IJEEP
INTERNATIONAL JOURNAL OF ENERGY ECONOMICS AND POLICY
EJ EconJournals
ISSN: 2146-4553

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2016, 6(3), 374-380.

EJ EconJournals

Uncertainty of Oil Proved Reserves and Economic Growth in Iran

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ABSTRACT

The relationship between the oil and the level of economic activity is a fundamental empirical issue in macroeconomics. Also, a part of major debates between the pessimists and the optimists approaches about economic growth is how uncertainty of proved reserves of non- renewable energy resources as a one of main inputs, effects on the economic growth; in other words, on the base of some optimistic new economic growth models, the uncertainty through positive shocks positively effects on the economic growth. So, to find some evidences about it, in this research we try to find experimentally direct effects of uncertainty of oil proved reserves on macroeconomics of Iran by using annually data from 1980 to 2013 by using Multivariate generalized auto-regressive conditional heteroskedasticity in-mean vector auto-regression (VAR) model. We find that uncertainty in oil proved reserves has not had statistically significant effect on aggregate output and the responses to positive and negative shocks are symmetric.

Keywords: Uncertainty, Oil Proved Reserves, Time Allocation of Resources, Vector Auto-regression Multivariate Generalized Auto-regressive Conditional Heteroskedasticity-in-Mean Vector Auto-regression
JEL Classifications: C32, E10, Q32

1. INTRODUCTION

Oil is one of the strategic goods in the world and also one of the principal factors of production and economic growth especially after industrial revolution. Moreover, Iran has 4^{th} rank of owning oil proved reserves in the world and as oil export income has high share in the annual gross domestic production (GDP), Iran has an economic depending to oil. In addition, as oil is a major factor in the production and is non-renewable, there are many doubts about future economic growth of Iran; so, to ensure long term economic growth and intergenerational justice, time allocation of non-renewable energy resources must be attend.

Furthermore, economists in the world have two pessimistic and optimistic approaches about economic growth. In 1798, Malthus (1798) suggested that neither technological progress nor the human ingenuity would be sufficient to overcome obstacles of population growth. He criticized the prevailing idea that nature would never limit growth. This view had already been expressed by the French philosopher Nicolas de Condorcet in 1794 (Malthus, 1798). The British classical economists likewise argued that in principle nature could limit growth, but such natural constraint would not be reached in any meaningful time frame. The most famous scholar who took this stance was Mill (1862). In 1862 he argued that social institutions and increases in social welfare would slow down population growth. Since the 1890s the debate increasingly considered the depletion of non-renewable resources as a major obstacle for growth. In this context, the former US President Roosevelt (1908) promoted the conservation movement. Research was deepened by Hotelling in 1931 and Barnett and Morse in 1963, who took an optimistic view. Barnett and Morse (1963) assumed that technological development would produce substitutes for scarce resources, reduce the relative prices of these goods and expand the total amount of economic reserves. Even so, they considered how the depletion of non-renewable resources could impede economic growth and what the optimal rate of depletion would be. Although they allowed for the possibility of scarce natural resources, scarcity was an idea only considered validity in theory. In fact most companies chose a higher rate of depletion, because they simply sought short-term profit maximization. However, the situation was not that serious as Barnett and Morse (1963) showed because the price of most minerals as well as agricultural products had fallen, not risen. The debate that continued, there were scholars who argued a more pessimistic view. The most cited publication of this phase was the limits to growth (Meadows, 1972), published by scholars at the Massachusetts Institute of Technology. They argued that the economy would soon stagnate and finally collapse because many critical non-renewable resources would be exhausted in the near future. Although most of their predictions have not come to pass, it is worth looking at their arguments as they had a deep impact on the debate. According to them population grows exponentially, whereas resources and food supply grow linear at lower rates. Hence (1) an insufficient supply of food for an increasing world population will be one limiting factor on growth in the near future. Another limiting factor will be (2) the depletion of natural resources. As a result raw materials will become extremely expensive and the depletion of non-renewable resources will lead to a sudden collapse of economic development instead of a smooth transition. Pollution will further limit the availability of natural resources (Meadows, 1972). In contrast, the optimists emphasized the short-term occurrence of over-consumption. Simon (1996) pointed out that in the short-run, it is indeed possible that supply will fall short; but in the long-run, increased price levels will boost production. For instance, rising food prices will make the application of new technologies profitable and agricultural output will be amplified (Kahn, 1976 and 2005). In fact, the price of resources indicates the underlying mechanism of scarcity rather than depletion. For oil the situation is likewise: A distinct pattern of fluctuating oil prices and new discoveries in the past demonstrate a strong correlation between oil demand and supply, because increased oil prices encourage oil companies to invest in exploring for oil, at deeper and less accessible layers. Although an unexpected demand shock cannot be covered in the short-run, market mechanisms will balance supply and demand in the long-run, albeit at eventually higher prices (Simon, 1996). In addition, the optimists argued that non-renewable resources as input in economic activities will lose their importance in the long-run. This pattern of adaptation can, for example, be illustrated by the unexpected diminishing importance of coal in developed countries. Simon (1996) stressed that the depletion of natural resources need not conflict with economic growth, because (1) a rising price will stimulate the search for new deposits and (2) increase the profitability of currently more expensive renewable resources.

During the next phase Dasgupta and Heal (1974) discussed whether it is possible to maintain sustained economic growth in light of diminishing non-renewable resources. Similarly Solow (1974) and Stiglitz (1974) showed that market economies may not lead to sustainable outcomes, i.e. market forces could lead to over consumption of non-renewable resources and hence limit growth. Anderson (1987) argued that even technological change could not impede this outcome. Only if capital accumulation can be substituted for non-renewable resources, can consumption levels be maintained in the long-run (Hartwick, 1977). A more optimistic perspective is the idea that investments into new technologies could decrease the costs of renewable energy and hence make the substitution of non-renewable resources feasible (Dasgupta and Stiglitz, 1981). During the last decades new economic growth models showed the effects of technological change and substitution on sustainable development. Though non-renewable resources are by definition finite, either in terms of supply or by relative pricing, there is no reason to argue that economic growth will be limited. Barro and Sala-I-Martin (1995) showed how sustained growth is possible. For example, as Schmalensee et al. (1998) has shown, pollution measured by per capita emissions has peaked in some OECD countries. Likewise there are scenarios that predict a falling demand for oil after the year 2030 (IEA (International Energy Agency), 2003) partly due to the substitution by cheaper renewable energy sources. Salo and Tahvonen (2001) emphasized that an unexpected demand shock cannot be covered in the short run, but supply will adjust to its demand in the long-run. Still there are scholars who argued that development in the long-run will reach a steady state. Daly (1991) assumed that sooner or later only renewable resources could be consumed, but a comparison with reality shows that the short-term occurrence of his predicted ‘cycle-stage’ seems unlikely. A more efficient employment of oil due to new technologies as well as the input of substitutes have compensated for overall increases in consumption. The pessimists acknowledged that technological progress and substitution could possibly compensate for increased demand and usage rates of non-renewable resources; however, these effects were not been taken sufficiently in to account (Tahvonen, 2000). The experience with oil proved the pessimistic assumptions to be misleading; instead of decreasing oil reserves due to its depletion, oil reserves have actually increased during the last decades (BP statistical review of world energy report, 2015; Radler, 2006). In the future it is possible that energy will continue to be produced from non-renewable resources as this is for several reasons: (1) The rate of depletion will change over time due to the development of new technologies, (2) there will be new discoveries of reserves, (3) consumer behavior will change over time and (4) the structural framework of the global economy will change due to such things as the implementation of various environmental regulations. However, amount of proved reserves of non-renewable resources are also stochastic and thus, amount of input of non-renewable energy and its changes can be seen as a one stochastic variable in the production function. In other words, examples of random negative shocks in the proved reserves are earthquakes, hurricanes, and war, while a random positive shock can be the discovery of an unexpected field and increasing of rate of depletion due to the development of new technologies.

Nevertheless, the debate between the pessimists and the optimists is mostly about how technological progress, human mind, uncertainty about the actual amount of reserves of resource and future prospects of oil prices, costs of production, and substitution cheaper renewable energy will affect on economical growth and whether they can overcome obstacles for future economic growth or not.

To investigate empirically the facts, there are vast literatures that examine empirically effects of different factors including uncertainty, depleting non-renewable resource, technological progress, human capital, and substitution cheaper renewable energy on economic growth. As an illustration, Tilton (1996) in his paper analytically considered both optimistic and pessimistic approaches about future economic growth by including major factors such as depleting non-renewable resource, uncertainty about the proved reserves of non-renewable energy resources, and technological progress. Also, Pasqual and Souto (2003) investigated on long term growth rate and managing natural resources under uncertainties and proved that intergenerational distribution of the resources is key to ensure long term growth rate. In continue, Gerlagha and Keyzerb (2004) studied path of long term economic growth by considering restrictions of intergenerational and uncertainties of non- renewable resources and showed that integration of economics depend to initial reserves of resources. Also, Martinet (2007) in their paper studied long term growth including non-renewable resources and technological progress by using control of variable approach. For more to see, Stamford da Silva (2008) and Schilling and Chiang (2011).

In this paper, we move the empirical literature forward by examining a part of major debates between the pessimists and the optimists approaches about economic growth which is how uncertainty about the actual amount of proved reserves of non-renewable resources effects on the economic growth and thus, whether for intergenerational justice, time allocation of non-renewable energy resources must be attend or not. It is mentioned that uncertainty of oil proved reserves includes random negative shocks such as earthquakes, hurricanes, and war, and random positive shock includes the discovery of an unexpected field and increasing of rate of depletion due to the development of new technologies. In this way, we try to find the direct effects of oil proved reserves uncertainty on real economic activity as well as the response of real GDP growth to oil reserves shocks by using annually data for the Iran as a country which has 4th rank of owning amount of oil proved reserves in the world. The model is based on a structural vector auto-regression (VAR) that is modified to accommodate generalized auto-regressive conditional heteroskedasticity (GARCH) in-mean errors, as detailed in Engle and Kroner (1995), Grier et al. (2004), Shields et al. (2005), and Elder and Serletis (2010). As a measure of uncertainty about the impending oil proved reserves, we utilize the conditional standard deviation of the forecast error for the change in the proved reserves of oil.

Our principal result is that uncertainty about the proved reserves of oil in the country has not had a significant effect on real GDP over the post-1980 period, including both positive (technology growth and discovering unexpected reserves) and negative (war) shocks, even after controlling for lagged oil proved reserves and lagged real output. We also conduct impulse-response analysis. Consistent with much of the literature, our impulse-responses are not estimated very precisely (we report one standard error confidence bands), but we find some evidence that accounting for uncertainty about oil reserves tends to alter the estimated response of real output to an oil reserves shock. In particular, the responses to positive and negative are symmetric. There are a few notification in interpreting our results. Our proxy for uncertainty is the conditional variance of oil proved reserves. This proxy reflects the dispersion in the forecast error generated by an econometric model applied to historical data and may not capture other forward-looking components of uncertainty that are not parameterized in the model. It may also be correlated with some other factor that is driving our result. Auto-regressive conditional heterskedasticity (ARCH-) based measures of uncertainty, however, have been very common, at least since their seminal application by Engle (1982) to inflation uncertainty.

The paper is organized as follows. Section 1 provides a brief description of the empirical model and addresses estimation issues. Section 2 presents the data and draws on the large empirical literature dealing with identification issues in structural VAR. Sections 3 assess the appropriateness of the econometric methodology by various information criteria, and discuss the empirical results. The final section concludes.

2. THE EMPIRICAL MODEL

As indicated above and same as Elder and Serletis (2010), we measure uncertainty about oil proved reserves as the standard deviation of the one-step-ahead forecast error, conditional on the contemporaneous information set. The standard deviation of this forecast error is a measure of dispersion in the forecast, and as such, is a measure of uncertainty about the impending realization of the proved reserves of oil. Such time-series measures of uncertainty have been very common, at least since Engle (1982) and Bollerslev (1986) applied univariate ARCH and GARCH models to measure inflation uncertainty. We follow same method with Elder and Serletis (2010).

Our empirical model is a multivariate annually GARCH- in-mean model in real GDP growth and the change in the proved reserves of oil and was first developed in Elder (1995, 2004). The operational assumption is that the dynamics of the structural system can be summarized by a linear function of the variables of interest plus a term related to the conditional variance. According to the basic GARCH framework which was extended by Engle et al. (1987), the conditional mean, y_t to depend on the conditional variance, δ_t^2. Following it and imposing some restriction, the conditional mean is as follow:

$$By_t = C + \sum_{i=1}^{p} \Gamma_i y_{t-i} + \Lambda(L)\sqrt{H_t} + e_t \qquad (1)$$

$dim\ (B) = dim\ (\Gamma_i) = (n*n)$ $\qquad$ $e_t|\Omega_{t-1} \sim iid\ N\ (0, H_t)$,

Where 0 is the null vector, $\Lambda\ (L)$ is a matrix polynominal in the lag operator, Ω_{t-1} denotes the available information set in period $t-1$, which includes variables dated $t-1$ and earlier.

The system is identified by imposing a sufficient number of exclusion restrictions on the matrix B, and assuming that the structural disturbances, e_t are uncorrelated. This specification allows the matrix of conditional standard deviations, denoted $\sqrt{H_t}$, to affect the conditional mean.

Testing whether oil proved reserves uncertainty affects real economic activity is a test of restrictions on the elements of $\Lambda(L)$ that relate the conditional standard deviation of oil reserved, given by the appropriate element of $\sqrt{H_t}$, to the conditional mean of y_t that is, if oil proved reserves uncertainty has positively affected output growth, then we would expect to find a positive and statistically significant coefficient on the conditional standard deviation of oil in the output equation. In our application, the vector y_t includes real output growth and the change in the proved reserves of oil.

In other words,

$$y_t = \begin{bmatrix} \Delta \ln oil_t \\ \Delta \ln y_t \end{bmatrix}; e_t = \begin{bmatrix} e_{\Delta \ln oil,t} \\ e_{\Delta \ln y,t} \end{bmatrix}; h_t = \begin{bmatrix} h_{\Delta \ln oil \Delta \ln oil,t} \\ h_{\Delta \ln y \Delta \ln y,t} \end{bmatrix};$$

$$B = \begin{bmatrix} 1 & 0 \\ b_{\Delta \ln oil} & 1 \end{bmatrix}; C = \begin{bmatrix} C_{\Delta \ln y} \\ C_{\Delta \ln oil} \end{bmatrix} \Gamma_i = \begin{bmatrix} 3^{(i)}_{11} & 3^{(i)}_{12} \\ 3^{(i)}_{21} & 3^{(i)}_{22} \end{bmatrix}; \Lambda(\mathrm{L}) = \begin{bmatrix} 0 \\ \Lambda(L)^{(j)}_{22} \end{bmatrix}.$$

The conditional variance H_t is modeled as multivariate GARCH on the base of Elder (2004), which shows that imposing a common identifying assumption in structural VARs greatly simplifies the variance function written in terms of the structural disturbances. That is, given the zero contemporaneous correlation of structural disturbances, the conditional variance matrix H_t is then diagonal, substantially reducing the requisite number of variance functions parameters. So, the variance function is as follow:

$$diag(H_t) = C_v + \sum_{j=1}^{f} F_j \, diag(H_{t-j}) + \sum_{k=1}^{g} G_k \, (e_{t-k} \, e_{t-k}{}') \quad (2)$$

Were *diag* is the operator that extracts the diagonal from a square matrix. If we impose the additional restriction that the conditional variance of $y_{i,t}$ depends only on its own past squared errors and its own past conditional variances, the parameter matrices F_j and G_k are also diagonal. Given the focus of this paper, this assumption is not restrictive, and it can be relaxed if we have particular interest in how the lagged uncertainty of one variable may interact with the conditional variance of another. We therefore estimate the variance function given by equation (2), with f = g = 1.

The multivariate GARCH-in-mean VAR, equations (1) and (2), can be estimated by full information maximum likelihood (FIML), which avoids Pagan's (1984) generated regressor problems associated with estimating the variance function parameters separately from the conditional mean parameters, as in Lee et al. (1995). The procedure is to maximize the log likelihood with respect to the structural parameters B, $C, \Gamma_i, \Lambda, C_v, F_j, and \, G_k$, where

$$l_t = -(\frac{n}{2}) \ln (2\Pi) + \frac{1}{2} \ln |B|^2 - \frac{1}{2} \ln |H_t| - \frac{1}{2} (e_t H_t^{-1} e_t{}').$$

We set the pre sample values of the conditional variance matrix H_0 to their unconditional expectation and condition on the pre sample values $y_0, y_{t-1}, \ldots, y_{t-p+1}$ To ensure that H_t is positive definite and e_t is covariance stationary, the following restrictions are imposed: C_v is element-wise positive, F and G are element-wise non negative, and the eigen values of (F + G) are less than one in modulus. Provided that the standard regularity conditions are satisfied, FIML estimates are asymptotically normal and efficient, with the asymptotic covariance matrix given by the inverse of Fisher's information matrix.

This procedure is computationally intensive, as it estimates all the structural parameters simultaneously, unlike the conventional procedures for a homoskedastic VAR. In a homoskedastic VAR, the reduced-form parameters are typically estimated by OLS and the structural parameters are recovered in a second stage either by a Cholesky decomposition or a maximum likelihood procedure applied to the reduced-form covariance matrix, requiring numerical optimization over as few as n (n − 1)/2 free parameters in B. Such simplified estimation schemes are not possible with this model, however, in part because the information matrix is not block diagonal.

Impulse responses are calculated as described in Elder (2003). The Monte Carlo method used to construct the confidence bands is described in Hamilton (1994 p. 337), adopted to our model. That is, the impulse responses are simulated from the maximum likelihood estimates (MLEs) of the model's parameters. Confidence intervals are generated by simulating 1,000 impulses responses, based on parameter values drawn randomly from the sampling distribution of the MLEs, where the covariance matrix of the MLEs is derived from an estimate of Fisher's information matrix.

3. DATA AND IDENTIFICATION

We use annually data for the Iran over the period from 1980 to 2013, including both positive (technology growth and discovering unexpected reserves) and negative (war) shocks, a total of 33 observations. We estimate our model using of real GDP and amount of proved reserves of oil; so, we have two variables - the real GDP (y_t) and the proved reserves of oil (o_t).

Furthermore, we use data for nominal GDP and GDP Deflator or real GDP, which are used to calculate GDP Deflator, from reports of central bank of Iran. Also, we use BP Statistical Review of World Energy (2015) annual data on oil proved reserves and basic year was 2004.

Figures 1 plot the logged levels and the first differences of real GDP and the proved reserves of oil ($Ln\, y_t$ and $\Delta ln\, y_t / ln\, o_t$ and $\Delta ln\, o_t$ series) respectively, for Iran.

A battery of unit root and stationary tests are conducted in Table 1 in the natural logs of real GDP and the oil proved reserves. In particular, we use the Augmented Dickey–Fuller (ADF) test (Dickey and Fuller, 1981) and the Dickey–Fuller GLS test (Elliot et al., 1996), assuming both a constant and trend, to determine whether the series have a unit root. Moreover, given that unit root tests have low power against trend stationary alternatives, we also use the KPSS test (Kwiatkowski et al., 1992) to test the null hypothesis of stationarity. As shown in Table 1, the null hypothesis of a unit root cannot be rejected at conventional significance levels by both the ADF and DF-GLS test statistics in approximately all data. Moreover, the null hypothesis of stationarity in the different methods of KPSS test has not shown same results for the same series; however, It can be approximately rejected at conventional significance levels. We thus conclude that real GDP and the oil proved reserves are nonstationary, or integrated of order one, I(1).

In panel Table 1 also, we repeat the unit root and stationarity tests using the first differences of the logs of the series. Clearly, all of tests have not shown same results for the same series; however, the

Figure 1: Iran (a) Logged real GDP and its growth rate. (b) Logged oil proved reserves and its rate of change

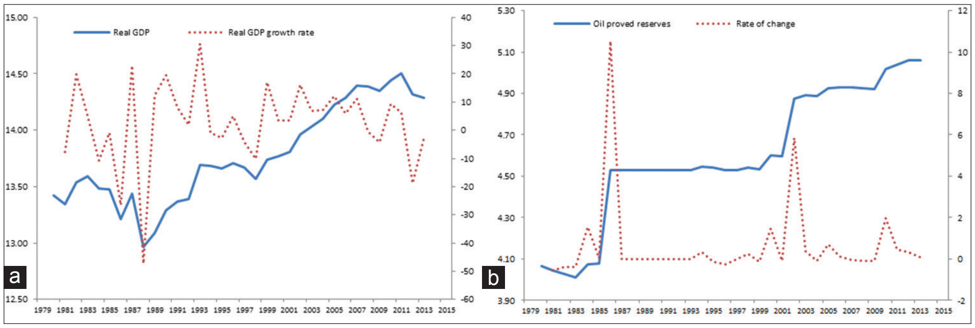


Table 1: Unit root and stationary tests

	Log levels				First differences of log levels			
	$ADF(\tau)$	$DF-GLS(\tau)$	$KPSS(\eta_{\mu}^{\wedge})$	$KPSS(\eta_{\tau}^{\wedge})$	$ADF(\tau)$	$DF-GLS(\tau)$	$KPSS(\eta_{\mu}^{\wedge})$	$KPSS(\eta_{\tau}^{\wedge})$
				A. Real GDP				
	−3.866	−2.300	0.587	0.132	−2.326	−2.523	0.121	0.094
				B. Oil proved reserves				
	−2.402	−2.478	0.728	0.074	−5.979	−6.058	0.060	0.058
%CV	−3.553	−3.190	0.463	0.146				

null hypotheses of the ADF and DF-GLS tests are mostly rejected and the null hypothesis of the KPSS test cannot be mostly rejected, suggesting that the logarithmic first differences are stationary, or integrated of order zero, I(0).

Due to the presence of unit roots in the logged levels, in the next section we estimate all models using the first differences of the logarithms of the series.

4. EMPIRICAL EVIDENCE

We estimate a multivariate GARCH-in-mean VAR with one lag, using annually observations on the log change in the proved reserves of oil and the log change in real GDP over 1980 to 2013 for the Iran. It must be mentioned that different lags considered and only in the one lag the model integrated. The point estimates of the conditional mean and conditional variance-covariance function parameters of the multivariate GARCH in-mean VAR are reported in Table 2 for and provide less support for the specification.

The primary coefficient of interest relates to the effect of oil proved reserves uncertainty on real GDP. This is the coefficient on the conditional standard deviation oil proved reserves changes in the output growth equation, which is reported in the Λ (L) matrix in Table 2. The null hypothesis that the true value of this coefficient is zero is not rejected at the 5% level in the period, thus providing evidence to not support the hypothesis that positive oil proved reserves uncertainty tends to increase real economic activity. Hence, uncertainty about the proved reserves of oil has not tended to increase real GDP over our sample and that effect is statistically not significant at conventional. On the base of variance-covariance function, there is evidence of ARCH in both real GDP and oil proved reserves. At a annually frequency, the volatility process for the proved reserved of oil is apparently persistent, as most of the coefficient are significant.

Table 2: Parameter Estimates for Iran

Model: Equations (1) and (2) with P=1, f=1 , and g=1

A. Conditional mean equation

$$B=\begin{bmatrix} 1 & 0 \\ 0.945(1.067)0 & 1 \end{bmatrix};C=\begin{bmatrix} 82.223(16.542) \\ -1.285(-1.364) \end{bmatrix};$$

$$\Gamma_1=\begin{bmatrix} -0.807(-2.229) & 5.255(0.836) \\ -0.113(-0.535) & 3.459(1.053) \end{bmatrix};\Lambda(L)=\begin{bmatrix} 0.000 \\ 0.001(0.783) \end{bmatrix}$$

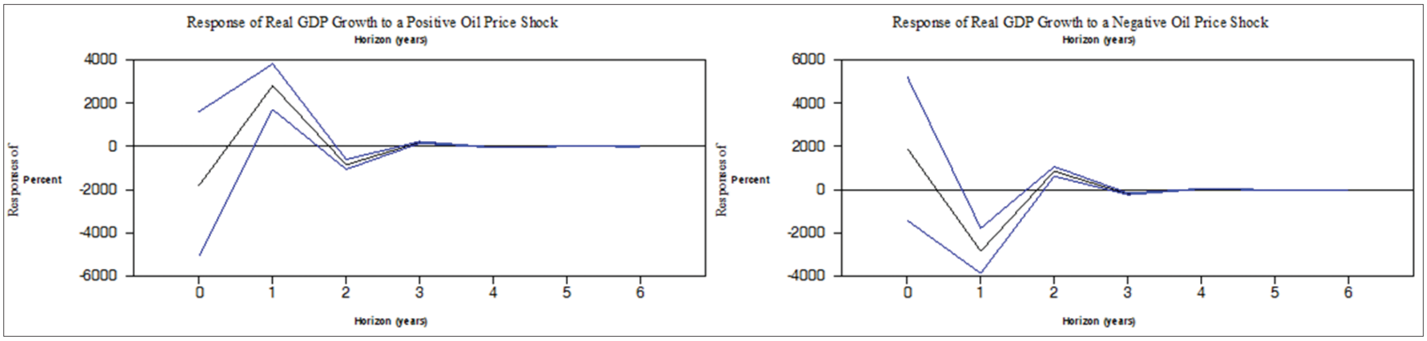
B. Conditional variance-covariance structure

$$C_v=\begin{bmatrix} 57.988(51.920) \\ 103.305(3.663) \end{bmatrix};F=\begin{bmatrix} 0.999(32303) \\ 0.315(1.689) \end{bmatrix};G=\begin{bmatrix} 0.000 \\ 0.164(2.492) \end{bmatrix}$$

To assess the effect of incorporating oil proved reserves uncertainty on the dynamic response of real GDP to an oil reserves shock, we plot the associated impulse responses in Figure 2, simulated from the MLEs of the model's parameters. The impulse responses are based on an oil shock equal to the annualized unconditional standard deviation of the change in the proved reserves of oil. We choose a shock of this magnitude to make the impulses comparable to those of standard homoskedastic VAR. We simulate the response of real output to both a positive and negative oil reserves shock, to investigate whether the responses to positive and negative shocks are symmetric or asymmetric. We also report one-standard error bands.

Consider first the top panel of figure, which reports the response of real output to a positive oil reserves shock. The impulse response indicates that, accounting for the effects of oil proved reserves uncertainty, an oil reserves shock tends to increase real GDP growth immediately in the Iran, inducing a upward revision in the annualized growth rate of real GDP. However, in the next period decreased under zero and after was going to be stable around zero. Also, the dynamic effect of the positive shock to the real GDP is not relatively persistent.

Figure 2: Impulse responses for Iran



In order to quantify the dynamic response of real GDP to oil reserves shocks, in the second panel of figure we report the impulse response of real GDP to a negative oil reserves shock. Clearly, our model estimates this effect very imprecisely, as the response of real GDP is well within one standard error of zero at all horizons. Hence, in our model the responses to positive and negative shocks are symmetric, in that the effect of a positive shock is not different from that of a negative shock.

5. CONCLUSION

A part of major debates between the pessimists and the optimists approaches about economic growth is how uncertainty about the actual amount of proved reserves of nonrenewable resource as a one of the principal factors in the production effects on the economic growth. In this paper, we examine the effects of oil proved reserves uncertainty on real economic activity in the Iran, in the context of a dynamic multivariate framework in which a structural VAR has been modified to accommodate multivariate GARCH-in-mean errors, as in Elder and Serletis (2010). In this model, oil proved reserves uncertainty is the conditional standard deviation of the one-period-ahead forecast error of the change in the proved reserves of oil.

Our main empirical result is that uncertainty about the proved reserves of oil has not had a significant effect on real output at the 5% level in our sample. We also find some evidence that the responses to positive and negative shocks are symmetric, in that the effect of a positive shock is not different from that of a negative shock. Further research might investigate by defining different proxy to measure oil reserves uncertainty.

Finally, our results do not provide some support evidence that uncertainty about oil proved reserves may ensure economic growth; so, time allocation of non-renewable energy resources to ensure economic growth and intergenerational justice must be attended.

REFERENCES

Anderson, C. (1987), The production process: Inputs and wastes. Journal of Environ-mental Economics and Management, 14, 1-12.

Barnett, H., Morse, C. (1963), Scarcity and Growth: The Economics of Natural Resources Availability. Baltimore: Published for the Resource for the Future, The Johns Hopkins Press. pXV, 288.

Barro, R., Sala-I-Martin, X. (1978), Economic Growth. New York: McGraw Hill.

Bollerslev, T. (1986), Generalized autoregressive conditional heteroskedasticity. Journal of Econometrics, 31, 307-327.

Daly, H. (1991), Steady State Economics. Washington, D.C: Island Press.

Dasgupta, P., Heal, G. (1974), The optimal depletion of natural resources. Review of Economic Studies, Symposium. p3-28.

Dasgupta, P., Stiglitz, J. (1981), Resource depletion under technological uncertainty. Econometrica, 49, 85-104.

Dickey, D., Fuller, W. (1981), Likelihood ratio statistics for autoregressive time series with a unit root. Econometrica, 49,1057-1072.

Elder, J. (1995), Macroeconomic and Financial Effects of Monetary Policy and Monetary Policy Uncertainty, Ph.D. Dissertation, University of Virginia.

Elder, J. (2003), An impulse-response-function for a vector auto-regression with multivariate GARCH-in-mean. Economics Letters, 79, 21-26.

Elder, J. (2004), Another perspective on the effects of inflation volatility, Journal of Money, Credit, and Banking, 36, 911-28.

Elder, J., Serletis, A. (2010), Oil price uncertainty. Journal of Money, Credit and Banking, 42, 1137-1159.

Elliott, G., Rothenberg, T.J., Stock, J.H. (1996), Efficient tests for an autoregressive unit root. Econometrica, 64, 813-836.

Engle, R.F. (1982), Autoregressive conditional heteroscedasticity with estimates of the variance of UK inflation. Econometrica, 50, 987-1008.

Engle, R.F., Kroner, K.F. (1995), Multivariate simultaneous generalized ARCH. Econometric Theory, 11, 122-150.

Engle, R.F., Lilien, D.M., Robins, R.P. (1987), Estimating time varying risk premia in the term structure: The ARCH-M model. Econometrica 55(2), 391.

Gerlagha, R., Keyzerb, M. (2004), Path-dependence in a Ramsey model with resource amenities and limited regeneration. Journal of Economic Dynamics and Control, 28, 1159-1184.

Grier, K.B., Henry, O.T., Olekalns, N., Shields, K. (2004), The asymmetric effects of uncertainty on inflation and output growth. Journal of Applied Econometrics, 19, 551-565.

Hamilton, J.D. (1994), Time Series Analysis. Princeton, NJ: Princeton University Press. p337.

Hartwick, J. (1977), International equity and the investing of rents from exhaustible resources. American Economic Review, 67, 972-974.

Hotelling, H. (1931), The economics of exhaustible resources. Journal of Political Economy, 39, 137-175.

International Energy Agency (IEA). (2003), Energy to 2050. Scenarios for a Sustainable Future. Paris: OECD/IEA.

Kahn, H. (1976), The Next 200 Years: A Scenario for America and the World. New York: Morrow. p4-11.

Kahn, J.R. (2005), The Economic Approach to Environmental and Natural Resources. Mason, OH: Thomson Southwestern.

Kwiatkowski, D., Philips, P.C.B., Yonocheo, S., Schmidt, P. (1992), Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic times series have a unit root? Journal of Econometrics, 54, 159-178.
Lee, K., Ni, S., Ratti, R.A. (1995), Oil shocks and the macroeconomy: The role of price variability. The Energy Journal, 16, 39-56.
Malthus, T. (1798), An Essay on the Principle of Population as it Affects the Future Improvement of Society. London: Ward Lock.
Martinet, V.L. (2007), Sustainability of an economy with an exhaustible resource: A viable control approach. Resource and Energy Economics, 29, 17-39.
Meadows, D.L. (1972), The Limits to Growth. London: Pan Books Ltd.
Mill, J.S. (2002), Principles of Political Economy. New York: Appleton.
Pagan, A. (1984), Econometric issues in the analysis of regressions with generated regressors. International Economic Review, 25, 221-247.
Pasqual, J., Souto, G. (2003), Sustainability in natural resource management. Ecological Economics, 46, 47-59.
Radler, M. (2006), Oil production, reserves increase slightly in 2006. Oil and Gas Journal, 104(47), 20-23.
Roosevelt, T. (1908), Conservation as a National Duty, Opening address at the Conference of Governors. Washington, DC.
Salo, S., Tahvonen, O. (2001), Oligopoly equilibria in nonrenewable resource markets. Journal of Economic Dynamics and Control, 25(5), 671-702.
Schilling, M., Chiang, L. (2011), The effect of natural resources on a sustainable development policy: The approach of non-sustainable externalities. Energy Policy, 39, 990-998.
Schmalensee, R., Stoker, T., Judson, R. (1998), World carbon dioxide emissions: 1950- 2050. The Review of Economics and Statistics, 80, 15-27.
Shields, K., Olekalns, N., Henry, Ó.T., Brooks, C. (2005), Measuring the response of macroeconomic uncertainty to shocks. The Review of Economics and Statistics, 87(2), 362-370.
Simon, J. (1996), The Ultimate Resource2. Princeton: Princeton University Press.
Solow, R.M. (1974), Intergenerational Equity and Exhaustible Resources. Review of Economic Studies, Symposium on the Economics of Exhaustible Resources. p29-46.
Stamford da Silva, A. (2008), Growth with exhaustible resource and endogenous extraction rate. Economic Modelling, 25, 1165-1174.
Stiglitz, J.E. (1974), Growth with exhaustible natural resources: Efficient and optimal growth paths. Review of Economic Studies, Symposium on the Economics of Exhaustible Resources, 123-137.
Tahvonen, O. (2000), Economic Sustainability and Scarcity of Natural Resources: A Brief Historical Review. Washington, DC: Resources for the Future.
Tilton, J.E. (1996), Exhaustible resources and sustainable development. Resources Policy, 22, 91-97.