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How do Tunisia stock markets respond to oil prices and underlying financial shocks?

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***Abstract*—In this paper, we investigate the effects of the structural shocks on the Tunisian stock market using the structural VAR approach for quarterly data over the period 1999 to 2014. The results show that the stock returns in Tunisia increase with oil prices only when the global economic activity improves. However, in response to other shocks the stock returns in Tunisia are not significant.**

***Keywords*—Oil price; Financial shock; Kalian's two-step approach; Tunisian stock returns.**

I. INTRODUCTION

Changes in the real price of oil are considered an important factor driving the fluctuations in the stock prices. Moreover, the importance of the response of the asset markets to the oil demand shocks, the supply shocks, and the financial shocks has recently been highlighted in the study of Wang Chen et al. (2014).

The oil importing countries such as Tunisia are influenced by developments in the global market of crude oil. The recent increases in the global oil price affected the Tunisian economy through a number of channels including the transfer of wealth to oil- exporting countries, increased costs of domestic production, inflationary pressures and financial markets.

Many works help examine the impact of oil prices on the stock returns in Tunisia (see for exemple, Wajdi Hamma, Anis Jarboui, and Ahmed Ghorbel (2013)). However, our study enables to determine this relation by using the approach of Kilian (2009). To our knowledge, this idea has not been fully addressed in the previous analyses.

To achieve our goal, we try to make an analysis of a two-step approach. This paper is organized as follows: We present the introduction in section 1. In section 2, we review the literature. Section 3 describes the data and the methodology. Section 4 presents the results and interpretations. Section 5 concludes.

II. LITERATURE REVIEW

TABLE I

The impacts of oil prices and the underling financial shocks in the stock market activities.

Authors	**Methodology**	**Objective**	**Results**
Wang Chen, Shigeyuki Hamori and Takuji Kinkyo 2014	**Model:** SVAR, Bootstrap estimation **Period:** January 1991 to December 2012 **Frequency:** Quarterly data from four structural shocks (oil supply shock, aggregate demand shock, oil-specific demand shock, and kcfsi index) and three macroeconomic indicators (the index of industrial production, the consumer price index, and the stock price index). The sample includes data for France ,Germany, Japan, the UK, and the USA	Identify four types of structural shocks that cause changes in oil prices, assess the relative importance of these shocks as the source of oil price changes, and examine their macroeconomic impacts.	The financial shock is a key determinant of oil prices and its macroeconomic impact is as important as the impact of other underlying shocks.
Wensheng Kang , Ronald A. Ratti , and Kyung Hwan Yoon 2015	**Model:** SVAR **Period:** January 1973-December 2013.	Examines the effects of global oil price shocks on the stock market return.	-Positive shocks to aggregate demand and to oil-market specific demand are associated with negative effects on the covariance of return and volatility. -Oil supply disruptions are associated with positive effects on the covariance

	Frequency: The daily data of the Chicago Board of Options Exchange (CBOE), oil supply shock, aggregate demand shock, and oil-specific demand shock		of return and volatility. -The spillover index between the structural oil price shocks and covariance of stock return volatility is large and highly statistically significant.
David C. Broadstock , George Filis 2014	**Model:** Scollar-Bekk, SVAR. **Period:** January 1995-July 2013. **Frequency**: Monthly data of NYSE and Shanghai Composite index, industrial sector indices (Banks, Metals & Mining, Oil& Gas, Retail and Technology), Brent crude oil price, world oil production, and global economic activity.	Examines the time-varying correlations between oil price shocks and stock returns in industrial sectors in China and the USA.	China is seemingly more resilient to oil shocks than the US.
Rangan Gupta, Mampho P. Modise 2013.	**Model:** Structural VAR approach **Period:** January 1973-Juillet 2011 **Frequency:** Monthly data for the price of crude oil, the global oil production, US petroleum stocks, the global activity index, and the Johannesburg Securities Exchange All share Index.	The dynamic relationship between different oil price shocks and the South African stock market.	-The stock returns only increase with oil prices when global economic activity improves. -In response to oil supply shocks and speculative demand shocks, the stock returns and the real price of oil move in opposite directions. -The oil supply shock contributes more to the variability in the real stock prices.

This literature review does not yet cover the underlying impact of oil prices on the stock returns in the Tunisia. The choice of investigating about Tunisia is based on the considerable lack of literature. We can now check the hypothesis according to which:

H1: Oil price shocks have a significantly different impact on the Tunisian stock returns.

H2: The financial stress index KCFSI has positive effects on the stock returns in Tunisia.

III. Methodology

In the light of the issues discussed in section 1, the methodology will be divided into two parts. The first focuses on the identification of the oil price structural shocks (the supply shock, the aggregate demand shock, the specific demand shock, and the financial shock) by estimating a VAR model.

In the second step, we examine the impact of the structural shocks on the stock returns in Tunisia by estimating the OLS regression.

1. A. First step: A structural VAR modelling.

In this step, we identify the structural shocks that underlay the oil price changes .The oil price shocks identified are (the aggregate demand shocks, the supply shocks , the specific demand shocks , and the financial shocks) .

A VAR model is estimated by using the log-difference of COP and ROP and the levels of the KCFSI, REA divided by 100.

In line with the approach taken by Kilian (2009), A standard VAR representation is used to generate the results, which are summarized using the Choleski decomposition, with the order being COP, ROP, and the KCFSI. This order determines the exogeneity of the variables; a shock on particular variables has a contemporaneous effect on the variables ordered after those particular variables but not before it. Following Kilian 2009, the COP is assumed to be responsive presumably due to the high adjustment costs of oil production, followed by REA and ROP. By adopting this ordering, we assume that the oil supply shock, the aggregate demand shock, and the oil-specific demand shock are captured by using the structural shock to COP, REA, and ROP, respectively.

This model SVAR is represented as follow:

$$A_0 Y_t = \alpha + \sum_{i=1}^{p} A_i Y_{t-i} + \varepsilon_t$$

Where y t is a (4 × 1) vector that contains four shocks of global crude oil production (COP), global real economic activity (REA), real oil prices (ROP), and the KCFSI index,

A 0 is a contemporaneous coefficient matrix, α denotes a vector of constant terms, and ε t is a vector of serially and mutually uncorrelated structural shocks.

$$e_t = A_0^{-1} \varepsilon_t$$

Where, e denotes the reduced-form errors.

Kilian and Vega 2011, show that oil prices do not respond contemporaneously to domestic macroeconomic news, which is consistent with the commonly used identifying assumption that oil price shocks are predetermined with respect to domestic macroeconomic aggregates. Hence, the reduced-form VAR is obtained by multiplying both sides of Eq. (1) by

This has the following recursive structure:

$$\begin{pmatrix} \mu_{11} \\ \mu_{21} \\ \mu_{31} \\ \mu_{41} \\ \mu_{51} \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{pmatrix} \begin{pmatrix} \xi\text{Oil supply shock} \\ \xi\text{Oil demand shock} \\ \xi\text{Oil specific demand shock} \\ \xi\text{Oil financial shock} \\ \xi\text{Oil monetary shock} \end{pmatrix}$$

2. *B. Second Step:*

In this step, we examine the impact of the identified structural shocks on the Tunisia stock return by estimating bootstrap techniques on the OLS regression. The structural shocks identified in the first step are standardized by subtracting the mean and dividing by the standard deviation. The dependent variable is the Tunisian stock return. Following Kilian (2009), the measures of quarterly shocks are constructed by averaging monthly shocks for each quarter.

The traditional regression analysis method assumes that the regression equation is $y_i = \beta_0 + \beta_1 x_i + \varepsilon_i$, (i=1, 2… n), where random error $\varepsilon_i \backsim N(0, \sigma^2)$. Under the assumption of error normality, the coefficient β can be estimated, while in the significant tests of regression, the corresponding distribution of test statistics is obtained. However, when the error is not normal or its distribution is unknown, the problem that arises is how to estimate the regression coefficient, how to estimate the confidence interval of coefficient and how to significantly test the regression equation. The use of the Bootstrap method to solve the above problems is required.

The independent variable x in the correlation model regression is a controllable variable where only y is a random variable. Random sampling error is ε_i , (i =1, 2,…., n). ε_i in regression accords with Gauss-Markov assumption:

$E(\varepsilon_i) = 0; Var(\varepsilon_i) = \sigma^2; Cov(\varepsilon_i, \varepsilon_j) = 0, (i \neq j)$

But ε_i is not always a normal distribution. It is noted that σ^2 is not the variance of residual $e_i = y_i - \hat{y}$. Normalize the residual e_i to obtain the revised residual $r_i = e_i - \frac{E(e_i)}{\sqrt{Var(e_i)}}$, (i=1,2,…, n). In order to better model the actual distribution of the residual, with the experience distribution, the revised residual can be centralized. The revised residual after centralizing $\bar{r} = \sum_{i=1}^{n} r_i$ by $\bar{r}_i = r_i - \bar{r}$.

Based on the model-based re-sampling in a linear regression: $x_1, x_2, .., x_n$ are unchanged.

$x_i^* = x_i$, (i=1, 2,…., n) and re-sample the regression residuals. Firstly, establish regression model with all samples and estimate the regression coefficients $\hat{\beta}_0$, $\hat{\beta}_1$. Secondly, the random residual r_i^* and calculate the dependant variables, that is (X_i^*, Y_i^*) in $y_i^* = \hat{\beta}_0 + \hat{\beta}_1 x_i + \varepsilon_i^*$, (i=1, 2,…, n) is a model based Bootstrap sample.

Based on the data mentioned above, the bootstrap regression model of our study takes the following form:

$\text{Log } RT_i^* = \hat{\beta}_0 + \log\hat{\beta}_1 x_i + \hat{\beta}_2 x_i + \log\hat{\beta}_3 x_i + \hat{\beta}_4 x_i + \varepsilon_i^*$, (i =1, 2… 4)

RT_i^*: Denotes the real rate of return on a representative domestic stock market portfolio measured by $\log(R/R_{it-1}$.)

x_i: Denotes the structural shock identified in step 1 in the quarter by using the log-difference of COP and ROP and the levels of the KCFSI, REA divided by 100.

ε_i^*: Denotes the error terms.

$\hat{\beta} = (\hat{\beta}_1; \hat{\beta}_2; \hat{\beta}_3; \hat{\beta}_4{}^*)$: Denotes the vector coefficient associated with the explanatory variables presented successfully (COP, REA, ROP, and KCFSI) .

TABLES 2
DESCRIPTION OF VARIABLES

COP	Oil supply shock is measured by using the total world crude oil production.
REA	Aggregate demand shock is measured by using the index developed by Kilian (2009).
ROP	Oil-specific demand shock is measured by using the US West Texas Intermediate price deflated by the US producer price index.
KCFSI	Financial shock is measured by global financial market conditions
RT	The variable of interest is deflated using Stock Market (Tunindex). The first difference of the natural logarithm is obtained to allow for stationarity.

Notes: COP, REA, and ROP are provided by the Energy Information Administration (EIA). The data of the KCFSI index are provided by http://www.kc.frb.org/research/indicatorsdata/kcfsi/. The data of Tunindex are provided by Yahoo Finance.

3. A. Result of first step: Impulse response to structural shock

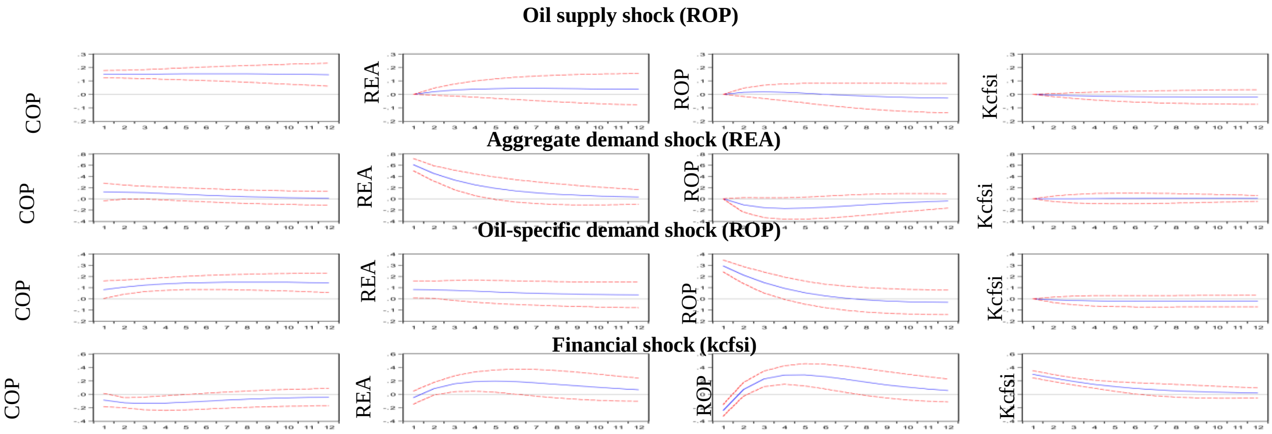

Fig.1. Cumulated responses to a one S.D. shock with two-standard error confidence bands. Note: the dotted lines represent two-standard error bands

In line 1, an unexpected disruption of oil supply causes a positive effect on the world oil production and the world economic activity. On the other hand, this shock has small and insignificant effects on the real oil price and the financial stress index, which is inconsistent with previous studies (Park and Kilian (2009)) which show that the response of the evolution of oil prices to the supply shocks is important and persists for several months. By cons, this result is consistent with those of conventional numerous works such as, that of Wang Yudong et al. (2012).

In line 2, the oil demand has greater and more persistent effects on the real economy, which means that an unexpected increase in the world demand for all industrial products causes a persistent rise and statistically significant increase in the real economic activity. The answer peaked at 8% after 1 quarter, followed by a downward trend after 8 quarters. On the other hand, this shock leads to a persistent decline in the real oil prices that are statistically significant over the entire forecast horizon. Moreover, the impact of this shock in the financial stress and the supply shocks is not significant.

In line 3, the Oil-specific demand shock leads to an increase of the real global activity in the first eight quarters. Also this shock has a statistically significant positive effect on the real oil prices in the seventh quarter. The Oil-specific demand shock causes an increase of the Global oil production, which reaches its maximum at about 1% over the entire forecast horizon. On the other hand, the impact of these chocks in the financial stress is not significant.

In the last line, the Innovations in the financial shocks have a negative and statistically significant effect on the global oil production. In the other hand, an unexpected worsening of the financial conditions causes a statistically significant increase in the ROP. This result is in line with Kilian and Park (2009).

4. B. Result of Second Step: The impact of the oil price chocks on the stock market returns.

TABLE III
SPECIFICATION TESTS OF THE MODEL BY BOOTSTRAPPING OLS MODEL.

This method is based on simulations, such as, Monte Carlo methods. Specifically, we use an overlapping moving block bootstrap method with block size 4 and 20,000 bootstrap replications.

	Coefficient	**Std.Err**	**Prob**	**(95% Conf. Interval)**
COP	0,2017826	0,3866479	0,602	-0,5560334 0,9595987
KCFSI	0.1654408	0,1576788	0,294	-0,143604 0,4744856
REA	-0,2838835	0,1043702	0,007***	-0,9563232 0,4884453
ROP	-0,1891019	0,3870749	0,625	-0,9477548 0,569551
Cons	0,009235	0,1224481	0,94	-0,2307589 0,2492289
R-Squared	0,1042			

Notes: Signifiances codes: *p<0,05, **p<0,01, ***p<0,001

The value of R-Squared = 0.1042 show that 10.42% of the variation in the stock returns in Tunisia are explained by oil price shocks variables related to the global oil. This lower percentage means the absence of integration of the Tunisian market in the global economy.

The reaction of the stock returns in Tunisia to the supply shocks is positive but not significant. In addition, an increase in the real price of oil due to oil supply disruptions will not have an effect on the consumer income and wealth, which causes the absence of changes in the stock performance. This result is not in line with the results of Kilian and Park (2009) who found a negative response in the returns of the US equities to the oil supply shocks.

The unexpected increase in the aggregate demand will result in lower stock returns in Tunisia with a coefficient to (-0, 2838835). This result indicated that growth in global economic activity induces the increases in crude oil will result in higher industry costs, which will negatively affect stock markets. This result is not in line with the results obtained by Kilian and Park (2009) for the US economy.

In Tunisia, the regulation limit and capital mobility control have much greater restrictions than in other countries. The Tunisian stock market is more separate and independent from the world economy. Therefore, we can say that the impact of oil-specific demand shock on Tunisian stock market returns is not significant.
The reaction of the stock returns in Tunisia to the shocks financial is positive and insignificant. This result is inconsistent with the studies of Wang Chen et al. (2014) who found that the impact of the financial shock on the share price is significant.

V. CONCLUSION

The results for Tunisia suggest that the relation is more persistent and more pronounced in the case of an aggregate demand shock. This result can be attributed to the relative importance of oil-related companies for a small economy with large reserves of crude oil. In addition, the findings presented in this paper indicate that a financial shock is not an important determinant of the Tunisian stock returns. This result seems to show that our starting hypothesis is not justified. More specifically, the evidence suggests that the Tunisian stock market is not more responsive to oil price shocks compared to the developed stock market.

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