National Bank of Ukraine

The Effects of Oil Price Shocks on the Ukrainian economy

Diana Obarianyk

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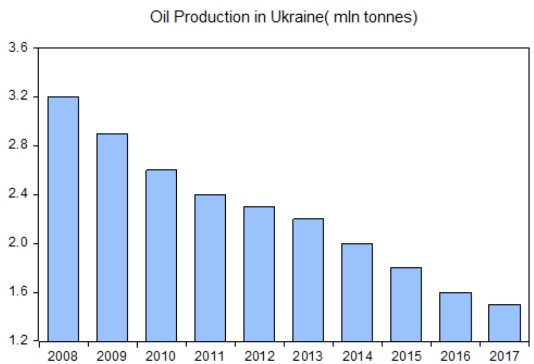
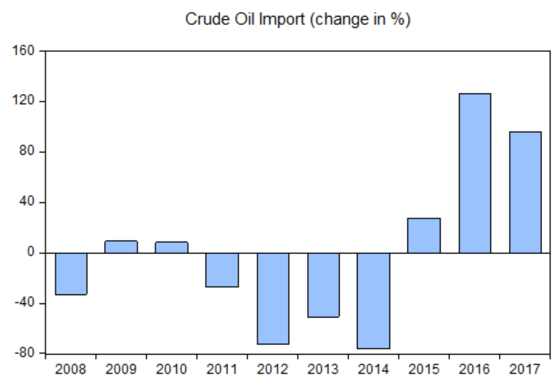
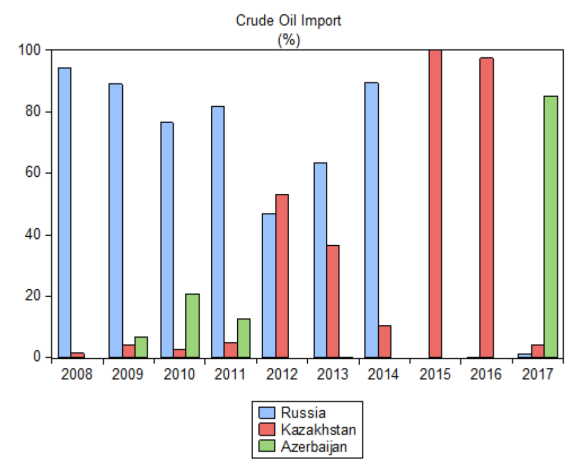
Situation with Oil in Ukraine

- Ukraine suffers from shortage of internal oil resources, so it's dependent on the other countries to satisfy all internal needs.
- Investigating the impact of oil price fluctuations on the Ukrainian macroeconomy can serve as the key to understanding the formation of macroeconomic parameters which predetermine social and economic development.
- Over the period 2017, Ukraine maintained the oil production at approximate1,5 mln tonnes, which satisfies only 10 % of internal needs.
- The share of oil and refined products costs in total import costs is about 22%.
- Oil is mainly imported from Azerbaijan and Kazakhstan.
- As a result, the Ukrainian economy is tightly connected with world prices for energy resources.







Understanding the consequences of oil price shocks is important and relevant for Ukraine for several reasons.

1

- It can have important policy implications especially in assessing the effect of large unexpected oil price shocks and the associated response of monetary authorities.

2

- It is useful for policy makers in order to maintain stable economy and stable inflation rate.

3

- Furthermore, evaluating these potential asymmetric effects is crucial to correctly model oil prices and selecting among alternative theories of the transmission mechanism behind oil price shocks.

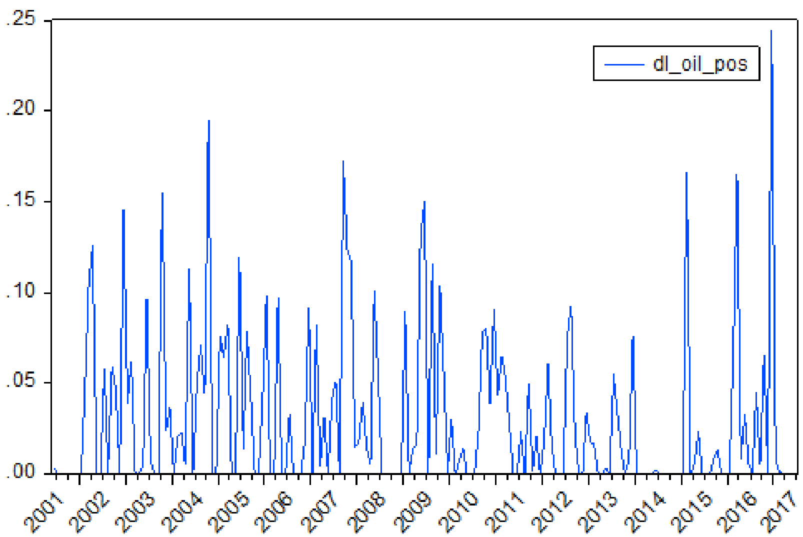
Literature review

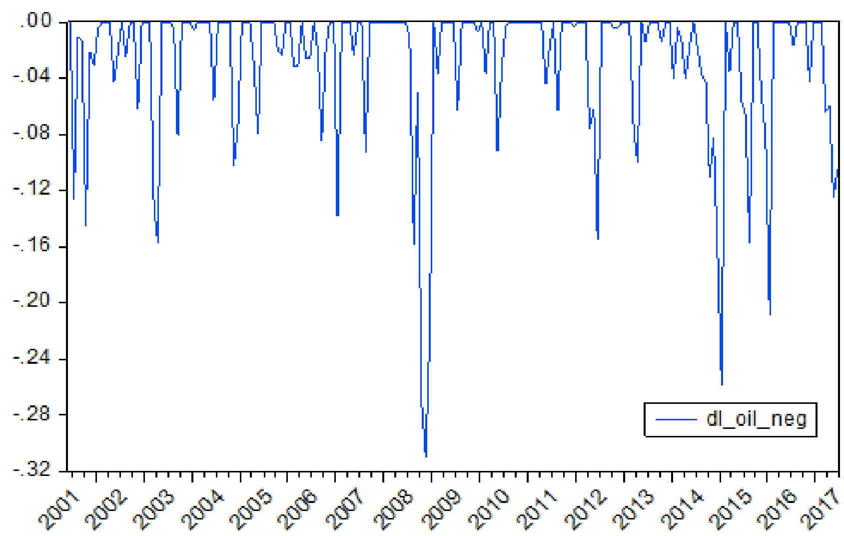
- A number of studies have suggested that oil price shocks are one of the main sources of fluctuations in aggregate economic activity (**Hamilton, 1983**).
- The literature proposed several linear and nonlinear measures of oil price shocks attempting to understand relationship between oil price shocks and macroeconomic variables. The asymmetric response of output to oil price shocks of different sign has been motivated by different theoretical models.
- The initial proposal to focus only on oil price increases was defined by Hamilton, who introduced the net oil price increase.
- One of the most common measures is the threshold model proposed by **Mork (1989)** accounting for positive and negative oil price shocks which has been employed in various studies. Mork extends the work of Hamilton (1983) and confirms the negative relationship between economic growth and oil price shock.

Different measures of oil shocks used in the literature: Positive and Negative Oil Price Shocks

- The basic idea of Mork's approach (1989) was to separate the original oil price series into two series: containing positive and negative growth rate observations respectively.
- The asymmetric specification distinguishing between positive oil price shocks and negative oil price shocks can be defined as follows:

- **Positive oil shock** $dl\_p_t^{+} = \max\{dl\_p_t, 0\}$
- **Negative oil shock** $dl\_p_t^{-} = \min\{dl\_p_t, 0\}$





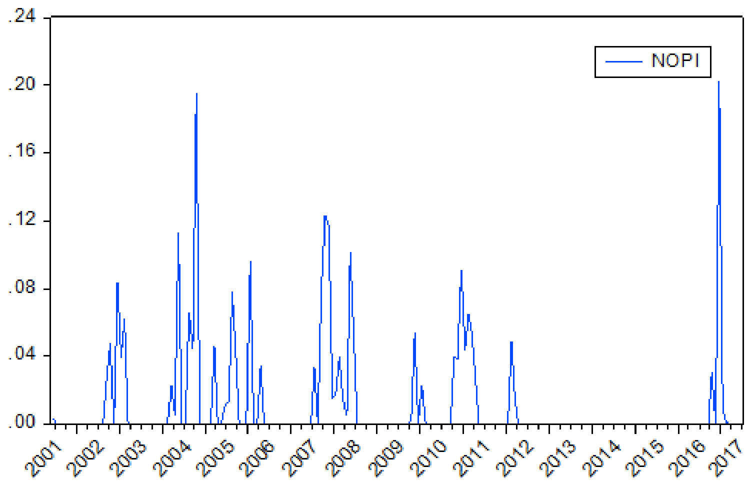
Different measures of oil shocks used in the literature: Net Oil Price Increase

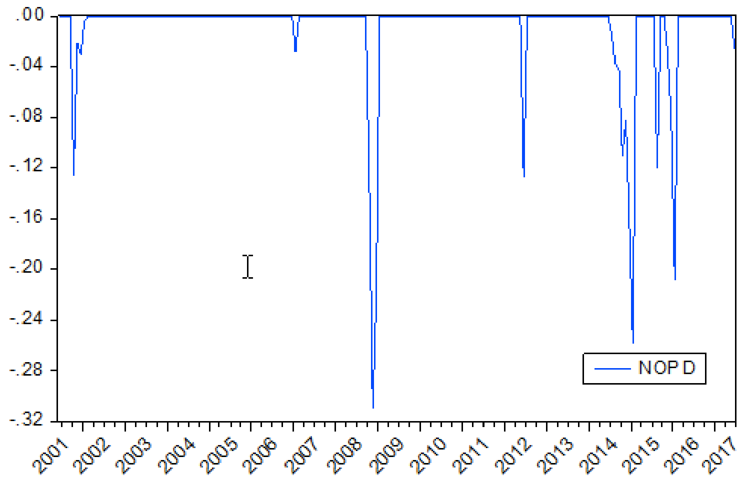
- Hamilton (1996) considered *net oil price increases* (NOPI) as a measure of oil price shock.

An oil price shock is defined as the amount by which the change in the oil price in month ***t*** exceeds the maximum value over the previous year.

$$NOPI_t = \max\{o, \ln \frac{p_t}{\max\{p_{t-1},..,p_{t-12}\}}\}$$

$$NOPD_t = \min\{o, \ln \frac{p_t}{\min\{p_{t-1},..,p_{t-12}\}}\}$$





Data

- **Sample:** 2001:m6 - 2017:m6
- **Data:**

➢ oil_t – crude oil price, Dated Brent, USD per barrel

➢ gdp_t – real GDP (in prices 2010), UAH Million

➢ usd_uah_t – exchange rate, USD/UAH

➢ cpi_t – CPI , % to previous month

➢ $nfuel_t$ – non-fuel price index (2005 = 100, includes Food and Beverages and Industrial Inputs Price Indices)

- All data are seasonally adjusted

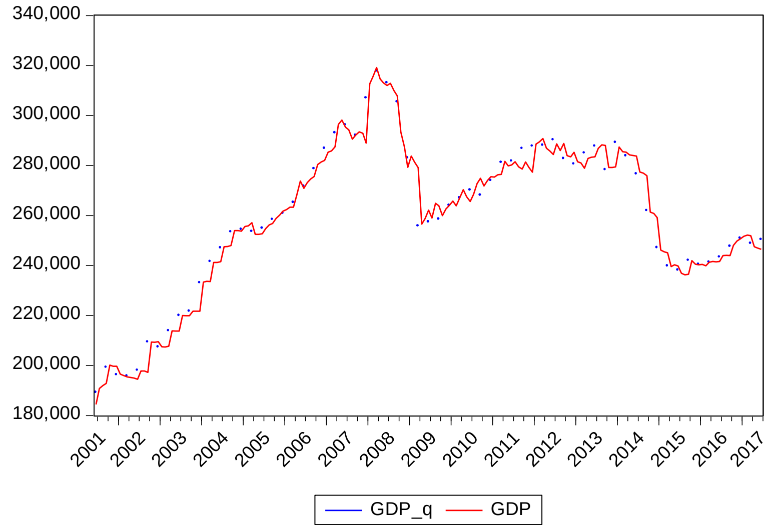
Monthly data for GDP

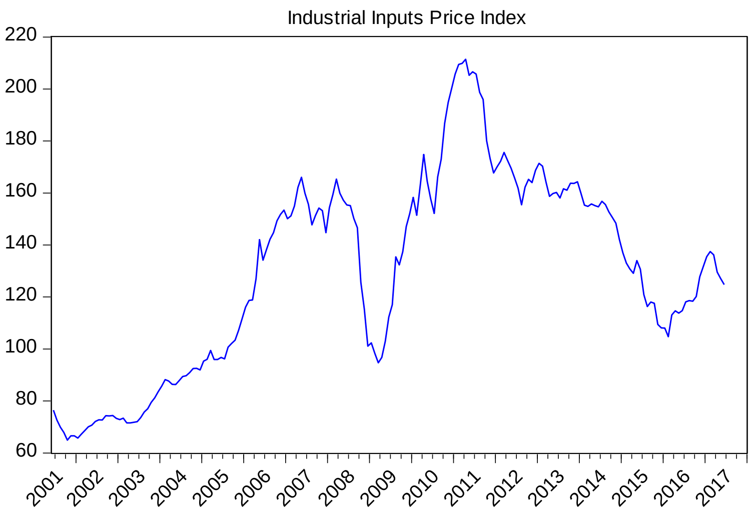
State space model:

$$signal : gdp_t = c_1 + sv_t * ipi_t + [\text{var} = \exp(c_2)]$$

$$state : sv_t = sv_{t-1} + [\text{var} = \exp(c_3)]$$

ipi_t - Industrial Inputs Price Index (2005 = 100)
(includes Agricultural Raw Materials and Metals Price Indices)





ARDL model

$$\log(gdp_t) = \alpha_0 + \alpha_{1i}\sum_{i=1}^{q}\log(gdp_{t-i}) + \alpha_{2j}\sum_{j=0}^{p} dl\_oil_{t-j}{}^{+} + \alpha_{3k}\sum_{k=0}^{r} dl\_oil_{t-k}{}^{-} + +\alpha_{4n}\sum_{n=0}^{z} nfuel_{t-n} + e_t$$

$$\log(usd\_uah_t) = \beta_0 + \beta_{1i}\sum_{i=1}^{q}\log(usd\_uah_{t-i}) + \beta_{2j}\sum_{j=0}^{p} dl\_oil_{t-j}{}^{+} + \beta_{3k}\sum_{k=0}^{r} dl\_oil_{t-k}{}^{-} + +\beta_{4n}\sum_{n=0}^{z} nfuel_{t-n} + u_t$$

$$cpi_t = \gamma_0 + \gamma_{1i}\sum_{i=1}^{q} cpi_{t-i} + \gamma_{2j}\sum_{j=0}^{p} dl\_oil_{t-j}{}^{+} + \gamma_{3k}\sum_{k=0}^{r} dl\_oil_{t-k}{}^{-} + \gamma_{4n}\sum_{n=0}^{z} nfuel_{t-n} + \omega_t$$

	gdp	*usd_uah*	*cpi*
q	3	1	12
p	0	0	1
r	6	2	4
z	1	3	0

ARDL model

Dependent Variable: LOG_GDP
Method: ARDL
Selected Model: ARDL(3, 0, 6, 1)

Variable	Coefficient
LOG_GDP(-1)	0.833416*
LOG_GDP(-2)	0.010843
LOG_GDP(-3)	0.135894*
DL_OILP_P	-0.020088
DL_OILP_N	0.062578*
DL_OILP_N(-1)	0.010620
DL_OILP_N(-2)	0.020851
DL_OILP_N(-3)	-0.015266
DL_OILP_N(-4)	0.044492*
DL_OILP_N(-5)	0.025523
DL_OILP_N(-6)	0.077745*
NFUEL	0.001277*
NFUEL(-1)	-0.001322*
C	0.261639

Dependent Variable: LOG_USD_UAH
Method: ARDL
Selected Model: ARDL(1, 0, 2, 3)

Variable	Coefficient
LOG_USD_UAH(	1.000843*
DL_OILP_P	-0.030697
DL_OILP_N	-0.193133*
DL_OILP_N(-1)	0.053083
DL_OILP_N(-2)	-0.282976*
NFUEL	-0.000520
NFUEL(-1)	-0.000959
NFUEL(-2)	0.002791*
NFUEL(-3)	-0.001178
C	-0.021961

Dependent Variable: CPI
Method: ARDL
Selected Model: ARDL(12, 1,

Variable	Coefficient
CPI(-1)	0.709231
CPI(-2)	-0.150478
CPI(-3)	0.064776
CPI(-4)	0.018205
CPI(-5)	0.144114
CPI(-6)	-0.251182*
CPI(-7)	0.247022*
CPI(-8)	-0.059043
CPI(-9)	0.054449
CPI(-10)	-0.085365
CPI(-11)	0.143197
CPI(-12)	-0.244352*
DL_OILP_P	1.405123
DL_OILP_P(-1)	3.51016*
DL_OILP_N	-0.557641
DL_OILP_N(-1)	-1.594026
DL_OILP_N(-2)	-1.286565
DL_OILP_N(-3)	-5.93651*
DL_OILP_N(-4)	2.488473
NFUEL	0.002229
C	40.68519

ARDL model

$$\log(gdp_t) = \alpha_0 + \alpha_{1i}\sum_{i=1}^{q}\log(gdp_{t-i}) + \alpha_{2j}\sum_{j=0}^{p} nopi_{t-j} + \alpha_{3k}\sum_{k=0}^{r} nopd_{t-k} + \alpha_{4n}\sum_{n=0}^{z} nfuel_{t-n} + e_t$$

$$\log(usd\_uah_t) = \beta_0 + \beta_{1i}\sum_{i=1}^{q}\log(usd\_uah_{t-i}) + \beta_{2j}\sum_{j=0}^{p} nopi_{t-j} + \beta_{3k}\sum_{k=0}^{r} nopd_{t-k} + \beta_{4n}\sum_{n=0}^{z} nfuel_{t-n} + u_t$$

$$cpi_t = \gamma_0 + \gamma_{1i}\sum_{i=1}^{q} cpi_{t-i} + \gamma_{2j}\sum_{j=0}^{p} nopi_{t-j} + \gamma_{3k}\sum_{k=0}^{r} nopd_{t-k} + \gamma_{4n}\sum_{n=0}^{z} nfuel_{t-n} + \omega_t$$

	gdp	*usd_uah*	*cpi*
q	10	1	12
p	0	0	0
r	5	2	5
z	5	1	0

ARDLmodel

Dependent Variable: LOG_GDP
Method: ARDL
Selected Model: ARDL(10, 0, 5, 5)

Variable	Coefficient
LOG_GDP(-1)	0.853393
LOG_GDP(-2)	0.014127
LOG_GDP(-3)	0.202900*
LOG_GDP(-4)	-0.178622*
LOG_GDP(-5)	0.014297
LOG_GDP(-6)	0.168272*
LOG_GDP(-7)	-0.130797
LOG_GDP(-8)	0.034628
LOG_GDP(-9)	0.104032
LOG_GDP(-10)	-0.108239*
NOPI	0.015809
NOPD	0.082533*
NOPD(-1)	0.037378
NOPD(-2)	-0.008359
NOPD(-3)	-0.010247
NOPD(-4)	0.052361
NOPD(-5)	0.088892*
NFUEL	0.001453*
NFUEL(-1)	-0.001791*
NFUEL(-2)	0.000483
NFUEL(-3)	-0.000876*
NFUEL(-4)	0.001309*
NFUEL(-5)	-0.000562*
C	0.325530*

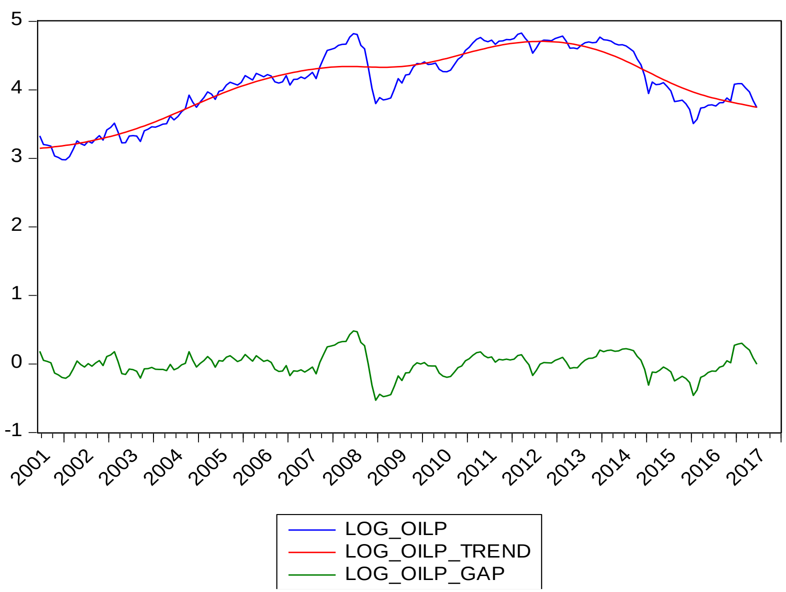
Dependent Variable: LOG_USD_UAH
Method: ARDL
Selected Model: ARDL(1, 0, 2, 1)

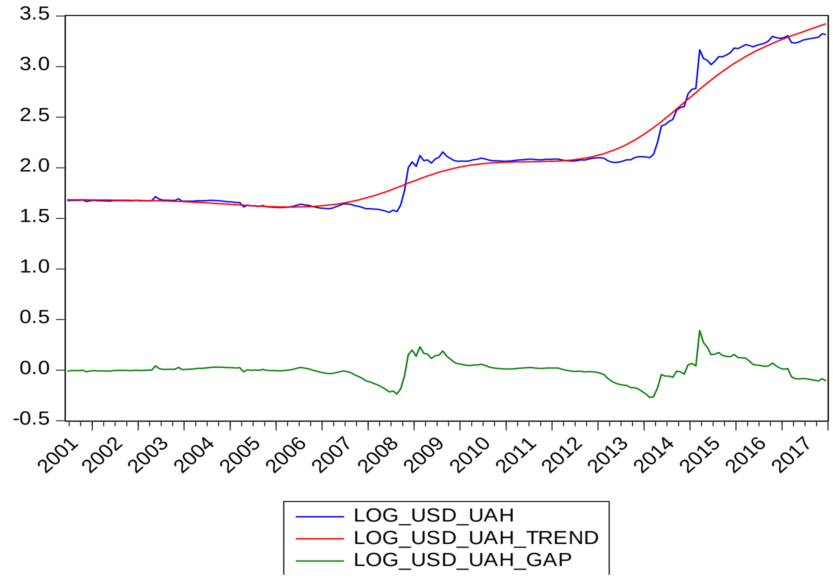
Variable	Coefficient
LOG_USD_UAH(-1)	0.997972*
NOPI	-0.031881
NOPD	-0.402711*
NOPD(-1)	0.299407*
NOPD(-2)	-0.429315*
NFUEL	-0.001471*
NFUEL(-1)	0.001582*
C	-0.007548

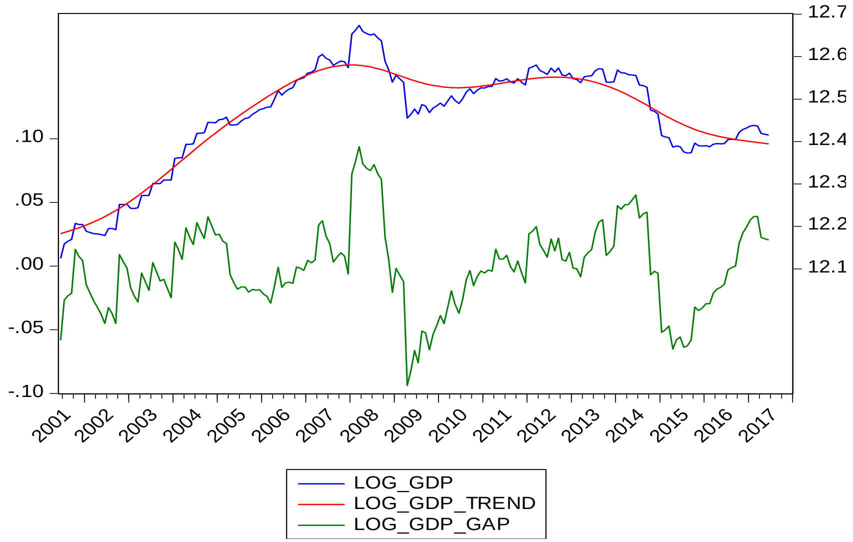
Dependent Variable: CPI
Method: ARDL
Selected Model: ARDL(12

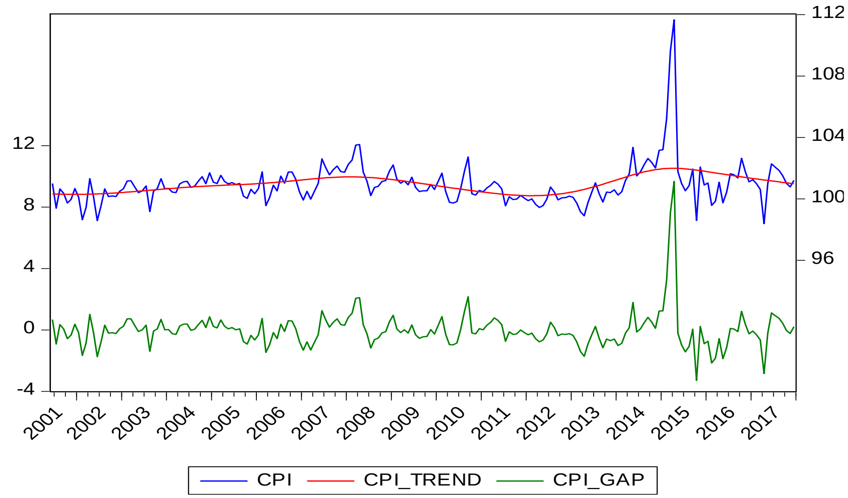
CPI(-1)	0.713307*
CPI(-2)	-0.232315*
CPI(-3)	0.086539
CPI(-4)	-0.008641
CPI(-5)	0.157646
CPI(-6)	-0.18838*
CPI(-7)	0.184387*
CPI(-8)	-0.020182
CPI(-9)	0.040892
CPI(-10)	-0.102386
CPI(-11)	0.123099
CPI(-12)	-0.272176*
NOPI	2.745440
NOPD	-0.700993
NOPD(-1)	-1.435844
NOPD(-2)	-1.610758
NOPD(-3)	-11.52409*
NOPD(-4)	6.610185*
NOPD(-5)	-4.825435*
NFUEL	0.001334
C	51.9471*

Hodrick–Prescott filter









TVAR approach

$$Y_t = (\Psi^1{}_o + \Psi_1^{\ 1}(L)Y_{t-1} + \Psi^1{}_2 X_t) + (\Psi^2{}_o + \Psi_1^{\ 2}(L)Y_{t-1} + \Psi^2{}_2 X_t)F(z_t) + \varepsilon_t$$

- z_t – threshold variable that determines regime of system
- $F(z_t)$ – smooth transition function, bounded between 0 and 1

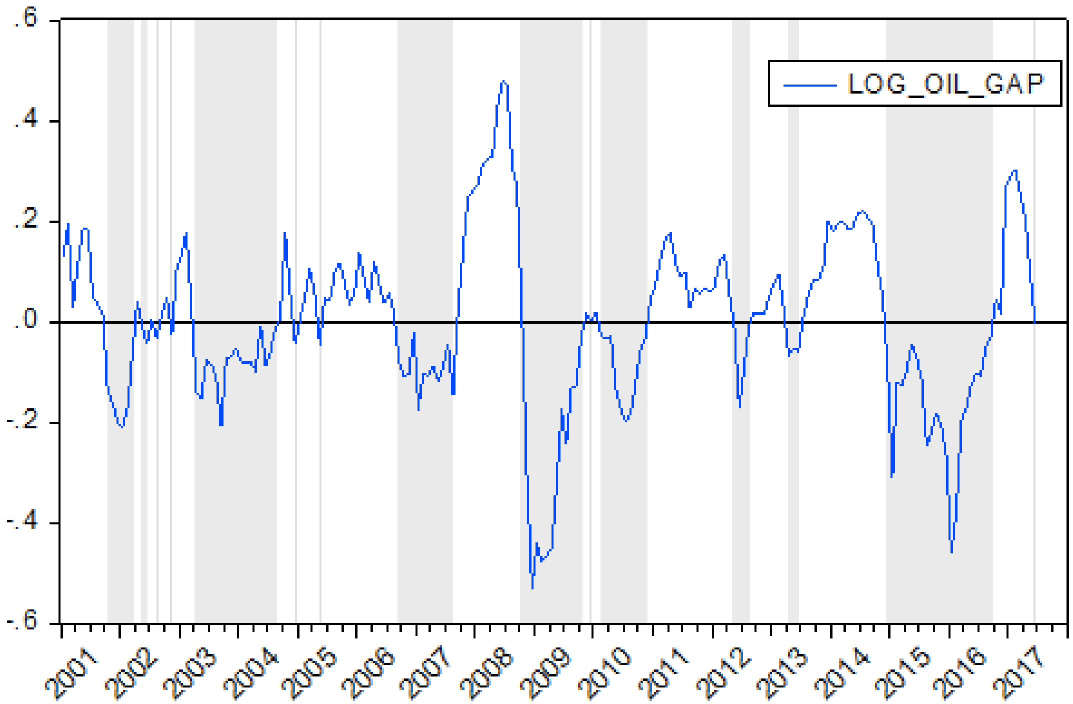
$$F(z_t) = \frac{1}{1 + \exp(-\gamma(z_t - tr)/std(z_t))}$$

- tr - threshold parameter
- γ - smoothnes parameter

- To find the suitable lag length for the TVAR, standard specifcation tests are used.
- Akaike information criterion and Schwartz information criterion both suggest an optimal lag length of 3.

Threshold variable

Threshold variable and estimated threshold parameter



Threshold variable: log_oil_gap

Threshold parameter: 0

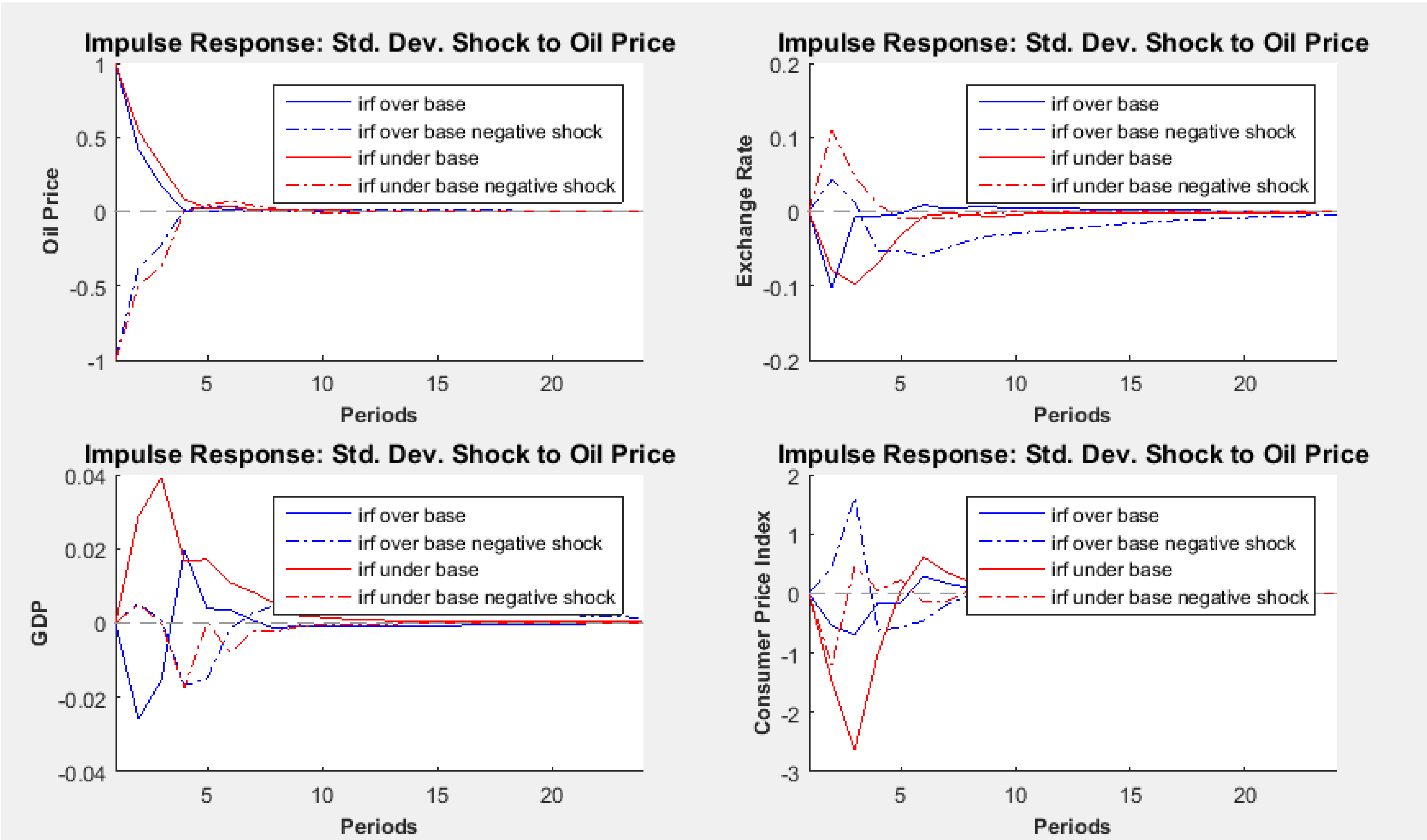
Observations over base: 91
Observations under base: 102

Smothness parameter: 9.6

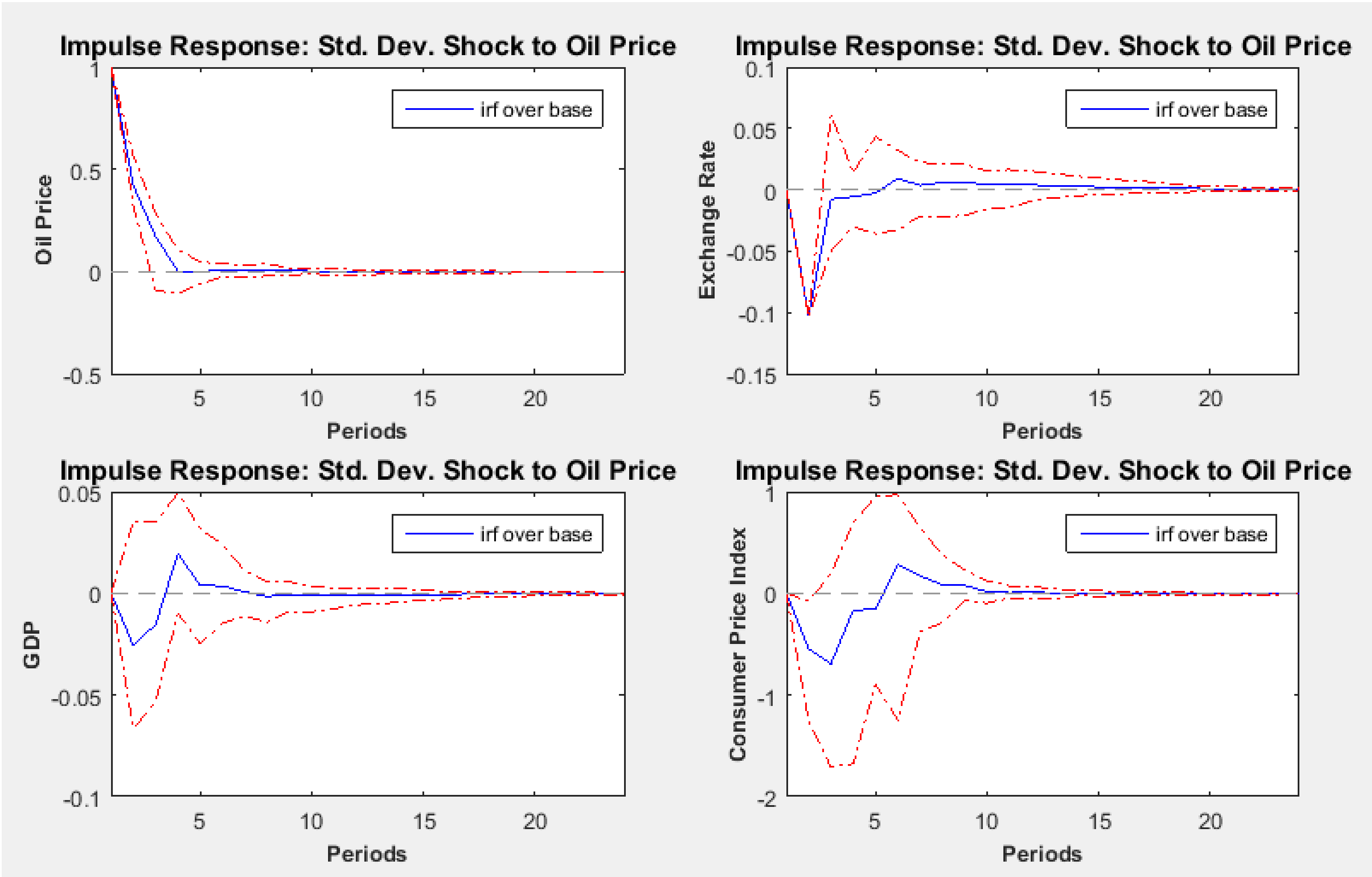
γ is the speed of adjustment parameter

- To find the suitable value for the smoothness parameter, LR is used.

Impulse response functions

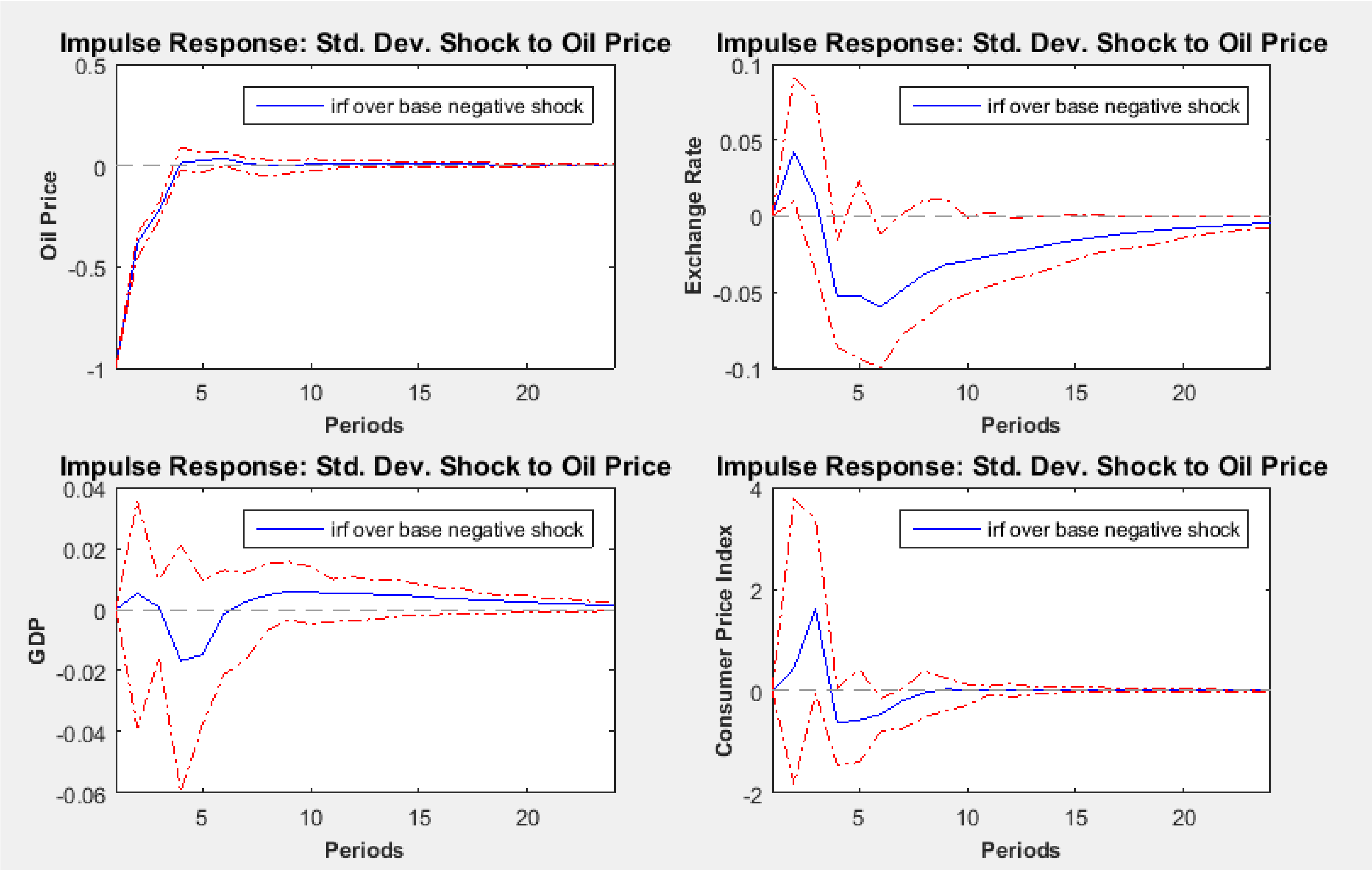


Impulse response functions: Positive shock

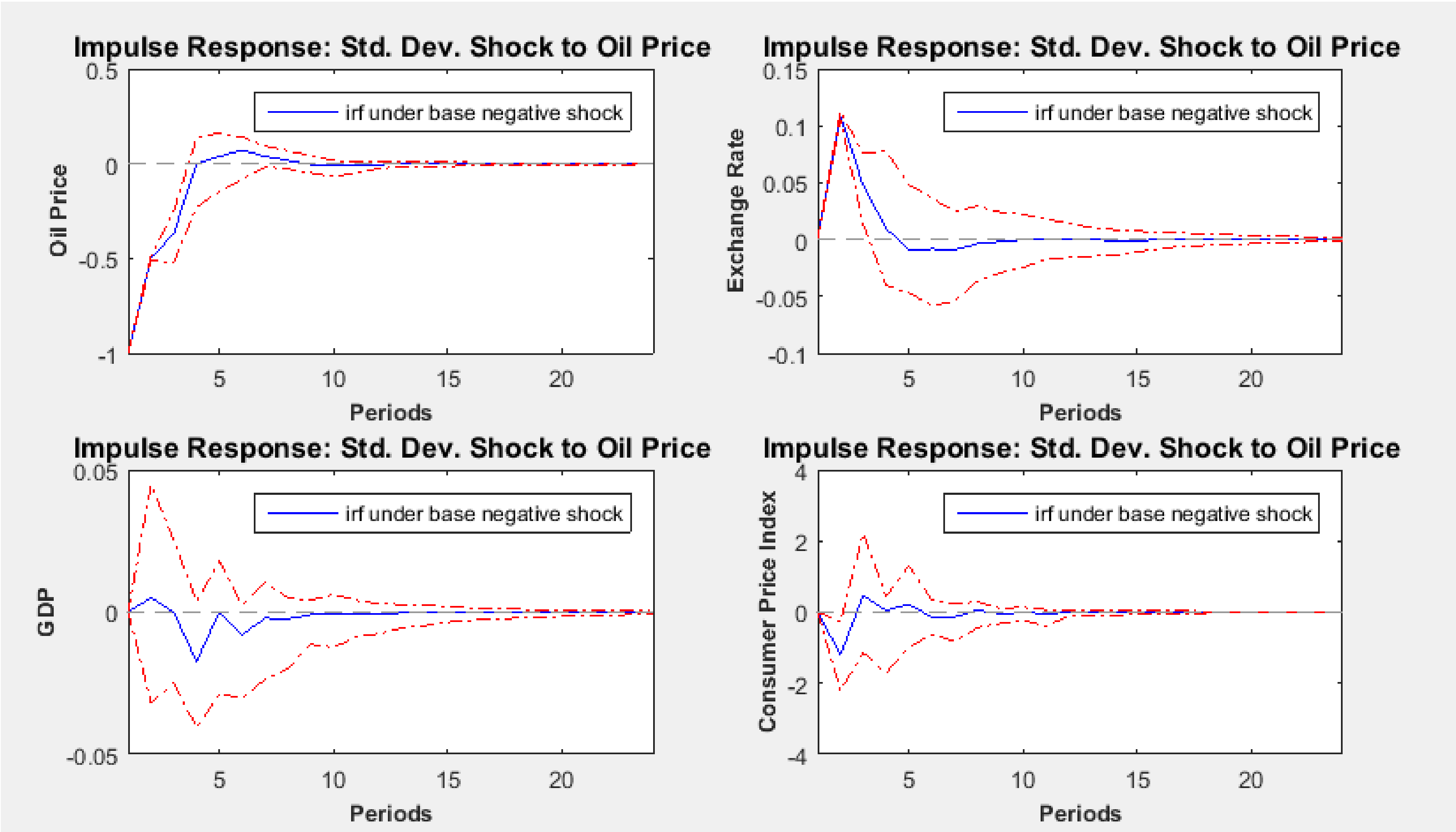


Impulse response functions: Positive shock

Impulse response functions: Negative shock



Impulse response functions: Negative shock



Conclusions

- The response of GDP to positive oil shock is larger than its response to negative shock.

- The results of TVAR model indicate that that oil price increases lead to:

- the rise of GDP during low-growth regime and to decline during high-growth regime
- the decline of CPI and exchange rate during both regimes.

- The reduction of CPI due to positive oil shock during low-growth regime is larger than during hign-growth regime.

- Negative oil price shock leads to the rise of GDP during first 3 years and after this period to the decline and to the rise of CPI and exchange rate during both regimes.

References

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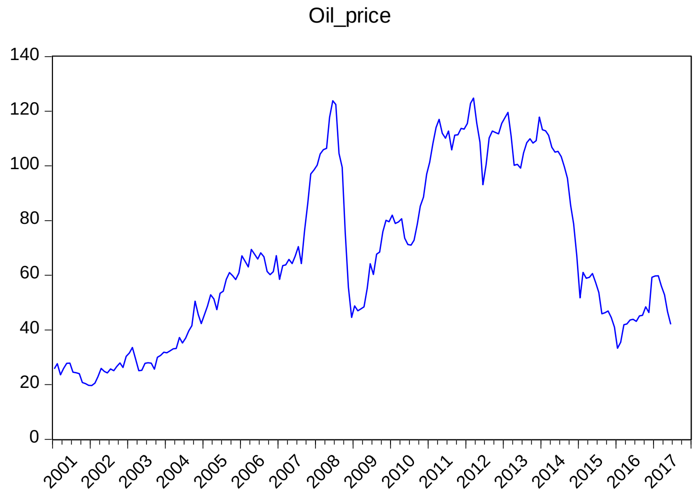
Appendix


Oil_price
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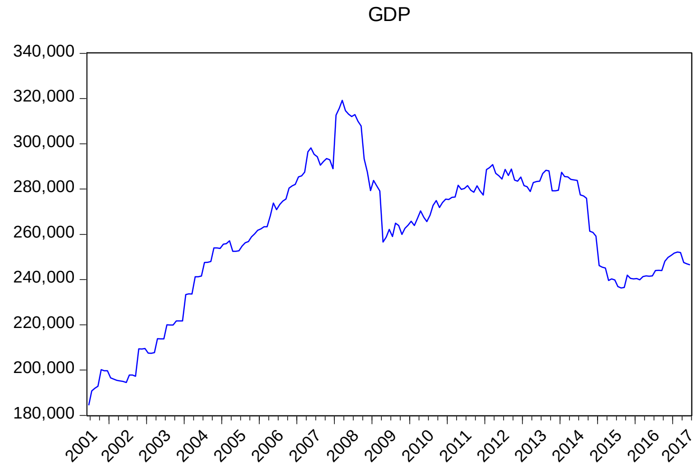
GDP
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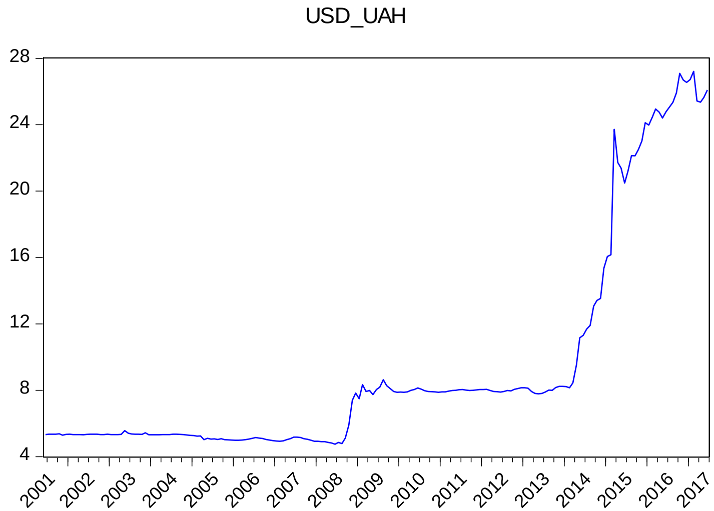
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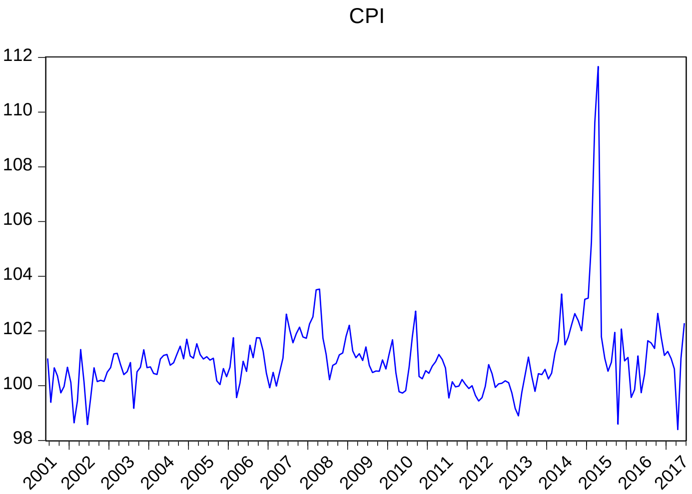
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