Assignment 6 Spring 2020

DUE DATE: Wednesday 19^{th}, May 2021.

I pledge to the Honor Code and to obey all rules for taking and performing homework assignments as specified by the course instructor.

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There are two questions.

Question1.

Consider the monthly unemployment rates of Michigan, Illinois, and Indiana from 1976.1 to 2017.2. Build a VAR model for this 3-dimensional time series. Simplify (or refine) the model by removing insignificant parameters with threshold of t-ratio 1.645, and perform model checking.The data are in m-unrate-MIILIN.txt.

1.1 Write down the final fitted model.

1.2 Obtain the plots of impulse response function of the fitted model and explain the relationship among the monthly unemployment rates of Michigan, Illinois, and Indiana from 1976.1 to 2017.2.

Question2.

Consider the monthly growth rate of M1 money supply of China and the growth rate of monthly crude oil price. The original data are from FRED. The crude oil prices are MCOILWTICO, Western Texas Intermediate. The data are in m-m1cnwti.txt with first column containing M1 series.

2.1 Obtain the time series plots of the bivariate time series, say z_t.

2.2 Build a VAR model for z_t, including simplification and model checking. Write down the fitted model.

2.3 Obtain the impulse response functions of the fitted model. What is the relationship between the M1 money supply of China and crude oil price, which represents commodity prices.

2.4 Obtain 1-step to 6-step ahead predictions of z_t at the forecast origin 2015.2.

2.5 Obtain the forecast error variance decomposition and explain it.

Question 1 : 1.1

```
Estimation results for equation MI:
===================================
MI = MI.l1 + IL.l1 + IN.l1 + MI.l2 + IL.l2 + IN.l2 + const

       Estimate Std. Error t value Pr(>|t|)
MI.l1  0.198967   0.044522   4.469 9.81e-06 ***
IL.l1  0.275604   0.073512   3.749 0.000199 ***
IN.l1  0.130995   0.049704   2.635 0.008673 **
MI.l2  0.309097   0.045360   6.814 2.84e-11 ***
IL.l2 -0.106027   0.072016  -1.472 0.141604
IN.l2  0.005618   0.050137   0.112 0.910836
const -0.043085   0.089680  -0.480 0.631141
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.978 on 482 degrees of freedom
Multiple R-Squared: 0.4075,     Adjusted R-squared: 0.4001
F-statistic: 55.24 on 6 and 482 DF,  p-value: < 2.2e-16
```

$$MI_t = \underset{(0.044522)}{0.198967}\,MI_{t-1} + \underset{(0.073512)}{0.275604}\,IL_{t-1} + \underset{(0.049704)}{0.130995}\,IN_{t-1} + \underset{(0.045360)}{0.309097}\,MI_{t-2}$$

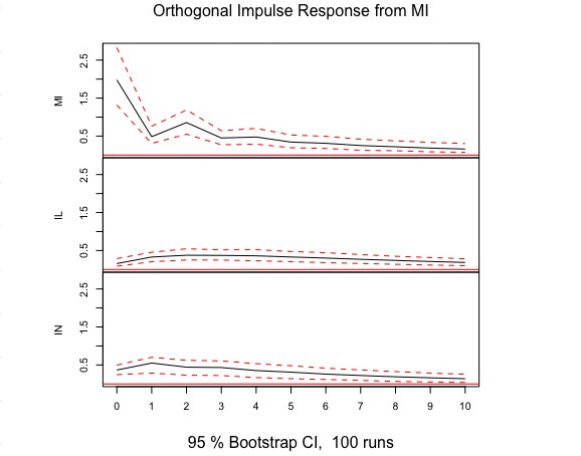
```
Estimation results for equation IL:
===================================
IL = MI.l1 + IL.l1 + IN.l1 + MI.l2 + IL.l2 + IN.l2 + const

      Estimate Std. Error t value Pr(>|t|)
MI.l1  0.10580    0.02743   3.856 0.000131 ***
IL.l1  0.52800    0.04530  11.656  < 2e-16 ***
IN.l1  0.10090    0.03063   3.294 0.001059 **
MI.l2  0.04956    0.02795   1.773 0.076841 .
IL.l2  0.18303    0.04438   4.125 4.37e-05 ***
IN.l2 -0.08484    0.03089  -2.746 0.006255 **
const  0.02069    0.05526   0.374 0.708207
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.219 on 482 degrees of freedom
Multiple R-Squared: 0.6581,     Adjusted R-squared: 0.6539
F-statistic: 154.7 on 6 and 482 DF,  p-value: < 2.2e-16
```

$$IL_t = \underset{(0.02747)}{0.10580}\,MI_{t-1} + \underset{(0.04530)}{0.52800}\,IL_{t-1} + \underset{(0.03063)}{0.10090}\,IN_{t-1} + \underset{(0.02795)}{0.04956}\,MI_{t-2} + \underset{(0.04438)}{0.18303}\,IL_{t-1} - \underset{(0.03089)}{0.08484}\,IN_{t-1}$$

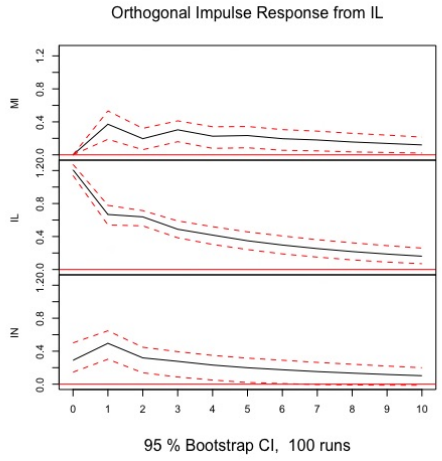
```
Estimation results for equation IN:
===================================
IN = MI.l1 + IL.l1 + IN.l1 + MI.l2 + IL.l2 + IN.l2 + const

       Estimate Std. Error t value Pr(>|t|)
MI.l1  0.151449   0.041706   3.631 0.000312 ***
IL.l1  0.273801   0.068861   3.976 8.08e-05 ***
IN.l1  0.568094   0.046560  12.201  < 2e-16 ***
MI.l2 -0.006117   0.042490  -0.144 0.885584
IL.l2 -0.169976   0.067460  -2.520 0.012069 *
IN.l2  0.013880   0.046965   0.296 0.767705
const -0.017227   0.084007  -0.205 0.837607
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 1.853 on 482 degrees of freedom
Multiple R-Squared: 0.5205,     Adjusted R-squared: 0.5145
F-statistic:  87.2 on 6 and 482 DF,  p-value: < 2.2e-16
```

$$IN_t = \underset{(0.041706)}{0.151449}\,MI_{t-1} + \underset{(0.068861)}{0.273801}\,IL_{t-1} + \underset{(0.046560)}{0.568094}\,IN_{t-1} - \underset{(0.067460)}{0.119976}\,IL_{t-2}$$

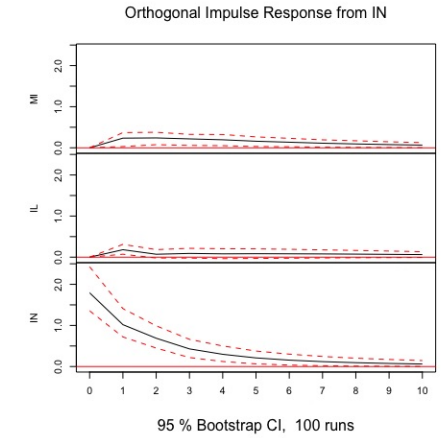
1.2 Obtain the plots of impulse response function of the fitted model and explain the relationship among the monthly unemployment rates of Michigan, Illinois, and Indiana from 1976.1 to 2017.2.



the unemployment rate of Michigan have effect only to itself. However, it does not have any effect to unemployment rate of Illinois, and Indiana from 1976.1 to 2017.2.



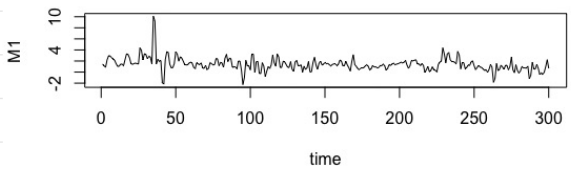
The monthly unemployment rate of Illinois have effect to itself and monthly unemployment rate of Michigan, Indiana from 1976.1 to 2017.2.

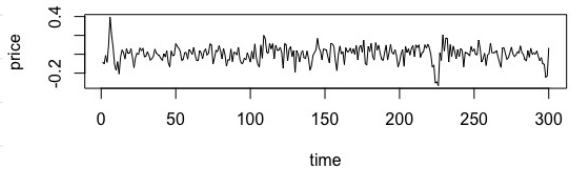


the monthly unemployment rate of Indiana have effect only to itself. However, it does not have any effect to monthly unemployment rate of Illinois, and Michigan from 1976.1 to 2017.2.

Question 2

2.1 Obtain the time series plots of the bivariate time series, say z_t.





2.2 Build a VAR model for z_t, including simplification and model checking. Write down the fitted model.

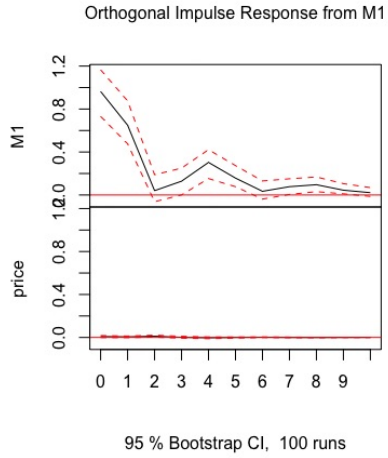
```
Estimation results for equation M1:
===================================
M1 = M1.l1 + price.l1 + M1.l2 + price.l2 + M1.l3 + price.l3 + const

          Estimate Std. Error t value Pr(>|t|)
M1.l1      0.66841    0.05465  12.230  < 2e-16 ***
price.l1   0.70145    0.70262   0.998    0.319
M1.l2     -0.40451    0.06295  -6.426 5.37e-10 ***
price.l2  -1.01842    0.73654  -1.383    0.168
M1.l3      0.37999    0.05474   6.942 2.53e-11 ***
price.l3  -0.43989    0.71537  -0.615    0.539
const      0.49736    0.10308   4.825 2.26e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


Residual standard error: 0.9633 on 290 degrees of freedom
Multiple R-Squared: 0.3901,     Adjusted R-squared: 0.3775
F-statistic: 30.91 on 6 and 290 DF,  p-value: < 2.2e-16
```

$$M_{1t} = \underset{(0.10708)}{0.49736} + \underset{(0.05465)}{0.66841}\, M_{1,t-1} - \underset{(0.06295)}{0.40451}\, M_{1,t-2} + \underset{(0.05474)}{0.37999}\, M_{1,t-3}$$

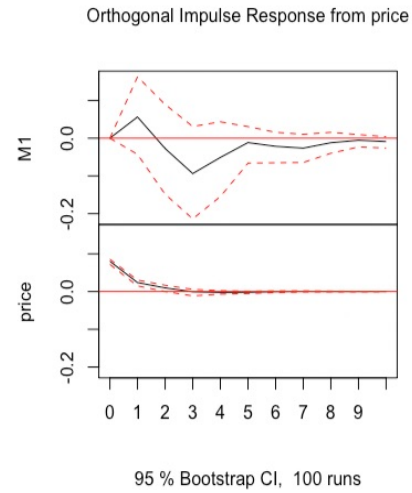
```
Estimation results for equation price:
======================================
price = M1.l1 + price.l1 + M1.l2 + price.l2 + M1.l3 + price.l3 + const

          Estimate Std. Error t value Pr(>|t|)
M1.l1     0.003467   0.004573   0.758    0.449
price.l1  0.296716   0.058787   5.047 7.93e-07 ***
M1.l2     0.007504   0.005267   1.425    0.155
price.l2  0.029814   0.061626   0.484    0.629
M1.l3    -0.007121   0.004580  -1.555    0.121
price.l3 -0.057191   0.059854  -0.956    0.340
const    -0.002715   0.008624  -0.315    0.753
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1


Residual standard error: 0.0806 on 290 degrees of freedom
Multiple R-Squared: 0.1153,     Adjusted R-squared: 0.09701
F-statistic:   6.3 on 6 and 290 DF,  p-value: 3.049e-06
```

$price_t = 0.296716\ price_{t-1}$
(0.058787)

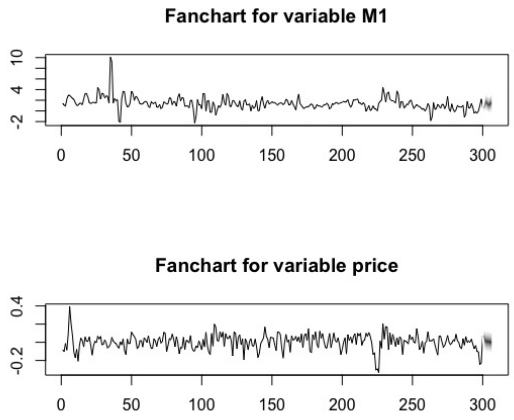
2.3 Obtain the impulse response functions of the fitted model. What is the relationship between the M1 money supply of China and crude oil price, which represents commodity prices.



We can see that price have effect to itself and M_1. However, M_1 have effect to only itself. Then price represent commodity price.



2.4 Obtain 1-step to 6-step ahead predictions of z_t at the forecast origin 2015.2.



2.5 Obtain the forecast error variance decomposition and explain it.

```
$M1
             M1        price
[1,] 1.0000000 0.000000000
[2,] 0.9976640 0.002336045
[3,] 0.9971155 0.002884469
[4,] 0.9908030 0.009196979
[5,] 0.9896296 0.010370432
[6,] 0.9897108 0.010289214

$price
             M1     price
[1,] 0.01089392 0.9891061
[2,] 0.01477258 0.9852274
[3,] 0.03227375 0.9677262
[4,] 0.03247842 0.9675216
[5,] 0.03407249 0.9659275
[6,] 0.03405620 0.9659438
```

100% of concurrent effect come from M_1 itself. However, M_1 contribute around 98-99% to itself and price contribute around 2-10% to M_1.

99% of concurrent effect come from price itself and 1% come from M_1. However, when forecasting ahead, 96-98% effect come from price and 1.5-3.4% come from M_1.