Algaeed, Abdulaziz Hamad

Article

The oil price volatility and a revisited Saudi import demand function : an empirical analysis

Reference: Algaeed, Abdulaziz Hamad (2018). The oil price volatility and a revisited Saudi import demand function : an empirical analysis. In: International Journal of Energy Economics and Policy 8 (6), S. 59 - 69.
doi:10.32479/ijeep.6243.

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2018, 8(6), 59-69.

The Oil Price Volatility and a Revisited Saudi Import Demand Function: An Empirical Analysis

Abdulaziz Hamad Algaeed*

Department of Finance and Banking, College of Business Administration, Dar Al Uloom University, Riyadh, Saudi Arabia.
*Email: ibngaeed@outlook.com

Received: 16 February2018 **Accepted:** 23 July 2018 **DOI:** https://doi.org/10.32479/ijeep.6243

ABSTRACT

The focus of this paper is to analyze theoretically and empirically the effects of a non-linear oil price shocks on Saudi import demand function covering the period of 1970–2015, utilizing unrestricted vector autoregressive (VAR) approach. Johansen's testing procedure result asserts the existence of stable long-run relationship between real aggregate import demand (RIM), oil price shocks (OILPI and OILPD), real gross domestic product (GDP), relative price (RP) and last year real foreign exchange (RFE_{t-1}). The findings confirm that the oil price shocks affect negatively RIM. The signs are not as expected and significant. Moreover, the coefficients had little magnitude and effects. Nonetheless, the income elasticity is greater than one, had the right sign, and statistically significant. The price elasticity is negative as expected and significant. As predicted in literature, foreign exchange coefficient is negative, but is not statistically significant. Although the oil price shocks are significant, their magnitudes are weak. This could be attributed to the strong effects that come from traditional import demand determinants.

Keywords: Vector Autoregressive, Import Demand, Saudi Arabia, Income Elasticity, Co-integration
JEL Classifications: C51, E22, Q43

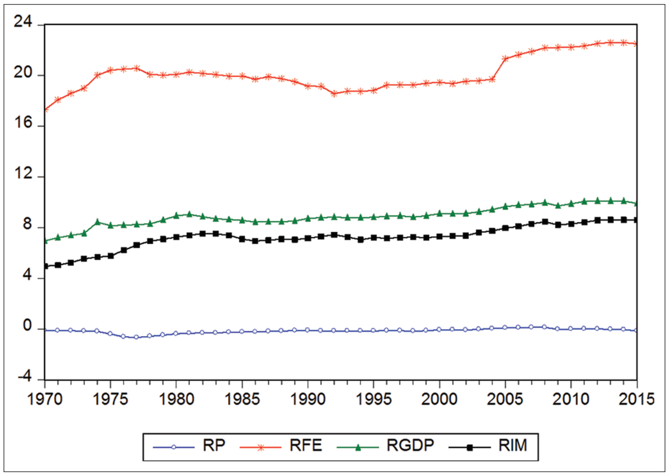
1. INTRODUCTION

Nowadays, globalization created much of interdependence between developed and developing nations. This situation motivated nations to strengthen their ties with each other to benefit from international trade as much as possible. The investigation of the conventional import demand function had much attention in the economic literature. The hard task is to determine and set well the determinants of import demand function. The plausible estimations help policy makers to identify macroeconomic deficiencies, and ignite ways and means to solve them. The traditional import demand functions are normally contain income elasticity which is characterized with high responses and to some extent moderated price elasticity (Rahman, 2007), Hussain (2007), and Hibber et al. (2012), and much more.

International trade contributes much to the less developed countries. Through trade, countries can export goods in which they have comparative advantages. Despite the usefulness of the disaggregation of the import demand function, aggregate import demand function will serve the purpose of measuring the impacts of oil price variations on the import consumption. Since Saudi Arabia is a developing nation, the big portion of the import demand is capital equipment and machinery which are needed to expand production, and promote development. Evidence from Figure 1 showed that imports have risen from 13.2% of gross domestic product (GDP) in 1974 to up to 48% of GDP in the year 1983. However, the import share of Saudi GDP is still high; it registered 30% of the GDP in 2016. Of course, the fluctuations of percentage of imports are due to the nature of oil price and earnings volatility. However, the value of imports reflects the strong growth of domestic aggregate demand due to the rise in oil receipts.

Not recently, it is widely known that Saudi Arabian economy, as a major producer of crude oil, being not bounded by foreign exchange

Figure 1: Real imports, relative price, real gross domestic product, and real foreign exchange (in log)



influx. However, during the 1970's and up to now the reliance on imports is a prominent sign of the Saudi economy. This is due to the state of development of the country. Many studies have tackled the slow of economic growth and suggested that policy makers should aim at increasing exports (Gumede, 2000). This suggestion implies more on export promotion or import liberalization. Following recent literature Senhadji (1998), Emran and Shilipi (2008), and Rashid and Razzaq (2010), an ad hoc model is developed with aggregated import demand function which includes real log GDP and RP that is, (P^T/P^N). The rationale behind using (P^T) instead of import prices is the lack of data for the period 1970–1980. In order to test Hemphill's approach, foreign reserves variable is implemented. Moreover, the oil price shocks are included too.

Studying and testing the import demand function for Saudi Arabia is of great interest. Paucity of literature and the type of studies are a motive to re-examine the import demand function with the inclusion of new variables. Nevertheless, with the recent stabilization of the macro economy, decline in oil income, transformation of the economy, and activation of the value added tax may have contributed to the changing trends in imports into the Saudi economy.

The main purpose of this paper is to investigate and estimate the aggregate import demand function in an oil-based economy. It considers shocks to the traditional import demand and the import-exchange demand functions. The chief findings of this investigation support the hypothesis that income elasticity with respect to import is greater than one which tells us that the rise in imports during the period under study is a direct result of the rise in income (oil earnings) rather than the decline in RP. Moreover, the results lend themselves to support the import-exchange formulation. However, the results attained are consistent with that in the import demand literature. The organization of this paper is as follows. Section 1 an introduction. Section 2 reviews and analyzes the theoretical and empirical related literature. Section 3 develops the theoretical model, estimation and discussions of the empirical evidence and their implications, and section 4 presents the conclusion and policy suggestions regarding this paper's findings.

2. REVIEW OF EMPIRICAL LITERATURE

In order to achieve maximum benefit of international trade, policy makers in each trading country should bear in mind that the mechanism of imports reaction to a changing economic condition is stronger and faster than reaction of exports. So, predictions should come as precise and accurate as the speed of variations in global economic situations nowadays.

Senhadji (1998) uses structural import demand equations to derive and estimate a large number of countries. He used recent time series methods that address nonstatioarity problems. He found average price elasticity is close to zero in the short-run and higher than 1 in the long-run. However, the income elasticity on average is <0.5, whereas the long-run income elasticities are close to 1.5. Finally, he used Monte Carlo methods to analyze short and long-run elasticities for sample properties for both OLS and fully modified OLS.

Gumede (2000) estimates the import demand function for South Africa, using time series techniques in order to model time series variables. He examines cyclical and trend behavior of import demand function starting from 1970. However, he studies at the relationship between capital goods imports and South African growth. He discusses the results obtained and compares them internationally. He concluded that labor intensive commodities have the largest share in total imports.

Rehman (2007) explains that many studies done on Pakistan using non-stationary data suffer from spurious regression problem. He attempts to estimate the aggregate import demand function for Pakistan employing Johansen and Juselius co-integration technique. Annual data from 1975 to 2005 is utilized. His findings show that there is long-run relationship among the variables under study. Stability test indicate stable import demand and the estimated results are plausible for policy implication.

Hussain (2007) estimates the long-run elasticities of the import demand function for Jordanian economy covering the period of 1980–2004. His study fails to find long-run relationship among the variables related to the import demand function under study by using Engel-Granger test of co-integration. He employed Stock-Watson dynamic OLS (1993) to derive long-run RP and income elasticity. His findings are as follows: RP elasticity is (−0.55) and income elasticity is (0.84), which strongly affect import demand in the short-run. Results explain the Jordanian long-run import demand behavior.

Emran and Shilipi (2008) argue that the paucity of data on domestic clearing price of imports in less developed countries, makes testing for price and income elasticity are a scary task. They developed a structural econometric model of two goods representative agent economy that incorporates a binding foreign exchange constraint, given administered prices of imports. Using RP of imports puts off the data problem and enables them to perform co-integration to estimate price and income responses. The price and income elasticity estimate for India and Sri Lanka. The estimates have the correct signs and high statistical significance and plausible for magnitudes.

Abayie and Nkrumah (2009) estimated the import demand function for Ghanaian economy covering the period of 1970–2002. The time series revealed long-run relationships between real exchange rate, GDP, and merchandise imports. Their findings suggest that real income is the main determinant of imports. Depreciation of Ghanaian currency and economic growth stimulate merchandise imports. Shocks to real exchange rate, real GDP, and imports are of interest in explaining various innovations in error variance of each variable with different times and magnitudes. At short time period, 65–95% of the shocks to the variables mentioned are caused by their own shocks.

Rashid and Razzaq (2010) develop a structural econometric model of import demand for Pakistan. This model is characterized by binding foreign exchange constraint. They used autoregressive distributed lag model (ARDL) and DOLS to estimate long-run coefficients of price and income elasticity. ARDL and Johansen's method for co-integration show strong evidence of long-run stable relationships among the variables included in the import demand function. The price and income elasticity have the correct sign and significant. The scarcity premium has the correct sign and significant indicating the existence of binding foreign exchange constraint on the aggregate import demand before and after trade liberalization.

Yue and Constant (2010) examine the dis-aggregated import demand model for Cote d'Ivoire for the period of 1970–2007. ARDL technique is implemented to capture the effect of consumption, investment, exports, and RP on import demand. They found that long-run relationships between the variables, and there exists inelastic import demand for consumption, investment, export expenditure, and RP. In the long-run exports and investment are the main determinants for import demand in Cote d'Ivoire. Also, the same variables are the main determinants for import demand in the short-run. Finally, import demand is not sensitive to change in prices.

Zhou and Dube (2011) adopt the bounds testing approach to examine the validity of the co-integration or stationarity restrictions embodied in five import demand model specifications for CIBS (China, India, Brazil, and South Africa) covering the period of 1970–2007. This approach identifies the long-run relationships in a sub set of the five models for each country alone of the CIBS group. They found that higher long-run income elasticity compared to earlier studies. They also found that the long-run income elasticity exceeds the short-run. Moreover, they found negative price elasticity but is not significant. However, traditional wisdom is not present in the results.

Haider et al. (2011) estimated import and export elasticity of Pakistan with its traditional partners and with some Asian economies. The purpose is to see the Pakistan's trade dynamics for the period 1973–2008. The main finding is that income is the corner stone in exports and imports. Pakistan imports are co-integrated with UAE and USA, whereas exports are co-integrated with USA and Japan. However, Pakistan exports and imports are co-integrated with Bangladesh and Sri Lanka. In fact, income and exchange rate influence Pakistan's foreign trade. They suggested that great efforts should be put to promote trade with emerging economies, India and China.

Hibber et al. (2012) investigate the Jamaican aggregate import demand function with the US and UK for the period of January 1996 till September 2010, using co-integration and error correction model, ECM, techniques. They used exchange rate volatility, real GDP, RP of imports, and real foreign exchange reserves as independent variables. They assert that evidence shows a unique co-integrating relationship between import demand and the rest of independent variables in the US and UK models. They examined short and long-run elasticity in both models. The Jamaican-US model shows that income elasticity is lower and negative than in the long-run. RP elasticity is three times as elastic as in short-run compared to the long-run. Volatility is negative in long-run but positive in the short-run. In the Jamaican-UK model, real GDP and volatility are less elastic in the short-run than the long-run. However, real foreign reserves and RP adjust much faster. They concluded that tight monetary policy has had a significant impact in the short-run only with the UK rather than the US.

Tirmazee and Naveed (2014) investigate the traditional import demand function for Pakistan for the period of 1970–2010. Utilizing VEC model and impulse response functions, they showed that RP and income are not significant as determinants of long-run import demand function for the given period. Using residuals of the traditional import demand function for the purpose of comparison with the traditional import demand with terms of trade and foreign exchange volatility as determinants, they found that the latter is largely suitable to explain the behavior of import demand in Pakistan. In addition to the former, they explored the peculiar trend of declining import to GDP ratio. They concluded that the falling ratio is due to the falling net capital inflow.

Aipi and Sabok (2015) address the issue of estimating import demand function which gained much attention in the field of international trade. Once the determinants of import are set, policy makers find it helpful in policy choices that enable them to attain macroeconomic stability and encourage growth. However, the explanatory variables that affect import demand vary from country to country according to the structural variables that influence trade. They used co-integration technique to estimate the traditional aggregate import demand. They concluded that price variable does not affect import demand in Papua New Guinea, whereas income variable had a strong effect on import demand in Papua New Guinea in the short-run and the long-run. Hence, income elasticity of demand for imports is more elastic in the short-run.

Ogbonna (2016) examines the aggregate import demand for Nigerian economy for the period of 1980–2010. He employed co-integration approach and evaluated VEC model for long-run causal relationship. The short-term coefficients were estimated for short-term causal relationships between dependent and independent variables. His results assert the existence of long-run stable and steady relationship between import demand function and real exchange rate, world price index, and disposable income. Furthermore, real exchange rate, world price index, disposable income, and structural adjustment policy jointly and significantly affect import demand in the long-run with causality is running from independent variables to the import demand function. In the short-run, all independent variables do not significantly cause import demand in Nigeria. He suggested that short-term variables embodied in the import demand function may not be effectively serving the development.

3. THEORETICAL MACRO MODEL, ESTIMATION, AND DISCUSSIONS

Following the literature in Rashid and Razzaq (2010), which is built on the work of Clarida (1994), the model incorporates a binding foreign exchange constraint. The representative agent consumes two goods, a home good (H_t) and imported good (M_t). There are two constraints, the budget constraint (asset accumulation), and foreign exchange availability constraint. The optimization problem of the representative agent is formulated as follows:

$$^{MAX}\left[H_t, M_t, A_t\right]^V = E\int_{t=0}^{\infty} e^{-\delta t} U\left(H_t, M_t\right) dt \quad (1)$$

Subject to:

$$\dot{A} = rA_t + \tilde{Y} - H_t P_t H_t$$

$$P_t M \leq F_t$$

Where P_t is *RP* of imports, A_t is assets, $\tilde{Y}$ is labor income, F_t is total amount of foreign exchange availability, δ is the subjective rate of time preference used by agent to discount future value, r is constant real interest rate, and $\dot{A} = dA_t / dt$ is a time derivative.

The standard price and income variables are irrelevant if the assumption of the second constraint is binding. The result is equality between amount of imports and the foreign exchange availability. The current value of Hamilton's function of the optimization problem of the representative agent can be written as:

$$L = U\left(H_t, M_t\right) + \gamma_t [rA_t + \tilde{Y}_t - H_t - P_t M_t] + \mu_t \left[F_t - P_t M_t\right] \quad (2)$$

H_t and M_t are control variables which is dependent upon state variable A_t as well as control. γ_t is the marginal utility of wealth. μ_t is the Lagrange multiplier associated with foreign exchange constraint. The maximum principal is defined as follows:

$$U_H = \partial L/\partial H = \gamma_t$$

$$U_M = \partial L/\partial H = Pt\,(\gamma_t + \mu_t)$$

$$\tilde{\gamma} = \partial L / \partial A = \gamma_t (\delta + r)$$

The assumption here is that U (•) is an addilog utility function such that:

$$U\left(H_t, M_t\right) + C_t H_t^{1-a} / 1 - a + B_t M_t^{1-\eta} / 1 - \eta \quad (3)$$

C_t and B_t are random, strictly stationary shock to preference. Inserting the addilog utility function into the current value, the Hamiltonian equation can be rewritten as:

$$L = C_t H_t^{1-a} / 1 - a + B_t M_t^{1-\eta} / 1 - \eta + \gamma_t \\ [rA_t + \tilde{Y}_t - H_t - P_t M_t] + \mu_t [F_t - P_t M_t] \quad (4)$$

Now the first order condition of the optimization problem is the following:

$$C_t H_t^{-a} = \gamma_t \quad (4a)$$

$$B_t M_t^{-\eta} = P_t \gamma_t (1 + \mu_t^*) = \gamma_t P_t^* \quad (4b)$$

$\mu_t^* = \mu_t / \gamma_t = \mu_t / U_H$ is the scarcity premia, and P^*_t is the scarcity price at which transactions occur in the secondary market if the secondary market fails to clear. Equation (4a) can be used to get rid of γ_t from equation (4b) and transform it into log, yield:

$$b_t - hm_t = C_t + P_t + ah_t + ln\,(1 + \mu_t^*) \quad (4c)$$

Here, the lower case letters denote natural logarithm of the assigned upper case letters. To derive the long-run import demand steady state, it is assumed that $\dot{A} = \tilde{\gamma} = 0$. In accordance, steady state requires equilibrium price relations such that: $P_t = P_t^*$. The total household income is assumed at equilibrium price. Y^*_t includes both labor and assets income. The steady state condition implies the following condition:

$$Y^* = H + P^* M \quad (5)$$

By applying steady state condition and taking logarithm, it is easy to get the following expression as:

$$h_t = ln\,(Y_t^* - P_t^* M_t) = ln\left(Y_t - P_t M_t\right) \quad (6)$$

To eliminate h_t, we substitute equation (6) into (4c), yields:

$$m_t = a / \eta \; ln\;\left(Y_t - P_t M_t\right) - 1/\eta\, p_t - 1/\eta\,(1 + \mu_t^*) + \zeta_t \quad (7)$$

Where: $\zeta_t = 1/\eta\,(b_t - c_t)$ is the composite preference shock. If foreign exchange constraint is not binding, then and the remaining import demand equation from (7) is the same as traditional import demand function Goldstein and Khan (1985), Amano and Wirjanto (1996). Y_t represents the total expenditure which includes domestic goods as well as imported items. $ln\,(Y_t - P_t M_t)$ is defined as GDP minus imports. When foreign exchange constraint is binding, the Kuhn-Tucker theorem requires that $\mu_t > 0$, and hence, $\mu_t^* > 0$. The application of equation (7) is difficult to apply in case of developing countries. The reason is that, data does not support μ_t^*. Emran and Shilipi (2008) argue that a good proxy for is the availability of foreign exchange. However, using foreign exchange availability could lead to the problem of near identity. They suggested total domestic expenditure (GDP + import –export) to the available foreign exchange resource denoted by Z_t. However, no direct impact of Z_t on import demand, but through , and is positively related. Since $\partial M_t^* / \partial Z_t > 0$, then the import demand will change negatively with change in Z_t such that:

$$\partial M_t / \partial Z_t = \partial M_t / \partial \mu_t^* \times \partial \mu_t^* / \partial Z_t < 0$$

At last, the following equation is derived for estimating import demand function:

$$m_t = a / \eta \, ln \left(Y_t - P_t M_t\right) - 1/\eta \, p_t - \Theta / \eta Z_t^* + \zeta_t = \Pi_1 ln \left(Y_t - P_t M_t\right) - \Pi_2 pt - \Pi_3 Z_t^* + \zeta_t \quad (8)$$

Where Z^*_t is Z_t multiplied by dummy variables.

The effectiveness of international trade policy depends highly on the magnitude of the flow of exports and imports, and on the price and income elasticity, whose play a major role in determining this magnitude. A number of studies have concentrated on the behavior of the disaggregated demand functions, Khan (1975), Kreinin (1973), Gafar (1988), and Rashid (1984). Although the disaggregation of the imports will serve in identifying the elasticity of the kind of imports, the availability of data dictates the use of aggregated import demand functions. Khan (1975) concluded that RP and real income help explain well the behavior of the demand functions in Venezuela. Therefore, the paucity of reliable data on the disaggregated import demand functions in some less developed countries makes the disaggregation less attractive. On the other hand, foreign exchange reserve is of critical importance in the less developed countries. Hemphill (1974) envisaged that the import demand function can be specified as a linear function of current and past values of foreign exchange receipts. According to him, the exchange receipts are "the sum of flows that are effectively exogenous in relation to the external balance policies of the authorities" (Hemphill, 1974. p. 643). The approach used here is similar in spirit to that of Salehi-Isfahani (1989), and Hemphill (1974). However, Hemphill proposed the import-exchange as a substitute for the standard import demand function. Our task here is to combine both the traditional and the proposed import-exchange demand functions and to subject them to empirical test using Saudi annual data from 1970 to 2015.

Basically, the conventional import demand function can be reproduced and written using log transformation technique as:

$$IM_t = \Psi_0 + \Psi_1 Y_t + \Psi_2 P_t + u_t \quad (9)$$

Where:

IM_t is the quantity of imports, Y_t is real GDP, P_t is RP (P^t/P^n), Ψ_0 the intercept term, Ψ_1, Ψ_2 are the income and price elasticity respectively, and u_t is the error term with the property of NID (0, σ^2).

As a usual procedure, we assume $\Psi_1 > 0$, and $\Psi_2 < 0$. However, we assume that price elasticity is to be homogenous of degree zero. Murray and Ginman (1976), argue that earlier researchers had constrained the import demand elasticity with respect to import prices (Ψ_2) to be equal in magnitude but opposite in sign to the elasticity of domestic prices. Their concern stems from the fact that weights are given to imported goods in import price are different than the domestically produced goods and hence, the preferences of consumers are different toward different goods. The estimation of equation (9) postulates the standard small country assumptions. The price of imports is treated as exogenous. Furthermore, no possibility of disequilibrium behavior on the part of the importing countries exists (Khan, 1975. p. 222).

Some economists have specified the import demand function to depend on the real expenditure on all goods, among other variables. The reasoning behind this type of formulation is that "the demand for imports should be related to domestic demand for all goods rather than to domestic goods plus foreign demand for domestic goods (exports), the use of real income would involve the latter" (Khan, 1976. p. 314). A delay of the responses of the consumers to the change may exist, resulting in an adjustment towards new equilibrium. Now we can write the desired level of imports, IM^*, as follows (Arize, 1987):

$$IM_t = \Phi \, IM_t^* + (1-\Phi) IM_{t-1} \quad (10)$$

The adjustment process can be written as the difference between desired levels of imports minus the actual level of imports lagged 1 year. Φ represents the adjustment coefficient which takes value between zero and one. A further assumption is that, the desired imports depend on real income and RP. Moreover, assuming specific functional form such that:

$$IM^* = \delta_0 + \delta_1 Y_t + \delta_2 P_t \quad (11)$$

Combining equations (10) and (11) yields:

$$IM = \Phi\delta_0 + \Phi\delta_1 Y_t + \Phi\delta_2 P_t + (1-\Phi) IM_{t-1} + e_t \quad (12)$$

Or:

$$IM_t = \varphi_0 + \varphi_1 Y_t + \varphi_2 P_t + \varphi_3 IM_{t-1} \quad (13)$$

Where:

$\varphi_0 = \Phi\delta_0$, $\varphi_1 = \Phi\delta_1$, $\varphi_2 = \Phi\delta_2$, and $\varphi_3 = (1-\Phi)$

A major criticism of this stock adjustment mechanism is that imports are considered flow rather than stock. Moreover, the demand for imports may reflect the desire to accumulate inventory. This variable can be added to the import demand function as the fraction of the difference between desired and actual inventory investment. Nevertheless, it is easy to specify the desired level of imports so that it includes investment and consumption expenditure (Heien, 1968).

In order to test Hemphill's approach, one assumes that the difference between the actual and the desired foreign exchange adjusts according to the following formula:

$$FE_t = \gamma \, FE_t^* + (1-\gamma) FE_{t-1} \quad (14)$$

Where FE_t and FE_{t-1} are the foreign exchange and foreign exchange lagged 1 year denominated in Saudi currency (Riyal). The is the desired level of foreign exchanges and γ represents the adjustment process with the value between zero and one. As a developing nation, Saudi Arabia depends highly on oil exports as a major source of revenue. Hence, it is appropriate to assume that the desired foreign exchange depend on oil price shocks (OP_t). Assuming a specific functional form, such that:

$$FE_t^* = \alpha_0 + \alpha_1 OP_t^i + u_{1t}; i = (+) \text{and} (-) \quad (15)$$

Substituting equation (15) into (14) yields:

$$FE_t = \alpha_0 \gamma + \gamma \alpha_1 OP_t^i + (1-\gamma) FE_{t-1} + u_{1t} \quad (16)$$

The import demand function can be rewritten as:

$$IM_t = \lambda_0 + \lambda_1 Y_t + \lambda_2 P_t + \lambda_3 FE_t + e_t \quad (17)$$

Now substituting equation (16) into (17) yields:

$$IM_t = \lambda_0 + \lambda_1 Y_t + \lambda_2 P_t + \lambda_3 (\alpha_0 \gamma + \gamma \alpha_1 OP_t^i + (1-\gamma) FE_{t-1} + e_t = (\lambda_0 + \lambda_3 \alpha_0 \gamma) + \lambda_1 Y_t + \lambda_2 P_t + \lambda_3 \gamma \alpha_1 OP_t^i + \lambda_3 (1-\gamma) FE_{t-1} + U_t \quad (18)$$

Equation (18) will be estimated using Robust ordinary least squares. Results are reported and explained thoroughly (Table 1).

3.1. The Non-linear Oil Price Shock

In the standard literature, the linear oil price shock specification which proposed by Mork (1989) discusses the positive and the negative oil price responses. In accordance, the non-linear oil price shock is specified as follows:

$$dOILP_t = \ln OILP_t - \ln OILP_{t-1}$$

Table 1: Robust least squares estimates of real import demand as a dependent Variable

Variables	Coefficient	z-statistic	Probability
Import demand with OILPI			
C	−3.570845	−7.676764	0.0000
RP_t	−0.674570	−3.424740	0.0006
$OILPI_t$	−0.004943	−6.279884	0.0000
$RGDP_t$	1.245228	16.17160	0.0000
RFE_{t-1}	−0.014264	−0.390513	0.6962
R^2	0.69		
R^2w	0.97		
R^2n	939.9664		
Import demand with OILPD			
C	−3.485142	−7.221761	0.0000
RP_t	−0.598185	−2.918260	0.0035
$OILPD_t$	−0.004378	−2.003517	0.0451
$RGDP_t$	1.226029	15.47446	0.0000
RFE_{t-1}	−0.014365	−0.386042	0.6995
R^2	0.62		
R^2w	0.97		
R^2n	807.3632		

In order to capture the real oil price asymmetry, one can write it in the following form:

$$OILPI_t = \max\{0, (OILP_t - OILP_{t-1})\}$$

For the real oil price decrease:

$$OILPD_t = \min\{0, (OILP_t - OILP_{t-1})\}$$

Where $OILP_t^i$, is real log oil price at time t. Employing Hamilton's (1996) method, NOPI and NOPD are constructed as:

$$NOPI_t^{45} = Max\{0, OILP_t - max(OILP_{t-1}, OILP_{t-1}, ..., OILP_{t-45})\}$$

$$NOPI_t^{45} = Min\{0, OILP_t - min(OILP_{t-1}, OILP_{t-1}, ..., OILP_{t-45})\}$$

Furthermore, Hamilton (1996) suggested net price increase, NOPI. This measurement is defined as a value of oil price in quarter t, p_t, exceeds the highest value over the last four quarters. So, an increase in oil price may be a result of price correction to earlier levels, which may not affect the economy as a whole.

Here, all variables in real log form. The data used here is collected from Saudi Arabian Monetary Authority, statistical year book 2016. The real oil price implemented here is OPEC basket price. The data covers the period of 1975–015. Table 1 shows estimates of robust least squares. The impact of oil price shock on real aggregated import demand is negative in both cases OILPI and OILPD. However, the oil price increase should be positive and both are significant at 5% level. The elasticity of RP is negative in both cases indicating that a 10% change in RP leads to 5.9–6.7% change in real imports. However the signs are as expected and significant at 1% level. Moreover, the price elasticity findings are consistent with what is in the literature that is <1. On the other hand, the income elasticity is >1 (1.2) and positive as expected and significant at 1% level. This finding is in line with the findings of researchers. A 10% change in income leads to about 12% in real imports. The foreign exchange reserves variable had the expected negative sign but is not significant. A 10% increase in foreign exchange leads to a 1.4% in real import demand. This finding is consistent with Rashid and Razzaq (2010). Their finding of Z_t is (−0.014) and not significant. Furthermore, Emran and Shilipi (2008) found it (0.71) for India but not significant and (0.29) for Sri Lanka and significant.

3.2. Unit Root Test

In the beginning, we start our analysis by determining the unit root. Economic variables time series may exhibit trending behavior (non-stationary means). In this case, trend remedy is required. De-trending procedures include differencing and time series regression. Time series with the property od I(1), differencing procedure is likely to be applied. However, time trend regression is plausible for I(0) time series. The purpose of using unit root testing is to decide if trending data ought to be differenced or use regression. Augmented Dickey Fuller (ADF) and Phillips-Peron (PP) tests are implemented here to test for stationarity of the time series. ADF test is performed using the following equation:

$$\Delta Y_t = \Phi + \gamma T + \lambda \Delta Yt - 1 + \Psi i \sum_{i-1}^{n} \Delta Y_{t-i} + \varepsilon t \quad (19)$$

Where Φ is a constant, γ is the coefficient of time trend T, λ and Ψ are the parameters where, $\lambda = \rho$-1, ΔY is the first difference of Y series, n is the number of lagged first differenced term, and ε_t is the error term. The PP test is performed using the following equation:

$$\Delta Y_t = \Pi + \eta T + \Theta \, \Delta Y_{t-1} + \varepsilon_t \quad (20)$$

Where Π is a constant, η is the coefficient of time trend T, Θ is the parameter and ε_t is the error term. Results are reported in Table 2. Both tests have been performed and exhibited that variables are stationary at the difference in the ADF and PP tests. Some of the variables, like RP, RGDP, and RFE_{t-1} are not stationary at level I(0). However, the model variables are stationary at difference I(1) and significant at 1% and 5% level. Nevertheless, to obtain short and long-run analyses, it is of interest to have all relevant variables in the same order, I (1).

3.3. Johansen Co-integration Test Results

Applying regression for non-stationary time series would result in spurious outcomes. The exception is that, linear dependent and independent variables wipe out stochastic trends yielding stationary results. In this regard, we describe these variables as co-integrated, such that:

$$Y_t = \lambda_1 X_{1,t} + \lambda_2 X_{2,t} + \ldots + \lambda_k X_{t,k} + \varepsilon_t \sim \mathrm{I}(0) \quad (21)$$

Testing for co-integration, in fact is parallel to testing k linear regression residuals (ε_t) for stationarity. The goal of Johansen test is to examine linear combinations of a set of independent variables (k) for an m time series variables in order to attain stationarity. In fact, the reduced rank of the X matrix is the trace test and the maximum eigenvalue test, such as:

$$J_{Trace} = -T \sum_{i=r+1}^{n} ln(1-\hat{\lambda}_i); \text{and } J_{Max} = -T \; ln \; (1-\hat{\lambda}_{r+1})$$

T is the sample size and is the i[th] largest correlation. Johansen's co-integration test necessitates lag length which can be obtained through unrestricted VAR model. Tests here used 1 lag depending on unrestricted VAR lag order, LR, FPE, AIC, and HQ. From Table 3, trace statistic test confirms the existence of 2 co-integrated equations at the 1% level. The null hypotheses for the trace and max tests are that, there are no co-integrations between real oil price variations, real GDP, RGDP, RP, RP, and real foreign exchanges lagged 1 year, RFE_{t-1}. The null hypotheses are rejected. Thus, there exist long-run relationships among the variables alluded to.

3.4. Causality Tests

Causality is said to be present as the relation between cause and effects. In this case the cause and effects occur between two set of variables, say X_t, and Y_t. X_t is said to Granger cause Y_t if Y_t is be better predicted by past information on X_t and Y_t rather than using past information in only Y_t. For pairwise Granger causality test, one should test for the absence of Granger causality using VAR, such as:

$$Y_t = \lambda_0 + \lambda_1 Y_{t-1} + \ldots + \lambda_k Y_{t-k} + \Psi_1 X_{t-1} + \ldots + \Psi_k X_{t-k} + U_t \quad (22)$$

$$X_t = \delta_0 + \delta_1 X_{t-1} + \ldots + \delta_k X_{t-k} + \gamma_1 Y_{t-1} + \ldots + \gamma_k Y_{t-k} + V_t \quad (23)$$

The results are unidirectional Granger causality from Y_t to X_t or from X_t to Y_t, or bidirectional causality or no Granger causality at all. It is clear that causality runs from OILPI to RGDP, and RP. Next, causality runs from RGDP to RIM (Tables 4 and 5).

3.5. Impulse Response Function

To test for asymmetric and impulse innovations in changes in oil prices, an unrestricted VAR is applied. One of the merits of using

Table 2: ADF and PP tests

Variables	ADF						PP					
	Level			1[st] difference			Level			1[st] difference		
Series	Intercept	T&I	None	Intercept	T&I	None	Intercept	T&I	None	Intercept	T&I	None
RP_t	1.20	2.01	0.89	3.38**	3.31**	3.43*	1.59	2.33	1.18	3.10**	3.01***	3.14*
$OILPI_t$	2.92	5.41*	1.47	4.16*	5.24*	9.26*	4.25*	5.42*	0.12	27.62*	29.19*	19.83*
$OILPD_t$	3.37**	4.68*	0.77	7.14*	6.96*	7.25*	3.37**	4.93*	0.49	9.83*	11.54*	10.09*
$RGDP_t$	2.13	2.99	1.71	6.05*	6.15*	5.59*	2.43	2.99	2.09	6.05*	6.15*	5.57*
RFE_{t-1}	1.32	1.42	2.03**	4.86*	4.79*	4.71*	1.62	1.48	1.41	4.88*	4.81*	4.72*

*,**, and *** are statistically significant at 1%, 5% and 10% level respectively. T&I: Trend and intercept. ADF: Augmented-Dickey Fuller, PP: Phillips-Perron

Table 3: Johansen co-integration test (lags=1)

H_0	H_A	Eigen values	λ_{Trace}	95%	H_0	H_A	λ_{Trace}	95%
OILPI								
r=0	r=1	0.596534	85.68334	69.81889	r=0	r=1	36.30650	33.87687
r=1	r=2	0.512714	49.37684	47.85613	r=1	r=2	28.75614	27.58434
r≤2	r=3	0.273740	20.62070	29.79707	r≤2	r=3	12.79388	21.13162
OILPD								
r=0	r=1	0.660241	95.19969	69.81889	r=0	r=1	46.41932	33.87687
r=1	r=2	0.445248	48.78037	47.85613	r≤1	r=2	25.33709	27.58434
r≤2	r=3	0.303098	23.44328	29.79707	r≤2	r=3	15.52778	21.13162

r indicates the number of co-integrating vector. Critical values are from Mackinnon et al. (1991) P values. *Indicates significance of the test statistic at 5% level

VAR is that, changes in oil price are related to changes in its own lags and to changes in other variables and their lags. Following Thankgod and Maxwell (2013), the unrestricted autoregressive VAR in reduced form of order p is as follows:

$$Y_t = c + \sum_{i=1}^{p} Ai y_{t-1} + \varepsilon_t \qquad (24)$$

Where $c = (c_1,\ldots, c_5)$ is the (5×1) intercept vector of the VAR. A_i is the i^{th} (5×5) matrix of autoregressive coefficients for i = 1, 2,…, p, and ε_t is the (5×1) generalization of a white noise process.

In this analysis, I use 5 endogenous variables ordered as $OILP^i$ (i = + and -), RGDP, RFE-1, RP and RIM. The unrestricted VAR system is constructed as follows:

$$\begin{bmatrix} oilpit \\ rgdpt \\ rfet \\ rpt \\ rimt \end{bmatrix} = \begin{bmatrix} c1 \\ c2 \\ c3 \\ c4 \\ c5 \end{bmatrix} + A(\mathrm{I}) \begin{bmatrix} oilpit-1 \\ rgdpt-1 \\ rfet-1 \\ rpt-1 \\ rimt-1 \end{bmatrix} + \begin{bmatrix} U1 \\ U2 \\ U3 \\ U4 \\ U5 \end{bmatrix}$$

Here A(I) is the lag polynomial errors. The error vectors are assumed to be mean zero but not auto-correlated. The unrestricted VAR can be transformed into moving average in order to analyze the system response to a shock on real oil prices, such that:

$$y_t = \mu + \sum_{i=0}^{\infty} \Psi_i \, \varepsilon_{t-i} \qquad (25)$$

Where Ψ_0 is identity matrix and μ is the mean of process. Figures 2 and 3 reveal the variance decomposition results for every variable at the forecast period starting from 1 up to 20 years. The beauty of variance decomposition helps to understand the variations in a variable's series explained by its own shocks against shocks from other variables. This means expectations stem from the fact that the variable explains almost all its forecast error variance at the short-run and smaller proportions at the long-run. Here, the assumption is that the shock is identified through a standard Cholesky decomposition with the order alluded to Abayie and Nkrumah (2013). Given OILPI, and from Figure 2 the contribution of RIM to its own shock in the short-run is about 12% in the 1st year. As time passes other factors affect shocks to RIM. In the 2nd year, the variations in RIM is accounted for 9% by RIM itself and continue to decline till it reaches 5% in the 20th year time span. Similarly, in terms of RGDP, about 16% of error variance is caused by RGDP itself in the 1st year and continue to diminish till 3% in the year 20. However, RIM is accounted for 8% besides other variables in the 1st year. The variations in RIM diminish over time. About 17% of error variance is attributed

Figure 2: Response to Cholesky one S. D. innovations ± 2 S. E. of RIM, RGDP, RP, and RFE_{t-1} to oil price increase

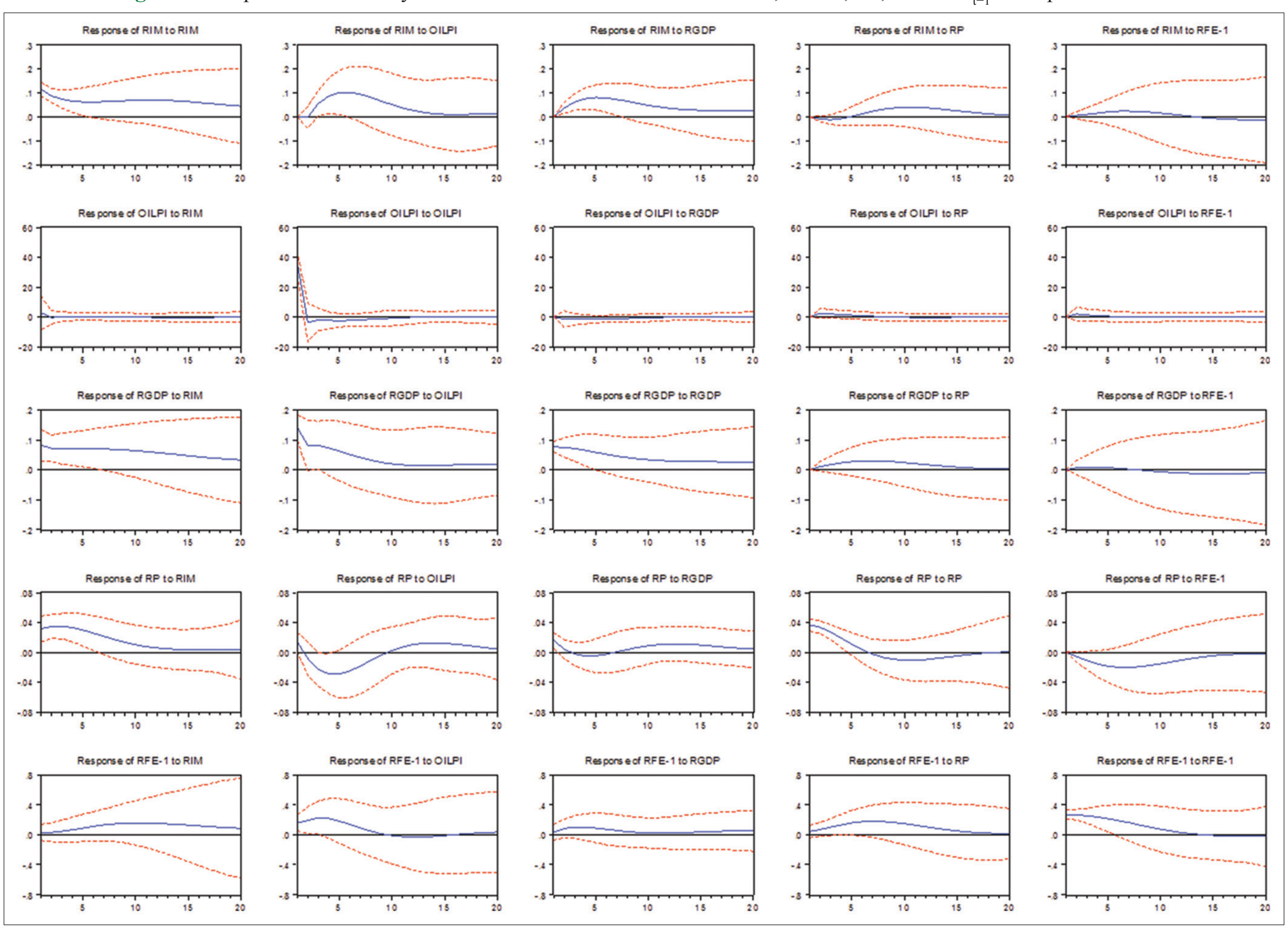
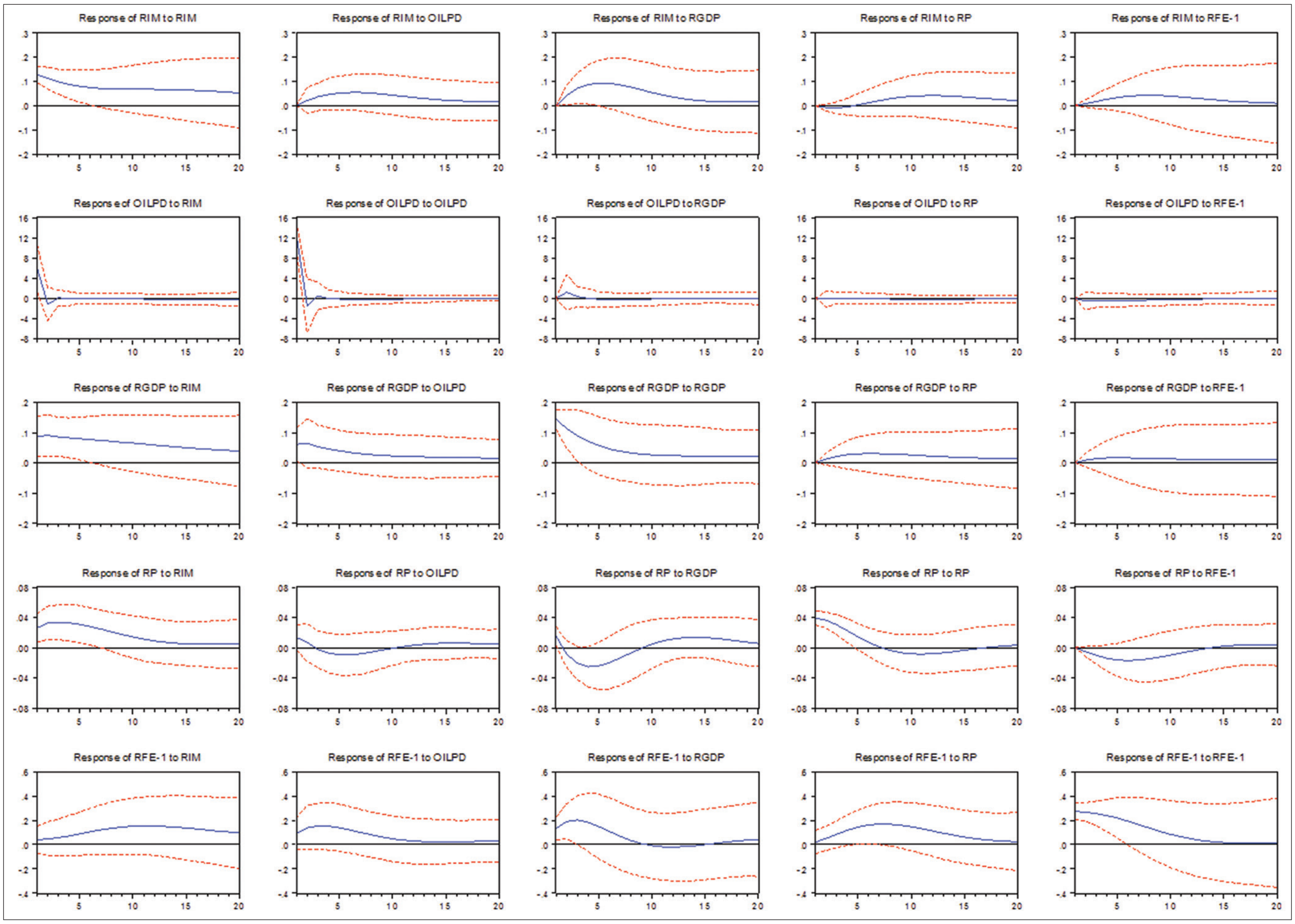


Figure 3: Response to Cholesky one S. D. innovations ± 2 S. E. of RIM, RGDP, RP, and RFE_{t-1} to oil price decrease



to OILPI own shock in the 1st year, 31% to RGDP, 3% to RIM, and −3.4% to RP. However, the RGDP, RP decline over time and RIM went up to −28% in the 14th year. Finally, 27% of the variations in RFE_{t-1} are attributed to its own shock in the 1st year. RGDP, RIM, RP, and OILPI explain not much of variations in the short-run. Nevertheless, only RIM accounted for 12% of shock to RFE_{t-1} in the 16th year. The foregone analysis reveals clearly that all mixed factors attributed to the shock in RIM and some other variables might be omitted responsible for more variations in RIM like political instability in the region, using the proxy for price of imports and terms of trade. On the other hand, With OILPD, Figure 3, I obtained the same results. This necessitates not repeating it. The overall findings did not support the Hemphill's argument about the role of foreign exchange in determining the import demand.

4. CONCLUSION AND POLICY RECOMMENDATIONS

The purpose of this paper has been to analyze and investigate the effects of oil price fluctuations on the traditional import demand function. An ad hoc model has been developed to incorporate the conventional import demand function, the oil price variations, and the foreign exchange approach. The usefulness of this study is that, the oil price fluctuations did not explain the changes in import demand. The income elasticity explained well the variations in the import demand function. These results are consistent with almost all of the studies of import demand functions. In addition, this paper has examined empirically the impacts of such a shock (increase and decrease) on the import demand function for the period of 1975–2015, using Robust OLS and unrestricted VAR (VAR) model. The Johansen co-integration tests showed an existence of long-run relationships among the variables, a non-linear oil price shocks (OILPI and OILPD), RIM, RGDP, RP, and RFE_{t-1}. In the short-run, and based on equation (18), RP influenced RIM negatively. Furthermore, a 10% change in RP will affect RIM by 6%. The coefficient is significant at 1% level and has the expected sign. On the other hand, A10% increase in real GDP leads to an increase in RIM by 13%, and vice versa.

The result here is in line with the findings in import demands studied, and acceptable for less developed countries. It is clear from analysis that foreign exchange lagged 1 year's sign is in line with the findings of Emran and Shilipi (2008), and Rashid and Razzaq (2010). However, the coefficient is not statistically significant. On the other hand, findings did not support Hemphill's argument. The sign of foreign exchange is negative and not significant at all. From the various decomposition results, one notes that our analysis variables own shocks are accounted for much of the variations in the import demand function.

Table 4: Pairwise Granger causality tests, lags 2

Null hypothesis	Observations	F-statistic	Probability
RGDP does not Granger cause RIM	44	6.91851	0.0027
RIM does not Granger cause RGDP		1.37882	0.2640
RP does not Granger cause RIM	44	2.15799	0.1292
RIM does not Granger cause RP		1.55833	0.2233
OILPI does no Granger on RIM	4	3.86254	0.0305
RIM does no Granger on OILPI		2.56535	0.0913
RFE-1 does not Granger on RIMI	44	2.31371	0.1123
RIM does not Granger on RFE-1		0.43290	0.6517
RP does not Granger on RGDP	44	0.83857	0.4400
RGDP does not Granger on RP		4.78404	0.0139
OILPI does not Granger on RGDP	40	4.64479	0.0163
RGDP does not Granger on OILPI		2.31098	0.1141
RFE-1 does not Granger on RGDP	44	0.04535	0.9557
RGDP does not Granger on RFE-1		0.82663	0.4450
OILPI does not Granger on RP	40	15.9011	1.E–05
RP does not Granger on OILPI		0.01338	0.9867
RFE-1 does not Granger on RP	44	1.67113	0.2012
RP does not Granger on RFE-1		1.85725	0.1696
RFE-1 does not Granger on OILPI	40	1.44580	0.2493
OILPI does not Granger on RFE-1		0.06463	0.9375

Table 5: Pairwise Granger causality tests, lags 2

Null hypothesis	Observations	F-statistic	Probability
RGDP does not Granger cause RIM	44	6.91851	0.0027
RIM does not Granger cause RGDP		1.37822	0.2640
RP does not Granger cause RIM	44	2.15799	0.1292
RIM does not Granger cause RP		1.55833	0.2233
OILPD does no Granger on RIM	43	0.17591	0.8394
RIM does no Granger on OILPD		2.18388	0.1265
RFE-1 does not Granger on RIMI	44	2.31371	0.1123
RIM does not Granger on RFE-1		0.43290	0.6517
RP does not Granger on RGDP	44	0.83857	0.4400
RGDP does not Granger on RP		4.78404	0.0139
OILPD does not Granger on RGDP	43	0.14145	0.8685
RGDP does not Granger on OILPD		0.33139	0.7200
RFE-1 does not Granger on RGDP	44	0.04535	0.9557
RGDP does not Granger on RFE-1		0.82663	0.4450
OILPD does not Granger on RP	43	2.13498	0.1322
RP does not Granger on OILPD		0.01633	0.9838
RFE-1 does not Granger on RP	44	1.67113	0.2012
RP does not Granger on RFE-1		1.85725	0.1696
RFE-1 does not Granger on OILPD	43	0.57557	0.5672
OILPD does not Granger on RFE-1		0.32698	0.7231

5. ACKNOWLEDGMENT

The author would like to thank deeply the deanship of graduate studies and scientific research at Dar Al-Uloom University in Riyadh, Saudi Arabia, for their financial support.

REFERENCES

Abayie, E., Nkrumah, J. (2009), Estimating an aggregate import demand function for Ghana. Journal of Science and Technology, 29(2), 54-62.

Aipi, B., Sabok, G. (2015), Estimating an Aggregate Import Demand Function for Papua New Guinea. Bank of Papua New Guinea Working Paper, BPNGWP.

Amano, R., Wirjanto, T. (1996), Intertemporal substitution, imports and the permanent income model. Journal of International Economics, 40, 439-457.

Arize, A. (1987), The elasticities and structural stability of import demand function for Nigeria: 1966-1977. Social and Economic Studies, 36, 171-186.

Emran, M., Shilipi, F. (2008), Estimating Import Demand Function in Developing Countries: A Structural Econometric Approach with Application to India and Sri Lanka. Institute for International Economic Policy Working Paper Series. Elliott school of International Affairs, The George Washington University, IIep-WP-2008-10.

Gafar, J. (1988), The determinants of import demand in Trinidad and Tobago: 1967-1984. Applied Economics, 20, 303-313.

Goldstein, M., Khan, M. (1985), Income and price effects in foreign trade. In: Jones, R., Kenen, P., editors. Handbook of International

Economics. Vol. 2. Amsterdam and New York, North Holland: Elsevier. p1041-1105.

Gumede, V. (2000), Import demand elasticities for South Africa: A co-integration analysis. Journal for Studies in Economics and Econometrics, 24, 21-37.

Gumede, V. (2000), Import performance and import demand functions for South Africa. Department of Trade and Industry, 33, 1-57.

Haider, J., Afzal, M., Riaz, F. (2011), Estimation of import and export demand functions using bilateral trade data: The case of Pakistan. BEH-Business and Economic Horizons, 6(3), 40-53.

Heien, D. (1968), Structural stability and the estimation of international import price elasticities. Kykols, 21, 695-711.

Hemphill, W. (1974), The effects of foreign exchange receipts on imports of less developed countries. IMF Staff Papers, 21, 637-677.

Hibber, K., Thaver, R., Hutchinso, M. (2012), An econometric analysis of Jamaica's import demand function with the US and UK. International Journal of Business and Finance Research, 6(1), 109-120.

Hussain, M. (2007), Estimating long-run elasticities of Jordanian import demand function: 1980-2004, an application of dynamic OLS. Applied Econometrics and International Development, 7(2), 171-182.

Khan, M. (1975), The structure and behavior of imports of Venezuela. The Review of Economics and Statistics, 57, 221-224.

Khan, M. (1976), A monetary model of balance of payments: The case of Venezuela. Journal of Monetary Economics, 2, 311-332.

Kreinin, M. (1973), Dis aggregated import demand functions: Further results. Southern Economic Journal, 40, 19-25.

Mork, K. (1989), Oil and macro-economy when prices go up and down: An extension of Hamilton's results. Journal of Political Economy, 97(3), 740-744.

Ogbonna, B. (2016), Estimating aggregate import demand function for Nigeria: Revisited. IOSR Journal of Business and Management, 18(3), 64-72.

Rahman, H. (2007), An econometric estimation of traditional import demand function for Pakistan. Pakistan Economic and Social Review, 45(2), 245-165.

Rashid, A., Razzaq, T. (2010), Estimating Import Demand Function in ARDL Framework: The Case of Pakistan. MPRA Paper, no. 23702.

Rashid, M. (1984), Modeling the developing economy: The Philippines. The Developing Economies, 22, 274-288.

Salehi-Isfahani, D. (1989), Oil exports, real exchange rate appreciation, and the demand for imports in Nigeria. Economic Development and Cultural Change, 37, 495-512.

Senhadji, A. (1998), Time series estimation of structural import demand equations: A cross-country analysis. IMF Staff Papers, 45(2), 236-268.

Tirmazee, Z., Naveed, R. (2014), Reviewing Pakistan's import demand function: A time series analysis, 1970-2010. The Lahore Journal of Economics, 19, 371-393.

Yue, Y., Constant, N. (2010), An econometric estimation of import demand function for Cote D'Ivoire. International Journal of Business and Management, 5(2), 77-84.

Zhou, Y., Dube, S. (2011), Import demand functions: Evidence from CIBS. Journal of Economics Development, 36(4), 73-96.