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Impacts of realized volatility of oil price over foreign trade related activities in Turkey

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Abstract Since 1973 oil crises, especially, small open economies have considered sudden and highly volatile movements in currencies and current account deficits. Oil prices have been breaking new historical price records since second quarter of 2014, especially from last quarter of 2015 to first quarter of 2016, which have gradually put pressure on political, geographical, and currencies risks in the Middle East and Eastern European countries. Similarly, because Turkish economy has been experienced serious current account deficit problems especially since 2002, the effect of decline in oil prices and increased volatility has been worth of investigating. For 2003M1–2015M7 period, export–import ratio, real exchange rate index, realized volatility in oil prices calculated based on monthly OPEC basket price, industrial production index, and consumer price index were collected to analyze these effects and causality relationship among these variables. Test results of unit root test with and without structural break, ARDL bound test and co-integration test were sorted out among variables. Initial result is that price volatility increases and total import decreases more sharply than total export after the decline in oil prices; thus, export–import ratio increases. Another is that there is a negative relationship between real exchange rate index and export–import ratio for real economy because of low oil substituents. As expected, inflation has an adverse effect on foreign trade ratio. Consequently, because of lower pressure of energy-induced inflation, economy policy makers will have some ability to change their priorities from inflation issue to other structural problems.

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1 Introduction

Most of sudden oil price shocks and volatility exert destructive influence on output, namely GDP, unemployment, inflation, exchange rates, and trade imbalances which are generally accepted as key indicators for an economy. In pursuit of exchange rate movements and cost items changes, these effects spread as systemic risks penetrating whole economy. First of all, these unexpected movements become important issue on sectorial behaviors and then, bypass rational behavior and damage market efficiency. This study examines daily OPEC basket price transformed into the monthly volatility, and their effects on industrial production index, real exchange rate index, consumer price index.

Especially, after 1980s because of the monetary and fiscal policy decisions and delays in their implementation, the difficulty in predicting the animal spirits of investors cause oil price changes and oil price volatility, that's why oil price volatility impacts on macroeconomic activities are mostly used variables in most of the researches instead of oil price changes (Hooker 1996, 2002; Rotemberg and Woodford 1996; Sauter and Awerbuch 2003; Hamilton 1983, 2000). The main reason for the use of oil price volatility in this study is the importance of the oil price volatility created by oil shocks and that it has a major impacts on consumers decisions and producers investment decisions which have huge share in general national income equation.

As mostly known by policy makers (monetary or fiscal) and investors, volatility in financial and commodity markets are frequently related with the risks because of their additive effects on uncertainty and postponed investment decisions (Guo and Kliesen 2005). Besides, the oil prices in Turkey are determined in the free market. The implementation of such liberalization inevitably reduces the effectiveness of policy makers' intervention tools (Aydın and Acar 2011). At this point all the results obtained from this study will reflect the effects of the volatility on all sectors and thus, general economy.

Especially, after the second quarter of 2014, increased volatility created by particularly sudden price movements in oil and other energy commodity prices has yielded remarkable results for countries such as Turkey which have fragilities in exchange rates and balance of payments. Therefore, channeling effects described here causes indirect influences on the macroeconomic activities as mentioned above. For instance, according to Rasche and Tatom (1977), between 1973 and 1974 the upward trends in prices initially affected volatility and thus, cost of the firms by leading a slowdown in the productivity of capital and labor, and finally reduced the US economy's potential output approximately 4–5% (Rasche and Tatom 1977). Aydın and Acar (2011) states that the primary influences of oil shocks are a reduction in consumption and decline in net investment inflows which gradually works through Turkish economy.

According to related studies of Hamilton (1996), Hooker (1996), and Sauler and Awerbuch (2003), the movements in oil price had upward trend during the period 1948–1985, but after 1986, up and down fluctuation in prices caused significant volatility. According to Sauter and Awerbuch (2003), after the increases in oil price volatility, the implemented monetary and fiscal policy measurements need to intervene the market along with interest rate and expenditure policy tools and then, this situation causes an increase in uncertainty and regression in investments.

During the last few years, according to the main stream paradigm (i.e., Neoclassical Economics), for crude oil which is defined as scarce sources in the world, especially the sudden demand shocks can result from the increasing global population, and GDP per capita. The increasingly brutal competition, and narrowing profitability ratio opportunities make equal effects as supply conditions (such as; weather conditions and geopolitical tensions, local/global war concerns). By the way, most of the studies in this literature indicate that these effects can differentiate in terms of outputs depending on the discussed period and areas. (Kyrtsou et al. 2009; Symeonidis et al. 2012; Solak 2012).

The supply shocks can emanate from some economic cycles, political risks, and oil price concerns of the producers like OPEC members. The related outputs of these negative or positive supply side shocks on the economy can be interacted with most of the indicators in the literature. For example, as a result of negative supply side shock, the average cost of the producers and other reel sector firms will increase then for the short term layoffs will be appeared in the labor markets. As a result of layoffs, according to the total demand theories, that will generate an effect on purchase power then GDP. These conditions will stimulate monetary and fiscal policies. Following the decline in growth, monetary policy authorities will undercut interest rates to pump money into the economy, then the starting of up down trend of interest rate cause the runaway of foreign capital investment (FCI), and consequently all these chain effects will damage financial stability. Of course, these kind of supply side shocks can be minimized by diversifying alternative energy resource equally (our next studies will refer to these kind of studies). (Economides and Wood 2009; Firuzan 2010; Brown et al. 2003; Aydın and Acar 2011; Hamilton 1996).

In literature, as known “Asymmetry in Effects” which represents nonlinear effects of upside and downside movements of oil prices on economy has been widely investigated by (Hooker 1996, 2002; Hamilton 1996, 2000) for different periods. They find that oil price increases had a negative impact on economy but could not reach a marked impact. The decreases in prices had a significant performance-enhancing result on economy. While Ferderer (1996) names these effects as “Asymmetric Puzzle”, according to test results obtained from his investigation, channels create oil shocks on the real side of the US economy. There are three different channels. These can be listed as counter inflationary monetary policy, sectorial shocks, and uncertainty.

The emergence of the oil shocks can usually result from conflicts of domestic or international political, geographical conditions. These oil shocks and conflicts lead to supply constraints on capital, labor and energy inputs. The demand or supply side shocks on energy inputs can be a pioneer step for the cost reduction policy in labor markets for short run and readjustments of firm's profitability for mid/long term (Hamilton 2000). Of course, these effects are not linear, as previously mentioned, price increases and decreases penetrate an economy in different magnitudes because of *"Asymmetry Effect"*.

Killian (2009) analyzes oil price shocks thru error terms (ε_t) as oil supply shock, oil aggregate demand and oil specific-demand shock with Vector Autoregressive (VAR) Model between 1975 and 2007 years for the USA. And, empirical results indicate that not only demand side shocks effectiveness but also oil supply side shocks are crucial in order to predetermine macroeconomic activities.

The increased cost of the other inputs and huge pressure on balance of payments deficits can be counted as the indirect effects of oil price shocks due to the rising energy prices (Aydın and Acar 2011; Gökçe 2013). This study coincides with empirical evidence that a shock causing volatility in oil prices in the long run will cause a decline over −0.0164 in GDP.

2 Data and methodology

As mentioned above, as a structural problem of Turkey's economy heavily dependent on energy import, especially oil, in order to investigate the oil price impacts on growth rate, the unit root tests we used for stationary of variables indicate that variables have different stationary level so ARDL Bound approach were founded reliable for co-integration analysis for the period of 2003M1–2015M7.

Here, the study uses the data such as X/M ratio (monthly),[1]) oil price realized volatility (monthly), inflation/CPI (monthly) and real exchange rate index (which is calculated by Central Bank of Turkey as a basket of currencies) or monthly converted exchange rate data obtained from (http://www.oanda.com/currency/average), and interbank rate change ratio from highest to lowest as determinants of trade deficits. All the data were transformed into logarithmic forms. The main reason to choice this data range is that a new politic term (Justice and Development Party came to power in 7 August 2002) because this politic party has been longest party remained in power in Turkish political history.

2.1 Data

In order to measure Turkey's output growth of the covered period, the industrial production index (IPI) data published monthly by Turkey Statistics Institute and which is not free from logarithmically transformed seasonal effects was used in monthly conversion made for realized volatility series. However, inclusion of IPI

[1] In literature, in common to measure level of foreign trade competitiveness of a country, researchers prefer to put a net value of foreign trade or export to import ratio into the model as variable (Rafiq et al. 2009; Durand and Giorno 1987).

negatively affected the significance of whole model and therefore, it is kept out from the model. If anyone demands test result of the inclusion of IPI into the model, we can provide test results.

OPEC basket price series has been received from the Organization of Petroleum Exporting Countries official website. OPEC basket price realized volatility series has been calculated from daily realized variance based on the recommendation of Merton (1980) formula as an indicator of risk which is measurable part of uncertainty in the markets (Merton 1980). And these daily realized volatility series were transformed into the quarterly realized volatility according to the recommendation of Andersen et al. (2003)'s formula which follows sum of squared of realized volatility procedure. (Andersen et al. 2003; Merton 1980).

$$\mathrm{REALVOL_t} = \sum_{\mathrm{i=1}}^{i_t} (RETURN\_REALVOL_i)^2$$

After the calculation of daily returns, the sum of squares of converted monthly returns give us the quarterly realized volatility of the required period (We can provide work file up on request) (Fig. 1).

The exports and imports ratio is an important indicator showing the fragility of the country's openness which is considered as appropriate in the literature. Therefore, this ratio is calculated and logarithmically transformed based upon the data on foreign trade indices published monthly by the Statistical Institute of Turkey.

Although Global Financial Crisis began in 2007–2008, there were weird movements in oil price. In contrast to the depressive reel economic conditions, oil prices exhibit an upward side trend instead of negative expectations of animal spirits. According to the popular perspective, these movements are based on financial sectors speculations. Since 2003, like all other commodities, oil has been transformed into financial products in spots and derivative markets. For this reason, after the increased demand for oil and future contracts, with the spillover effects on arbitrage channel, non-producers speculative movements penetrate pump price of oil and reel economy (Killian and Murhpy 2009).

To explain Brent oil price up and down trends and our empirical results taken from break point unit root test in 2010, mostly we can refer to the news. As is known, last months, all the World has been shocked with the Brexit referendum result of United Kingdom. According to the results, half of U.K society voted to exit

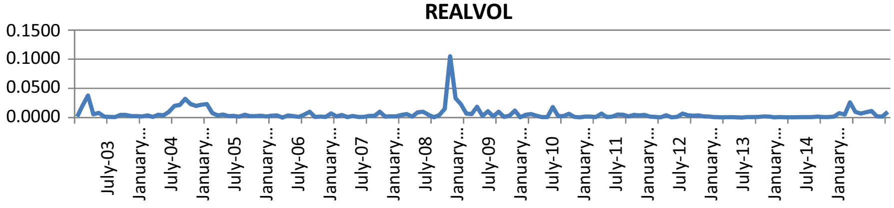

Fig. 1 OPEC Basket Price Realized Volatility, 2003 M1–2015M7 *Source*: http://www.opec.org/opec_web/en/data_graphs/40.html. Microsoft Excel 2016 was used to create artwork

from EU. But of course, at the point that we have reached today it was started to send signal with the alerts of exit necessity of Greece from EU on behalf of the future competence. During this period Euro currency had depreciated against other currencies, especially against U.S.A. dollar. Consequently, USA dollar gained back its global currencies reputation in the public eye, and the depreciation of Euro/Dollar parity caused a decline in all commodities like Brent oil price.

In contrast to the common usage of literature, we used ratio of export/import of Turkey as dependent variable because it has more powerful quantitative indicator than other stock or variables like total foreign trade or trade balance (Fig. 2). In the literature, mostly discussed ratio transformed variables have been accepted stronger than some other statistical indicator in order to indicate country's competitive strength/power globally (Das 2002; Lizardi 2006; Kennedy and Thirlwall 1983).

In order to see the effect of foreign currency on exports and imports ratio, the study provides benefits in examining the real exchange rate index published by the Central Bank of Turkish Republic. Logarithmic transformation of real exchange rate index was carried out (Fig. 3).

As it is well known, the consumer price index, especially relative cheapness and expensiveness of imported goods prices compared to domestic prices exerts significant impacts on exports to import ratio. Therefore, logarithmic transformation of the consumer price index published by Statistical Institute of Turkey was included in the analysis (Fig. 4).

2.2 Unit root test results

Before estimating, the co-integration method that will be implemented for the series is necessary to check which level they are co-integrated. For this purpose, to determine I(d) value for each series, the study benefits from a bunch of test such as followings: the Augmented Dickey-Fuller (ADF) (Dickey and Fuller 1981) the autoregressive process allowed as permitting delays as AR (p), Kwiatkowski-Phillips-Schmidt-Shin (KPSS) (1992) developed an alternative unit root test which reverse the alternative and null hypothesis' arguments, depending on the difficulty of critical value to reject. Phillips–Perron (PP) (1988) developed a unit root test which can test the existence of the relationship between the non-parametric and error terms. PP Unit Root Test is developed for improvement of some of the weaknesses of the Ziwot Andrews test determining the trend of the average in the breaking years and common breaks in both series (Perron (1997)).

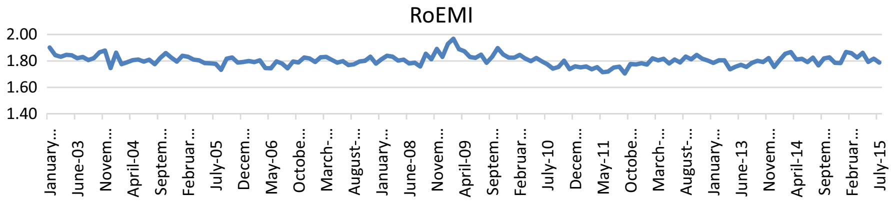

Fig. 2 Rate of Export to Import, 2003M1–2015M7 *Source*: http://www.tuik.gov.tr/PreIstatistikTablo.do?istab_id=1544. Microsoft Excel 2016 was used to create artwork

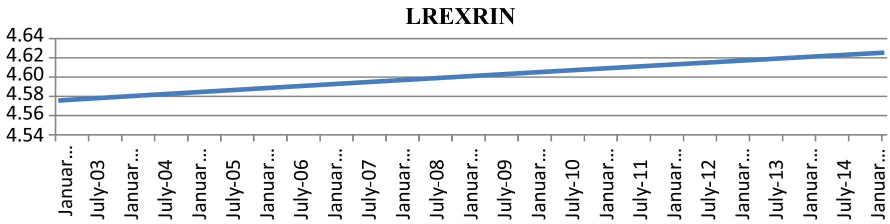

Fig. 3 Real Exchange Rate Index, 2003M1-2015M7 *Source*: http://www.tuik.gov.tr/PreIstatistikTablo.do?istab_id=1544. Microsoft Excel 2016 was used to create artwork

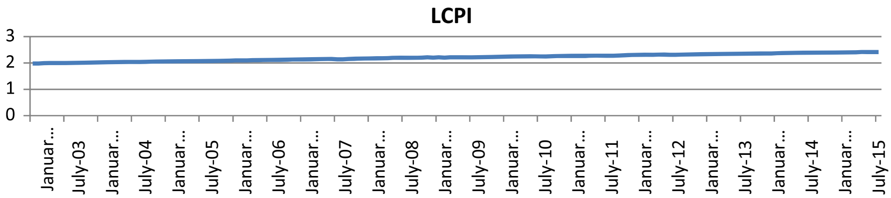

Fig. 4 Consumer Price Index-2003M1-20015M7 *Source*: http://www.tuik.gov.tr/PreIstatistikTablo.do?istab_id=1014. Microsoft Excel 2016 was used to create artwork

Table 1 ADF Unit root test results (intercept)

ADF test variable	Test statistics		Critical values 95% confidentiality	Decisions
	Level	First difference (ıntercept)		
LROEMI	−4.55	−13.15	−2.8824	I(0)
LREXRIN	−3.61	−9.22	−2.8824	I(0)
LCPI	−0.66	−9.25	−2.8824	I(1)
REALVOL	−7.62	−9.67	−2.8824	I(0)

Classical unit root tests can make decisions on the stability of the series in cases where the existing structural breaks (Tables 1, 2, 3, 4, 5, 6). In Eviews 9 econometric program, a sudden change in the average year break and dummy variables for breaking year are determined with Break Point Additive outlier unit root test (Perron 1989).

As seen on the KPSS and Phillips–Perron test results, the variables in our model has a different level of co-integration at I(0) and I(1). Thus, the ARDL Bound Testing Approach stands applicable (Table 7). After the determination of experienced sudden deviations from the average variable, an extra test has been applied as a test procedure in which Additive Outlier Test with Breakpoint and dummy variable are added to the period range.

Dummy10 variable in our model indicates a breakage in the average in May 2010 as the Additive Outlier Test with Breakpoint over LROEMI average as noted by Bruman and Otto (1988) in Eviews 9 program. When there is a determination of a

Table 2 ADF unit root test results (intercept + trend)

ADF test variable	Test statistics		Critical values 95% confidentiality	Decisions
	Level	First difference (ıntercept + trend)		
LROEMI	−4.54	−13.11	−3.4428	I(0)
LREXRIN	−3.73	−9.35	−3.4428	I(0)
LCPI	−4.44	−9.25	−3.4428	I(0)
REALVOL	−7.75	−9.64	−3.4428	I(0)

Table 3 KPSS unit root test results (intercept)

KPSS test variable	Test statistics		Critical values 95% confidentiality	Decisions
	Level	First difference (ıntercept)		
LROEMI	0.14	0.04	0.463	I(0)
LREXRIN	0.29	0.22	0.463	I(0)
LCPI	1.47	0.34	0.463	I(0)
REALVOL	0.25	0.18	0.463	I(0)

Table 4 KPSS unit root test results (intercept + trend)

KPSS test variable	Test statistics		Critical values 95% confidentiality	Decisions
	Level	First difference (intercept + trend)		
LROEMI	0.07	0.02	0.146	I(0)
LREXRIN	0.28	0.036	0.146	I(1)
LCPI	0.28	0.18	0.146	I(0)
REALVOL	0.05	0.18	0.146	I(0)

breakage on average belonged to a period, other observations except May 2010 are marked as of 0 (Bruman and Otto 1988).

2.3 ARDL bound approach test results

ARDL method examines long-term relationship between the variables in the model through F test concept not only in the case of variables or series having only I(0) or I(1) as noted in Pesaran et al. (2001) but also in the case of co-integration in different levels (Pesaran et al. 2001: p. 295–296).

> According to Pesaran et al. (2001),
> "The conditional ECMs (12)–(16), derived from the underlying VAR(p) model (2), may also be interpreted as an autoregressive distributed

Table 5 Philips–Perron unit root test results (ıntercept)

PP test variable	Test statistics		Critical values 95% Confidentality	Decisions
	Level	First difference (ıntercept)		
LROEMI	−7.463	−21.79	−2.880	I(1)
LREXRIN	−3.31	−9.22	−2.880	I(1)
LCPI	−2.44	−15.44	−2.880	I(0)
REALVOL	−7.65	−73.12	−2.880	I(1)

Table 6 Philips–perron unit root test results (intercept + trend)

PP test variables	Test statistics		Critical value 95% confidentality	Decisions
	Level	First difference (ıntercept + trend)		
LROEMI	−7.49	−21.73	−3.44	I(1)
LREXRIN	−3.28	−9.23	−3.44	I(0)
LCPI	−3.49	−25.57	−3.44	I(1)
REALVOL	−7.74	−82.90	−3.44	I(1)

Table 7 The detection of constant breaking year with additive outlier breakpoint unit root test

LROEMI	
Break specification	Intercept only
Break type	Additive Outlier
Break selection	Minimize Dickey-Fuller t-statistic
Break date	2010M6
t statistics (0.05 critical value and prob. value)	−7.881647 (−4.859812) (<0.01)

* Vogelsang (1993) asymptotic one-sided *p* values

> lag model of orders (p,p,…,p) (ARDL(p,…,p)). However, one could also allow for differential lag lengths on the lagged variables yt-i and $x_{t\text{-}i}$ in (2) to arrive at, for example, an ARDL(p,p_1,…,p)[2] model without affecting the asymptotic results derived from this section. Hence, our approach is quite general in the sense that one can use a flexible choice for the dynamic lag structure in (12)–(16)[2] as well as allowing for short-run feedbacks from the lagged dependent variables, $\Delta y{-}i$, i = 1,…,p, to Δx_t in (7)" (Pesaran et al. 2001)[2]

For the determination of appropriate length of delays and the number of variables to be placed in the model, the Akaike (AIC) information criterion is used to search for top 20 models.

[2] Please see Appendix for Case I (1)–Case IV(5) formulas.

In the ARDL approach, it will be initially benefited from the Unrestricted Error Correction Model (UECM) for estimating the following long-term coefficients and afterwards, determining the appropriate length of the delay (Keskin 2008).

$$\begin{aligned}\text{dlroemi} = c + b1\sum_{i=1}^{m}\text{dlroemi}_{t-i} + b2\sum_{i=1}^{m}\text{dlipi}_{\text{t}-i} + b3\sum_{i=1}^{m}\text{dlrexrin}_{\text{t}-i} \\ + b4\sum_{i=1}^{m}\text{dlcpi}_{\text{t}-i} + b5\sum_{i=1}^{t}\text{drealvol}_{\text{t}-1} + b6\text{lroemi}_{\text{t}-1} + b7\text{lipi}_{\text{t}-1} \\ + b8\text{lrexrin}_{\text{t}-1} + b9\text{lcpi}_{\text{t}-1} + b10\text{realvol}_{\text{t}-1}\end{aligned}$$

In this model, d is the series of the first difference taken; c is constant coefficients; b1, b2, b3, b4 are short-term coefficients because they are handled through taking difference; b5, b6, b7, b8, b9, b10 represent long-term coefficients since there is no difference taking process. After determining the level of stability for variables with the unit root tests applied above, determination of the appropriate length of delay and the number of variables to be placed in the model, the Akaike (AIC) information criterion is used to search for top 20 models.

From the perspective of dynamic delay length, ARDL (3,1,0,8) is preferred, when autocorrelation disappears for UECM and AIC, information criterion is taken into consideration. For studies which were used in ARDL approach, the most important coefficients diagnostic test is.

Breusch–Godfrey serial correlation LM Test because the most important problem to cope with is the existence of autocorrelation among lag values of error terms. As seen below in Table 8, we handle this problem with optimal leg length selection.

H0 There is no autocorrelation between error terms

H1 There is autocorrelation between error terms

As is seen, autocorrelation is no longer an issue in the model since it also contains short-term coefficients preferred for UECM. At this stage, F test is applied for overall significance test for whole model over length of the delays for ARDL Bound Testing approach and it should be compared with the upper and lower critical table values that the Pesaran et al. (2001) presented in their article (Table 9).

Because F statistic calculated on the overall significance of the model is higher than the upper and lower critical table values placed in Pesaran et al. (2001), we can infer that there can be a long-term co-integration among exports to import ratio, real exchange rate and consumer price index (Table 10).

As expected, error correction term value (−0.405627) was between 0 and -1 and it was found to be negative. The probability values seem very significant. Investigation between the variables on a monthly basis and hence, achieving to a balance at high level are possible (Table 11).

The model enables to find a positive relationship between exports and imports ratio and realized volatility of oil prices. This empirical finding means that increased volatility can be signal of the fall of oil prices due to risk perception of markets and therefore, means that there is an improvement in our trade balance.

Table 8 Breusch Godfrey serial correlation LM test

Lag length (2)	0.743(0.68)

* Results contain F statistics outside of parenthesis and Chisquare prob value in parenthesis

Table 9 ARDL bound F test statistic with lower and upper bound values

Critical values(5%)			
k	F statistic	Lower bound values	Upper bound values
3	5.102	3.38	4.23

Table 10 ARDL-long term coefficients and error correction model

Cointegrating form				
Variable	Coefficient	t-statistic	Prob.	
D(LROEMI(−1))	−0.375201	0.088321	−4.248134	0.0000
D(LROEMI(−2))	−0.189006	0.079416	−2.379942	0.0188
D(LREALVOL)	0.002386	0.004631	0.515180	0.6073
D(LREXRIN)	−0.304596	0.213292	−1.428073	0.1558
D(LCPI)	3.610644	0.878732	4.108924	0.0001
D(LCPI(−1))	−1.155972	0.938671	−1.231498	0.2204
D(LCPI(−2))	−0.924667	0.924052	−1.000666	0.3189
D(LCPI(−3))	−2.694341	0.924990	−2.912831	0.0042
D(LCPI(−4))	0.856613	0.905723	0.945779	0.3461
D(LCPI(−5))	−1.194918	0.913563	−1.307975	0.1933
D(LCPI(−6))	−0.646608	0.909775	−0.710734	0.4786
D(LCPI(−7))	−2.586221	0.905549	−2.855972	0.0050
D(DUMMY10)	0.041628	0.022914	1.816743	0.0717
C	−2.814584	0.544257	−5.171421	0.0000
CointEq(−1)	−0.405627	0.078419	−5.172525	0.0000

Because all variables in Granger causality model were moving through the VAR model, they are considered internal and symmetrical, and are investigated bidirectional or unidirectional causality, if there is no causality, it is concluded that the variable is statistically independent (Dasgupta 2009).

In examination of Chi square values in Table 12, or in cases of probability of value less than 0.05, it can be concluded that there are Granger causality between variables.

The existence of mutual causality can be investigated by means of making mutual control among variables that have one-way causality. When the values in Table 12 are examined, LOREMI as a dependent variable has one-way causality with REALVOL, and realized volatility Granger causes of the export to import ratio. Even this result is enough to support the main hypothesis guiding the article itself. As expected, LOREMI variable does not Granger causes REALVOL variable.

Table 11 Long run coefficients

Variable	Coefficient	t-statistic	Prob.
LREALVOL	0.026611	1.643462	0.1028
LREXRIN	−0.704310	−2.356044	0.0200
LCPI	5.171426	2.792398	0.0061
DUMMY10	0.099411	1.188722	0.2368
@TREND	−0.014952	−2.770672	0.0064

Table 12 VAR Granger causality/block exogeneity wald tests

Excluded	Chi-sq	df	Prob.
Dependent variable: LROEMI			
LREALVOL	9.088633	2	0.0106
LREXRIN	0.104785	2	0.9490
LCPI	0.717086	2	0.6987
DUMMY10	1.620713	2	0.4447
All	10.96666	8	0.2036
Dependent variable: REALVOL			
LROEMI	0.254406	2	0.8806
LREXRIN	1.484173	2	0.4761
LCPI	3.657702	2	0.1606
DUMMY10	0.389846	2	0.8229
All	5.092207	8	0.7477
Dependent variable: LREXRIN			
LROEMI	1.810612	2	0.4044
LREALVOL	5.636219	2	0.0597
LCPI	1.623067	2	0.4442
DUMMY10	0.577886	2	0.7491
All	8.990469	8	0.3431
Dependent variable: LCPI			
LROEMI	1.751637	2	0.4165
LREALVOL	0.464777	2	0.7926
LREXRIN	1.956236	2	0.3760
DUMMY10	3.290570	2	0.1930
All	7.699220	8	0.4634

Because Turkey does not have enough amount of consumption or production volume that may affect oil price volatility is the fact. Moreover, LOREXRIN as a dependent variable has one-way causality with REALVOL, and realized volatility Granger causes of the export to import ratio.

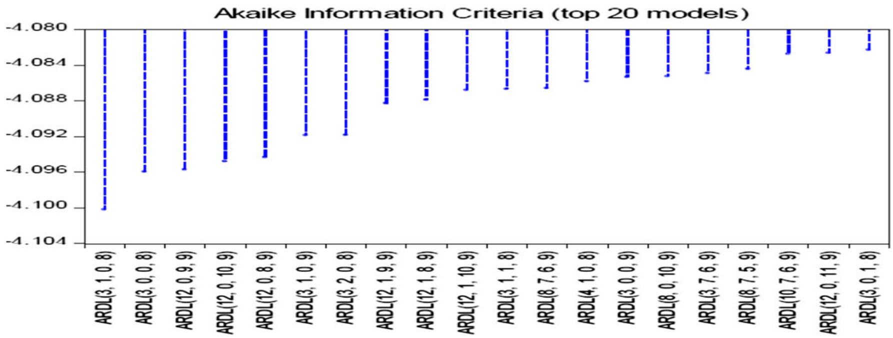

Fig. 5 Dentermination of proper lag structure for ARDL bound test

2.4 Impulse response functions

In order to analyze the response of variables against one sided innovations with two standard unit error of themselves by benefiting Cholesky decomposition (degree of freedom adjusted) method, we implied Monte Carlo simulations with 100 repetitions for maximum 10 (months) adjustment period.

According to results in Fig. 5, all variables in the model are to be influenced by the results of their own innovations. Previously, as reflected by the coefficient obtained according to both ARDL long-term coefficient table and also the Granger test results, export to import ratio, LROEMI, exhibits positive sensitivity to LREALVOL that belongs to oil price volatility obtained from the OPEC basket prices. When bandwidth is examined, it will be apparent that positive two standard deviation innovations in LREALVOL loses its effect on LROEMI only 8 periods (or, months).

Two standard deviation innovations in LREALVOL causes an expanding bandwidth along with periods (or, months) over LREXRIN so that two standard deviation innovations on oil price volatility (due to slowness in correcting the speed of market perception and policy delays such as identification and implementation in policy) show their impact on the real exchange rate after 5 periods (or, months).

3 Conclusion and further studies

The study was divided into two parts. In the first part, OPEC basket prices are converted to monthly realized volatility, and in the second part investigates causality relationship through ARDL approach among the (REALVOL) the real exchange rate index (LREXRIN), Exports to Imports ratio (LROEMI) and the Consumer Price Index (LCPI). The biggest advantage of the ARDL bounds testing approach is to allow co-integration at different levels of stability (Fig. 6). For this purpose, ADF, Phillips Perron and KPSS unit root tests intended at which level variables are co-integrated were used and thus, it is identified co-integration in different stagnation like I(0) and I(1). According to F critical table values of the

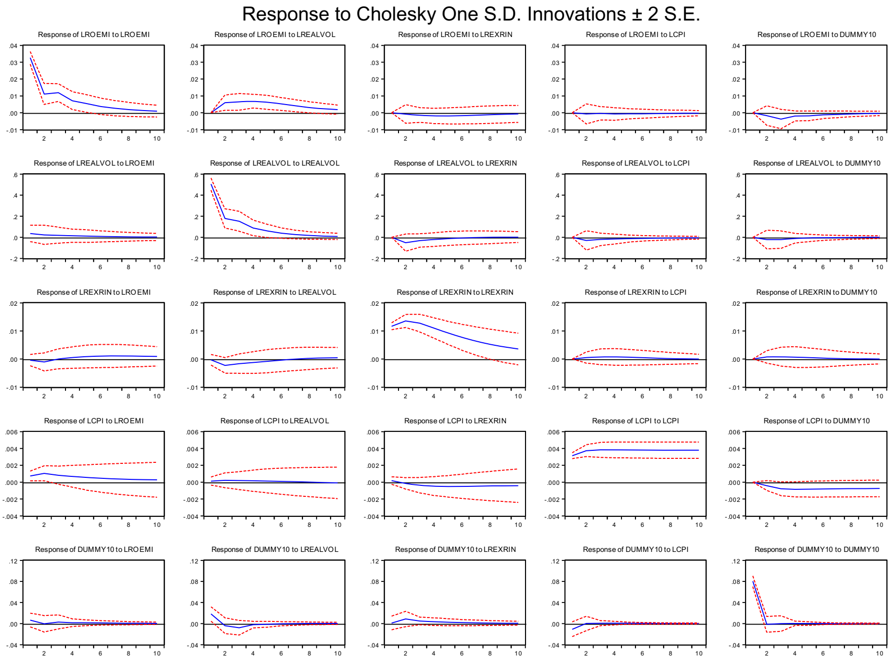

Fig. 6 Impulse responses to Cholesky one sided innovations to 2. Standard Error

ARDL bounds testing, it has been determined co- integration with a long-term among the variables listed above. The key findings of the study is to expect theoretical results among oil price volatility (LREALVOL), exports to import ratio (LROEMI), and real exchange rate index (LREXRIN).

Currently, aftermath 1973 oil crisis, most of the countries, notably U.S.A. [app. 714 million barrels capacity, Department of Energy's Office of Petroleum Reserves (OPR)], has established government-controlled Strategic Petroleum Reserves.[3] Countries who heavily dependent on petroleum products can refer this way as an ability in order to response to the sudden oil crisis. By the way, as alternative protection of oil shocks can be a diversification of oil suppliers and taking long or short positions in derivative markets against risks.

Consequently, as mentioned earlier, especially crude oil, natural gas and the most of commodities are traded as financial products in recent years. For this reason, decision makers such as politic actors of state agencies and managers of private sectors must seriously consider highly volatile market trends, particularly, because they have features of main raw materials. Shocks/innovations originated from oil and natural gas markets must be considered to minimize risks, as well as they should consider their pairwise causality between macroeconomic indicators like economic growth, current account deficit and unemployment. Therefore, they must determine optimal hedge strategies and benefit from derivative products efficiently in line with the midterm program objectives. In addition, for this purpose, regulators can make

3 http://energy.gov/fe/services/petroleum-reserves; accessed Feb. 8th 2016.

policies which enable to improve financial deepening. This study can humbly be a pioneer for further or any related studies which can be built on to research for the causes of crude oil and natural gas volatility and pairwise causality between macroeconomic indicators following the collapse of prices from $110 to $46 since June of 2014 and afterwards, there has been further decline on the prices about $30, especially in Feb. 2016.

Appendix

Pesaran et al. 2001: pp. 295–296;

Case I (no intercepts; no trends) $c_0 = 0$ and $c_1 = 0$. That is, $\mu = 0$ and $\gamma = 0$. Hence, the ECM (8) becomes

$$\Delta y_t = \pi_{yy} y_{t-1} + \boldsymbol{\pi}_{yx.x} \mathbf{x}_{t-1} + \sum_{i=1}^{p-1} \psi'_i \Delta \mathbf{z}_{t-i} + \omega' \Delta \mathbf{x}_t + u_t \quad (1)$$

Case II (restricted intercepts; no trends) $c_0 = -(\pi_{yy}, \boldsymbol{\pi}_{yx\cdot x})\mu$ and $c_1 = 0$. Here, $\gamma = 0$.The ECM is

$$\Delta y_t = \pi_{yy}(y_{t-1} - \mu_y) + \boldsymbol{\pi}_{yx.x}(\mathbf{x}_{t-1} - \mu_x) + \sum_{i=1}^{p-1} \psi'_i \Delta \mathbf{z}_{t-i} + \omega' \Delta \mathbf{x}_t + u_t \quad (2)$$

Case III (unrestricted intercepts; no trends) $c_0 \neq 0$ and $c_1 = 0$. Again, $\gamma = 0$. Now, the intercept restriction $c_0 = -(\pi_{yy}, \boldsymbol{\pi}_{yx.x})\mu$ is ignored and the ECM is

$$\Delta y_t = c_0 + \pi_{yy} y_{t-1} + \boldsymbol{\pi}_{yx.x} \mathbf{x}_{t-1} + \sum_{i=1}^{p-1} \psi'_i \Delta \mathbf{z}_{t-i} + \omega' \Delta \mathbf{x}_t + u_t \quad (3)$$

Case IV (unrestricted intercepts; restricted trends) $c_0 \neq 0$ and $c_1 = -(\pi_{yy}, \boldsymbol{\pi}_{yx.x})\mu$

$$\Delta y_t = c_0 + \pi_{yy}(y_{t-1} - \gamma_y t) + \boldsymbol{\pi}_{yx.x}(\mathbf{x}_{t-1} - \gamma_x t) + \sum_{i=1}^{p-1} \psi'_i \Delta \mathbf{z}_{t-i} + \omega' \Delta \mathbf{x}_t + u_t \quad (4)$$

Case V (unrestricted intercepts; unrestricted trends) $c_0 \neq 0$ and $c_1 \neq 0$ Here, the deterministic trend restriction $c_1 = -(\pi yy, \boldsymbol{\pi} yx.x)\mu$ is ignored and the ECM is

$$\Delta y_t = c_0 + c_1 t + \pi_{yy} y_{t-1} + \boldsymbol{\pi}_{yx.x} \mathbf{x}_{t-1} + \sum_{i=1}^{p-1} \psi'_i \Delta \mathbf{z}_{t-i} + \omega' \Delta \mathbf{x}_t + u_t \quad (5)$$

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