ANALYZING EFFECTS OF OIL PRICE SHOCKS ON SECTORS OF INDIAN ECONOMY

STUDY ORIENTED PROJECT

Submitted by:

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1. Introduction:

India is a diverse country with the people taking up occupation in several different sectors. Due to the advancements in technologies, almost every sector or job is dependent on oil, be it directly or indirectly. This is true not only for India but for every single country in the world. Some countries are blessed with abundant oil reserves and thus earn revenue by selling it to the countries which lack sufficient oil reserves. Due to the increasing populations as well, the demand for various goods and services increases dramatically, thereby causing a rise in demand and use of oil. India is just behind China in population terms and might soon overtake it. Keeping this in mind along with the meagre amount of oil reserves that India has, it is safe to assume that Oil demand will be drastically increasing from India in the coming future. This makes India a net oil importer and has significant impact on Indian Forex Reserves and the Government budget. Merging all this together augments the importance of understanding the importance of oil on various sectors of the Indian economy. Most literature work done for India focuses on impact of oil prices on macro-economic variables like GDP, Inflation Rate, Exchange Rate etc, but very few studies go to the sectoral level.

This being said, the main aim of this project is to understand the impact of oil price shocks on the various sectors of Indian economy. The hypothesis to be tested can be broadly put forward as:

1) Oil price shocks have a significant impact on % GDP contribution on Agriculture, Manufacturing, Construction and Transport sectors.

2) Effects of oil price shocks are transferred to these sectors after a gap of 1 or 2 quarters.

2. Literature Review:

Oil is an important commodity in almost sector of every economy. Be it an agricultural activity or a part of services sector, oil somehow finds use in all of these. Owing to its high resourcefulness, almost every economy is heavily dependent on oil and this dependence grows with each passing day. Countries which are net producers of oil usually enjoy high revenues from it and are benefitted with increase in oil prices. However almost every major economy in the world is a net oil importer and thus fluctuations in oil prices have a dramatic effect on both, macroeconomic and microeconomic parameters of the nation.

Numerous studies have been conducted to determine the effect of an oil price shock on a given economy and the common notion is that degree of effects vary with various factors like dependence of a nation on oil, its advancements in the field of renewable sources of energy (Iceland) ,etc. Majority of the work done in this field primarily looks at the effects of oil price shocks on macroeconomic variables likes GDP, Inflation Rate, Exchange Rate etc. Sajal Ghosh and Kakali Kanjilal (2014) deployed a extended Vector Autoregressive (VAR) model along with a Markov Switching Regime to look at effects of oil price fluctuations on Indian macro variables like IIP, CPI, Inflation, Forex reserves etc. One of their major findings was to show that inflation and foreign exchange reserves are greatly affected by shocks in oil price since India is heavily dependent on imported oil. They also concluded that movement of oil price was exogenous with respect to movement in Indian macroeconomic variables.

Though the studies at a more deeper, grassroots level are sparse, their implications have far reaching impact on how decisions are made at a sectoral level. A study by PwC UK analysed the effects of an oil price decrease on the UK economy using a CGE model. It was noted that the oil and gas extraction sectors were negatively affected whereas agriculture and transport sector showed promising growth. The study also gave a general idea about which industries are dependent on oil and are likely to be affected by a random shock in oil prices. Apart from industries like Construction and Finance, various indicators like employment rate, household spending, trade deficit, government spending were affected by the assumed oil price shock.

Supporting the claims by the PwC article, Kiseok Lee and Shawn Ni (2002) look at oil price shocks using industry level data. They used structural VAR models with recursive blocks using both macro variables and industry level data. The Impulse Response Functions generated from the model indicate that industries that have a large cost share of oil like the petroleum refineries or industrial chemicals reduce supply following an increase in oil prices whereas automobile sectors are faced with reduced demand since increase in oil prices reduces real income of households.

A study by Rebeca Jimenez-Rodriguez (2008) showed that increase in oil price had a significant negative impact on GDP growth and contributed to higher inflationary pressures on oil importing countries. The study employed a recursively identified bivariate VAR model using real oil price and specific industrial outputs from sectors like textiles, food and beverage, metal products, machinery, chemical industries etc. The generated IRF's were used to look for similarities and dissimilarities amongst the effects of an oil price shock on 6 OECD countries. It was found that movements in various industrial outputs were similar across US and UK but different across the other 4 nations namely France, Germany, Italy and Spain.

Mohd Shaari, Tan Pei and Hafizah Rahim (2013) looked at effects of oil price shocks on the agriculture, construction, manufacturing and transport sectors of Malaysia. The study conducted general tests to check for stationarity, cointegration and Granger Causality on % share in GDP of above mentioned sectors and oil price in domestic currency. The cointegration test showed long term relationships between oil price changes and the output of the sectors whereas the Granger Causality tests unearthed relations between directions of movements of sectoral outputs in response to an oil price shock. Using a VAR model, Alper and Torul (2009) concluded that oil price increase did not affect manufacturing sectors of Turkey in an aggregate term, however effects on real production growth rate in various manufacturing subsectors were observed. Studies on the Iranian economy showed significant negative impact of oil price on the agriculture and industrial sector since these two sectors form a major part of the Iranian GDP. Results from Hanson et al (2010)'s study on US agricultural sector show its dependence on energy such as oil. All these studies can be related to India since a majority of the Indian population is employed in the agricultural sector and is highly dependent on imported oil and oil based products.

3. Data Sources:

The analysis is based on identifying effects of oil price shocks on various sectors of the Indian economy taking into account 4 sectors namely Agriculture, Manufacturing, Construction and Transport. These sectors were chosen because of their maximum contribution to the Indian GDP. Contribution to GDP (%) for these sectors is chosen since it gives the clearest picture about the performance of these sectors. This data has been taken from the RBI official website. Quarterly data for the same has been collected starting from 2004-2015. Apart from this, oil prices have been chosen to see the effects on the variables. Dollar price per barrel of oil was obtained from online sources. However in order to have a set of homogenous units in the equation, the dollar price was converted to Indian Rupees using exchange rate prevailing for the corresponding quarters. In case quarterly exchange rate was not available, average of monthly exchange rate was chosen as the accepted exchange rate.

4. Methodology:

A Vector Autoregressive (VAR) and Vector Error Correction Model (VECM) have been implemented to look for long and short run effects of oil price shocks on the Indian economy. All the implementation has been done in the software R.

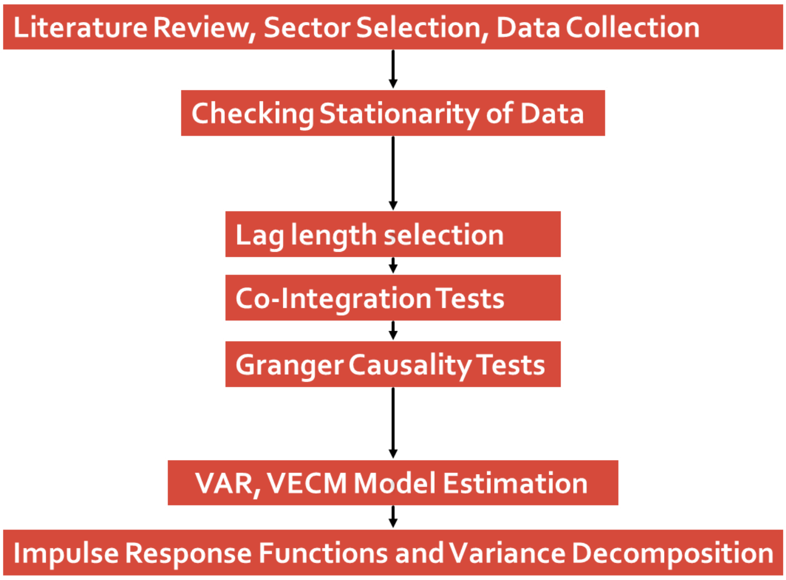

FIGURE 1: METHODOLOGY

The above flow chart (Figure 1) briefly describes the procedure followed in the paper. Firstly, the stationarity of all the variables was checked using the KPSS test which has the null hypothesis of stationarity. Following this a Johansen based co-integartion model was adopted to look for long run relationships amongst the variables. Along with this, optimal lag length was selected for all the variables using the Akaike Information Criterion and the Schwarz Information Criterion. Next, Granger Causality tests were implemented to look for direction of influence amongst variables. Based on the above results, a VAR model is implemented from a VECM model to look for long and short run relationships between variables. Various regression equations of the variables are obtained that depend upon lagged values of the variables. Impulse Response Functions are generated to look for effect of oil price shocks on all the 4 variables. Lastly, Forecast Error Variance Decomposition is undertaken to look for the strength of influence of each variables on the other variables.

5. Results:

KPSS Stationarity Tests		
Sector	**Test Statistic**	**P-value**
Agriculture	0.030895	0.1
Manufacturing	0.32504	0.1
Construction	0.156	0.1
Transport	0.15994	0.1
Oil	0.052753	0.1

Table 1: KPSS Unit Root Tests

The above table (Table 1) shows the results of the Stationarity tests carried out using the KPSS Test. All variables are seen to be unit root stationary as they do not reject the null hypothesis of stationarity at first difference.

Co-Integration Tests				
	Trace Tests		Eigenvalue Tests	
	Test	5 pct	Test	5pct
r=4	1.12	8.18	1.2	8.18
r=3	7.54	17.95	6.42	14.9
r=2	28.46	31.52	20.92	21.07
r=1	63.24	48.28	34.78	27.14
r=0	135.92	66.49	72.68	33.32

Table 2: Johansen Co-Integration Tests

Johansen Cointegration results (Table 2) reveal the presence of 2 long run co-integrating long run relationship amongst the variables. These results are seen from both the eigenvalue and trace statistic test where the null hypothesis can't be rejected at 5 % level of significance. These results are then used to build up a VAR and a VECM model.

Instantaneous and Granger Causality tests both reveal the presence of Granger Causation between oil and the GDP contribution of agriculture, manufacturing, construction and transport sectors. The results can be seen in the below table, where the null hypothesis on causality is rejected in both the cases due to small p-values. (Figure 2)

```
$Granger

        Granger causality H0: oil do not Granger-cause agri manu const trans

data:  VAR object var_est
F-Test = 6.803, df1 = 12, df2 = 135, p-value = 1.706e-09


$Instant

        H0: No instantaneous causality between: oil and agri manu const trans

data:  VAR object var_est
Chi-squared = 12.006, df = 4, p-value = 0.0173
```

FIGURE 2: GRANGER CAUSALITY TEST RESULTS

The Vector Autoregressive (VAR) model is implemented using the information obtained from the previous tests. The analysis reveals the following equations for the variables, dependent on the lagged terms. Only the significant terms are included.

1) $oil = -4.716 + 0.601 * oil(l1) + 1.25 * agri(l1)$

2) $agri = 5.64 + 0.13 * oil(l1) - 0.41 * agri(l1) - 0.67 * agri(l2) - 0.78 * agri(l3) + 2.10 * trans(l3)$

3) $manu = 0.064 * oil(l1) - 0.0194 * oil(l2) - 0.21 * agri(l2)$

4) $const = 0.56 * agri(l1) - 0.45 * trans * (l1) - 0.05 * oil(l2) - 0.15 * agri(l2) + 0.49 * trans(l3)$

5) $trans = 0.85 + 0.04 * oil(l1) - 0.28 * agri(l2) + 0.54 * trans(l2) - 0.05 * oil(l3) - 0.14 * agri(l3) + 0.38 * const(l3)$

It is evident from the equations that oil has an impact on the future values of all the 4 variables. It is seen that oil has a positive impact on agriculture, manufacturing and transport in the first lag, which might be due effects of oil price shocks not yet percolating deep down. However from the second lag onwards the coefficients of the oil parameter are negative which are in line with the economic logic and can also be confirmed from the Impulse Response Functions discussed later on. However, a surprising result is the independence of agriculture GDP on oil barring a positive impact at lag 1. This is astounding because agriculture is affected by rising oil prices which affects transport and then affects agriculture. All results are in line with economic logic and also confirm with the Response Functions discussed later on.

The impulse response functions (Figure 3) generated using the VAR model reveal interesting results, which confirm with the economic logic. It can be seen that apart from agriculture, all variables boom for one quarter or so before the effects of oil price increase start showing their effects where in the GDP contribution decreases/shows a negative response. Agriculture on the other hand is impacted in the same time period as the oil price change and negative effects are seen very quickly. Roughly after around 2 quarters on average all sectors start showing negative effects to an increase in oil price which is consistent with the economic logic that oil price increases makes production in these sectors costly thus reducing their contribution.

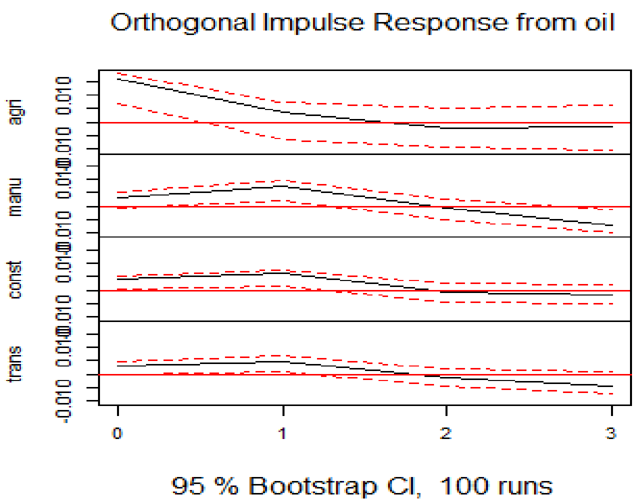

FIGURE 3: IMPULSE RESPONSE FUNCTIONS

Forecast Error Variance Decomposition (Figure 4) tells us about the variability that occurs in a variables due the factors that influence it, at different time lags. The procedure carried out in this context reveals that majority of fluctuations in the macroeconomic variables and oil prices is caused by that variable itself, apart from a few situations. For example, variance in construction at lag 3 and 2 is shown majorly by the manufacturing and oil variables combined while variance in transport at lag 3 is 50% explained by changes in transport itself while the remaining 50% is distributed over agriculture, manufacturing and oil values which confirms with the economic logic. This shows that effects of oil price shocks percolate into the other variables after a period of 1 quarter.

```
$oil
           oil       agri        manu      const        trans
[1,] 1.0000000 0.00000000 0.000000000 0.00000000 0.0000000000
[2,] 0.9222088 0.05423932 0.003264553 0.01982971 0.0004576275
[3,] 0.8676220 0.06389993 0.011422873 0.04602361 0.0110315884

$agri
           oil      agri        manu       const        trans
[1,] 0.3814193 0.6185807 0.000000000 0.000000000 0.0000000000
[2,] 0.3539224 0.6413919 0.001553109 0.002681912 0.0004506778
[3,] 0.3044117 0.6128628 0.071092902 0.003012430 0.0086202290

$manu
            oil         agri      manu      const        trans
[1,] 0.09750168 0.0009179095 0.9015804 0.00000000 0.0000000000
[2,] 0.36125670 0.0025252670 0.6254578 0.01022220 0.0005380638
[3,] 0.32034292 0.0192015543 0.6440515 0.01136871 0.0050352753

$const
           oil       agri      manu     const      trans
[1,] 0.2058957 0.01138824 0.2434684 0.5392477 0.00000000
[2,] 0.3236521 0.01688952 0.2829919 0.3130917 0.06337478
[3,] 0.3059879 0.05144183 0.2879442 0.2948163 0.05980981

$trans
           oil       agri      manu       const     trans
[1,] 0.1063192 0.06705286 0.2179233 0.004046285 0.6046584
[2,] 0.2846281 0.06639625 0.1653171 0.005451056 0.4782075
[3,] 0.2330208 0.12815940 0.1404799 0.004639759 0.4937002
```

FIGURE 4: FORECAST ERROR VARIANCE DECOMPOSITION RESULTS

6. Conclusions:

The work's main aim to determine the impact of oil price shocks on various sectors of the Indian economy. Mostly all literature work done in this field focuses on macro-economic variables and thus this study provides a necessary outlook at a deeper level. Starting from stationarity till Forecast Error Variance Decomposition, all results provide significant details about how the oil price shocks affect each sector. Apart from being unit root stationary, all variables are integrated in the long run. These relationships are laid out as equations prior in the paper. All significant coefficients are mentioned which not only confirm with economic logic but also are of correct sign in the Indian context. Impulse Response Functions show us that following oil price shocks, it takes the economy on average 1.5 quarters to reach equilibrium. Lastly, FEVD results show how each variable is impacted by other variables at different time lags. These results, thus, will not only provide an in depth view of effects of oil price shocks on the major sectors of Indian economy, but also help authorities make better policy decisions by considering the lag length effects as well.

It should be noted that these results are just a primary work and in no way should it be considered as final. Lots of work can be done on this if provided with adequate data.

References:

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Data Sources:

GDP Data Set: https://dbie.rbi.org.in/DBIE/dbie.rbi?site=home/

Monthly Oil Prices (Rs.): http://www.indexmundi.com/commodities/?commodity=crude-oil&months=120&currency=inr

US $ to INR Exchange Rate: https://www.oanda.com/currency/average

APPENDIX

A1: Complete results of the Vector Autoregressive (VAR) Model:

```
## VAR Estimation Results:
## =========================
## Endogenous variables: oil, agri, manu, const, trans
## Deterministic variables: const
## Sample size: 39
## Log Likelihood: 597.744
## Roots of the characteristic polynomial:
## 0.9961 0.9868 0.9868 0.9459 0.9459 0.7694 0.7694 0.6875 0.6875 0.5764 0
.524 0.524 0.5142 0.1712 0.1712
## Call:
## VAR(y = DF, p = 3, type = "const")
##
##
## Estimation results for equation oil:
## ====================================
## oil = oil.l1 + agri.l1 + manu.l1 + const.l1 + trans.l1 + oil.l2 + agri.
l2 + manu.l2 + const.l2 + trans.l2 + oil.l3 + agri.l3 + manu.l3 + const.l3
 + trans.l3 + const
##
##          Estimate Std. Error t value Pr(>|t|)
## oil.l1    0.60069    0.21999   2.730   0.0119 *
## agri.l1   1.24988    0.55309   2.260   0.0336 *
## manu.l1   0.28389    2.29362   0.124   0.9026
## const.l1 -2.14953    1.90288  -1.130   0.2703
## trans.l1  0.30739    2.20990   0.139   0.8906
## oil.l2   -0.37800    0.24553  -1.540   0.1373
## agri.l2   0.85292    0.51767   1.648   0.1130
## manu.l2   1.87542    2.15917   0.869   0.3940
## const.l2 -0.16063    2.13003  -0.075   0.9405
## trans.l2 -2.88078    2.25522  -1.277   0.2142
## oil.l3   -0.03196    0.25970  -0.123   0.9031
## agri.l3   0.33332    0.65041   0.512   0.6132
## manu.l3  -1.80111    1.89905  -0.948   0.3528
## const.l3  2.50859    1.75518   1.429   0.1664
## trans.l3  2.01115    2.11651   0.950   0.3519
## const    -4.71678    2.56555  -1.839   0.0789 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.07771 on 23 degrees of freedom
## Multiple R-Squared: 0.8642,  Adjusted R-squared: 0.7756
## F-statistic: 9.758 on 15 and 23 DF,  p-value: 1.124e-06
##
##
## Estimation results for equation agri:
## =====================================
## agri = oil.l1 + agri.l1 + manu.l1 + const.l1 + trans.l1 + oil.l2 + agri
.l2 + manu.l2 + const.l2 + trans.l2 + oil.l3 + agri.l3 + manu.l3 + const.l
```

```
3 + trans.l3 + const
##
##           Estimate Std. Error t value Pr(>|t|)
## oil.l1    0.13745    0.07193   1.911 0.068558 .
## agri.l1  -0.41154    0.18084  -2.276 0.032494 *
## manu.l1  -0.04727    0.74992  -0.063 0.950281
## const.l1 -0.21429    0.62217  -0.344 0.733652
## trans.l1  0.08101    0.72255   0.112 0.911709
## oil.l2    0.06064    0.08028   0.755 0.457683
## agri.l2  -0.66994    0.16926  -3.958 0.000624 ***
## manu.l2  -0.53465    0.70596  -0.757 0.456536
## const.l2  0.20552    0.69644   0.295 0.770563
## trans.l2 -0.50138    0.73737  -0.680 0.503318
## oil.l3    0.07929    0.08491   0.934 0.360140
## agri.l3  -0.78033    0.21266  -3.669 0.001274 **
## manu.l3  -0.50078    0.62091  -0.807 0.428206
## const.l3  0.10661    0.57388   0.186 0.854255
## trans.l3  2.10767    0.69202   3.046 0.005739 **
## const     5.64703    0.83883   6.732 7.24e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.02541 on 23 degrees of freedom
## Multiple R-Squared: 0.9512,  Adjusted R-squared: 0.9194
## F-statistic: 29.88 on 15 and 23 DF,  p-value: 1.536e-11
##
##
## Estimation results for equation manu:
## =====================================
## manu = oil.l1 + agri.l1 + manu.l1 + const.l1 + trans.l1 + oil.l2 + agri
.l2 + manu.l2 + const.l2 + trans.l2 + oil.l3 + agri.l3 + manu.l3 + const.l
3 + trans.l3 + const
##
##            Estimate Std. Error t value Pr(>|t|)
## oil.l1    0.064582   0.027567   2.343  0.02816 *
## agri.l1   0.008899   0.069306   0.128  0.89895
## manu.l1   0.443248   0.287407   1.542  0.13667
## const.l1  0.197134   0.238445   0.827  0.41687
## trans.l1  0.043929   0.276917   0.159  0.87534
## oil.l2   -0.085161   0.030767  -2.768  0.01094 *
## agri.l2  -0.212060   0.064867  -3.269  0.00337 **
## manu.l2   0.157285   0.270560   0.581  0.56667
## const.l2 -0.141293   0.266909  -0.529  0.60162
## trans.l2  0.175913   0.282597   0.622  0.53974
## oil.l3   -0.045452   0.032542  -1.397  0.17583
## agri.l3  -0.035534   0.081501  -0.436  0.66690
## manu.l3  -0.045513   0.237965  -0.191  0.85000
## const.l3  0.322829   0.219937   1.468  0.15570
## trans.l3  0.014128   0.265214   0.053  0.95798
## const     0.536433   0.321482   1.669  0.10875
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
##
## Residual standard error: 0.009738 on 23 degrees of freedom
## Multiple R-Squared: 0.9925,  Adjusted R-squared: 0.9876
## F-statistic: 202.9 on 15 and 23 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation const:
## ======================================
## const = oil.l1 + agri.l1 + manu.l1 + const.l1 + trans.l1 + oil.l2 + agr
i.l2 + manu.l2 + const.l2 + trans.l2 + oil.l3 + agri.l3 + manu.l3 + const.
l3 + trans.l3 + const
##
##          Estimate Std. Error t value Pr(>|t|)
## oil.l1    0.03218    0.02600   1.238   0.2282
## agri.l1   0.09315    0.06536   1.425   0.1675
## manu.l1   0.56622    0.27104   2.089   0.0480 *
## const.l1  0.38206    0.22486   1.699   0.1028
## trans.l1 -0.45333    0.26114  -1.736   0.0960 .
## oil.l2   -0.05828    0.02901  -2.009   0.0565 .
## agri.l2  -0.15269    0.06117  -2.496   0.0202 *
## manu.l2  -0.32023    0.25515  -1.255   0.2221
## const.l2 -0.02522    0.25171  -0.100   0.9211
## trans.l2  0.18454    0.26650   0.692   0.4956
## oil.l3    0.03506    0.03069   1.143   0.2650
## agri.l3  -0.05620    0.07686  -0.731   0.4720
## manu.l3  -0.08760    0.22441  -0.390   0.6998
## const.l3  0.17255    0.20741   0.832   0.4140
## trans.l3  0.49353    0.25011   1.973   0.0606 .
## const     0.44681    0.30317   1.474   0.1541
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.009183 on 23 degrees of freedom
## Multiple R-Squared: 0.9922,  Adjusted R-squared: 0.9871
## F-statistic:   195 on 15 and 23 DF,  p-value: < 2.2e-16
##
##
## Estimation results for equation trans:
## ======================================
## trans = oil.l1 + agri.l1 + manu.l1 + const.l1 + trans.l1 + oil.l2 + agr
i.l2 + manu.l2 + const.l2 + trans.l2 + oil.l3 + agri.l3 + manu.l3 + const.
l3 + trans.l3 + const
##
##          Estimate Std. Error t value Pr(>|t|)
## oil.l1    0.04495    0.02576   1.745  0.09434 .
## agri.l1   0.03757    0.06476   0.580  0.56747
## manu.l1  -0.08473    0.26856  -0.315  0.75524
## const.l1  0.05646    0.22281   0.253  0.80222
## trans.l1  0.23547    0.25876   0.910  0.37227
## oil.l2   -0.02494    0.02875  -0.867  0.39465
## agri.l2  -0.28454    0.06061  -4.694 9.97e-05 ***
## manu.l2  -0.10854    0.25282  -0.429  0.67170
## const.l2  0.07094    0.24941   0.284  0.77862
```

```
## trans.l2  0.53948    0.26407   2.043  0.05268 .
## oil.l3   -0.05411    0.03041  -1.780  0.08837 .
## agri.l3  -0.14392    0.07616  -1.890  0.07146 .
## manu.l3  -0.10711    0.22236  -0.482  0.63459
## const.l3  0.38225    0.20552   1.860  0.07573 .
## trans.l3  0.23230    0.24783   0.937  0.35831
## const     0.85195    0.30040   2.836  0.00936 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##
## Residual standard error: 0.0091 on 23 degrees of freedom
## Multiple R-Squared: 0.9949,  Adjusted R-squared: 0.9915
## F-statistic: 297.1 on 15 and 23 DF,  p-value: < 2.2e-16
##
##
##
## Covariance matrix of residuals:
##             oil      agri      manu     const     trans
## oil   0.0060393 1.220e-03 2.363e-04 3.238e-04 2.306e-04
## agri  0.0012195 6.456e-04 5.361e-05 8.498e-05 9.365e-05
## manu  0.0002363 5.361e-05 9.483e-05 5.486e-05 4.899e-05
## const 0.0003238 8.498e-05 5.486e-05 8.433e-05 3.782e-05
## trans 0.0002306 9.365e-05 4.899e-05 3.782e-05 8.280e-05
##
## Correlation matrix of residuals:
##          oil   agri   manu  const  trans
## oil   1.0000 0.6176 0.3123 0.4538 0.3261
## agri  0.6176 1.0000 0.2167 0.3642 0.4050
## manu  0.3123 0.2167 1.0000 0.6134 0.5529
## const 0.4538 0.3642 0.6134 1.0000 0.4526
## trans 0.3261 0.4050 0.5529 0.4526 1.0000
```

A2: R code for the analysis:

````
---
title: "SOP"
author: "Kathan"
date: "1 October 2016"
output: html_document
---

```{r setup, include=FALSE}
knitr::opts_chunk$set(echo = TRUE)
```

## Study Oriented Project Analysis

This displays all the results and analysis done on the data-set created for the SOP.

```{r,echo=FALSE}
#Reading in data,modifying it,initiating libraries.
data<-read.csv("Final_Data.csv")
````
````

~~~~
data<-data[1:42,]
suppressWarnings(suppressMessages(library(tseries)))
suppressWarnings(suppressMessages(library(ggplot2)))
suppressWarnings(suppressMessages(library(vars)))
suppressWarnings(suppressMessages(library(urca)))
for(i in c(3,4,5,6,10)){
  data[,i]<-log10(data[,i])
}
oil<-data[,10]
agri<-data[,3]
manu<-data[,4]
const<-data[,5]
trans<-data[,6]
DF<-data.frame(oil,agri,manu,const,trans)
```
##Checking Stationarity for all parameters
###Agriculture
```{r,echo=FALSE}
###Agriculture
suppressWarnings(kpss.test(diff(data[,3])))
```
###Manufacturing
```{r,echo=FALSE}
###Manufacturing
suppressWarnings(kpss.test(diff(data[,4])))
```
###Construction
```{r,echo=FALSE}
###Construction
suppressWarnings(kpss.test(diff(data[,5])))
```
###Transport
```{r,echo=FALSE}
###Transport
suppressWarnings(kpss.test(diff(data[,6])))
```
###Oil
```{r,echo=FALSE}
###Oil
suppressWarnings(kpss.test(diff(data[,10])))
```
##Co-Integration Tests
###All 5 parameters taken as a group
```{r}
CoInt<-ca.jo(DF,K=3,spec="longrun")
summary(CoInt)
```
###Determing proper lag length of the input matrix for VAR Model
```{r}
VARselect(data.frame(data[,3],data[,4],data[,5],data[,6],data[,10]))$selection
```
~~~~

````
###Creating VAR Model
```{r}
var_est<-VAR(DF,p=3,type="const")
VECM<-cajorls(CoInt,r=2)
VAR<-vec2var(CoInt,r=2)
summary(var_est)
```
###Impulse Response Functions
```{r}
irf_est<-irf(var_est,impulse="oil",response=c("agri","manu","const","trans"),n.ahead=3,ortho
=TRUE)
plot(irf_est)
```
###Forecast Error Variance Decomposition
```{r}
fevd(var_est,n.ahead=3)
```
###Granger Causality Tests
```{r}
causality(var_est,cause="oil")
```
````