Developing a Dynamic Model for Iran's Economy

Hossein Mirzaei[1]

Abstract

This paper analyzes the effects of oil price shocks on the Iranian business cycle using the framework of real business cycle theory. A theoretical framework is modified to investigate cyclical behaviour of the economy in response to oil price shocks. The strategy of this study is to set up a simple Cobb-Douglas production function model and explore the extent to which it can account for the observed behaviour of Iranian economy from 1959 to 2009. This research adds to an up-and-coming body of evidence supporting the hypothesis that business cycles are influenced by oil price shocks in the international oil market. It also provides a platform increasing our understanding of the cyclical behaviour of Iran's economy, feeding into literature of primary commodity dependent economy. The starting point of our analysis is a standard dynamic general equilibrium model for a small open economy in which oil is included as a productive input. The oil price and the exchange rate are initially assumed to be those determined by the international markets. Hence our starting point is taking those prices as given. Oil price shocks are considered to be one of the possible sources of fluctuations in an economy and follow a stochastic process. They influence significantly the size and path of aggregate fluctuations and illuminate other features of business cycle. This analysis allows us to prove the extent to which oil price shocks can account for the Iranian business cycle.

Keywords: Real business cycle, oil price shocks, Modelling Iranian economy

1. Introduction

The aim of this paper is to explain the factors affecting the Iranian business cycles, and to provide a suitable framework for the analysis of macroeconomic fluctuations. A common argument is that the business cycle is caused not only by fluctuations in aggregate demand, but also by random shocks in the supply side of economics. Within the real business cycle (RBC) framework, the factors, such as oil price shocks, affecting the business cycle of the Iranian economy and supply side are identified and estimated. We specify and estimate a model which is an extension of the RBC model and which is designed to explain determinants of the time path of

[1] Ph.D. in Economics, Associate professor and head of Department of Economics, Karaj Payame Noor University, Post Code 3157836899, Tehran, Iran, Email: mirzaei_h@pnu.ac.ir or mirzaeih@yahoo.com

real GDP. It also attempts to model output and looks at its ability to identify the turning points of Iranian business cycles. The model, in short, explains the movements of real output.

There are issues that RBC models have been used widely elsewhere and with potentially useful adjustment can be applied for the Iranian economy as an opportunity to analyze and explain unexpected shocks. The observed cyclical behaviour of the Iranian economy seems to be influenced by the current shocks which seen an unanticipated oil price shocks in the international oil market. The RBC model provides a platform to increase our understanding of the output behaviour of the Iranian economy, and attempts to find the nature of these shocks based on historical time series data due to movements in GDP and oil price and examine the relationship between oil price and business cycles. Jones and Leiby (1996) argued that research effort has gone into introduce oil price shocks in RBC models and statistically testing their importance as a contributor to business cycles. Lama (2005) identified and extracted the cyclical behaviour component of economic time series in developing countries using RBC approach.

The remainder of the paper is organised as follows. Section 2 presents a literature review of real business cycle theory using the methods of the stochastic dynamic general equilibrium model. Section 3 explains justification of methodology and model used to analyze business cycles. Section 4 presents the questions and hypotheses to be tested. Section 5 reports the results of empirical estimation of the model. The results are discussed in section 6 and followed by conclusions in section 7.

2. Literature Review

In the last four decades, macroeconomic research has attempted to construct a model of the aggregate variables, which is theoretically consistent with past observations and which can be used for policy planning and analysis. An influential group of classical macroeconomists, led by Kydland and Prescott (1982), have developed a theory that takes a strong stand on the sources of shocks that cause cyclical fluctuations. This theory, known as the RBC theory, argues that real shocks to the economy are the primary cause of the business cycle. Real shocks are disturbances to the real side of the economy; for example, those shocks that affect the production function, the size of the labour force, real government expenditure, and the spending and saving decisions of consumers (Abel and Bernanke, 1992).

The central prediction of the theory is that real phenomena, and not nominal ones, cause the business cycle. Real shocks are contrasted with nominal shocks, which are shocks to money supply or money demand, and fiscal shocks to aggregate supply and demand. Kydland and Prescott (1982) seek to model a competitive general equilibrium theory which is essentially the Ramsey-Solow Neoclassical model of economic growth. It is attractive to say that the Solow residual represents the growth of knowledge as technology shocks in the short-run.

Employing Kydland and Prescott (1982) methodology requires two steps. The first concerns measurement, data series must be consistent with model series. The second step concerns reporting, the same statistics should be computed for the model and the revised data. In order to achieve the dynamics required to statistically mach the data, it is necessary for the postulated technology shocks to be highly persistent (King and Rebelo, 1987). Kydland and Prescott (1991) also stress that the

RBC model is impracticable in the sense that it aims only to capture only certain features of the data rather than to provide a complete explanation of them.

King and Plosser (1988) also suggested alternative specifications and extensions to the basic neoclassical framework. First, they show how to incorporate stochastic growth into the model so that the shock that drive the growth process also drives the cyclical properties of the model. Second, following Romer (1986), Lucas (1988), and King and Rebelo (1987), they consider models that generate endogenous growth. The idea of using endogenous growth elements to study business cycles argues that many authors have successfully incorporated endogenous sources of growth in dynamic statistical general equilibrium models and shown that this line of research can lead to substantial improvement over simple RBC models (Matheron, 2003). Third, they show how one can incorporate government actions into the framework. This opens up an important area of research for these models because it enables them to begin the analysis of government policies that are thought to be important in evaluating business cycles (King and Plosser, 1988). RBC theory regards stochastic fluctuations in productivity as the source of fluctuations in economic activity (Stadler, 1994).

The neoclassical model of capital accumulation, augmented by shocks to productivity, is the basic framework for RBC analysis (Stadler, 1994). Plosser (1989) argued that the basic neoclassical model of capital accumulation can provide an important framework for developing our understanding of economic fluctuations. Danthine and Donaldson (1993) suggested that RBC approach implies a methodology for the study of business cycles, which involves two components: an empirical review and quantitative theory. It also comprises the dynamic general equilibrium models, which can be evaluated either quantitatively or qualitatively in terms of their ability to reproduce the basic features of business cycles. Such comparisons are useful in highlighting similarities and deviations, which are both necessary ingredients to further the development of good theory. A 'good' theory of the business cycle is quantitative as well as qualitative (McGrattan, 2006).

In addition, a vast majority of the studies focused on the cross-country differences and similarities of business cycle characteristics of major developed economies. While a limited number of studies consider developing countries, there exists no comparative study that examines the sources of macroeconomic fluctuations and business cycle characteristics in the oil-exporting countries using the methods of the stochastic dynamic general equilibrium business cycle theory (Sayan and Kose, 2003). Overall, the RBC approach has generated many new insights and techniques that assist in modelling the macroeconomy. Romer (2001) argued that the importance of understanding the causes of aggregate economic fluctuations is the central goal of macroeconomics.

3. Methodology and the Model

The revival of interest in economic dynamics has given a new emphasis to time series by using lagged dependent variable. Enders (1995) suggests that stochastic difference equations can take place quite naturally from dynamic economic models. An important issue in econometrics is the need to integrate short-run dynamics with long-run equlibria. The traditional approach to the modelling of short-run disequilibria is the partial adjustment model (PAM). The analysis of short-run dynamics is often done by eliminating trends in the variables, usually by differencing (Maddala, 2001). Some studies include a lagged dependent variable as a regressor, giving as a justification the argument that an economy may be able to immediately and fully adjust towards the equilibrium value which is consistent with the values of all the independent variables in the regression.

The economic theory suggests that the production function needs to produce a given output under the amount of technology. Gujarati (2003) argues that to transform a static production function to a dynamic model, an adjustment or partial adjustment model may be used. Following Griliches (1979), a simple production function can be specified as $Y_t = F(K_t, N_t, u_t)$ relating some measure of output (Y_t), at the macro (country) level, to the inputs K_t, N_t, and u_t; where N_t stands for labour, K_t is capital stock, and u_t represents all other unmeasured determinants of output (see also Crespi and Geuna, 2005).

The argument is based on a Cobb-Douglas production function relating output (Y_t) in period (t) to labour (N_t), and capital stock (K_t) is defined as follows:

$$Y_t = Ae^{u_t} K_t^{\alpha} N_t^{\beta} \qquad (1)$$

where A is the temporary change in total factor productivity, e is the exponential; $\alpha \text{ and } \beta$ are returns to scale, u_t is the error term, and t is the time index. Taking logarithms from both sides:

$$\log Y_t = \log A + \alpha \log K_t + \beta \log N_t + u_t \qquad (2)$$

where:

$$\log Y_t = y_t^*,\ \log A = \mu_0,\ \alpha \log K_t = \mu_1 k_t,\ \beta \log N_t = \mu_2 n_t \qquad (3)$$

To simplify, suppose the following Cobb-Douglas production function in logs that the desired level (planned level/optimal value) of output (y_t^*) is a linear function of inputs capital (k_t) and labour (n_t) as follows:

$$y_t^* = \mu_0 + \mu_1 k_t + \mu_2 n_t + u_t \qquad (4)$$

where n_t is the log of labour, k_t is the log of capital, u_t is the random error term, and y_t^* is the log of optimal/desired (long-run) value of output (y), but that the economy chooses only partially to adjust the value of y towards this equilibrium within the current period. This model is named the long-run or equilibrium, production function for output.

The equation 3 contains the dependent variable with one period lagged as an explanatory variable. This is called an autoregressive model or a dynamic model (Gujarati, 2003). The dynamic model is easily generalised to allow for more complicated, and often more realistic, adjustment processes.

Suppose that the error term (v_t) is subject to first-order autocorrelation and follows:

$$\upsilon_t = \rho \upsilon_{t-1} + \varepsilon_t \qquad (5)$$

Now we can rewrite the equation (4) as:

$$y_t = b_0 + b_1 k_t + b_2 n_t + b_3 y_{t-1} + \rho \nu_{t-1} + \varepsilon_t \qquad (6)$$

But it also holds that y_{t-1} depends on υ_{t-1}, since if (6.33) true for t, it is also true for (t-1).

$$y_{t-1} = b_0 + b_1 k_{t-1} + b_2 n_{t-1} + b_3 y_{t-2} + \nu_{t-1} \qquad (7)$$

from which it shows that the error term (ν_t) is correlated with y_{t-1}, and $\rho \neq 0$. Thus OLS becomes inconsistent and biased. Verbeek (2004) suggests that a possible solution is the use of maximum likelihood or instrumental variables techniques.

4. The Questions and Hypotheses

Evidence suggests that two sectors exist in Iran; one is the oil sector, the other is the non-oil sector. Oil revenues fluctuate over time in order with changes in the price of oil and/or exchange rate. The non-oil sector depends upon the government policy and five-year plans. This opportunity allows us to take into account any changes in the price of oil, exchange rate, in planning system. The research questions are:

1. Are there business cycles in Iran?
2. How can Iranian business cycles be explained by oil price shocks?
3. Can RBC theory be applied to oil dependent economies?

In view of the foregoing observations the following are the main hypotheses to be investigated in the study:

1. The coefficient of capital and labour are positive.
2. The shock variable has an adverse effect on output.
3. There is a significant relationship between shocks and output.

5. Empirical Estimation

We estimated static and dynamic regression of oil GDP. The results of static and dynamic models are reported in Table 1.

Table 1 Static and Dynamic Model of Oil GDP

Variables/Models	Static	Dynamic (-1)
Dependent (DLOG(YO))	β (t-ratio)	β (t-ratio)
Intercept	0.073 (1.89)	0.07 (1.77)
Capital (DLOG(KO))	0.87 (1.87)	0.85 (1.69)
Labour (DLOG(NO))	0.17 (0.32)	0.17 (0.31)
Quadratic of Oil price shocks (PS2)	-0.0005 (-1.51)	-0.0005 (-1.39)
Intercept Dummy (D2)	-0.57 (-5.45)	-0.56 (-5.05)
Quadratic of ER shocks (QXX)	-0.000001(-0.85)	-0.0000001 (-0.79)
Dependent (DLOG(YO(-1))		0.03 (0.24)
R-Squared (R^2)	0.46	0.46
Adjusted R-Squared ($\overline{R}^2$)	0.39	0.37

Number of observations	46	46
D.W	2.08	2.10
F-Statistic		0.06
Chi-Square		43.29

Overall the results of t-statistics of dynamic regression with one period lagged dependent variable show that the coefficient of y_{t-1} is insignificant and there is no difference between R^2 of static and dynamic model. So, it can be suggested that the dynamic model does not improve the results and the static model can be used for this case. The relation between lagged dependent variable and cyclical fluctuations can cause the output to fluctuate. Dependent variable (y_t) varies directly with y_{t-1}. The direct dependence of y_t on y_{t-1} gives the output behaviour to cumulative movement up or down (Matthews, 1959).

However, in a dynamic model with a lagged dependent variable, the Durbin-Watson test is an inappropriate test, because the condition that the explanatory variables can be treated as deterministic is violated (Verbeek, 2004). Assuming that the explanatory variables are non-stochastic, their values are fixed in repeated sampling. So, one could argue that the Durbin-Watson test may not be useful in econometrics involving time series data with lagged dependent variable (Gujarati, 2003).

An alternative test is provided by the Breusch (1978)-Godfrey (1978) Lagrange Multiplier (LM) test for test of autocorrelation.[2] The LM test statistic is asymptotically distributed as a $\chi^2(p)$ with p degrees of freedom. This test statistic can be computed as T multiplied by R^2 of a regression of the least squares residuals v_t on v_{t-1} and all included explanatory variables (including the relevant lagged dependent variable) (Verbeek, 2004).

Breusch-Godfrey precedes the test by assuming the following equation:

$$y_t = b_0 + b_1 k_t + b_2 l_t + b_3 y_{t-1} + v_t \qquad (8)$$

Assume that the error term v_t pursues the pth-order autoregressive, AR (P) as follows:

$$v_t = \rho_1 v_{t-1} + \rho_2 v_{t-2} + ... + \rho_p v_{t-p} + \varepsilon_t \qquad (9)$$

where ε_t is a error term. The null hypothesis $H_0 : \rho_1 = \rho_2 = ... = \rho_p = 0$ shows there is no serial correlation of any order (Gujarati, 2003).

The LM test is conducted for oil GDP; the results are shown in Table 2.

Table 2 Breusch-Godfrey Serial Correlation LM Test for Oil GDP

Variables/Models	Dynamic (-1)
Dependent (Residual)	β (t-ratio)

[2] In general, this test allows for (1) non-stochastic regressor such as the lagged values of the dependent variable; (2) higher-order autoregressive schemes such as AR(1), AR(2); and (3) simple or higher-order moving average of white noise error terms (Gujarati, 2003).

Intercept	0.03 (0.79)
Capital (DLOG(KO))	-0.56 (-1.09)
Labour (DLOG(NO))	0.08 (0.17)
Quadratic of Oil price shocks (PS2)	0.00005 (0.17)
Intercept Dummy (D2)	0.0009 (0.009)
Quadratic of ER shocks (QXX)	-0.00000001 (-0.82)
Dependent (DLOG(YO(-1))	-0.21 (-1.52)
Residual (-1)	-0.24 (-1.29)
R-Squared (R^2)	0.13
Adjusted R-Squared ($\overline{R}^2$)	-0.05
Number of observations	46
D.W	1.79
F-Statistic [Probability]	5.04 [0.03]
Chi-Square (Obs*R-squared) [Prob.]	5.42 [0.02]

To determine whether the null hypothesis can be rejected in this case, it is necessary to determine the critical $\chi^2(1)$ value from χ^2 Table (the critical χ^2 value is 6.34).

Since the calculated Breusch-Godfrey LM test statistic of 5.42 less than the critical $\chi^2(1)$ value, we cannot reject the hypothesis of no serial correlation up to lag order 1 at the 99% confidence level for oil sector.

The same procedure described above can be applied for the non-oil sector and the results are reported in Table 3.

Table 3 Static and Dynamic Model of Non-Oil GDP

Variables/Models	Static	Dynamic (-1)	Dynamic (-2)
Dependent (DLOG(YNO))	β (t-ratio)	β (t-ratio)	β (t-ratio)
Intercept	-0.05 (-1.94)	-0.05 (-2.26)	-0.05 (-2.04)
Capital (DLOG(KNO))	0.76 (6.78)	0.94 (5.59)	0.99 (4.90)
Labour (DLOG(NNO))	0.03 (0.86)	0.02 (0.63)	0.02 (0.65)
Government Expenditure Share (SG)	0.003 (2.21)	0.004 (2.51)	0.003 (2.25)
Intercept Dummy (D2)	-0.08 (-2.99)	-0.08 (-3.19)	-0.08 (-2.99)
GDP in Oil Sector (DLOG(YO(-1))	0.08 (2.74)	0.08 (2.97)	0.08 (2.82)
Dependent (DLOG(YNO(-1))		-0.20 (-1.39)	-0.19 (-1.25)
Dependent (DLOG(YNO(-2))			-0.07 (-0.50)
R-Squared (R^2)	0.66	0.68	0.68
Adjusted R-Squared ($\overline{R}^2$)	0.61	0.62	0.67
Number of observations	46	46	46
D.W	2.02	1.64	1.73

F-Statistic	1.95	0.50
Chi-Square	40.98	41.21

- Compiled by Author, data source: Central bank of Iran

Overall, the coefficients of lagged dependent variable are statistically insignificant and they cannot improve the model. Dependent variable (y_t) varies inversely with y_{t-1}, and y_{t-2}. This shows that all lag orders are capable of leading to a cycle.

Following Matthews (1966), and based on the result of dynamic equations and the cyclical behaviour of the Iranian economy, it can be suggested that non-oil GDP (output) fluctuates in cycles of diminishing amplitude, which converge upon equilibrium. These are called damped cycles that depend on the size and value of the coefficients of lagged dependent variables in the equations. Damped cycles could result from a fair range of values of the parameters, so the extreme coincidence required to produce a long period of cycles of constant amplitude is avoided.

Since cyclical fluctuations of economic activity have persisted with unexpected shocks, the non-oil GDP model can make damped cycles. These fluctuations caused by war, technology changes or oil price shocks occur quite frequently and at random intervals. Their continued occurrence maintains the cyclical behaviour when it would otherwise disappear. The behaviour of output related these disturbances are cyclical, even though the shocks themselves occur at random intervals (Matthews, 1959).

To follow an identical procedure to that organized for the oil sector a LM test for non-oil sector is applied and the results are shown in Table 4.

Table 4 Breusch-Godfrey Serial Correlation LM Test for Non-Oil GDP

Variables/Models	Dynamic (-1)	Dynamic (-2)
Dependent (Residual)	β (t-ratio)	β (t-ratio)
Intercept	-0.02 (-0.80)	0.01 (0.49)
Capital (DLOG(KNO))	0.03 (0.19)	-0.26 (-1.31)
Labour (DLOG(NNO))	0.004 (1.10)	0.001 (0.36)
Government Expenditure Share (SG)	0.001 (0.86)	-0.0005 (-0.27)
Intercept Dummy (D2)	-0.03 (-1.34)	0.01 (0.36)
GDP in Oil Sector (DLOG(YO(-1))	-0.03 (-1.09)	0.009 (0.31)
Dependent (DLOG(YNO(-1))	-0.007 (-0.05)	0.11 (0.69)
Dependent (DLOG(YNO(-2))		0.07 (0.52)
Residual (-1)	0.18 (1.11)	0.14 (0.76)
Residual (-2)		-0.07 (-0.37)
R-Squared (R^2)	0.12	0.09
Adjusted R-Squared ($\overline{R}^2$)	-0.06	-0.16
Number of observations	46	46

D.W	1.97	2.09
F-Statistic [Probability]	4.70 [0.04]	1.65 [0.21]
Chi-square (Obs*squared) [Prob.]	5.08 [0.02]	3.92 [0.14]

To determine whether the null hypothesis can be rejected in this case, it is necessary to determine the critical $\chi^2(1)$ value from χ^2 Table (the critical χ^2 value is 3.84). Since the calculated Breusch-Godfrey LM test statistic of 5.08 exceeds the critical $\chi^2(1)$ value, we can reject the hypothesis of no serial correlation up to lag order 1 at the 95% confidence level for non-oil sector. But the results of second order lag show there is no serial correlation ($\chi^2(2) = 5.99 \succ 3.92$) at the 95% confidence level for non-oil sector.

Following the studies of Eckaus (1957), dynamic difference-equation models of economic fluctuations have been found useful tools for a complete description of aggregate economic activity. The models here have led to a better appreciation of cycle-producing forces and the character of cyclical movements. These models have been developed in a variety of forms based on different assumptions about time sequences and using different types of production functions as components.

6. Discussion of the Results

This research has modelled business cycles in Iran during the period 1959-2009. The hypotheses tested here were that oil price shocks have an adverse effect on output, that asymmetrical positive shocks are more significant than negative, that the quadratic form captures negative shocks better than positive ones and that, overall, there is a significant relationship between shocks and output. The models used to test these hypotheses have been modified from real business cycle theory, using a production function approach which is consistent with the Cobb-Douglas production function.

The conception of a production function has been used to provide empirical explanation of intertemporal differences in the economic growth. To adopt the framework of the production function approach to the Iranian economy, a number of assumptions have been made. Oil price shocks are a linear function of lags of past data which are defined as the deviation of oil prices from those predicted in each five-year plan. OPEC can also set the price of oil by controlling oil production levels based on changes in the oil market conditions. Results of the econometric analyses provided a degree of support for a number of the hypotheses, in particular, that the shock variable has an adverse effect on output. Results show that there is a negative relationship between oil price shocks and output in Iran's economy.

The positive and significant coefficient for capital in the non-oil sector, but partly insignificant in oil sector lends support to our hypothesis that the coefficient of capital is positive. The negative and insignificant labour coefficient was not able to support our hypotheses that the labour is positively related to output. This may reflect the problem that the quality of data for labour is poor.

The estimated models explain how the oil shock variable impacts on the macroeconomic fluctuation and cyclical behaviour of the Iranian economy. The production function approach is applied within the theoretical framework of RBC theory for the macroeconomic level and uses OLS regression technique to model the GDP of the entire economy, which is conventionally divided into oil and non-oil sectors. The production function in each sector is specified and estimated. The model was used to test the significance of hypotheses using various definitions of the shock variable to capture unanticipated oil prices shocks.

The distinction between the exchange rate and the price of oil after converting it into the local currency explains the issue of the relative inflation rate and purchasing power parity between the nominal and real exchange rate used to evaluate the price of oil in nominal or real term. It was found that neither positive nor negative effects of exchange rate shocks have any significant effect on oil output. Therefore, it can be concluded that positive shocks that are unforeseen have a greater effect on output rather than negative shocks. However, the results show that both nominal and real exchange is not significant and there is not much difference to choose between them.

The model used dummy variables to allow for the Iranian revolution and the Iran-Iraq war. The estimation results showed that the effect of the dummy variable is significant for the war period. The coefficient on the intercept dummy was seen to be highly significant and the effect of oil price shocks was negative on the intercept of the model. The results also show that the shocks caused by high oil prices during 1979-1986 had a persistent effect on Iran's business cycles. The slope dummy had positive effects on the economy, whilst the effects of the intercept dummy were negative. The interaction effects between dummy variables found that there are different effects of interaction dummies in the oil and non-oil sector. In general, the results show that all the coefficients of dummies are statistically insignificant, and only second oil shock/Revolution and third oil shock on oil output, and war and OPEC have significant effects on both oil and non-oil output.

7. Conclusions

The results revealed that both government expenditure and oil GDP with a one period lag had a significant and positive effect on the non-oil sector. So, the government can play an important role in the economy by designing five-year plans and making plausible policies when the oil prices changes by adjusting the shocks in the oil sector, and smoothing government expenditure in the non-oil sector. In particular, the model does particularly well in accounting for the response of these variables during the second major oil price shock (1979-88). This shock not only accounts for macroeconomic fluctuations but also satisfactorily explains the cyclical behaviour of the economy.

Macroeconomic fluctuations may occur if the movement of output is controlled from proceeding beyond a certain point or if some lags of the dependent variable are present in the model. The lag hypothesis by itself is not capable of explaining the recurrence of cycles of constant amplitude such as oil output, except non-oil output which indicates a damp cycle using second order lag of dependent variable. However, when the model is subject to continually external disturbances such as unexpected shocks, fluctuations may result in steady state.

To transform a static model to a dynamic model, a partial adjustment model was applied by using lagged dependent variables, which can cause fluctuations in output.

The dynamic model was generalised to allow for more complicated and often more realistic adjustment processes. It was found that the lag modelling by itself was not able to explain the reappearance of constant amplitude oil output cycles, whilst non-oil output was specified a damp cycle using second order lag of dependent variable.

8. References

Abel, A.B., and Bernanke, B.S. (1992) “Macroeconomics” Addison-Wesley.

Bierens, H.J. (2003) “Econometric Analysis of Linearized Singular Dynamic Stochastic General Equilibrium Models” *Pennsylvania State University* U.S, and Tilburg University, http://econ.la.psu.edu/~hbierens/SDSGEM.PDF

Bierens, H.J. (2006) “Econometric Analysis of Linearized Singular Dynamic Stochastic General Equilibrium Models” *Journal of Econometrics* (forthcoming)

Crespi, G., and Geuna, A. (2005) “Modelling and Measuring Scientific Production: Results for a Panel of OECD Countries” Electronic Working Paper Series 133.

Danthine, J.P., and Donaldson, J.B. (1993) “Methodological and empirical issues in real business cycle theory” European Economic Review 37: 1-35 North-Holland.

Eckaus, R.S. (1957) “The stability of dynamic models” *The Review of Economics and Statistics* **39**(2): 172-182.

Enders, W. (1995) “Applied Econometric Time Series” John Wiley and Sons, Inc. Canada.

Frisch, R. (1933) “Propagation problems and impulse problems in dynamic economics” in: *Economic essays in honour of Gustav Cassel*, Allen & Unwin, London, 171-205.

Gujarati, D.N. (2003) “Basic Econometrics” 4th Edition McGraw-Hill, International ed.

Gao, W., Hartley, P., Sickles, R.C. (2006) “Optimal dynamic production policy: The case of a large oil field in Saudi Arabia” *http://www.ruf.rice.edu/~econ/faculty/Hartley/GaoHartleySickles2006.pdf.*

Griliches, Z. (1979) “Issues in Assessing the Contribution of Research and Development to Productivity Growth”, The Bell Journal of Economics, 10: 92-116.

Jones, D.W., Leiby, P.N. (1996) “The macroeconomic impacts of oil price shocks: A review of literature and issues” Energy Division, Oak Ridge National Laboratory.

Kim, C.J., and Nelson, C.R. (1998) “Business Cycle Turning Points, a New Coincident Index, and Tests of Duration Dependence Based on a Dynamic Factor Model with Regime Switching” *Review of Economics and Statistics* **80**(2): 188-201.

King, R.G., and Plosser, C.I. (1988) “Real business cycles: Introduction” Journal of Monetary Economics 21: 191-193.

King, R.G., and Rebelo, S.T. (1987) “Business cycles with endogenous growth” Unpublished manuscript (University of Rochester, Rochester, NY)

Kydland, F., and Prescott, E.C. (1982) “Time to build and aggregate fluctuations” Econometrica 50: 1345-1370.

Kydland, F.E., and Prescott, E.C. (1991) “The econometrics of general equilibrium approach to business cycles” Scandinavian Journal of Economics 93(2): 161-179.

Lucas, R.E. (1988) “On the mechanics of economic development” Journal of Monetary Economics 22: 3-42.

Maddala, G. S. (2001) “Introduction to Econometrics” John Wiley and Sons Ltd. England.

Matheron, J. (2003) “Is Growth Useful in RBC Models?” Economic Modelling 20 (3): 605-22.

Matthews, R.C.O. (1959) “A study in the trade cycle history” Cambridge

Moradi, M.A. (2000) “Dynamic modelling of inflation in a small open economy: The case of Iran” *Ph.D. Thesis* University of Liverpool.

Plosser, C.I. (1989) “Understanding Real Business Cycles in Symposia: Real Business Cycles” Journal of Economic Perspectives 3(3): 51-78.

Romer, P. (1986) “Increasing returns and long-run growth” Journal of Political Economy 94: 1002-1037.

Romer, D. (2001) “Advanced Macroeconomics” University of California, Berkeley, McGraw Hill Companies

Salehi-Isfahani, D. (1986) “Oil supply and economic development strategy: a dynamic planning approach” *Journal of Development Economics* **21**: 1-23.

Salehi-Isfahani, D. (1996) “Review of: The economy of Islamic Iran: Between state and market” *Journal of Economic Literature* **34**(2): June

Salehi-Isfahani, D. (2002) “Microeconomics of growth in Iran: The role of households”http://www.gdnet.org/pdf2/gdn_library/global_research_projects/explaining_growth/Iran_households_final.pdf

Samadi, S., and Abdolmajid, J. (2004) “An Analysis of Business Cycle in Iran” *Tahghighat-e-Eghtesadi* (In Farsi) 66: 139-153

Sayan, S., and Kose, M.A. (2003) “Business cycle characteristics and transmission of crises in a globalized economy: The case of MENA and Europe” Mediterranean program, 4th Mediterranean Social and Political Research Meeting.

Stadler, G.W. (1994) “Real business cycles” Journal of Economic Literature 32 (4): 1750-1783.

Verbeek, M. (2004) “A Guide to Modern Econometrics” John Wiley & Sons Ltd.

Wirl, F. (1991) “Dynamic Demand, Consumers’ Expectations and Monopolistic Resource Extraction: An Application to OPEC Pricing Policies” *Empirical Economics* 16 (4): 379-400.