Measurement in the Social Sciences (TT 2007) Appendix 1.3: Standard Error of SRM Point Estimates

Dave Armstrong
University of Oxford
Department of Politics and International Relations

e: david.armstrong@politics.ox.ac.uk
w: http://users.ox.ac.uk/∼polf0104

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This is relatively new work and as such, I don't want to put this in the notes as there is not yet a supporting piece of peer-reviewed literature for the ideas presented here. However, I think it is interesting and useful to think about the uncertainty inherent in these placement scores.

1 Why Standard Errors

We had the following theoretical model:

$$Y_{ij} = T_i + U_{ij}$$

and we ended up with the following result for any single observation i:

$$E(Y) = T + E(U)$$

where $Y = y_1, y_2, \ldots, y_k$ and $U = u_1, u_2, \ldots, u_k$. Given our assumption that $E(U) = 0$ we can *estimate* T with $E(Y) = \left(\frac{1}{n}\right)\sum_{j=1}^{k} y_j$ for each i. Now, the usual way of using these variables is to just include them in a regression analysis or something like that. However, there is some uncertainty here that keeps even this estimate from being a perfect representation of T. If we had an infinite number of Y variables that all met our model assumptions, then we could get an essentially error-free estimate of T. How do we know this? Central Limit Theorem.

Central Limit Theorem says that for any set of numbers $x = x_1, x_2, x_3, \ldots, x_n$ from any arbitrary distribution (meaning it doesn't have to be normal) with mean μ_x and standard deviation σ_x , the mean of x is distributed normally. Specifically:

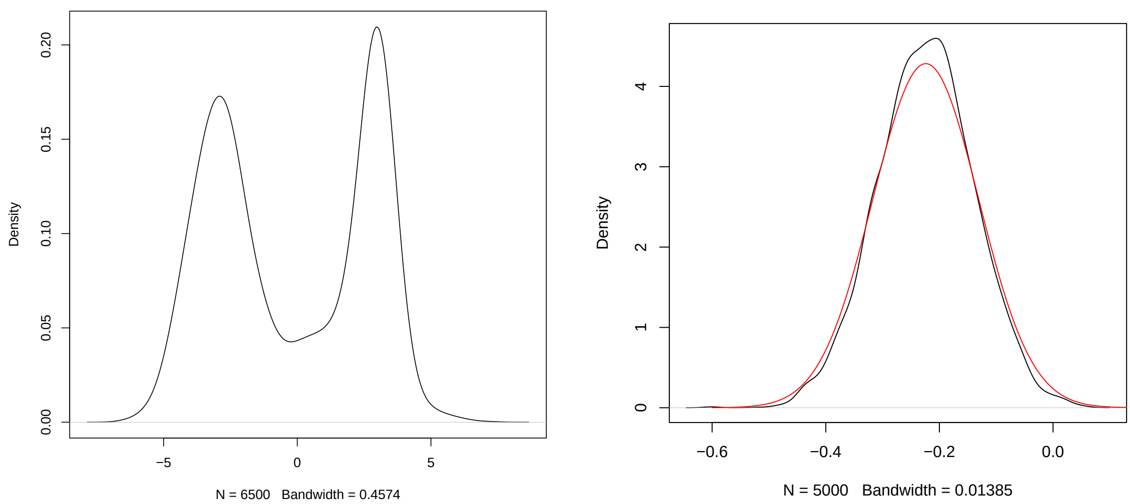
$$\bar{x} \sim \mathcal{N}\left(\mu_x, \frac{\sigma_x}{\sqrt{n}}\right)$$

I have generated a variable x which has the following distribution like in figure 1a. I will do the following thing 5000 times:

1. Draw 1000 observations from this variable.
2. Calculate the mean of the variable.
3. Record the mean in a new variable x.bar.

The density of the mean looks like figure 1b.

Figure 1: Distribution of X and its mean



(a) Distribution of X (b) Distribution of $\overline{X}$

We are estimating the "true" dimension with the mean of a few points. The mean of those few points should also have a know sampling distribution given the CLT. You can get this in the following way:

- In Stata:

```
for var spendserv-womrole: egen ZX  = std(X)
egen scalesd=rowsd(Zspendserv-Zwomrole)
gen scalese = scalesd/sqrt(nonmiss)
```

- In SPSS:

```
COMPUTE scalesd = SD(Zspendserv TO Zwomrole).
EXECUTE.

COMPUTE scalese = scalesd / sqrt(8-NMiss).
EXECUTE.
```

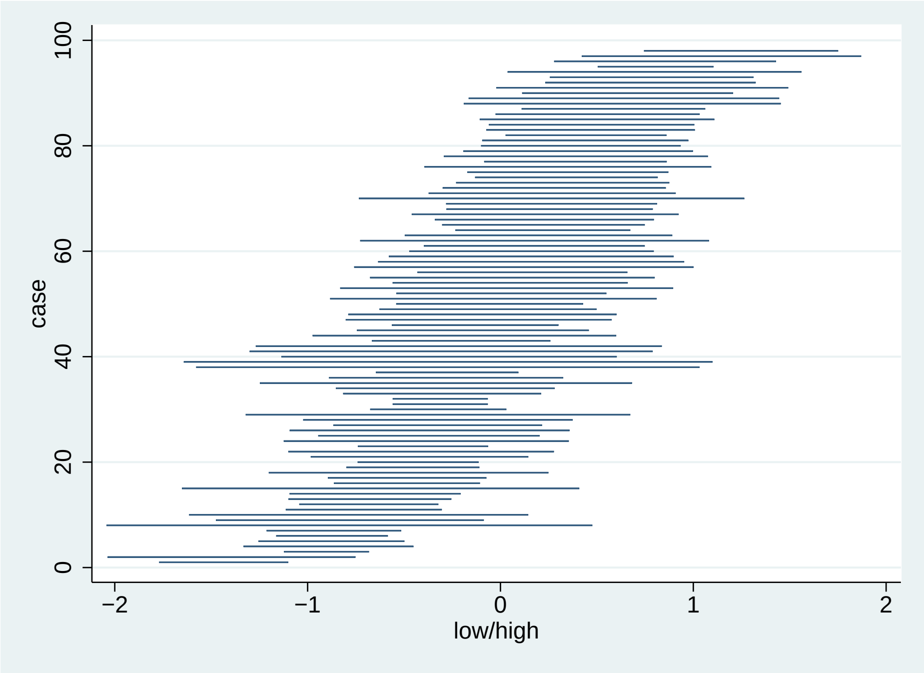
Now, we can sample a few of these, say 100 and draw a graph to see whether we have some people who look significantly different from other people.

In Stata, we can do this as follows:

```
gen low = scale1 - 2*scalese
gen high = scale1 + 2*scalese
preserve
sample 100, count
sort scale1
gen case = _n
graph twoway rbar low high case, barwidth(.2) horizontal
restore
```

You should get a graph that looks something like this:

Figure 2: 95% CI's for SRM point estimates for a Random sample of 100 cases



I'm sure there is a way to do this in SPSS, but I can't figure it out. I can provide this much code:

```
COMPUTE case = $CASENUM.
EXECUTE.

SORT CASES BY
  scale (D) .
COMPUTE casesort = $CASENUM.
EXECUTE.

COMPUTE low = scale - 2*scalese.
COMPUTE high = scale + 2*scalese.
EXECUTE.
```

If someone figures it out and wants to let me know, I can post it for the class, but if not, I guess we'll be stuck with the Stata version of this.

What you would *hope* is that the standard errors on the point estimates are not too large. You can see that there is considerable variation in the width of those intervals and this suggests a person who is all over the board on these different variables. This is not necessarily a violation of the modelling assumptions, but it is something worth taking a look at. Look for a paper in the relatively near future from Ray Duch and me about how to incorporate these standard errors in the predictive statistical models. By the time it comes out, hopefully we'll have a Stata routine that will allow you to do this relatively easily.