Analysis of Macroeconomic Variables under the World Financial Crisis
Fuzzy logic approach

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ABSTRACT

Undoubtedly the impact of global financial crisis on the economy is obvious and undeniable. The world financial crisis has a great impact on macroeconomic variables of countries. The crisis can affect the Petroleum Exporting Countries and oil-dependent economies especially on crude oil prices and its revenues. Iran's economy among the aspects of the Petroleum Exporting Countries has an important place in production and oil revenues. The main purpose of this study, is analyzing the effect of financial crisis on world oil prices and macro variables such as inflation, the price of heavy oil, oil revenues and GDP growth in Iran during 1997-2008 using Fuzzy- logic approach. The results of this study indicate that the average price of crude oil and oil revenues increased and also inflation has increased too. In addition, the average growth rate is also decreased.

INTRODUCTION

Current crisis affects most developing countries through the world and has reflected in the fall of stock prices, low liquidity and reduce of credit facilities in these countries. Economical crisis affects Iran's economy by decreasing demand for oil.

Considering the interaction of economic and financial networks worldwide, the incidence of such a situation is not unexpected. However the questions is proposed that whether the crisis has an impact on the Iran's economy or not? Crude oil as one of the most important factors of production always has had a special place in the world economy. Especially after the oil crisis in the17th decades which lead to economic recession in the west world the focus draw to oil and oil products as an important factor of production, the relationship between economic growth and oil was analyzed at the eightieths. Fluctuations and changes in oil prices and significant impact on the macroeconomic variables has attracted by many economists.

Empirically, there are many reasons that oil price fluctuations affect macroeconomic variables. Fluctuations in oil prices led to irreversible loss of investment, reduced demand and total supply, Energy price changes and then changing the amount of energy consumptions of firms; reduce of labor productivity, capital followed to potential production. Oil prices often have been caused inflation and low investment rates in industrialized countries. The main issue of this study is analyzing the effect of financial crisis on basic macroeconomic variables such as inflation, the price of heavy oil, oil revenues and GDP growth in Iran during the 1998-2007. So in this research routine econometric techniques are not used instead Fuzzy logic technique is replaced for analyzing the variables.

RESEARCH LITERATURE

1-2- Theoretical Foundations

The relationship between macroeconomic variables for industrial countries and oil price has been issue of many studies in the last four decades of economic literature[1]. All studies before the oil price shock in 1985 used the linear models to measure these effects, accordingly increasing and decreasing oil price has symmetrical effects on economical activities.

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[1]. Hamilton(1983), Burbidge and Harrison(1984), Grisser and Goodwin (1986), Mork (1989), Hamilton(1996), Bernanke et al. (1997), Hamilton and Herrera (2001), Hamilton (2003).

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The results of these studies generally indicate the existence of a negative correlation between oil prices and economic activity in industrialized countries. But since 1985 the oil market experienced a fifty percent reduction in price which makes the mention relation weaker. After reduction of oil prices effects of oil prices on economic growth of industrialized countries based on the stipulated line is reduced. So economists were facing a basic assumption. Increasing and decreasing oil price does not have symmetrical effects on the economical growth of countries.[1] Effects of oil price fluctuations on macroeconomic variables are possible in the frame of a macroeconomic model. More studies in this field took place in industrialized countries, which often are importers of oil. Oil in these countries is one of the factors of production and increasing of its price has had an inflation and recession effects. But studies for developing countries, which are oil exporters, Dutch disease as one of the most important theoretical foundations can be considered in this field. Mehrara & Niki Oskouei (2006). According to the Dutch disease phenomenon, if the economy face with sudden increase in export price of raw goods and crude oil leads to increase in income and then increase in domestic demands. The main reaction against this momentum of the economy is followed by increasing of labor demand and wages. Therefore, increasing wages reduces benefit in export sectors, and finally the effect of momentum due to the sudden oil price, lead to reduce the value of money and increase the real exchange rate. Some studies support the view that price instability not only affects the macroeconomic variables in high prices levels, but also all price levels unequally. There is considerable empirical evidences that bind oil price changes with variables such as GDP, stock returns and interest rate. Hamilton (1983) .In some cases, the effects of oil price volatility, are shown asymmetrically, namely that the oil price rise has caused economical recession But decreasing of oil prices is not lead to its thriving.

Sadorsky (1993). Moreover, the asymmetry is not reckoned as one of the explanations to explain the effect of volatility of oil prices in different levels.

2-2- Empirical studies

several domestic and foreign studies carried out for checking the effect of oil prices on macroeconomic variable particularly capital investment and economic growth , In most studies regression analysis has been used in order to finding the effect of oil price shocks on macroeconomic variables . Therefore this study is important because of its using of Non-regression analysis, such as fuzzy logic to analyze the effects of macroeconomic variables such as inflation and oil prices on economic growth in Iran. In this section the most important internal and external studies are considered.

A) Foreign studies

In a study for Kuwait have concluded that symmetric shocks in oil prices are the most important factors affecting macro-economic variables such as GDP and the general price level in this country (Eltoni & Awadi, 2001:89). In his study, uses the self-regression analysis to evaluate the effects of oil price fluctuations on macroeconomic variables such as GDP and unemployment rate in Nigeria during the years 1980-2004 . The results show that the impact of oil price volatility on economic growth is not significant (Ayadi, 2005:203).

They studied the effects of oil price shocks on the macro-economic variables in Philippine during 1981-2003 (Raguindin & Reyes, 2005:29). The results indicate that oil price shocks have significant & negative impact on the GDP in this country.

Rebeca 2007 in a survey using regression analysis VAR, have checked the effects of oil price shocks on GDP growth in some OECD member countries(Jim, 2007:216). Their study results show that a nonlinear relation has been established between oil price shocks and GDP growth of countries in this collection, and rising oil prices, has significant and positive impact on economic growth in the Petroleum Exporting Countries.

They (Olomola & Adejumo, 2006:26) have used the regression analysis to capture the effects of oil price shocks on macroeconomic variables such as GDP, inflation and money supply in Nigeria during 1970-2003 . The results show that oil price shocks do not have a significant effect on economic growth.

She (El-Anashasy, 2006:25) has studied the relationship between oil price shocks and economic growth for Venezuela during the years 1950-2001. They reach to the conclusion that long-term and short-term oil price shocks will affect macroeconomic variables such as government consumption expenditure, government revenues and GDP .

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[1] Mork (1989), Lee et al.(1995), Hamilton (1996), Hooker (1996), Hooker (1999), Hamilton (2003)

Lescaroux & Mignon (2008) in a study using Granger causality test, examine the relationship between oil prices and macroeconomic variables in the set of countries exporting and importing Oil. This study shows that there is a one-way causality relationship from the price of oil to GDP variable and the general price level.

They (Farzanegan & Gunther, 2009:137) In a study using a regression model review oil price shocks affects on the Iran economy during the years 1975-2006. The results indicate that a strong positive relationship between changes in oil prices and economic growth is established.

B) Internal studies

They (Hadian & Parsa, 2006:117) During a study using a vector error correction model and instantaneous response functions and variance analysis evaluate the effects of oil price volatility on a number of macroeconomic variables such as GDP, general price level and employment for the period 1961-2005 in Iran. In this study, they have reached the conclusion that one of the main causes of fluctuations in macroeconomic variables is the price of oil changes. And about 20 percent of the volatility of GDP and 60 percent of the general price level fluctuations is caused due to fluctuations in oil prices.

He (Dadghar, 2006:79) examine the relationship between inflation and economic growth in the period of 1959-2004 using conditional least squares (CLS)**.** Their research results show that there is a one-way causality relationship between inflation and economic growth in Iran and in an inflation domain a positive correlation between growth and inflation is established. They (Abrishami & etal, 2008:10) in a paper studied the asymmetric effects of oil prices on economic growth and development of member countries of Organization of Economic Cooperation & Development (OECD) during the years 1960-2002 . Their study results show that the effects of increasing or decreasing oil prices in all studied countries are not identical and oil price volatility has asymmetric effects on GDP growth in these countries.

3- OBJECTIVE OF RESEARCH

The main purpose of this study is analyzing the effect of financial crisis on world oil prices and macroeconomic variables such as inflation, the price of heavy oil, oil revenues and GDP growth in Iran during 1998-2007 using fuzzy logic.

4- RESEARCH QUESTIONS

This study is going to answer following questions:

1- What is the effect of global financial crisis on global oil price variable?
2- What is the effect of global financial crisis on Iran's inflation rate?
3- What is the effect of global financial crisis on economic growth?

5 – METHODOLOGY

This research is an analytical – applicable study that the results could be used in order to improve economical policy makers decisions in implementing fiscal and monetary policies in critical conditions. In this study variable rates of economic growth (GDP growth), inflation rate, the average price of heavy oil and Iran's oil earnings were used during 1998 -2007. It should be noted that all statistics related to the variables GDP based on the price index of year 1998, price index of goods and services and Iran income of crude oil according billion Rials have been used central bank data and also related information of variable price of crude oil in Iran have been used the OPEC Statistical Bulletin (2007 report). Rates of economic growth are defined as GDP growth rate and inflation rate as growth rate of goods and services price index.

5-RESEARCH FINDINGS

The aim of present research is extracting Fuzzy process for variable rates of economic growth, inflation; the average price of heavy oil and oil revenues in period 1998-2007.For the purpose of this study, conventional regression analysis are not used but analysis of Fuzzy Logic are used instead. Statistical information and research data are shown in following table.

Table 1. Statistics and information related to macroeconomic variables

Year	Economic growth price (100%)	Inflation level (100%)	Average price of heavy oil in Iran (USD $)	Crude oil revenues (billion Rial)
1998	2.87	18.1	11.45	22530
1999	1.6	20.1	16.93	44170.4
2000	4.96	12.6	26.02	59448.5
2001	3.28	11.4	21.67	71957.1
2002	7.56	15.8	23.09	102626.4
2003	6.83	15.6	26.34	128153.9
2004	4.84	15.2	33.06	150413.3
2005	5.7	10.4	47.99	186342.4
2006	6.17	11.9	59.27	181881.2
2007	6.89	18.4	67.06	173519.1

Source: National Accounts Central Bank of Islamic Republic of Iran and OPEC statistics table (information provided in the 2007 edition)

In continue changes of price growth variables, inflation level, the average oil price and the amount of crude oil production in Iran are examined between the years 1998-2007 as the chart:

Chart (1). The trend of economic growth value in Iran 1998-2007
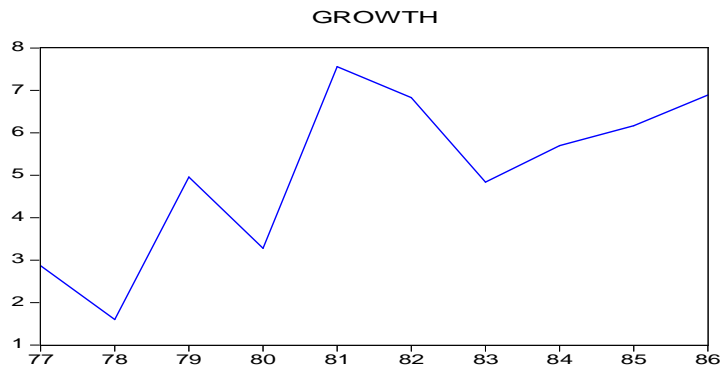
Based on chart No. 1 can be stated that the price of Iran's economic growth during studied years in 2002 with 7.57 was reached to a maximum value and also between 2005 to 2007 has uptrend.

Chart No. (2). Inflation value trend in 1998-2007
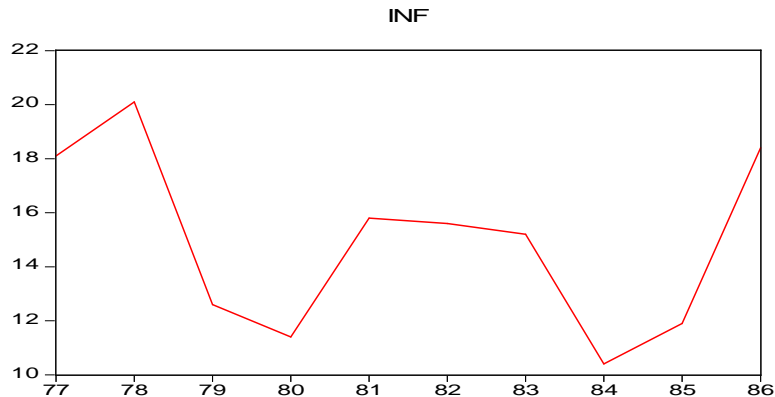
Based on chart No. 2 can be expressed that the rate of inflation in Iran between the research years in 2005 with 10.4 had reached its minimum value, and during 2005 to 2007 has been viewed uptrend. In addition, between the years 1998-2005 has been viewed almost downside.

Chart No.(3). Trend value of heavy oil in Iran during 1998-2007
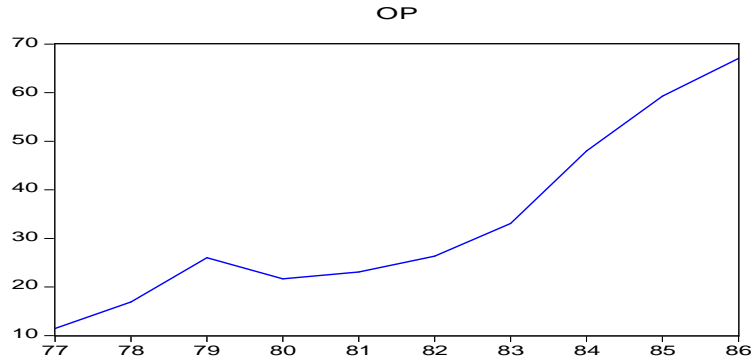
Based on chart No. 3 can be expressed that the price of heavy oil in Iran between the studied years in 1999 with 21.67had reached to its minimum value and also between 2002 to 2007 has uptrend .one reasons for increasing the price of Iran oil during the time of research was the world and OPEC average growth of oil price value.

Chart (4). Iran's oil revenue trend between 1998-2007.
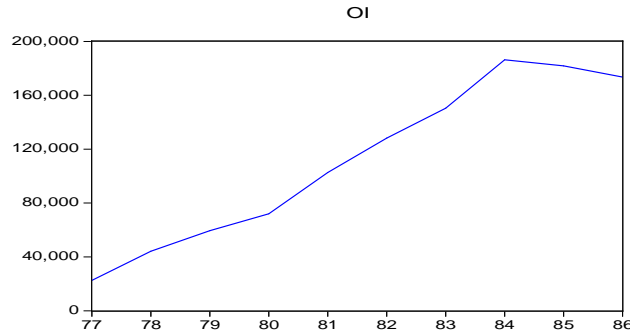
Based on the diagram No. 4 can be expressed that in crude oil prices of Iran until 2005, uptrend was viewed and then in the years 2006-2007 it was low. The growth of world and OPEC oil average prices was the reason for growth of Iran Crude Oil income during the studied period.
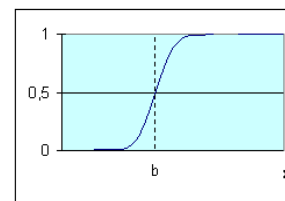
Making indexes fuzzy and methods:

For making all indexed fuzzy the Gauss Function is sued as below.
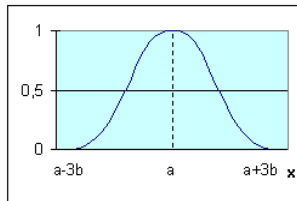
$$\mu_6(x,a,b) = \exp\left[-\frac{(x-a)^2}{2b^2}\right]$$
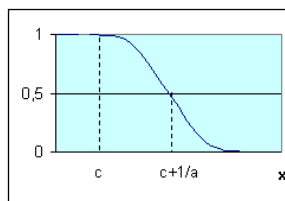
$$\mu_4(x,a,b,c) =$$
$$= \begin{cases} 1, & \text{если } x \le c; \\ \{1+[a(x-c)]^b\}^{-1}, & \text{если } x > c. \end{cases}$$

$$\mu_7(x,a,b) =$$
$$= \{1 + \exp[-a(x-b)]\}^{-1}$$

Using economic analysis of the first section ,the term of entry and exit variables are defined as "Low, Medium and Good" and the limits of above and below has been shown in the table below(Zadeh, 1973:78)

Table 2: Terms & distances of indexes

Terms / Results	Low	Medium	Good
Oil price (USD)	0-22	20 – 42	40 - ∞
Inflation	+∞ - 8	8 – 5	6 – 0
Revenue from crude oil production	2000 – 2300	2200 - 2500	2300 - ∞
GDP growth	-∞ - 1	0 – 3	2 - ∞

Method and logic rule was formed using Table (1). Rules and methods that the price per barrel of oil on the world market with price of 20 dollars ,the level of inflation 5% and revenue from oil sales was 2000 billion Rials is shown in the below form.
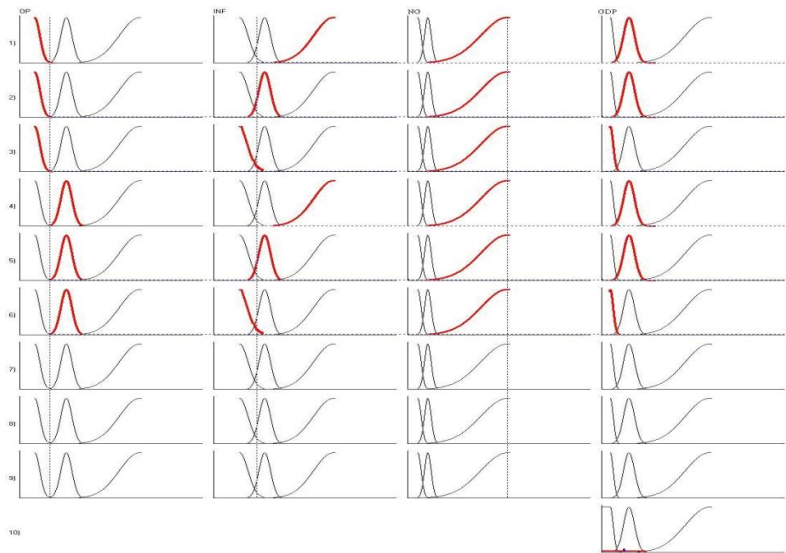
To solve the problem, Input variables of given approximate prices and the degree of public domestic production growth (GDP) has been obtained (Table 3).

Table 3 :Conclusions derived of problem solving

Results						
Oil price	20	30	40	50	70	100
Revenue from crude oil production	2000	2200	2200	2300	2400	2400
Inflation Rate	5	7	9	15	15	20
GDP growth	1.43	1.80	3.61	6.0	6.0	6.0

Source: Research Computing

This study shows that with increasing oil prices in world markets, Iran's economic growth is increased too and the effect of inflation rate variable on economic growth is weak. In addition to this survey to obtain accurate results, in regard to different oil prices, studding input variable, the practical applicability of problem for solving the issue will be high.

Since the main purpose of this study, is explanation of fuzzy logic for four research variables, so for each variable considering the short study period, two-year moving average was used , therefore normal or average value is calculated for each variable. It is worth to mentioning that for calculating normal value of each variable middle parameter can be used. After determining the average or normal values for each variable the quantities accompany level which determines the amount of high, very high, low and very low is calculated for each variable. To calculate the value of accompany level of variables,

One or two standard deviations around the average (normal or average amount of data has been used). For example, the rate of economic growth based on two-year moving average in 1999 ,2.23 the amount is normal or average growth rate,6.14 very high growth rate,4.16 high growth rate,0.28 low growth rate,-1.67 very low growth rate. Along with calculated values for the four considered variables, and that the number of studied years are 10 years from 1998 to 2008, a five member matrix for each year and in total 10*20 matrixes will be obtained. Each of the points will represent the failed points. Then, after the matrix calculation, the actual values of each variable are related to the size of quantity.

For example, in 1378, the value of real economic growth rate is equal to 1.6 which is calculated by accompany amounts, this growth rate value for the year 1999 is in the range of low and medium growth rate. Because according to calculate accompany amounts for the year 1999, 0.28 is a low growth rate and 2.23 is a moderate or normal economic growth rate. For the year 2000 the real economic growth rate was equal to 4.96 while the normal rate was 3.28.also accompany level for High and Very High economic growth rate was respectively 5.23 and 7.19. In the other words the amount of real growth rate for the year 2000 was between normal and high growth rates. So the Fuzzy logic relates a real amount to different accompany levels. For example, in 1999 economic growth rate value was equal to1.6 that according to Fuzzy logic that this amount is in the range of medium and low. But how much medium or low depends on the situation of this rate than failure points. In fuzzy logic to determine accompany levels membership functions is used. In this study, the following membership function is used:

$$\mu_{xi} = \frac{\left| x_{J} - x \right|}{SD}$$

In above relation, xi represents the amount close to the actual amount, Xi another amount of accompanies levels and SD is Standard Deviation of observations in the studied period. for example the actual growth rate for 1999 was 1.6 and the value was closed to actual value, and 2.23 he value of economic growth was Normal or medium and other value of accompany level 0.28 is a low growth rate. Thus by calculating above relation for amount of 2.23, the membership grade value for medium or normal economic growth rate will be equal to 0.675. Calculating the membership degrees for normal rates of economic growth can be expressed that normal rate of economic growth with membership grade of 0.675 is belonging to economic growth sets. In general for 5 case low, medium, high and very high and 4 variables 635 statues is occur. For rate of inflation variable can also be repeated this calculation.

For instance in the year 1998 the normal inflation rate was 19.1 which the accompany values of it for inflation rate was high, very high, low and very low which respectively are 25.69,22.39,15.81 and 12.51. The amount of actual inflation rate for the year 1999 equal to 20.1 is in the ranges of normal and high inflation rates. In other words the inflation rate in that year is both normal and high inflation rate. But how much normal or high depends on the situation of this rate than failure points. For example, to calculate the degree of membership of normal inflation rate value equal to 0.303 and the membership degree of high inflation rate is equal to 0.99.for Iran heavy oil price variable can do also made the relevant calculation .

For example, in 1999 average heavy oil price 19/14 has been considered as normal price and high and very high oil prices in order are 32.8 and 51.4. So 16.93 is the actual price in the normal and high price range. In other words the inflation rate in that year is both normal and high inflation rate. But how much normal or high depends on the situation of oil price than failure points. Calculating the membership degrees for normal or average price, using relation (6) the amount 0.147 will be obtained.

For the variable of crude oil income we can express that in the year 1999, Iran income of crude oil was equal to 33350.2 USD, accompany values of High, very High, Low & very Low Iran oil income were respectively 154437.66, 93893.893, 27193.53, 18737.26 billion Rials, which the amount of actual oil Income for the year 1999 was 44170.4 .so it is in the normal & high ranges of revenues. In other words Iran revenues of oil for that year is will be both normal income and high income. But how much normal or high depends on the situation of this point to than failure points. For example, degree of membership value of oil revenues using the relation (6) equals to 0.18 and membership degree of oil revenues is 0.89.

8- RESEARCH CONCLUSION

The main goal of this study is determining fuzzy logic for economic growth variable rates, inflation rate, average oil prices of Iran's heavy crude oil and amount of oil production in Iran during the years 1998-2007. So at first by using a two-year moving average, normal average value of each of these four variables was calculated, and then the position of each actual observation than accompany points for each year was determined. The results indicate that economic growth rate has upward tendency during the years 2005-2007 and normal or average growth rate equals to 5.07 percent and membership grade is 0.675. Moreover in order to changing the inflation rate, the optimum amount or the average inflation rate is equal to 14.95 during the studied years and calculated membership degree was 0.95. In addition, the average price of Iran heavy oil is calculated about 33.29 and its degree of membership equal to 0.234. Regarding the variable of Crude oil revenue it can be expressed that income of crude oil has risen until the year 2005 and in the years 2007 and 2008 gradually decreased. In addition to the optimum amount or average for this variable has been calulates about 112104.2 billion Rials and its membership degree about 0.69.

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