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WORLD OIL PRICE IMPACT ON INTEREST RATE AND UNEMPLOYMENT: EVIDENCE FROM EURO

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Abstract

Notable increases in the world price of oil have been generally recognized implies economic activities and macroeconomic policies. This paper tries to analyze the oil price and macroeconomic policy relationship by means of analyzing the impact of oil prices on real interest rate and unemployment. This paper tests these relationships in Europe Area Countries using annual data from 1970 to 2009 by using AWM database. Innovation or shock in world price of oil will affect the real interest rate and unemployment from initial period and fade away in very long time horizon.

Keywords: *world price of oil, interest rate, unemployment, Euro zone*

Abstrak

Tingginya harga minyak dunia telah dipercaya sebagai faktor yang mempengaruhi aktifitas ekonomi dan kebijakan makroekonomi. Penelitian ini bertujuan untuk menganalisis hubungan antara harga minyak dan kebijakan makroekonomi dengan menganalisis dampak harga minyak pada tingkat bunga riil dan pengangguran. Studi ini menguji hubungan tersebut di negara-negara Eropa dengan menggunakan data tahunan mulai tahun 1970- 2009 dengan database AWM. Inovasi dan tingginya harga minta akan mempengaruhi suku bunga riil dan pengangguran mulai dari periode awal dan berakhir dalam jangka waktu yang lama.

Kata Kunci: *harga minyak dunia, suku bunga, pengangguran, zona Euro*

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INTRODUTION

Oil unquestionable becomes important part of the economy because of its function as an "economic lubricants". Its price, however, fluctuates and affects the worldwide economy. Based on historical series, oil price faces a bumpy pattern from 19th century.

During period 1862-1864 was became the first oil shock. The onset of the U.S. Civil War brought about a surge in prices and commodity demands generally. According to Cunado and Gracia (2003), prices of oil continue to rise dramatically since the World War II. During the period 1960–1999, there were four notably oil shocks: first period was in 1973–1974, when the Organization of Petroleum Exporting Countries first imposed an oil embargo and then greatly increased world crude oil prices from $3.4 to $13.4 per barrel. Secondly, in 1978–1979, after the Iranian revolution disrupted oil supplies, the price rose from $20 to $30 per barrel. The following shock was in 1990 in accordance with the Iraq's invasion of Kuwait. At this period the price went from $16 to $26 per barrel. The fourth was in 1999 when the prices have grown up from $12 to $24 per barrel.

In the early 21st century, the fluctuation was continued. The price climbed in 2002 due to production cutting of oil in Venezuela and second Persian Gulf War; when the U.S. attacks on Iraq. These would both be characterized as exogenous geopolitical events. During 2007-2008 increase of oil price was generated by growing economic demand and stagnant supply. The IMF estimated real gross world product grew at an average annual rate of 4.7%and world oil consumption grew 3% per year. These strong demand pressures were the key reason for the steady increase in the price of oil over this period, though there was initially enough excess capacity to keep production growing along with demand (Hamilton, 2013).

Perhaps more than hundreds of empirical studies find that oil price exacerbates the macroeconomic activities in net oil-importing countries through the demand-side (income transfer) and supply-side (production cost) channels. From the demand side analyses, Ferderer (1996) states the oil shock can lower aggregate demand due to the price rise redistributes income from the net oil importers to exporters. Brown and Yucel (2002) mention that if consumers expect the rise in oil prices to be temporary, or if they expect the short term effects on output to be greater than the long-term effects, they will enable to manage their consumption level by saving less or borrowing more which boosts the equilibrium real interest rate. With slowing output growth and an increase in the real interest rate, the demand for real cash balances falls, and for a given rate of growth in the monetary aggregate, the rate of inflation increases. Therefore, rising oil prices reduce GDP growth and boost real interest rates and the measured rate of inflation (Ito, 2010)

From aggregate supply side, Ferderer (1996), Brown and Yucel (2002), Dogrul and Soytas (2010) state that increasing energy prices become an indicative of the reduced availability of a basic input to production. Those mean that firms purchase less energy, hence productivity of any given amount of capital and labor declines and potential output falls. The decline in productivity growth lessens real wage growth and increases the unemployment rate at which inflation accelerates. In the case of sticky wage, the reduction in economic growth will lead to increased unemployment and a further reduction in GDP growth. The reduction in GDP growth is accompanied by a reduction in labor productivity. Unless real wages fall by as much as the reduction in labor productivity, firms will lay off workers, which will generate increased unemployment and further GDP losses. Ahmad (2013). If wages are nominally sticky downward, the only mechanism through which the necessary wage reduction can occur is through unexpected inflation that is at least as great as the reduction in GDP growth.

Cunado and Gracia (2003), which analyze oil price impact on inflation in European countries, show that oil price has permanent effects on inflation. Furthermore, significant differences are found among the responses of the countries to these shocks. Another important thing is that the effect of oil prices on growth is asymmetric. Although a rise in oil price has a significant negative effect on growth, a fall in oil price does not cause an economic expansion (Cunado and Gracia, 2003, Hamilton, 2013, and Abeysinghe, 2001).

Empirical evidence impact of oil price that covering Asian countries conducted by Cunado and Gracia (2005). They suggest that oil prices have a significant effect on both economic activity and price indexes, although the impact is limited to the short run and more significant when oil price shocks are defined in local currencies. Abeysinghe (2001) reveals the identical result, however the transmission effect of oil prices on growth may not be that important for a large economy like the US but it could play a critical role in small open economies such as in Asian.

Dogrul and Soytas (2010) analyze unemployment rate and two input prices, namely energy (crude oil) and capital (real interest rate) in an emerging market, Turkey, for the period 2005:01–2009:08. By using Structural Vector-Autoregrresion, they find the real world price of oil and interest rate improve the forecasts of unemployment in the long run. This finding supports the hypothesis that labor is a substitute factor of production for capital and energy.

The latest studies reveal that the impact of hiking price of oil not brings huge impact on macroeconomic indicators. Schmidt and Zimmermann (2005) and Schmidt and Zimmermann (2007) take study in Germany economy why the effects of oil price shocks on the German economy have reduced. They show that the oil intensity of production was reduced since the oil price-shocks of the seventies and early eighties. In this case oil prices would have become of minor importance for business cycle analysis. Loscheland Oberndorfer (2009) take further specific analyses impact of oil price on unemployment in Germany by using monthly data from 1973 to 2008. The result confirms those two prior studies; although volatility of oil price impacts still affect unemployment in Germany, the effects is weakened in Germany especially after 1980s when the economy getting efficient in using energy.

From those dynamic literature review results, it is still a big room to explore the impact of oil price onto macroeconomic performance. The main goal of this paper is to analyze the world oil price–macroeconomic relationship from supply side by means of applying Structural Vector-Autoregressive (SVAR) on the oil price– real interest rate, and oil price – unemployment for euro area by using annual data for the period 1971-2009. All variables are in natural logarithmic terms. The data is based on yearly Area-wide Model (AWM) database 10th version. The AWM database covers a wide range aggregation of macroeconomic time-series of sixteen countries in Euro area.

The plan of the paper is as follows. First of all I briefly present the overview of price of oil condition across the centuries. Secondly, I discuss some empirical evidence that can link the fluctuation of oil price-macroeconomic indicators and also provide methodology and data selection that will be employed. Thirdly, methodology and data selection will be explained briefly. In the main part of this paper, I analyze the impact of oil price toward unemployment and interest rate in euro area. Finally, the last part will provides some concluding remarks.

METHODOLOGY AND DATA SELECTION

In order to find the relationship among oil price and macroeconomic variables, this paper will use a structural VAR model (SVAR). SVAResssentially employs economic theory to sort out the contemporaneous links among the variables. This method requires identifying assumptions that allow correlation to be interpreted causally (Stock and Watson, 2011). Standard practice in VAR analysis is to report output from Granger-causality tests, impulse responses, and forecast error variance decompositions. Stock and Watson (2011) explain that Granger-causality evaluate whether the lagged values of a variable can predict other variables. Impulse response function can be applied to trace out the response of current and future values of each variables to a one-unit increase in the current value of one of the VAR errors, assuming that this error will return to zero in subsequent periods and that all other errors are equal to zero. The last thing to be noted, VAR provides forecast error decomposition which is the percentage of the variance of the error made in forecasting a variable due to a specific shock at a certain period.

This paper focuses on impact of oil price on two macroeconomics indicators namely real interest rate and unemployment. The world oil price variable measured in real term rather than in nominal term to get rid from world inflation bias and also adjusted in Euro rather than US Dollar. This specification is based on Abeysinghe (2001) specification.

$$LOIL_t = \log\left(\frac{NOIL_t}{WGDP_{DEF_t}} \times ER_t\right) \tag{1}$$

$LOIL_t$: Log real world oil price; $NOIL_t$: Nominal world oil price; $WGDP_{DEFt}$: World GDP deflator; ER_t: Euro per US$ exchange rate

Interest rate is converted into real term as well.

$$REALIR_t = NIR_t - HICP_t \tag{2}$$

$REALIR_t$: Real interest rate in Europe (%); NIR_t: Nominal short term interest rate ; $HICP_t$: Overall Harmonized Index of Consumer Prices; Unemployment ($LUNN_t$) is in logarithmic number of unemployment in period t.

RESULT AND DISCUSSION

First step to make SVAR model, we have to make sure that all those variables are stationer[1]. One of the methods is by applying Augmented Dickey-Fuller unit root test. From Table 1 we can conclude that not all variables are stationer in level but they are stationer in first different (using intercept or using intercept & trend).

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[1] Spencer (1989) highlights the important of stationarity since the VAR approach relies on the presumption that the economic variables under consideration are covariance stationarity. Non stationary variables can be transformed through "trend removal" procedure such as taking first differences.

It is important to note that through residual test, our data have no auto-correlation, not normally distributed, and homoscedasticity (See Appendix 1, 2, and 3). After all variables are stationer in the same level, we can specify the maximum lag. In our case, optimum lag length *k* is determined to be 1 by final prediction error (FPE), likelihood ratio test (LR), Akaike info criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn (HQ) (Table 2) and all the inverse roots are inside the circle (Figure 1).

Table 1. Augmented Dickey-Fuller Unit Root Test

ADF test in Level			**ADF test in 1st Different**		
	Variables	t-statistics		Variables	t-statistics
Intercept	loil	-2.1904	Intercept	Loil	-6.698*
	realir	-1.4282		Realer	-4.3693*
	lunn	-2.9194**		Lunn	-3.2060**
Intercept & Trend	loil	-2.1518	Intercept & Trend	Loil	-6.6066*
	realir	-2.3774		Realer	-4.4304*
	lunn	-2.1133		Lunn	3.6795**

Note: *) statistically significant at α 1%
**) statistically significant at α 5%
***) statistically significant at α 10%

Table 2. Lag Length Specification

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-197.4080	NA	13.73833	11.13378	11.26574	11.17984
1	-5.767242	340.6947*	0.000540*	0.987069*	1.514909*	1.171299*
2	-1.196861	7.363391	0.000699	1.233159	2.156878	1.555562
3	4.615436	8.395540	0.000860	1.410254	2.729853	1.870829

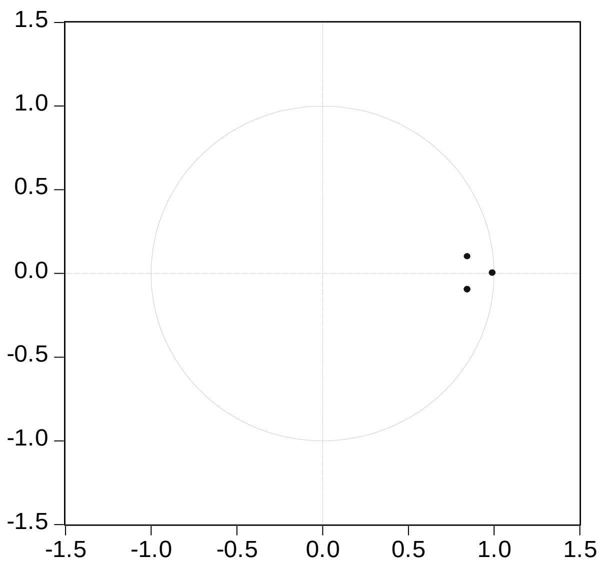

Figure 1. Inverse Roots of AR Characteristic Polynomial

Table 3. Johansen Cointegration Test

Hypothesized No. Of CE(s)	Eigenvalue	Trace Statistic	5% Critical Value	Probability
None *	0.467709	30.52866	29.79707	0.0411
At most 1	0.191293	7.828339	15.49471	0.4839
At most 2	0.005122	0.184871	3.841466	0.6672

Although all variables are stationer in first different, we can still apply SVAR in level since our model is cointegrated[2]. It has been tested using Johansen Cointegration test (Table 3). The procedure involves a SVAR in levels make us not loss of information due to differencing. SVAR model in this paper as follow:

$$V_t = \alpha_V + \beta_1 V_{t-1} + \varepsilon_{Vt} \quad (3)$$

where V_t=($LOIL_t$, RIR_t, $LUNN_t$), αv is a (3×1) vector of constants, β_1 is (3×3) coefficient matrices, and ε_{Vt} denotes white noise residuals. In our case, optimum lag length *k* is determined to be 1.

Long Run Granger Causality and Generalized Impulse Responses

The Granger causality framework allows for testing the existence and the direction of causality between variables (table 4).

We observe that there are only some variables have Granger causality. Lag value of price of oil and unemployment can significantly, individually or together, help to predict real interest rate. Lag price of oil also can predict unemployment whereas real interest rate does not. These results generally confirm what Dogrul and Soytas (2010) did in Turky case. Therefore the real world price of oil and interest rate improve the forecasts of unemployment in the long run.

Now we are in position to explain how the responses of unemployment, oil price and interest rate toone standard deviation shocks to other variables in the SVAR. Impulse response function (Figure 2) explains shock in oil price increases the real interest rate and the impact tends to stand still even until 30 years. Shock on real interest rate leads to negative response on unemployment and fades away after 17 years. Shock in oil price initially gives negative impact on unemployment. Nevertheless, it gradually brings positive impact after 2 years, reaches the peak at seventh years after, and slightly fades away. Those means that oil price fluctuation bring huge impact toward real interest rate and unemployment.

In forecast error variance decomposition (figure 3) we use 10 years time horizon. Forecast of oil price is steadily attributed to oil price itself. Other two variables do not give significant contributions. It makes sense since oil price is exogenously given from world economy. The fluctuation in real interest rate is affected by real interest rate itself across the time then followed by oil price. However the contribution of unemployment is very small along the period. Shock in unemployment rate is mainly affected by real interest rate whereas contribution of unemployment itself is lower. Interestingly, in the initial period, contribution of oil price toward unemployment is very small however its contribution increases gradually.

[2] Wooldridge (2013) states cointegration applies when two series are stationer in first different, but a linear combinationof them is in level. This kind of regression is not spurious, buttells something about the long-run relationship between them.

Table 4. Granger Causality Test

From	To	test statistics	p-value
REALIR	LOIL	0.565138	0.4522
LUNN	LOIL	1.464788	0.2262
REALIR and LUNN	LOIL	1.684591	0.4307
LOIL	REALIR	9.103531	0.0026*
LUNN	REALIR	3.171558	0.0749***
LOIL and LUNN	REALIR	14.12472	0.0009*
LOIL	LUNN	6.948099	0.0084*
REALIR	LUNN	0.120640	0.7283
LOIL and REALIR	LUNN	7.427383	0.0244**

*) statistically significant at α 1%; **) statistically significant at α 10%

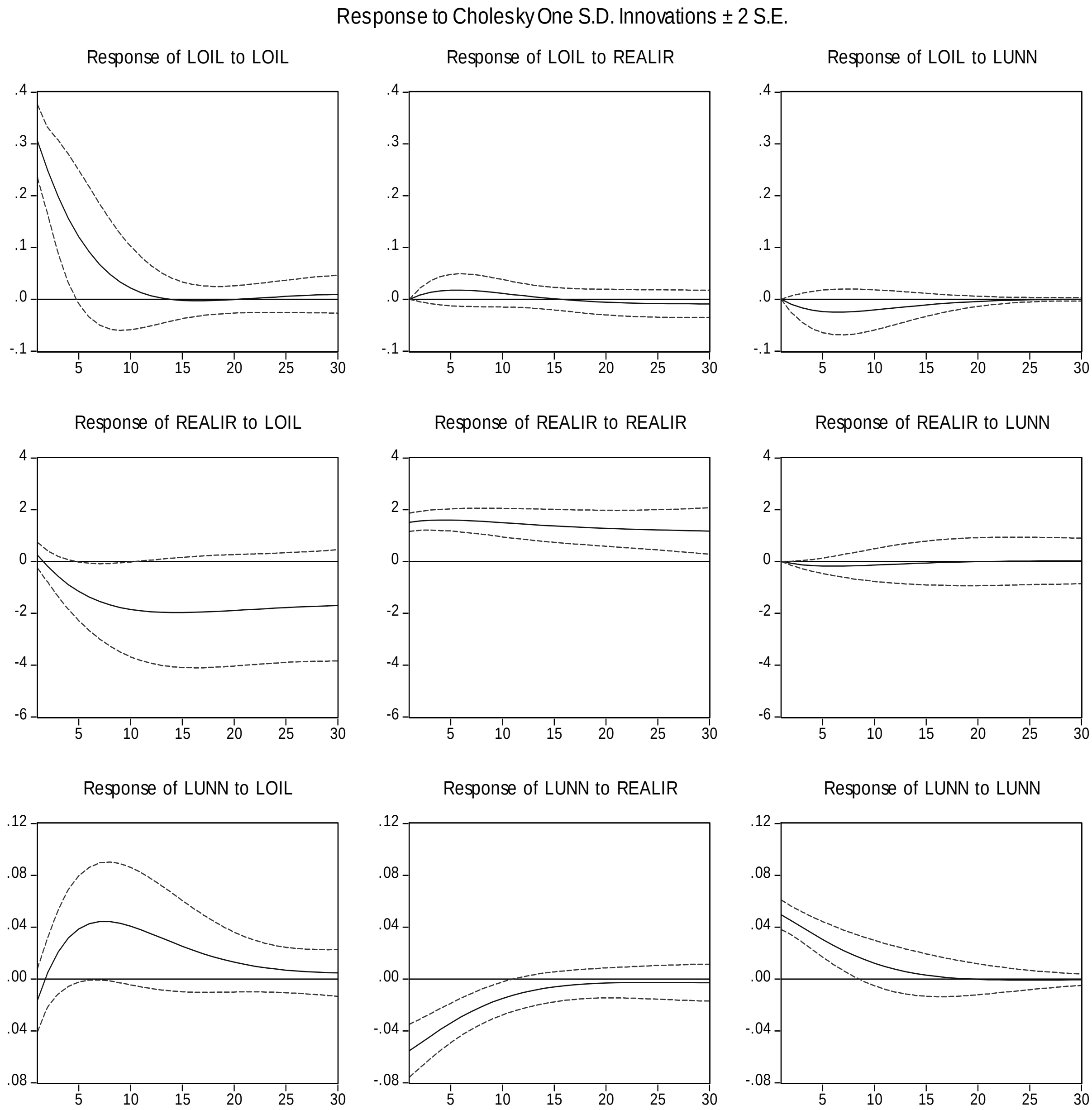

Figure 2. Impulse Response Function

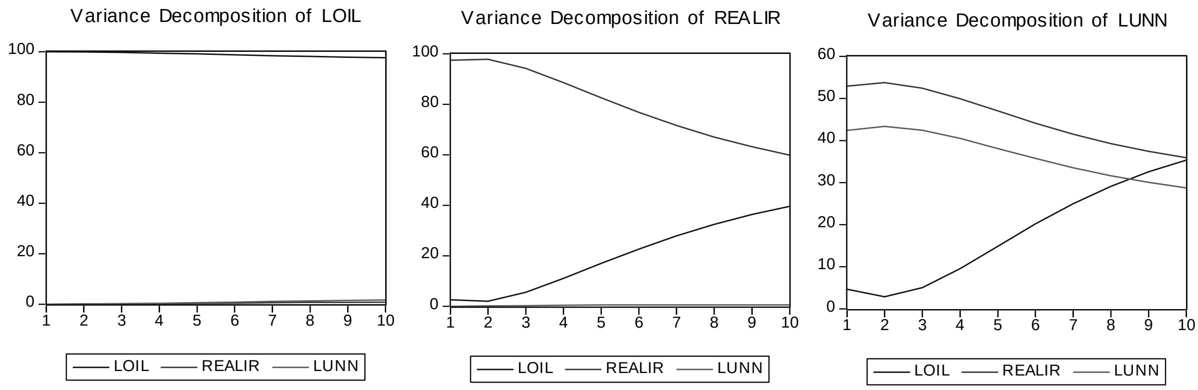

Figure 3. Variance decomposition

CONCLUSION

A lot of researches have been done to find relation of hiking oil price and some macroeconomic indicators. Here we present the effect of oil price toward two fundamental macroeconomic indicators from supply side; real interest rate and unemployment in aggregate euro area. We use help SVAR method to prove it.

We find that innovation or shock in world price of oil will affect the real interest rate and unemployment from initial period and fade away in very long time horizon. Our findings in euro area confirm what have been suggested by previous researcher that shock in world oil price will affect on unemployment as well as real interest rate.

The weakness from this research is data limitation since AWM only provide annually data that make it difficult to split data to differentiate period before and after 1980 in order to see the exact effect of efficient energy using like what have Loschel and Oberndorfer (2009), Schmidt and Zimmermann (2005) and Schmidt and Zimmermann (2007) been done in Germany case.

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APPENDIX
(E-views output)

Appendix 1: LM Test

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 01/03/14 Time: 20:39
Sample: 1970 2009
Included observations: 38

Lags	LM-Stat	Prob
1	7.821475	0.5522
2	7.211241	0.6151
3	14.43492	0.1077
4	6.817196	0.6561
5	10.44691	0.3155
6	11.47532	0.2445
7	9.103428	0.4278
8	10.39309	0.3196
9	9.525184	0.3903
10	3.493471	0.9415
11	9.428591	0.3987
12	6.026257	0.7373

Probs from chi-square with 9 df.

Appendix 2: Normality Test

VAR Residual Normality Tests
Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Date: 01/03/14 Time: 20:39
Sample: 1970 2009
Included observations: 38

Component	Skewness	Chi-sq	df	Prob.
1	0.029311	0.005441	1	0.9412
2	-0.277787	0.488717	1	0.4845
3	0.738059	3.449960	1	0.0633
Joint		3.944118	3	0.2676
Component	Kurtosis	Chi-sq	df	Prob.
1	2.749111	0.099663	1	0.7522
2	2.451942	0.475583	1	0.4904
3	3.114838	0.020881	1	0.8851
Joint		0.596127	3	0.8973
Component	Jarque-Bera	df	Prob.	
1	0.105104	2	0.9488	
2	0.964299	2	0.6175	
3	3.470841	2	0.1763	
Joint	4.540244	6	0.6040	

Appendix 3: Heteoskedasticity Test

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 01/03/14 Time: 20:40
Sample: 1970 2009
Included observations: 38

Joint test:

Chi-sq	df	Prob.
52.01015	36	0.0410

Individual components:

Dependent	R-squared	F(6,31)	Prob.	Chi-sq(6)
res1*res1	0.134543	0.803206	0.5751	5.112641
res2*res2	0.190013	1.212033	0.3266	7.220478
res3*res3	0.260766	1.822553	0.1271	9.909119
res2*res1	0.162824	1.004871	0.4399	6.187293
res3*res1	0.114792	0.670001	0.6745	4.362084
res3*res2	0.193755	1.241642	0.3125	7.362693

Appendix 4: VAR Result

Vector Autoregression Estimates
Date: 01/03/14 Time: 20:41
Sample (adjusted): 1972 2009
Included observations: 38 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LOIL	REALIR	LUNN
LOIL(-1)	0.802081	-1.508612	0.065207
	(0.09949)	(0.50000)	(0.02474)
	[8.06209]	[-3.01721]	[2.63592]
REALIR(-1)	-0.001965	0.978781	0.000226
	(0.00261)	(0.01314)	(0.00065)
	[-0.75176]	[74.5140]	[0.34733]
LUNN(-1)	-0.198376	-1.467034	0.907148
	(0.16391)	(0.82377)	(0.04076)
	[-1.21028]	[-1.78089]	[22.2578]
C	2.340304	13.83339	0.705927
	(1.34267)	(6.74794)	(0.33386)
	[1.74302]	[2.05002]	[2.11445]
R-squared	0.657749	0.998217	0.979439
Adj. R-squared	0.627551	0.998060	0.977625
Sum sq. resids	3.179669	80.31298	0.196593
S.E. equation	0.305810	1.536928	0.076041
F-statistic	21.78081	6345.031	539.8734
Log likelihood	-6.784290	-68.13822	46.10020
Akaike AIC	0.567594	3.796748	-2.215800
Schwarz SC	0.739972	3.969126	-2.043423
Mean dependent	3.242326	-73.11547	9.195516
S.D. dependent	0.501093	34.89133	0.508349

Determinant resid covariance (dof adj.)	0.000528
Determinant resid covariance	0.000378
Log likelihood	-12.03392
Akaike information criterion	1.264943
Schwarz criterion	1.782076

Appendix 5: Short Run Structural VAR Output

Structural VAR Estimates
Date: 01/03/14 Time: 20:41
Sample (adjusted): 1972 2009
Included observations: 38 after adjustments
Estimation method: method of scoring (analytic derivatives)
Convergence achieved after 10 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I
Restriction Type: short-run pattern matrix

A =

1	0	0
C(1)	1	0
C(2)	C(3)	1

B =

C(4)	0	0
0	C(5)	0
0	0	C(6)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.805333	0.804751	-1.000724	0.3170
C(2)	0.024287	0.026615	0.912515	0.3615
C(3)	0.036465	0.005296	6.885693	0.0000
C(4)	0.305810	0.035079	8.717798	0.0000
C(5)	1.517067	0.174020	8.717798	0.0000
C(6)	0.049525	0.005681	8.717798	0.0000
Log likelihood	-18.37378			

Estimated A matrix:

1.000000	0.000000	0.000000
-0.805333	1.000000	0.000000
0.024287	0.036465	1.000000

Estimated B matrix:

0.305810	0.000000	0.000000
0.000000	1.517067	0.000000
0.000000	0.000000	0.049525

Appendix 6: Long Run Structural VAR Output

Structural VAR Estimates
Date: 01/03/14 Time: 20:41
Sample (adjusted): 1972 2009
Included observations: 38 after adjustments
Estimation method: method of scoring (analytic derivatives)
Convergence achieved after 23 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I
Restriction Type: long-run pattern matrix
Long-run response pattern:

C(1)	0	0
C(2)	C(4)	0
C(3)	C(5)	C(6)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	3.641434	0.417701	8.717798	0.0000
C(2)	-387.4043	47.44902	-8.164642	0.0000
C(3)	1.626881	0.210137	7.742010	0.0000
C(4)	102.5306	11.76106	8.717798	0.0000
C(5)	-0.509109	0.076951	-6.616001	0.0000
C(6)	0.308902	0.035433	8.717798	0.0000
Log likelihood	-18.37378			

Estimated A matrix:

1.000000	0.000000	0.000000
0.000000	1.000000	0.000000
0.000000	0.000000	1.000000

Estimated B matrix:

0.282263	0.100459	0.061279
-0.340038	1.428691	0.453170
0.001058	-0.070416	0.028682