economies

MDPI

Article

Symmetries or Asymmetries: How MSCI Index Advanced European Markets' Exchange Rates Respond to Macro-Economic Fundamentals

Mosab I. Tabash [1,*], Muhammad AsadUllah [2], Quratulain Siddiq [3], Marwan Mansour [4,5], Linda Nalini Daniel [6] and Mujeeb Saif Mohsen Al-Absy [7]

[1] Department of Business Administration, College of Business, Al Ain University, Al Ain P.O. Box 64141, United Arab Emirates
[2] Karachi Institute of Economics and Technology, College of Management Sciences, Karachi 75080, Pakistan; m.asadullah@kiet.edu.pk
[3] School of Economics and Business Administration, Chongqing University, Chongqing 400044, China; qurat.siddiq@hotmail.com
[4] Accounting Department, Business Faculty, Amman Arab University, Amman 11953, Jordan; m.mansour@aau.edu.jo
[5] Jadara Research Center, Jadara University, Irbid 21110, Jordan
[6] Business Department, Higher Colleges of Technology, Abu Dhabi P.O. Box 41012, United Arab Emirates; lindasuku@gmail.com
[7] Accounting and Financial Science Department, College of Administrative and Financial Science, Gulf University, Sanad 26489, Bahrain; dr.mujeeb.saif@gulfuniversity.edu.bh
* Correspondence: mosab.tabash@aau.ac.ae

Citation: Tabash, Mosab I., Muhammad Asadullah, Quratulain Siddiq, Marwan Mansour, Linda Nalini Daniel, and Mujeeb Saif Mohsen Al-Absy. 2024. Symmetries or Asymmetries: How MSCI Index Advanced European Markets' Exchange Rates Respond to Macro-Economic Fundamentals *Economies* 12: 326. https://doi.org/10.3390/economies12120326

Academic Editor: Robert Czudaj

Received: 7 October 2024
Revised: 16 November 2024
Accepted: 19 November 2024
Published: 28 November 2024

Abstract: The purpose of this study is to find symmetries and asymmetries in the exchange rate and macroeconomic fundamentals of advanced European markets, namely Denmark, the Euro Area, and United Kingdom, for the period of 2011 to 2022 via application of the NARDL technique. The findings reveal that interest rate affects DKK exchange rate asymmetrically in the long and short run, whereas money supply affects it in the short run. Foreign reserves are found to be helpful for all three currencies in stabilizing the exchange rate. A decline in gold price weakens GBP, DKK, and EUR in the long run. Previous studies suggest that the existence of asymmetrical relationships justifies the selection of NARDL for empirical analysis. This study makes a contribution to the existing literature, as it proves that forecasting via NARDL is also robust for analysis. The findings have significant policy implications for financial applications.

Keywords: exchange rate; NARDL; symmetries; asymmetries; forecasting

JEL Classification Code: E37; E47; F47

1. Introduction

Europe is a developed continent and significant economic zone of the world, having an impact on the current state and prospects of the global economy. According to the World Economic Forum Report (2023), the European Commission forecasted that the EU's economic growth was expected to face an upward trend compared to the previous year; the expected growth in 2023 was 0.8% compared to 0.3% in 2022. For economic growth, an important parameter is to stabilize the respective currency and keep an eye on factors that may affect the exchange rate (Kassi et al. 2019); hence, it is important for European markets to keep EUR and other major currencies on the right track to achieving 2023's goals.

Europe consists of forty-four countries with varying levels of trade and economy. Hence, this study focused on European countries with advanced markets that have floating exchange rate currencies and are indexed by MSCI (Morgan Stanley Capital International). In this context, there are twenty-two countries which represent the three strongest currencies of Europe. The leading currency in Europe is EUR, which is the second leading currency in global trade. There are twenty full-time member countries in the EUR area: Austria, Belgium, Croatia, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia, and Spain. The second most significant currency in Europe is GBP of the United Kingdom. Finally, Denmark has been endorsed as an advanced market; hence, DKK was added as the third currency for this study.

According to the Czech National Bank Report of 2024, the Danish government has a systematic mechanism to manage DKK's stability. Danish government policy ensures that their central bank analyzes market movement and intervenes accordingly. If DKK faces upward pressure, the central bank starts selling DKK and purchasing EUR and vice versa to maintain exchange rate equilibrium. Due to its large currency reserves, the central bank has room to intervene in the financial market.

In the recent 2024 Monetary Policy Report by the Bank of England, it is stated that during the last year, inflation and costly imports exerted a negative impact on GBP against EUR, but now, at the start of the current year, it has been strengthening, which is a good sign. Overall, in the current year, the GBP exchange rate has stabilized by 4% against USD and 1% against EUR.

It is difficult to understand the behavior of an exchange rate via conventional macro-economic and symmetric univariate models; the primary limitation is the inability to assess the asymmetric relationship between explanatory and dependent variables. That is the reason for the failure of previous models, for instance, when considering the impact of oil prices on the growth of an economy. Here, it is important to mention earlier researchers' conclusions. (i) An increase in oil prices preceded all but one of the five significant recessions that hit the United States at the end of World War II and in 1973. (ii) According to Barsky and Kilian (2001), the fundamental cause of stagflation in the 1970s was not the price of oil, but rather monetary factors. (iii) More importantly, Mork (1989) observed that, while an increase in oil prices has a negative impact on GDP, a fall in oil prices would result in economic growth, at least in the United States. (iv) Kilian (2009) laid the framework for a rigorous assessment of the asymmetric effect of oil price shocks by criticizing symmetry-assuming studies since they saw exogenous oil price shocks as a factor. A non-linear relationship might exist with other macro-economic fundamentals; examples of non-linear relationships between exchange rate and macro-economic fundamentals can be found in previous research (Chinn 1991; Arghyrou and Chortareas 2006; Aghion et al. 2009; Vieira et al. 2013; Alagidede and Ibrahim 2016).

For the above-mentioned purpose, the NARDL model is applied in this study to analyze the asymmetric and symmetric relationship between exchange rate and macro-economic fundamentals. This NARDL model was developed by Shin et al. (2014) and is an extension of an earlier NARDL model, which was only capable of gauging the linear relationship between dependent and independent variables. This study, using the NARDL model, will be an addition to the existing finance literature, as its application provides significant results. There are numerous macro-economic fundamentals that have been used by previous researchers to check their linear relationship with exchange rate. From these fundamentals, the most significant explanatory variables were selected for this study, i.e., money supply (Kim et al. 2000), interest rate (Groen 2000), GDP (Hwang and Wu 2011), inflation (Hwang and Wu 2011), trade balance (Qayyum et al. 2016), and oil and gold prices (Barsky and Kilian 2001). The economy of Europe is also at stake after Brexit, which is evident from the geographical, economical, and immigration-related policy transformations in the UK and other euro countries. The above could be the most important reason to determine the significant indicators for these respective countries.

The aim of this research study is to provide a robust model for forecasting the exchange rate of MSCI index advanced markets for achieving their 2023 goals. The reason for the selection of European advanced markets is their currencies' fluctuation due to ongoing global pressure, i.e., the US loan ceiling, Ukraine war, and Brexit. As a result, the British GBP, EUR, and DKK have been depreciating continually against the US dollar. Considering the above, the objective of this study is to find answers for the following:

1. Firstly, it investigates the influence of the selected explanatory variables on the exchange rate.

2. Secondly, it investigates the effect of composition of explanatory variables (negative or positive) on the exchange rate and examines whether the relationship between exchange rate and the explanatory variables is symmetric or asymmetric.

3. Lastly, it aims to determine whether the NARDL model can effectively forecast the exchange rate of MSCI Index European advanced markets. This study would contribute to the existing literature, as the NARDL has not been previously used for forecasting exchange rates.

2. Literature Review

There are several theories in the literature explaining the relationship between exchange rates and macroeconomic fundamentals. Most of these theories emphasize linear relationships; however, many have been rejected by researchers. The theories related to the exchange rate determination and findings of previous researchers are as follows:

(a) The Balance of Payment Theory

Each country's balance of payment influences the exchange rate between two incompatible currencies, in accordance with Johnson's (1977) balance of payment theory. The demand for any specific currency is considered to exert pressure on exchange rate value in relation to other paper currencies. Consequentially, a depreciation trend was observed by other currencies.

The balance of payment hypothesis has faced criticism from economists, theorists, academics, and practitioners for several reasons, some of which are as follows:

1. Even though there are imbalances in the market today, such as exchange restrictions and trade-related inadequacies, this theory irrationally assumes the existence of perfect competition.

2. The BOP hypothesis invalidly assumes that internal price level and exchange rate have no causal relationship. However, price volatility does influence exchange rate to some extent.

3. From this perspective, exchange is the function of balance of payments, not the other way around, and the exchange rate itself ultimately causes adjustments in the balance of payments position.

(b) The Interest Parity Theory

The interest parity hypothesis, in contrast to Keynes' Balance of Payment theory from 1936, presupposes that demand and supply of each nation's national currency determine the exchange rate. Exchange rates, unlike interest rates, are directly influenced by actual income and price levels.

The following drawback of the theory has made economists lose interest in it.

1. This strategy failed to account for changes in the value of major currencies during 1973–1977 currency floatation and did not adequately consider business factors.

2. This technique incorrectly assumes that bonds are correctly alternating.

3. Because the indicators showed incorrect signs during analysis, this model performed poorly in experiments.

(c) The Portfolio Balance Approach Theory

The portfolio balance approach developed by Markowitz (1952) was designed to address the limitations of the monetary approach. Bonds and international trade are acknowledged as faulty replacements, and the model incorporates commerce. The core

principle of this method is that exchange rate equilibrium can be established by balancing the supply and demand of financial assets.

According to this theory, expanding money supply results in a decrease in interest rates. This shift causes the domestic currency to weaken, increasing exports and decreasing imports.

There are not many drawbacks to the portfolio balance method. First, the exchange rate element is disregarded. Second, it does not take trade flow into account. Many academics claimed that empirical research carried out on the subject had produced inconsistent results. The current application of this approach does not fully explain how exchange rates are determined.

The above-mentioned theories, shown in Table 1, provide a symmetric relationship between different macroeconomic fundamentals and the exchange rate, but they also face criticism. One reason was researchers' failure to recognize and consider non-linearity.

Table 1. Shortcomings in exchange rate theories.

Theory	Shortcomings
The Balance of Payment Theory	• This theory assumes existence of perfect competition, whereas there are imperfections in today's market. • This theory postulates that exchange rate is a function of balance of payment, whereas exchange rate itself sometimes brings about adjustment in balance of payment. • (Alonso and Garcimartín 1998)
The Monetary Approach to Exchange Rate Theory	• This approach failed to describe the deviations in foreign exchange rates of major currencies during the period of currency floatation since 1973. • (Afat et al. 2015)
The Portfolio Balance Approach Theory	• It disregards real income as an element of exchange rate and does not deal with trade flows. • Produced only miscellaneous outcomes. The current form of this approach does not constitute a comprehensive theory. • (Magud et al. 2011)

The relationship between exchange rates and macroeconomic fundamentals has long been a subject of interest to economists and policymakers. Traditionally, the focus has been on linear relationships, where changes in macroeconomic fundamentals lead to proportional changes in exchange rates. However, recent research has revealed evidence of non-linearity in this relationship, suggesting that the impact of macroeconomic fundamentals on exchange rates may be contingent upon various factors and may exhibit non-linear patterns. This literature review aims to provide an overview of key studies investigating non-linearity and their implications.

The literature provides evidence suggesting the possibility of an asymmetric or non-linear relationship between exchange rates and different macroeconomic indicators. For instance, many academics have examined the connection between exchange rate and interest rate using direct causality methods and have not found any concrete proof of correlation between the two. (Kayhan et al. 2013; Tari and Abasiz 2009; Asadullah et al. 2020; Rasheed et al. 2020). MacDonald and Nagayasu's (2000) panel sample cointegration analysis revealed a weak link in the long-term relationship between exchange rates and interest rates at the equilibrium.

Gente and León-Ledesma (2006) examined the effects of foreign interest rate changes on the exchange rate of various East Asian countries by using VAR analysis. They concluded that there is a significant long-term negative relationship between exchange rate and interest rate in South Korea and Malaysia, whereas GDP factor had a significant positive relationship with exchange rate in Malaysia and Thailand.

In another cross-sectional study, Lee-Lee and Hui-Boon (2007) analyzed the exchange rate movement via ARDL and VAR approaches in Southeast Asian countries. Their findings evidenced that money supply and trade balance affect MYR significantly in the short run. Further money supply has also increased pressure on the THB and SGD. Lastly, interest rate shows minimal impact in Southeast Asian countries.

The literature highlights numerous studies reporting varied results regarding the relationship between the exchange rate and the macroeconomic fundamentals. According to Cuestas and Mourelle (2011), it is crucial to account for the non-linear relationship between the exchange rate and the GDP to reduce the likelihood of erroneous regression results. Numerous researchers have discovered a non-linear link between the exchange rate and GDP, including Goda and Priewe (2020), Aghion et al. (2009), Vieira et al. (2013), and Alagidede and Ibrahim (2016). According to Vieira et al. (2013), high exchange rates boost economic growth in both established and emerging economies, while low exchange rates have the opposite effect.

Asık (2023) tested the impact of inflation on TRY's exchange rate against USD, focusing on currency devaluation shocks in Turkey due to various factors. The author applied the NARDL approach for the purpose of analysis and concluded that inflation has a significant relationship with the exchange rate. Therefore, exchange rate fluctuations should be carefully monitored by the policymakers.

Sa'ad et al. (2023) has also applied the NARDL approach in their study to find the impact of oil price shocks and inflation on the exchange rate of the Nigerian currency. The results provided evidence of an asymmetric relationship between the exchange rate and oil price and inflation.

Qayyum et al. (2016), Hussain and Bashir (2013), and Magee (1973) proved that in certain economies, an asymmetrical relationship between trade balance and exchange rate is caused by the J-Curve. Chinn (1991) used both linear and non-linear methods to examine the connection between the exchange rate and trade balance. The author provided monthly data to test the link between RMSE and MAE. The author concluded that nonlinear dynamics are present in many trade balances. In this instance, the nonlinear model performs better than the linear one.

Several international studies have confirmed a nonlinear relationship between trade balance and exchange rate, including research by Aliyu and Tijjani (2015), Karamelikli (2016), Lin and Fu (2015), and Hassani et al. (2014). Arghyrou and Chortareas (2006) stated that this relationship has had structural breaks over the past forty years and is often nonlinear. According to Floyd (2007), the link between the exchange rate and the trade balance is ambiguous.

Additionally, oil and gold prices are significant determinants of the exchange rate. However, research studies analyzing the asymmetric relationship between currencies of European advanced markets and gold and oil prices remain scarce in the existing literature. Therefore, to address this gap, the study incorporates two time series into a single set of explanatory variables.

The existing literature concludes that macroeconomic fundamentals may exhibit linear or non-linear relationships with exchange rates. Hence, it is essential identify the variables that could affect the exchange rate of advanced European countries in future. Further, the failure of earlier theories in determining exchange rates highlights the need to find the key determinants of exchange rate for European advanced markets, as indexed by the MSCI. As Europe is going through the process of re-structuring after Brexit 2020, it is important to stabilize the exchange rate of these markets to achieve EU goals 2023.

To address this issue, the NARDL model will be applied to analyze the symmetries and asymmetries between the exchange rate and macroeconomic fundamentals. The NARDL model provides both long- and short-run coefficients by decomposing the variable into positive and negative sub-variables. Both short-run and long-run significant variables will be identified in the empirical analysis section. The following hypotheses have been developed after reviewing the existing literature.

H1: *There is an asymmetrical relationship between the exchange rate and GDP.*

H2: *There is an asymmetrical relationship between the exchange rate and money supply.*

H3: *There is an asymmetrical relationship between the exchange rate and interest rate.*

H4: *There is an asymmetrical relationship between the exchange rate and inflation.*

H5: *There is an asymmetrical relationship between the exchange rate and trade balance.*

H6: *There is an asymmetrical relationship between the exchange rate and oil price.*

H7: *There is an asymmetrical relationship between the exchange rate and gold price.*

H8: *There is an asymmetrical relationship between the exchange rate and foreign reserves.*

The macroeconomic fundamentals include money supply, foreign reserves, GDP, interest rate, inflation rate, oil price, gold price and trade balance. Further, the above hypotheses are formulated for each advanced European market's currency individually, namely GBP, EUR and DKK.

3. Methodology

3.1. Data

The data used for this study are time series data of exchange rates covering the period from 2012 to 2022 sourced from the IFS website (database of IMF). The selected data have a monthly frequency due to the unavailability of daily data for the explanatory variables interest rate, inflation rate, oil price, gold price, trade balance, foreign reserves, GDP and money supply. In this study, Industrial Production Index (IPI) has been taken as the proxy of GDP because it is available on a monthly basis. Additionally, this proxy aligns with previous studies that have used the same proxy (Bildirici et al. 2011; Civcir and Akçağlayan 2010; Mansour et al. 2024; Soybilgen et al. 2019). IPI calculates the output of an economy in relation to a base year and includes sectors like energy, gas, manufacturing, electric and mining. Using GDP as a variable will not be viable due to unavailability of monthly data, and IPI fills this gap by representing the GDP precisely. For money supply, the money base growth is selected as the indicator of money supply since the data are available, and it also provides more accurate information about money supply (Funashima 2020).

3.2. Sample

The sample for this study consists of three advanced markets of the European economy indexed by MSCI. These markets are the Euro Zone, United Kingdom and Denmark. The selection of these markets is justified by the fact that they are classified as Advanced Markets by MSCI. The Eurozone itself is the combination of twenty EU member states. Studying this sample is significant because the EU is the largest global economy, with a GDP per capita of EUR 25,000.

3.3. Statistical Instrument

Before discussing NARDL, it is important to explore the history of ARDL, which provided the basis for Shin et al. (2014) to create the NARDL technique. The Auto Regressive Distributive Model is a time series-based causal econometric methodology with a few shortcomings.

Previous research has not extensively focused on predicting currency rates using ARDL. An analysis of the relationship between the explanatory and dependent variables can be carried out using econometric models. Similarly, using an econometric model to

identify the variables affecting an exchange rate can help to identify the determinant variables and the causes for their volatility. In this study, both dependent and controllable factor panel analysis are conducted.

To discover asymmetric impacts in the long term and short term using positive and negative partial sum decompositions, Shin et al. (2014) created a non-linear ARDL model. The NARDL approach encompasses more information for researchers than ARDL. To obtain the desired results, the analysis can be performed initially on a small sample size. Secondly, they can be used whether the regressor is stationary at level or at the first difference (i.e., I (0) or I (1)), depending on the situation. If stationary, the mean, variance, and co-variance of the time series should be constant; otherwise, the time series will not be effective for the further analysis.

The NARDL approach has gained the attention of current researchers, and hence, it is extensively applied (Asık 2023; Kumar et al. 2023; Amor et al. 2023; Shamwil et al. 2023). Anderl and Caporale (2023) have applied both ARDL and NARDL in their study and found NARDL's results more robust and reliable than the ARDL technique due to its unique characteristics.

In NARDL, the lag selection criterion is a simple automatic selection, which follows optimal lag selection via Akaike or Bayesian criteria (Kripfganz and Schneider 2023). There is also a manual method to determine the appropriate lag by either finding the least AIC or other information criterion of different lag combinations and then choosing the minimum AIC or Schwarz value.

4. Empirical Results

Like ARDL, the time series should be stationary at the level or at first difference; this is one of the pre-requisites of the NARDL technique. So the time series of exchange rate data has been tested via Augmented Dicky Fuller and Phillips–Perron test to avoid bias. Table 2 shows that the exchange rate time series of all three markets was found to be stationary at the first difference, fulfilling the initial criteria of NARDL analysis.

Table 2. Unit root of exchange rate time series.

Country	ADF Test		PPP Test	
	Level	1st Diff.	Level	1st Diff.
Denmark	−1.752380	−11.61459 **	−1.915538	−11.64234 **
Euro Area	−1.925379	−11.08257 **	−2.084963	−11.05532 **
United Kingdom	−2.396959	−11.71410 **	−2.499652	−11.63799 **

** Significant at 5%.

Figures 1–3 represent the graph of DKK, EUR, and GBP at level and first difference. All time series have an upward trend at difference and are stationary at level, whereas at first difference, all trends have been removed and series are found to be stationary and fit for the time series analysis. In the above figures, we can also find the upward trend in exchange rate in DKK, EUR and GBP. There is a sharp increase in exchange rate in EUR and DKK during the financial year 2014 and 2015, whereas both currencies appreciated in 2018. GBP faced sharp depreciation from 2014 to 2016, whereas it gained against USD in 2018.

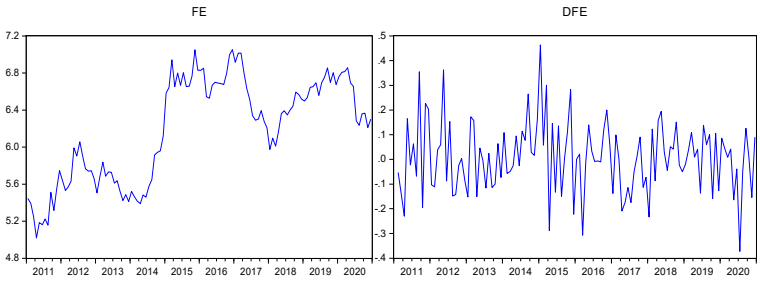

Figure 1. Denmark.

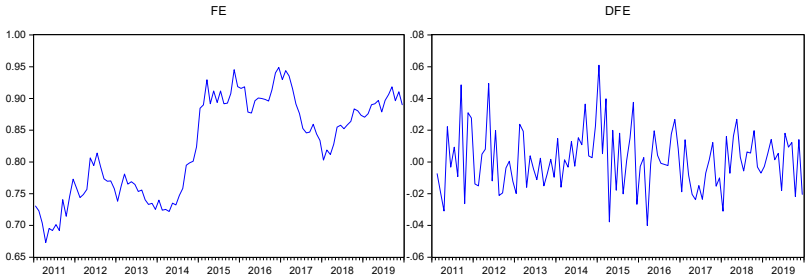

Figure 2. Euro Area.

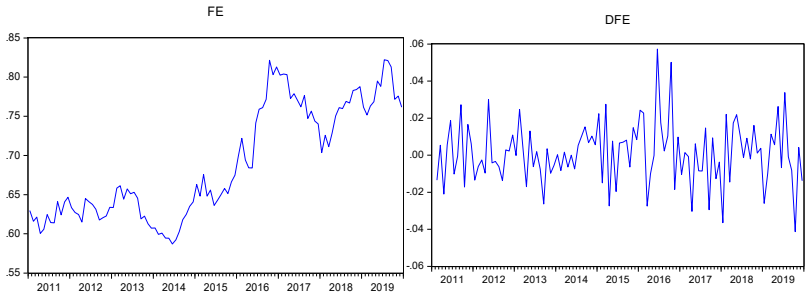

Figure 3. United Kingdom.

After testing the unit root of exchange rate of all markets, it is also important to test the unit root of explanatory variables which are included in the NARDL analysis. Table 3 illustrates the unit root of oil price and gold price, which are mutual in the above-mentioned three cases, i.e., Denmark, Euro Area, and United Kingdom.

Table 3. Unit root of oil price and gold price.

Variable	ADF Test		Phillip–Peron Test	
	Level	**1st Diff.**	**Level**	**1st Diff.**
Oil Price	−2.6640	−8.5447 **	−2.2433	−8.3373 **
Gold Price	−0.0626	−8.7842 **	−0.3256	−8.7474 **

** Significant at 5%.

Table 3 further demonstrates that time series data of oil and gold price are found stationary at first difference; therefore, we can include these variables as explanatory variables in the NARDL analysis.

As discussed earlier, the other selected explanatory variables, i.e., interest rate, inflation rate, trade balance, GDP, money supply and foreign reserves' unit root, are also tested and illustrated in Table 4. Table 4 shows that all variables are found to be stationary either at level or at first difference. None of the variables violate the NARDL pre-requisite criteria, i.e., stationary at the second difference.

Table 4. Unit root of explanatory variables.

	ADF Test		PP Test	
Variables	**Level**	**1st Diff**	**Level**	**1st Diff.**
Denmark				
Foreign Reserves	−3.3746	−9.245 **	−3.4068	−9.2455 **
Money Supply	−3.1050	−10.996 **	−3.3983	−10.999 **
Inflation Rate	−1.1393	−10.097 **	−1.1372	−10.148 **
Interest Rate	−5.0075 **	-	−1.4729	−7.4784 **
Trade Balance	−8.2738 **	-	−7.9812 **	-
GDP	−9.3070	−10.6517 **	−9.0556 **	-
Euro Area				
Foreign Reserves	−2.2276	−10.505 **	−2.3985	−15.686 **
Money Supply	−3.2798	−7.4680 **	−2.0893	−7.9521 **
Inflation Rate	−3.0014	−12.126 **	−3.0136	−12.192 **
Interest Rate	−1.8338	−9.1822 **	−2.1268	−9.1831 **
Trade Balance	−1.8297	−3.5006 **	−6.4736 **	-
GDP	−3.4671 **	-	−10.176 **	-
United Kingdom				
Foreign Reserves	0.2421	−13.9124 **	−3.6833 **	-
Money Supply	−2.7450	−4.5892 **	−2.4023	−4.4800 **
Inflation Rate	−3.9119 **	-	−2.2755	−9.9799 **
Interest Rate	2.999 *	-	3.2517 *	-
Trade Balance	−4.864 **	-	−9.0823 **	-
GDP	−3.5110 **	-	−10.798 **	-

Note: **, * show the significance level at 5% and 10% levels.

Table 5 shows the most significant part of the study, namely long-term coefficients that depict the association of explanatory variables with the exchange rate. In the case of Demark, the log linear equation has been run due to the existence of autocorrelation, as it is important to ensure that the time series does not possess the problem of autocorrelation, heteroscedasticity or normality (Mansour et al. 2023). The diagnostic test results are available in Table 6.

Table 5. Long-run coefficients.

Country	Long-Run Coefficients
Denmark	LOG(FE) = 1.5241 − 0.000 × FR_NEG − 0.023 × INF_POS + 0.4721 × IR_POS + 0.123 × IR_NEG (−2.836) (−2.126) (2.417) (2.517) [0.006] [0.037] [0.018] [0.014] −0.002 × GDP_POS − 0.000 × GP_NEG + 0.004 × OP_POS − 0.0003 × OP_NEG (−2.028) (−2.384) (2.882) (−4.103) [0.047] [0.020] [0.005] [0.000] Bound Test, F Statistic: 3.4833493 I0 Bound: 3.39, I1 Bound: 2.96 (5% significance)
Euro Area	FE = 0.7048 + 0.0012 × MS_POS − 0.0002 × GP_POS − 0.003 × OP_NEG − (2.777) (−2.752) (−3.918) [0.007] [0.008] [0.000] 0.000 × TB_POS + 0.000 × FR_NEG (−1.991) (1.990) [0.005] [0.005] Bound Test, F Statistic: 3.8303 I0 Bound: 3.79, I1 Bound: 2.96 (5% significance)

United Kingdom	FE = 0.256 − 0.0000 × FR_POS (1.999) [0.003] Bound Test, F Statistic: 3.1828 I0 Bound: 3.06, I1 Bound: 1.95 (10% significance)

The above table illustrates that in the Denmark market, a decline in one unit of foreign reserves and gold prices leads to minor appreciation of DKK. It is also concluded that the relationship between the exchange rate and interest rate is asymmetric, i.e., DKK devalued during the period of interest rate fluctuation; this it is inconsistent with the findings of Kayhan et al. (2013), Tari and Abasiz (2009), MacDonald and Nagayasu's (2000) and Gente and León-Ledesma (2006). The above findings related to interest rate and exchange rate reject the postulation of the Interest Parity Theory, which proposes a linear relationship between these two variables. With a one unit increase in the interest rate, the exchange rate devalued by 0.47 percent, but a one unit decrease in interest rate led to devaluation of DKK by 0.12 percent. The above relationship shows non-linearity, and that is why the NARDL approach is better than ARDL in this study. The changes in the oil prices also affect DKK significantly and are found to be asymmetric, like interest rate. The increase or decrease in oil price affects/devalues the Danish currency. When there is a decline in oil prices, exchange rates appreciate, but the proportion is a little higher in the case of the increase in oil prices. This signifies more payments abroad for the purchase of gasoline. The asymmetric relationship of oil and exchange rate supports the findings of Sa'ad et al. (2023), as they obtained the same results in their study. The decrease in gold prices and foreign reserves devalues the Danish currency, though with a lesser impact. Hence, considering the above relationship in the trend of prices, the government of Denmark and traders may purchase gold from the global market when the price of gold is low. This could be one of the reasons for the devaluation of currency during that period. It also evidences that an increase in GDP helps strengthen DKK to some extent, and this is consistent with the findings of Goda and Priewe (2020), Aghion et al. (2009), Vieira et al. (2013), Alagidede and Ibrahim 2016, and Gente and León-Ledesma (2006) Higher inflation also stabilizes DKK in the long run because productive inflation is significant for the growth of any economy. The results are inconsistent with the postulation of The Interest Parity Theory, but confirm the findings of Sa'ad et al. (2023).

In the Euro Zone, the money supply affects the exchange rate of EUR negatively in the case of an increase in money supply in the market, which is consistent with the postulation of The Portfolio Balance Approach theory and the results of Lee-Lee and Hui-Boon (2007). A one unit increase in money supply leads to a devaluation of the currency by 0.001 percent. Like Denmark, EUR also loses its value during the tenure of increase in gold prices, and decrease in oil prices and foreign reserves. EUR has gained its value with trade surplus and an increase in gold prices. The devaluation of EUR with trade surplus affirms the postulation of the balance of payment theory approach. It is also consistent with the results of Lee-Lee and Hui-Boon (2007) and inconsistent with the findings of Qayyum et al. (2016), Lin and Fu (2015), Aliyu and Tijjani (2015). The British GBP emerges as one of the strongest currencies, as only an increase in foreign reserves enhances the value of GBP, with minor changes. None of the other variables affect the exchange rate in the long run. In NARDL, it is important to determine the validity of long-run coefficients; therefore, the Bound testing approach has been applied. The theory suggests that if the F-statistic is higher than the upper and lower bounds, then it is evidence of the long-run relationship between the dependent and independent variables; on the other hand, if the F-statistic value lies between the upper and lower bounds at any level significance, then the long-term relationship is inconclusive (Shahbaz et al. 2012). In the above cases, it is found that the F-statistics are higher than the upper and lower bounds in the case of Denmark, the United Kingdom and the Euro Zone markets; therefore, it is evident that the above-men-

tioned long run relationship between the exchange rate and the macroeconomic fundamentals is justified. The t-statistics and *p*-values are shown in round and box brackets, respectively.

Table 6 interprets the short-run coefficients of the exchange rate. The results evidence that inflation plays a significant role in determining the exchange rate, as was observed in the section of long-run models. It has been observed that the decrease in inflation weakens the Euro Area currency, which is inconsistent with the Interest Parity Theory postulations. Consumption increases during the inflation period in the Euro area, which eventually increases the demand for goods and services. The short-term decrease in money supply devalues EUR slightly, which is inconsistent with the Portfolio Balance Approach theory postulations. The short-term interest rate also plays an essential part in determining the exchange rate.

Table 6. Short-run coefficients in advanced markets.

Country	Short Run Coefficients
Denmark	$\Delta \text{LOG(ER)}_t = -0.6395 - 0.000 \times \Delta \text{FR\_NEG}_t + 0.3163 \times \text{IR\_POS}_{t-3} + 0.0119$ *
	(−2.501) (2.265)
	[0.015] [0.027]
	$\Delta \text{IR\_NEG}_t + 0.000 \times \Delta \text{MS\_POS}_{t-2} + 0.000 \times \Delta \text{MS\_NEG}_{t-1}$
	(2.597) (2.222) (2.263)
	[0.021] [0.030] [0.027]
	$+0.001 \times \Delta \text{GDP\_POS}_{t-1} - 0.000 \times \Delta \text{GP\_NEG}_t$
	(2.214) (−2.197)
	[0.030] [0.032]
	F = 64.5509 [0.000]
Euro Area	$\Delta \text{FE} = -0.6022 + 0.000 \times \Delta \text{MS\_NEG}_t - 0.007 \times \Delta \text{INF\_NEG}_t$
	(2.363) (2.425)
	[0.030] [0.028]
	F = 63.883 [0.000]
United Kingdom	$\Delta \text{FE} = -0.0899 - 0.002 \times \Delta \text{OP\_POS}_{t-2}$
	(−2.090)
	[0.040]
	F = 11.8849 [0.000]

Note: * shows the significance level at 10% levels.

In the case of DKK, an increase in three-month IR_POS_{t-3} and one-month short-run interest rate IR_POS_t causes DKK to appreciate by 0.3163 units. It is also against the Interest Parity Theory, which postulates that interest rate and exchange rate have an inverse relationship. It is also found that there is an asymmetric relationship between money supply and interest rate and exchange rate, which negates the Portfolio Balance approach theory postulations. In the short term, DKK loses its value in all four of the above-mentioned cases. Like the long run, DKK was also devalued with a decrease in gold price in the short run.

GBP loses its value due to an increase in oil price in the short run, indicating that the UK buys more oil during the period of low oil prices, which is consistent with the findings of Sa'ad et al. (2023). The t-statistics and *p*-values are shown in round and square brackets, respectively.

Table 7 describes the results of diagnostic tests related to the above-mentioned markets. The NARDL approach assumes that data do not contain the problem of serial autocorrelation, heteroscedasticity, normality or omission; therefore, the Rest Ramsey Test, Breusch Pagan Test for heteroscedasticity, Breusch–Godfrey test for serial correlation and

Normality test are used. The resulting *p*-values show that there are no problems of heteroscedasticity, autocorrelation, omission or normality in the data of the selected markets; therefore, we can conclude that the results from NARDL are reliable and valid. The Reset RAMSEY test also shows that the models are fit and there is no issue of omission of important variables in the model.

Table 7. Diagnostic tests results.

Markets	Diagnostic Tests			
	Normality	Heteroskedasticity	Serial Correlation	RAMSEY Test
Denmark	0.9015	0.9909	0.8653	0.9101
Euro Area	0.8719	0.5698	0.2577	0.1115
United Kingdom	0.2434	0.8078	0.1166	0.9962

Figures 4–6 below depict the values of cumulative Sum (CUSUM) and its square value for Denmark, the Euro Area and the United Kingdom. The figures below indicate the stability of the NARDL model, as the model criteria do not surpass the upper or lower layers in any case and stay within a stable zone.

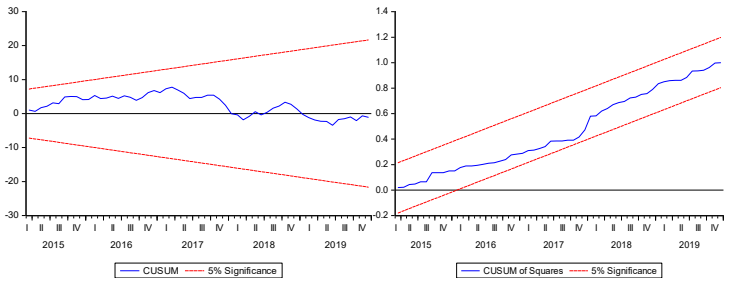

Figure 4. CUSUM and CUSUM of Square—Denmark.

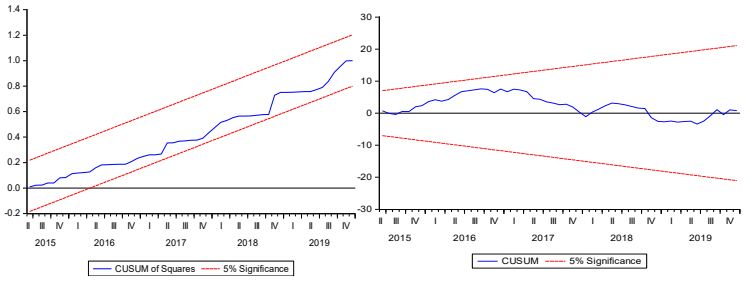

Figure 5. CUSUM and CUSUM of Square—Euro Area.

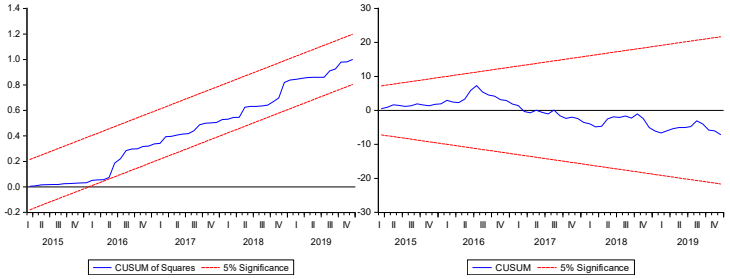

Figure 6. CUSUM and CUSUM of Square—United Kingdom.

Table 8 shows the Mean Absolute Percentage Error (MAPE) values, which were derived from NARDL analysis. The values of 2022 are forecasted by the NARDL method to validate the findings, i.e., whether or not long-run and short-run coefficients can forecast the exchange rate. The results suggest that NARDL is also capable of forecasting the exchange rate along with assessing the linear or non-linear relationship between the exchange rate and macroeconomic fundamentals. The resultant MAPE values are less than two. These are highly robust values in the context of forecasting; hence, it is a contribution to the literature of finance to apply NARDL for the purpose of forecasting any time series.

Table 8. MAPE values (forecasting).

Market	Denmark	Euro Area	United Kingdom
MAPE Values	1.580	1.390	1.947

5. Conclusions and Policy Implications

The objective of this study is to determine the symmetric and asymmetric relationship between exchange rate and selected macroeconomic fundamentals (oil prices, gold prices, GDP and foreign reserves) of Morgan Stanley Capital International (MSCI) indexed advanced European markets, namely Denmark, the Euro Zone and the United Kingdom, via the application of NARDL. The purpose of choosing these European advanced markets is that their currencies fall under floating exchange rate regimes, namely DKK, EUR and GBP. The results suggest that the application of NARDL is significant because there is an asymmetric relationship between the explanatory and dependent variables, as we discussed in the previous section. The NARDL method also possesses robust characteristics of forecasting, as the resultant MAPE values are less than two, which itself is evidence of its robustness.

Further, the study suggests that the Danish government should implement such policies that would protect DKK in future. Policy makers should stabilize the foreign reserves because the fall in reserves leads to a devaluation of the currency. At present, the foreign reserves of the Danish economy lie between USD 75 and 76 billion, though it is noticeable that during 2015, it reached its highest, at USD 108 billion. Hence, the financial policy to be followed by Denmark should be well defined in relation to interest rates, as both rise and fall lead to a devaluation of its currency. That is, international investors do not deposit or invest in Denmark, as they may find better options globally. The interest rate in Denmark is too low, at 2.85%, to attract any investor; this could be considered the reason for currency devaluation, as investors opt for other global investment options. Productive inflation is an indicator of economic growth; this can be observed in Denmark, as controlled inflation strengthens DKK. Productive inflation leads to the cycle of growth; when GDP increases, DKK strengthens. The GDP of Denmark reached an all-time high in fiscal year 2023, at approximately USD 398.3 billion, which ultimately supported DKK. Therefore, it is suggested that the Danish government should continue and control the policies related to the inflation that enhances their growth and stabilizes the currency.

The currency of the United Kingdom is distinctive, because other than foreign reserves, other macroeconomic variables do not play any significant role in the determination of its currency exchange rate. When foreign reserves increase, the GBP appreciates against USD; therefore, it is recommended for policy makers to stabilize or enhance foreign reserves to keep the currency in the optimal zone. In the case of the Euro Zone, policy makers should prepare such policies to avoid an increase in money supply and try to stabilize the foreign reserves, Otherwise, EUR will lose its value against USD. Surprisingly, the Euro Zone is not an oil-producing economy, but EUR weakens when oil prices decline. One of the reasons for the above relationship is the excessive and forward purchasing of oil at lower prices, which eventually decreases the foreign reserves and weakens EUR against USD. Subsequently, when cheap oil is used in the production cycle, GDP increases and EUR strengthens. This policy should be carefully handled by policy makers, as it may

cause concern during a global recession. The economy of the UK has been almost stagnant since 2000, i.e., the GDP lies around USD 3.131 trillion; therefore, no impact of exchange rate output, either an increase or decrease, has been observed. Even though GDP seems satisfactory for the policy makers, achieving the optimum level requires finding additional opportunities to further enhance economic growth.

Further, the result of diagnostic testing reveals that there is no autocorrelation, heteroscedasticity, omission or normality; therefore, the data and findings are validated. The bound testing approach has also been applied in this study to confirm the long-run relationship between the exchange rate and independent variables. Further, the cumulative sum (CUSUM) and CUSUMQ are run to determine the stability of all models. The CUSUM and CUSUMQ figures illustrate that the model criteria fall within the favorable zone, which is evidence of the stability of all NARDL models; hence, the findings are authenticated.

Moreover, it is concluded that NARDL can play a vital role in determining the exchange rate equilibrium by identifying the significant indicators. With the help of NARDL, we can also forecast the exchange rate of European advanced markets as indexed by the MSCI Index. It is observed that the Euro Area and Denmark have structured policies which weaken their currency in the first stage and strengthen them in the second stage, whereas GBP is an exception to macroeconomic linkages. Considering the circumstances discussed above, the concern is that during recession, the economy will face difficult challenges. Hence, policy makers need to prepare alternate plans. The findings will also be beneficial in future periods when the EU undergoes transformation from both geographical and economic standpoints.

From the findings, it is recommended to the Danish monetary policy makers to keep the interest rate low because the increase in interest rate will devalue the currency. The short-term increase in deposit affects DKK more significantly than in the long run. Furthermore, an increase in interest rate leads to an increase in inflation; therefore, if the interest rate is at the optimal level, the productive inflation tends to appreciate DKK. The fiscal policy makers should prepare such policies, which will eventually lead to trade balance, because gold and oil trade have played an important role in the determination of equilibrium of DKK against USD.

In the case of the Euro Area, the fiscal policy should be prepared to limit the injection of money supply into the market, as this depreciates EUR against USD. They should also keep an eye on reserves, because if foreign reserves dilute, EUR depreciates. The Euro Area policy makers should purchase and save crude oil at cheaper prices, which will strengthen EUR against USD and help to stabilize the trade balance and foreign reserves.

For GBP, the Central Bank of England should follow a straight job of maintaining their foreign reserves in the long run and purchase their oil requirements more when the prices are low, because an increase in oil prices devalues GBP against USD in the short run.

The contributions of the study can be concluded in three concise points, mentioned below:

1. The findings contradict the postulation of existing conventional theories related to determining exchange rates.
2. The study is an additional contribution to the existing literature, as NARDL has not been applied extensively in advanced market exchange rate determination.
3. The above results will be beneficial for policy makers, as they forecast exchange rate effectively and efficiently, as evidenced from the finding that MAPE value in all cases is less than two percent; hence, it validates the novel contribution to the existing literature.

Author Contributions: Conceptualization, M.I.T., M.M. and Q.S.; methodology, M.I.T., M.A., Q.S. and M.M., validation, M.I.T., M.A., Q.S., M.M., L.N.D. and M.S.M.A.-A.; writing—original draft, M.I.T. and M.A., literature review, M.I.T., Q.S., L.N.D., M.M., M.A. and M.S.M.A.-A.; results, M.M.;

supervision, L.N.D. and M.S.M.A.-A.; resources, M.M., Q.S. and M.S.M.A.-A. All authors have read and agreed to the published version of the manuscript.

Funding: There is no external funding.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are available upon request.

Conflicts of Interest: There is no conflict of interest.

References

Afat, Dinçer., Marta. Gómez-Puig, and Simón Sosvilla-Rivero. 2015. The failure of the monetary model of exchange rate determination. *Applied Economics* 47: 4607–29.

Aghion, Philippe, Philippe Bacchetta, Romain, Ranciere, and Kenneth Rogoff. 2009. Exchange rate volatility and productivity growth: The role of financial development, Journal of Monetary Economics, 56(4), 494–513.

Alagidede, Paul, and Muazu Ibrahim. 2016. *On the Cause and Effects of Exchange Rate Volatility on Economic Growth: Evidence from Ghana.* IGC Working Paper. London: IGC.

Annual Report 2023–2024, World Economic Forum, retrieved from https://www.weforum.org/publications/annual-report-2023-2024/ (accessed on 12 September 2024).

Aliyu, Jibrilla, and Mohammed Tijjani. 2015. Asymmetric cointegration between exchange rate and trade balance in Nigeria. *Cogent Economics and Finance* 3: 104521.

Alonso, José, and Carlos Garcimartí. 1998. A new approach to balance-of-payments constraint: Some empirical evidence. *Journal of Post Keynesian Economics* 21: 259–82.

Anderl, Christina, and Guglielmo Maria Caporale. 2023. The Asymmetric Impact of Economic Policy and Oil Price Uncertainty on Inflation: Evidence from Developed and Emerging Economies (2023). CESifo Working Paper No. 10276. Available online: https://ssrn.com/abstract=4359382 (accessed on 15 July 2024). http://doi.org/10.2139/ssrn.4359382.

Arghyrou, Michael G., and Georgios Chortareas. 2006. Real exchange rates and current account imbalances in the Euro-area. Available online: https://core.ac.uk/download/pdf/6301242.pdf (accessed on 15 July 2024).

Asadullah, Muhammad, Adnan Bashir and Abdur Rahman Aleemi. 2020. Forecasting exchange rates: An empirical application to Pakistani rupee. *Journal of Asian Finance, Economics, and Business* 8: 339–47.

Asık, Bekir. 2023. Testing the Asymmetric Relationship Between Cpi, Ppi, and Exchange Rates: An Application of the Ardl and Nardl Methods. *Pressacademia Procedia* 16: 215–16. https://doi.org/10.17261/Pressacademia.2023.1696.

Barsky, Robert B., and Lutz Kilian. 2001. Do we really know that oil caused the great stagflation? A monetary alternative. *NBER Macroeconomics Annual* 16: 137–83.

Bildirici, Melike, Elçin A. Alp, and Fazil Kayikçi. 2011. Relationship between hot money and Economic growth: Tar-integration and MS-VAR analysis. *African Journal of Business Management* 5: 1060–75.

Chinn, Menzie David. 1991. Some linear and nonlinear thoughts on exchange rates. *Journal of Intranational. Cfoney und Finance* 10: 14–230.

Civcir, Irfan, and Anıl Akçağlayan. 2010. Inflation targeting and the exchange rate: Does it matter in Turkey? *Journal of Policy Modelling* 32: 339–54.

Cuestas, Juan Carlos, and Estefania Mourelle. 2011. Nonlinearities in real exchange rate determination: Do African exchange rates follow a random walk? *Applied Economics* 43: 243–58.

Floyd, John. 2007. The Balance of Payments and the Exchange Rate. Available online: http://www.chass.utoronto.ca/~floyd/bpx.html (accessed on 10 August 2024).

Funashima, Yoshito. 2020. Money Stock Versus Monetary Base in Time–Frequency Exchange Rate Determination. *Journal of International Money and Finance* 104: 102150. https://doi.org/10.1016/j.jimonfin.2020.102150.

Gente, Karine, and Miguel A. Leon-Ledesma. 2006. Does the World Real Interest Rate Affect the Real Exchange Rate? The South East Asian Experience. *The Journal of International Trade & Economic Development: An International and Comparative Review* 15: 441–67.

Goda, Thomas, and Jan Priewe. 2020. Determinants of real exchange rate movements in 15 emerging market economies. *Brazilian Journal of Political Economy* 40: 214–37.

Groen, Jan JJ. 2000. The Monetary Exchange Rate Model as a Long-Run Phenomenon. *Journal of International Economics* 52: 299–319.

Hassani, P., T. Akhoondzadeh, M. Babazadeh, and F. Salimic. 2014. The study of Bilateral Trade Balance of Iran and Turkey in Exchange Rate Uncertainty (Holding Marshall-Lerner Condition with Non-linear STAR Model). *Reef Resources Assessment and Management Technical Paper* 40: 265–78.

Hussain, Muntazir, and Usman Bashir. 2013. Dynamics of Trade Balance and the J-Curve Phenomenon: Evidence from Pakistan. *The Journal of Commerce* 5: 90–96.

Hwang, Jen-Te, and Ming-Jia Wu. 2011. Inflation and economic growth in China: An empirical analysis. *China & World Economy* 19: 67–84.

Johnson, Harry Gordon. 1977. *Money, Balance-of-Payments Theory, and the International Monetary Problem.* Princeton: International Finance Section, Department of Economics, Princeton University, Princeton, USA.

Karamelikli, Huseyin. 2016. Linear and Nonlinear Dynamics of the Turkish Trade Balance. *International Journal of Economics and Finance* 8: 20–34.
Kassi, Diby François, Gang Sun, Ning Ding, Dilesha Nawadali Rathnayake, and Guy Roland Assamoi. 2019. Asymmetry in exchange rate pass-through to consumer prices: Evidence from emerging and developing Asian. *Economic Analysis and Policy* 62: 357–72.
Kayhan, Selim, Tayfur Bayat, and Ahmet Uğur. 2013. Interest rates and exchange rate relationship in BRIC-T countries. *Ege Academic Review* 13: 227–36.
Kilian, Lutz. 2009. Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review* 99: 1053–69.
Kripfganz, Sebastian, and Daniel C. Schneider. 2023. ARDL: Estimating autoregressive distributed lag and equilibrium correction models. *The Stata Journal* 23: 983–1019.
Kim, Soyoung, and Nouriel Roubini. 2000. Exchange rate anomalies in the industrial countries: A solution with a structural VAR approach. *Journal of Monetary economics* 45: 561–586.
Kumar, Suresh, Ankit Kumar, and Gurcharan Singh. 2023. Causal relationship among international crude oil, gold, exchange rate, and stock market: Fresh evidence from NARDL testing approach. *International Journal of Finance and Economics* 28: 47–57. https://doi.org/10.1002/ijfe.2404.
Lee-Lee, Chong, and Tan Hui-Boon. 2007. Macroeconomic Factors of Exchange Rate Volatility Evidence from Four Neighboring ASEAN Economies. *Studies in Economics and Finance* 24: 266–85.
Lin, Mon-Li, and Tze-Wei Fu. 2015. Nonlinear Effect of Exchange Rates on Trade Balance: A Recommendation for Emerging Countries' Exchange Rate Policy. *International Journal of Economics and Financial Research* 1: 90–96.
MacDonald, Ronald, and Jun Nagayasu. 2000. The long-run relationship between real exchange rates and real interest rate differentials: A panel study. *IMF Staff Papers* 47: 116–28.
Magee, Stephen P. 1973. Currency Contracts, Pass Through and Devaluation. *Brooking Papers on Economic Activity* 4: 303–25.
Magud, Nicolas E., Carmen M. Reinhart, and Kenneth S. Rogoff. 2011. *Capital Controls: Myth and Reality-A Portfolio Balance Approach* (No. w16805). Cambridge: National Bureau of Economic Research.
Marwan Mansour, Ismail Y. Yamin, Mohammed Saram, Ahmad Alduwailah, Nasser Al-Enzi, Belal Mahmoud AlWadi, Ahmad Marei. 2024. Capital structure and performance nexus: Insights from fixed-effects and quantile analysis. *Journal of Infrastructure, Policy and Development* 8: 5119. https://doi.org/10.24294/jipd.v8i7.5119.
Marwan Mansour, Mo'taz Al Zobi, Mohammed Saram, Luay Daoud and Ahmad Marei. 2023. Does executive compensation matter to bank performance? Experimental evidence from Jordan. *Banks and Bank Systems* 18: 164–76. https://doi.org/10.21511/bbs.18(3).2023.14.
Markowitz, Harry. 1952. Portfolio Selection. *The Journal of Finance* 7: 77–91. https://doi.org/10.2307/2975974.
Mork, Knut Anton. 1989. Oil and the macroeconomy when prices go up and down: an extension of Hamilton's results. *Journal of political Economy*, 97: 740–744.
Qayyum, Abdul, Sidra Nazir, and Muhammad Jawad. 2016. Nonlinearity Between RER and Trade Balance: A Case Study of Pakistan. Available online: https://mpra.ub.uni muenchen.de/72589/1/MPRA_paper_72589.pdf (accessed on 28 July 2024).
Rasheed, Abdul, Muhammad Asadullah, and Imam Uddin. 2020. PKR exchange rate forecasting through univariate and multivariate time series techniques. *NICE Research Journal* 13: 49–67.
Sa'ad, Suleiman, Ali, Baba Usman, Solomon Ochada Omaye, and Hamisu Yau. 2023. Asymmetric Pass-through Effects of Oil Price Shocks and Exchange Rates on Inflation in Nigeria: Evidence from a Nonlinear ARDL Model. *ESI Preprints* 13: 350.
Shahbaz, Muhammad, Hooi Hooi Lean, and Muhammad Shahbaz Shabbir. 2012. Environmental Kuznets curve hypothesis in Pakistan: cointegration and Granger causality. *Renewable and Sustainable Energy Reviews* 16: 2947–2953.
Shamwil, Muhammed, Abubakar Bala, Kamal Kabiru Shehu, Abdul Yunusa, and Mohammed Yaro Idriss. 2023. Asymmetric Impact of Some Selected Macroeconomic Variables on Natural Gas Consumption in Nigeria. *Journal of Economics and Allied Research* 8: 252–65.
Shin, Yongcheol, Byungchul Yu, and Matthew Greenwood-Nimmo. 2014. Modelling asymmetric co-integration and dynamic multipliers in a non-linear ARDL framework. In *Festschrift in Honor of Schmidt*. Edited by R. C. Sickles and W. C. Horrace. Berlin/Heidelberg: Springer, pp. 281–314.
Soybilgen Barış, Huseyin Kaya, and Dincer Dedeoglu. 2019. Evaluating the effect of geopolitical risks on the growth rates of emerging countries. *Economics Bulletin* 39: 717–25.
Tari, Recep, and Tezcan Abasiz. 2009. Frequency domain approach and short run and long run causality test: Evidence from Turkey for interest rate and exchange rate relationship. *METU Studies in Development* 36: 405–21.
Amor, Thouraya Hadj, Ridha Nouria, Christophe Rault, and Anamaria Diana Sova. 2023. Real exchange rate misalignments and economic growth in Tunisia: New evidence from a threshold analysis of asymmetric adjustments, *The Quarterly Review of Economics and Finance* 88: 215–27.
Vieira, Falvio V., Marcio Holland, Cleomar Gomes da Silva, and Luiz Bottecchia. 2013. Growth and Exchange Rate Volatility: A Panel Data Analysis. *Applied Economics* 45: 3733–41.