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Saudi's Export Demand Function: The ARDL Approach

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Abstract

Saudi Arabia has been witnessing a rapid growth in exports more specifically since the inception of 21st century. The paper intends to estimate Saudi's export demand function using bound test approach to cointegration developed by Pesaran et al (2001). The result shows that there is long run equilibrium relationship between demand for export, world income and real effective exchange rate. The elasticity of demand for Saudi's export with respect to world income and real effective exchange rate (REER) has been found to elastic, both, in the short run as well in the long run. The export has been found to more elastic in the short run than in the long run with respect to both the variables.

Key Words: Export demand, price and income elasticity, bound test**.**

JEL Classification: F14

Abbreviations:

ADF: Augmented Dicky-Fuller; PP: Philips-Perron test; UECM: Unrestricted Error Correction Model; AIC: Akaike Information Criteria; ARDL: Autoregressive Distributed Lag; OLS: Ordinary Least Square; VECM: Vector Error Correction Model; CUSUM: Cumulative Sum of Recursive Residual; CUSUMSQ: Cumulative Sum of Recursive Residual Sum of Square.

1. Introduction

The role of export in economic growth and development of a country is generally recognized by neo classical the development theory pioneered by Solow (1956) and Swan (1956). This has also been empirically found in the case of Newly Industrialized Economies (NIEs) and Association of South East Asian Nations (ASEAN). The export of Saudi during the recent period has increased at a very high rate. It has increased at rate of 11 percent per annum during the period of 1991 to 2011. More recently since 2001, the export has increased at a compound rate about 18.3 percent per annum. Though, the increase in price of oil has been one of the factors for increase in such record of growth in export, the non oil export sector has also recorded better growth rate than the oil sector. The non oil sector has increased at an annual compound rate of 13 percent per annum during the period 1991 to 2011 and 19 percent during 2001 to 2011, at a rate higher than that of oil export during the same period.

Since 1986, Saudi Arabia follow pegged exchange rate policy vis a vis US dollar. Exchange rate has a direct impact on price of tradable goods including export. With constant exchange rate the price of export may be expected to remain constant for countries that follow fixed exchange rate system with dollar provided other conditions remain same. However, Saudi Arabia exports only 13 percent to United States of America (USA) and about 3 percent to Gulf region which has fixed exchange rate with dollar. Rest of the 84 percent of the export goes to other countries which do not have such pegged currency system. Thus, an appreciation of dollar with respect to other currencies will make export costly and uncompetitive in export market. This will adversely affect export from the country and also other sectors of the economy. However, the depreciation of the dollar will make export more competitive in world market that would promote export from different sectors of the economy. Hence country's economic policy and more specifically the trade policy would depend upon the nature of the export demand for its product and more precisely its price and income elasticity. It is in this context, the paper seeks to estimate the price and income elasticity of demand for Saudi products in international market by estimating the export demand function of Saudi Arabia.

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Though there are ample literature on export demand function estimating price and income elasticity of demand for the developing countries, not much have been done in the context of Saudi Arabia.

The paper is organized as follows. Section 2 briefly presents the export demand function. This is followed by econometric methodology used to estimate the demand equation and also find the causal relation of export with its determinants in section 3. Section 4 discusses the empirical results and concluding remarks are given in section 5.

2. Data and Model

To estimate the demand for Saudi's exports, the imperfect substitute model proposed by Goldstein and Khan (1985) has been followed. The model assumes that neither imports nor exports are perfect substitutes of domestic products. Exports are imperfect substitutes in world markets for other countries' domestically produced goods, or for third countries' exports. The conventional demand theory says that, the consumer is postulated to maximize utility subject to a budget constraint. In this respect, export demand function is specified as a function of the relative price of exports and the rest of the world's real income. Since exchange rate directly affects the prices of exportable goods, the paper is using real effective exchange rate (REER) instead of relative price of export. Thus the export demand function can be expressed as:

$$lX_t = \alpha_0 + \alpha_1 REER_t + \alpha_2 GDPW_t + e_t \quad \ldots\ldots\ldots\ldots\ldots(1)$$

The description of the variables is given below;

l denotes natural log of the variables;

X refers to volume of Saudi's exports measured by deflating export in nominal terms by price of import;

REER is real effective exchange rate of Saudi Arabia;

GDPW is rest of the world real income;

t refers to time period.

In the equation, α1 is price elasticity and α2 is real income elasticity of export demand. Based on the theory of demand, α1 should have negative sign, implying that the demand for India's products in international market will increase with depreciation of riyal in real terms and vice-versa; α2 is expected to have a positive sign, as the demand for Saudi's export is expected to increase with increase in the world economic activity. The model estimation is based on annual data between the years 1980-2010. The data have been obtained from UN Database and UNCTADSTAT 2013.

Econometric Methodology

The study involves three steps to estimate the demand equation for Saudi Arabia's exports. In the first step the nature of the data or order of integration of the variables, is examined. This is because if the data is found to be non stationary, as most of the macroeconomic data happen to be, then application of OLS technique may give spurious results. In order to avoid that, stationary test of the variables is required. For the purpose, Augmented Dicky-Fuller test (ADF-test) and Philips-Perron test (PP test) have been applied. The ADF test is based on the assumption that the error term is statistically independent and has a constant variance.

Philips and Perron (1988) developed a generalization of the ADF test procedure that allows for fairly mild assumptions concerning the distribution of errors. While the ADF test corrects for higher order serial correlation by adding the lagged difference term on the right hand side, the PP test makes a correction to the t-statistics of the coefficient from the AR(1) regression to account for the serial correlation in residual term. So, the PP statistics are just modification of the ADF t-statistics that takes into account less restrictive nature of the error process. For the reason, the present study has also conducted PP test to examine the stationary nature of the variables under consideration.

Once the order of integration is known and it is found that all the variables are not stationary but integrated of order equal to or less than one, the presence of long run relationship is examined with the help of bound test approach to cointegration developed by Pesaran et al (2001). This method has some advantages. One, bound test approach is robust for small size sample. Mah (2000) used Pesaran's approach to estimate disaggregated import demand function for Korea with 18 annual observations. Other examples are from Pattichis (1999) and Tang and Nair (2002). Second, failure to test hypothesis due to endogeneity problem under Engle-Granger method can be resolved through this method. Another advantage associated with it is that it can be used even if all the variables are not integrated of same order. So long as the dependent variable is integrated of order one and explanatory variables are integrated of order not higher than one i.e. integrated of order zero or order one or mix of integrated of order zero and order one, there can still be a long run relationship between these variables provided that they are cointegrated.

In order to investigate the presence of long run equilibrium relationship (cointegration) among these variables through bound test approach, following unrestricted error correction model (UECM) (equation 2) can be estimated.

$$\Delta lX_t = \alpha_0 + \sum_{j=1}^{n} \alpha_{1j}\, \Delta lX_{t-j} + \sum_{j=0}^{n} \alpha_{2j}\, \Delta lREER_{t-j} + \alpha_{3j} \sum_{j=1}^{n} \Delta lGDPW_{t-1} + \beta_1 lX_{t-1} + \beta_2 lREER_{t-1} + \beta_3 lGDPW_{t-1} \quad \ldots\ldots\ldots\ldots\ldots(2)$$

Where, Δ represents first difference operator and l is natural log of respective variables. βi represents the long run parameters, while α_{ji} represent the short run parameters. To estimate the above equation, the maximum number of lags for the variables in level is set equal to one. The appropriate number of lags for the first differenced variables is determined on the basis of Akaike Information Criterion (AIC), from maximum of three lags. After estimating equation 2 by ordinary least square (OLS) method, the null hypothesis of no cointegartion is examined on the basis of the Wald or F- statistic used to assess the significance of the lagged level explanatory variables included in the equation, i.e.

H0: β1 = β2 = β3 = 0; (no cointegration exists) and

HA: β1 ≠ β2 ≠ β3 ≠ 0. (cointegration exists)

Pesaran et al (2001) have provided two sets of critical value bounds. At conventional level of significance of 1 percent, 5 percent or 10 percent, if the calculated F-value falls outside the critical bound values, a conclusive inference can be made about accepting or rejecting the null hypothesis of no cointegration among the variables. If the F-value is greater than the upper limit of the bound values, we reject the null hypothesis of no cointegration among the variables under study. If the F-value is less than the lower limit of the bound value, then we accept the null hypothesis of no cointegration among these variables. However, if the calculated F-value falls within the critical bound limits, then the order of integration of the explanatory variables needs to be known before drawing any conclusion.

From the estimated UECM, the long run elasticities are measured from the coefficients of the one lagged level explanatory variables divided by the coefficient of the lagged level dependent variable and then multiplied by minus one. Short run elasticities are measured from the coefficients of the first differenced lagged variables in estimated UECM. To ascertain the goodness of fit of the ARDL model, relevant diagnostic tests are conducted. The diagnostic tests examine the normality, serial correlation and heteroskedasticity associated with the model. RESET test is done to test for specification of the model. To examine the stability of long run parameters together with short run movement, cumulative sum (CUSUM) and cumulative sum square (CUSUMSQ) have been employed.

Empirical Results and Analyses

As it is difficult on priori to decide between ADF test or PP test about the superiority of method to examine the stationary nature of the variables, the paper followed Enders (1995) suggestion to use both the methods for the purpose to conclude with confidence. Thus, the study used both the tests at level and at first difference. The result is reported in table 1a and 1b. The ADF result in table 1a shows that all variables, except world income, are non stationary at level but are stationary at first difference. The Philips-Perron unit root test shown in table 1b also confirms the ADF test result. Thus, we may conclude that all the variables included in the model are integrated of order one i.e. I(1).

In order to examine the relationship between the demand for Saudi's export, world economic activity, real effective exchange rate, the UECM version of ARDL model (Pesaran et al, 2001) with lag three (selected on the basis of AIC shown in table-2) is estimated. Then following Hendry's general to specific modeling approach, a parsimonious model is selected for equation by gradually deleting the insignificant coefficients. The result of the equation is presented in table 3. The diagnostic tests like Breusch-Godfrey serial correlation LM test, the ARCH test, Breusch-Pagan-Godfrey test and White test for heteroskedasticity, Jarque-Bera test for normality of the residual term, and Ramsey RESET test for model specification confirm that the equation is correctly specified and error term behaves normally. There is no problem of serial correlation, heteroskedasticity. Random terms are normally distributed and model is correctly specified. Further, figure 1 and 2 shows that the plots of CUSUM and CUSUMSQ remain within the 5% critical bounds of the equation. Neither CUSUM nor CUSUMSQ crossed the critical bound, indicating no evidence of structural instability.

The result of the bound test to examine the presence of long run relationship between export demand, world income, real effective exchange rate is given in table 4. The result shows that the computed F-statistics (F=7.5) is greater than the critical upper bound value at 1 percent level. Thus, we may conclude that there exists a long run stable relationship between these variables.

The result of UECM shows that exports are significantly related to all the three variables as is revealed from the t-values of the coefficients. The signs of all the coefficients are also consistent with theoretical expectation. The export demand is positively related to world income and is negatively related to real effective exchange rate (REER). Table 5 reports the results about the short run and long run income and price elasticity of demand for Saudi's exports. The result shows that the export is highly sensitive to change in world economic activity and REER. The elasticity of demand for Saudi's export is very high with respect to both of the variables, both in the short run as well as in the long run. However, elasticity of demand is the long run is less than elasticity of demand in short run. Higher income elasticity of export demand signifies that growth in world economic activity will translate into growth of Saudi's export sector and slow down of economic activity in the world will have an adverse effect on export sector of the country.

Conclusion and Policy Implications

The primary objective of the paper is to estimate Saudi's export demand function and calculate its income and price elasticities taking the possible non stationarity in the data into account. The result shows that there is long run stable relationship between demand for Saudi's export, world income and real effective exchange rate. The result further shows that the sign of income and price elasticity of export demand is consistent with the theory and many of the studies on the subject and are statistically significant too. The magnitude of income elasticity is much more than unity, both in the short run and in the long run. This implies that the export will continue to grow so long as the world economy grows. Hence export should be treated as an engine of growth and the Saudi government should continue to promote export of different sectors and also try to diversify its export base. However, the elasticity of export demand with respect to exchange rate is negative and also very high. The dollar is now a days witnessing appreciation against major currencies. Due to fixed exchange rate between riyal and dollar, riyal also witness appreciation against these currencies. This may adversely affect growth of Saudi's export and its diversification strategies to promote export of different products.

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Table 1a: Unit Root Test Result (ADF test)

Variables		Level			First Difference		
		C	C&T	None	C	C&T	None
lX		-0.329738	-2.542691	1.489036	-4.515115*	-4.492118*	-4.165294*
lGDPw		-0.540688	-1.749561	8.711929	-3.919124*	-3.885599**	-1.384280
lREER		-1.866400	-4.059430**	-0.603754	-3.043403**	-2.990781	-3.169452**
Critical Values	1%	-3.788030	-4.467895	-2.679735	-3.808546	-4.498307	-3.808546
	5%	-3.012363	-3.644963	-1.958088	-3.020686	-3.658446	-3.020686
	10%	-2.646119	-3.261452	-1.607830	-2.650413	-3.268973	-2.650413

- Critical values are of Mc Kinnon (1996)
- * and ** represent significant at 1% and 5% level.

Number of lags based on Schwarz information criteria (SIC) criteria.

Table 1b: Unit Root Test Result (PP test)

Variables		Level			First Difference		
		C	C&T	None	C	C&T	None
lX		0.115622	-2.441160	3.120224	-5.039956*	-5.415615*	-4.158987*
lGDPw		-0.583119	-1.749561	9.308201	-3.900918*	-4.202049**	-1.200259
lREER		-1.840084	-1.730374	-0.603754	-2.954031**	-2.909920	-3.097468*
Critical Values	1%	-3.788030	-4.467895	-2.679735	-3.808546	-4.498307	-2.685718
	5%	-3.012363	-3.644963	-1.958088	-3.020686	-3.658446	-1.959071
	10%	-2.646119	-3.261452	-1.607830	-2.650413	-3.268973	-1.607456

- Critical values are of Mc Kinnon (1996)
- * and ** represent significant at 1% and 5% level.

Table 2: Lag Selection for Bound Test

No. of Lags	AIC	SBC	HQ
0	-4.944376	-4.795254	-4.919138
1	-10.35716	-9.760676	-10.25621
2	-10.92557	-9.881713	-10.74891
3	-11.57357*	-10.08235*	-11.32120*

* represents lag selected

Table 3: Result of UECM of Export Demand Equation

Variables	Coefficients	SE	t-Statistics	Prob
LRXSA(-1)	2.712420	0.988400	2.744254	0.0406
LREER(-1)	13.34876	5.070857	2.632446	0.0464
LRGDPW(-1)	-5.274923	1.969928	-2.677723	0.0439
D(LRXSA(-1))	-2.989506	0.964724	-3.098819	0.0269
D(LRXSA(-2))	-2.464583	0.825821	-2.984403	0.0306
D(LRXSA(-3))	0.844648	0.304224	2.776402	0.0391
D(LRGDPW)	24.68396	5.673353	4.350859	0.0074
D(LRGDPW(-1))	8.272440	4.006643	2.064681	0.0939
D(LRGDPW(-2))	12.38631	4.962349	2.496058	0.0548
D(LREER)	5.740903	2.780086	2.065009	0.0938
D(LREER(-1))	-9.358947	3.235165	-2.892881	0.0341
D(LREER(-2))	-14.29642	4.738592	-3.017018	0.0295
D(LREER(-3))	4.537581	1.436408	3.158979	0.0251
Diagnostic Tests				
R square			0.948110	
Adjusted R square			0.823573	
Breusch-Godfrey Serial Correlation LM (1) Test			F-statistic 0.871234 Prob. F(3,2) [0.5736]	
Heteroskedasticity Test: Breusch-Pagan-Godfrey			F-statistic 3.244617 Prob. F(13,4) (0.1326)	
Heteroskedasticity Test: ARCH			0.485907 Prob. F(1,15) (0.4964)	
Heteroskedasticity Test: White			0.549579 Prob. F(13,4) (0.8147)	
Jarque –Bera Normality Test			.722462 Prob. (0.696818)	
Ramsey RESET			1.614685 Prob. F(1,4) (0.2727)	

Note: *, **, and *** shows significant at 1%, 5% and 10% level respectively. Values in square brackets are probability values.

Table 4: Bound Test for Cointegration

Calculated F-Values: 7.499*		
Significance Level	Critical Level	
	Lower Bound	Upper Bound
1 Percent	3.88	5.30
5 Percent	2.72	3.83
10Percent	2.17	3.19

Note: The reported bounds critical values are taken from Pesaran et al. (2001), Table C1.i: Case I: UnrestricteNo intercept and no trend with two regressors case, p. 300.

* shows significant at 1 percent.

Table 5: Short Run and Long Run Elasticity

Variables	Short Run Elasticity	Long Run Elasticity
World Income	37.1	1.94
REER	-19.1	-4.92

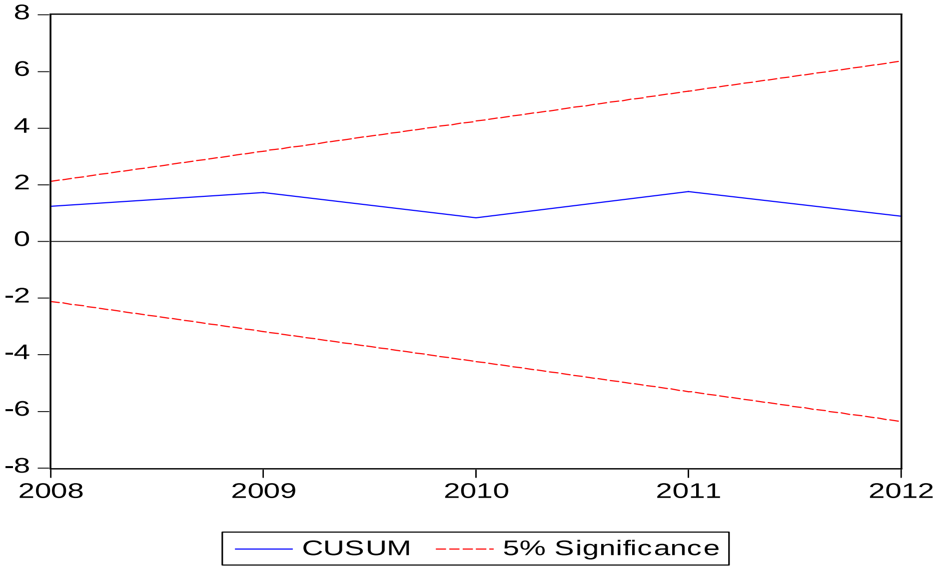

Figure 1: Plot of CUSUM Test

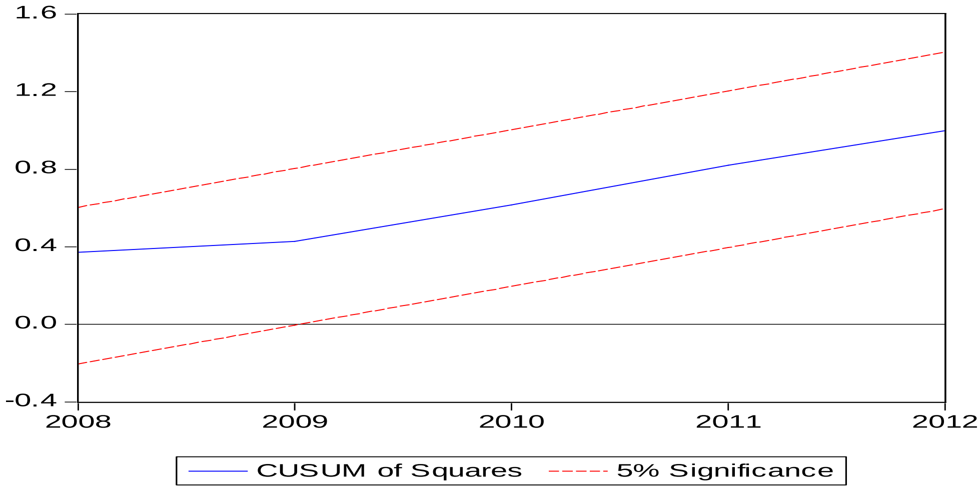

Figure 2: Plot of CUSUMSQ Test