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The Impact of Crude Oil, gold price & Their Volatilities on Stock Markets: Evidence from Selected Member of OPEC

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ABSTRACT

Analyzing the impact factors for absorbing the more deposit and liquidity of private sector for financing long-run investment and aiding to growth of economy is useful for the country. Hence, Not only capital market measures' is one of the significant macro-economic factors which are considered in analyzing of economic conditions but also the reaction of these indices to economic events has notable importance.But these measures are extremely affected byexogenous factors. Measures of crude oil and gold prices are among the most important indices which affect economic and political conditions of each country. In this paper we examine the volatility of crude oil and gold price with GARCH model by using statistics of selected members of OPEC and global crude oil gold prices and then we survey the relation between the crude oil, gold prices and their volatilizes with stock markets by panel data model. The results suggest that (1) crude oil prices have a significant positive effect on stock exchange index of studied countries meanwhile this effect is negative for gold price.(2) The volatility of crude oil prices has scant positive effect on stock markets of selected country meanwhile the positive effect of gold is more noticeable.
KEYWORDS: Stock exchange,Crude oil price, Gold price, Volatility.

Classification JEL: G1, Q43, C4

1- INTRODUCTION

Stock exchange as part of capital market in a country has remarkable role in guiding deposits to different sections of economy. (Jones, 2009) in fact these markets conditions are extremely influential to real sector of economy at the same time extremely affected by other sectors of economy (not necessarily in short-term). One of the main task of these markets are contribution to have fair securities prices and speeding up the transactions.This is done through directing deposits and liquidity of private sector to finance long-term investment projects. This is crystal clear that stock markets are not only under impact of national economy but also global economy.

For instance, the 1930 great depression had been started from New York Stock Exchange (NYSE) also the 1997 crisis of southeastern of Asia affect global economy included Iran through decreasing demand for crude oil and sharp elapse of its price.As mentioned above there is a meaningful relation between stock exchange evolutions and economy cycle.

Crude oil prices as a strong exogenous impact on plenty of macroeconomic factors included stock index. On the other hand Gold prices as important variation are explanatory for most of the international monetary and finance evolutions although this role has beendiminished through time. Explain such a relation is to guide policymakers toward setting monetary policy. Modern portfolio theory of Markowitz (1952) and Black-Scholes pricing model (1973) had been formed base on volatility and expected return relation by the assumption of constantvolatility through time.Meanwhile,as Bollerslev et al (1992) deducted volatilities is not constant so for modeling volatility the conditional models of ARCH and GARCH should be used otherwise predictions from volatilities are not right and reliable. Following that Engle mentioned his theory of dynamic volatilities (2002) through explanation of return and volatility relation by ARCH and GARCH in different capital asset pricing models (CAPM) which is counted as new approach in pricing capital assets. As a result in this paper we use the same method for examining the effect of global crude oil and gold prices as well as their volatilities on stock markets of selected member of OPEC. In this study we are going to answer the following two questions: (1) is there any significant relation between gold and crude oil prices with stock market of selected members of OPEC. (2)Is there any significant relation between gold and crude oil volatilities with stock market of selected members of OPEC?

2- RELATED LITERATURE

Nandha& Faff (2007) examined the mutual effects of price shocks' and stock exchange returns via global industry measures. They found that crude oil price has negative impact on all of the industries except mine

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extraction and oil & gas industry.Maghyereh and Al-Kandari (2007)appliedNon-Linear Co-integration Analysis for testing the relation of crude oil and stock markets of GCC[1]. They conclude that crude oil price has non-linear effect on stock exchange indices in GCC country. Moon & Yu (2009) checked out the impact of short-run slip-over of daily stock returns and volatilities between U.S.A and China via GARCH-M[2]. They tested the information slip-over impact on return and volatility of S&P 500 and Shanghai stock exchange indices during 1999 to 2007. They found some evidence of volatilities slip-over effects of U.S.A stock market on China stock exchange. Meticulous survey of empirical studies showed that there is no research in which Contagion of volatilities between stock indices been examined by considering retention effect. The theoretical extension following empirical analysis in this paper is first step toward enriching the literature.

Alouei and Jamazi (2009) tested a mediator variable between Crude Oil Company and stock exchange in England, France and Japan by E-GARCH[3] model. They discovered two implied eventsinseries behaviors' a low median and high variance as well as high median and low variancerelation. They provided some evidence which showed economic crisis followed low median and high variance regimes.

Behran and Nikolov (2010) they measured the dynamic relation between stock exchange and crude oil prices in Russia by two variables E-GARCH model. They selected three important events (11th September of 2001, Iraq war 2003 & internal Iraq war 2006) and they reached to a negative relation between Russia stock exchange and crude oil prices.

Li and Chiu(2011) used a single variant GARCH model to test S&P 500 index and WTI crude oil prices relation. They concluded that significant volatilities in crude oil prices would have negative impact on S&P500 return but their results has not been approved in low price volatilities.

3- Theoretical context

For examining the effect of global gold and crude oil prices on stock markets of selected OPEC members we use theoretical context for Maintenance and asset pricing models. In particular we applied asset pricing model of Lucas (1987) which is counted as basic model because Lucas assumes an economic in which exist a representative consumer. This consumer maximize the below utility function:

$$U_t = E\left[\sum_{t=0}^{\infty} \beta^t U(C_t)\right] \qquad (1)$$

In whichC_t is a stochastic process and representative of a unit commodity, β is discount factor, U_t is utility function and $E$is expectation operator. Consumable commodity is being produced in n different production unit. Key assumption of Lucas is that the produced commodity is not storable$y_t = (y_{1t}, \dots, y_{nt})$ and it's perishable. So consumption is equal to produced commodity which means:

$$C_t = \sum_{i=1}^{n} y_{it}$$

To simplify we assume that production is exogenous and there is no possibility of influencing any production unit (Lucas, 1987). Possession of these production units in each period was determined in a competitive stock market as well dividable share for each unit. Stocks were transacted in a market that price vector $p_t = (p_{1t}, \dots, p_{nt})$ are determined competitively.

In this economy, by considering a budget restriction could determine quantity of equilibrium consumption and maintained asset. But main goal of Lucas is to determine equilibrium price of asset. He assumes all the information about current and future of economic has been tabloid in y vector. Regarding recursive preferences of consumer and equality of periods the problem could be solved through same approach for all the periods. Therefore dynamic optimization equation can be rewritten as below:

$$MaxU = E\left[\sum_{t=0}^{\infty} (1-r)^{-t} U(C_t)\right] \qquad (2)$$

In which r is discount rate and $0 < (1-r)^{-t} < 1$ is discount factor or the previously mentionedβ . The consumer would receive its dividend in each period and then decide how much to expend or hold for the next period. The consumer budget restriction is as below:

$$C_t + P_t'.x_t \le P_t'.z_t = (P_t + D_t)'x_{t-1} \quad (3)$$

In which $x_t$is a vector of X_{it} ($X_{it}$is the amount asset $i$that consumer holds between period t and $t+1$), z is a representative of stocks vector which maintained by consumer. P_t&$D_t$are respectively price and stock dividend vector in t period. The ($'$) is a sign of transpose vector. From our first condition of optimization we have:

$$p_{it}u'(c_t) = (1+r)^{-1}E_t[u'(c_{t+1})(P_{it+1} + D_{it+1})] \qquad i = 1, \dots, n$$

For calculationp_t :

1Gulf Cooperation Council
2Garch in Mean
3Exponential GARCH

$$p_{it} = E_t\left[\sum_{j=1}^{\infty}(1+r)^{-j}\left(\frac{u'(c_{it+j})}{u'(c_t)}D_{it+j}\right)\right]$$

It means price is equal to expected dividends which discount factor for period $t+j$is marginal substitution rate between consumption in time $t+j$and time t. If consumer be risk neutral, marginal utility of consumption will be constant[4].In this case equilibrium price would be:

$$p_{it} = E_t\left[\sum_{j=1}^{\infty}(1+r)^{-j}\left(D_{it+j}\right)\right]$$

Above equation shows that stock price is equal to discounted expected dividends. Therefore any change in expected dividends could impact on stock prices. Whereas future dividends are not observable like discount rate, one could consider its discounted value effected from macroeconomic and other influential market factors.[5]

According to Sharp model, impact factors for stock index have been classified in two general sections as below:

4- Internal factors: include all the impact factors which are related to firm operations and the decision made in there.

5- External factors (macro): include all the factors which are out of firm directors' authorities and effect firm operations somewhat. These could be studied in the form of political and economic factors also economic factors divided to actual and monetary factors.

APT[6]considers actual return of securities as function of economic factors and it allows using more than one systematic factorcontrary to CAPM. In a portfolio, specific risk of a stock is insignificant anderror terms of individual stocks are not correlated. These circumstances show only variables' risk is important and systematic risk is inevitable meanwhile non-systematic risk is avoidable by diversification.

According to mentioned theories could be concluded that prices of different assets determined from expected dividends and discount rate. As mentioned above dividends are not observable so any factors which impact on dividends and discount rate would affect stock price.

Crude oil price and its volatility are two indirect drastic factors which affect dividends and discount rate. Because oil price and its volatility are out of firm's management authorities and operation according to sharp model, they are among the external macroeconomic factors. Likewise gold as substitute asset for stocks would affect expected dividends and discount rate.

For exporter of crude oil, increase of oil income would cause optimism expectation and increase activities at economy level of country. By forming this expectation for Existent Corporationin stock exchange and expectancy of profitability growth for them would increase stock index on the other hand following expansionofoil income,expenses and investments would increase as well. Stock markets would react positively to these circumstances and employment and economic activities would increase. On the contrary decline of oil price would cause uncertainty for investment projects. Since profitability of corporations were affected by oil income that would decrease stock price.

Ascent of gold price would absorb part of the stock market liquidity which causes descent of stock index.

Influential variables on stock indices in selected countries along studied time-series fluctuated. Non-linear equation would be estimate the model better.

Therefore the equation would be as below:

$$LnIND = \alpha + \beta_1 lnP + \beta_1 LnVOL + \beta_1 lnGOLD + \beta_1 LnVOLGOLD$$

In which IND is representative of stock index,P is measure for crude oil price and its coefficient is positive theoretically meanwhile VOL shows oil price volatility. GOLD is representative of Global gold price which its coefficient is negative base on what has been discussed above in the meantime GOLDVOL shows gold volatility. $\beta_1, \beta_2, \beta_3$ & β_4 areelasticity'sfor stock market of selected country toward respectively oil price, oil volatility,gold price and its volatility.

4-RESULTS

4-1- Data, Indices& Studied markets

In this paper OPEC crude oil prices (for each barrel) and overall index of 5 selected countries has been applied. Data are monthly and because of limited accessibility for overall index of selected countries[7], we used April 2001 to November 2011for Iran, January 2007 to November 2011 for Saudi Arabia, December 2003

4.Because in that case utility function would be linear

5.All the above formulas are derived from the Lucas(1987) paper

6.Arbitrage Pricing Theory

7.Overall index of studied countries has been extracted from www.tse.ir for Iran andwww.btflive.com for Arabic country. For OPEC crude oil prices we used www.opec.org.

toNovember 2011 for United Emirates of Arabia , July 2003 to November 2011 for Qatar and June 2001 to November 2011 for Kuwait. At the beginning first difference of variables then logarithm of variables has been used.

4-2- Research model and estimation approach

Main purpose of this study is examining of crude oil, gold prices and their volatilities impact on stock markets of selected country. At the first sectionwe estimate volatility measures of crude oil and gold. In standard literature for estimating volatility measures, ARCH and GARCH technique has been being used[8]. Itis one of the most important approaches which is used for different fields of econometrics specifically in analyzing financial markets to estimate uncertainty and volatility measures and is known as Auto Regressive Conditional Heteroscedasticity. In this approach, conditional variance is varying due to information of former period and past prediction error and it displays variable volatility.

And at the second section for examining crude oil, gold price and their volatilities impact on stock markets panel data approach has been used. Basically statistic data is classified as time-series, cross-sectional and panel (combined) data which third one is more employed in recent years. In this method a series of cross-section units along several years is being fitted. Advantages of using this data are sample enlargement, decreasing serial correlation, ascent of efficiency, lowering estimation bias, restricted heteroscedasticity , possibility of economic effects separation and so on (Heshiao,2003), because of the larger number of observations and data , this method is more trustable and it allows to test more models.

4-3- Descriptive Statistics of Crude oil and Gold price

As shown below oil and gold price series have positive skewnesses and their kurtoses are lower than normal distribution. And according to Tarque- Bera[9] statistics (1980) they are not in each of normal standard significant level.

Table (1) descriptive statistics

Statistics / Variables	Mean	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis	JB	Probability
crude oil price	56.6	131.32	17.53	28.68	0.59	2.48	9.23	[0.009]
Gold price	696.38	1771.88	260.48	397.91	0.93	2.94	18.92	[0.000]

The numbers in [] shows the probability of null Hypothesis acceptance

The issue which should be considered about time series is stationary test because most of the time series variables in economic are non-stationary. Therefore before utilizing any variables in the model we should test whether they are stationary or not. For recognizing stationary from non-stationary time series different tests such as Unit Root Tests and Augmented Dickey-Fuller is being used. In fact this is for prevention from encountering wrong regression. The results of the unit root test are as below:

Table (2) Unit root test results for crude oil and gold prices (Augmented Dickey-Fuller)

Variables / Critical values	Crude Oil price	Gold price
Generalized Dickey-Fuller statistic	-1.62	2.66
1%	-3.48	-3.48
5%	-2.88	-2.88
10%	-2.57	-2.57
Probabilities	[0.46]	[1.00]

umbers in [] shows the probability of null Hypothesis accep

At the first section, for estimating gold and crude oil volatilities the Generalized Autoregressive Conditional Heteroscedasticity model has been used. Before estimating GARCH is necessary to estimate ARIMA for crude oil and gold prices10. Since gold and crude oil variables are first order augmented according to Dickey-Fuller test, first order differences of them has been used for modeling. Due to correlation graph, and first differences of oil and gold prices best ARIMA model for them are respectively ARIMA (2,1,1) and ARIMA (2,12).

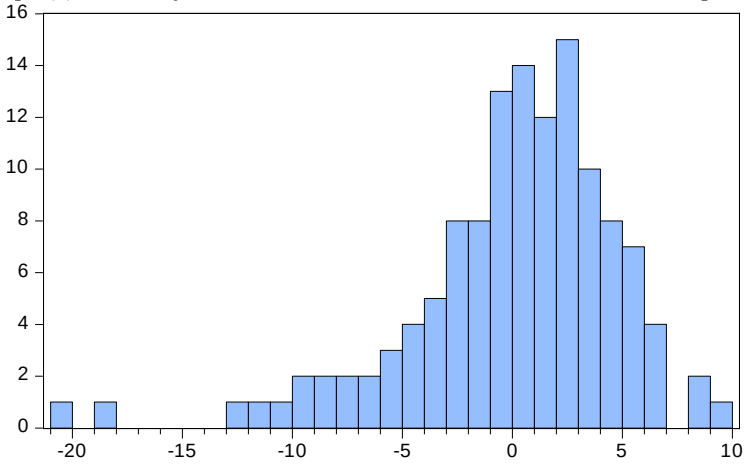
8For further study see Applied Econometrics time series by (Eders,2004)

9The Jarque–Bera (JB) statistic is a goodness-of-fit measure of the departure of the distribution of a data series from normality, based on the levels of skewness and excess kurtosis. The JB statistic is $\chi 2$ distributed with 2 degrees of freedom.

10First stage of GARCH estimating process for a variable is modeling ARIMA and estimating that for studied variable .

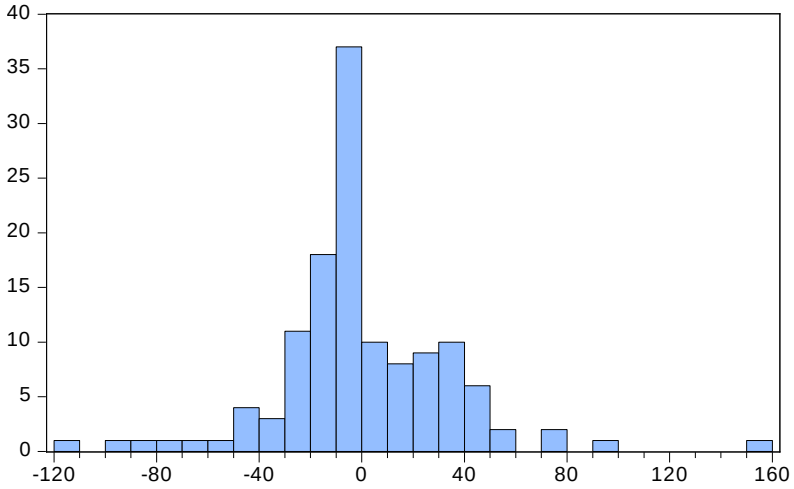
Applying Lagrange Multiplier (LM) and white tests shows that estimated models has no serial correlation however HeteroscedasticityAkaike, Schwarz- Bayesian Criterion (AIC & SBC) inevitable. Because of Heteroscedasticity it is necessary to use Autoregressive Conditional Heteroscedasticity. Ultimately normality test on residualsof ARIMA model shows that its distribution are not normal so for estimating GARCH model Quasi maximum likelihood estimation approach should be used.

Graph (1) Normality test for error terms of ARIMA model for crude oil price



Series: Residuals	
Sample 2001M04 2011M10	
Observations 127	
Mean	0.002194
Median	0.689405
Maximum	9.918250
Minimum	-20.85674
Std. Dev.	4.913977
Skewness	-1.306638
Kurtosis	5.971329
Jarque-Bera	82.85695
Probability	0.000000

Graph (2) Normality test for error terms of ARIMA model for crude oil price



Series: Residuals	
Sample 2001M04 2011M11	
Observations 128	
Mean	0.008194
Median	-4.440065
Maximum	154.3285
Minimum	-112.8597
Std. Dev.	33.87096
Skewness	0.493513
Kurtosis	6.762786
Jarque-Bera	80.70814
Probability	0.000000

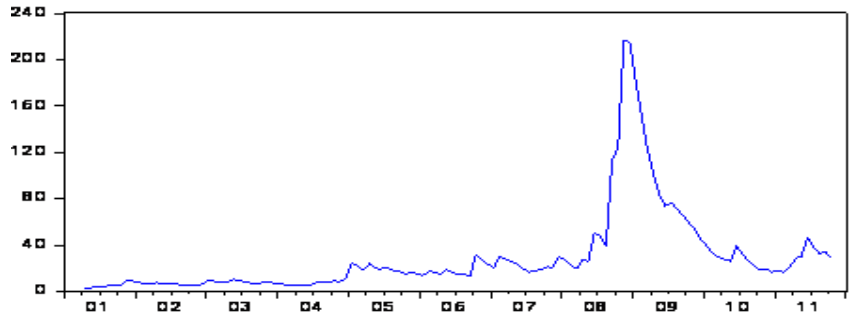
Last stage for calculating crude oil and gold volatility measures is estimating conditional variance equation in Heteroscedasticity conditions. Regarding to AIC and SBC the best model for estimating crude oil price liaison is GARCH (1,1) and GARCH (2,2) for gold price liaison. Estimation results for crude oil and gold prices are as below:

$$GARCH = 0.69 + 0.19 \times RESID(-1)^2 + 0.8 \times GARCH(-1)$$

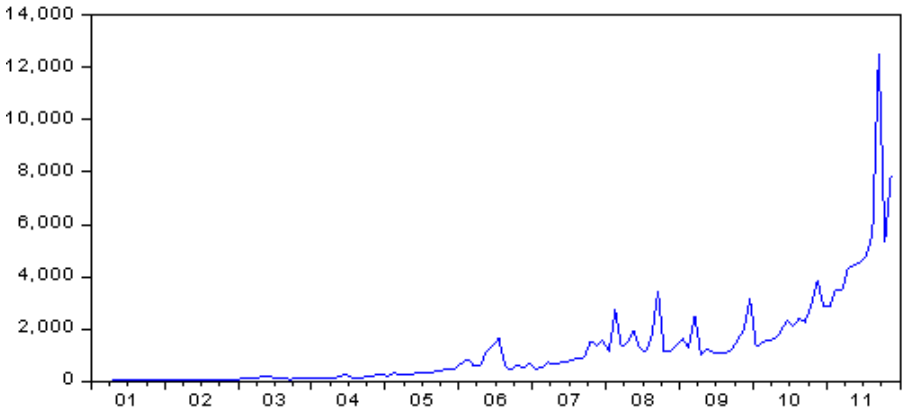
$$GARCH = 0.31 + 0.21 \times RESID(-1)^2 - 0.28 \times RESID(-2)^2 + 1.17 \times GARCH(-1) - 0.06 \times GARCH(-2)$$

Above mentioned equations shows GARCH model for calculating crude oil and gold volatilities. Volatility measures have been estimated from above mentioned model and their graphs are as below:

Graph (3) Volatility of Crude oil price



Graph (4) Volatility of Gold price



At the second section we examine research hypothesizes by using panel data model. Due to high variations of research variables and their non-stationary quality for estimating panel data model their logarithm is being used. Before estimating the model is essential to check whether estimate the model by panel data or ordinary least square method. Required statistics for testing this hypothesis is as below in which RSS_R shows RestrictedSum squared residuals andRSS_{UR} is Un-Restricted Sum squared residuals. In this equation N is representative sections number (here are the countries), T shows length of period and K is number of model parameters.

$$F_{N-1,NT-N-K} = \frac{(RSS_R - RSS_{UR})/N-1}{RSS_{UR}/(NT-N-K)}$$

Null and Alternative Hypothesizes are as below (Green, 1993):

$$H_0: Panel\ Data\ could\ not\ be\ used$$
$$H_1: Panel\ Data\ could\ be\ used$$

$$F_{4,492} = \frac{(231-55)/4}{55/492}$$

Since calculated statistic at 95% confidence level is greater than table statistic so null hypothesis is rejected which means we could use panel data model.

4-5- Fixed and Random effects test:

To recognize which method for panel data model (Random or Fixed effects) is suitable;Hausman test (1980) should be applied. In Hausmantest, null and alternative hypothesis are as below:

$$H_0: E(U_i, X_i) = 0$$
$$H_1: E(U_i, X_i) \neq 0$$

Null hypothesis means that error terms (which include individual effects) and explanatory variables are independent. Meanwhile alternative hypothesis states error terms and explanatory variables are correlated.The Hausman statistic is for selecting between fixed and random effects method which is $\chi 2$ distributed with K degree of freedom which its calculation is as below:

$$\chi^2(K) = (b-\hat{\beta})\Sigma^{-1}(b-\hat{\beta})$$

$$VAR(\alpha, \acute{\beta}) = VAR(\acute{b}) - VAR(\acute{\beta}) = \Sigma$$

If null hypothesis rejected fixed effects method should be applied. According to Hausman test if b is estimator of fixed effects and $\hat{\beta}$ is estimator of random effect, Hausman proved that W statistic would have $\chi 2$ distribution.

$$W = (b - \hat{\beta})\Sigma^{-1}(b - \hat{\beta}) \sim \chi^2(K)$$

If calculated $\chi 2$ is more than table statistics then null hypothesis would be rejected which means error terms of intercept and explanatory variable would be correlated.

The calculated statistic according to Hausmon test is 990 which means null hypothesis would be rejected there for fixed effect should be applied.

In the estimated model all of the coefficients are significant which according to contextual theories verified all the independent variables. $R^2 = 0.744$shows high determination strength of the model by independent variables. Considering that logarithms of variables' were used then all the coefficients are elasticity of dependent variables to independent variables.

Elasticity of selected countries stock market to oil price and its volatility are respectively 0.95,0.04 meanwhile elasticity of selected countries stock market to gold price and its volatility are respectively -1.3,0.34.

6- DISCUSSIONAND RESULTS

In this paper volatility of crude oil and gold prices has been estimated with GARCH model then the relation of gold, crude oil prices and their volatilities with stock markets of selected member of OPEC has been examined by panel data model. The results shows crude oil price has significant positive effect on stock index of studied countries; also gold price has noticeable significant negative effect on stock indices of selected country meanwhile crude oil and gold volatilities' have respectively low positive effects and noticeable significant positive effects on stock markets of studied countries.

These results shows that although crude oil price volatility has inevitable impact on most of the macro-economic factors, because of small scale of capital market for selected countries and lag of its impact on corporations profitability and their stock prices, stock index in those countries has a minor repercussion to Global crude oil prices .

Also according to the majority of households' recognition from investing in gold compares to other assets, gold investing is a drastic competitors for capital market. Hence stock index reaction to gold price and its volatility is rigorous. We can conclude stock indices volatility is more predictable by Global gold price index.

The limitation which we encountered with that was lack of statistics for the same period for all the selected countries. For proceeding papers one would use more countries including oil importers.

Table(3) Results of model estimation

Dependent Variable: LNIND?				
Method: Pooled Least Squares				
Sample (adjusted): 2001M04 2011M10				
Included observations: 126 after adjustments				
Cross-sections included: 5				
Total pool (unbalanced) observations: 501				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.97738	0.453578	24.20177	0
LNP?	0.957429	0.07498	12.76904	0
LNVOL?	0.045946	0.024645	1.864313	0.063
LNGOLD?	-1.300561	0.099334	-13.09283	0
LNVOLGOLD?	0.343373	0.045816	7.494554	0
Fixed Effects (Cross)				
_AE--C	-0.905355			
_IRI--C	0.52952			
_KU--C	0.08713			
_QATAR--C	0.111711			
_SU--C	-0.059994			
	Effects Specification			
Cross-section fixed (dummy variables)				
R-squared	0.744607	Mean dependent var	8.730189	
Adjusted R-	0.740454	S.D. dependent var	0.656575	
S.E. of regression	0.334496	Akaike info criterion	0.665419	
Sum squared	55.04877	Schwarz criterion	0.741166	
Log likelihood	-157.6873	Hannan-Quinn criter.	0.695139	
F-statistic	179.3051	Durbin-Watson stat	0.206579	
Prob(F-statistic)	0			

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