

Models and Measures

“All models are wrong; some are useful”
Statistician George Box

When we apply mathematics, we make some kind of *model* of whatever it is we are studying. Examples of mathematical models include:

- the equation of motion for an object falling under the influence of gravity
- models of population growth
- models for the spread of diseases

and many more. As Box reminds us, we usually can't expect to have exact models. For example, the equation of motion for an object falling under the influence of gravity neglects air resistance. (More on this this afternoon.)

The models used to apply mathematics often require some kind of *variable* or *measurement* of what we are studying. For example, in studying the motion of an object falling in gravity, we have variables time and height. In physics, the variables are usually pretty clear to identify.

But in most applications of the type we will be studying, selecting the appropriate variables is often a big part of the problem. For example, if you are comparing how big people are, you could look at height or you could look at weight. Both are measures of “bigness,” but although there is a loose relationship between height and weight, they don't give us the same information. One measure might be better for some purposes, the other for other purposes, and you might need both for some purposes.

Case Study: One example that was in the news a few years ago and again this spring is the *poverty threshold*. This was developed by statistician Mollie Orshansky, who died at age 91 in December, 2006. In order to conduct the “War on Poverty” during the Johnson administration, it was necessary to have some way to determine how many people were poor. In practice, simple ways are more feasible than complex ways. Orshansky, who worked for the Social Security Administration, proposed the formula

Poverty threshold (for annual income) = 3X annual cost of “thrifty food plan”

The “thrifty food plan” was the cheapest of four food plans already developed by the Department of Agriculture. It was “designed for temporary or emergency use when funds are low.” She multiplied by 3 since it had been established that families with three or more people spent about one third of their after-tax income on food. 124 thresholds were calculated, depending on family size, farm/non-farm status, etc. The Federal government adopted Orshansky's method as the official definition of poverty. Thresholds were re-calculated each year (based on annual census data), with some modifications in the formula being introduced over the years (e.g., the formula was modified to be based on the Consumer Price Index rather than on the thrifty food plan).

Several criticisms of this measure of poverty have been offered. They include:

- Which types of income are included or excluded. (e.g., income from public assistance programs such as food stamps)
- The assumption that families spend one-third of their income on food may no longer be reasonable; the typical fraction is now about one-sixth, since housing, transportation, and utilities now make up a larger portion of spending than they did in the sixties. Also, families now may have additional expenses (e.g., childcare) that are not accounted for in the formula.

It is estimated that modifying the poverty threshold to take into account all the criticisms would result in higher numbers of people classified as poor, which would increase the cost of assistance programs.

Oshansky herself was not enthusiastic about the measure she developed. She intended it as a research tool, not as a means of determining who was eligible for federal poverty programs. She has been quoted as saying, "The best that can be said of the measure is that at a time when it seemed useful, it was there."

For about a decade, the Census Bureau, based on recommendations from the National Academy of Sciences, has been publishing alternative measures of poverty, but later than the official measure. In March, 2010, the U.S. Department of Commerce announced that it will develop a Supplemental Poverty Measure (SPM), that will be published at the same time as the official poverty measure in 2011. However, the current official poverty measure will still be the basis for eligibility for Federal programs. The SPM is expected to be revised as it is studied more.

Lessons to be learned from this case study:

- Sometimes measures are used "because they are there," and then become difficult to change because they have been used so much.
- Measures may need to be based on data that is available.
- The choice of measure can have consequences; people may support or oppose a measure because of those consequences.
- The definition of the measure is important to take into account in interpreting results of a study or report.

For more information on the poverty threshold, see

<http://www.ocpp.org/poverty/how.htm>

<http://www.npr.org/templates/story/story.php?storyId=9750949>

<http://aspe.hhs.gov/poverty/papers/relabs.htm>

<http://aspe.hhs.gov/poverty/papers/Orshslct.htm>

<http://www.commerce.gov/news/press-releases/2010/03/02/census-bureau-develop-supplemental-poverty-measure>

