Indian Journal of Fundamental and Applied Life Sciences ISSN: 2231– 6345 (Online)
An Open Access, Online International Journal Available at http:// http://www.cibtech.org/sp.ed/jls/2014/01/jls.htm
2014 Vol. 4 (S1) April-June, pp. 996-1004/Bahadorkhah and Aminifard
Research Article

INVESTIGATING THE RELATIONSHIP BETWEEN THE OIL PRICES, INTEREST RATE AND UNEMPLOYMENT RATE IN IRANIAN ECONOMY

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ABSTRACT
While the interrelation between oil price changes, economic activity and employment is an important issue that has been studied mainly for developed countries, little attention has been devoted to inquiries on fluctuations in the price of crude oil and its impact on employment for developing economies In spite of the previous studies in Iran which considered Dutch disease as a theoretical base of effecting oil price changes on Iran macro-economy variables, this study by applying an efficacy wage model of Carruth et al. (1998), investigates the causality relationship between unemployment rate and prices of two inputs, namely energy (crude oil) and capital (real interest rates) in the economy of Iran in the period 1973-2012.The results of applying the models of autoregressive distributed lag (ARDL) and error correction (ECM), shows that the real price of oil and real interest rate are the cause of unemployment in Iran's economy in the short-run and long-run. This finding supports the hypothesis that labor is a substitute factor of production for capital and energy.

***Keywords**: Unemployment Rate, Real Interest Rate, Oil Price, Causality Relationship*

INTRODUCTION
Unemployment is an important macroeconomic and political problem all economies confront. Due to its social and economic consequences, it is essential for policy makers to identify the factors that are affecting the unemployment rate the most. Furthermore, policy makers must also realize that the dynamics of unemployment and other factors may differ among countries at different stages of economic development. Developing countries are known to have higher unemployment rates than developed countries, with the former having higher economic growth rates than the latter. In industrial developed countries, although unemployment forces a lot of social and economic expenses to the society, in developing countries unemployment links to economic poverty and endangers these societies. High level of unemployment has been also observed in Iran, playing a major role in both the government's internal and international economic policies .
Imbalance in the labor market causes the unemployment phenomenon. Considering unemployment in a supply–demand framework, it can be argued that the level of employment depends on factors such as the productivity of labor, wages, price level, and prices of other factors of production. On a macroeconomic level, unemployment rate will also follow closely the local factors such as the state of the economy, business cycles, the technology level, and population demographics, as well as global factors like energy prices. Here, one of the most important energies used in the process of producing most of the industries is crude oil which its price is determined in global level and the changes in the price of oil as a super exogenous variable can affect the economic activities of a country and unemployment through different ways. So, policymakers need a clear understanding of the dynamics and microeconomic fundamentals through which factors influence the unemployment rate in the long run, in order to devise sound macroeconomic programs .
There are several studies addressing the relationship between oil price changes and employment directly for developed countries. Hamilton (1983) finds that oil price change has a strong causal and negative

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correlation with real GNP growth and positive correlation with unemployment from 1948 to 1980 in the U.S.A. using Granger causality .

Applying several different filters, Ewing and Thompson (2007) find that oil prices are negatively and contemporaneously correlated with unemployment cycles in the U.S. The literature on developing countries is not as deep. For example in an analysis of the Greek economy Papapetrou (2001) confirms the immediate and negative effect of an oil price shock on employment. The studies of Hadian and Parsa (2009) and Hadian and Rezaie Sakha (2009), also confirmed the negative effect of oil price shock on employment in economy of Iran .

In this paper by using efficiency wage framework that enables us to theoretically relate real oil price, real interest rate, and unemployment, we answer to this fundamental question that: Are the oil price and interest rate the causes of unemployment in Iranian economy in short-run and long-run?

REASERCH METHODOLOGY

Theoretical Framework

Previous studies document various transmission channels through which oil price shocks may have an impact on the economic activity (Davis and Haltiwanger, 2001; Brown and Yucel, 2002; Lardic and Mignon, 2008). First, there is a classical supply side effect according to which an oil price increase leads to reduction in output since the price increases signaling the reduced availability of basic input to production. As a result, growth rate and productivity decline. Slowing productivity growth decreases real wage growth and increases the unemployment rate (Brown and Yücel, 1999, 2002). Oil price shocks can increase the marginal cost of production in many industries reducing the production and thus increasing the unemployment. Since relocation of specialized labor and capital from one industry to another is costly, workers do not relocate immediately but wait for conditions to get better and thus aggregate employment declines. After an oil shock, since the investment determines the potential output capacity in the long run, higher input prices caused by oil price shocks reduce the investments thus output decreases (Brown and Yücel, 2002)

Second transmission channel is the wealth transfer effect emphasizing the shift in purchasing power from oil importing nations to oil exporting nations (Fried and Schultze, 1975; Dohner, 1981). The shift in purchasing power parity leads to reduction in the consumer demand for oil importing nations and increases consumer demand in oil exporting nations.

Consequently, world consumer demand for goods produced in oil importing nations is reduced and the world supply of savings is increased. Increasing supply of savings causes real interest rates to decrease. Diminishing world interest rate should stimulate investment that balances the reduction in consumption and leaves aggregate demand unchanged in the oil importing countries. As Brown and Yücel (2002) emphasized, if prices are downward sticky, the reduction in demand for goods produced in oil importing countries will further reduce the GDP growth. If the price level cannot fall, consumption spending will fall more than increases in investments leading to the fall of aggregate demand and further slowing economic growth.

Real balance effect is the third transmission channel discussed by Pierce and Enzler (1974) and Mork (1994). According to the real balance effect, increase in oil prices would lead to increase in money demand. When monetary authorities fail to increase money supply to meet growing money demand, interest rate will rise deteriorating the growth rate. Brown and Yücel (2002) discussed the impact of monetary policy giving more detail. Inflation effect is another transmission channel which establishes a relationship between domestic inflation and oil prices. When the observed inflation is caused by oil price-increased cost shocks, a contractionary monetary policy can deteriorate the long-term output by increased interest rate and decreased investment (Tang et al., 2009). The fifth transmission channel works via effects of oil shocks on the labor market by changing relative production costs in some industries. As Loungani (1986) discussed, if the oil price increases are long-lasting, it can change the production structure and have an important impact on unemployment. Oil price shock can increase the marginal cost of production in many sectors that are oil intensive and can motivate firms to adopt new production methods that are less-oil intensive. This change in turn generates capital and labor reallocation across sectors that can affect unemployment in the long run. Since the workers have industry specific-skill and job search is time consuming, labor absorption process tends to take time increasing the amount of unemployment. In other words, higher dispersion of sectoral shocks cause higher unemployment rate by increasing the amount of labor reallocation.

Sixth transmission channel is Dutch disease through which oil can affect economic activities and unemployment. "Dutch disease phenomenon is contributed to a mood in which the unexpected and sudden increase in exchange income resulted from resources discovery leads to the increase in the real rate of exchange and reduction in production and employment in exchangeable section (tradable section). The result of Dutch diseases in oil exporting countries is the increase in national income of oil section rather than non-oil sections, and this increase in national income leads to the increase in the aggregate demand of economy, the increase in the prices, and interest in non-exchangeable part in comparison with the exchangeable part and this fact subsequently leads to coming invests to non-exchangeable part and empowering this sector and weakening exchangeable part in most of the single-product economies (Abrishami and Mohseni, 2002)

So, real production and growth of economy decrease and unemployment increases. Another dimension through which energy prices may influence unemployment is through the relative prices of factors of production. According to Carruth et al. (1998), the efficiency wage models provide an attractive framework to investigate the relationship between energy prices and employment for at least 3 reasons. First, the criticism regarding the different relative sizes of changes in wages and employment in classical models is avoided. Second, it allows voluntary unemployment. The third reason is the most important one that is also motivating this paper. That is, the link between unemployment and other factor prices, including oil, has a theoretical explanation in the efficiency wage framework. Carruth et al. (1998) point out that without any assumptions regarding the elasticity of labor supply, the change in the equilibrium in labor market can be attributed to demand changes triggered by changes in input prices.

Probably, except only for Carruth et al. (1998), efficiency wage models either ignore energy or treat it as a secondary input in the production process. Beaudreau (2005) however, argues that energy must be considered as a primary factor of production, as no work is possible without energy from an engineering point of view. We follow the efficiency wage model proposed by Carruth et al. (1998). Their model starts with the following wage equation from Shapiro and Stiglitz (1984) (see Carruth et al. (1998) for the derivation of Eqs. (1) and (2):

$$Logw = Logb + f + \frac{f \times s}{[1 - p(u)](1 - s)}$$

Where, w is the wage rate, b represents any unemployment benefits, f is effort, s is the probability of shirking successfully, u is the unemployment rate, and p(u) is the probability by which an unemployed person finds a job. Assuming constant returns to scale production function which is homogeneous of degree one and perfect competition in the final good market, Carruth et al. (1998) show that there exists a relationship between real input prices.

$$\mu = c(w, r, ep)$$

Here, the interest rate r reflects the capital rental rate and ep is the energy price. Carruth et al. (1998) derive the equilibrium unemployment rate from Eqs.(1) and (2):

$$U^* = U^*(r, ep, b(\mu), f, s)$$

As a result of comparative static analysis Carruth et al. (1998) show that the equilibrium unemployment rate depends on the real interest rate and the real energy price; whereas, it is neutral to total supply and technology. A rise in oil price erodes profits and the economy must adjust to equilibrium where there are no economic profits or losses. Assuming that workers do not shirk, this adjustment takes place through an

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increase in equilibrium unemployment because wages and unemployment are inversely related. A similar adjustment also takes place when interest rates rise. Carruth et al. (1998) see unemployment as a "discipline device". As real input prices rise, wages decline leading to higher unemployment rates. Following the Carruth et al. (1998) model we investigate the relationship between the unemployment rate, real energy prices, and the real interest rate in Iran.

Econometric Model

In this paper, based on the efficiency wage model of Carruth et al. (1998), our aim is to examine the dynamic relationship between oil prices, unemployment rate and real interest rate in Iran. To explore the relationship between the real interest rate, the real price of energy and the unemployment rate, we use annual data from 1973 to 2012 (40 observations). The unemployment rate and Interest rate data are taken respectively from economic reports of Central Bank of Iran and Iran statistics' center. Oil price data is from the OPEC data base. Interest rates deflated by consumer price indexes and unemployment is the civilian unemployment rate in percent and the oil price series is the U.S. dollar per barrel market price of crude oil deflated by consumer price indexes.

All data are used in natural logarithms. Considering the equation (3), and adding unified exchange rate variable, the equation (4) was described for investigating the relationship between oil price, interest rate and unemployment in economy of Iran:

$$LU_t = \alpha_0 + \alpha_1 LR_t + \alpha_2 LOILP_t + \alpha_3 LDUM_t + \varepsilon_t$$

Where, Lu is the unemployment rate log, LR is the real interest rate log, LOILP is the log of real oil price, ε denotes error term, and α0, ..., α3 are the coefficients that must be estimated. DUM is the dummy variable of unified exchange rate, which to regarding the impact of this policy, is considered an amount for the years after 2001 and for other years will amount to zero.

In order to investigate long-run and short-run relationship between dependent variable and explanatory variables of the model Engle-Granger approach can be applied, which is not advised in the regressions more than two variables because of its weak points. The other method is the maximum likelihood by Johansen-Juselius. However, because of its limitations like the requirement of variables integration from equal degree, better strategies are suggested for analyzing long-run and short-run relationships between the variables, among them ARDL model can be pointed. ARDL methodology is practical even if the variables are a combination of I(0) and I(1).In other words, in this method there is no need for dividing variables to correlative variables from 1 and 0 degrees (Pesaran, 1997). So, in the present study ARDL model is used.

The dynamic form of ARDL for the selected model in this study is as it follows:

$$\Delta LU_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta LU_{t-i} + \sum_{i=1}^{q} \alpha_{2i} \Delta LR_{t-i} + \sum_{i=1}^{r} \alpha_{3i} \Delta LOILP_{t-i} + \sum_{i=1}^{S} \alpha_{4i} \Delta DUM_{t-i}$$
$$+ \alpha_5 LU_{t-1} + \alpha_6 LR_{t-1} + \alpha_7 LOILP_{t-1} + \alpha_8 LDUM_{t-1} + \varepsilon_t$$

Although, co-integration tests can determine the existence or non-existence of Granger causality relationship between variables, it is not able to determine the direction of causality relationship. Engle-Granger (1987) stated that if X_t and Y_t are co-integrated there is always an Error Correction Model (ECM) between them. Therefore, in order to investigate Granger causality relationship between the variables the ECM can be applied. Error Correction Model indicates that the changes in dependent variable are a subordinate of deviation from long-run relationship (which is introduced by error correction term) and the changes of other descriptive variables. So, in order to investigate causality direction and making difference between long-run and short-run, the appropriate error correction model with the main model is introduced as following:

$$\Delta LU_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \Delta LU_{t-i} + \sum_{i=1}^{q} \alpha_{2i} \Delta LR_{t-i} + \sum_{i=1}^{r} \alpha_{3i} \Delta LOILP_{t-i} + \sum_{i=1}^{S} \alpha_{4i} \Delta DUM_{t-i} + \alpha_5 ECT_{t-1} + \varepsilon_t \quad , \quad -1 < \alpha_0 < 0$$

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In which, ECTt-1 is an error-correction terms and shows the speed of error-correction and tendency to long-run adjustment. The coefficient of this terms (α5) shows that in each period how much of dependent variable imbalance is adjusted and gets close to long-run equilibrium.

RESULTS

Assess the Stationary Properties of the Variables

In traditional econometric, the assumption is that the mean and variance of the variables are fixed during the time and their covariance doesn't change by determined lags, in other words, the variable is static. However, the recent studies showed that this assumption has changed about many variables during the time, and covariance is not constant in determined lags, which shows their non-stationary. If the model is assessed by non-stationary variables false regression may result. It means that however they may not significant relationship between the variables, regression may have a high determined coefficient (R^2) , and this fact may lead to inappropriate inferences about the relationships between the variables.
Therefore in order to assess the stationary properties of the variables employed, we utilized augmented Dickey and Fuller (1979) (ADF) unit root test and its results are summarized in table 1.

Table 1: The results of Augmented Dicky Fuller (ADF) unit root test, with intercept

`	Variable	Symbol	Test Statistic	Prob
Level	Log of real interest rate	LR	$-4.55^{(0)}$	0.000
First difference	Log of unemployment rate	LU	$-4.24^{(1)}$	0.000
	Log of real oil price	LOILP	$-7.92^{(1)}$	0.000

Lag lengths are determined via SIC and are in parentheses. The null hypothesis is unit root.
Critical value at a significance level of 5% is equal to -2.93

The results of table 1, indicate that the log of real interest rate variable is stationary in level and with intercept. But the other variables are not stable in any of the level moods, so stationary test was performed on difference of such variables. The results of the late study showed that the logs of real oil price and unemployment rate are stable in the first order difference and with the intercept. So in order to investigate short-run and long-run relationships between variables, ARDL model was selected

Estimating model by ARDL method

The analysis and inference in ARDL approach includes 3 equations, dynamic, long-run, and error-correction which are indicated in the following:

Estimating ARDL approach dynamic form

For determining the model's appropriate lag, regarding the sample's size, Schwartz Bayesian's Criterion (SBC) was used. The software has selected at most one lag in equation from among different regressions and according to Schwartz Bayesian from among $(m+1)^{k+1}$ estimated model it selected a regression which considered one lag for unemployment rate and real interest rate logarithm, but it considered no lag for other variable in model. By considering ARDL dynamic form for intended model in equation (5), ARDL (1, 1, 0) dynamic model was assessed by applying Microfit4.1 software and the results are presented in table 2.
The results of the table 2 shows that coefficient of determination (R^2=0.73) indicative a rather good descriptive power of model. By considering the final section of table 2 in all diagnostic tests on residuals, at least significant level is bigger than error level of 5%. So the null hypothesis (H^0) is not rejected and

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classic hypotheses (lack of serial correlation existence, appropriate functional form, the normality of residuals, and the existence of heteroscedasticity) are confirmed for the intended model.

Table 2: The results of ARDL dynamic model

Variable	Symbol	Coefficient	Standard Error
Log of unemployment rate with a lag	LU(-1)	0.588 [a]	0.097
Log of real interest rate	LR	0.038 [b]	0.020
Log of real interest rate with a lag	LR(-1)	0.042 [b]	0.021
Log of real oil price	LOILP	0.062 [a]	0.018
Intercept	C	0.393 [a]	0.229
Dummy variable of unified exchange rate	DEX	-0.168 [a]	0.043
F=17.76[0.000]	R^2 =0.73	$\bar{R}^2$ =0.69	

Diagnostic Tests		
Test Statistics	**LM Version [prob]**	**F Version [porb]**
Serial Correlation	1.103 [0.293]	0.931 [0.342]
Functional Form	0.045 [0.831]	0.037 [0.848]
Normality	2.578 [0.275]	Not applicable
Heteroscedasticity	0.162 [0.687]	0.154 [0.696]

[a] *Indicates significance at 1%. and* [b] *Indicates significance at 5%.*
Source: findings of research

Now, by applying these results, the existence or lack of existence of co-integration (long-run relationship) between the variables of dynamic model can be tested. If the sum of coefficients with the relevant lags to dependent variable is less than 1, dynamic model orients towards long-run Equilibrium model.
The required t-statistic for the above test based on what was mentioned before is calculated as following:

$$t = \frac{\sum_{i=1}^{p} \hat{\alpha}_i}{\sum_{i=1}^{p} S\,\hat{\alpha}_i} = \frac{0.588-1}{0.097} = -4.24$$

Because the suggested critical quantity by Banerjee, A., and et al, (1993) is in the confidence level of 95%(=-3.82) is smaller than absolute value of resulted t-statistic, it can be concluded that there is a long-run relationship between the model variables.

Estimating the long run coefficients by ARDL approach
The results of long-run model assessment are presented in table 3:

Table 3: Long-run results of estimating the ARDL model

Variable	Symbol	Coefficient	prob
Log of real interest rate	LR	0.20	0.006
Log of real oil price	LOILP	0.15	0.004
Intercept	C	0.96	0.023
Dummy variable of unified exchange rate	DEX	-0.41	0.002

Source: findings of research

According to the reported results in table 3, the signs of assessed coefficients of considered variables in the model confirms suggested theoretical framework in this study and it is such that a percent increase in real interest rate in long-run increases unemployment rate to 0.20 percent and a percent increase in the real price of oil in long-run increases unemployment rate to 0.15 percent. The effect of dummy variable of unified exchange rate on unemployment rate is negative, that is the long-run coefficient of this variable in the model is -0.41. It means that executing equalization exchange rate policy decreases unemployment rate in the country. The effect of this variable can be interpreted as this: executing this policy on one hand decreases rent-seeking activities in exchange part and decreasing the risk of programming for future investments and on the other hand, provides the arrangement for establishment exchange reserve fund which is penetrated into the country's economy to increase employment.

2.2.3. Estimating ECM for the selected ARDL model

The existence of co-integration between the mentioned variables in the model provides a base for applying error-correction model. The most important reason for popularity of these models is that makes a relationship between short-run volatility of these variables to long-run balancing quantities. These models are in fact a kind of minor adjustment models, in which they measure the effective forces in short-run and the speed of getting close to balancing quantity by entering reliable remains from a long-run relationship. For this purpose, in the present study error-correction model was assessed after estimating long-run relationship between the variables which the results are presented in table 4:

Table 4: The results of estimating the ECM

Variable	Symbol	Coefficient	prob
log of real interest rates	dLR	0.038	0.006
log of real oil price	dLOILP	0.062	0.001
intercept	dC	0.393	0.096
Dummy variable of unified exchange rate	dDEX	-0.168	0.000
Error correction term	ECT(-1)	-0.411	0.000

"d" represents the first order difference of the variables.

According to the obtained results in table 4, the significant and expected effect of mentioned variables in the model is proved on unemployment rate in short-run. The results also show that Error-Correction Term coefficient [ECT(-1)] is significant and includes the expected sign (negative). The quantity of this coefficient shows that 41 percent of deviations (imbalances) of unemployment rate variable are resolved through their long- run balancing quantities. In other words, in condition of any shock or imbalance in unemployment rate variable, they will be balanced again after 2.5 periods, so movement towards equilibrium is almost fast.

Investigating the causality relationship between the variables

Vector error-correction model in addition to determining the direction of Granger causality relationship between the variables, enables us to make a difference between long-run and short-run Granger causality. This task is done by Wald test on error-correction equation coefficients.

Insignificance error-correction term coefficient in this test shows that there is no Granger causality relationship between descriptive variables in comparison with dependent variable in long-run. The insignificance of sum of lags in each descriptive variables shows that there is no Granger causality relationship between each descriptive variable in comparison with dependent variable in short-run. The insignificance of sum of lags in each descriptive variable along with error- correction term coefficient shows that there is no Granger causality between each descriptive variable in comparison with dependent variable in long-run (Masih and Masih, 1997). The results of short-run and long-run Granger causality relationship in independent variables in comparison with dependent variables (unemployment rate) are summarized in table 5 and 6 respectively.

Table 5: Causality test results of short-run

Dependent variable	Influential variable	Wald statistics	Critical value	Direction of causality
LU	LR	5.8	0.04 [a]	LR → LU
LU	LOILP	14	0.00 [b]	LOILP→ LU

[a] Indicates significance at 5%. and [b] Indicates significance at 1%.
Arrows indicate the direction of causality.

Table 6: Causality test results of long-run

Dependent variable	Influential variable	Wald statistic	Critical value	Direction of causality
LU	ECT(-1)	20	0.00 [a]	LR&LOLP→LU

[a] Indicates significance at 5%. Arrows indicate the direction of causality.

The presented results in table 5 and 6 shows that the real oil price and real interest rate are Granger cause unemployment in the economy of Iran in short-run and long-run. Hence, knowledge of real price of oil and interest rate may improve the forecasts of the unemployment rate. The reverse does not hold, therefore the causality is not bi-directional

CONCLUSION

In spite of the previous studies in Iran which considered Dutch disease as a theoretical base of effecting oil price changes on Iran macro-economy variables, this study investigates the relationship between oil price and interest rate with unemployment rate in Iran's economy by applying an efficacy wage model of Carruth et al. (1998). The general results of this study shows that the positive affect of production factor prices (oil price and interest rate) on unemployment rate. In the frame of the suggested efficacy-wage model, this fact is interpreted like this: when the price of productions (oil price and interest rate) increases, the producer for remaining in competitive market should decreases the price of labor forces (wages), regarding the reversed relationship between unemployment and wages' level, unemployment increases. In fact here, unemployment performs as a "discipline device" and it is such that when the real prices of energy and capital increases, the wages' decrease leads to increase in unemployment rate. Besides, the results of investigation of the causality relationship between the variables show that the real price of oil and real interest rate are the cause of unemployment in Iran's economy in short-run and long-run. Our results suggest that in the short run and long run both the real price of oil and the real interest rate have an effect on the unemployment rate in Iran, confirming Carruth, et al. (1998) results for the U.S. The Andreopoulos (2009) results for U.S. during recessions are also similar. Our results also suggest that labor is a substitute factor of production for capital and energy in Iran. We understand that oil shocks operate mainly through conventional aggregate channels, transmitting oil price increases to the labor market in Iran, as Hamilton (1988) suggested. This study brings forth a question of whether the theory also holds for other developing countries.

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