



# **Estimating the Impact of the Macroeconomic Indicators Shocks on KSA Non-oil Exports 1970-2019: (SVAR) Analysis and (NARDL) Assessment**

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## **ABSTRACT**

Studies employ various methods to explain the presence of the Impact of the macroeconomic indicators shocks on non-oil exports, including applying models to the case of emerging economies. However, the non-oil exports have different determinants in some countries. To revisit this puzzle, we analyzed the Estimating the Impact of the macroeconomic indicators shocks on KSA non-oil exports: (SVAR) analysis and (NARDL) assessment. Short run and long run shocks between the selected variables and result's is checked through the SVAR, NARDL model. Our results confirm co-integration, positive shocks results show that macroeconomic indicators shocks have significantly influence on non-oil exports. The empirical results based on SVAR, NARDL most relationships are weak and negative except for non-oil exports, monetary reserves. Here we can observe the elasticities or contemporaneous relations between variables. We see negative relations between non-oil exports and GDP, Exchange Rate and inflation in the same interval, while an increase in non-oil exports has nearly no impact on both GDP, exchange rate and inflation. The results provide statistically, economics supported evidence that can guide policy makers regarding action priorities and identify other opportunities to facilitate reducing the Impact of the macroeconomic indicators shocks on non-oil exports in Saudi Arabia.

**Keywords:** Non-oil Exports, Inflation Rate, Monetary Reserves, Gross Domestic Product, Structural Vector Autoregression, Nonlinear Autoregressive Distributive Lag

**JEL Classifications:** E31, E52

## **1. INTRODUCTION**

Non-oil exports in Saudi Arabia decreased to 47050 Million SAR in the first quarter of 2020 from 52787 Million SAR in the fourth quarter of 2019. Non-Oil Exports in Saudi Arabia averaged 41964.28 Million SAR from 2006 until 2020, reaching an all-time high of 60357 Million SAR in the second quarter of 2018 and a record low of 19786 Million SAR in the first quarter of 2006. Data from the Saudi Arabian Monetary Agency (SAMA, 2016) suggests relationships may exist between non-oil exports, Inflation rate, stability of real effective exchange rate, and international reserves, and real GDP. Moreover, during the past few years, the non-oil trade deficit in Saudi Arabia has come under great

scrutiny, leading to questions regarding the factors that may have contributed to this deficit.

Macroeconomics helps to understand the functioning of a complicated modern economic system. It describes how the economy as a whole functions and how the level of national income and employment is determined on the basis of aggregate demand and aggregate supply, to achieve the goal of economic growth, higher level of GDP, and higher level of employment. It analyzes the forces which determine economic growth of a country and explains how to reach the highest state of economic growth and sustain it and also how to bring stability in price level and analyze fluctuations in business activities.

It suggests policy measures to control inflation and deflation (Mohsen, 2014).

Specifically, this study examined the Impact of the macroeconomic indicators shocks like (real effective exchange rate, and international reserves and GDP) on KSA non-oil exports from 1970 to 2019: (SVAR) analysis and (NARDL) assessment. The results provide statistically, economics supported evidence that can guide policy makers regarding action priorities and identify other opportunities to facilitate reducing the Impact of the macroeconomic indicators shocks on non-oil exports in Saudi Arabia. Also, this research substantially increases the body of knowledge regarding the validity of Dependence on export diversification as a mechanism to address structural imbalances in the economy. It is against this background that this study examined the Estimating the Impact of the macroeconomic indicators shocks on KSA non-oil exports between 1970 and 2019; while addressing the following issues: (1). What is the trend and impact of macroeconomic indicators shocks on non-oil exports in KSA?. (2). Is there any significant relationship between macroeconomic indicators shocks and non-oil exports in KSA? (3). What is the effect of macroeconomic indicators shocks on non-oil exports in KSA?

The model constructed using the (SVAR, NARDL) for measuring Estimating the Impact of the macroeconomic indicators shocks on KSA non-oil exports. non-oil exports can generate effects on the level and volatility of inflation, can influence the level of the GDP, can And increase the strength of monetary reserves, exchange rate stability. Moreover, non-oil exports level can also influence some other macroeconomic indicators variables. On the other hand, some papers demonstrate that prediction performance might be very poor if traditional statistical and econometric models, such as linear regressions, are employed (Weigend and Gershenfeld, 1994). This is because traditional statistical and econometric models are built on linear assumptions, which, as a result, fail to capture the nonlinear patterns hidden in a series of some economic variables (Yu et al., 2007). It is a fact that of some economic variables may not adjust instantaneously to newly available information.

## 2. LITERATURE REVIEW

Engaging in Export diversification is recognized as a successful method for developing economic growth, a robust monetary reserves, and achieve welfare. Non-oil exports accounts for Rated ratio of the gross domestic product (GDP) of several Oil-exporting countries, especially in light of oil price shocks and the Corona epidemic. Saudi non-oil economy recorded a 3.3% growth at the end of last year, with the overall growth of 0.3% during 2019, according to the Saudi General Authority for Statistics. The total economic growth was below expectations, however, the contraction of the oil sector was remarkably noticeable with the non-oil sector increasing its contribution to reaching 3.3%, as the Saudi government aims to increase the private sector's contribution to the country's GDP. According to the latest data from the Ministry of Economy and Planning, there has been a sharp rise in the non-oil exports in 2019. In the first quarter, non-oil exports reached a US\$ 3.13 billion (SR 11.73 billion), up some 37% from

US\$ 2.28 billion (SR 8.55 billion) in the same quarter of year 2018. The Ministry expects this trend to continue, particularly as high levels of investment are currently being channeled into the industrial sector.

Few studies have been conducted to study the relationship between macroeconomic indicators shocks, non-oil exports a in the literature. The result of these studies varies from one to the other; owing to the difference in methodologies and time frames as well as the variables captured in the models. Therefore, in the present study we employ the more robust technique SVAR and NARDL, and apply multivariate framework by including macroeconomic indicators with non-oil exports. These state-of-the-art techniques have not been employed in the KSA context to study the relationships among these variables. Although the ample number of studies focused on causality between Non-oil exports and some of macroeconomic indicators, the consensus has not been reached yet. Thus, more research should be done to establish the direction and the Impact of the macroeconomic indicators shocks on KSA non-oil exports using these techniques and Approach e.g., (Zaheer, 2017), This study examines the dynamic effects of the oil price (OP) shocks on the key macroeconomic variables of Pakistan. A structural vector autoregressive model is used on yearly data from 1960 to 2014. The impulse response functions indicate that the OP shocks depress the real gross domestic product while the real exchange rate also experiences depreciation. However, the long-term interest rate and the inflation rate (INF) rise as a result of a positive OP shock. The unanticipated changes in these macroeconomic variables threaten the economic stability of Pakistan; specifically, higher inflation and interest rates hamper the economy's growth rate. Lastly, the variance decomposition analysis illustrates that the OP shocks have the most impact on the INF of Pakistan.

A large empirical literature has examined the transmission mechanism of structural shocks in great detail (Mumtaz, 2011). The possible role played by changes in the volatility of shocks has largely been overlooked in vector autoregression based applications. This paper proposes an extended vector autoregression where the volatility of structural shocks is allowed to be time-varying and to have a direct impact on the endogenous variables included in the model. The proposed model is applied to US data to consider the potential impact of changes in the volatility of monetary policy shocks. The results suggest that while an increase in this volatility has a statistically significant impact on GDP growth and inflation, the relative contribution of these shocks to the forecast error variance of these variables is estimated to be small.

Kose and Baimaganbetov (2015) assesses empirically the asymmetric effects of real oil price shocks on the industrial production, real exchange rate and inflation in Kazakhstan for the monthly period 2000-2013 by using a structural vector autoregression (SVAR) model. SVAR analysis is carried out using the scaled model. The empirical findings show that the negative oil price shocks have a larger impact on Kazakhstan economic performance.

Mohaddes (2019) developed a quarterly macro-econometric model for the Saudi economy over the period 1981Q2-2018Q2 and integrate it within a compact model of the world economy (including the global oil market). This framework enables us to disentangle the size and speed of the transmission of growth shocks originating from the United States, China and the world economy to Saudi Arabia, as well as study the implications of stress in global financial markets, low oil prices and domestic fiscal adjustment on the Saudi economy. Results show that Saudi Arabia's economy is more sensitive to developments in China than to shocks in the United States—in line with the direction of evolving trade patterns and China's growing role in the global oil market. A global growth slowdown (e.g., from trade tensions or geopolitical developments) could have significant implications for Saudi Arabia (with a growth elasticity of about 2½ after 1 year) and the oil market (reducing prices by about 5% for 0.5 percentage point reduction in global growth). We also illustrate that a 10% lower oil prices and stress in global financial markets could both have a negative effect on the Saudi economy, but given the prevailing social contract in Saudi Arabia, their impact is countered by fiscal easing. Finally, we argue that a domestic fiscal adjustment in Saudi Arabia does not show a negative impact on economic growth in the data. The impact on growth would depend upon the quality of fiscal adjustment and whether it is complemented with structural reforms or not.

Economists agree that persistent trade deficits indicate poor economic health (Aljebrin, 2019). However, opinions vary widely regarding the factors that influence trade deficits. The researcher used stock and Watson's dynamic ordinary least squares (DOLS) approach (1993) as an empirical method to estimate the critical parameters of the non-oil trade deficit in Saudi Arabia over a 25-year period (1998-2015). To meet the requirements of the DOLS application, a time series was used to analyze the data. This allowed the designation of the order of integration for each series, generating the data for review. The results of our assessment suggest that a unique theoretical sign can be expected for the individual variables. This confirms that statistically significant positive relationships exist between the non-oil trade deficit and (a) real income, (b) relative national prices to foreign prices, and (c) international reserves. In contrast, a negative and considerable correlation was found between the Real Effective Exchange Rate (REER) and the non-oil trade deficit. Policymakers are currently challenged with controlling the domestic inflation rate, and the results of this study substantiate the positive relationship between Saudi Arabia's non-oil trade deficit and relative domestic to foreign prices. Therefore, the findings indicate that controlling domestic prices is an important element of managing the non-oil trade deficit. The negative relationship between the non-oil trade deficit and real effective exchange rate strongly suggests that policymakers should also support the real effective exchange rate. Saudi Arabia needs strategic plans and policies that promote the development of innovative and dynamic trade sectors that potentially accelerate economic diversification. Economic diversification is dependent on inventive processes that improve productivity, products that promote sustainable growth, new markets, and institutions that allow for more efficient production. Strategies should strive to encourage both vertical and horizontal diversification beyond oil production, which would further integrate non-oil trade into the

global value chain and attract foreign direct investment to the non-oil sector.

### 2.1. Economic Structure in Saudi Arabia

The Saudi economy maintained its growth throughout 2016-2019 by investing in development projects and continuing structural and regulatory reforms. These reforms focused on attaining economic growth sustained through a diversified production base and varying the types of goods and services exported, in addition to expanding the non-oil sector's contributions. Saudi Arabia's real GDP increased by 3.5% to a little over SAR 2,520 billion in 2015 based on the 2010 constant prices, which is comparable to the increase of 3.6% in 2014. In 2015, the GDP of the oil sector grew by 4.0% to just over SAR 1,085 billion, and the overall GDP of the non-oil sector rose by slightly more than 3% to almost SAR 1,415 billion. In 2015, the growth rate of the non-oil private sector GDP increased by 3.4% to almost SAR 990 billion, while that of the non-oil government sector increased 2.5% to nearly SAR 425 billion (SAMA, 2016).

### 2.2. The Economic Transmission Mechanism in KSA

In Saudi Arabia, monetary policy is tied to exchange rate policy. The policy objective is to maintain the dollar/riyal exchange rate as stable as possible so that public confidence is maintained and the inflow of capital is encouraged for domestic investment. Against this background, exchange rate policy has generally reflected the goal of internal price stability and balance-of-payments considerations. In achieving these objectives, SAMA moved from the SDR to the dollar as the numeracies for the riyal. In times of capital surpluses (the late 1970s) the riyal remained pegged to a strong numeracies, and the dollar/riyal exchange rate was frequently adjusted to reflect the SDR's strength against the dollar. Stability is difficult to define, particularly when a currency is pegged to a reserve currency or a basket of currencies. In Saudi Arabia, stability has been defined with reference to the dollar, which is the intervention currency. The dollar is used as an intervention currency because oil income is denominated and received in dollars. This means that the riyal virtually floats against non-dollar currencies. Frequent changes in the exchange rate tend to inject uncertainty in estimating the cost of imported goods and services. It is, therefore, considered desirable to keep the exchange rate as stable as possible and to adjust it only when absolutely necessary. In the 1980s, the balance of payments remained the overriding factor in exchange rate policy. The correction in the value of the dollar from the mid-1980s has been instrumental in reducing Saudi Arabia's current account deficit (except in the immediate aftermath of the Gulf crisis). The combination of the decline in the dollar (the numeraire) and low domestic inflation rate has prevented the riyal from becoming overvalued, as measured by the IMF's real effective exchange rate (Al-Jasser, 2008).

After reviewing the previous studies and according to the researcher's knowledge, there is no study that investigates this problem and these methodologies and models. Motivated by these lacunas, it is needed to establish an empirical study to re-investigate the Impact of the macroeconomic indicators shocks on KSA non-oil exports using a multivariate framework. This study differs from the previous studies in at least two dimensions.

First, besides the SVAR and NARDL. The remainder of this paper or article is organized and divided as follows. Section 2 will discuss the data, empirical model and econometric methods used in this study. Section 3 will present the empirical findings of this study. Finally, Section 4 will report the concluding remarks of this study.

### 2.3. KSA Non-oil exports and Macroeconomic Variables

Figures 1-5 shows the graph of KSA non-oil exports and Macroeconomic Variables. From the graphs it is observable that there is serious co-movement between change KSA non-oil exports and Macroeconomic Variables. A critical look at the graphs indicates that most period of economic downturn in the KSA coincides with the period of fall in GDP. Similarly, period of economic boom in the country also coincides with period of hike in GDP thus this suggests that GDP is a very important determinant of economic performance in the KSA.

## 3. DATA, MODEL AND METHODS

### 3.1. Data and Empirical Modeling

Data were collected the annual data for non-oil exports and macroeconomic indicators shocks from the International Monetary Fund. Annual sample period from 1970 to 2019. The descriptive statistics show that the standard deviations differ among variables. In addition, at the 5% significance level, we find that all variables are normally distributed (Jarque-Bera, Skewness and Kurtosis statistics) Table 1.

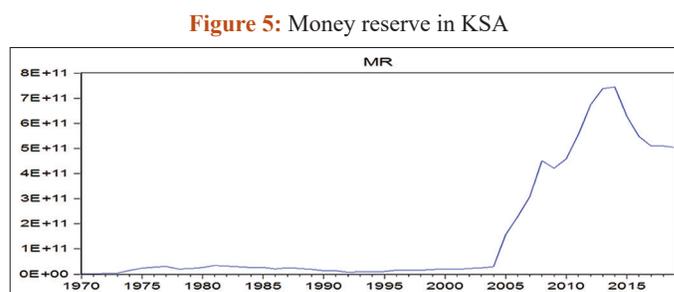
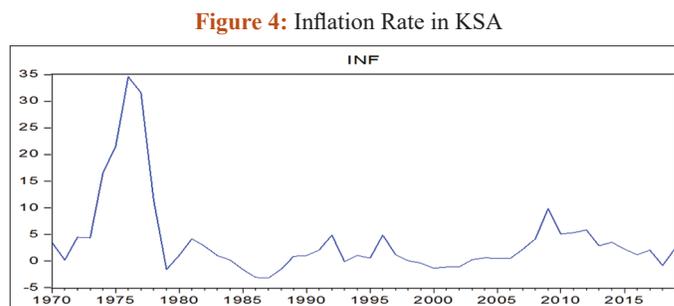
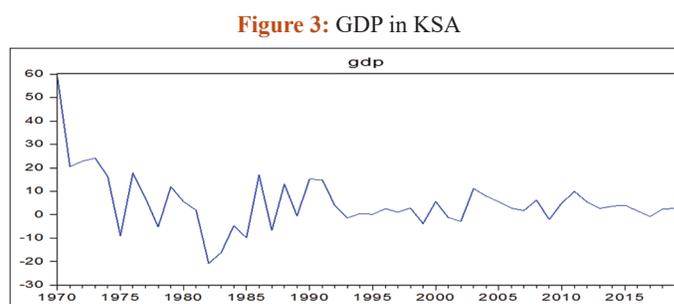
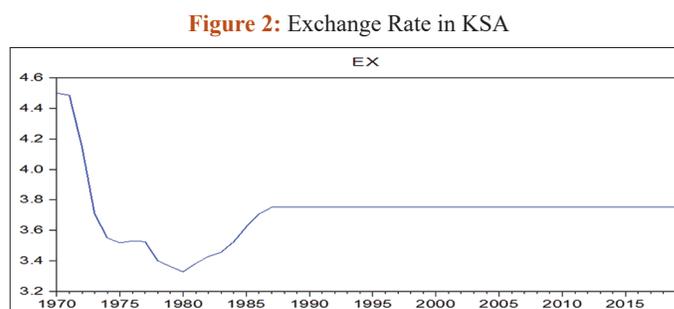
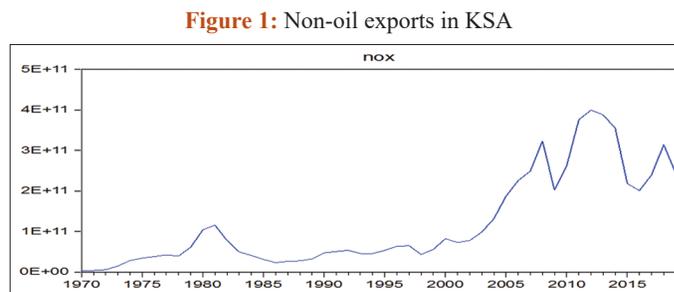
### 3.2. Accommodations Approach (Methodology)

Prior empirical and theoretical analyses imply that there are many factors that influence the non-oil exports. The researcher investigated potential Impact of the macroeconomic indicators shocks on KSA non-oil exports and the factors likely to affect the non-oil exports, basing the assessment on the macroeconomic indicators shocks. The macroeconomic indicators that were considered for this study were summarized, like inflation rat (INF), monetary reserves (MR), exchange rate stability (EX), and Gross Domestic Product, (GDP).

$$NOE_t = B_0 + B_1 INF_t + B_2 MR_t + B_3 EX_t + B_4 GDP_t + U_t$$

#### 3.2.1. SVAR approach

Sims (1980a) suggested that VARs are a fruitful way to organize data because they can be used as a sort of battleground for testing alternative theories. Our experience over the past 30 years has confirmed the wisdom of this suggestion. In some respects, VARs represent a natural statistical tool for economists. Economists are accustomed to thinking of economic models in terms of impulses and propagation mechanisms, and VARs are a device for organizing the data precisely into these categories (Sims, 1980a). The methodology used is a structural SVAR that uses restrictions imposed by economic theory to uncover the system. They for, it is needed to have in mind that a SVAR is only a theoretical construct and as Sims (1980) said, it is an interpretation of historical data and it is non-observable so it can't be estimated directly. The structural form VAR model of the study:



$$AX_t = B_0 + \gamma(K) X_{t-1} + Be_t$$

where  $\beta_0$  is a constant,  $\gamma(K)$  is a fourth order lag polynomial,  $e_t$  is a vector of the structural shocks,  $(X_t) = (INF_t, MR_t, EXR_t, RGDP_t)$

**Table 1: Descriptive statistics**

Statistics	MR	INF	GDP	EX	NOX
Mean	161750724980.049	3.734941	5.063976	3.718312	119462061113.1257
Median	161750724980.049	1.214072	2.840882	3.750000	62431688637.29756
Maximum	744440513643.462	34.57611	8.64733	4.500000	399419733333.3334
Minimum	669558000	-3.203331	-20.72989	3.326742	2731714666.666667
Std. Deviation	238994285619.1253	7.517770	11.90510	0.214502	115273837921.2691
Skewness	1.260147039832232	2.769170	1.705150	1.580041	1.108188
Kurtosis	2.968903737564805	10.72339	9.759317	8.230227	2.932769
Jarque Bera	13.23510	188.1750	119.4136	77.79457	10.24342

is the vector containing the endogenous variables and ( $A$ ) is a matrix describing the relation among the endogenous variables in time ( $t$ ), or in other words, the contemporaneous relation or elasticities between them. From the structural form we can multiply by  $X_{t-1}$  in order to obtain the reduced form VAR to be able to estimate the model, ( $e_t$ ) is a vector of the structural shocks. Estimation gives the error terms  $e$  defined as  $e_t = B^{-1}\varepsilon_t$  so  $\varepsilon_t = Be_t$ . The main purpose of SVAR estimation is to obtain non-recursive orthogonalization of the error terms for impulse response analysis. ( $Ae_t = Bu_t$ ). In order to estimate the orthogonal factorization matrices you need to provide additional identifying restrictions. Two types of identifying restrictions: short-run and long-run. For either type, the identifying restrictions can be specified either in text form or by pattern matrices.

**3.2.2. System of SVAR**

Sims (1980) suggested using a recursive system. For this we need to restrict some of the parameters in the VAR. Ex: assume  $y$  is contemporaneously affected by  $z$  but not vice-versa. Thus we assume that  $b_{12}=0$ . In other words,  $y$  is affected by both structural innovations of  $y$  and  $z$ , while  $z$  is affected only by its own structural innovation. This is a triangular decomposition also called Cholesky decomposition. Then we have 9 parameter estimates and 9 unknown structural parameters, and SVAR is exactly identified. Now the SVAR system becomes:

$$\begin{bmatrix} 1 & b_{12} \\ 0 & 1 \end{bmatrix} \begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

$$B^{-1} = \frac{1}{(1-b_{21}b_{12})} \begin{bmatrix} 1 & -b_{12} \\ -b_{21} & 1 \end{bmatrix} = \begin{bmatrix} 1 & -b_{12} \\ 0 & 1 \end{bmatrix}$$

Hence the VAR system in standard form can be written:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} b_{10} - b_{12}b_{20} \\ b_{20} \end{bmatrix} + \begin{bmatrix} (c_{11} - b_{12}c_{21}) & (c_{12} - b_{12}c_{22}) \\ c_{21} & c_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{yt} - b_{12}\varepsilon_{zt} \\ \varepsilon_{zt} \end{bmatrix}$$

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}$$

If we match the coefficients in matrix with the estimates in function, we can extract the coefficients of the SVAR:

$$a_{10} = b_{10} - b_{12}b_{20} \quad a_{20} = b_{20} \quad e_1 = \varepsilon_y - b_{12}e_z$$

$$a_{11} = c_{11} - b_{12}c_{21} \quad a_{21} = c_{21} \quad e_2 = e_z$$

$$a_{12} = c_{12} - b_{12}c_{22} \quad a_{22} = c_{22}$$

$$Cov_{12} = \frac{-(b_{12}\sigma_z^2 + b_{21}\sigma_y^2)}{\Delta^2} = -b_{12}\sigma_z^2$$

**3.2.3. Objections to the SVAR methodology**

The SVAR methodology has become a popular but controversial tool for the analysis of the monetary transmission mechanism and business cycle fluctuations. The main challenges to the SVAR approach. These can be grouped into three categories: First, many observers have doubts on the role of shocks in SVAR models. Particular in monetary economics it is questionable whether the estimated monetary policy shocks are truly measuring a relevant part of central bank behavior. Second, there is concern that the widespread use of informal restrictions in SVAR models may give rise to undisciplined data mining. This raises the broader question of what can be learned from these models if they reflect, due to the informal restrictions, largely the prejudice of the modeler. Third, the orthogonally restriction is a major source of concern (Gottschalk, 2001).

**3.2.4. The nonlinear ARDL model (NARDL)**

The asymmetric ARDL model is essentially an asymmetric extension of the linear ARDL approach to modeling long-run levels. Shin et al (2012) made two important contributions. First, they derived the dynamic error correction representation associated with the asymmetric long-run cointegrating regression, resulting in the nonlinear autoregressive distributed lag (NARDL) model. Second, they developed asymmetric cumulative dynamic multipliers that allow them to trace the asymmetric adjustment patterns following positive and negative shocks to the explanatory variables.

One main features of these models is that they estimate long term relationship between model variables and also short term dynamism of model. In addition, Measuring long-term equilibrium relationship with a non-linear method it enables researcher to identify how much time is needed for an effect of one shock on model to be adjusted. The asymmetric nonlinear model NARDL applied in this paper is a relatively new technique for detecting both long- and short-run asymmetries between economic variables. The model was advanced by Shin et al. (2009) and is an asymmetric expansion of the above mentioned linear ARDL model. Following Pesaran and Shin (1998), Pesaran et al. (2001), Schorderet (2004)

**Table 2: Unit root tests**

Variables	Augmented Dickey- Fuller		Philip-Perron test (PP)		KPSS test		Remarks
	Level	1 <sup>st</sup> difference	Level	1 <sup>st</sup> difference	Level	1 <sup>st</sup> difference	
NOEt	-1.2246	-6.057***	-1.101	-5.980***	0.706	0.0924**	1
INFt	-2.343	-5.127***	-2.537	-4.993***	0.252	0.0787*	1
MRt	-0.915	-3.713***	-0.546	-3.741***	0.631	0.154**	1
EXt	-13.758**	-7.716***	-3.983***	-2.904***	0.108	0.324***	1
GDPt	-6.950**	-12.361***	-6.950**	-14.214***	0.266*	0.310***	1

The ADF unit root tests have been performed with intercept and trend first at the level and then at first difference. Also, The PP unit root tests have been performed with Newey-West using Bartlett Kernel. The root test results for KPSS. The Spectral estimation method selected is Bartlett Kernel, and the Newey-West method is used for bandwidth. (\*, \*\*, \*\*\*) represents significance at 10%, 5%, and 1%

and Shin et al. (2009). Furthermore, if  $x$  and  $y$  have nonlinear relationships, the use of the ARDL approach is inappropriate. Authors in (Shin et al., 2014) proposed an extension of (Shin and Smith, 2001) to characterize the asymmetric property of two series. In line with (Shin et al., 2014), the nonlinear version of the NARDL approach can be defined as:

$$NOE_t = f(INF_t^+, INF_t^-, MR_t^+, MR_t^-, EXR_t^+, EXR_t^-, RGDP_t^+, RGDP_t^-)$$

Transformation the NARDL into positive and negative partial sums the NARDL with (p, q)

$$J_t^+ = \sum_{k=1}^t \Delta J_t^+ = \sum_{k=1}^t \max(\Delta J_t, 0) \text{ and } J_t^- = \sum_{k=1}^t \Delta J_t^- = \sum_{k=1}^t \min(\Delta J_t, 0)$$

## 4. EMPIRICAL RESULTS AND DISCUSSION

The starting point is to study the time series properties of the variables under consideration to avoid any spurious relationships between them. If the time series properties of the variables are satisfied, then possible long-term relationships or co-integration are likely to exist, The analytical procedure adopted in this study include: the specification of the empirical models, the concept of SVAR, NARDL. The baseline empirical model is specified to capture the hypothesized relationship among the core variables namely  $NOEt$ ,  $INFt$ ,  $MRt$ ,  $EXt$ ,  $GDPt$  in KSA. The test for the stationarity status of all variables to determine their order of integration is necessary before proceeding with the SVAR, NARDL tests, the ADF, PP and KPSS methods are used to determine the stationary of the variables and the results are presented in Table 2.

### 4.1. Unit Root Tests (ADF), (PP) and (KPSS)

The presence of unit root indicates that a time series is nonstationary. Unit root tests proposed by Phillips (1987) and Perron (1988), Augmented Dickey-Fuller (Dickey and Fuller (1979)), and the KPSS test.

### 4.2. SVAR

Most relationships are weak and negative except for non-oil exports, monetary reserves, GDP and exchange rate (Table 3). Here we can observe the elasticities or contemporaneous relations between variables. We see negative relations between non-oil exports and GDP, exchange Rate and inflation in the same interval, while an increase in non-oil exports has nearly no impact on both GDP, exchange rate and inflation.

**Table 3: Estimated A matrix (SVAR)**

	NOX	INF	GDP	EX	MR
NOX	1	-0.069	-0.140	-0.011	0.934
INF	-0.069	1	0.104	-0.240	-0.026
GDP	-0.140	0.104	1	0.603	-0.097
EX	-0.011	-0.2407	0.603	1	0.067
MR	0.934	-0.0267	-0.097	0.067	1

The LR, AIC, SC and HQ information criteria all suggest 5 lags respectively, which is indicated by the asterisk (\*) next to the test statistic (Table 4). As most of the time these information criteria frequently indicate different lag lengths, meaning that the 'correct' lag length can depend on the criteria or measure we use. This is typical of these tests and researchers often use the criterion most "convenient" for their needs.

There is a noteworthy contribution of macroeconomic indicators uncertainty shock to non-oil exports of 2.4% over the 10 years horizon thus non-oil exports uncertainty shock explains between 0.30 and 5.01% variations in GDP (Table 5). The same pattern is also observed for the all the variables. Similarly there is a notable contribution to INF over the 10 years horizon where the non-oil exports uncertainty shock explains between 0.37 and 5.05% variations in INF.

Graphs show the impact of an initial increase of a unit of non-oil exports on all the variables of macroeconomic indicators shocks in KSA during a period of (10 years). In response to a positive one-standard deviation structural shock to non-oil exports, the non-oil exports gap first increases for some two periods before falling thereafter, inflation increases and is positive for all 10 periods and the exchange rate increases in response to a shock to itself. The positive response of the non-oil exports gap is insignificant throughout, GDP shows a significant response to ff between periods 4 and 7 and the positive shock of non-oil exports to itself persists from some 7 periods.

### 4.3. Results of NARDL

Table 4 reveals the arguments for valid long-run relationships among the variables. According to the results of Table 4, the null hypothesis of long-run and short run symmetry is clearly rejected at the 1% level. For Model 1, the null hypothesis of only long run symmetry is clearly rejected at the 1% level. The F-test indicates co-integration in both cases. The models show that the Wald test is unable to reject long-run asymmetry. Therefore, in the long run, non-oil export will converge toward a symmetric long run relationship between macroeconomic indicators shocks.

**Table 4: VAR lag order selection criteria**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2680.781	NA	4.77e+45	<b>119.3680</b>	119.5688	<b>119.4429</b>
1	-2463.705	<b>376.2650</b>	9.43e+41	<b>110.8313</b>	112.0358	<b>111.2803</b>
2	-2420.419	<b>65.40907</b>	4.37e+41	<b>110.0186</b>	112.2268	<b>110.8418</b>
3	-2399.362	<b>27.14081</b>	5.82e+41	<b>110.1939</b>	113.4057	<b>111.3912</b>
4	-2350.636	<b>51.97421</b>	2.55e+41	<b>109.1394</b>	113.3549	<b>110.7109</b>
5	-2305.722	<b>37.92738*</b>	1.60e+41*	<b>108.2543*</b>	111.4736*	<b>110.2000*</b>

\*indicates lag order selected by the criterion

**Table 5: Forecast error variance decomposition of realised volatility**

Time	INF	MR	EX	GDP
1	2.972420	0.473735	1.016032	3.531138
2	2.821009	0.492195	1.037696	5.773700
3	4.164929	0.722415	1.020617	5.720812
4	4.591837	1.003268	1.058339	5.671616
5	4.605921	1.010148	1.059019	6.053286
6	4.821101	1.044772	1.073506	6.025696
7	4.767501	1.028634	1.683206	6.078060
8	4.757896	1.024282	1.723763	6.126808
9	4.737653	1.018239	1.935262	6.097027
10	4.809306	1.027882	2.178956	6.062263

**Table 6: Results of NARDL**

Dependent variable: LnNOE <sub>t</sub>			
Long-run results non-linear specification			
Variable	Coefficient	Stan. Error	t-Stat
D(MR_POS)	0.834461	0.085420	9.768952***
D(MR_NEG)	1.348574	0.145519	9.267361***
D(INF_POS)	-1303312719.085505	1019989211.070478	0.000000***
D(INF_NEG)	595290686.509310	773073276.845801	0.000000***
D(GDP_POS)	1738051929.247912	541016418.060525	0.000000***
D(GDP_NEG)	-579828285.378776	575878702.497763	0.000000***
D(EX_POS)	-52730235905.781450	144055901886.63059	0.000000***
D(EX_NEG)	-39328059523.781138	35598643463.218681	0.000000***
CointEq(-1)	-1.007601	0.090614	-11.119731***
R <sup>2</sup> = 0.91,	R <sup>2</sup> = 0.87,	F-test=3.890570	D.W= 2.06
SSE=	SSR,	ARCH=3.89	JB=5.21
WLS=28.206			
Cointeq = NOX - (0.3263*MR_POS + 0.3830*MR_NEG -1293480329.4*INF_POS -453508064.02*INF_NEG + 2255748225.6*GDP_POS + 255176411.7*GDP_NEG - 441042003862.6*EX_POS - 39031362654.4*EX_NEG - 3893612548.8)			

**Table 7: Results of Wald test**

Wald test			
Equation: NARDL(1, 1,1,0,1,1,1,1,0)			
Test statistic	Value	df	Probability
F-statistic	28.20622	(4, 32)	0.0000
Chi-square	112.8249	4	0.0000

Null hypothesis: C(2)=C(3)=C(4)=C(5)=0

0.62 AND will reduce the Real Gross Domestic Product by 0.75 (appreciation) and similar negative movement will increase the exchange rate by 0.81%, will increase inflation rate by 0.38, will increase the monetary reserves by 0.52 AND will increase the Real Gross Domestic Product by 0.44 (depreciation) in the short run. This indicates that negative movement has more influence on exchange rate in the short-run. In long-run.

Macroeconomic indicators shocks in KSA are more willing to increase non-oil exports instantaneously in case of an increase in non-oil exports. However, non-oil exports exhibit more flexible behavior than Macroeconomic indicators in case of increase and decrease of (INF), (GDP). The important point is that the short-run negative asymmetry is more persistent in KSA. According to short-run coefficients, an increase in non-oil exports is passed through to (MR), (EX). The results show that 1% positive movement in non-oil exports will reduce the exchange rate by 0.05%, will reduce the inflation rate by 0.08, will reduce the monetary reserves by

(+) and (-) denote the long-run coefficients associated with positive and negative changes of non-oil exports. SSE = Standard Error of Estimate, SSR = Sum of Squared Residuals, JB = Jarque-Bera Test, ARCH = Autoregressive Conditional Heteroskedasticity. WLS refers to the Wald test of long-run symmetry while WKS denotes the Wald test of the additive short run symmetry condition. F denotes the Pesaran Shin-Simith F test statistic for k=4. Upper-bound test statistic at 1%, 2.5%, 5% and 10% are 4.1, 3.7, 3.39 and 3.06. The results indicate that the computed F-statistics for the model is greater than the upper bound critical value of 3.89 at 1% significance level. This implies that there is a long run nonlinear

relationship between non-oil export and macroeconomic indicators shocks in KSA.

4.3.1. Cumulative asymmetric adjustments

The asymmetric adjustments from an initial long-run equilibrium to a new long-run equilibrium after a negative or positive unitary shock affecting the non-oil export in KSA can be learned from the dynamic multipliers (Table 6). Figure 6 show the predicted dynamic

multipliers for the adjustment of macroeconomic indicators shocks under the four NARDL specifications we consider. The asymmetry curve depicts the linear combination of the dynamic multipliers associated with positive and negative shocks. The positive and negative change curves provide the information about the asymmetric adjustment to positive and negative shocks at a given forecasting horizon respectively. Lower band and upper band for asymmetry indicate the 95% confidence interval.

Figure 6: Impulse-response results of macroeconomic indicators shocks on KSA non-oil export

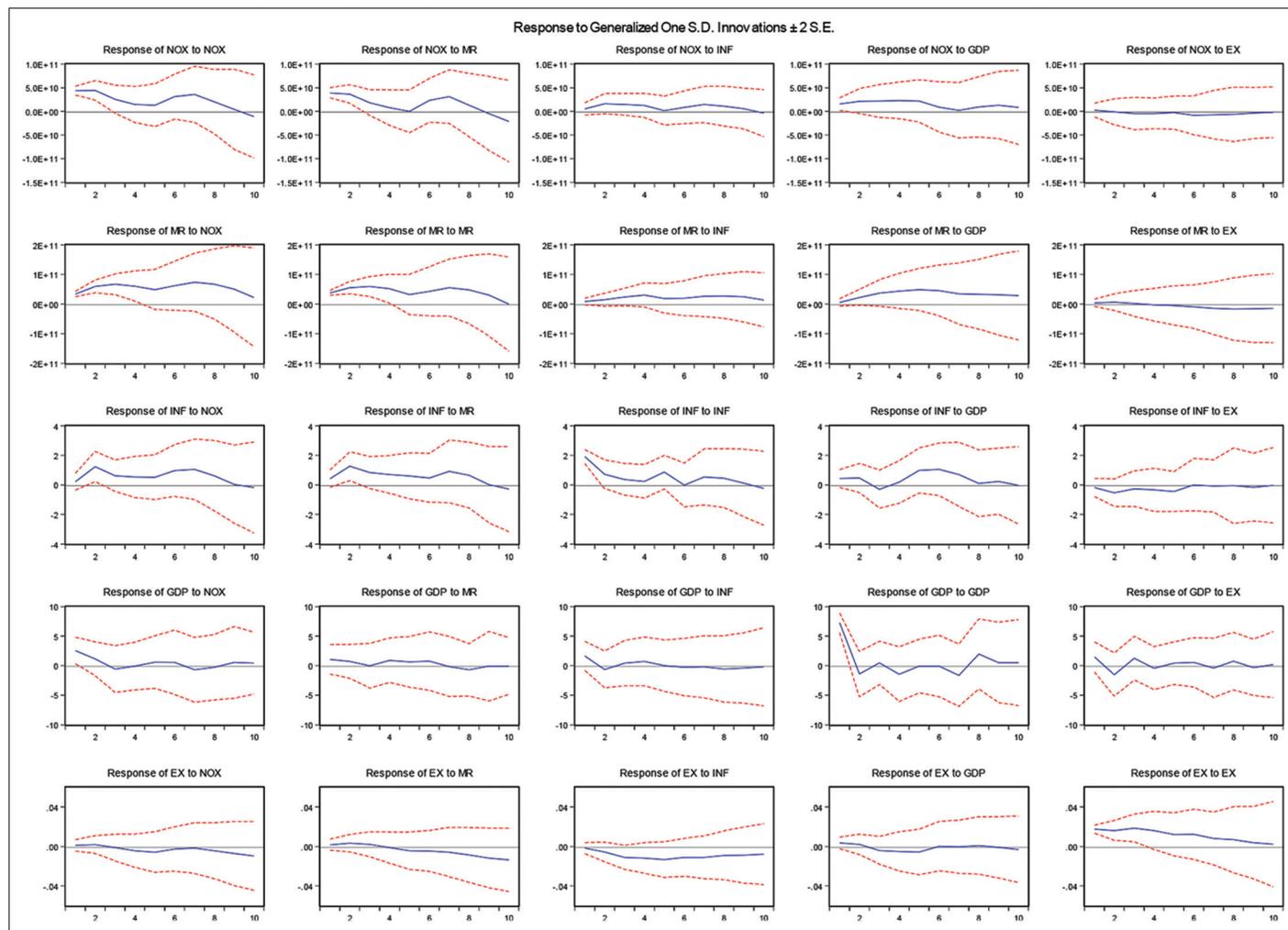


Table 8: Short-run NARDL results

Dependent Variable: LnNOE <sub>t</sub>			
Short-run results Non- Linear Specification			
Variable	Coefficient	Stan. Error	t-Stat
D(MR_POS)	0.326317	0.020907	15.607903***
D(MR_NEG)	0.382996	0.062424	6.135406***
D(INF_POS)	-1293480329.483587	1021498966.005065	-1.266257
D(INF_NEG)	-453508064.026827	563892295.021929	-0.804246
D(GDP_POS)	2255748225.610276	520830216.449895	4.331063***
D(GDP_NEG)	255176411.758324	553651745.058786	0.460897
D(EX_POS)	-441042003862.65525	70175765142.353150	-6.284819***
D(EX_NEG)	-39031362654.439950	35661189697.019981	-1.094505
CoIntEq(-1)	-3893612548.898918	30674082610.416831	-2.126935**
R <sup>2</sup> =0.91,		R <sup>2</sup> = 0.87,	F-test=3.890570
D.W=2.06		SSE=	SSR=
ARCH=3.89		JB= 5.21	WLS= 28.206

**Figure 7:** Cumulative asymmetric adjustments of non-oil export in KSA

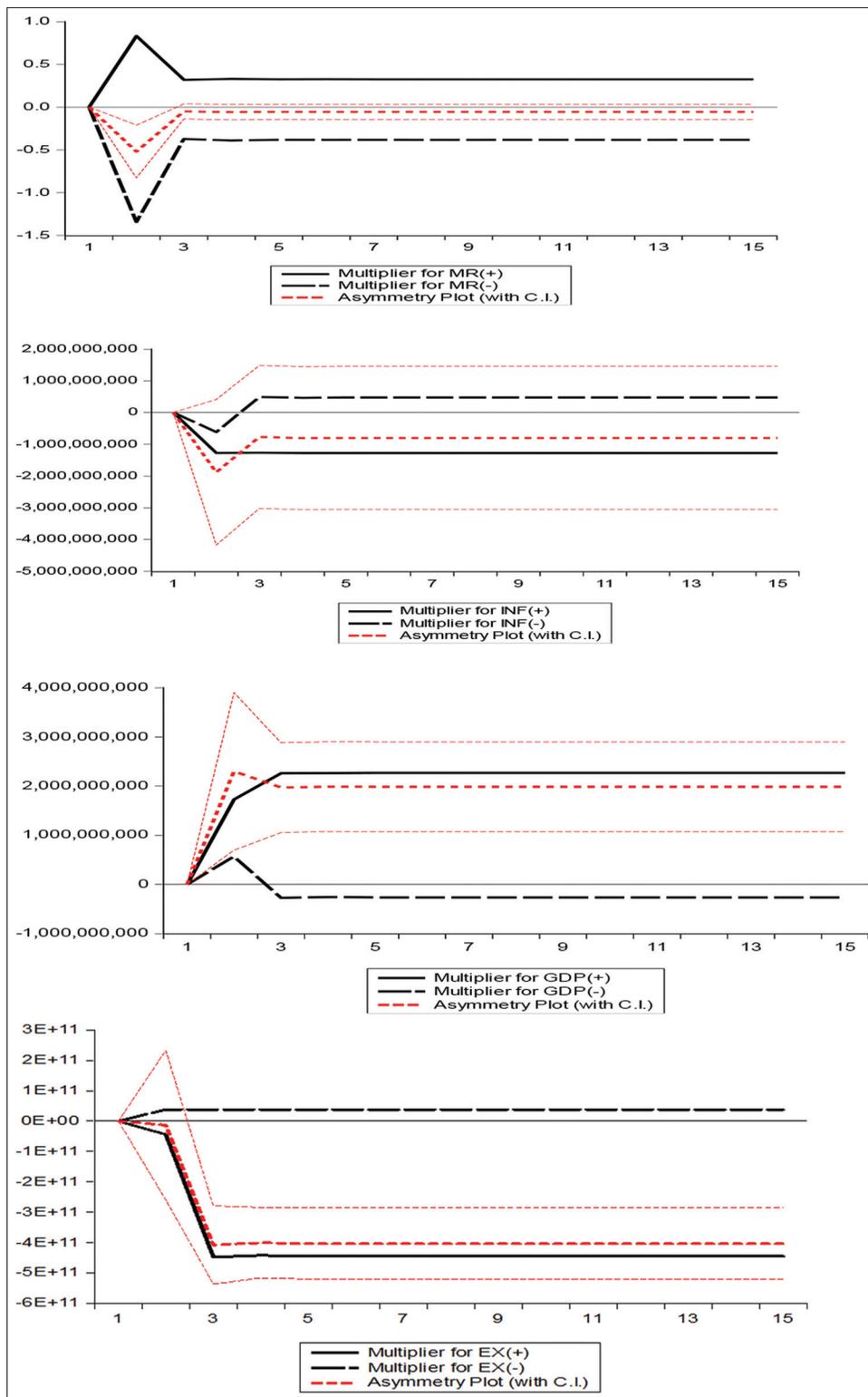


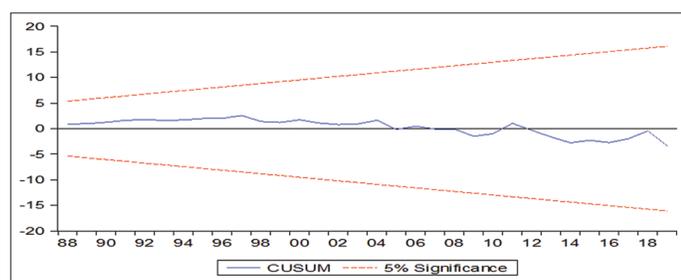
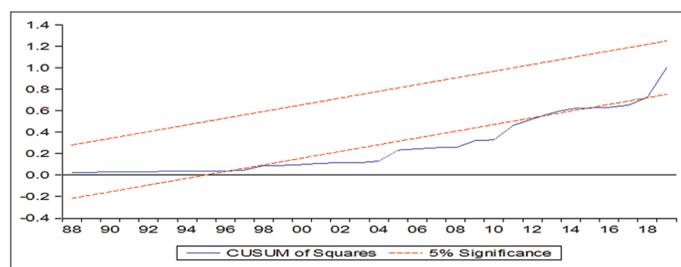
Figure 7 depict the asymmetric adjustments from an initial long-run equilibrium to a new long-run equilibrium. The results of the Wald tests for symmetries, show that the NARDL (1, 1, 1, 0, 1, 1, 1, 1, 0) specification with long-run asymmetry is selected as the bestsuited model for the non-oil export case. In the specification allowing for both long-run and short-run asymmetries, most of the coefficients associated with the short-run asymmetric effects of

non-oil export are insignificant. The non-oil export is affected by the macroeconomic indicators shocks. The results of the best-suited model indicate that non-oil exports react more to inflation decreases than to GDP increases in the long-run. These findings are also confirmed by those of the model incorporating both short- and long-run asymmetries. And the NARDL regression suggest that the sign of the relationship between non-oil export and GDP is in line

with theoretical priors, with the link having been more stable than that between non-oil export and Exchange rate over 1970- 2019. There is some evidence that the non-oil export elasticity of inflation Rate may be smaller in periods of non-oil export depreciation. The results of Wald Test, all statistics is significant (Table 7).

The results from NARDL show that positive movement in macroeconomic indicators shocks has more influence on non-oil export in KSA than negative movement in macroeconomic indicators shocks in the short-run (Table 8). Categorically, 1% increase in the Inflation rate will increase non-oil export by 12% while similar decrease in the Inflation rate will decrease the non-oil export by 0.45% in the short-run. The effect of positive movement in Inflation rate is statistically significant on non-oil export but that of negative movement is statistically insignificant.

#### 4.4. (CUSUM) and (CUSUMSQ) - NARDL (1, 1,1,0,1,1,1,0)



## 5. CONCLUSION

The study took up estimating the Impact of the macroeconomic indicators shocks on KSA non-oil exports 1970-2019. The study employed two econometric models. The first technique is SVAR which allows imposition of three long run restrictions to examine the dynamic relationship among the choice variables. Result of the variance decomposition analysis indicate that macroeconomic indicators shocks have considerable contributions in explaining the shocks to non-oil exports both in the short-run and long-run, while non-oil exports have predictive power on macroeconomic indicators shocks only in the long-run. However, the predictive power of macroeconomic indicators shocks in explaining the shocks to the non-oil exports in KSA is much stronger even in the long-run. The second technique is NARDL which allows imposition of long run restrictions to examine the equilibrium relationship is short and long term.

The results show macroeconomic indicators shocks in KSA are more willing to increase non-oil exports instantaneously in case

of an increase in non-oil exports. However, non-oil exports exhibit more flexible behavior than Macroeconomic indicators in case of increase and decrease of (INF), (GDP). The important point is that the short-run negative asymmetry is more persistent in KSA. According to short-run coefficients, an increase in non-oil exports is passed through to (MR), (EX). The results show that 1% positive movement in non-oil exports will reduce the exchange rate by 0.05%, will reduce the inflation rate by 0.08, will reduce the monetary reserves by 0.62 AND will reduce the real gross domestic product by 0.75 (appreciation) and similar negative movement will increase the exchange rate by 0.81%, will increase inflation rate by 0.38, will increase the monetary reserves by 0.52 AND will increase the real gross domestic product by 0.44 (depreciation) in the short run. This indicates that negative movement has more influence on exchange rate in the short-run, in long-run.

These conclusions have three important implications to policy-makers in KSA. First, policy-makers in KSA need to pay more attention to economic. By diversifying exports to increase and strengthen cash reserves. Second, to maintain a stable environment for economic growth, policy-makers should keep eyes on achieving economic stability and improve resilience to uncertain events like macroeconomic indicators shocks. Third, in order to ensure the healthy development of growth economy we should complete the maintaining the stability of the Saudi riyal against other currencies such as bring global economic policy uncertainty into the consideration.

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