Suggested Solution to the Empirical Part of Assignment 4

1 Empirical Part

Note: Please take a look at the R script for this solution. The results and the figures are appended at the end of this document.

1. (a) The impulse responses are the same as the ones with Cholesky decomposition. This is due to the fact that we have the same model.

   (b) We impose this restriction by making amat matrix diagonal in the svar function. In our representation this implies $b_{12} = b_{21} = 0$.

   (c) The p-value of the test of overidentification in part(b) is 0.1 which tells us that we are at the boundary of rejection at conventional levels. The model in part(b) is overidentified because we impose more restrictions than we require for identification of the structural parameters.

   (a) Two criteria suggest 3 lags and two criteria including SC suggest 2 lags Therefore, we choose 2 lags for our reduced form VAR estimation. The estimated reduced form model suggests a very good fit for unemployment where R-square is very high. This can be explained by high degree of persistence of the level of unemployment. We also find that 22% of the variation in real GDP growth can be explained by its own lags and lags of unemployment.

   (b) The imposed long-run restriction implies that demand shocks have no long-run effect on the level of real GDP. By construction, we can test the long-run effect on only I(1) variables. Since real GDP is the I(1) variable in this system, we can impose zero long-run restriction on this series.

(c) Since GDP is differenced to estimate the reduced form VAR, we need to calculate the accumulated response to find out the impact of structural shock on the level of real GDP. The results below suggest that a negative demand shock (shock to unemployment) reduces output instantaneously and its impact vanishes after around 25 quarters. The peak response occurs in 2nd quarter. Variance decomposition using the long-run restriction suggests that around 40% of the variation of real GDP growth at all forecast horizons is explained by demand shocks, whereas bigger chunk of the variation is explained by supply shocks. Variance decomposition for unemployment shows that at short forecast horizons most of the variations is explained by demand shocks. At longer forecast horizons, around the role of supply shock increases.

(d) and

(e) As expected we find that most of the variation in detrended unemployment even at longer horizons is explained by demand shocks. Also, for GDP growth we find that around 75% of the variation at different forecast horizons is explained by demand shocks.

$selection
AIC(n) HQ(n) SC(n) FPE(n)
     1   1   1   1

$criteria
                       1   2   3   4
AIC(n) -2.027664e+01 -2.024850e+01 -2.022785e+01 -2.019845e+01
HQ(n) -2.024158e+01 -2.019007e+01 -2.014604e+01 -2.009326e+01
SC(n) -2.018963e+01 -2.010348e+01 -2.002481e+01 -1.993740e+01
FPE(n) 1.563027e-09 1.607650e-09 1.641243e-09 1.690272e-09

VAR Estimation Results:
=========================
Endogenous variables: dspot, fp
Deterministic variables: const
Sample size: 243
Log Likelihood: 1778.274
Roots of the characteristic polynomial:
0.9067 0.073
Call:
VAR(y = vardata0, p = 1, type = "const")

Estimation results for equation dspot:
======================================
dspot = dspot.l1 + fp.l1 + const

          Estimate Std. Error t value Pr(>|t|)
dspot.l1 0.068651   0.064653   1.062   0.289
fp.l1   -1.574356   0.809686 -1.944   0.053 .
const   -0.004625   0.002875 -1.609   0.109

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.03402 on 240 degrees of freedom
Multiple R-Squared: 0.02295,   Adjusted R-squared: 0.01481
F-statistic: 2.819 on 2 and 240 DF, p-value: 0.06165

Estimation results for equation fp:
======================================
fp = dspot.l1 + fp.l1 + const

          Estimate Std. Error t value Pr(>|t|)
dspot.l1 2.313e-03 2.200e-03   1.051   0.2941
fp.l1   9.110e-01 2.755e-02 33.065   <2e-16 ***
const   -1.901e-04 9.783e-05 -1.943   0.0531 .

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.001158 on 240 degrees of freedom
Multiple R-Squared: 0.822,   Adjusted R-squared: 0.8205
F-statistic: 554.1 on 2 and 240 DF, p-value: < 2.2e-16

Covariance matrix of residuals:
          dspot   fp
dspot 1.158e-03 -2.182e-06
fp   -2.182e-06 1.340e-06

Correlation matrix of residuals:
```
          dspot       fp
dspot  1.00000 -0.05539
fp    -0.05539  1.00000
```


```
       [,1] [,2]
[1,]      1    0
[2,]     NA    1
       [,1] [,2]
[1,]     NA    0
[2,]      0   NA
windows
       2
       [,1] [,2]
[1,]      1    0
[2,]      0    1
       [,1] [,2]
[1,]     NA    0
[2,]      0   NA
windows
       2
```
$selection
```
AIC(n)  HQ(n)   SC(n) FPE(n)
     3      3       1      3
```

$criteria
```
                    1            2            3            4
AIC(n)  -2.96436396  -3.04260944  -3.08835824  -3.05268618
HQ(n)   -2.91651218  -2.96285648  -2.97670409  -2.90913085
SC(n)   -2.84655395  -2.84625943  -2.81346823  -2.69925616
FPE(n)   0.05159377   0.04771237   0.04558232   0.04724424
```


VAR Estimation Results:
=========================
Endogenous variables: dyt, unt
Deterministic variables: const
Sample size: 158
Log Likelihood: -212.598
Roots of the characteristic polynomial:
0.9095 0.3908
Call:
VAR(y = var.bq, p = 1, type = "const")

Estimation results for equation dyt:
====================================
dyt = dyt.l1 + unt.l1 + const

```
         Estimate Std. Error t value Pr(>|t|)
dyt.l1   0.34666    0.07403    4.683 6.14e-06 ***
unt.l1   0.09724    0.04446    2.187   0.0302 *
const   -0.08928    0.27282   -0.327   0.7439
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```


Residual standard error: 0.9321 on 155 degrees of freedom
Multiple R-Squared: 0.1427,   Adjusted R-squared: 0.1316
F-statistic: 12.89 on 2 and 155 DF, p-value: 6.603e-06

Estimation results for equation unt:
===================================
unt = dyt.l1 + unt.l1 + const

	Estimate	Std. Error	t value	Pr(>|t|)	
dyt.l1	-0.25548	0.02594	-9.848	< 2e-16	***
unt.l1	0.95364	0.01558	61.206	< 2e-16	***
const	0.47345	0.09561	4.952	1.9e-06	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3266 on 155 degrees of freedom
Multiple R-Squared: 0.9619,   Adjusted R-squared: 0.9614
F-statistic: 1955 on 2 and 155 DF, p-value: < 2.2e-16

Covariance matrix of residuals:
```
        dyt      unt
dyt  0.8689 -0.2004
unt -0.2004  0.1067
```

Correlation matrix of residuals:
```
        dyt      unt
dyt  1.0000 -0.6583
unt -0.6583  1.0000
```


SVAR Estimation Results:
========================

Call:
BQ(x = model.bq.rf)

Type: Blanchard-Quah
Sample size: 158
Log Likelihood: -215.627

Estimated contemporaneous impact matrix:
```
        dyt      unt
dyt 0.63585 -0.6816
unt 0.03312  0.3250
```

Estimated identified long run impact matrix:
```
        dyt    unt
dyt  0.5931 0.000
unt -2.5539 7.009
```

Covariance matrix of reduced form residuals (*100):
```
        dyt     unt
dyt  86.89 -20.04
unt -20.04  10.67
```
windows
       2
$selection
```
AIC(n)  HQ(n)  SC(n) FPE(n)
     3      2      2      3
```

$criteria
	1	2	3	4

```
AIC(n) -2.97401932 -3.06290344 -3.08203933 -3.04732249
HQ(n)  -2.92616754 -2.98315048 -2.97038519 -2.90376716
SC(n)  -2.85620931 -2.86655343 -2.80714932 -2.69389248
FPE(n)  0.05109801  0.04675385  0.04587127  0.04749832
```

VAR Estimation Results:
=========================
Endogenous variables: dyt, unt
Deterministic variables: const
Sample size: 157
Log Likelihood: -196.813
Roots of the characteristic polynomial:
0.7776 0.7776 0.1263 0.1263
Call:
VAR(y = var.bq, p = 2, type = "const")

Estimation results for equation dyt:
================================
dyt = dyt.l1 + unt.l1 + dyt.l2 + unt.l2 + const

```
        Estimate Std. Error t value Pr(>|t|)
dyt.l1   0.18086    0.10583   1.709   0.0895 .
unt.l1  -0.35501    0.30130  -1.178   0.2405
dyt.l2   0.04003    0.09446   0.424   0.6723
unt.l2   0.47191    0.29746   1.586   0.1147
const   -0.10984    0.30267  -0.363   0.7172
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 0.9224 on 152 degrees of freedom
Multiple R-Squared: 0.1651,   Adjusted R-squared: 0.1431
F-statistic: 7.513 on 4 and 152 DF, p-value: 1.504e-05

Estimation results for equation unt:
================================
unt = dyt.l1 + unt.l1 + dyt.l2 + unt.l2 + const

```
        Estimate Std. Error t value Pr(>|t|)
dyt.l1  -0.16209    0.03534  -4.587 9.34e-06 ***
unt.l1   1.22812    0.10060  12.208  < 2e-16 ***
dyt.l2  -0.04439    0.03154  -1.407   0.1614
unt.l2  -0.28224    0.09932  -2.842   0.0051 **
const    0.47539    0.10106   4.704 5.68e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 0.308 on 152 degrees of freedom
Multiple R-Squared: 0.9663,   Adjusted R-squared: 0.9654
F-statistic: 1088 on 4 and 152 DF, p-value: < 2.2e-16

Covariance matrix of residuals:
```
        dyt      unt
dyt  0.8508 -0.18925
unt -0.1892  0.09484
```

Correlation matrix of residuals:

```
         dyt      unt
dyt  1.0000 -0.6662
unt -0.6662  1.0000
```

SVAR Estimation Results:
========================

Call:
BQ(x = model.bq1.rf)

Type: Blanchard-Quah
Sample size: 157
Log Likelihood: -201.895

Estimated contemporaneous impact matrix:
```
         dyt      unt
dyt 0.64081 -0.6634
unt 0.02265  0.3071
```

Estimated identified long run impact matrix:
```
         dyt    unt
dyt   0.563 0.000
unt  -1.729 5.675
```

Covariance matrix of reduced form residuals (*100):
```
         dyt      unt
dyt   85.08 -18.925
unt  -18.92   9.484
windows
      2
windows
      2
```
$selection
```
AIC(n)  HQ(n)  SC(n) FPE(n)
     1      1      1      1
```

$criteria
```
                     1              2              3              4
AIC(n) -2.027664e+01 -2.024850e+01 -2.022785e+01 -2.019845e+01
HQ(n)  -2.024158e+01 -2.019007e+01 -2.014604e+01 -2.009326e+01
SC(n)  -2.018963e+01 -2.010348e+01 -2.002481e+01 -1.993740e+01
FPE(n)  1.563027e-09  1.607650e-09  1.641243e-09  1.690272e-09
```

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Call:
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dspot = dspot.l1 + fp.l1 + const

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          Estimate Std. Error t value Pr(>|t|)
```

```
dspot.l1   0.068651    0.064653    1.062    0.289
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Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

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F-statistic: 2.819 on 2 and 240 DF, p-value: 0.06165

Estimation results for equation fp:
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fp = dspot.l1 + fp.l1 + const

```
           Estimate Std. Error t value Pr(>|t|)
dspot.l1  2.313e-03  2.200e-03   1.051   0.2941
fp.l1     9.110e-01  2.755e-02  33.065   <2e-16 ***
const    -1.901e-04  9.783e-05  -1.943   0.0531 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Residual standard error: 0.001158 on 240 degrees of freedom
Multiple R-Squared: 0.822,   Adjusted R-squared: 0.8205
F-statistic: 554.1 on 2 and 240 DF, p-value: < 2.2e-16

Covariance matrix of residuals:
          dspot   fp
dspot 1.158e-03 -2.182e-06
fp   -2.182e-06 1.340e-06

Correlation matrix of residuals:
          dspot   fp
dspot 1.00000 -0.05539
fp   -0.05539 1.00000


```
      [,1] [,2]
[1,]    1    0
[2,]   NA    1
      [,1] [,2]
[1,]   NA    0
[2,]    0   NA
null device
          1
      [,1] [,2]
[1,]    1    0
[2,]    0    1
      [,1] [,2]
[1,]   NA    0
[2,]    0   NA
null device
          1
```
$selection
AIC(n) HQ(n)   SC(n) FPE(n)
    3   3   1   3

$criteria
                   1   2   3   4

```
AIC(n)  -2.96436396 -3.04260944 -3.08835824 -3.05268618
HQ(n)   -2.91651218 -2.96285648 -2.97670409 -2.90913085
SC(n)   -2.84655395 -2.84625943 -2.81346823 -2.69925616
FPE(n)   0.05159377  0.04771237  0.04558232  0.04724424
```

VAR Estimation Results:
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Endogenous variables: dyt, unt
Deterministic variables: const
Sample size: 157
Log Likelihood: -196.813
Roots of the characteristic polynomial:
0.7776 0.7776 0.1263 0.1263
Call:
VAR(y = var.bq, p = 2, type = "const")

Estimation results for equation dyt:
====================================
dyt = dyt.l1 + unt.l1 + dyt.l2 + unt.l2 + const

	Estimate	Std. Error	t value	Pr(>|t|)	
dyt.l1	0.18086	0.10583	1.709	0.0895	.
unt.l1	-0.35501	0.30130	-1.178	0.2405	
dyt.l2	0.04003	0.09446	0.424	0.6723	
unt.l2	0.47191	0.29746	1.586	0.1147	
const	-0.10984	0.30267	-0.363	0.7172	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9224 on 152 degrees of freedom
Multiple R-Squared: 0.1651,   Adjusted R-squared: 0.1431
F-statistic: 7.513 on 4 and 152 DF, p-value: 1.504e-05

Estimation results for equation unt:
====================================
unt = dyt.l1 + unt.l1 + dyt.l2 + unt.l2 + const

	Estimate	Std. Error	t value	Pr(>|t|)	
dyt.l1	-0.16209	0.03534	-4.587	9.34e-06	***
unt.l1	1.22812	0.10060	12.208	< 2e-16	***
dyt.l2	-0.04439	0.03154	-1.407	0.1614	
unt.l2	-0.28224	0.09932	-2.842	0.0051	**
const	0.47539	0.10106	4.704	5.68e-06	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.308 on 152 degrees of freedom
Multiple R-Squared: 0.9663,   Adjusted R-squared: 0.9654
F-statistic: 1088 on 4 and 152 DF, p-value: < 2.2e-16

Covariance matrix of residuals:
```
        dyt      unt
dyt  0.8508 -0.18925
unt -0.1892  0.09484
```

Correlation matrix of residuals:

```
         dyt      unt
dyt  1.0000 -0.6662
unt -0.6662  1.0000
```

SVAR Estimation Results:
========================

Call:
BQ(x = model.bq.rf)

Type: Blanchard-Quah
Sample size: 157
Log Likelihood: -201.895

Estimated contemporaneous impact matrix:
```
          dyt      unt
dyt 0.64081 -0.6634
unt 0.02265  0.3071
```

Estimated identified long run impact matrix:
```
         dyt    unt
dyt   0.563 0.000
unt -1.729 5.675
```

Covariance matrix of reduced form residuals (*100):
```
         dyt      unt
dyt  85.08 -18.925
unt -18.92   9.484
null device
         1
```
$selection
```
AIC(n)  HQ(n)  SC(n) FPE(n)
     3      2      2      3
```

$criteria
```
                   1           2           3           4
AIC(n) -2.97401932 -3.06290344 -3.08203933 -3.04732249
HQ(n)  -2.92616754 -2.98315048 -2.97038519 -2.90376716
SC(n)  -2.85620931 -2.86655343 -2.80714932 -2.69389248
FPE(n)  0.05109801  0.04675385  0.04587127  0.04749832
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Deterministic variables: const
Sample size: 157
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Roots of the characteristic polynomial:
0.7776 0.7776 0.1263 0.1263
Call:
VAR(y = var.bq, p = 2, type = "const")

Estimation results for equation dyt:
====================================
dyt = dyt.l1 + unt.l1 + dyt.l2 + unt.l2 + const

```
       Estimate Std. Error t value Pr(>|t|)
dyt.l1  0.18086    0.10583   1.709   0.0895 .
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```

```
dyt.l2   0.04003     0.09446     0.424    0.6723
unt.l2   0.47191     0.29746     1.586    0.1147
const   -0.10984     0.30267    -0.363    0.7172
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


Residual standard error: 0.9224 on 152 degrees of freedom
Multiple R-Squared: 0.1651,      Adjusted R-squared: 0.1431
F-statistic: 7.513 on 4 and 152 DF,  p-value: 1.504e-05


Estimation results for equation unt:
===================================
unt = dyt.l1 + unt.l1 + dyt.l2 + unt.l2 + const

         Estimate Std. Error t value Pr(>|t|)
dyt.l1  -0.16209     0.03534   -4.587 9.34e-06 ***
unt.l1   1.22812     0.10060   12.208  < 2e-16 ***
dyt.l2  -0.04439     0.03154   -1.407   0.1614
unt.l2  -0.28224     0.09932   -2.842   0.0051 **
const    0.47539     0.10106    4.704 5.68e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1


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Multiple R-Squared: 0.9663,      Adjusted R-squared: 0.9654
F-statistic:  1088 on 4 and 152 DF,  p-value: < 2.2e-16



Covariance matrix of residuals:
         dyt       unt
dyt   0.8508 -0.18925
unt  -0.1892  0.09484

Correlation matrix of residuals:
         dyt       unt
dyt   1.0000 -0.6662
unt  -0.6662  1.0000



SVAR Estimation Results:
========================

Call:
BQ(x = model.bq1.rf)

Type: Blanchard-Quah
Sample size: 157
Log Likelihood: -201.895

Estimated contemporaneous impact matrix:
          dyt       unt
dyt  0.64081  -0.6634
unt  0.02265   0.3071

Estimated identified long run impact matrix:
         dyt     unt
dyt    0.563  0.000
unt   -1.729  5.675
```
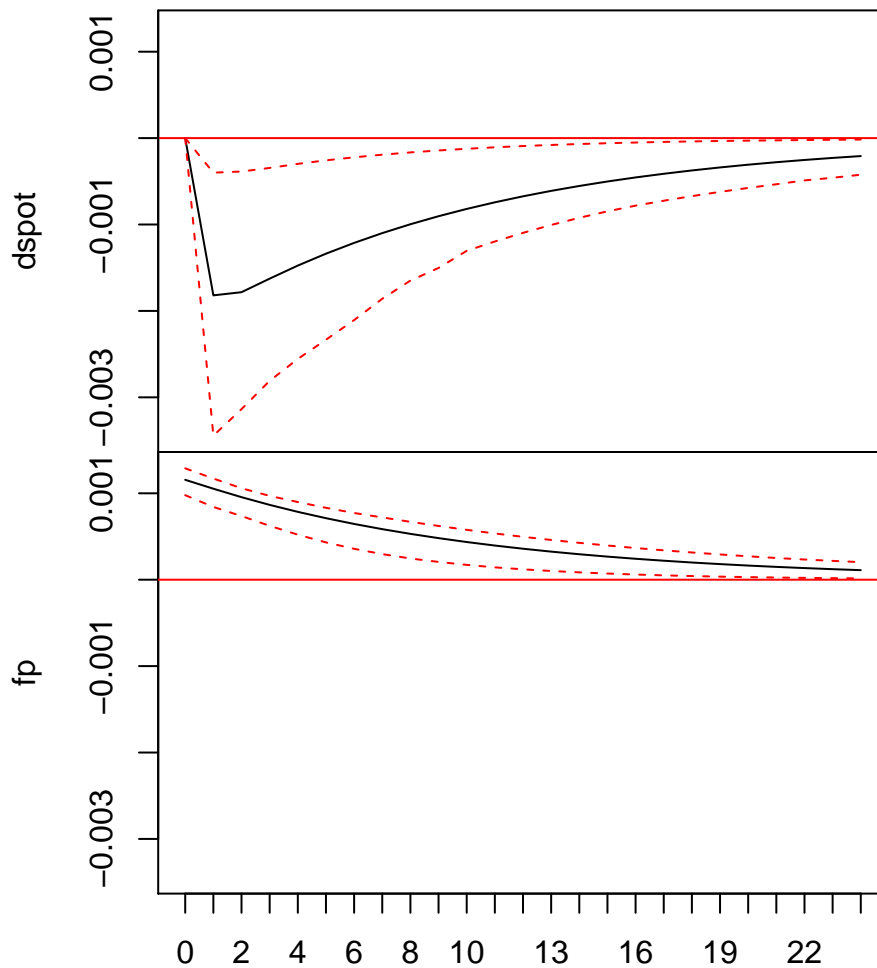
Covariance matrix of reduced form residuals (*100):
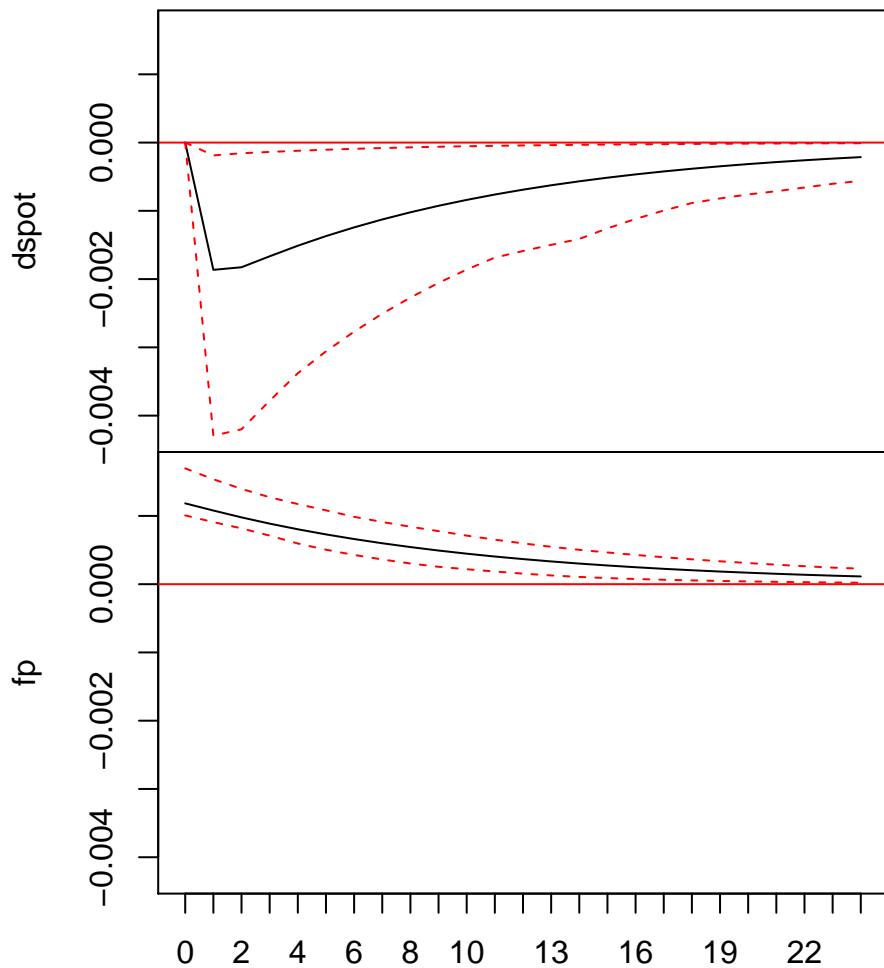```
        dyt   unt
dyt 85.08 -18.925
unt -18.92   9.484
```
null device
          1
null device
          1

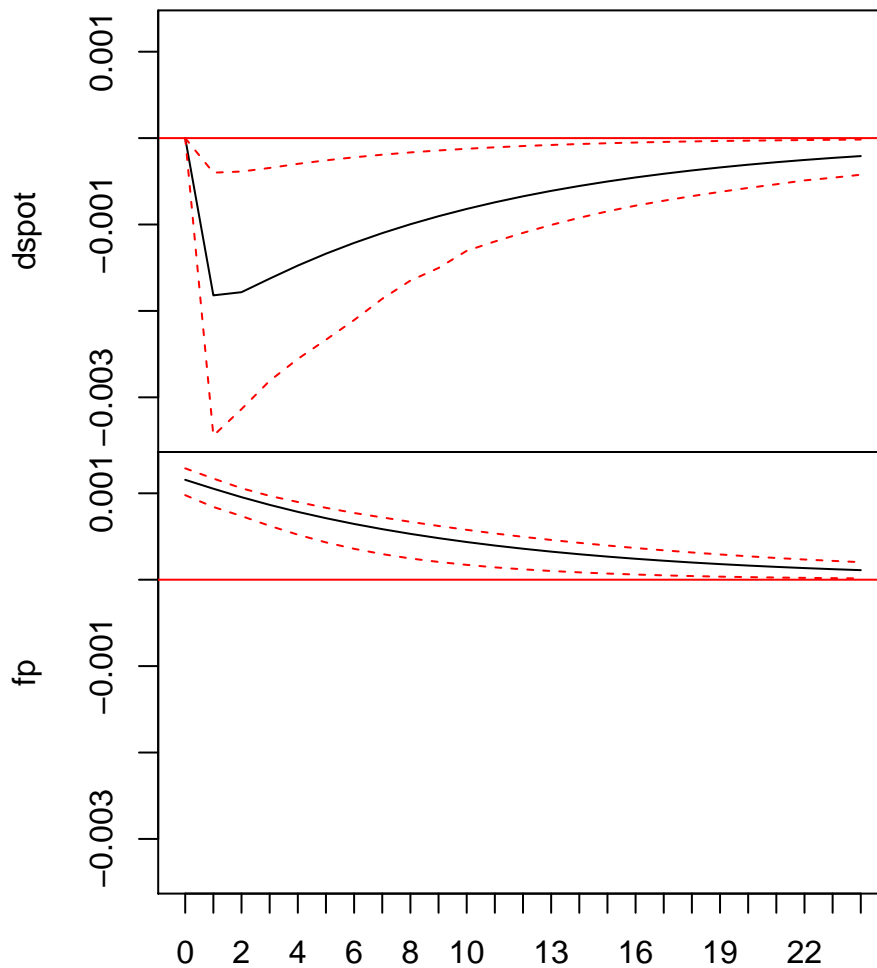# Orthogonal Impulse Response from fp



90 % Bootstrap CI,  100 runs
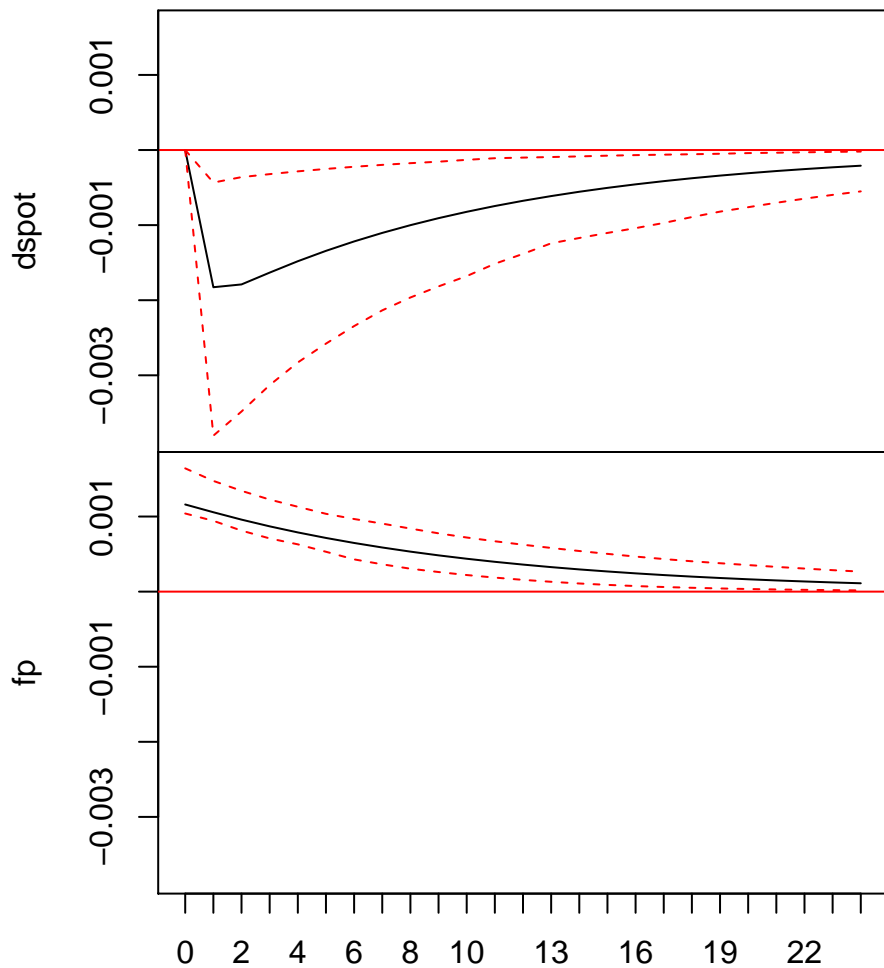
SVAR Impulse Response from fp

90 % Bootstrap CI,  100 runs
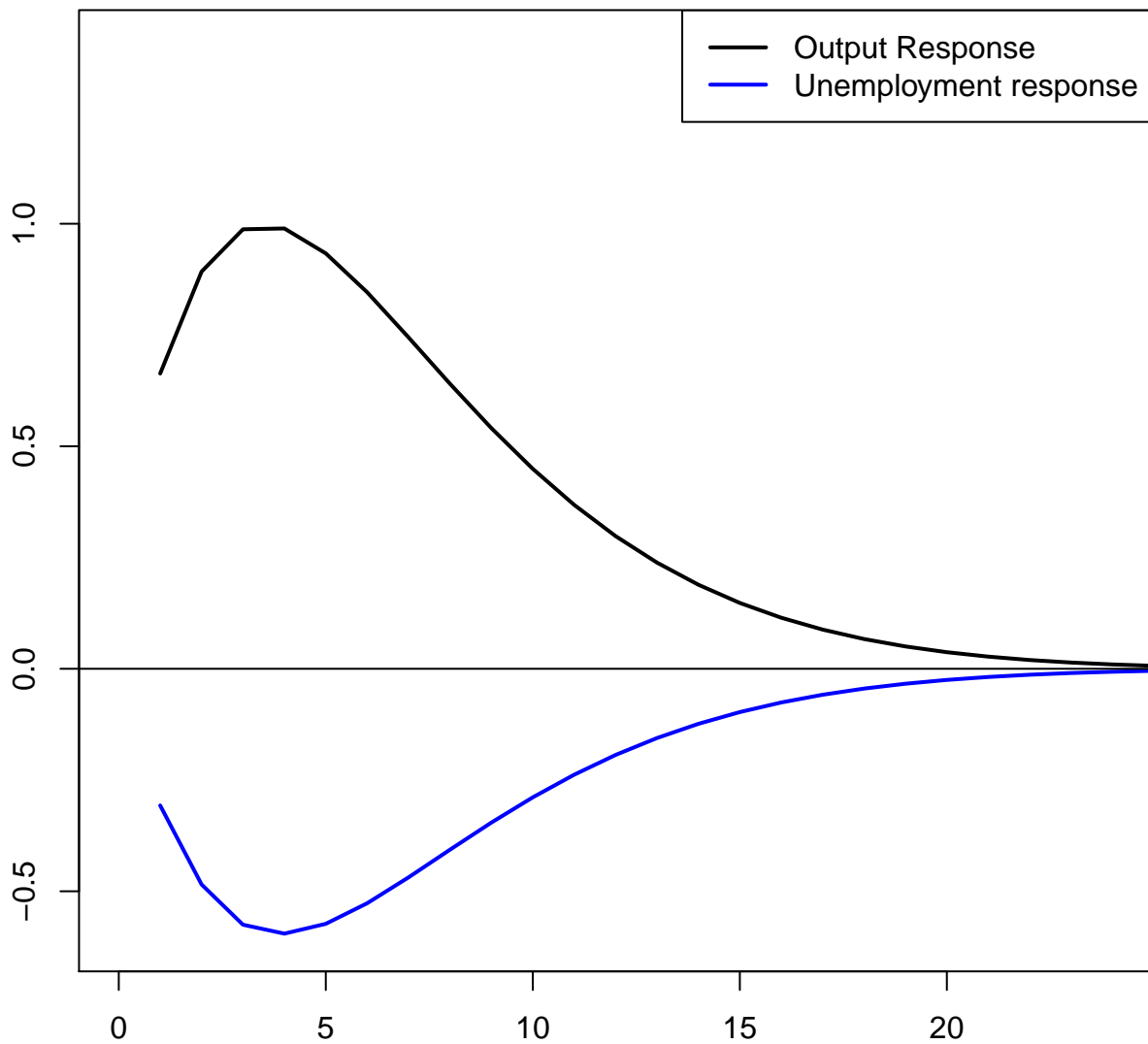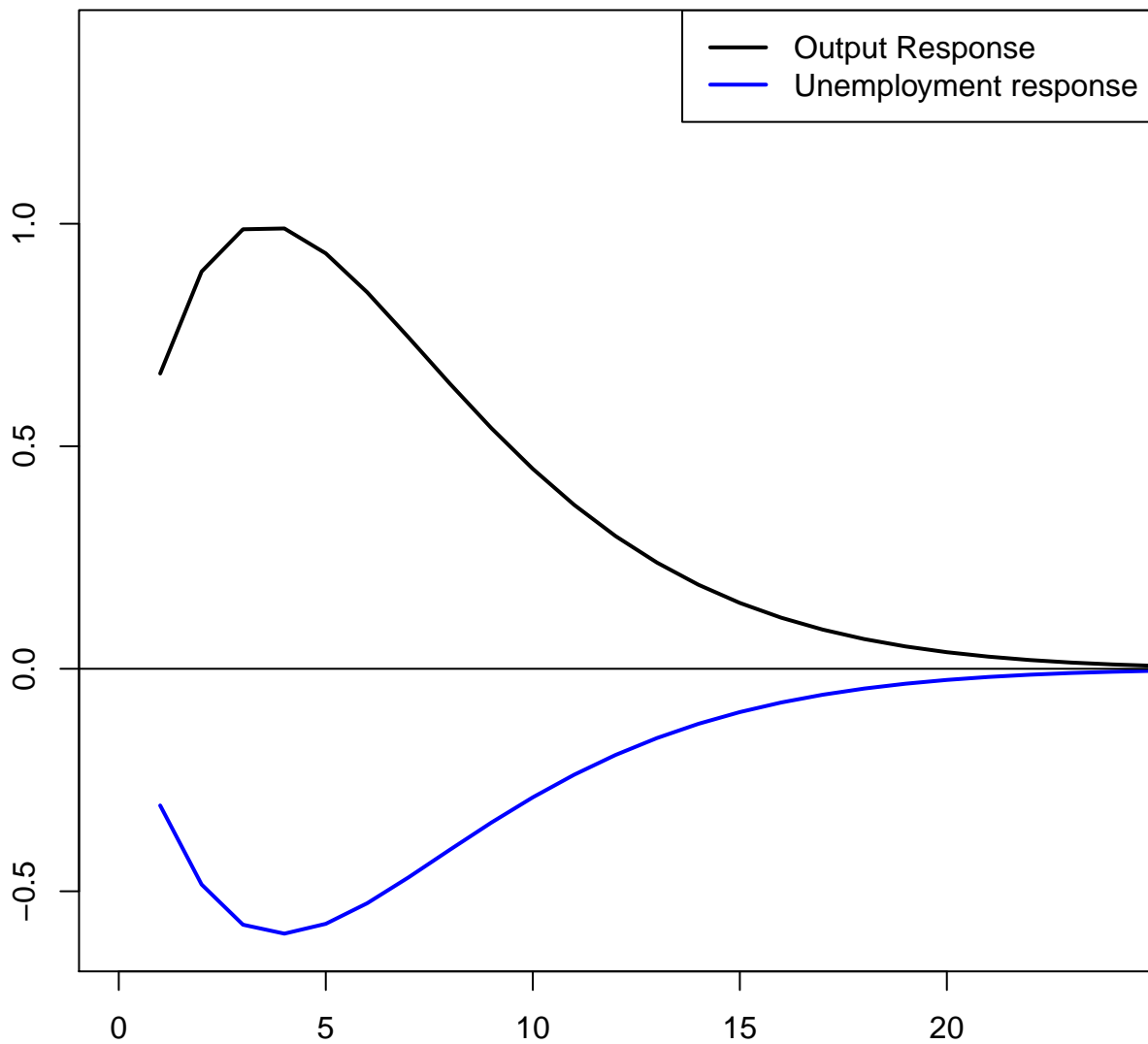
# Orthogonal Impulse Response from fp



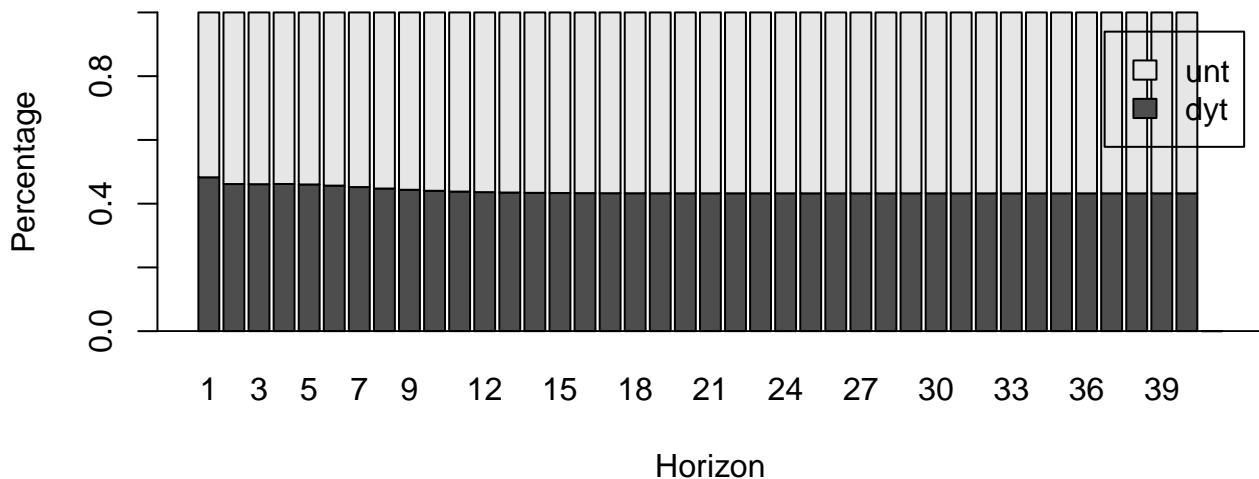90 % Bootstrap CI,  100 runs

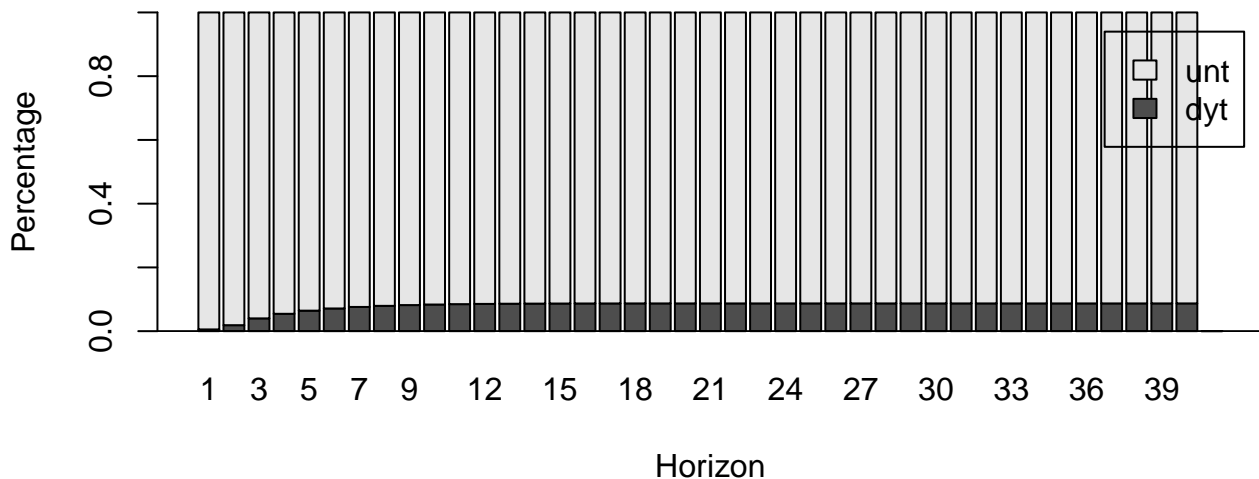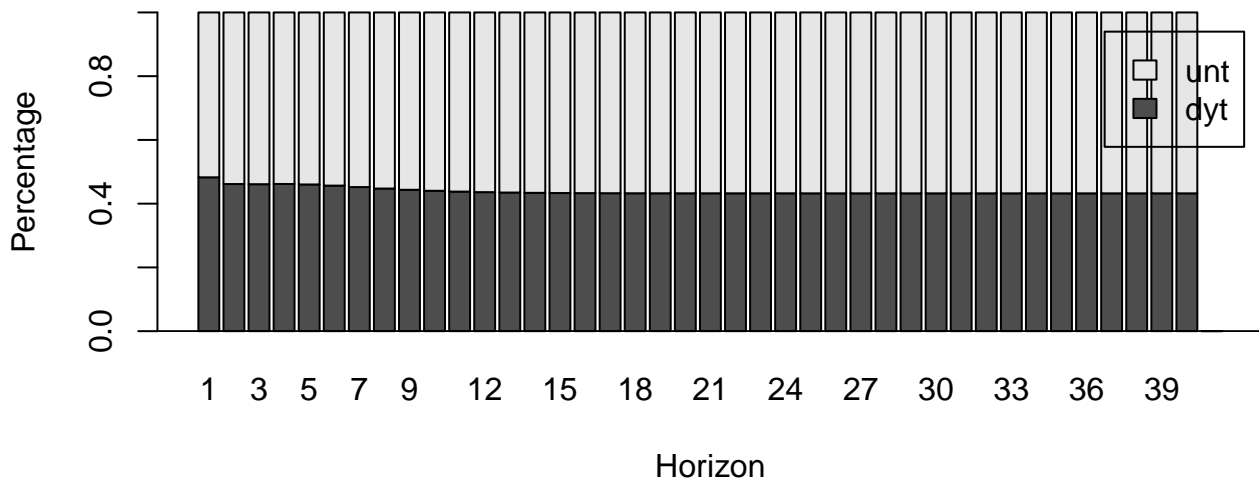SVAR Impulse Response from fp

90 % Bootstrap CI,  100 runs

**FEVD for dyt**

Percentage

Horizon

**FEVD for unt**

Percentage

Horizon

**FEVD for dyt**

Percentage

Horizon

**FEVD for unt**

Percentage

Horizon