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The effect of oil price shocks on the Saudi manufacturing sector

Abdelhamid A. Mahboub[1], Heba E. Ahmad[2]

Abstract

This paper aims to examine the effects of oil price shocks on the manufacturing sector in Saudi Arabia during the period 2002 – 2014, using quarterly data. A unit root test was conducted, in which the data were shown to be non-stationary in the level, and they became stationary in the first difference for all variables. The co-integration model was applied, and the results indicated that no co-integrating equation exists, which means that there is no long run effect of oil price shocks on the manufacturing sector. So, we estimate a Vector Auto Regressive model, the results of which implied that oil price shocks do not affect in the manufacturing sector in the short run, and it may have an effect on the manufacturing sector after 10 quarter according to the impulse response function.

Keywords: Oil prices; Manufacturing sector; Saudi Arabia economy; VAR

JEL Classification: C10, E31, L60, L72, Q41

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1. Introduction:

The recent fall of oil prices since June 2014 is just one round of a series of fluctuations, in the form of shocks, in oil prices. Nevertheless, a debate has arisen about the effect of this price fall on the world economy in general and on oil exporting countries in particular. The economy of Saudi Arabia, the major oil exporting country, is not an exception in this matter of course.

The main objective of this paper is to estimate quantitatively, in the economy of Saudi Arabia, whether there exists an impact of oil price shocks on the output of the manufacturing sector, and whether it is a positive (direct) or a negative (inverse) relationship.

The focus on the manufacturing sector here is for two reasons. First, the Saudi economic planning and policy have long targeted to diversify the sources of Gross Domestic Product GDP. Growth of the manufacturing sector is expected to be very important in this diversification process. Second, the growth of manufacturing sector is one of the important measures and/or indicators of economic development. For both reasons we have chosen to study 'the effect of oil price shocks on the Saudi manufacturing sector' in our paper.

Theoretical Background and Related Literature:

Theoretically, the change in oil prices is expected to have two contradictory effects on the manufacturing sector. For example the fall in oil prices, given that energy is an essential input to manufacturing industries (especially petrochemicals, which commonly represent a major industrial subsector in most oil rich countries), will reduce the cost of production. This may very well induce manufacturing output. Many researches have emphasized this effect. Alper and Torul (2009) have studied this relationship in the Turkish economy, using the Vector Auto Regressive (VAR)

Model for Turkish 1988-2006 data, and found that while oil price increases did not significantly affect the manufacturing sector in aggregate terms, some sub-sectors are adversely affected. Guidi (2015) has done a similar exercise on the UK economy, applying the VAR model for the 1970-2006 data. He found that the positive oil price changes resulted in a consistent contraction in manufacturing output, while the services sector did not seem to be affected by these increases in oil prices. As for Fukunaga, Hirakata and Sudo (2010), who studied the issue in the US and Japan economies at industry level, they have found that the way oil price changes affect each industry depends on what kind of underlying shock drives oil price changes, as well as on industry characteristics, i.e. whether the industry is oil-intensive industry or not. Again the inverse effect of oil price changes on industrial output appeared in most of the cases with different degrees. These preceding examples emphasize the role of oil as affecting the cost of production and hence the industrial total product.

But on the other hand, and especially in Saudi Arabia where the government plays an important role in supporting domestic industrial firms, the lower oil price will reduce oil export revenues (given the inelastic demand for oil). The government may not be able to provide the same level of support to domestic industry as it used to do. There is a great deal of researches sharing the same results that a fall in oil prices reduces government expenditure in oil exporting countries. See for example El Anshasy and Bradley (2011), Dizaji (2014), Garkaz et al. (2012), Hamdi and Sbia (2013). However, in the context of Saudi Arabia, some writers referred to the fact that the country has accumulated enough reserves as a buffer stock against unexpected drop in oil prices and revenues. This should reduce the effects on domestic industrial firms. Therefore, what is expected, according to this line of thinking, is that the manufacturing sector in Saudi economy will not be significantly affected by the oil price changes via the cost of production. The government is, in fact, subsidizing the price. Whitley and Makhijani (2014) have reported this observation. Accordingly, the effect is expected to be through the effect on the government expenditures only.

The above discussion shows that the net effect of oil price fall on the manufacturing sector is not known for sure. The same two contradictory effects apply to the case of an increase in oil prices but in the opposite directions, and the net effect is again uncertain. Therefore, there is a need for an empirical research to estimate and test this relationship. This paper tends to do the job in the context of the Saudi Economy.

Research Hypothesis:

This paper plans to test the following hypothesis:

The oil price shocks have a significantly inverse effect on the output of the manufacturing sector in Saudi Arabia.

2. Manufacturing Sector in Saudi Economy:

Manufacturing sector in the Saudi economy is growing continuously since there has been a realization of the importance of diversifying the economy. Growth of the manufacturing sector is expected to be in the heart of this diversification process. Besides, the growth of manufacturing sector is one of the important measures and/or indicators of economic development. Specifically, the relative share of manufacturing sector in generating GDP is expected to increase in the course of economic development. During the period considered in this paper, the annual growth rate of the manufacturing output has increased from 3.4% in 2002 and jumped to 13.5% in 2004 and stayed around 7% and 10% in the remaining period.

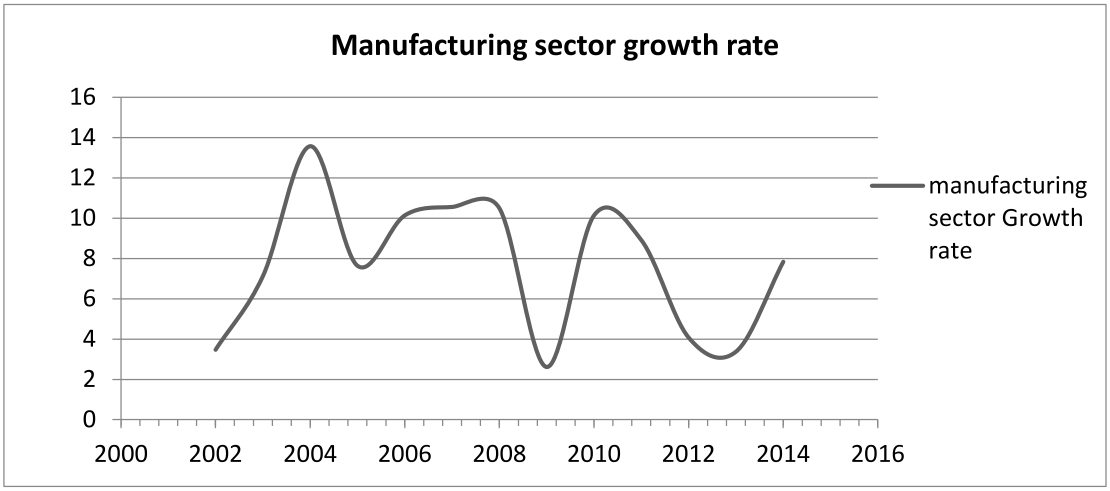


Figure 1 Manufacturing sector growth rate

Source: World Development Indicators, http://data.worldbank.org/data-catalog/world-development-indicators

The two giant existing industrial complexes, SABIC and Saudi ARAMCO are already producing plastics and petrochemical products and they are heading towards the production of aluminum. Saudi Arabia is endowed by two ingredients needed to produce aluminum; bauxite ore and cheap electricity, and hence the country aims at developing the aluminum industry into the production of car parts and even fully assembled cars (The Economist, 2015). Besides, there is already an investment spending plan of more than $70 billion in building up six new "economic cities" with modern infrastructure and business-friendly regulations.

Transforming the economy into industrialization is not an easy journey, especially with the existence of oil export revenues that tend to delay the incentive for such transformation. During the years covered by this study, the manufacturing output as a percentage of GDP was around 10% to 13% (SAMA, several issues). Similarly, the exports of manufacture as percentage of merchandise exports were running between 7% and 11%, as appears in the following table, which supports our previous remark that industrialization was slower than it should have been for several years because of the high oil export revenues.

Table 1 Manufacturing sector growth rate

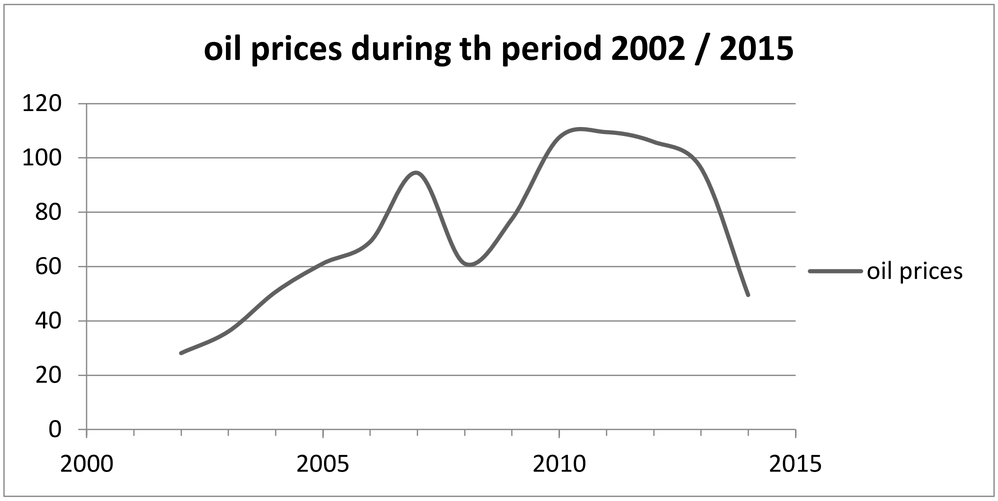
Year	2000	2001	2002	2003	2004	2005	2006
%	7.1	9.8	9.6	10.4	9.3	8.1	8.0
Year	2007	2008	2009	2010	2011	2012	2013
%	8.7	6.0	8.1	11.1	10.3	10.5	11.2

Source: World Development Indicators, http://data.worldbank.org/data-catalog/world-development-indicators.

3. Changes in Oil Prices:

World oil prices were always subject to changes. The world market forces, no doubt, are responsible for these changes. However, since there exist a few big sellers and a few big buyers, the final outcome of interaction among them does not necessarily agree with the traditional supply and demand model. During the years considered in this paper, oil price increased from $28.1 per barrel in 2003 to the highest level $109.45 per barrel in 2012 and then back to $26.94 per barrel in 2016. The following graph summarizes these movements in oil prices.

Figure 2 Oil prices changes



Source: World Development Indicators WDI, http://data.worldbank.org/data-catalog/world-development-indicators

The low value of the price elasticity of international demand for oil results in similar movements (in direction) in export revenues, and in the Saudi economy this is very true.

4. The Model and its Estimation

As expected, the manufacturing output can be affected by many other variables besides the oil prices. We need to include these variables when we assess the relationship between oil prices and manufacturing output. We have already mentioned the government subsidies. Also the government expenditures in general represent a significant component of domestic demand for manufacturing products. In addition, when these products are exportable, the exchange rate must be considered in the analysis.

In order to test our hypothesis, we will use the Vector Auto–Regressive (VAR) model to estimate the relationship between oil price changes and the manufacturing sector output in Saudi Arabia. The data set, for each variable included in the model, consists of quarterly observations for the period Q1:2002 to Q4: 2014.

All the data will come from World Development Indicators, WDI reports. The EVIEWS package will be used for estimation and hypothesis testing purposes.

4.1. Variables, Data and Methodology

The focus of the study is to estimate the relationship between oil price shocks and manufacturing sector product. The model contains five variables, namely oil price, industrial exports, government expenditure, real exchange rate and manufacturing sector product.

$$Ln\ manuf_t = c + Ln\ oil\_price_t + Ln\ Real\_exch_t + Ln\ export_t + \varepsilon_t \quad (1)$$

We define the variables as follows:

- **Ln manuft** is the log of the manufacturing sector product growth rate
- **Ln oil_price** is the log of oil price
- **Ln Gov** is the log of Government expenditure (% of GDP)
- **Ln Real_exch** is log of the index of real effective exchange rate.
- **Ln export** is the log of the industrial exports (% the total exports of goods and services.

4.2. Unit Root Test

The first step in constructing time series data is to determine the stationarity property of each variable. All variables were tested at the levels using the Augmented Dickey-Fuller (ADF) Test. Consider the equation below:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha \sum_{i=1}^{p} \Delta Y_{t-1} + u_t \qquad (2)$$

where Y is the variable of interest, Δ is the change, t is the time trend and the difference operator, P is the number of time lags, and u is the white noise residual of zero mean and constant mean and variance. The parameters $\alpha_1, \alpha_2, \beta_1, \ldots \beta_m$ are to be estimated. If the stationarity test is significant, the variable data series is stationary and has no unit root. Thus, the null hypothesis will be rejected.

The results from the tests of the study are discussed. Unit root test based on Augmented dickey-fuller (ADF) was performed to measure the stationarity property of the time series data. The results are shown below.

Table 2 Augmented Dicky Fuller test Results

Variables	Level		1st Difference	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
Oil_price	1.63	2.22	6.83***	6.86***
Real_exch	2.9	1.9	7.06***	8.09***
Manufat	2.74	2.35	5.69**	5.44**
Export	1.58	1.95	6.90***	6.93***
Gov	1.9	2.27	6.93***	6.99***

Note:(*, **) and (***) indicates the rejection of the null hypothesis of non-stationary at 10%, 5% and 1% significance level.
*MacKinnon (1996) one-sided p-values.

Table 2 shows that all variables (oil prices, manufacturing value added, gov, real_exhange and Export) are non-stationary at the level with the constant and with the time trend. However, in the first difference test, the results for all variables showed that they are significant. This means all variables are stationary.

4.3. Estimating VAR model

The second step is testing the long run relationship between our variables, so we used Johansen test (Johansen, 1991) the results of the Johansen co-integration test by using trace test and max-Eigen value test. The results indicate that there is no co-integrating equation at 5% level. Therefore there are not long-run effects of oil prices on manufacturing sector. So we can't run error correction model, but we run vector auto regressive model (Gujarati and Porter, 2008).

The VAR model has been used in similar researches as it appears in the above mentioned examples. Besides, it allows us to utilize the impulse response function and variance decomposition, which assess the current and future effects of oil price shocks on the economic variables included in the model. The variance decomposition analysis will allow us to assess the relative importance of oil price shocks on the volatility of the other variables. An identified VAR model has the following form:

$$\mathbf{Y}_t = \mathbf{\Pi}_1 \mathbf{Y}_{t-1} + \mathbf{\Pi}_2 \mathbf{Y}_{t-2} + \cdots + \mathbf{\Pi}_p \mathbf{Y}_{t-p} + \mathbf{\Phi D}_t + \mathbf{G X}_t + \varepsilon_t \qquad (3)$$

Where: D_t represents an (l×1) matrix of deterministic components, X_t represents an (m ×1) matrix of exogenous variables, and Φ and G are parameter matrices.

4.4. VAR Lag Length order Criteria

The optimal lag length of the VAR is (4) according to AIC, SC and HQ indexes (Table 3).

Table 3 VAR Lag Length order Criteria

Lag	LogL	AIC	SC	HQ
0	-622.28	28.51	28.71	28.58
1	-434.58	21.11	22.33	21.56
2	-426.49	21.88	24.11	22.71
3	-408.54	22.20	25.45	23.40
4	-232.6*	15.35*	19.61*	16.93*

*Indicates lag order selected by the criterion

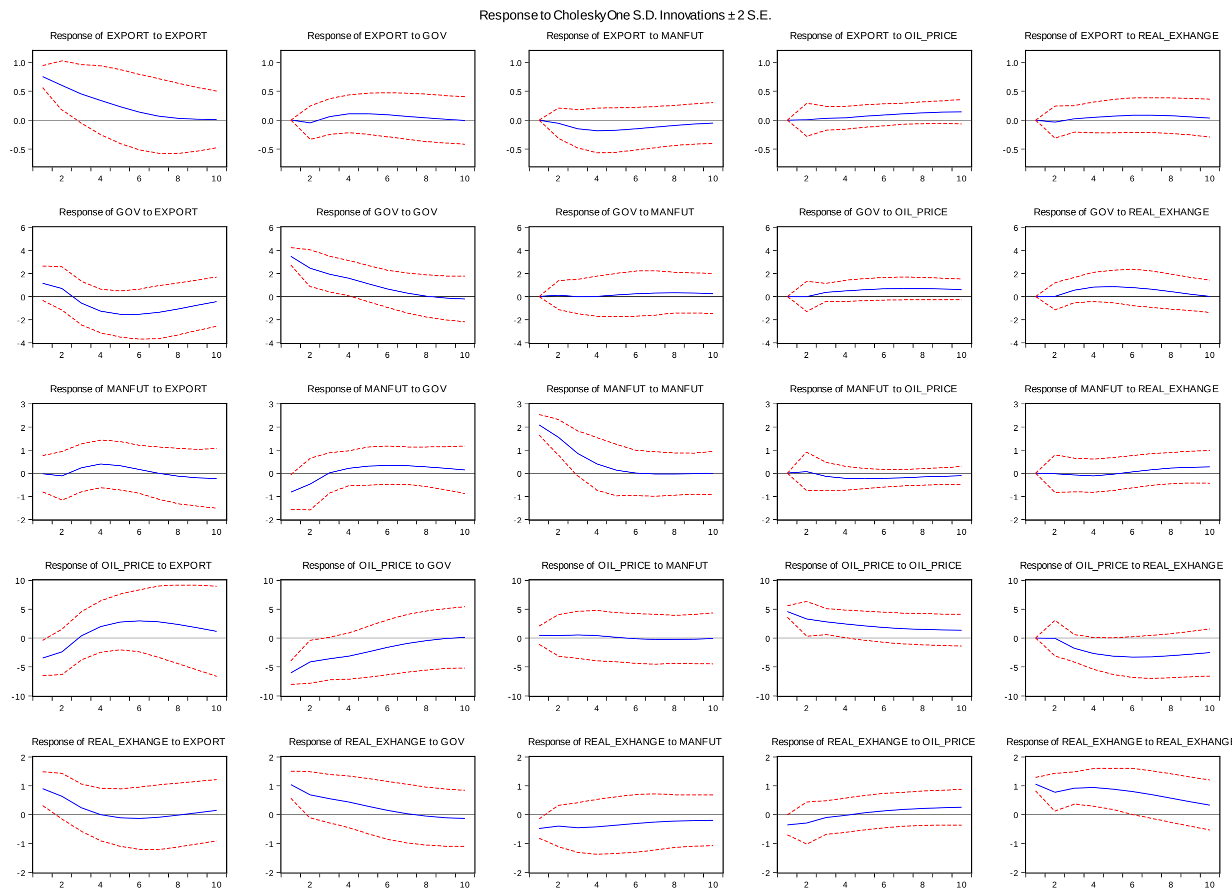
AIC: Akaike information criterion; SC: Schwarz information criterion and HQ: Hannan – Quinn information

After determining the optimal lag-length of the VAR models by log-likelihood ratio criterion, and Akaike information criterion. We estimate the effect of oil prices shocks, on all variables specially the manufacturing sector product in Saudi Arabia during the period using the impulse response function as follow:

4.5. The impulse response functions

As a conclusion, the VAR "manuf – oil_price" model can be considered representative to describe autoregressive connections between oil prices shocks and manufacturing sector growth rate of Saudi Arabia. Based on the model, we can identify four impulse responses (illustrated in Figure 3), which evaluates the effect of a shock on variations in current or future values of the oil prices and manufacturing sector growth and the other variables. Accumulated response to Cholesky one S.D. innovations ± 2 S.E.

Figure 3 The impulse response functions



Based on the chart analysis in (Figure 3) we can state the following estimations: 1. A +2% shock in the oil prices level generates almost no effect on the Saudi Arabia manufacturing sector growth rate in during the period of the forecast. The results of VAR estimation supported this result, as the estimation shows that the oil pries parameter was non-significant during the period. On the other hand according to the result of the impulse response function and var results oil prices has positive effect on the government spending during the next 10 Quarters.

5. Conclusion

Investigating the relationship between oil prices and manufacturing sector has been an issue of interest now. While numerous studies have been conducted and substantial progress have been achieved on developed economies, particularly on the U.S. economy, the dynamics for emerging small open economies have not been revealed, yet. In this study, we investigate the effects of oil prices and the growth of the manufacturing sector production in Saudi Arabia. Using many control variables in the literature, as well as real exchange industrial exports, government expenditure and the index of the real effective exchange rate, we perform multivariate VARs in order to estimate the net effect of oil price changes on the growth rate of the manufacturing sector.

We find out that oil product price has no effect on the manufacturing sector product in Saudi Arabia, it means that we accept the null hypothesis. The results of VAR estimation and the impulse response function supported this result, as the estimation shows that the oil prices parameter was non-significant during the period. On the other hand according to the result of the impulse response function and var results oil prices has positive effect on the government spending during the next 10 time period

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Appendix

Vector Autoregression Estimates
Date: 02/08/16 Time: 23:02
Sample (adjusted): 2003Q3 2015Q4
Included observations: 50 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EXPORT	GOV	INDUSTRY	OIL_PRIES
EXPORT(-1)	0.791368	-0.020524	0.032524	-0.102324
	(0.72730)	(0.96445)	(0.57308)	(3.04529)
	[1.08808]	[-0.02128]	[0.05675]	[-0.03360]
EXPORT(-2)	0.591894	-0.457804	0.400470	0.419420
	(0.69283)	(0.91873)	(0.54591)	(2.90093)
	[0.85432]	[-0.49830]	[0.73358]	[0.14458]
GOV(-1)	-0.044504	0.815782	-0.038168	-0.331627
	(0.37325)	(0.49495)	(0.29410)	(1.56284)
	[-0.11923]	[1.64820]	[-0.12978]	[-0.21220]
GOV(-2)	-0.143350	0.285357	-0.067256	0.611112
	(0.37310)	(0.49475)	(0.29398)	(1.56219)
	[-0.38422]	[0.57677]	[-0.22878]	[0.39119]
INDUSTRY(-1)	-0.141465	0.149947	0.630596	-0.339393
	(1.10266)	(1.46219)	(0.86884)	(4.61695)
	[-0.12829]	[0.10255]	[0.72579]	[-0.07351]
INDUSTRY(-2)	-1.029453	1.221105	-0.692037	0.386579
	(1.05047)	(1.39298)	(0.82771)	(4.39840)
	[-0.98000]	[0.87661]	[-0.83609]	[0.08789]
OIL_PRIES(-1)	0.007996	-0.014483	0.004669	0.913250
	(0.03987)	(0.05287)	(0.03141)	(0.16693)
	[0.20057]	[-0.27396]	[0.14862]	[5.47085]
OIL_PRIES(-2)	0.046830	-0.057082	0.043388	-0.054645
	(0.04211)	(0.05584)	(0.03318)	(0.17632)
	[1.11209]	[-1.02224]	[1.30765]	[-0.30993]
C	60.28460	-59.03997	45.24374	-30.13979
	(19.3018)	(25.5952)	(15.2087)	(80.8183)
	[3.12327]	[-2.30668]	[2.97485]	[-0.37293]
R-squared	0.816157	0.754726	0.772635	0.843183
Adj. R-squared	0.780285	0.706868	0.728271	0.812584
Sum sq. resids	297.4358	523.0182	184.6652	5214.566
S.E. equation	2.693424	3.571630	2.122270	11.27761
F-statistic	22.75205	15.77003	17.41582	27.55637
Log likelihood	-115.5263	-129.6368	-103.6100	-187.1266
Akaike AIC	4.981053	5.545470	4.504399	7.845065
Schwarz SC	5.325217	5.889634	4.848563	8.189229
Mean dependent	53.08936	77.22038	59.94379	74.59360
S.D. dependent	5.746125	6.596824	4.071294	26.05039

Determinant resid covariance (dof adj.)	211.1864
Determinant resid covariance	95.48197
Log likelihood	-397.7611
Akaike information criterion	17.35045
Schwarz criterion	18.72710

VAR Equations

EXPORT = 0.791368075696*EXPORT(-1) + 0.591894314474*EXPORT(-2) - 0.0445042271081*GOV(-1) - 0.143349600433*GOV(-2) - 0.141465350179* manuf(-1) - 1.0294529512 manuf (-2) + 0.00799636914773*OIL_PRIES(-1) + 0.0468298648837*OIL_PRIES(-2) + 60.284601835

GOV = - 0.0205243778026*EXPORT(-1) - 0.457804122515*EXPORT(-2) + 0.815781809736*GOV(-1) + 0.285357259442*GOV(-2) + 0.149947310276*manuf (-1) + 1.22110452631*Imanuf (-2) - 0.014483176159*OIL_PRIES(-1) - 0.0570816422531*OIL_PRIES(-2) - 59.0399676346

Manuf = 0.0325236739807*EXPORT(-1) + 0.400470365344*EXPORT(-2) - 0.038167878675*GOV(-1) - 0.0672562279498*GOV(-2) + 0.630595950465*manuf(-1) - 0.692037057396*manuf(-2) + 0.00466859720261*OIL_PRIES(-1) + 0.0433881615622*OIL_PRIES(-2) + 45.2437429096

OIL_PRIES = - 0.102323519875*EXPORT(-1) + 0.419420119416*EXPORT(-2) - 0.331627480937*GOV(-1) + 0.611111692213*GOV(-2) - 0.33939301152*manuf (-1) + 0.386578862988*manuf (-2) + 0.913250076818*OIL_PRIES(-1) - 0.0546453023902*OIL_PRIES(-2) - 30.1397882213