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The Asymmetrical Effects of Oil Market Shocks on Tehran Stock Exchange: A Regime Switching Model

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ABSTRACT

In this paper, strong observation of stock market return dependence on regime switching has been obtained which is based on a two regime MS-EGARCH (1, 1). According to estimation results, first regime is related to variance regime and low average (recession). The second regime is related to variance and high average (expansion). In average regime and low variance, price oil shocks had negative effect on stock yield and it did not have a significant effect on stock market output variance. But in variance regime and high average it had significant positive effect on level of variance and level of stock yield average. The above results showed the asymmetrical effects of crude oil on stock output in two stagnation regime and expansion regime.
JEL classification: G14, Q41, E32
KEYWORDS: Oil Shocks, Tehran Stock Exchange, Regime Switching

INTRODUCTION

In new studies, there is no general and strong agreement about the effect of oil price shocks on economic activities. It is difficult to explain such relationships as it has been affected by complicated economic events such as structural changes. This is in a way that recent researches have supported a natural change in the relationship between oil prices and economic activities. Raymond and Rich(1997), Clements and Krolzig(2002) Holmes and Wang(2003), Jammaziand Aloui(2009) by using selecting method Markovhave concluded asymmetrical effects of crude oil shocks on business cycles in England and America. Aloui and Jammazi (2010) by using a two regime MS-EGARCHmodel has analyzed the relationship between oil market fluctuation and stock price for France, England and Japan for term of 1989-2007.

According to the above study results, oil price increase has a meaningful effect on both stock return fluctuations and the possibility of transition in allover the regime in equation to the oil shocks effect on a dynamic stock market, consider that the empirical literature is restricted on MS-EGARCH, MS-AR and MS-GARCH models by using an unobserved component model with a Markov switching heteroscedasticity model they have analyzed the sensitivity of permanent and transitory outputof Gulf cooperation council to oil. To sum up, the regime changes have been proved in stock market. This can be an encouragement for us to analyze the existence or non-existence of regime changes in Iran stock market and the role of exterior factors to determine the way of stock output movement.

In this paper, some observation of high fluctuation terms of stock market output has been identified. Then the relation of these fluctuations with oil market has been analyzed. The used method in here is based on a two regime MS-EGARCH model which has been used in Henry (2009) studies. This model makes it possible for the variance to change in difficult regimes of stock output in a way that the output of Markov chain is supposed to be non-observable. In addition, it has been supposed that the stock output may move in all over the different regime fluctuations which are identified by interaction with the foreign market fluctuations. In this study, in addition to reversed MS-GARCH model the selected model as the conditional variance is related to the last present shocks of the economy, therefore it is brought under control of the regime which are related to impact and persistence and asymmetrical response to a completely flexible shock.

1. DATA AND METHODOLOGY

In this paper, the monthly data of oil price and Tehran stock exchange price index in 2000-2010 have been used. The above variants are provided from central bank of Iran and international monetary fund (IMF)

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respectively. The oil price changes in each term are considered as oil price shock in comparison with the previous term. Moreover, according to equation (1), the logarithm of Tehran Exchange Price Index in per term to the previous term is multiplied to 100. It is considered as the Tehran Exchange stock output (Aloui and Jammazi 2008).

$$r_t = 100 \times \ln\left(\frac{TEPIX_t}{TEPIX_{t-1}}\right) \qquad (1)$$

In this research, we have used the likelihood ratio test which is proposed by Garcia and Perron (1996). It is to identify the numbers of regimes of Markov models. In H_0 no changes in stock market fluctuation is investigated by a process EGARCH (1,1) (one regime) against structure MS_EGARCH which consist of changes in stock output market fluctuation. It is necessary to point out that average and variance are separately estimated. Hannan Quinn (1974) by using the Akaike measures attempted to describe the regression rank in average function to determine zero and for variance model function EGARCH(1, 1) devote good value to stock output series.

The static of LR test is determined by $LR=2|\ln L_{MS\text{-}EGARCH} - \ln L_{EGARCH}|$ and the crisis value is according to Davies (1987) P value which has been suggested by Garcia and Perron. According to chart (1) there are strong results about regime changes in stock market fluctuation. Therefore, they can be described by a tow regime MS_EGARCH model in a better way. The above results are compatible with the results of Henrry (2009) and Aloui and Jammazi (2009) studies.

Table 1: Models comparison

EGARCH (ln L_{EGARCH})	MS-EGARCH((ln $L_{MS\text{-}EGATCH}$)	LR test statistica
221.161	227.337	12.35***

Notes: The LR test statistic approximately follows a χ^2 distribution
Notes: Figures in the parentheses are the t-values, *** indicate significance

3. The Markov-switching exponential GARCH(MS-EGARCH) framework

First, consider a simple EGARCH(1,1) process introduced by Nelson (1991) for y_t,

$$y_t = f(x_t;\vartheta) + \varepsilon_t \varepsilon_t / I_{t-1} \rightarrow D(0, h_t) \qquad (2)$$

$$\ln(h_t) = \omega_0 + \varphi\left[\left|\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}\right| - \sqrt{2/\pi}\right] + \beta \ln(h_{t-1}) + \delta \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \qquad (3)$$

In Eq. (2) $f(x_t;\vartheta)$ refers to the conditional mean, x_t is a vector of M explanatory variables, that may include lagged $y_t's$, ϑ is a $(M \times 1)$ vector of parameters, I_{t-1} is the information set that contains all information available at time $(t-1)$, and ε_t is the error term. Hamilton and Susmel (1994) have modified the conditional variance equation to make the conditional variance depend on the states of the economy. According, Henry (2009), the basic $MS-EGARCH\ (1,1)$ model can be written as follows:

$$y_t = \mu_{it} + \varepsilon_t \quad \varepsilon_t / I_{t-1} \rightarrow D(0, h_{i,t}) \qquad (4)$$

$$\ln(h_{it}) = \omega_i + \varphi_i\left[\left|\frac{\varepsilon_{t-1}}{\sqrt{h_{it-1}}}\right| - \sqrt{2/\pi}\right] + \beta_i \ln(h_{i,t-1}) + \delta_i \frac{\varepsilon_{t-1}}{\sqrt{h_{i,t-1}}} \qquad (5)$$

The transition between the states is governed by a first order Markov process as follows (Hamilton, 1989):

$$P(S_t = 0/S_{t-1} = 0) = p_{00}$$

$$P(S_t = 0/S_{t-1} = 0) = 1 - p_{00} \qquad (6)$$

$$P(S_t = 1/S_{t-1} = 1) = 1 - p_{00}$$

$$P(S_t = 1/S_{t-1} = 1) = p_{11}$$

With p is the probability that the economy swithches at time t from state 1 (or 0) to state 0 (or 1). It is convenient to summarize these transition probabilities in a (2×2) matrix $\begin{bmatrix} p_{00} & 1-p_{11} \\ 1-p_{00} & p_{11} \end{bmatrix}$.When the probabilities summation areone. The logistic functional form is as:

$$p_{00} = \frac{e(\theta_0)}{1+e(\theta_0)} \text{and} p_{11} = \frac{e(\partial_0)}{1+e(\partial_0)} \qquad (7)$$

According to Hamilton (1989) and Gray (1995), the MS-EGARCH can be estimated using maximum Likelihood techniques. In this paper like Aloui and Jammazi(2009) we consider the oil price shocks as information variable. The extended MS-EGARCH(1-1)model will be written as follows:

$$y_t = \mu_{it} + \eta_i x_{t-1} + \varepsilon_t \qquad \varepsilon_t / I_{t-1} \rightarrow D(0, h_{i,t}) \qquad (8)$$

$$\ln(h_{it}) = \omega_i + \varphi_i \left[\left| \frac{\varepsilon_{t-1}}{\sqrt{h_{it-1}}} \right| - \sqrt{2/\pi} \right] + \beta_i \ln(h_{i,t-1}) + \delta_i \frac{\varepsilon_{t-1}}{\sqrt{h_{i,t-1}}} + \lambda_i x_{t-1} \quad (9)$$

In Eq. (8) and (8) $x_{t-1}$is an oil price change in t-1 time period.

4. MS-EGARCH model with proved transition probabilities

In this section, the results of estimating single variable MS_EGARCH model with proved transition probabilities have been offered for Tehran stock market of valuable papers. Therefore, all parameters in average the model, δ_1 and δ_2 asymmetrical effects of coefficients have been determined insignificant. Consequently, by omitting asymmetrical effects coefficients maintain in table 2:

Estimated parameters of the MS-EGARCH(1, 1)

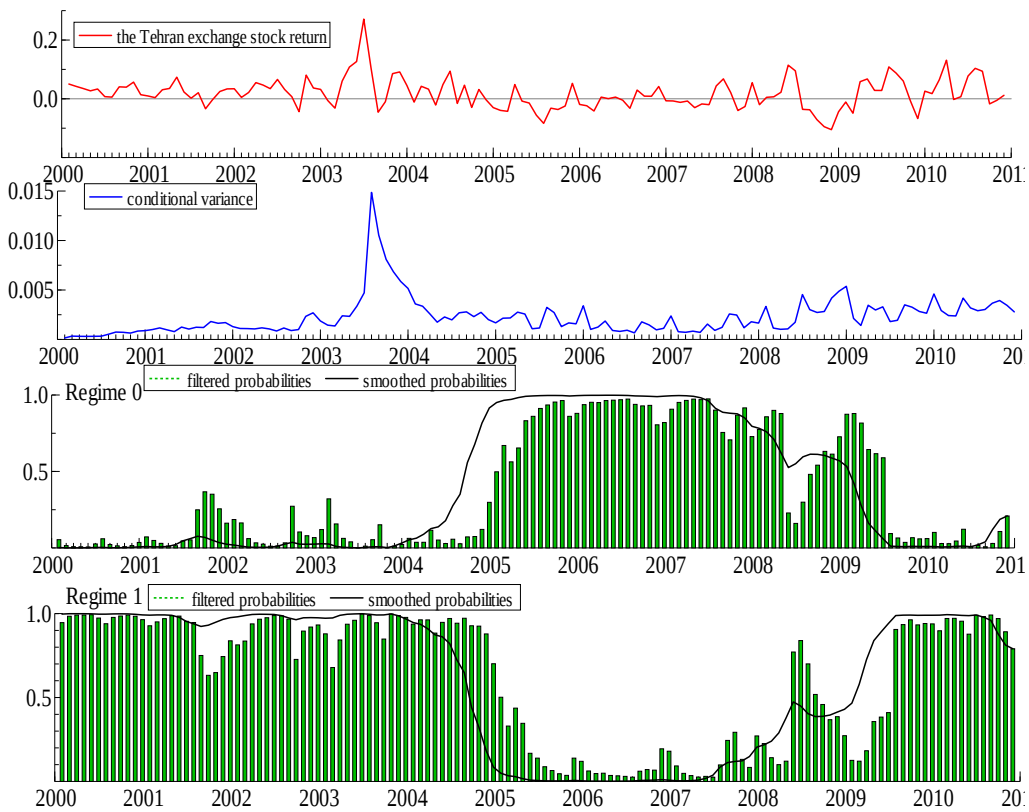
t-value	Coefficient	
-1.374*	-0.0048	μ_0
8.012***	0.032	μ_1
15.38***	7.412	ω_0
17.67***	8.92	ω_1
1.19	0.059	φ_0
12.52***	0.8839	φ_1
2.36**	0.993	β_0
5.79***	1.328	β_1
3.09***	0.3304	θ_0
-3.53***	-4.109	∂_0
6.11***	0.9654	p_{00}
3.11**	0.9838	p_{11}
	227.337	Log-likelihood
Q(9) = 7.79	Q(12) = 6.13	

Notes: Figures in the parentheses are the t-values, ***, ** and * indicate significance at the 1%, 5% and 10% significance levels.

The estimated results from above table can be indicated as follow:

1. The results were found by estimating two regimes. The first one is a regime which have recognized stock market behavior in recession situation along with low expected output and low fluctuations and the second one is a regime have recognized stock market behavior in expansion situations along with high expected output and high fluctuations. Regarding the results of the average fixed term and the conditional variance, it is clear that regime 2 is higher than regime 1. The output average during recession(μ_0) in each month is estimated -0.0048 which is significantly different with regime 1. Moreover in regime 2 its amount(μ_1) raised to 0.032.
2. The results of estimating transition probabilities p_{00}andp_{11}both are greatly significant for stock output. Considering the results, it is less probable to stay in regime 1 (p_{00} about 0.9654) in comparison with staying in regime 2 (p_{00} about 0.9838). However, having a large amount of them imply that just a great incident can transmit stock output or valuable papers output of fluctuations series from one regime to the other(and vice versa).

3. In EGARCH model, $\beta_0$andβ_1 which capture the resistance in conditional variance are significant for stock output. As it was mentioned, asymmetrical effects of coefficients δ_1 and δ_2 for stock market output are not significant and are omitted from model. Thus, not being significant of the mentioned coefficients shows that output of the Tehran stock market valuable paper reflects the reactions symmetrically to positive and negative changes.
4. The results of Box–Pierce test (B-P) with rank of 12 in Whiteness, show error terms. Similarly, H_0 is accepted with rank of 12 since there is no serials correlation in errors square root which is indicating left variance heteroscedasticity in error components. The results show that Markov method selecting model offered 2 regimes of an acceptable approximation in variance inequality of stock market.
5. In order to properly interpret 2 regimes in figure 1, flatten probabilities for MS-EGARCH model with 2 regimes of output of Tehran stock exchange market valuable paper.
   Figure1,flattened and filtered probabilities of stock returns semi variable single variable of for MS-EGARCH model.



Source: researcher's computations

Regarding figure 1, the findings show that MS-EGARCH model in capturing stock output series changes way act well in both regime 1 and 2. Moreover, figure1 shows that variance between 2 regimes changes according to high variance situation and high average (expansion phase) while low variance situation and low output (recession phase).

4. The impacts of crude oil shocks and stock return shifts behavior within recession and expansion regimes

In this part we insert the oil shock variable into the mean and variance function of MS-EGARCH model. To this end, MS-EGARCH model is extended through fixed transition probabilities. To determine whether the

oil price shocks are effectual on stock market return or not,likelihood ratio of the two models is compared in the case of existence or nonexistence of oil shock.

Table 2: Models comparison

MS-EGARCH((ln $L_{MS\text{-}EGATCH}$)	MS-EGARCH((ln $L_{MS\text{-}EGATCH}$)	LR test statistica
227.337	238.262	**21.85*** **

Notes: The LR test statistic approximately follows a χ^2 distribution
Notes: Figures in the parentheses are the t-values, *** indicate significance

The results of the test reveal that non-variable model is rejected when placed at the level one of significance. These findings provide observations regarding the significant effectiveness of crude oil shocks on the Tehran exchange stock return. Estimation results of MS-EGARCH (1.1) model with fixed transition probabilities are counted in table 4.

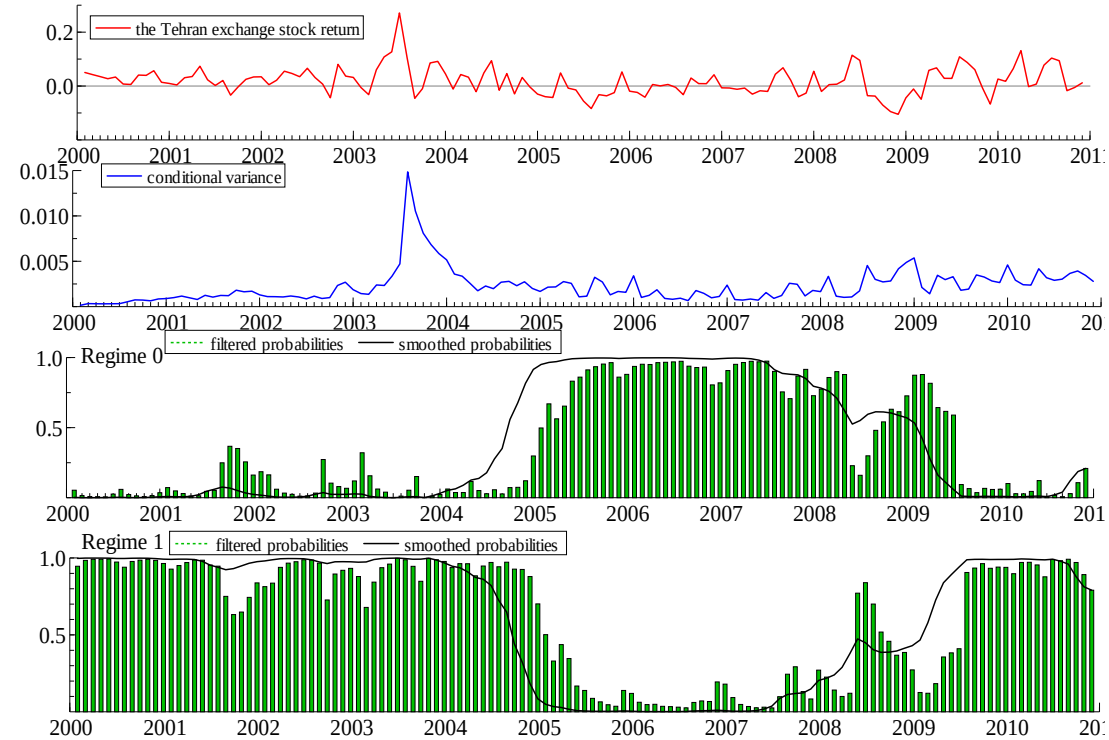
Table 3: Estimated parameters of the MS-EGARCH(1,1)

t-value	Coefficient	
1.916*	0.0112	μ_0
3.63***	0.03	μ_1
-2.13**	-0.0042	$\boldsymbol{\eta_0}$
12.94***	0.0055	$\boldsymbol{\eta_1}$
16.21***	7.413	ω_0
16.98***	9.035	ω_1
1.012	0.0027	φ_0
10.22***	0.908	φ_1
1.81*	0.998	β_0
4.798***	1.257	β_1
-1.103	-0.1452	$\boldsymbol{\lambda_0}$
3.29***	0.0924	$\boldsymbol{\lambda_1}$
4.12***	2.978	θ_0
-3.52***	-2.979	∂_0
5.67***	0.9515	p_{00}
4.44**	0.9516	p_{11}
	238.262	Log-likelihood
Q(9) = 6.6901	Q(12) = 5.69	

Notes: Figures in the parentheses are the t-values, ***, ** and * indicate significance at the 1%, 5% and 10% significance levels.

The estimation results for zero models are consistent with low variance-low mean regime and regime one is consistent with high variance-high mean. According to the results of table 4, estimated indices of oil shock are significantly different from zero. These impacts are positive in zero regimes and negative in one regime. Based on the estimation results within low mean and variance regime, oil price shocks have negative impact on the stock return ($\eta_0 = -0.0042$) and doesn't significantly effect the variance of stock market return, but in high variance and mean regime has positive significant impact on both variance level and average level of stock return ($\eta_1 = 0.0055, \lambda_1 = 0.0924$). The aforesaid results demonstrate crude oil asymmetrical impacts on stock return within its two recession and expansion regimes. The outcomes of Box Pierce (B-P) diagnostic test with the rank of 12, indicates that Markov two regime switching model offers an acceptable fit within inconsistency of stock return variance. In figure 2, the flattened probabilities for MS-EGARCH(1,1) model with the two regimes of Tehran stock exchange market return inclusion of the first pause of oil price variable are presented.

Figure 2: flattened and filtered probabilities of MS-EGARCH(1,1) model along with inclusion of the first oil price variable pause



Source: researcher's computations

Based on figure 2 MS-EGARCH model along with inclusion of first oil price variable pause, in comparison to non-variable MS-EGARCH model, functions better in mastering the path of set changes in both zero and one regimes.

6.Summary and concluding remarks

In this paper we have studied the role of stock market volatilities in explaining the equity markets behavior using monthly data covering the years 2000 to 2010. The empirical approach of this study is based on a two regime MS-EGARCH(1,1) model. The following conclusions are drawn:

The presented MS-EGARCH model with switching in the mean and in the variance offers a better statistical fit to the data. The results suggest that real stock returns display significant evidence of regime switching. The first regime is consistent with low mean and variance regime and the second one is consistent with high variance and mean.

The estimated indices of oil shock vary significantly from zero. These impacts are positive in zero regimes and negative in one regime. According to estimation results in low mean and variance regime, oil price shocks don't have negative impact on stock return and don't significantly affect the variance of stock market return but in high variance and mean regime influence both level of variance and average of the stock return level positively and significantly. The aforesaid results are the sign of crude oil asymmetrical effects on the stock return in its two recessions and expansion regimes.

In future studies, it can be dealt with applied policies in different phases of stock market return and its impacts on the stock market return and its rival asset market.

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