2020M1. During that period the two variables changed intercepts and slopes; therefore, the dummy variable will take the value 1 in the afore-mentioned period and 0 otherwise.

5.4 Nonlinearity tests

The NARDL technique is currently widely used in testing non-linear relationships (see, for example, Sharma and Kautish, 2019). However, prior to estimating our models using the NARDL technique, we conduct a BDS independence test (created by Broock et al. in 1996) to check for nonlinearity. This test is now conventionally done in the literature on NARDL as a prior examination of the existence of nonlinearity in each of the selected variables (See for example the studies by Sharma and Kautish (2020), Mujtaba et al (2020) and Jiao et al (2021)). The results of the BDS test applied to our time series appearing in Table 6 reject the null hypothesis that our time series variables are identically and independently distributed, which supports our choice of the NARDL model.

Table 6. The Results of the BDS Test for Nonlinearity

BDS Statistics Series	Dimension 2	Dimension 3	Dimension 4	Dimension 5	Dimension 6
LEGX30	0.203023***	0.346478***	0.446947***	0.517276***	0.566064***
LEX	0.202595***	0.341748***	0.437333***	0.503338***	0.549905***
LDR	0.195389***	0.329269***	0.421562***	0.483055***	0.622528***
LCPI	0.205464***	0.348543***	0.448761***	0.519347***	0.569518***

Source: Author's calculations. ***denotes the rejection of the null hypothesis that the residual is iid at the 1% significance level.

5.5 Results

5.5.1 The ARDL models

To probe the effect of the exchange rate, interest rate, and the price level on stock prices and determine whether their impacts are symmetric or asymmetric both in the short and long run,

we estimate the ARDL and NARDL models in equations (1) to (14). We start first with a more general model where we incorporate the three independent variables (model 1). We then follow it by constructing a more parsimonious model (model 2) that exhibits almost the same results but overcomes some diagnostic issues. We allow a maximum number of lags of 12 lags with the number of lags automatically selected using the Akaike information criterion (AIC). Results of the long-run and short-run coefficients estimated by the ARDL model are reported in Table 7, followed by the CUSUM and the CUMSUMSQ tests of model stability in Figures 2 and 3.

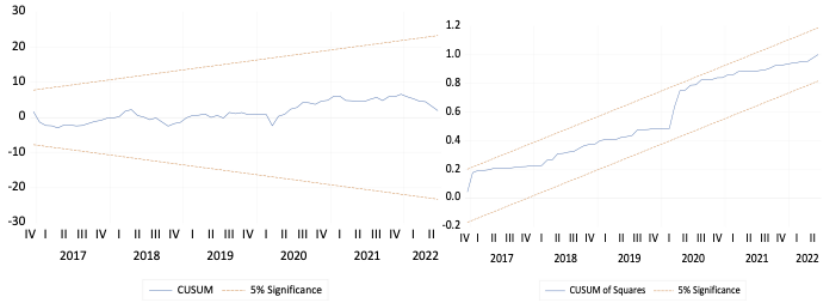
Focusing on the short-run effects of the exchange rate and the price level on stock prices, we find a contemporaneous positive impact of a rise in LEX (appreciation of the US$ or depreciation of the LE) on stock prices, whereas there is no significant impact of the price level on stock prices in the short run. This indicates that the LE's depreciation represents an inducement for foreign firms to buy stocks at cheaper prices, which leads in turn to higher cash flows, higher stock demand, and higher stock prices.

Table 7. Linear ARDL coefficient estimates and diagnostic checks

Short run results of ARDL models		
Dependent variable LEGX30	Model 1	Model 2
Constant	2.172023	2.011871***
Trend	0.004307	0.004130***
D(LEX)	0.323850***	0.321356 * **
D(LEX(–1))		-0.163675
D(LDR)	-0.016086	
D(LDR (-1))	–0.309482 * *	
D(LDR(–2))	-0.223783	
D(LCPI)	0.265625	0.253103
DUMMY	0.074712***	0.054811 * **
Long run results of ARDL model		
Dependent variable D(LEGX30)	Model 1	Model 2
LEX	2.533341**	2.540073*
LDR	-0.935780	
LCPI	–14.49344***	–14.46181***
Diagnostic checks		
CointEq(-1)*	–0.037457 * **	–0.036054 * **
Adj. R-sq	0.178038	0.156178
Serial correlation LM test (Obs.R^2)	12.08011	12.85592
Breusch-Pagan-Godfrey heteroskedasticity test (Obs.R^2)	26.66584	10.13341
CUSUM	Stable	Stable
CUSUMSQ	Stable	Stable
A R D L	$(1, 1, 3, 1)$	$(1, 2, 1)$
F-Bounds Test	10.05732 * **	12.07669***
Observations	267	268
Model Selection	Akaike	Akaike

Source: Author's calculations. *** indicates a 1% significance level, **indicates a 5% significance level, * indicates a 10% significance level. The F-Bounds test tests the null hypothesis of no-cointegration against the alternative of cointegration. LM is the Breusch- Godfrey serial correlation test with a Chi-square distribution with 12 degrees of freedom. The CUSUM test is the cumulative sum of recursive residuals and the CUSUMQ test is the cumulative sum of squares of recursive residuals and both are used to estimate the stability of the coefficients

Figure 2: CUSUM and CUSUMSQ of the ARDL model 1



Source: Author's calculations

Figure 3: CUSUM and CUSUMSQ of the ARDL model 1

Source: Author's calculations

Concerning the interest rate, results show that there is a significant negative relation between LDR and stock prices in the short run, indicating that an interest rate rise leads to a significant decline in stock prices after a one-month lag. The dummy variable representing the period of the severe devaluation of the LE in November 2016 (for a three-month period) after which it appreciated gradually (opposite to its natural trend) until the first month of 2020, is very significant. There is no significant impact of a rise in the price level in the short run.

Focusing on the long run, we find evidence of cointegration from the F-statistics bound test which is significant at the 1% significance level. Cointegration is also confirmed from the ECTt-1 term which is both negative and significant. Diagnostic tests show that the models do not suffer from serial correlation and heteroskedasticity and are quite stable as manifest in the CUSUM and CUSMSQ figures. As evident from the results, in the long run, a 1% depreciation of the pound leads to a 2.5% rise in the stock index (at the 10% significance level) while a 1% rise in the consumer price index leads to a 14% decline in the stock market index in both models. There is no significant impact of the interest rate in the long run.

5.6 The NARDL models

We now assess whether there is an asymmetry in the impact of the positive versus the negative shock in each of the independent variables through the application of the NARDL models (table 8). Estimating model 1 first reveals that there are no short run positive or negative coefficients of the interest rate as such variables (differenced LDR) did not appear in the model. In the long run, both the positive and negative shocks from LDR on stock prices were insignificant. The coefficients of the other two independent variables – LEX and LCPI – were nearly identical in the two models. Furthermore, since model 1 – although stable and free from serial correlation – suffered from model misspecification and heteroskedasticity as apparent from the results of the Ramsey RESET and

Breusch-Pagan-Godfrey heteroskedasticity tests respectively, we therefore focus our estimates on our second parsimonious and more preferred model (model 2), which excludes the insignificant interest rate from the model, but bears almost the same coefficient values and the significance levels. Model 2 therefore acts as a robustness check on the significance of the other two independent variables – LEX and LCPI. Short and long run results of the NARDL models appear in table 8, followed by the CUSUM and CUSUMSQ stability tests graphs of the two models in figures 4 and 5.

Figure 4: CUSUM and CUSUMSQ of the NARDL model 1

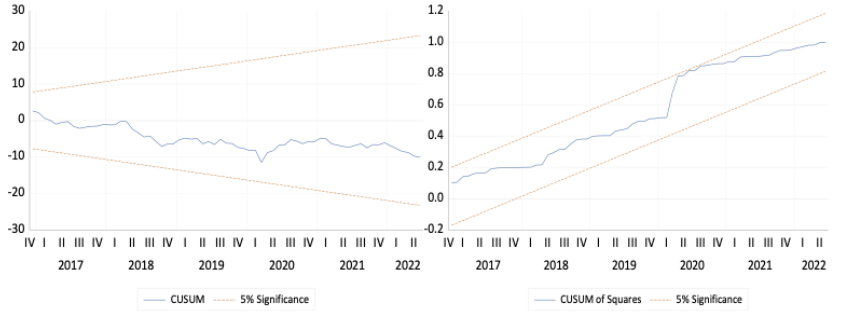
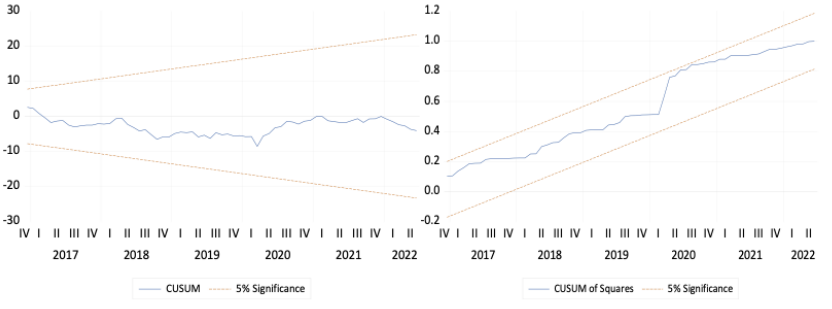


Figure 5: CUSUM and CUSUMSQ of the NARDL model 2



A glance at Table 8 on the results of NARDL models discloses a considerable asymmetric effect of a positive and a negative shock in the US$ relative to the LE in the very short run. In other words, in the very short run (the contemporaneous impact), a 1% positive increase in the US$ (depreciation of the LE) results in a 0.3% rise in the stock market price index; whereas a 1% decrease in the US$ relative to the LE (appreciation of the Egyptian pound) leads to a 0.9% fall in the stock price index. Yet the latter is only significant at the 10% significance level. It thus appears that the appreciation of the Egyptian pound may have a greater contemporaneous negative impact on stock market prices than the positive contemporaneous impact the depreciation of the pound has on stock prices. However, the contemporaneous positive impact of the pound's depreciation on stock prices soon turns to a negative impact on stock prices in the short run and specifically in months one and three after the shock. In the long run, the impact of a positive shock in the dollar (depreciation of the pound) is extremely significant with a 1% rise in the dollar value leading to a nearly 2% rise in stock prices.

On the other hand, there does not appear to be any impact on stock prices from either positive or negative shocks in LCPI in the short run, as the coefficient from the positive shock is insignificant while the impact of a negative shock is nonexistent. However, in the long run, the impact of a positive shock in the price level (inflation) has a very significant negative impact on stock prices since a 1% rise in LCPI results in a 12% fall in the stock price index. The impact of a negative shock

Table 8. NARDL coefficient estimates and diagnostic checks

Short run results of the NARDL model		
Dependent variable		
LEGX30	Model 1	Model 2
Constant	0.200518 * **	0.223688***
Trend	0.004769 * **	0.005126***
D (LEX$^+$)	0.271550**	0.319215***
D (LEX$^+$(–1))	–0.200324*	–0.182587*
D (LEX$^+$(–2))	-0.161745	-0.148409
D (LEX$^+$(–3))	–0.413117 * **	–0.410921***
D (LEX$^-$)	-0.915913	–0.999178*
D (LCPI$^+$)	0.634373	0.743370
DUMMY	0.118849 * **	0.066257****
Long run results of the NARDL model		
Dependent variable D(LEGX30)	Model 1	Model 2
LEX $^+$	1.489589	2.054087**
LEX $^-$	4.925227	0.949914
LDR$^+$	-0.132152	
LDR$^-$	-3.386045	
LCPI$^+$	–11.91534**	–12.32218***
LCPI$^-$	-1.068819	-9.881906
Diagnostic	checks	
	Model 1	Model 2
CointEg(-1)*	–0.048081***	–0.051799***
Adj. R-sq	0.186797	0.177355
Serial correlation LM test (Obs.R^2)	12.31991	14.32461
Ramsey RESET test (t-statistic)	3.519775[0.0005]	0.213704[0.8310]
CUSUM	Stable	Stable
CUSUMSQ	Stable	Stable
Breusch-Pagan-Godfrey heteroskedasticity test (Obs. R^2)	25.30563	21.41089*
F-Bounds Test	6.413219***	8.370588***
Observations	265	265
Model Selection	Akaike	Akaike

Source: Author's calculations. *** indicates 1% significance level, **indicates 5% significance level, * indicates 10% significance level. The F-Bounds test tests the null hypothesis of no-cointegration against the alternative of cointegration. LM is Breusch- Godfrey serial correlation test with a Chi-square distribution (2) with 13 degrees of freedom. RESET test is Ramsey's test for functional misspecification. It is distributed as 2 with 1 degree of freedom. P-values are in square brackets. The CUSUM test is the cumulative sum of recursive residuals and the CUSUMQ test is the cumulative sum of squares of recursive residuals and both are used to estimate the stability of the coefficients.

on LCPI is insignificant which also attests to the existence of long run asymmetry in the impact of changes in the price level on stock prices. All estimates are also stable as depicted by the CUSUM and the CUSUMSQ stability tests.

5.6.1 Wald tests

To confirm our results concerning the asymmetric impacts of our two variables we conduct Wald tests. Table 9 represents a summary of our Wald tests for LEX, LDR, and LCPI. The null hypothesis of the absence of symmetry in the impact of the exchange rate on stock prices in the short run is rejected at the 5% significance level, which confirms the asymmetric impact of the exchange rate in the very short run. However, concerning the price level, it is clear that the null hypothesis is not rejected, which confirms the nonexistence of asymmetry in the short run. Although the NARDL for model 1 showed that both the coefficients from a positive and negative shock in the interest rate are insignificant, we conducted a Wald test to test their asymmetry which confirmed the nonexistence of asymmetric effects in the short run.

Concerning the long run, the Wald test pinpoints the existence of symmetry in the impacts of a positive and negative shock of the exchange rate in the long run. This is somewhat strange as the coefficient from a 1% rise in LEX (depreciation of the LE) led to a significant 2.1% fall in stock prices (Table 7), whereas the coefficient from a 1% decrease in LE (appreciation of the LE) was insignificant. As for the interest rate and the price level we did not conduct Wald test for them as there were no positive or negative variables for LDR and no negative variables of LCPI in the long run. However, it is evident from Table 7 that there are long-run asymmetric impacts for LCPI on stock prices, as the coefficient for the positive LCPI shock is economically and statistically significant while that of a negative LCPI is not.

Table 9. Wald tests for long and short-run asymmetric effects

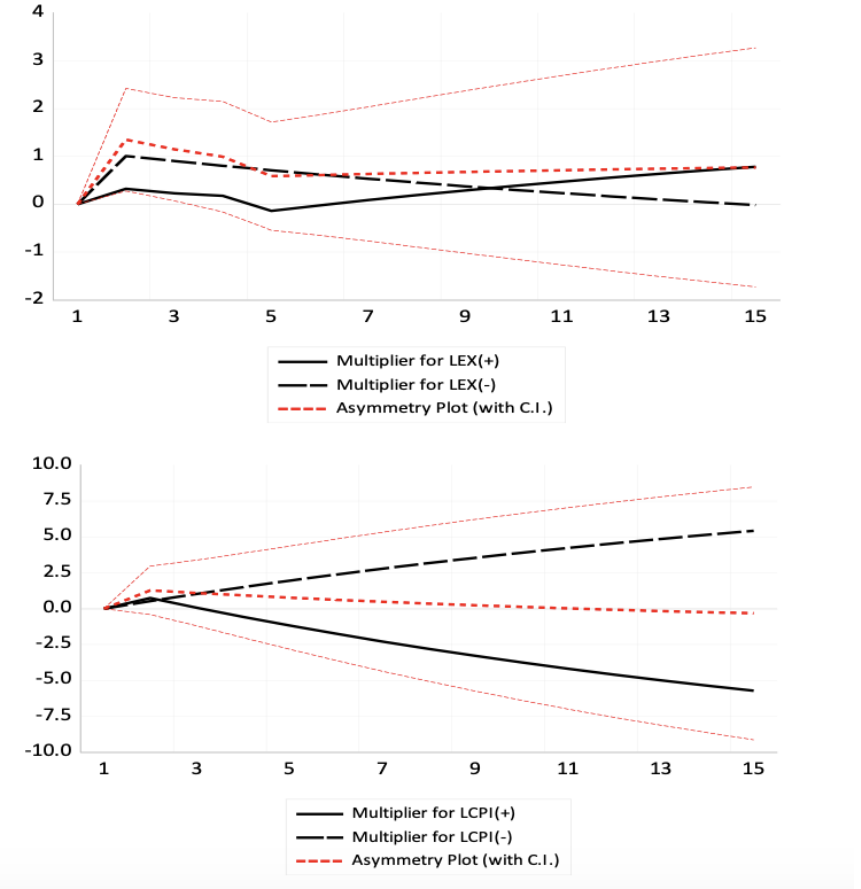
	Short run	Long run
t-Statistic	2.080543	0.376059
W_{LEX}	(0.0385**)	(0.7072)
Result	There is a significant asymmetric contemporaneous effect in the short run	No asymmetric effect in the long run
t-statistic	0.425607	
W_{LDR}	(0.6708)	
Result	No asymmetric effect in the short run. Coefficients from both positive and negative shock are insignificant	No asymmetric effect in the long run. Coefficients from both positive and negative shock are insignificant
t-statistic	-0.254280	
W_{LCPI}	(0.7995)	
Result	No asymmetric effect in the short run. Coefficients from both and positive and negative shock are insignificant	There is a clear asymmetric effect in the long run as only the coefficient from a positive shock is both economically and statistically significant

Source: Computed by the author

5.6.2 Dynamic multipliers

As a robustness check for our results, figure 6 depicts the dynamic multipliers of the estimated NARDL model. These multipliers assess the dynamic adjustments to equilibrium in response to a shock in the independent variable (Shin et al, 2014).

Figure 6: Dynamic multipliers of the NARDL model



Source: Author's calculations

The dynamic multipliers confirm the results from the NARDL models. The thick and dashed curves represent the reactions of stock price to a 1 percent increase and decrease in US$ relative to the LE respectively. The dotted curve represents the asymmetry curve which captures the linear combination of the dynamic multipliers related to the positive and negative shocks in the price of the US dollar relative to the Egyptian pound. The thin dotted curves represent the 95 percent confidence interval of the asymmetry curve. It is clear that the appreciation of the Egyptian pound has a greater contemporaneous negative impact on stock market prices than the positive contemporaneous impact the depreciation of the pound has on stock prices. However, after a few months, the impact of the pound's appreciation fades out, while the impact of the pound's depreciation results in a rise in stock prices in the long run. These results confirm the long-run results of NARDL model in Table 7 rather than the Wald results (which assumes symmetry in the long run) in Table 8, as the asymmetry curve, which captures the linear combination of the dynamic multipliers related to both the positive and negative shocks, rises above zero – and remains above it – as a result of the stronger impact of LEX+ compared to LEX-. The figures depict that a depreciation of the LE obviously raises stock prices

with a greater magnitude than the fall in stock prices resulting from an appreciation of the LE.

On the other hand, the impact of a positive shock in the price level seems to outweigh the impact of a negative shock in the same variable in the long run as apparent from the dotted curve that represents the asymmetry curve, and which captures the linear combination of the dynamic multipliers related to the positive and negative shocks. It is quite evident that an increase in the price level will depress stock prices in the long run.

6. Conclusion

This paper employs ARDL and NARDL models to examine the short-run and long-run relationship between stock prices on one hand and each of the exchange rate, the interest rate and the price level in Egypt. We conduct our ARDL and NARDL cointegration analyses by utilizing monthly time series variables from January 2000 until June 2022, and using Egypt's main stock market index EGX30 to account for stock prices. The appreciation of the LE may have a stronger instantaneous impact on stock prices than a depreciation of the LE; however, the impact of the appreciation is very short-lived, unlike that of a depreciation which has a very strong instantaneous impact in raising stock prices, in addition to the significant long-lasting effect of raising stock prices in the long run. Our results align with those of Adjasi, Biekpe, and Osei (2011) on the positive impact of the depreciation of the pound on stock market prices in Egypt, but are at odds with those of Abouwafia and Chambers (2015). They also partially align with El-Masry and Badr (2021) on the short-run impact of the exchange rate on stock prices in Egypt but challenge their long-run results on the non-existence of a long-run relation. It is worth noting that according to our results, the instantaneous positive impact of depreciation on stock prices may turn negative after the first and third months, probably due to expectations from foreign investors of further depreciation of the LE, implying lower costs of buying stocks at the local currency and therefore higher returns. Results as such provide some support to the ICAPM as investors may adjust their portfolios over time, especially in times of uncertainty. Moving to the long run, our result indicated that the impact of a devaluation of the LE on stock prices is very significant and positive, advocating the flow-oriented approach. However, according to Bahmani-Oskooee and Saha (2016), devaluation increases a country's competitiveness and boosts stock prices only when that country has more export-oriented firms than import-oriented ones. While Egypt's imports in 2021 (81.94 billion) far exceeded its exports in the same year (44.85 billion), yet Egypt's recent history always showed that after each devaluation foreign capital poured into the country's stocks. For example, after the severe devaluation of November 2016, the EGX30 index hit a five-year high with foreign investors and institutions, including Gulf-based investors, on the buying side (PWC, n.d.). Our results on the asymmetric impact of the exchange rate on stock prices in both the short and long runs thus partially or totally support those by Bahmani-Oskooee and Saha (2016; 2018), Cheah, Yiew and Ng (2017), Alsamara, Yaghi, and Mrabet (2020), Kassouri and Altıntaş (2020), Mohamed and Sahin (2020), Nusair and Olson (2022) and Saidi et al (2021).

Our findings, albeit from the AEDL model only, also revealed that there is a significant negative relation between the interest rate and stock prices in the short run, aligning with the results of Moussa, and Delhoumi (2022). No results appeared from the NARDL model whether symmetric or asymmetric related to the impact of interest rate on stock prices neither in the short nor in the long run, which attests to the temporary impact of interest rate on stock prices. In addition, a similar negative relation between the inflation rate and stock prices exists but in the long run. In fact, the impact of inflation is very depressing on stock prices in the long run. This conclusion should be taken in tandem with our previous finding on the exchange rate since a devaluation of the LE is usually accompanied – sometimes simultaneously – by the a rise in the price level. This happened in all previous episodes of the Egyptian pound devaluations, especially the severe devaluation of November 2016, which was followed by hikes in inflation amounting to 23.3%, 28.1%, 30.3% and 31.5% on a year-to-year basis on the months immediately following the devaluation (December

2016 to April 2017). In July 2017, inflation had risen by 33% compared to July 2016 (Central Bank of Egypt, n.d.). As the devaluation of the LE was the main cause behind inflation, which negatively affects stock prices, policymakers should consider the net impacts of the aggregate and cumulative effects of both variables in the long run. While the impacts of both variables were significant in the long run, the magnitude of the negative impact of inflation exceedingly outweighs the positive impact of the devaluation on stock prices. In other words, combined together, devaluation of the LE if coupled with ensuing inflation would decrease stock prices in the long run.

6.1 Implications for policymakers

One fundamental policy implication that can thus be drawn from our research is that while policymakers may be induced to devalue the LE to make stocks cheaper and more attractive to foreign investors, the inflation that succeeds the devaluation will deter investors, thereby outweighing the gains in the stock market from the devaluation. The reasons why higher prices may be a deterrent include higher import costs to the investor which may not be covered by the higher prices or investing in the rising-priced goods (such as real estate) as a substitute to investment in stocks. One of the conditions of the recent IMF's agreement to disburse a $3 billion loan to Egypt is that Egypt resorts to a perpetual flexible exchange rate regime to overcome its macroeconomic imbalances (Moneim, 2022). Accordingly, as several new rounds of devaluations of the LE are probable in the near future, policymakers should take into consideration the *cumulative net asymmetric effects* of any new devaluation on the stock prices in the long run. As previously mentioned, devaluation of the LE if coupled with ensuing inflation may very well decrease stock prices in the long run.

6.2 Implications for researchers

The results of the study provide integral information to the Egyptian stock market stakeholders and many others in similar emerging economies. Nevertheless, the present study did not assess the asymmetric impact of contemporary external shocks (such as the Russian-Ukraine war) on stock prices in Egypt. Accordingly, the study leaves the scope for further analysis.

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