Measurement 93 (2016) 379–384

Contents lists available at ScienceDirect

Measurement

journal homepage: www.elsevier.com/locate/measurement

Over-measurement

Kim Sawyer [a,*], Howard Sankey [a], Ric Lombardo [b]

[a] School of Historical and Philosophical Studies, University of Melbourne, Australia
[b] RMIT University, Australia

ARTICLE INFO

Article history:
Received 19 June 2015
Received in revised form 20 March 2016
Accepted 5 July 2016
Available online 11 July 2016

Keywords:
Measurability
Over-measurement
Portfolio
Anchoring
Convergence

ABSTRACT

Measurement is a special type of evaluation that is more exact than either opinion or estimation. In the social sciences, in particular, most evaluations are not measures, but rather mixtures of opinion and estimation. Over-measurement represents anchoring to evaluations which are not measures. For an over-measured characteristic, single measures are used when instead a portfolio of possible measures should be used. There are three implications. First, measurements of characteristics which depend on the over-measured characteristic are biased. Secondly, decisions which depend on the over-measured characteristic are biased. Thirdly, over-measurement biases the measurement of uncertainty.

© 2016 Elsevier Ltd. All rights reserved.

1. Introduction

In his Epistemology of Measurement, Mari [1] asserts that measurement is a specific form of evaluation. While the term measurement is often used synonymously with other types of evaluation, measurement is a process with more precision. The purpose of measurement is to construct a measure function to determine measurement values from a sample of observations; just as the purpose of estimation is to construct an estimator to determine estimates from a sample of observations. A measure function has more exactitude than an estimator, and more structure than an opinion. Measure functions and measurement values have invariance properties not shared by other forms of evaluation. A measure function should be invariant across observers, continuous across time and continuous across small perturbations of characteristics, conditions summarized in Sawyer et al. [2]. These invariance and continuity conditions distinguish measurement from other types of evaluation.

Measurement is a process designed to measure characteristics of objects.[1] Finkelstein [3, p. 41] defined measurement as the process which assigns symbols to attributes of real objects and events, with the purpose of quantification. Rossi [4, p. 558] defined the process in terms of the empirical properties of the characteristics, a reference measurement scale and a measuring system. And Urbanski and Samsonowicz [5, p. 36] distinguished two stages; a mapping of states of real objects into states of measuring instruments and a mapping of states of measuring instruments into real numbers. But the measurement process is more involved than just a mapping from a state space of characteristics onto the real number line. As discussed by Sawyer et al. [2, p. 95], measurement typically involves a process of convergence from an initial measure function to an existing measure function.[2] The process is an iterative process with the initial measure as its starting point. The measurement process depends on the initial measure[3]; and often the process is anchored by that measure. For example, Mohs scale of hardness (Cordua [6]) was the first measure of mineralogical hardness and subsequent measures of hardness correlate highly with it. Similarly, measures of the national accounts have been anchored by the system of national accounts first proposed by Meade and Stone [7]. Regarding measurement as an iterative process necessarily leads to questions as to whether the process is convergent and whether one measure or a portfolio of measures is required.

* Corresponding author.
E-mail address: kim.sawyer@unimelb.edu.au (K. Sawyer).

[1] Consistent with Rossi [4, p. 546] we use the term characteristic in preference to attribute or the more commonly used property or quantity of the *International Vocabulary of Metrology(VIM).* Characteristics such as length, mass, electric charge and electric resistance are standard benchmarks for measurability, but the formulation is sufficiently general to allow for the measurement of the derived quantities common in the social sciences (see Rossi [4, p. 556].

[2] In the discussion which follows, for ease of exposition we use the term measure to refer to a measure function, and measurement values to refer to the realizations of the measure function.

[3] Measurement processes with different initial measures are possible for measuring the same characteristic, but the resulting measures are likely to be highly correlated. In the discussion, we assume a single measurement process.

http://dx.doi.org/10.1016/j.measurement.2016.07.034
0263-2241/© 2016 Elsevier Ltd. All rights reserved.

The questions posed in this paper relate to the convergence of the measurement process; in particular whether for every characteristic the measurement process necessarily converges to a measure function which satisfies invariance and continuity properties; and the implications of measuring characteristics for which the measurement process is not convergent. In sum, we posit the question is it possible to over-measure and if so, what are the consequences of over-measurement?

Section 2 begins with an exposition of measurement and how it differs from other evaluations such as opinion and estimation. In Section 3 the concept of over-measurement is defined and the consequences of over-measurement explored. Section 4 presents an illustration of over-measurement by examining a measure of the economy the gross domestic product GDP.

2. Convergence to a measure

Following Rossi [8] and Sawyer et al. [2], we consider a set of objects X and define an evaluation function m^* to be a conditional real-valued function on X

$$m^*(\tau(x)|o,d,t,Z) \tag{1}$$

where τ is a common characteristic indexed by objects x in X, o is an observer, d is a measuring instrument, t is time, and Z is a set of ceteris paribus conditions. The following are assumed

(i) m^* represents an evaluation function of the objects x in terms of the characteristic τ conditional on the observer o, the measuring instrument d, and conditions Z at time t. The realized values of m^* depend on o, d, t and Z and the sensitivity of the realized values of m^* to these variables underscores the discussion of invariance and continuity that follows. m^* can be either a continuous or discrete function of the characteristic τ. [4]

(ii) From Rossi [4, p. 558]), it is assumed that the set of objects X is well-defined in terms of τ, that the empirical properties of τ can be identified, and that a reference measurement scale and measuring system based on that scale can be constructed. This assumes that the characteristic must at least be ordinal, as noted by Rossi [4, p. 556]. The characteristic τ is then assumed to be measurable and a real-valued measure function can be constructed.

(iii) Eq. (1) is a general evaluation function designed to be representative of a wide range of problems which may admit to a measurement process. For expositional purposes, it is assumed that the observer o is a representative observer who follows a reference measurement procedure, that the measuring instrument d is calibrated to a specified reference scale, and that the units of measurement are those adopted by convention.

(iv) It is assumed that the accuracy of the measuring device as well as the observer's perceptions impact on the measure. However, it does not take account of the possibility that τ itself may be affected by the observer o or the measuring instrument d; for example, in the measurement of the economy where expectations of observers may affect the characteristics that are measured.

We consider three forms of evaluation function, measurement defined by a measure m, estimation defined by an estimator m^e, and opinion defined by m^o. Sawyer et al. [2, p. 92] discussed five conditions that a measure should satisfy, invariance with respect to observers and instruments, continuity with respect to characteristics and time, and preservation of the order structure of the underlying characteristic. These conditions are given by

2.1. Observer invariance

For two representative observers $o1$ and $o2$, a measure m should be invariant across observers,

$$Pr(m(\tau(x|o1,d,t,Z)) - m(\tau(x|o2,d,t,Z)) \neq 0) = 0 \tag{2}$$

so that the probability that the measure differs for the two observers is 0.

2.2. Instrument invariance

For two instruments $d1$ and $d2$, a measure m should be invariant across the instruments

$$Pr(m(\tau(x|o,d1,t,Z)) - m(\tau(x|o,d2,t,Z)) \neq 0) = 0 \tag{3}$$

so that the probability that the measure differs for two instruments is 0.

2.3. Characteristic continuity[5]

For small increments $d\tau$ in the characteristic, and for a set X of bounded variation in τ, as $d\tau$ approaches 0,

$$Pr(m(\tau + d\tau(x|o,d,t,Z)) - m(\tau(x|o,d,t,Z)) \neq 0) \text{ approaches } 0 \tag{4}$$

so that in probability the measure is continuous with respect to the characteristic τ.

2.4. Time continuity

For small increments in time dt, as dt approaches 0,

$$Pr(m(\tau(x|o,d,t+dt,Z)) - m(\tau(x|o,d,t,Z)) \neq 0) \text{ approaches } 0 \tag{5}$$

so that in probability the measure is continuous with respect to time t.

2.5. Order structures

Rossi [8, p. 37] identifies three types of order structures.

2.5.1. Weak order structures

For order structures which result in order scales, a weak order relation $\geqslant_R$ across objects is a binary relation satisfying two conditions so that for objects $x(1)$, $x(2)$, and $x(3)$ in X.

(i) Completeness: either $x(1) \geqslant_R x(2)$ or $x(2) \geqslant_R x(1)$.
(ii) Transitivity: if $x(1) \geqslant_R x(2)$ and $x(2) \geqslant_R x(3)$, then $x(1) \geqslant_R x(3)$.

2.5.2. Difference structures

For difference structures which are the basis of interval scales, a weak order relation $\geqslant_R$ is applied to intervals between objects in X. If Δ_{12} is the interval between $x(1)$ and $x(2)$, then Δ_{12} satisfies the two conditions of completeness and transitivity of a weak order condition.

[4] Both categorical and non-categorical discrete evaluation functions are possible, even when the latent characteristic is continuous. For example, in the ranking of universities, the latent characteristic is the quality of the university, but the measure is an ordinal measure.

[5] This condition refers to continuity in the latent characteristic τ, not the measure function m. In discrete measure functions such as categorical and non-categorical, the continuity in the underlying latent characteristic still applies; similar to the stochastic utility function approach used in limited dependent variable models. See Maddala [9].

Download English Version:

https://daneshyari.com/en/article/7122813

Download Persian Version:

https://daneshyari.com/article/7122813

Daneshyari.com