

BUSINESS CYCLES AND MACROECONOMIC DYNAMICS: A MS-ARDL APPROACH

Zahra Parsaeian¹, Seyed Yahya Abtahi^{1,2}, and Zahra Nasrollahi³

¹Department of Humanities college of Economy , Yazd Science and Research Branch, Islamic Azad University, Yazd, Iran

²Department of Humanities college of Economy, Yazd Science and Research Branch, Islamic Azad University, Yazd, Iran

³Department of Economics, University of Yazd, Iran

ABSTRACT

Survey the impact of macroeconomic variable on economic growth has always been the main topic of economy in countries that has formed economic theories. In this regard, the present study has investigated the effects of macroeconomic variable dynamics and identified the business cycle behavior during 1992 to 2010 in Iran. Data has been collected from the World Bank and the research method is ARDL Markov switching model. Results show that Inflation and money supply in recession regime have a positive impact and in expansion regime have a negative impact on GDP. Exchange rate in both regimes has a negative impact on GDP. Transition probability matrix indicates the economy is more likely to remain in recession. Graphs illustrate recession periods are more than expansion periods.

KEYWORDS: Business Cycles, Expansion, Macroeconomic Dynamics, Markov Switching Model, Recession.

INTRODUCTION

The relationship between macroeconomic variables and economic growth in many countries has always been a topic of discussion among economists. The way of changes macroeconomic variable (the most important variable is economic growth) is called macroeconomic dynamics. This matter is investigated as the business cycle. Several theoretical and experimental topics have been presented in this field. Economic planning is meaningless without recognition of fluctuations in GDP and its root. Business cycles are a kind of expansion and recession in the economy. The important note is the creation of a serial correlation between GDP data. Business cycle is not specified due to random deviations around a common value, because GDP is the most comprehensive measure of the level of economic activity and GDP fluctuations has a special role in the study of business-cycle. Business cycle consists of two phases: a phase of the expansion that economic activities have tended to reinforce it and a phase of recession that economic activities have tended to undermine this stage. Passing from one phase to another phase is characterized by a peak. The important thing in this case is to apply the model to identify sudden changes in business cycle behavior. Markov switching model is a model that expresses regime changes in the time series business cycle. Business Cycle is regular and systematic fluctuations in macroeconomic activities in the country. Fluctuations in the economy of a country can be seasonal and cyclical. The distinctive feature between seasonal and cyclical fluctuations is that seasonal fluctuations (for example increase in demand for many commodities near to the New Year) occur at certain intervals of time, whereas the occurrence business cycle cannot be predicted at certain intervals of time. Stages of the business cycle are stated in expansion, prosperity (peak) and recession step (Filardo, 1994). Juglar is the first scientist who realized the cycle period in 1860. Then other economists in their studies have pointed four stages of crisis, recovery, expansion and recession. Total of this process constitutes an economic period that is known as the classical cycle. Attention to the business cycle decreased in the 1950s and 1960s. After the great recession of the 1970s and 1980s, most economists focused on business cycles topic (Psaradakis, 2003). The purpose of this study is the survey of the effects of macroeconomic variables on economic growth and identifying the business cycle regime behavior.

Krolzig and Sensier (2000) have examined British business cycle using by Markov switching model. The results indicated that in the six-part of production, there is evidence of a business cycle by oil shocks. Wei Chen and Lung Lin (2000) used Markov switching model to examine the business cycle in Taiwan. The model proves that coincident and leading indicators of the business cycle detection and prediction of the GDP are effective in Taiwan's economy. Also

¹Corresponding Author

the recession period is longer than the expansion period. Kaufmann (2003) has analyzed European business cycles by gasoline clustering in the period 1978-2001. Results showed a common business cycle in the euro area in the long period. Moolman (2004) in a study has investigated South African business cycle using Markov switching model. Results showed two distinct phases in the high growth rate and the low growth rate. Also found a strong relationship between interest rates and the business cycle. Kholodilin (2006) used two-factor Markov switching model to forecast German business cycle. The results indicate that two-factor model is more useful than single-factor model in recognition of the economic downturn and anticipation turning point. Jean Louis and Simons (2007) have examined Business cycle in Canada, Mexico and the United States in the period 1963-2002. Results showed Canada and the United States reach turning point faster than Mexico. Caraianni (2010) has investigated business cycles of Romania using Markov-switching approach. Findings showed the business cycle of Romania has experienced a recession in 2008. The expected duration of the recession is 18 months. Castro (2011) has analyzed Time dependence of the Portugal business cycle with Markov switching model. The results showed that there were four main stagnations in the past three decades. Medhioub and Eleuch (2013) have investigated Business cycles in Tunisia. The result of this method for identifying turning points is useful and easier than Informal methods. Other studies Morley and Piger (2009) for the United States and Krolzig and Toro (2001) for European countries, have investigated the business cycle.

MATERIALS AND METHODS

Methodology

The econometric method of this research is Markov switching model. Suppose we are interested in modeling such a simple time-series Y_t that this is stationary and stochastic. In most studies, k order is used to study autoregressive model:

$$y_t = \alpha + \sum_{j=1}^k \phi_j y_{t-j} + \varepsilon_t \quad (1)$$

It is assumed that the error term ε_t has been distributed normally with mean zero and σ^2 variance. Order k autoregressive model is a model that is used as a tool for the time series dynamic behaviors and has a good performance to predict the future trend of the time series.

In many cases, time series has different behaviors (different regimes) during time periods. For example, we may be faced with a switch model as follows:

$$y_t = \alpha_{s_t} + \sum_{j=1}^k \phi_{j,s_t} y_{t-j} + \varepsilon_t \quad (2)$$

The error term ε_t has been distributed normally with mean zero and σ^2 variance. In equation 2, S_t indicates the type of regime at time t. The parameters can be easily changed over time. These assumptions are called model simplification assumptions (Krolzig, 1997).

Dependent variable is GDP and the independent variables are inflation, money supply, exchange rate and lag of GDP. The model has been estimated in two states without exchange rate (model 3) and with the exchange rate (model 4).

$$gdpr = c + \sum_{j=1}^q \alpha_j gdpr_{t-j} + \sum_{i=m}^p \beta_i inf_{i-m} + \sum_{g=n}^y \delta_g m + \varepsilon_t \quad (3)$$

$$gdpr = c + \sum_{j=1}^q \alpha_j gdpr_{t-j} + \sum_{i=m}^p \beta_i inf_{i-m} + \sum_{g=n}^y \delta_g m + \sum_{v=1}^k \gamma_v ex + \varepsilon_t \quad (4)$$

Unit root test of Phillips - Perron (PP) is used to test variables stationary.

The data of this study are time series from 1992 to 2010 that has been collected from World Bank (WDI) database. Data includes inflation (INF), Gross Domestic Product (GDP), money supply (M), exchange rate (Ex). Variables with their symbol are given in table 1.

Table (1): Research Variables

| Variables | Symbol | Type |
|------------------------|--------|-------------|
| Gross Domestic Product | GDP | Dependent |
| Inflation | INF | Independent |
| Money Supply | Ex | Independent |
| Exchange Rate | M | Independent |

RESULTS AND DISCUSSION

Table 2 presents the results of unit root tests (PP) to check the stationary of the variables. At first, variables are not stationary at level, repeating this test for the first difference indicated that all variables are stationary in the first difference. In other words, all the variables are I (1).

Table (2): unit root test

| variables | Status of stationary | PP | Critical value | results |
|------------|----------------------------|--------|----------------|---------|
| GDP | Level | -0.27 | -2.93 | - |
| | 1 st difference | -14.53 | -2.93 | I(1) |
| Inf | Level | 0.85 | -2.94 | - |
| | 1 st difference | -5.21 | -2.93 | I(1) |
| Ex | Level | -2.38 | -2.94 | - |
| | 1 st difference | -6.67 | -2.93 | I(1) |
| M | Level | -1.44 | -2.93 | - |
| | 1 st difference | -6.45 | -2.93 | I(1) |

Source: research findings

Results of Markov switching model without exchange rate

In this section the results of the Markov switching model ARDL without exchange rate is given. The results have been estimated in two regimes: recession regime (0) and expansion regime (1). Table 3 contains the results of the recession regime. The coefficient of GDP is negative and significant in all three lags. The coefficient of inflation is positive and significant in the first lag. The coefficient of the money supply without lag and in the first and second lag is positive but not significant. Therefore, in recession regime, GDP with lag and inflation have significant impact on the dependent variable.

Table (3): Results of ARDL model without exchange rate in recession regime

| variables | coefficient | t- statistic | standard error | Prob. |
|-----------------------|-------------|--------------|----------------|-------|
| C | 0.003 | 0.41 | 0.007 | 0.67 |
| GDP (1) | -0.61 | -7.03 | 0.08 | 0.00 |
| GDP (2) | -0.65 | -8.66 | 0.07 | 0.00 |
| GDP (3) | -0.63 | -7.07 | 0.08 | 0.00 |
| Inf (1) | 0.06 | 1.73 | 0.03 | 0.08 |
| M | 0.12 | 0.93 | 0.13 | 0.35 |
| M (1) | 0.09 | 0.64 | 0.14 | 0.52 |
| M (2) | 0.06 | 0.47 | 0.13 | 0.63 |
| σ₀ | 0.012 | 10.6 | 0.001 | 0.000 |
| P₀₀ | | | 0.93 | |
| P₀₁ | | | 0.49 | |

Source: research findings

The expansion regime result is given in table 4. In this regime, intercept is equal to 0.06 and significant positive that indicates the expansion regime. The coefficient of GDP is negative and significant in all three lags. The coefficient of inflation is negative and significant in the first lag that shows in the expansion regime, inflation has a negative impact on economic growth (unlike recession regime). The coefficient of the money supply without lag and in the first lag is negative and significant. Thus, all variables have a significant impact on the dependent variable (GDP). Variance of recession regime (σ_0) is 0.012 and the variance of expansion regime (σ_1) is 0.00. This indicates that the variance of the recession is more than the expansion and fluctuation is less in the expansion regime.

Table (4): Results of ARDL model without exchange rate in expansion regime

| variables | coefficient | t- statistic | standard error | Prob. |
|-----------------|-------------|--------------|----------------|-------|
| C | 0.06 | 3.6 | 1.41 | 0.00 |
| GDP (1) | -1.17 | -2.9 | 1.92 | 0.00 |
| GDP (2) | -1.13 | -3.1 | 1.71 | 0.00 |
| GDP (3) | -0.63 | -4.2 | 1.65 | 0.00 |
| Inf (1) | -0.14 | -2.7 | 1.46 | 0.00 |
| M | -0.49 | -1.9 | 1.56 | 0.00 |
| M (1) | -0.75 | -7.3 | 1.6 | 0.00 |
| M (2) | 0.49 | 4.1 | 1.66 | 0.00 |
| σ_1 | 0.00 | - | - | 0.99 |
| P ₁₀ | | | 0.06 | |
| P ₁₁ | | | 0.5 | |

Source: research findings

Transition probability matrix for expansion and recession regimes has been estimated as follows:

$$P = \begin{bmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{bmatrix} = \begin{bmatrix} 0.93 & 0.49 \\ 0.06 & 0.50 \end{bmatrix}$$

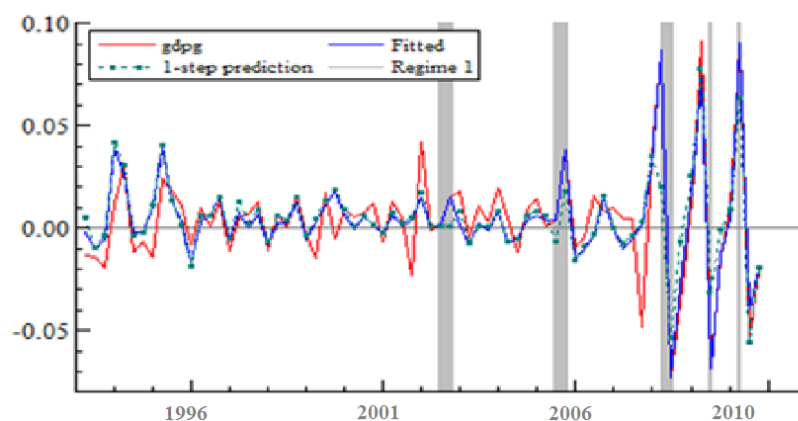
The transition probability matrix illustrates the probability that the recession will have a tendency to remain in this state (P₀₀) is 93% and the probability that recession transfer to the expansion status (P₀₁) is 49%. Also the probability that expansion will have a tendency to remain in this state (P₁₁) is 50% and the probability that expansion transfer to the recession (P₁₀) is 6%. Therefore according to the transition probability matrix, the recession is more stable than the expansion in the business cycle of Iran.

Also, using by transition probability matrix in Markov-switching model can be estimated the average period of recession or expansion. The results indicate that the average period of recession is 14.28 years and the average period of expansion is 2 years.

$$\text{The average period of recession} = \frac{1}{1-p_{00}} = \frac{1}{1-0.93} = 14.28$$

$$\text{The average period of expansion} = \frac{1}{1-p_{11}} = \frac{1}{1-0.5} = 2$$

Graph 1 shows the results of the smoothed curves related to economic growth in recession and expansion during the period 1992-2010 simultaneously. In this diagram is given economic growth and fitted status and also marked lanes represent expansion regime. In the years 2002, 2005, 2008, 2009 and 2010 is observed an expansion situation in the business cycle. Generally during the research period, recession periods are more than expansion periods.



Graph (1): Economic growth and fitted status (without exchange rate)

Results of Markov switching model with exchange rate

This section gives the results of the Markov switching model ARDL with exchange rate. The results have been estimated in two regimes: recession regime (0) and expansion regime (1). Table 5 contains the results of the recession regime. The coefficient of GDP is negative and significant in all three lags. The coefficient of inflation is positive in all three lags, but significant in the third lag. The coefficients of money supply are positive, but significant in the third lag. Exchange rate has been estimated without lag, first, second and third lag. The coefficients of the exchange rate are negative in all lags except the first lag. Only without lag is significant.

Table (5): Results of ARDL model with exchange rate in recession regime

| variables | coefficient | t- statistic | standard error | Prob. |
|-----------------|-------------|--------------|----------------|-------|
| C | -0.007 | -0.6 | 0.01 | 0.49 |
| GDP (1) | -0.67 | -5.8 | 0.11 | 0.00 |
| GDP (2) | -0.62 | -5.3 | 0.11 | 0.00 |
| GDP (3) | -0.64 | -4.43 | 0.14 | 0.00 |
| Inf (1) | 0.03 | 0.65 | 0.04 | 0.51 |
| Inf (2) | 0.02 | 0.55 | 0.04 | 0.58 |
| Inf (3) | 0.07 | 1.72 | 0.04 | 0.09 |
| M | 0.23 | 1.24 | 0.19 | 0.22 |
| M (1) | 0.13 | 0.78 | 0.17 | 0.43 |
| M (2) | 0.03 | 0.26 | 0.14 | 0.79 |
| M (3) | 0.3 | 2.11 | 0.14 | 0.04 |
| Ex | -0.15 | -2.7 | 0.05 | 0.01 |
| Ex (1) | 0.2 | 1.61 | 0.12 | 0.11 |
| Ex (2) | -0.14 | -1.4 | 0.1 | 0.17 |
| Ex (3) | -0.044 | -0.6 | 0.07 | 0.54 |
| σ_0 | 0.01 | 9.92 | 0.001 | 0.00 |
| P ₀₀ | 0.88 | | | |
| P ₀₁ | 0.49 | | | |

Source: research findings

In interpreting the results in table 5 it can be stated that inflation and money supply have a positive impact on GDP. In recession situation, inflation is as an economic stimulus to boost economic growth. However, this impact would be lagged. Also money supply will act similarly. Based on the quantity theory of money, expansionary monetary policy increases the price level, Therefore Money supply affects GDP. Exchange rate without lag affects economic growth and indicates the high influence of the exchange rate on the economy. Exchange rate increase in a short period of time will reduce economic growth. Expansion regimen result is given in table 6. In this regime, intercept is equal to 0.02 and significant positive that indicates the expansion regime. The coefficient of GDP is negative and significant in all three lags. The coefficients of inflation are significant in all lags and negative only in second lag. The coefficients of money supply are positive without lag and in the second lag and all coefficients are significant. The coefficients of the exchange rate are negative and significant in all lags.

In interpreting the results in table 6 it can be stated that in expansion situation inflation and money supply have a negative impact on GDP. Exchange rate in the expansion regime in short term boosts exports and increases GDP. However, in the long run with pressure on prices and market volatility will create a negative effect on economic growth. Thus, all variables have a significant impact on the dependent variable (GDP). Variance of recession regime (σ_0) is 0.01 and the variance of expansion regime (σ_1) is 0.00. This indicates that the variance of the recession is more than the expansion and fluctuation is less in the expansion regime. In fact, when the economy is facing a recession, fluctuations and changes are high and the economy is vulnerable.

Transition probability matrix for expansion and recession regimes has been estimated as follows:

$$P = \begin{bmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{bmatrix} = \begin{bmatrix} 0.88 & 0.49 \\ 0.11 & 0.50 \end{bmatrix}$$

Table (6): Results of ARDL model with exchange rate in expansion regime

| variables | coefficient | t- statistic | standard error | Prob. |
|-----------------------|-------------|--------------|----------------|-------|
| C | 0.02 | 4.81 | 1.007 | 0.00 |
| GDP (1) | -0.58 | 2.22 | 1.59 | 0.00 |
| GDP (2) | -0.64 | 3.11 | 2.88 | 0.00 |
| GDP (3) | -0.19 | 3.53 | 2.1 | 0.00 |
| Inf (1) | 0.24 | 2.88 | 1.75 | 0.00 |
| Inf (2) | -0.41 | 1.97 | 1.67 | 0.00 |
| Inf (3) | 0.37 | 1.89 | 1.4 | 0.00 |
| M | 0.07 | 2.72 | 0.51 | 0.00 |
| M (1) | -0.83 | 3.74 | 3.07 | 0.00 |
| M (2) | 0.44 | 5.22 | 2.00 | 0.00 |
| M (3) | -0.047 | 4.43 | 2.23 | 0.00 |
| Ex | 0.01 | 3.51 | 2.19 | 0.00 |
| Ex (1) | -0.1 | 1.82 | 1.67 | 0.00 |
| Ex (2) | -0.009 | 2.28 | 2.007 | 0.00 |
| Ex (3) | -0.16 | 3.29 | 2.17 | 0.00 |
| σ_1 | 0.00 | - | - | 0.96 |
| P₁₀ | | | 0.11 | |
| P₁₁ | | | 0.50 | |

Source: research findings

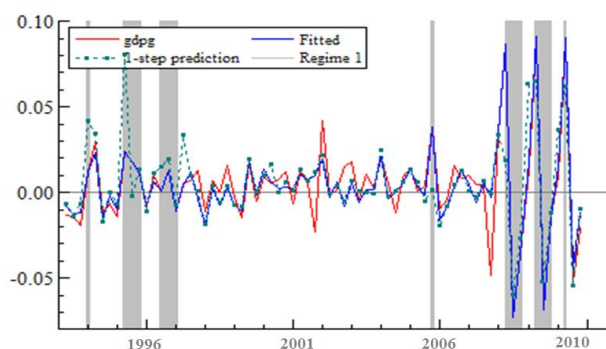
The transition probability matrix illustrates the probability that the recession will have a tendency to remain in this state (P_{00}) is 88% and the probability that recession transfer to the expansion status (P_{01}) is 49%. Also the probability that expansion will have a tendency to remain in this state (P_{11}) is 50% and the probability that expansion transfer to the recession (P_{10}) is 11%. Therefore according to the transition probability matrix, the recession is more stable than the expansion in the business cycle of Iran.

Also, using by transition probability matrix in Markov-switching model can be estimated the average period of recession or expansion. The results indicate that the average period of recession is 8.33 years and the average period of expansion is 2 years. Indeed, the economy is more likely to remain in recession or in other words, exit from the recession much harder and takes a lot of time.

$$\text{The average period of recession} = \frac{1}{1-p_{00}} = \frac{1}{1-0.88} = 8.33$$

$$\text{The average period of expansion} = \frac{1}{1-p_{11}} = \frac{1}{1-0.5} = 2$$

Graph 2 indicates the results of the smoothed curves related to economic growth in recession and expansion during the period 1992-2010. In this diagram is given economic growth and fitted status and also marked lanes represent expansion regime. In the years 1994, 1995, 1996, 2005, 2008, 2009 and 2010 is observed a expansion situation in the business cycle. Generally during the research period, recession periods are more than expansion periods.



Graph (2): Economic growth and fitted status (with exchange rate)

CONCLUSION

In this study have been investigated the impacts of macroeconomic variables on economic growth and business cycles in Iran. The results of the Markov switching model ARDL without and with exchange rate are the same. Inflation and money supply have a positive impact on GDP in recession regime. Also inflation and money supply has a negative impact on GDP in expansion regime. Exchange rate has a negative impact on GDP in recession regime. Although, Exchange rate increases GDP in the expansion regime in the short term and will have a negative effect on economic growth in the long run. Generally the exchange rate in both regimes has a negative impact on economic growth. Transition probability matrix indicated the economy is more likely to remain in recession. Smoothed curves related to economic growth showed during the research period, recession periods are more than expansion periods.

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