Title

tmo — Estimating standard errors via the Thresholding Multiple Outcomes (TMO) method.

Syntax

tmo, cmd(*cmdline*) **x**(*varname*) **ylist**(*varlist*) **idvar**(*varname*) [options]

options	Description
cmd(*cmdline***)**	*cmdline* is the command that produces the regression of interest - **tmo** currently supports regressions using regress, reghdfe, ivreg2, or ivreghdfe
x(*varname***)**	regressor of interest in *cmd* for which to estimate TMO standard errors - **tmo** estimates the standard error for only this declared independent variable
ylist(*varlist***)**	list of auxiliary outcomes to use in **tmo**
idvar(*varname***)**	location identifier variable; must be unique (within each *t* for panel case)
misslimit(#)	limit for proportion of observations allowed to be missing for auxiliary outcomes - auxiliary outcomes missing more than **misslimit** are not used - **misslimit** must be between [0,1]; default is 0.1
Panel setting	
timevar(*varname***)**	time identifier variable; must be declared for panel case
Distance-based settings	
latitude(*varname***)**	latitude variable in signed decimal degrees
longitude(*varname***)**	longitude variable in signed decimal degrees
distthreshold(#)	distance threshold in miles to allow for arbitrary correlation between pairs of locations that are *distthreshold* or fewer miles apart - setting *distthreshold* combines **tmo** with a Conley adjustment using a uniform kernel - requires setting *latitude* and *longitude*
Saving figures and tables	
filesuffix(*str***)**	folder path and base filename for saving figures and results - required for **plot** or **save** options below
savedyad	save Stata data file with correlation and contribution to standard error for each location pair
plotq	save plot of optimal threshold estimator
plothist	save plot for histogram of correlations between locations
plothistnbins(#)	number of bins for histogram of correlations (default 10000)
plotse	save plot for standard error estimates across thresholds
saveplotseest	save Stata data file with standard error estimates across thresholds

saveest	save results in **r()** to Stata data file

Custom threshold

threshold(#)	set custom threshold instead of using the optimal threshold from the interquartile range method - *threshold* must be between [0,1]
thresholdoff	turns off the **tmo** adjustment entirely

SCPC options

scpc_cmd(*cmdline***)**	command for regression of interest before applying scpc adjustment - setting *scpc_cmd* combines **tmo** with the SCPC method from Müller and Watson (2022)
scpc_uncond	turns on the unconditional SCPC Inference setting

Description

This Stata package implements the Thresholding Multiple Outcomes (TMO) method for estimating standard errors in DellaVigna et al. (2025). The TMO method accounts for spatial correlation between locations by using a set of auxiliary outcomes to estimate the correlation of errors between locations. TMO allows pairs of locations with correlations above the optimal threshold to have correlated error terms in the standard error estimate.

To use the **tmo** package, enter the Stata command that produces the regression of interest in the **cmd()** option. **tmo** calculates the TMO standard error for the independent variable specified in **x()**.

Examples

Load US county dataset

```
. use "https://raw.githubusercontent.com/wjnkim/tmo/master/example/county_differences.dta",
    clear
```

Define list of auxiliary outcomes

```
. qui ds fips stfips PIN_persincpc_d EDU_college_d, not
. local ylist `r(varlist)'
```

Regression of interest: change in per capita income on change in college educated with state fixed effects

```
. reg PIN_persincpc_d EDU_college_d i.stfips, r
```

Run TMO

```
. tmo, cmd(reg PIN_persincpc_d EDU_college_d i.stfips, r) x(EDU_college_d) ylist(`ylist')
    i(fips)
```

Run TMO and save figures

```
. tmo, cmd(reg PIN_persincpc_d EDU_college_d i.stfips, r) x(EDU_college_d) ylist(`ylist')
    i(fips) file(./example) plotq plothist plotse
```

Panel example

```
. use "https://raw.githubusercontent.com/wjnkim/tmo/master/example/county_panel.dta", clear
. qui ds fips stfips EMN_farm EDU_publicenroll year, not
. local ylist `r(varlist)'
. tmo, cmd(reghdfe EMN_farm EDU_publicenroll i.year, absorb(stfips) cluster(fips))
    x(EDU_publicenroll) ylist(`ylist') i(fips) t(year) file(./example_panel) plotq plothist
```

Stored results

tmo stores the following in **r()**:

Scalars

r(beta)	coefficient on **x()**
r(tmo_se)	TMO standard error estimate
r(orig_se)	original standard error from **cmd()**
r(lb)	lower bound of 95% confidence interval
r(ub)	upper bound of 95% confidence interval
r(threshold)	optimal threshold (using interquartile range method)
r(pct_ge_thres)	% of location pairs with correlations above the optimal threshold
r(pct_ge_thres_nocl)	% of inter-cluster location pairs with correlations above the optimal threshold
r(T)	number of time periods
r(N)	number of observations
r(N_loc)	number of locations
r(N_clust)	number of clusters
r(N_outcomes)	number of outcomes used to estimate correlations between locations
r(dof)	degrees of freedom for estimating correlations between locations
r(finite_sample_dof)	finite sample adjustment for variance calculation

Dependencies

tmo requires the gtools package. Please run ssc install gtools to install.

tmo has been tested on the following versions of reghdfe, ivreghdfe, and ivreg2. Earlier versions of these packages may run into errors.
- reghdfe version 6.12.3
- ivreghdfe version 1.1.3
- ivreg2 version 4.1.12

Disclaimer

This package is in beta/testing mode. Please use cautiously and feel free to report any errors to wjnkim@stanford.edu.

References

DellaVigna, Stefano, Guido Imbens, Woojin Kim, and David Ritzwoller. (2025). "Using Multiple Outcomes to Adjust Standard Errors for Spatial Correlation." https://arxiv.org/abs/2504.13295

Müller, Ulrich K. and Mark W. Watson "Spatial Correlation Robust Inference", Econometrica 90 (2022), 2901–2935. https://www.princeton.edu/~umueller/SHAR.pdf.