

A survey analysis example

Thomas Lumley

June 24, 2024

This document provides a simple example analysis of a survey data set, a subsample from the California Academic Performance Index, an annual set of tests used to evaluate California schools. The API website, including the original data files are at <http://api.cde.ca.gov>. The subsample was generated as a teaching example by Academic Technology Services at UCLA and was obtained from http://www.ats.ucla.edu/stat/stata/Library/svy_survey.htm.

We have a cluster sample in which 15 school districts were sampled and then all schools in each district. This is in the data frame `apiclus1`, loaded with `data(api)`. The two-stage sample is defined by the sampling unit (`dnum`) and the population size (`fpc`). Sampling weights are computed from the population sizes, but could be provided separately.

```
> library(survey)
> data(api)
> dclus1 <- svydesign(id = ~dnum, weights = ~pw, data = apiclus1, fpc = ~fpc)
```

The `svydesign` function returns an object containing the survey data and metadata.

```
> summary(dclus1)
```

1 - level Cluster Sampling design

With (15) clusters.

```
svydesign(id = ~dnum, weights = ~pw, data = apiclus1, fpc = ~fpc)
```

Probabilities:

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
0.02954	0.02954	0.02954	0.02954	0.02954	0.02954

Population size (PSUs): 757

Data variables:

[1]	"cds"	"styp"	"name"	"sname"	"snum"	"dname"
[7]	"dnum"	"cname"	"cnum"	"flag"	"pcttest"	"api00"
[13]	"api99"	"target"	"growth"	"sch.wide"	"comp.imp"	"both"
[19]	"awards"	"meals"	"ell"	"yr.rnd"	"mobility"	"acs.k3"
[25]	"acs.46"	"acs.core"	"pct.resp"	"not.hsg"	"hsg"	"some.col"
[31]	"col.grad"	"grad.sch"	"avg.ed"	"full"	"emer"	"enroll"
[37]	"api.stu"	"fpc"	"pw"			

We can compute summary statistics to estimate the mean, median, and quartiles of the Academic Performance Index in the year 2000, the number of elementary, middle, and high schools in the state, the total number of students, and the proportion who took the test. Each function takes a formula object describing the variables and a survey design object containing the data.

```
> svymean(~api00, dclus1)

      mean      SE
api00 644.17 23.542

> svyquantile(~api00, dclus1, quantile=c(0.25,0.5,0.75), ci=TRUE)

$api00
  quantile ci.2.5 ci.97.5      se
0.25      552    492     627 31.47166
0.5       652    561     714 35.66788
0.75      719    696     777 18.88300

attr("hasci")
[1] TRUE
attr("class")
[1] "newsvyquantile"

> svytotal(~stype, dclus1)

      total      SE
stypeE 4873.97 1333.32
stypeH  473.86  158.70
stypeM  846.17  167.55

> svytotal(~enroll, dclus1)

      total      SE
enroll 3404940 932235

> svyratio(~api.stu,~enroll, dclus1)

Ratio estimator: svyratio.survey.design2(~api.stu, ~enroll, dclus1)
Ratios=
      enroll
api.stu 0.8497087
SEs=
      enroll
api.stu 0.008386297
```

The ordinary R subsetting functions `[` and `subset` work correctly on these survey objects, carrying along the metadata needed for valid standard errors. Here we compute the proportion of high school students who took the test

```

> svyratio(~api.stu, ~enroll, design=subset(dclus1, stype=="H"))

Ratio estimator: svyratio.survey.design2(~api.stu, ~enroll, design = subset(dclus1,
  stype == "H"))
Ratios=
      enroll
api.stu 0.8300683
SEs=
      enroll
api.stu 0.01472607

```

The warnings referred to in the output occurred because several school districts have only one high school sampled, making the second stage standard error estimation unreliable.

Specifying a large number of variables is made easier by the `make.formula` function

```

> vars<-names(apiclus1)[c(12:13,16:23,27:37)]
> svymean(make.formula(vars), dclus1, na.rm=TRUE)

```

	mean	SE
api00	643.203822	25.4936
api99	605.490446	25.4987
sch.wideNo	0.127389	0.0247
sch.wideYes	0.872611	0.0247
comp.impNo	0.273885	0.0365
comp.impYes	0.726115	0.0365
bothNo	0.273885	0.0365
bothYes	0.726115	0.0365
awardsNo	0.292994	0.0397
awardsYes	0.707006	0.0397
meals	50.636943	6.6588
ell	26.891720	2.1567
yr.rndNo	0.942675	0.0358
yr.rndYes	0.057325	0.0358
mobility	17.719745	1.4555
pct.resp	67.171975	9.6553
not.hsg	23.082803	3.1976
hsg	24.847134	1.1167
some.col	25.210191	1.4709
col.grad	20.611465	1.7305
grad.sch	6.229299	1.5361
avg.ed	2.621529	0.1054
full	87.127389	2.1624
emer	10.968153	1.7612
enroll	573.713376	46.5959
api.stu	487.318471	41.4182

Summary statistics for subsets can also be computed with `svyby`. Here we compute the average proportion of “English language learners” and of students eligible for subsidized school meals for elementary, middle, and high schools

```
> svyby(~ell+meals, ~stype, design=dclus1, svymean)
```

	stype	ell	meals	se.ell	se.meals
E	E	29.69444	53.09028	1.411617	7.070399
H	H	15.00000	37.57143	5.347065	5.912262
M	M	22.68000	43.08000	2.952862	6.017110

Regression models show that these socioeconomic variables predict API score and whether the school achieved its API target

```
> regmodel <- svyglm(api00~ell+meals,design=dclus1)
> logitmodel <- svyglm(I(sch.wide=="Yes")~ell+meals, design=dclus1, family=quasibinomial())
> summary(regmodel)
```

Call:

```
svyglm(formula = api00 ~ ell + meals, design = dclus1)
```

Survey design:

```
svydesign(id = ~dnum, weights = ~pw, data = apiclus1, fpc = ~fpc)
```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	817.1823	18.6709	43.768	1.32e-14 ***
ell	-0.5088	0.3259	-1.561	0.144
meals	-3.1456	0.3018	-10.423	2.29e-07 ***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for gaussian family taken to be 3161.207)

Number of Fisher Scoring iterations: 2

```
> summary(logitmodel)
```

Call:

```
svyglm(formula = I(sch.wide == "Yes") ~ ell + meals, design = dclus1,
       family = quasibinomial())
```

Survey design:

```
svydesign(id = ~dnum, weights = ~pw, data = apiclus1, fpc = ~fpc)
```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	1.899557	0.509915	3.725	0.00290 **

```

ell          0.039925  0.012443  3.209  0.00751 **
meals        -0.019115  0.008825  -2.166  0.05117 .

```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for quasibinomial family taken to be 0.9627734)

Number of Fisher Scoring iterations: 5

We can calibrate the sampling using the statewide total for the previous year's API

```
> gclus1 <- calibrate(dclus1, formula=~api99, population=c(6194, 3914069))
```

which improves estimation of some quantities

```
> svymean(~api00, gclus1)
```

```

          mean      SE
api00 666.72 3.2959

```

```
> svyquantile(~api00, gclus1, quantile=c(0.25,0.5,0.75), ci=TRUE)
```

```

$api00
  quantile ci.2.5 ci.97.5      se
0.25      595    561     627 15.386145
0.5       684    664     698  7.926196
0.75      737    722     759  8.625566

```

```
attr("hasci")
```

```
[1] TRUE
```

```
attr("class")
```

```
[1] "newsvyquantile"
```

```
> svytotal(~stype, gclus1)
```

```

          total      SE
stypeE 4881.77 302.15
stypeH  463.35 183.03
stypeM  848.88 194.76

```

```
> svytotal(~enroll, gclus1)
```

```

          total      SE
enroll 3357372 243227

```

```
> svyratio(~api.stu, ~enroll, gclus1)
```

```
Ratio estimator: svyratio.survey.design2(~api.stu, ~enroll, gclus1)
Ratios=
      enroll
api.stu 0.8506941
SEs=
      enroll
api.stu 0.008674888
```