

# Robust Standard Errors in Small Samples

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August 20, 2019

The package `ShiftShareSE` implements confidence intervals proposed by Adão et al. [2019] for inference in shift-share least squares and instrumental variables regressions, in which the regressor of interest (or the instrument) has a shift-share structure, as in Bartik [1991]. A shift-share variable has the structure  $X_i = \sum_{s=1}^S w_{is} \mathcal{X}_s$ , where  $i$  indexes regions,  $s$  indexes sectors,  $\mathcal{X}_s$  are sectoral shifters (or shocks), and  $w_{is}$  are shares, such as initial share of region  $i$ 's employment in sector  $s$ .

This vignette illustrates the use of the package using a dataset from Autor et al. [2013] (ADH hereafter). The dataset is included in the package as the list `ADH`. The first element of the list, `ADH$reg` is a data-frame with regional variables, the second element, `ADH$sic` is a vector of SIC codes for the sectors, and `ADH$W` is a matrix of shares. See `?ADH` for a description of the dataset.

We now replicate column (1) of Table 5 in Adão et al. [2019]. First we load the package, define the vector of controls, and define a vector of 3-digit SIC codes:

```
library("ShiftShareSE")
ctrls <- "t2 + l_shind_manuf_cbp + l_sh_popedu_c + l_sh_popfborn +
         l_sh_empl_f + l_sh_routine33 + l_task_outsource + division"
sic <- floor(ADH$sic/10)
```

We cluster the standard errors at the 3-digit SIC code (using the option `sector_cvar`), and, following ADH, weight the data using the weights `ADH$reg$weights`. See `?reg_ss` and `?ivreg_ss` for full description of the options.

The first-stage regression:

```
reg_ss(as.formula(paste("shock ~ ", ctrl)), W = ADH$W,
       X = IV, data = ADH$reg, weights = weights, region_cvar = statefip,
       sector_cvar = sic, method = "all")
#> Estimate: 0.6310409
#>
#> Inference:
#>               Std. Error      p-value Lower CI Upper CI
#> Homoscedastic 0.02732516 0.000000e+00 0.5774846 0.6845973
#> EHW          0.08700719 4.083400e-13 0.4605100 0.8015719
#> Reg. cluster 0.09142372 5.113909e-12 0.4518537 0.8102281
#> AKM          0.05296055 0.000000e+00 0.5272402 0.7348417
#> AKMO         0.07671358 1.282891e-03 0.5375710 0.8382827
```

Note that for "AKMO", "Std. Error" corresponds to the normalized standard error, i.e. the length of the confidence interval divided by  $2z_{1-\alpha/2}$ .

The reduced-form and IV regressions:

```
reg_ss(as.formula(paste("d_sh_empl ~", ctrl)), W = ADH$W,
       X = IV, data = ADH$reg, region_cvar = statefip, weights = weights,
```

```

    sector_cvar = sic, method = "all")
#> Estimate: -0.4885687
#>
#> Inference:
#>
#>      Std. Error      p-value    Lower CI    Upper CI
#> Homoscedastic 0.06332778 1.221245e-14 -0.6126889 -0.3644485
#> EHW          0.11244360 1.392685e-05 -0.7089541 -0.2681833
#> Reg. cluster 0.07578147 1.140306e-10 -0.6370977 -0.3400398
#> AKM          0.16419445 2.924641e-03 -0.8103839 -0.1667535
#> AKMO         0.25437489 4.218033e-04 -1.2368853 -0.2397541
ivreg_ss(as.formula(paste("d_sh_empl ~", ctrl, "| shock")),
  W = ADH$W, X = IV, data = ADH$reg, region_cvar = statefip,
  weights = weights, sector_cvar = sic, method = "all")
#> Estimate: -0.7742267
#>
#> Inference:
#>
#>      Std. Error      p-value    Lower CI    Upper CI
#> Homoscedastic 0.1069532 4.523049e-13 -0.9838511 -0.5646022
#> EHW          0.1647892 2.623532e-06 -1.0972075 -0.4512459
#> Reg. cluster 0.1758096 1.063809e-05 -1.1188071 -0.4296462
#> AKM          0.2403730 1.277718e-03 -1.2453492 -0.3031041
#> AKMO         0.3318966 4.218033e-04 -1.6903240 -0.3893132

```

## References

- Rodrigo Adão, Michal Kolesár, and Eduardo Morales. Inference in shift-share designs: Theory and inference. *Quarterly Journal of Economics*, forthcoming, August 2019. doi: 10.1093/qje/qjz025.
- David H. Autor, David Dorn, and Gordon H. Hanson. The China syndrome: Local labor market effects of import competition in the United States. *American Economic Review*, 103(6):2121–2168, October 2013. doi: 10.1257/aer.103.6.2121.
- Timothy J. Bartik. *Who Benefits from State and Local Economic Development Policies?* W.E. Upjohn Institute for Employment Research, Kalamazoo, MI, 1991.