Non-metric PLS path modelling: a new approach to building a composite indicator of job quality

Mario Fordellone and Giovanna Boccuzzo
University of Padua
Padua, Italy
fordellone@stat.unipd.it

Keywords: Composite indicator, Path modeling, Partial Least Squares, Formative approach, Reflective approach

Background: In recent years, several alternative methods have been used to construct composite indicators (CIs). In this work, we propose a job quality CI based on partial least square (PLS) path modelling (Vinzi et al., 2010), and we aim to address some considerations about its applicability. The results obtained will be compared with those derived from a job quality indicator that was obtained through the “traditional” approach (Boccuzzo and Gianecchini, 2015).

The traditional structure of CIs is hierarchical. The concept of job quality is comprised of various dimensions, where each is composed of several elementary indicators that may be represented by variables that can be directly measured (Fig. 1).
In its most simple formulation, a CI can be computed using a weighted average:

\[ CI = \sum_{p=1}^{P} \alpha_p \left( \sum_{j=1}^{N_p} I_{j} w_{j} \right), \]

where \( p \) is the index for the dimensions, \( j \) is the index for the elementary indicators composing each dimension, \( N_p \) is the number of indicators forming the \( p^{th} \) dimension, \( \alpha_p \) is the weight of the \( p^{th} \) dimension, \( I_j \) is the \( j^{th} \) elementary indicator and \( w_j \) is the weight of the \( j^{th} \) elementary indicator.

The traditional hierarchical structure of the composite indicator is very similar to those of path models. In a path diagram, we represent latent variables that are related to each other and measured using manifest variables (Fig. 2). In Fig. 2, the boxes represent observed variables, and the circles represent latent variables.

There is an important difference between the traditional structure of a composite indicator and the corresponding path model: an additional block of elementary indicators (manifest variables) is related to the overall latent construct (CI). In the traditional approach, weights are estimated outside the model, such as by using expert opinions or external statistical approaches.

The relationship between each dimension and its indicators and between the complex concept and its dimensions can be described through two different approaches: formative and reflective. In the first case, the latent construct is formed by its indicators; in the second case, the observed indicators are caused by the latent variable. In traditional CI theory, the formative approach is
primarily used (e.g. in the Human Development Index or for a great deal of the OCDE CIs). Conversely, the reflective approach is extensively used in psychometrics (e.g. the SF-36 or SF-12 health indicators). In path modelling, we also need manifest variables related to the composite indicator. Therefore, we have to decide which relationship should be used in this case: the formative or the reflective relationship.

**Objectives:** The objectives of this paper are (i) to analyse the opportunity presented by path models to construct a composite indicator of job quality, (ii) to analyse how the relationship between indicators and latent constructs can give different results and (iii) to compare our results with those obtained by Boccuzzo and Gianecchini (2015).

**Methods:** When measuring job quality, several dimensions should be considered. The choice of dimension also depends on the target population. In this work, we will refer to young graduates. The most relevant dimensions of job quality for graduates are as follows: the economic dimension, which concerns all aspects related to the economic exchanges between workers and employers, the professional dimension, which concerns how job characteristics are related to workers’ skills and ambitions and finally the work-life balance dimension, which involves aspects that affect both workers’ personal lives and work relationships (Boccuzzo and Gianecchini, 2015).

The job quality indicator was computed using data from the Agorà longitudinal survey on the career outcomes of graduates from the University of Padova (Fabbris, 2012).

Two types of path models are proposed. The *formative model* includes all formative relationships between dimensions and their indicators. The *hybrid model* includes formative relationships between a single dimension and its elementary indicators as well as reflective relationships between the composite indicator and its elementary indicators.

Elementary indicators related to the composite indicator include several job satisfaction aspects. From a conceptual point of view, the choice between the formative and reflective approach is not trivial (James and Jones, 1980).

The PLS is the estimation method used (Sanchez, 2013), specifically the non-metric version (NM-PLS) proposed by Russolillo (2012), to determine the presence of non-continuous variables in the data.

**Results and conclusion:** We verified that the results could be very different depending on the approach (formative or hybrid) and the number of elementary indicators related to the overall construct and their correlations. To obtain stable results, we satisfied the following three conditions. First, the number of elementary indicators for each dimension should not be too low, as almost three indicators are necessary. Second, the correlation among elementary indicators should be carefully analysed to correctly assign indicators to the dimensions and to ensure the stability of the model. Third, that is based on reflective measurements of the general latent concept, is less influenced by the correlation among elementary indicators because the estimation procedure is based on simple regression and not multiple regression (as it is in the formative approach).

Compared to the formative model, we have observed that the hybrid model provides results that are more reliable, especially in terms of the weights associated with the dimensions of the job quality construct. Furthermore, the results of the hybrid model are more similar to those obtained by Boccuzzo and Gianecchini (2015).
Main references


