/*

Replication code for Bonander (2017) "Estimating the population-level impact.." published in Injury Prevention.

(Written and tested in Stata 12 and 13.)

_____

BEGIN BY COPYING ALL CODE IN THE FILE TO STATAS .do-FILE EDITOR.

_____

Install synth package (type help synth for details and code)

_____

*/

*ssc install synth //remove * before this code to install

*help synth

/*

_____

Open the dataset

_____

*/

```
*Change ... to the directory where you unzipped your data file.
cd "..."

use rep_opioids.dta, clear

*Define the incidence rate variable (per 100.000 population)

gen rate = deaths/population*100000

**Identify and drop states with missing outcome values (Synth doesn't like
**missing values)
gen missing = missing(rate)
tab state if missing==1
by statecode (missing), sort: drop if missing[_N]==1

*Tell Stata that the data is a panel dataset
xtset statecode year


/*
_____________________________________________________________________________
Notes on the Synth code
_____________________________________________________________________________

The code works as follows:

synth outcomevar covariate(s), options

where outcomevar is the outcome variable (rate in this case) and covariate(s)
```

is a list of variables to match on. We can specify options for each variable
using () to modify the period matched on (see help file for further details).

The options trunit(), trperiod() specifiy the treated state (id for Florida=12)
and the start of the intervention period (2010).

keep() tells synth to store the results in a separate file, which is useful
for e.g. plotting in external programs, since it stores the outcomes in the
synthetic control unit. We will also exploit this feature later on to produce
inferential statistics using permutation tests.

unitnames() makes the output easier to interpet by displaying state names,
as stored in the variable state, instead of id numbers.

Section 1: Model selection.

Run a set of different matching specifications to select the best model

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We begin by selecting the best fitting matching specifiation,
using the models suggested by Ferman et al. (2016, referenced in the paper).

The results are stored in separate files (see the keep() option), which
can be used for plotting them together.

We can use this test for model selection by choosing the model that minimizes
the pre-intervention RMSPE (which is what Synth reports in the output), and present
this model as the main result (as is done in the paper). We can also plot the

stored results to identify if the results holds (approximately) for all or any

alternative specification (which lends more confidence in the results).

As discussed in the paper, we choose the best fitting model of the options

that do not include the full vector of pre-intervention outcome years, since

other covariates are included in the model (see notes below).

*/

*All years (note that covariate weights are set to zero in models with all outcome year)[1]

```
synth rate rate(1999) rate(2000) rate(2001) rate(2002) rate(2003) rate(2004) rate(2005) rate(2006)
rate(2007) rate(2008) rate(2009) gdp inc unemp_rate, ///
trunit(12) trperiod(2010) fig keep(spec_1.dta, replace) unitnames(state)
```

*Odd years

```
synth rate rate(1999) rate(2001) rate(2003) rate(2005) rate(2007) rate(2009) gdp inc unemp_rate, ///
trunit(12) trperiod(2010) fig keep(spec_2.dta, replace) unitnames(state)
```

*Even years (best fit)

```
synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, ///
trunit(12) trperiod(2010) fig keep(spec_3.dta, replace) unitnames(state)
```

*Average

```
synth rate rate gdp inc unemp_rate, ///
trunit(12) trperiod(2010) fig keep(spec_4.dta, replace) unitnames(state)
```

```
*First half

synth rate rate(1999) rate(2001) rate(2002) rate(2003) rate(2004) rate(2005) gdp inc unemp_rate, ///
trunit(12) trperiod(2010) fig keep(spec_5.dta, replace) unitnames(state)

*First three fourths

synth rate rate(1999) rate(2001) rate(2002) rate(2003) gdp inc unemp_rate, ///
trunit(12) trperiod(2010) fig keep(spec_6.dta, replace) unitnames(state)


/*NOTE [1]

We can extract the information regarding variable weights to probe how much
importance is given to each predictor in the model (this is based on their
predictive power). In the model using the entire range of outcome years,
the covariate weights for gdp inc and unemp_rate will be set to 0 (and are
hence redundant). Choosing one of the other model options
is likely preferable in cases when other covariates are included.

The main output tells us the unit weights and predictor balance,
but omits the variable weights. However, the variable weight matrix
can still be extracted after estimation using:

*/

matlist e(V_matrix)
```

```
/*

Which gives the results for the lastest model estimated. Now check

to compare against the model that matches on all years:

*/

qui synth rate rate(1999) rate(2000) rate(2001) rate(2002) rate(2003) rate(2004) rate(2005) rate(2006)
rate(2007) rate(2008) rate(2009) gdp inc unemp_rate, ///

trunit(12) trperiod(2010)

matlist e(V_matrix) //the variable weights for gdp, inc and unemp_rate are now = 0

/*

_____

Section 2: Main analysis.

Run synth to perform the main analysis as presented in the paper.

_____

Here we match on the outcome itself (every even year in the pre-intervention

period) and the pre-intervention averages of gdp, inc and unemp_rate. We explore

other options below, but for now: this is the model with the best pre-intervention

fit, as measured by the RMSPE (lower=better).

*/

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, ///

trunit(12) trperiod(2010) fig keep(main_res.dta, replace) unitnames(state)
```

/*

_____

Section 2: Inferential statistics as suggested by Abadie, Diamond and Heinmuller

We will now perform two placebo permutation tests (one graphical and one
"formal" test).

The graphical test gives us a hint regarding the distribution
of placebo results from untreated states, but is sometimes hard to read.

The other produces a pseudo p-value by ranking the states (placebo and Florida)
according to their post/pre-intervention RMSPE ratio (larger ratio=bigger effect
estimate irrespective of direction).

_____

*/

****

SPAGHETTI PLOT

****

/*
This code runs through all units in the dataset and estimate a synthetic
control unit for each one of them. It then stores and merges the results
from all of these iterations (46 total), producing a new variable containing
the difference between the observed values of outcome Y to the synthetic values
of Y for every year in the time series. We define the variable as the
estimated effect for unit i at time t.

```
In the end, it plots the placebo results in gray against the main results
for the treated unit (Florida) in black.

NOTE: Make sure to run the entire loop at once.

*/

set more off
egen id = group(statecode)
xtset id year

forvalues i = 1/46 { //change last number to number of units in the data

tempfile synth_`i' //tempfile to store the results from model `i'

qui synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, ///
trunit(`i') trperiod(2010) keep(`synth_`i'', replace)
}

forvalues i = 1/46 { //change last number to number of units in the data

use `synth_`i'', clear

rename _time years

gen tr_effect_`i' = _Y_treated - _Y_synthetic

keep years tr_effect_`i'
```

```
drop if missing(years)

save `synth_`i'', replace
}

use `synth_1', clear

forvalues i = 2/46 { //change last number to number of units in the data
qui merge 1:1 years using `synth_`i'', nogenerate
}

local lp

forvalues i = 1/46{ //change last number to number of units in the data
  local lp `lp' line tr_effect_`i' years, lcolor(gs12) lpattern(solid) ||
}

twoway `lp' || line tr_effect_9 years, ///
lcolor(black) lpattern(solid) legend(off) xline(2010, lpattern(dash) lcolor(black)) ylab(,nogrid)

/* NOTES:

(1) Change "line tr_effect_9" to tr_effect_[treatunit] to highlight other treatment
units in the plot. Also, change xline([year],...) to the intervention year.
In the paper, I use the resulting dataset (now in use) to generate Fig. 4, which
also highlights the placebos with the same or greater post/pre-RMSPE ratio. I use an
external plotting program for this, although code can easily be added to
the twoway plot above to highlight specific placebos.
```

(2) The forvalues loop is only valid if id codes are in consecutive order.
If not, generate a new id var using "egen newid = group(oldid)" and identify
value of the treatment unit on the new id variable and the change input values
indicated in the code above. (This is not a problem in this dataset)

*/

****

"PSEUDO P-VALUES" AND POST/PRE RMSPE RATIOS

****

/*

Next, let's calculate a pseudo p-value based on the rank of the treatment unit's
post/pre-RMSPE ratio compared to the untreated placebo units post/pre-RMSPE
ratios (as in Abadie, Diamond and Heinmuller 2010, referenced in the paper).
We use the placebo effect dataset genereted by the code above for this,
so the code for the spaghetti plot above must be run first.

*/

```
preserve
gen post = 0
replace post = 1 if years>=2010 //change intervention year if needed
```

```
forvalues i = 1/46 { //change last number to to number of units/panels in the data
gen error_squared_`i' = (tr_effect_`i')^2
}
collapse (mean) error_squared_*, by(post)
reshape long error_squared_, i(post) j(id)
reshape wide error_squared_, i(id) j(post)
gen rootpre = sqrt(error_squared_0)
gen rootpost = sqrt(error_squared_1)
gen Ratio = rootpost/rootpre
summarize Ratio if id==9, meanonly //change id to treatunit
scalar treatRMSPE = r(mean)
gen prob = 0
replace prob = 1 if Ratio>=treatRMSPE
summarize prob, meanonly
scalar pval = r(mean)
tempname resmat //list post/pre ratios for all units
    forvalues i = 1/46 { //change last number to to number of units/panels in the data
                summarize Ratio if id==`i', meanonly
                matrix `resmat' = nullmat(`resmat') \ r(mean)
    local names `"`names' `"`i'"'"'
    }
    mat colnames `resmat' = "Post/Pre Ratio"
    mat rownames `resmat' = `names'
    matlist `resmat' , row("Temp ID")
matrix pvalue = pval
mat colnames pvalue = "p-value"
mat rownames pvalue = "Ratio trunit"
matlist pvalue //probability of finding post/pre ratio => ratio in treatment unit
restore
```

```
/*
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Section 3: Sensitivity analysis (leave-one-out)
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In this section, we run the leave-one-out sensitivity analysis as presented
in the paper. We begin by opening the analysis dataset again.

*/

use opioids.dta, clear

*Define the incidence rate variable (per 100.000 population)

gen rate = deaths/population*100000

*Add covariates

merge 1:1 state year using "Covariates\unemp_panel.dta", nogenerate
merge 1:1 state year using "Covariates\capita_gdp_panel.dta", nogenerate
merge 1:1 state year using "Covariates\personal_capita_income_panel.dta", nogenerate

**Identify and drop states with missing outcome values (Synth doesn't like
**missing values)
gen missing = missing(rate)
tab state if missing==1
by statecode (missing), sort: drop if missing[_N]==1
```

```
*Tell Stata that the data is a panel dataset
xtset statecode year


*****************************
*********LEAVE ONE OUT********
*****************************

/*

This procedure can get a little tedious as we will do it by hand,
checking the pre-intervention RMSPE for each model, and iteratively
removing the state that recieved the largest weight in the previous
iteration. As we saw in the main analysis, Maine was the largest
contributor to the synthetic control unit. As such, we begin by
dropping Maine from the donor pool. In iteration 2, we will notice
that Hawaii is the largest contributor, so iteration 3 will drop
both Maine and Hawaii, etc, until we obtain a model with twice
the prediction errors as in the main analysis (RMSPE for the main analysis
is 0.55, so we will keep going until it is >1.10. Turns out
this results in 35 iterations before we stop. (In an ideal case,
we would probably be better off by writing a algorithm that
automates this process.)

*/

**Drop Maine (Iter 1)

preserve
```

```
drop if state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_1.dta, replace)

restore


**Drop Hawaii & Maine (Iter 2)


preserve

drop if state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_2.dta, replace)

restore


**Drop Pennsylvania, Hawaii & Maine  (Iter 3)


preserve

drop if state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_3.dta, replace)

restore


**Drop Arkansas,Pennsylvania, Hawaii & Maine (Iter 4)


preserve

drop if state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_4.dta, replace)

restore


**Drop Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 5)
```

```
preserve

drop if state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_5.dta, replace)

restore
```

**Drop Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 6)

```
preserve

drop if state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_6.dta, replace)

restore
```

**Drop NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 7)

```
preserve

drop if state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_7.dta, replace)

restore
```

**Drop Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 8)

```
preserve
```

```
drop if state=="Virginia"|state=="New
Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii
"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12)
trperiod(2010) unitnames(state) fig keep(loo_8.dta, replace)

restore
```

**Drop Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 9)

```
preserve

drop if state=="Maryland"|state=="Virginia"|state=="New
Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii
"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12)
trperiod(2010) unitnames(state) fig keep(loo_9.dta, replace)

restore
```

**Drop New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 10)

```
preserve

drop if state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New
Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii
"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12)
trperiod(2010) unitnames(state) fig keep(loo_10.dta, replace)

restore
```

**Drop Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 11)

```
preserve

drop if state=="Washington"|state=="New
Hampshire"|state=="Maryland"|state=="Virginia"|state=="New
```

Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_11.dta, replace)

restore

**Drop Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 12)

preserve

drop if state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_12.dta, replace)

restore

**Drop Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 13)

preserve

drop if state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_13.dta, replace)

restore

**Drop Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 14)

```
preserve

drop if state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_14.dta, replace)

restore
```

**Drop Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 15)

```
preserve

drop if state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_15.dta, replace)

restore
```

**Drop Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 16)

```
preserve

drop if state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_16.dta, replace)

restore
```

**Drop Louisiana, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 17)

preserve

drop if
state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_17.dta, replace)

restore

**Drop Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 18)

preserve

drop if
state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_18.dta, replace)

restore

**Drop Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 19)

preserve

drop if
state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New

```
Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii
"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12)
trperiod(2010) unitnames(state) fig keep(loo_19.dta, replace)

restore
```

**Drop Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 20)

```
preserve

drop if
state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgi
a"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New
Hampshire"|state=="Maryland"|state=="Virginia"|state=="New
Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii
"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12)
trperiod(2010) unitnames(state) fig keep(loo_20.dta, replace)

restore
```

**Drop NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 21)

```
preserve

drop if state=="North
Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|stat
e=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New
Hampshire"|state=="Maryland"|state=="Virginia"|state=="New
Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii
"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12)
trperiod(2010) unitnames(state) fig keep(loo_21.dta, replace)

restore
```

**Drop Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 22)

preserve

drop if state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_22.dta, replace)

restore

**Drop Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 23)

preserve

drop if state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_23.dta, replace)

restore

**Drop Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 24)

preserve

drop if state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|stat

e=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_24.dta, replace)

restore

**Drop Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 25)

preserve

drop if state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_25.dta, replace)

restore

**Drop Delaware, Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 26)

preserve

drop if state=="Delaware"|state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New

Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_26.dta, replace)

restore

**Drop Massachusetts, Delaware, Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 27)

preserve

drop if state=="Massachusetts"|state=="Delaware"|state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_27.dta, replace)

restore

**Drop Colorado, Massachusetts, Delaware, Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 28)

preserve

drop if state=="Colorado"|state=="Massachusetts"|state=="Delaware"|state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_28.dta, replace)

restore

**Drop Iowa, Colorado, Massachusetts, Delaware, Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 29)

preserve

drop if state=="Iowa"|state=="Colorado"|state=="Massachusetts"|state=="Delaware"|state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_29.dta, replace)

restore

**Drop Indiana, Iowa, Colorado, Massachusetts, Delaware, Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 30)

preserve

drop if state=="Indiana"|state=="Iowa"|state=="Colorado"|state=="Massachusetts"|state=="Delaware"|state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_30.dta, replace)

restore

**Drop Wisconsin, Indiana, Iowa, Colorado, Massachusetts, Delaware, Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 31)

preserve

drop if
state=="Wisconsin"|state=="Indiana"|state=="Iowa"|state=="Colorado"|state=="Massachusetts"|state=="Delaware"|state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North
Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New
Hampshire"|state=="Maryland"|state=="Virginia"|state=="New
Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_31.dta, replace)

restore

**Drop Illinois, Wisconsin, Indiana, Iowa, Colorado, Massachusetts, Delaware, Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 32)

preserve

drop if
state=="Illinois"|state=="Wisconsin"|state=="Indiana"|state=="Iowa"|state=="Colorado"|state=="Massachusetts"|state=="Delaware"|state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North
Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New
Hampshire"|state=="Maryland"|state=="Virginia"|state=="New
Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_32.dta, replace)

restore

**Drop Vermont, Illinois, Wisconsin, Indiana, Iowa, Colorado, Massachusetts, Delaware, Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 33)

preserve

drop if state=="Vermont"|state=="Illinois"|state=="Wisconsin"|state=="Indiana"|state=="Iowa"|state=="Colorado"|state=="Massachusetts"|state=="Delaware"|state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_33.dta, replace)

restore

**Drop Missi., Vermont, Illinois, Wisconsin, Indiana, Iowa, Colorado, Massachusetts, Delaware, Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 34)

preserve

drop if state=="Mississippi"|state=="Vermont"|state=="Illinois"|state=="Wisconsin"|state=="Indiana"|state=="Iowa"|state=="Colorado"|state=="Massachusetts"|state=="Delaware"|state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_34.dta, replace)

restore

**Drop Missouri, Missi., Vermont, Illinois, Wisconsin, Indiana, Iowa, Colorado, Massachusetts, Delaware, Minnesota, Connecticut, Tennessee, Nevada, NC, Ohio, Montana, Alabama, Utah, Georgia, Idaho, Texas, Ariz., Washing, New Hamp., Maryland, Virginia, NJ, Kansas, Cali, Arkansas,Pennsylvania, Hawaii & Maine (Iter 35)

preserve

drop if state=="Missouri"|state=="Mississippi"|state=="Vermont"|state=="Illinois"|state=="Wisconsin"|state=="Indiana"|state=="Iowa"|state=="Colorado"|state=="Massachusetts"|state=="Delaware"|state=="Minnesota"|state=="Connecticut"|state=="Tennessee"|state=="Nevada"|state=="North Carolina"|state=="Ohio"|state=="Montana"|state=="Alabama"|state=="Louisiana"|state=="Utah"|state=="Georgia"|state=="Idaho"|state=="Texas"|state=="Arizona"|state=="Washington"|state=="New Hampshire"|state=="Maryland"|state=="Virginia"|state=="New Jersey"|state=="Kansas"|state=="California"|state=="Arkansas"|state=="Pennsylvania"|state=="Hawaii"|state=="Maine"

synth rate rate(2000) rate(2002) rate(2004) rate(2006) rate(2008) gdp inc unemp_rate, trunit(12) trperiod(2010) unitnames(state) fig keep(loo_35.dta, replace)

restore

/*

_____

Plot the results

_____

*/

use loo_1, clear

rename _time years

keep years _Y_treated _Y_synthetic

rename _Y_treated observed

rename _Y_synthetic loo_1

```
drop if missing(years)

save loo_1, replace

forvalues i = 2/35 { //change last number to number of leave one out-iterations

use loo_`i', clear

rename _time years

keep years _Y_synthetic

rename _Y_synthetic loo_`i'

drop if missing(years)

save loo_`i', replace
}

use loo_1, clear

forvalues i = 2/35 { //change last number to number of leave one out-iterations
qui merge 1:1 years using loo_`i', nogenerate
}

local lp

forvalues i = 1/35{ //change last number to number of leave one out-iterations
  local lp `lp' line loo_`i' years, lcolor(gs12) lpattern(solid) ||
```

```
}

twoway `lp' || line observed years, ///
lcolor(black) lpattern(solid) legend(off) xline(2010, lpattern(dash) lcolor(black)) ylab(,nogrid)
```