Metadata of the chapter that will be visualized online

Chapter Title	Composite Index Construction	
Copyright Year	2013	
Copyright Holder	Springer Science+Business Media Dordrecht	
Corresponding Author	Family Name	**Land**
	Particle	
	Given Name	**Kenneth C.**
	Suffix	
	Division/Department	Department of Sociology
	Organization/University	Duke University
	Postbox	P.O. Box 90088
	Postcode	27708-0088
	City	Durham
	State	NC
	Country	USA
	Email	kland@soc.duke.edu

C

Composite Index Construction

Kenneth C. Land
Department of Sociology, Duke University,
Durham, NC, USA

Synonyms

Aggregate social indicators; Summary quality-of-life indices

Definition

Social scientists study and develop measures, indicators, or indices of *overall well-being/quality of life (WB/QOL)* for individuals living in specific communities/countries/societies at specific points in time. Policy makers increasingly study such measures, indicators, and indices and seek to develop public policies and practices that improve overall WB/QOL.

Ultimately, however, each individual is responsible for assessing her/his overall WB/QOL. This can be done, for example, by comparing her/his contemporary circumstances to those of a previous time and/or by comparing her/his circumstances to those of others at the same time but living in another location. To do so, an individual must, at least informally, engage in the following activities: (1) select the indicators of those aspects of life circumstances that are important to her or him, (2) obtain data from social reports or other news sources on changes in those indicators or in comparison to other locations, and (3) integrate those indicators across disparate aspects or domains of life to achieve a judgment of overall progress or relative status on WB/QOL. ▶ Composite index construction in ▶ quality-of-life research is a systematization of this informal comparison process.

Description

Examples of Composite Well-Being/Quality-of-Life Indices

Composite indices are widely used in modern societies with many long-standing examples being indices of one aspect or another of the economy. Common examples include stock market price indices, ▶ consumer price indices, and ▶ consumer confidence indices. The use of composite indices in WB/QOL studies is a more recent development. Some examples are:

- The ▶ Human Development Index (HDI; United Nations Development Program, 2001)
- The ▶ Index of Economic Well-Being (IEWB; Osberg & Sharpe, 2000)
- The National Well-Being Accounts (NWBA; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004)
- The ▶ Index of Social Progress (ISP; Estes, 1988, 1997)
- The ▶ Happy Life-Expectancy Scale (HLE; Veenhoven, 1996)

A.C. Michalos (ed.), *Encyclopedia of Quality of Life Research*,
DOI 10.1007/978-94-007-0753-5,

- The ▶ Netherlands' Living Conditions Index (LCI; Boelhouwer & Stoop, 1999)
- *The Economist* Intelligence Unit's Quality of Life Index (EIU-QOLI; The Economist Intelligence Unit 2005)
- The Australian Unity Well-Being Index (AUWBI; Cummins, Woerner, Tomyn, Gibson, & Knapp, 2005)
- The Foundation for Child Development ▶ Child and Youth Well-Being Index (FCD-CWI; Land, Lamb, & Mustillo, 2001; Land, Lamb, Meadows, & Taylor, 2007)

Some of these composite indices, such as the HDI, were developed mostly for cross-sectional comparisons among geographical units such as nations, and others, such as the LCI, were developed mostly for over-time comparisons within units, but most of them can be used in both cross-sectional and over-time comparisons.

Principles for Constructing Composite WB/QOL Indices

Hagerty and Land (2012) stated seven principles for the construction of composite WB/QOL indices. These can be summarily stated:

- Each of the indicators that compose an index should be ▶ reliable and ▶ valid.
- For transparency, a WB/QOL index should not be reported alone, but as part of a report that shows each underlying indicator.
- A WB/QOL index should be disaggregated, or at least be capable of disaggregation, for population subgroups.
- A WB/QOL index should be robust to incomplete data or other data problems.
- A WB/QOL index should reflect the best model of how people actually make WB/QOL judgments for themselves.
- A WB/QOL index should reflect the ▶ weights that individuals give to ▶ indicators and ▶ domains of well-being.
- For use in policy formation, analysis, and decisions, a WB/QOL index should be accepted by a large majority of individuals in a governmental entity.

While each of these principles may seem relatively simple and straightforward, they are important and strong criteria and may require considerable research work for verification.

The Weighted Average Model of WB/QOL Judgments

With regard to the fifth principle, based on evidence from prior subjective well-being studies, Hagerty & Land (2007, 2012); adopted a weighted average description of individuals' WB/QOL judgments. This description states, for example, that if the judgment task is, say, one of comparing WB/QOL among a set of countries, as in the HDI, and if we define individual i's *importance weight* for the kth social indicator as w_{ik} and i's overall QOL judgment for country n as Q_{in}, then we can predict their QOL judgments with the *weighted average model (WAM)*:

$$Q_{in} = \Sigma_k \, w_{ik} x_{kn}, w_{ik} > 0, \text{ for } n = 1, \ldots, N \text{ countries},$$

where x_{kn} is the score for the kth social indicator of country n, K is the total number of social indicators that individuals use to make their judgments of QOL, and the summation is taken over all K indicators. Adopting this additive model also benefits the fourth principle of WB/QOL index construction stated above, since additive models are quite robust to errors in measurement.

Using the WAM and a correlation coefficient measure of agreement between two WB/QOL indices, Hagerty and Land (2007) calculated the average agreement between the HDI (which uses equal weights of its three country-level indicators of health, education, and material well-being – ▶ life expectancy at birth, a normalized index of mean years of schooling of adults age 25 and expected years of schooling for current students, and gross national income per capita, respectively) and the rankings of countries that results from using weights from a sample survey of 1502 US citizens in the World Values Survey (WVS; Inglehart et al., 2000). Mean agreement between the HDI index ratings of QOL and the 1502 individuals'

ratings (predicted from their weights) was + .97 (standard error of estimate = .04).

This is remarkably high. Hagerty and Land (2007) probed why agreement should be so high even though the equal weighting in the HDI differs from the unequal weights that individuals report in the WVS. Using the WAM of QOL judgments, they proved mathematically that several factors affect agreement for any index. Specifically, they show that agreement will be higher when:

1. The index is based on cross-sectional data rather than time-series data.
2. The distribution of individuals' weights is unimodal rather than bimodal (as in abortion where conflict is much higher because weights are extreme and bimodal).
3. The distribution of individuals' weights is not negatively correlated across indices (people who highly value one indicator always place a very low value on another indicator).
4. Individuals' weights are all positive (or all negative) for each indicator.

The HDI and the WVS conform to all four of these properties. Hence, the agreement induced by the equal weights used in HDI is quite high compared to the index calculated using the unequal weights that are reported in the WVS.

Using the WAM of WB/QOL judgments, Hagerty and Land (2007) also showed mathematically that:

- If a survey is available to measure the distribution of individuals' importance weights for each indicator, then there exists *an optimal weighting scheme* – specifically, agreement is maximized when the index is constructed using the mean weights of individuals in the population.

But, since such surveys are often not available, they also proved that:

- Constructing an index with equal weights produces what in statistics is termed *a minimax estimator* (i.e., equal weighting will minimize maximum possible disagreements).

The importance of this second property pertains to the fact that many existing WB/QOL indices, such as the HDI and several others cited above, have used equal weighting of their component indicators and/or domains of well-being because of the simplicity and transparency of equal weights and the lack of a strong rationale for an unequal weighting scheme. Within the context of the WAM, the minimax statistical properties of the equal weighting method now have been established.

The Weighted Product Model of WB/QOL Judgments and Data Envelopment Analysis

Using similar notation, the *weighted product model (WPM)* of well-being/quality-of-life judgments can be written as

$$Q_{in} = \Pi_k[(x_{ik})^{w_{ik}}], w_{ik} > 0,$$

where the product is taken over all K units being compared.

Note that the weighted average model described above can be viewed as a logarithmic transformation of the weighted product model.

Zhou, Ang and Zhou (2010) studied the WPM and proposed a multiplicative optimization extension thereof by application of ▶ data envelopment analysis (DEA)-type methods to determine the values of weights of individual indicators in a composite index such as the life expectancy, education, and gross domestic product per capita indicators used to calculate the Human Development Index. The DEA method originally was developed for efficiency analysis in economics and management science (Charnes, Cooper, & Rhodes, 1978; Charnes, Cooper, Lewin, & Seiford, 1994; Land, Lovell, & Thore, 1993). It transforms a multiplicative optimization problem into a series of linear programming problems (Danzig, 1963) in which weights for composite scores are determined by internal comparisons of each of a set of entities with each other with respect to their efficiency in producing outputs (e.g., consumer products) from given levels of inputs (e.g., labor, capital).

Zhou, Ang, and Zhou (2010) applied DEA to calculate two sets of weights for the component indicators of a composite QOL index – a set of "best" weights for each entity calculated in comparison to the "best practice" entity or

entities on each specific indicator and a set of "worst" weights calculated in comparison to the "worst practice" entity or entities on each specific indicator. They then calculated composite index scores for each entity being compared as weighted averages of logarithmic transformations of the two sets of weights and, in the absence of "decision makers or analysts [having] no particular preference" (Zhou, Ang, & Zhou, 2010, p. 173) for one set of weights or the other, suggest equal weighting as a "fairly neutral choice." Note, however, that, as summarized above, Hagerty and Land (2007) have shown that equal weighting methods have minimax statistical properties in the sense that they minimize extreme disagreements on weights. This gives a precise statistical meaning to the equal weights as a neutral choice.

Zhou, Ang, and Zhou (2010) suggested, in addition, that this extension of the WP method can provide an alternative to subjectively determined weights for composite indices. Given the logarithmic relationship between the WAM and WPM models of WB/QOL judgments, however, it is entirely possible that individuals as well as decision makers and analysts use an informal version, or at least some approximation thereto, of the equal weighting of "best practice" (distance from the best-performing unit(s)) and "worst practice" (distance from the worst-performing unit(s)) relative rankings to arrive at composite index scores/summary judgments. Thus, rather than being alternatives, the DEA-weighted average approach may, in fact, be a representation of the cognitive processes by which subjective WB/QOL judgments are made.

Other Methods of Composite WB/QOL Index Construction

In addition to the WAM, WPM, and DEA methods, a number of additional methods or general composite index construction (not limited to WB/QOL indices) are described in Nardo, Saisana, Saltelli, Tarantola, Hoffman, and Giovannini (2005).

Cross-References

- ▶ Canadian Index of Wellbeing
- ▶ Subjective Weighting

References

Boelhouwer, J., & Stoop, I. (1999). Measuring well-being in the Netherlands: The SCP index from 1974 to 1997. *Social Indicators Research, 48*, 51–75.

Charnes, A., Cooper, W. W., Lewin, A. Y., & Seiford, L. M. (Eds.). (1994). *Data envelopment analysis: Theory, methodology, and application*. Boston: Kluwer Academic Publishers.

Charnes, A., Cooper, W. W., & Rhodes, E. L. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research, 2*, 429–444.

Cummins, R.A., Woerner J., Tomyn, A., Gibson, A., & Knapp T. (2005). Australian unity wellbeing, index: (Report 14) – "The wellbeing of Australians – Personal relationships". Melbourne: Australian Centre on Quality of Life, School of Psychology, Deakin University. ISBN 1 7415 6024 1 http://www.deakin.edu.au/research/acqol/index_wellbeing/index.htm

Estes, R. J. (1988). *Trends in world social development: The social progress of nations, 1970–1987*. New York: Praeger.

Estes, R. J. (1997). Social development trends in Europe, 1970–1994: Development prospects for the new Europe. *Social Indicators Research, 42*(1), 1–19.

Hagerty, M. R., & Land, K. C. (2007). Constructing summary indices of quality of life: A model for the effect of heterogeneous importance weights. *Sociological Methods and Research, 35*, 455–496.

Hagerty, M. R., & Land, K. E. (2012). Issues in composite index construction: The measurement of overall quality of life. In K. C. Land, A. C. Michalos, & M. J. Sirgy (Eds.), *Handbook of social indicators and quality-of-life research*. New York: Springer.

Kahneman, D., Krueger, A. B., Schkade, D., Schwarz, N. & Stone, A. (2004). Toward national well-being accounts. *American Economic Association Papers and Proceedings*, (May), 429–434.

Land, K. C., Lamb, V. L., & Mustillo, S. K. (2001). Child and youth well-being in the United States, 1975–1998: Some findings from a new index. *Social Indicators Research, 56*, 241–320.

Land, K. C., Lamb, V. L., Meadows, S. O., & Taylor, A. (2007). Measuring trends in child well-being: An evidence-based approach. *Social Indicators Research, 80*, 105–132.

Land, K. C., Lovell, C. A. K., & Thore, S. (1993). Chance-constrained data envelopment analysis. *Managerial and Decision Economics, 14*, 541–554.

Nardo, M., Saisana, M., Saltelli, A., Tarantola, S., Hofman, A., & Giovannini, E. (2005). *Handbook on*

constructing composite indicators: Methodology and user guide. Paris: Organization for Economic Co-operation and Development.

Osberg, L., & Sharpe, A. (2000). *International comparisons of trends in economic well-being*. Paper presented at the annual meeting of the American Economic Association, Boston, MA.

United Nations Development Program. (2001). *Human development report*. New York: Oxford University Press.

Veenhoven, R. (1996). Happy life-expectancy: A comprehensive measure of quality of life in nations. *Social Indicators Research, 39*, 1–58.

Zhou, P., Ang, B. W., & Zhou, D. Q. (2010). Weighting and aggregation in composite index construction: A multiplicative optimization approach. *Social Indicators Research, 96*, 169–181.

Author Query Form

Encyclopedia of Quality of Life Research
Chapter No: 3317

Query Refs.	Details Required	Author's response
AU1	Please provide details of "The Economist Intelligence Unit 2005, Inglehart et al. 2000, Danzig 1963" in the reference list.	