ECO 395M: Time Series Econometrics

Rising Inflation and Taylor Rule in Turkey (2002-2020)

THE UNIVERSITY OF TEXAS AUSTIN

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by

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May 7, 2021

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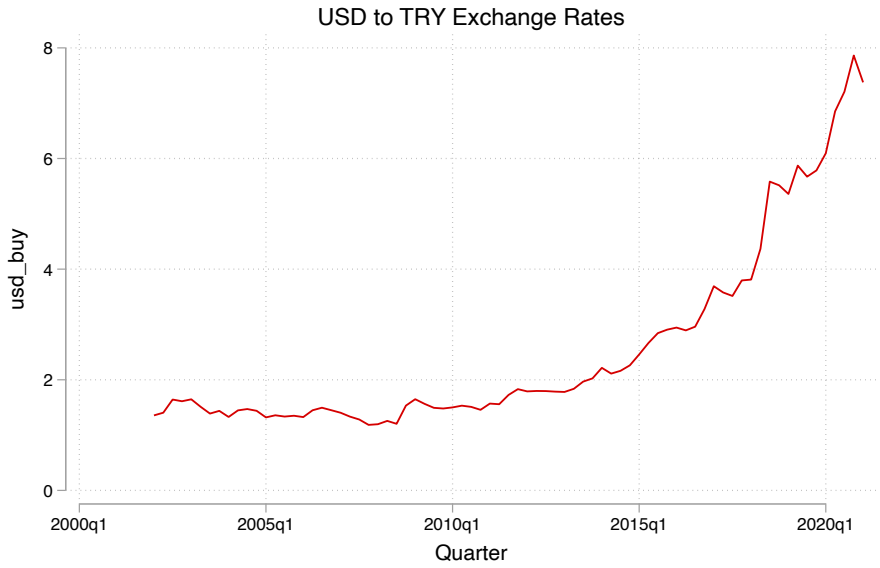
1 Introduction

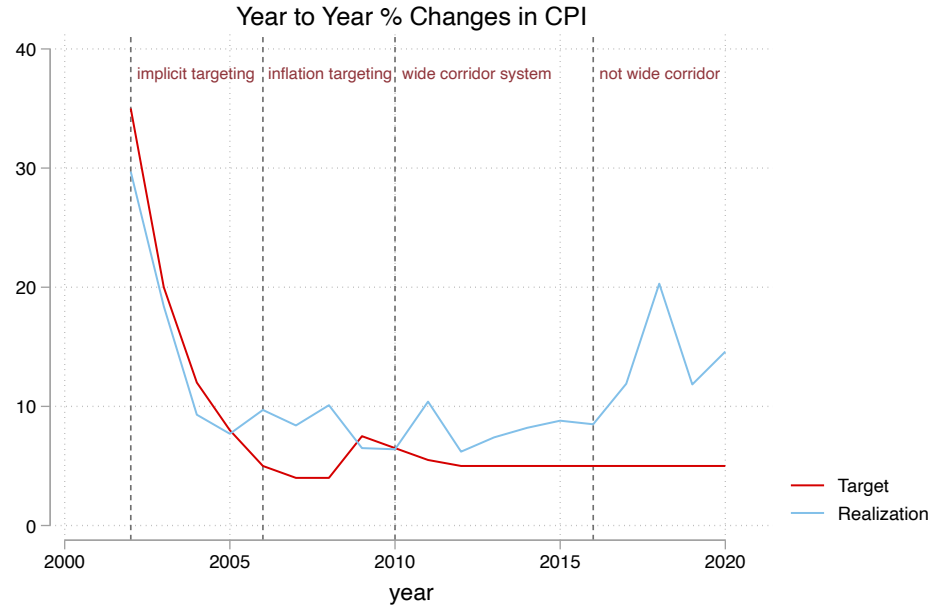
Year-to-year percent change in Consumer Price Index has been above ten percent in Turkey since 2017. Coupled with the ever-continuous devaluation of Turkish Lira against the dollar and euro, the Turkish Economy is currently in a very concerning place. In this project, I study how the government responded to the rising inflation rates and what policies might have contributed to its rise and the devaluation of Turkish Lira in the first place.



1.1 Background

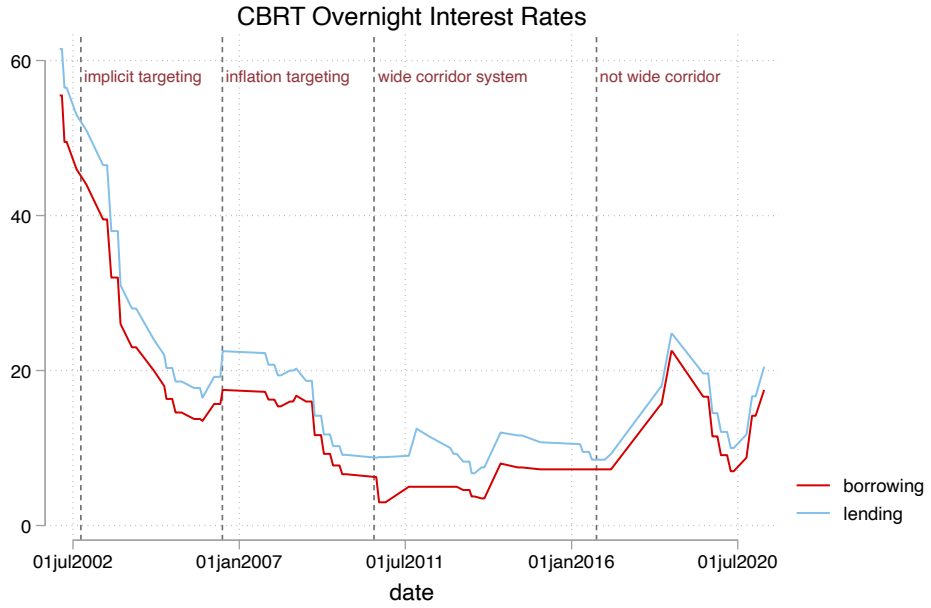
The political instability in Turkey in the 1990s brought a lack of trust in the government, large budget deficits, and foreign disinvestment. IMF issued a warning for financial crisis in 1996 and agreed to loan Turkey $11.4 billion in 2000 (BBC, 2000). The loan was insufficient, and the government's actions could not stop the stock market crash. Interest rates and inflation kept rising while tens of thousands lost their jobs.

In February 2001, the Central Bank of Republic of Turkey (CBRT) and the government made a joint decision to implement a floating exchange rate regime. Soon after, the government adopted the Program of Transition to a Strong Economy and passed an amendment to the Central Bank Law. This gave CBRT more authority and independence to implement monetary policy.



The following three years (2002-2005) is referred to as Implicit Inflation Targeting Period where the CBRT announced inflation targets jointly with the Turkish Government. In 2006, the Monetary Policy Committee received full authority over interest rates, began meeting on a monthly basis, and made meeting notes accessible to public. All these measures, along with other structural changes in fiscal policy, led to lower inflation and a more stable Turkish Economy.

Following the 2008 Global Financial Crisis, CBRT introduced new monetary policy tools such as reserve options mechanism, required reserve coefficient, and wide corridor system. After 2016, the Bank fixed the gap in the lending and borrowing rates citing that it "makes it difficult to understand the monetary policy stance" (TCMB).



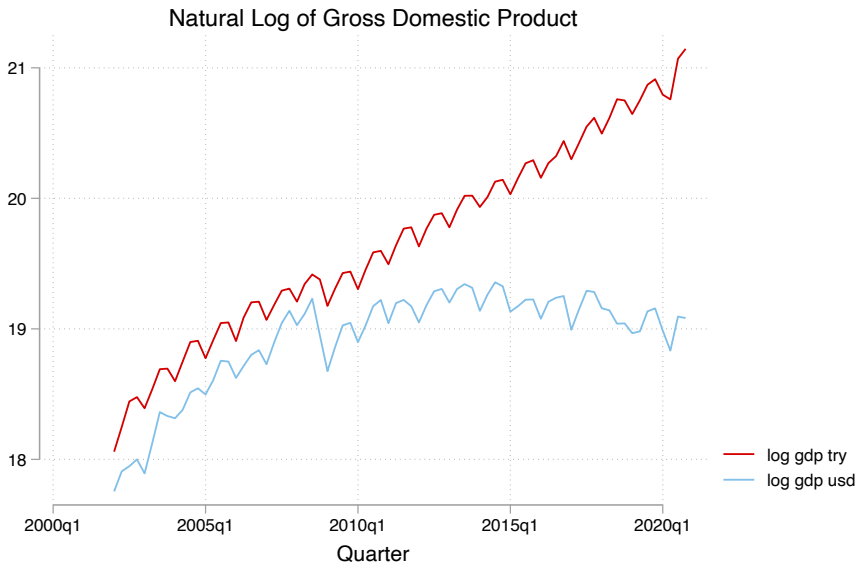
2 Data

I have gathered data from the Ministry of Treasury and Finance, TurkStat, and Central Bank of Turkey:

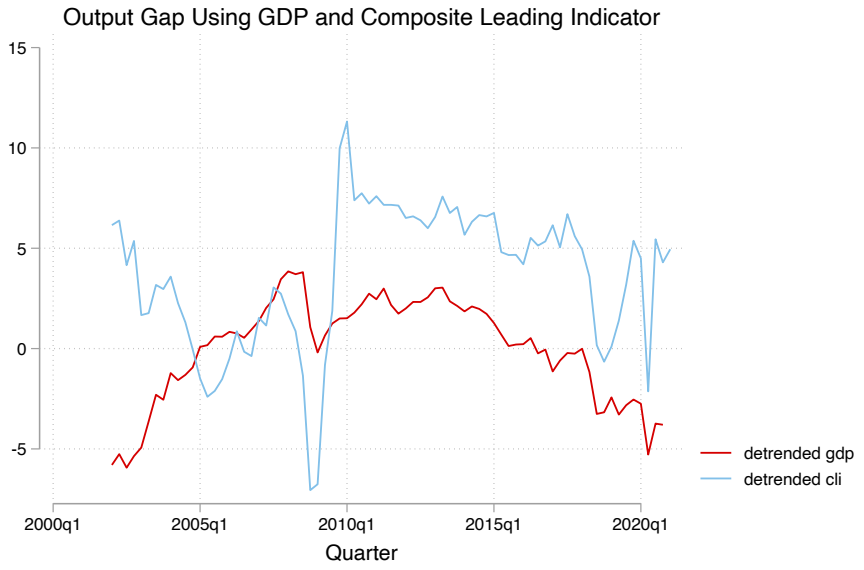
- https://www.hmb.gov.tr/hmb-veri-dagitim-sistemi
- https://www.tuik.gov.tr/
- https://www.tcmb.gov.tr/

.

My variables include: CBRT overnight interest rates, Consumer Price Index, Producer Price Index, Gross Domestic Product, USD-TRY Exchange Rates, Borsa Istanbul Volume, Foreign Direct Investment, and more. The observations go from the first quarter of 2002 to the first quarter of 2021 (2020 Q4 for some).



I define output gap in two ways. First, I transform the GDP to its natural log form and take the residuals from an OLS regression with trend and quarter dummies. The other way is I deseaonalize the OECD's Composite Leading Indicator (CLI) which is designed to "provide early signals of turning points in business cycles" (OECD 2021). I report the results from the former in this paper. Please see the comments and labels in the provided Do-File for more information on data and transformation.



3 Model Estimation and Results

$$i_t = \pi_t + r_t^* + a_\pi \left(\pi_t - \pi_t^*\right) + a_y \left(y_t - \bar{y}_t\right)$$

.

Following the literature, I try to estimate the Taylor Equation and take the overnight borrowing rate to be the policy variable. However, it is important to note that CBRT has multiple rates in its toolbox as discussed above.

3.0.1 Short-Run Structural Vector Auto-Regressive Model

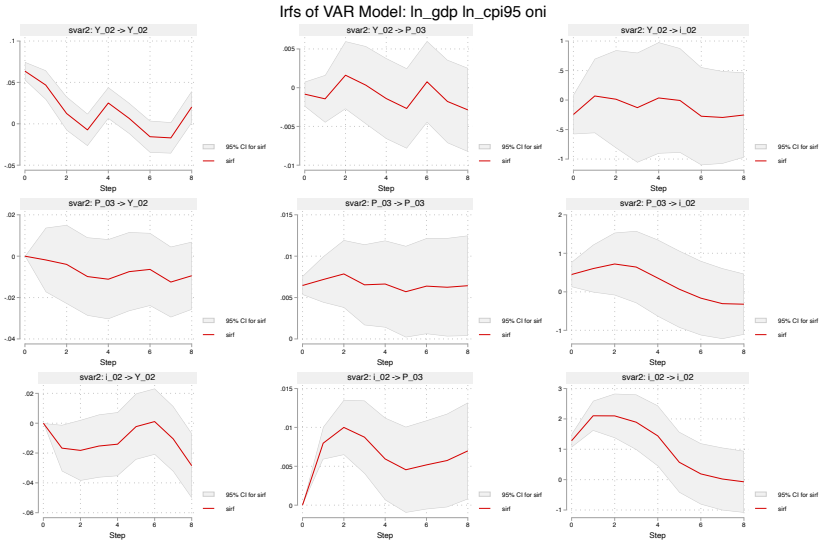
For short-run SVAR, I assume inflation has no contemporaneous effect on output gap and that it takes at least a quarter for Central Bank policy to influence inflation and output.

$$\begin{aligned}
\Delta lny_t &= \alpha_1 + \beta_{12}\pi_t + \beta_{13} i_t + \gamma_{11}\Delta lny_{t-1} + \gamma_{12}\pi_{t-1} + \gamma_{13} i_{t-1} + \cdots + \varepsilon_{1t} \\
&= \alpha_1 + \gamma_{11}\Delta lny_{t-1} + \gamma_{12}\pi_{t-1} + \gamma_{13} i_{t-1} + \cdots + \varepsilon_{1t} \\
\pi_t &= \alpha_2 + \beta_{21}\Delta lny_t + \beta_{23} i_t + \gamma_{21}\Delta lny_{t-1} + \gamma_{22}\pi_{t-1} + \gamma_{23} i_{t-1} + \cdots + \varepsilon_{2t} \\
&= \alpha_2 + \beta_{21}\Delta lny_t + \gamma_{21}\Delta lny_{t-1} + \gamma_{22}\pi_{t-1} + \gamma_{23} i_{t-1} + \cdots + \varepsilon_{2t} \\
i_t &= \alpha_3 + \beta_{31}\Delta lny_t + \beta_{32}\pi_t + \gamma_{31}\Delta lny_{t-1} + \gamma_{32}\pi_{t-1} + \gamma_{33} i_{t-1} + \cdots + \varepsilon_{2t}
\end{aligned}$$

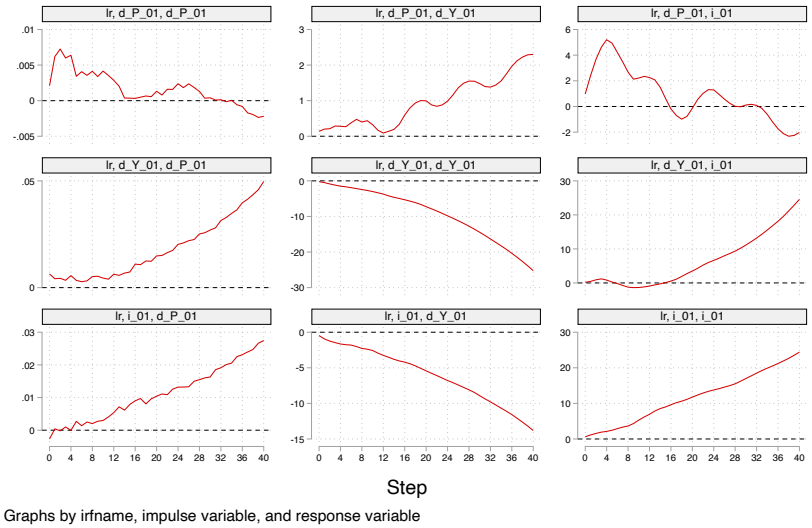
In matrix notation,

$$\begin{bmatrix} 1 & 0 & 0 \\ -\beta_{21} & 1 & 0 \\ -\beta_{31} & -\beta_{32} & 1 \end{bmatrix} \begin{pmatrix} \Delta lny_t \\ \pi_t \\ i_t \end{pmatrix} = \begin{pmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \end{pmatrix} + \sum_{i=1}^{8} A_i z_{t-i} + \varepsilon_t$$

$$B z_t = \alpha + \sum_{i=1}^{8} A_i z_{t-i} + \varepsilon_t$$

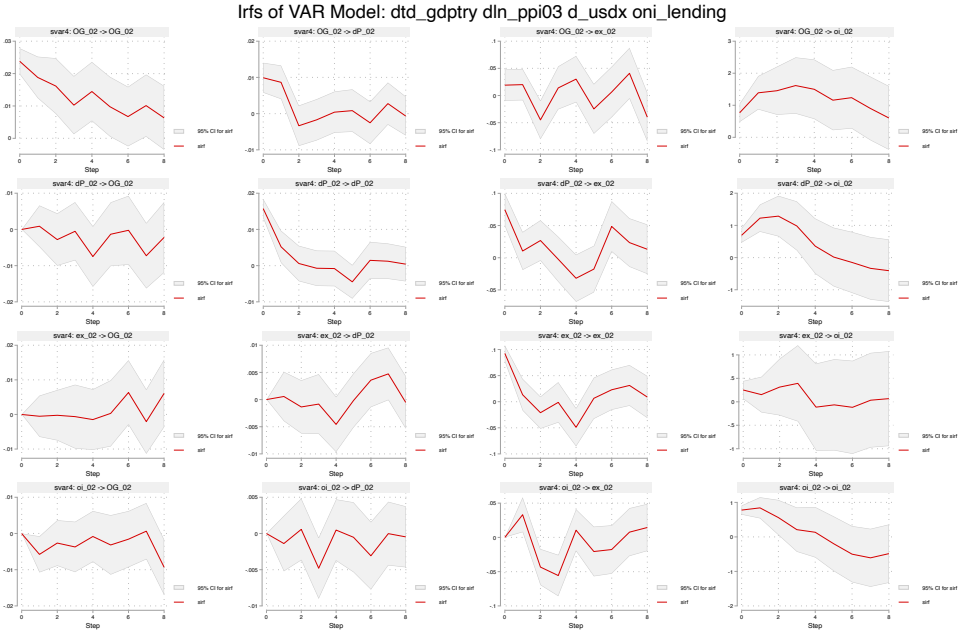


I find that shocks to output leads to higher prices and the effect is persistent. This would imply the growth we observe in Turkey in the past two decades is mostly demand-driven. Furthermore, shocks to Overnight Borrowing Rates lead to higher and persistent rises in inflation. This is contradictory with the standard theory and an example of price puzzle. CBRT seems to responds to growing economy by reducing rates (at least in the first few quarters). This is at odds with what standard macroeconomic theory would suggest the bank to do: contractionary policy during booms. Below is a figure of Cumulative IRFs from Long Run SVAR model.



3.0.2 SVAR Including Exchange Rates

In this model, I do not convert the output levels to dollar and keep them in terms of nominal Turkish Lira. Instead, I include USD/TRY exchange rates in the model. In order to combat the price puzzle, I use producer price index instead of CPI as a measure of inflation.



We see that a rise in CBRT interest rate does not lead to higher prices (no more price puzzle). A shock to the value of US Dollar against Turkish Lira eventually increases inflation. And a shock to overnight lending rates lowers the exchange rate in the second and third quarters that follow.

We also observe CBRT to be responding to growth more inline with theory by increasing interest rates (at least for six quarters). Furthermore, the CBRT tries to fight inflation by also increasing interest rates for about four quarters.

In my further studies on this subject, I plan to have monthly data and analyze these decades in three parts: 2002-2010, 2011-2016, 2016-2021. I also want to utilize Kalman Filter to better understand and show how the ways the Central Bank interpreted the economy and responded to its shocks have evolved.

4 References

1. Alkan, Buket. Journal of Economics and Political Economy; Istanbul Vol. 6, Iss. 1, (Mar 2019): 78-93. DOI:10.1453/jepe.v6i1.1851

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4. Khakimov, O.A. Erdogan, Levent Cağlarirmak, Necla. (2010). Assessing monetary policy rule in Turkey. International Journal of Economic Perspectives. 4. 319-330.

5. OECD. "Leading Indicators - Composite Leading Indicator (CLI)" OECD Data, data.oecd.org/leadind/compo leading-indicator-cli.htm.

6. TCMB. Central Bank Monetary Policy Framework. www.tcmb.gov.tr/wps/wcm/connect/EN/TCMB+EN/Main+Menu/Core+Functions/Monetary+Policy/Cer

```
1  ********************************************************************************
   ************
2  * Title: Time Series Project @ UT Austin MA in Econ Opt
   III                     *
3  * Author: Lutfi
   Sun                                                              *
4  * Date: Thursday April 25,
   2021                                                  *
5  ********************************************************************************
   ************
6
7  capture log close
8  clear all
9  drop _all
10 macro drop _all
11
12 cd "/Users/lutfisun/Desktop/turkey_taylor_project"
13
14 log using tsproject.log, replace
15
16 *-------------------------------------------------------------------
   ------------
17 * Overnight Interest Rates
18 *-------------------------------------------------------------------
   ------------
19
20 import delimited "data/cb_oni.csv"
21
22 * data on overnight interest rates is missing for some most months
   and
23 * not available quarterly (could not find) so, i will take
   averages of
24 * observations within the same quarter
25
26 gen edate = date(date, "DM20Y")
27 format edate %d
28 gen quarter = quarter(edate)
29 gen year = year(edate)
30 gen yq = yq(year, quarter)
31
32 egen oni_b = mean(oni_borrowing), by(yq)
33 egen oni_l = mean(oni_lending ), by(yq)
34
35 label variable edate "date"
36 label variable oni_b "borrowing"
37 label variable oni_l "lending"
38
39 graph twoway line oni_b oni_l edate, name(cb_oni)  ///
```

```
40      title("CBRT Overnight Interest Rates") xline(15600 17000 18500
    20700) ///
41      text(58 15602  "implicit targeting" 58 17002 "inflation
    targeting", placement(east) size(.25cm) color(maroon)) ///
42      text(58 18503  "wide corridor system" 58 20703 "not wide
    corridor", placement(east) size(.25cm) color(maroon))
43
44  graph export "figures/cb_oni.pdf", name(cb_oni) replace
45
46  drop oni_borrowing oni_lending edate quarter year
47  duplicates drop yq, force
48
49  save "data/cb_oni.dta", replace
50
51  *-----------------------------------------------------------------
    ------------
52  * Inflation Target
53  *-----------------------------------------------------------------
    ------------
54
55  clear
56  import delimited "data/cb_inflation.csv"
57
58  graph twoway line target realization year, name(cb_inflation) xsc(r
    (2002 2021)noextend)  ///
59      title("Year to Year % Changes in CPI") xline(2002 2006 2010
    2016) ///
60      text(38 2002.1  "implicit targeting" 38 2006.06 "inflation
    targeting", placement(east) size(.25cm) color(maroon)) ///
61      text(38 2010.1  "wide corridor system" 38 2016.1 "not wide
    corridor", placement(east) size(.25cm) color(maroon))
62
63  graph export "figures/cb_inflation.pdf", name(cb_inflation) replace
64
65  gen quarter = 1
66  gen yq = yq(year, quarter)
67
68  drop year quarter
69  duplicates drop yq, force
70
71  save "data/cb_inflation.dta", replace
72
73  *-----------------------------------------------------------------
    ------------
74  * Merge All
75  *-----------------------------------------------------------------
    ------------
76
```

```
77  clear
78  import delimited "data/evds_clean.csv", parselocale(en_US)
79
80  gen yq = quarterly(date, "YQ")
81  format yq %tq
82
83  merge m:m yq using "data/cb_oni.dta", generate(merg1)
84  merge m:m yq using "data/cb_inflation.dta", generate(merg2)
85
86  drop merg*
87  duplicates drop yq, force
88  sort yq
89  tset yq
90
91  ssc install fillmissing, replace
92  fillmissing oni_b oni_l target, with(previous)
93
94  save "data/merged_clean.dta", replace
95
96  *------------------------------------------------------------------
    ------------
97  * Figures
98  *------------------------------------------------------------------
    ------------
99
100 * output
101
102 gen ln_gdp = log(gdp)
103 sort yq
104 gen d_ln_gdp = D.ln_gdp
105
106 gen gdp_usd = gdp / usd_buy
107 gen ln_gdp_usd = log(gdp_usd )
108
109 label variable yq "Quarter"
110 label variable ln_gdp "log gdp try"
111 label variable ln_gdp_usd "log gdp usd"
112
113 graph twoway line ln_gdp ln_gdp_usd yq, name(gdp) title("Natural
    Log of Gross Domestic Product")
114 graph export "figures/gdp.pdf", name(gdp) replace
115
116 gen quarter = quarter(dofq(yq))
117 gen period2 = _n * _n
118 reg ln_gdp_usd yq i.quarter
119 predict ln_gdp_usd_hat
120
121 predict output_gap, resid
```

```
122 gen output_gap_10 = 10*output_gap
123 label variable output_gap_10 "detrended gdp"
124 label variable oecd_cli_dtd "detrended cli"
125
126 graph twoway (line output_gap_10 oecd_cli_dtd yq), name(output_gap)
     title("Output Gap Using GDP and Composite Leading Indicator")
127 graph export "figures/output_gap.pdf", name(output_gap) replace
128
129 * inflation
130
131 gen ln_cpi95 = log(cpi95_all)
132 gen d_ln_cpi95 = D.ln_cpi95
133
134 graph twoway line d_ln_cpi95 yq, name(d_ln_cpi95) title("Changes
    in Log Cost of Living 95")
135 graph export "figures/d_ln_cpi95.pdf", name(d_ln_cpi95) replace
136
137 gen ln_cpi03 = log(cpi03_all)
138 gen d_ln_cpi03 = D.ln_cpi03
139
140 graph twoway line d_ln_cpi03 yq, name(d_ln_cpi03) title("Changes
    in Log Cost of Living 03")
141 graph export "figures/d_ln_cpi03.pdf", name(d_ln_cpi03) replace
142
143 * forex
144
145 graph twoway line usd_buy yq, name(usd_fx_rates) title("USD to TRY
    Exchange Rates")
146 graph export "figures/usd_fx_rates.pdf", name(usd_fx_rates) replace
147
148 *-----------------------------------------------------------------
    ------------
149 * Short Run SVAR Analysis (USD)
150 *-----------------------------------------------------------------
    ------------
151
152 gen OG_01 = output_gap_10
153 gen dP_01 = D.ln_cpi95
154 gen oi_01 = oni_b
155
156 matrix A1 = (1,0,0 \ .,1,0 \ .,.,1)
157 matrix B1 = (.,0,0 \ 0,.,0 \ 0,0,.)
158
159 svar OG_01 dP_01 oi_01, lags(1/8) aeq(A1) beq(B1)
160 irf create svar1, set(var_diff1, replace)
161 irf cgraph (svar1 OG_01 OG_01 sirf) (svar1 OG_01 dP_01 sirf) (svar1
     OG_01 oi_01 sirf) ///
162             (svar1 dP_01 OG_01 sirf) (svar1 dP_01 dP_01 sirf) (svar1
```

```
     dP_01 oi_01 sirf) ///
163              (svar1 oi_01 OG_01 sirf) (svar1 oi_01 dP_01 sirf) (svar1
     oi_01 oi_01 sirf), ///
164              title ("Irfs of VAR Model: dtd_gdp_usd d_ln_cpi95 oni",
    size(small))
165
166  graph export "figures/svar1.pdf", replace
167
168  *
169  gen Y_02 = ln_gdp_usd
170  gen P_03 = ln_cpi03
171  gen i_02 = oni_b
172
173  svar Y_02 P_03 i_02, lags(1/8) aeq(A1) beq(B1)
174  irf create svar2, set(var_ln2, replace)
175  irf cgraph (svar2 Y_02 Y_02 sirf) (svar2 Y_02 P_03 sirf) (svar2
    Y_02 i_02 sirf) ///
176              (svar2 P_03 Y_02 sirf) (svar2 P_03 P_03 sirf) (svar2
    P_03 i_02 sirf) ///
177              (svar2 i_02 Y_02 sirf) (svar2 i_02 P_03 sirf) (svar2
    i_02 i_02 sirf), ///
178              title ("Irfs of VAR Model: ln_gdp ln_cpi95 oni", size(
    small))
179
180  graph export "figures/svar2.pdf", replace
181
182  save "data/merged_clean_post.dta", replace
183
184
185  *-----------------------------------------------------------------
    ------------
186  * Short Run SVAR Analysis (TRY and PPI)
187  *-----------------------------------------------------------------
    ------------
188
189  gen ln_gdp_try = log(gdp)
190  reg ln_gdp_try yq i.quarter
191  predict og_try, resid
192
193  gen ln_ppi03 = log(ppi_03)
194
195  gen OG_02 = og_try
196  gen dP_02 = D.ln_ppi03
197  gen ex_02 = D.usd_buy
198  gen oi_02 = oni_l
199
200  matrix A2 = (1,0,0,0 \ .,1,0,0 \ .,.,1,0 \ .,.,.,1)
201  matrix B2 = (.,0,0,0 \ 0,.,0,0 \ 0,0,.,0 \ 0,0,0,.)
```

```
202
203 svar OG_02 dP_02 ex_02 oi_02, lags(1/8) aeq(A2) beq(B2)
204 irf create svar4, set(var_diff2, replace)
205 irf cgraph (svar4 OG_02 OG_02 sirf) (svar4 OG_02 dP_02 sirf) (svar4
     OG_02 ex_02 sirf) (svar4 OG_02 oi_02 sirf) ///
206             (svar4 dP_02 OG_02 sirf) (svar4 dP_02 dP_02 sirf) (svar4
     dP_02 ex_02 sirf) (svar4 dP_02 oi_02 sirf) ///
207             (svar4 ex_02 OG_02 sirf) (svar4 ex_02 dP_02 sirf) (svar4
     ex_02 ex_02 sirf) (svar4 ex_02 oi_02 sirf) ///
208             (svar4 oi_02 OG_02 sirf) (svar4 oi_02 dP_02 sirf) (svar4
     oi_02 ex_02 sirf) (svar4 oi_02 oi_02 sirf), ///
209             title ("Irfs of VAR Model: dtd_gdptry dln_ppi03 d_usdx
    oni_lending", size(small))
210
211 graph export "figures/svar4_try.pdf", replace
212
213 *
214 gen ln_usd = log(usd_buy)
215
216 gen OG_03 = ln_gdp_try
217 gen dP_03 = ln_ppi03
218 gen ex_03 = ln_usd
219 gen oi_03 = oni_l
220
221 svar OG_03 dP_03 ex_03 oi_03, lags(1/8) aeq(A2) beq(B2)
222 irf create svar4, set(var_diff2, replace)
223 irf cgraph (svar4 OG_03 OG_03 sirf) (svar4 OG_03 dP_03 sirf) (svar4
     OG_03 ex_03 sirf) (svar4 OG_03 oi_03 sirf) ///
224             (svar4 dP_03 OG_03 sirf) (svar4 dP_03 dP_03 sirf) (svar4
     dP_03 ex_03 sirf) (svar4 dP_03 oi_03 sirf) ///
225             (svar4 ex_03 OG_03 sirf) (svar4 ex_03 dP_03 sirf) (svar4
     ex_03 ex_03 sirf) (svar4 ex_03 oi_03 sirf) ///
226             (svar4 oi_03 OG_03 sirf) (svar4 oi_03 dP_03 sirf) (svar4
     oi_03 ex_03 sirf) (svar4 oi_03 oi_03 sirf), ///
227             title ("Irfs of VAR Model: lngdptry lnppi03 lnusdx
    oni_lending", size(small))
228
229
230 graph export "figures/svar4_try2.pdf", replace
231
232 save "data/merged_clean_post.dta", replace
233
234
235 *-----------------------------------------------------------------
    ------------
236 * Long Run SVAR Analysis 1
237 *-----------------------------------------------------------------
    ------------
```

```
238
239 *Assume 1) in the long run, demand shocks (inflation shocks) and
    policy shocks have no effect on the output.
240 *And the policy shocks have no effect on the inflation level
    (inflation rate is the real variable).
241
242 matrix C = (.,0,0 \ .,.,0 \ .,.,.) //no 1's on the diagonal
243
244 svar d_Y_01 d_P_01 i_01, lags(1/12) lreq(C)
245 irf create lr, set(lrirf1) step(40) replace
246 *view IRF (not cumulative )
247 irf graph sirf, yline(0,lcolor(black)) xlabel(0(4)40) byopts(
    yrescale) set(lrirf1)
248 graph export "figures/lvar_irf.pdf", replace
249
250 *create cumulative irf graphs for responses of output variable
251 use lrirf1.irf, clear
252 sort irfname impulse response step
253 gen csirf = sirf
254 by irfname impulse: replace csirf = sum(sirf) if response== "d_Y_01"
255 order irfname impulse response step sirf csirf
256 save lrirf3.irf, replace
257
258 irf set lrirf3.irf
259 irf graph csirf, yline(0,lcolor(black)) noci xlabel(0(4)40) byopts(
    yrescale)
260
261 *create cumulative irf graphs for responses of all variables
262 by irfname impulse: replace csirf = sum(sirf) if response !=
    "d_Y_01"
263 save lrirf3.irf, replace
264
265 irf set lrirf3.irf
266 irf graph csirf, yline(0,lcolor(black)) noci xlabel(0(4)40) byopts(
    yrescale)
267 graph export "figures/lvar_cumulative.pdf", replace
268
269 *-----------------------------------------------------------------
    ------------
270 * Long Run SVAR Analysis 2
271 *-----------------------------------------------------------------
    ------------
272
273 matrix C = (.,0,0,0 \ .,.,0,0 \ .,.,.,0 \ .,.,.,.) //no 1's on the
    diagonal
274
275 svar OG_02 dP_03 ex_03 oi_03, lags(1/12) lreq(C)
276 irf create lr, set(lrirf1) step(40) replace
```

```
irf graph sirf, yline(0,lcolor(black)) xlabel(0(4)40) byopts(yrescale) set(lrirf1)
graph export "figures/lvar_irf3.pdf", replace

*create cumulative irf graphs for responses of output variable
use lrirf1.irf, clear
sort irfname impulse response step
gen csirf = sirf
by irfname impulse: replace csirf = sum(sirf) if response== "OG_02"
order irfname impulse response step sirf csirf
save lrirf3.irf, replace

irf set lrirf3.irf
irf graph csirf, yline(0,lcolor(black)) noci xlabel(0(4)40) byopts(yrescale)

*create cumulative irf graphs for responses of all variables
by irfname impulse: replace csirf = sum(sirf) if response != "OG_02"
save lrirf3.irf, replace

irf set lrirf3.irf
irf graph csirf, yline(0,lcolor(black)) noci xlabel(0(4)40) byopts(yrescale)
graph export "figures/lvar_cumulative3.pdf", replace

*-------------------------------------------------------------------------
use "data/merged_clean_post.dta", clear


/* a. Test for a unit root in r1 and r3 series using several augmented Dickey Fuller tests.
gen t = _n
tset t
graph twoway line r1 r3 t

dfuller r1
dfuller r1, trend
dfuller r1, drift
*/


log close

```