Common Method Bias in PLS-SEM: A Full Collinearity Assessment Approach

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ABSTRACT

The author discusses common method bias in the context of structural equation modeling employing the partial least squares method (PLS-SEM). Two datasets were created through a Monte Carlo simulation to illustrate the discussion: one contaminated by common method bias, and the other not contaminated. A practical approach is presented for the identification of common method bias based on variance inflation factors generated via a full collinearity test. The author’s discussion builds on an illustrative model in the field of e-collaboration, with outputs generated by the software WarpPLS. They demonstrate that the full collinearity test is successful in the identification of common method bias with a model that nevertheless passes standard convergent and discriminant validity assessment criteria based on a confirmation factor analysis.

Keywords: Common Method Bias, e-Collaboration Technology, Monte Carlo Simulation, Partial Least Squares, Structural Equation Modeling

INTRODUCTION

The method of path analysis has been developed by Wright (1934; 1960) to study causal assumptions in the field of evolutionary biology (Kock, 2011), and now provides the foundation on which structural equation modeling (SEM) rests. Both path analysis and SEM rely on the creation of models expressing causal relationships through links among variables.

Two main types of SEM exist today: covariance-based and PLS-based SEM. While the former relies on the minimization of differences between covariance matrices, the latter employs the partial least squares method (PLS) developed by Herman Wold (Wold, 1980). PLS-based SEM is often referred to simply as PLS-SEM, and is widely used in the field of e-collaboration and many other fields.

Regardless of SEM flavor, models expressing causal assumptions include latent variables. These latent variables are measured indirectly through other variables generally known as indicators (Maruyama, 1998; Mueller, 1996). Indicator values are usually obtained from questionnaires where answers are provided on numeric scales, of which the most commonly used are Likert-type scales (Cohen et al., 2003).

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Using questionnaires answered on Likert-type scales constitutes an integral part of an SEM study’s measurement method. Common method bias is a phenomenon that is caused by the measurement method used in an SEM study, and not by the network of causes and effects among latent variables in the model being studied.

We provide a discussion of common method bias in PLS-SEM, and of a method for its identification based on full collinearity tests (Kock & Lynn, 2012). Our discussion builds on an illustrative model in the field of e-collaboration, with outputs from the software WarpPLS, version 5.0 (Kock, 2015).

The algorithm used to generate latent variable scores based on indicators was PLS Mode A, employing the path weighting scheme. While this is the algorithm-scheme combination most commonly used in PLS-SEM, it is by no means the only combination available. The recent emergence of factor-based PLS-SEM algorithms further broadened the space of existing combinations (Kock, 2014).

We created two datasets based on a Monte Carlo simulation (Robert & Casella, 2005; Paxton et al., 2001). One of the two datasets was contaminated by common method bias; the other was not. We demonstrate that the full collinearity test is successful in the identification of common method bias with a model that nevertheless passes standard validity assessment criteria based on a confirmation factor analysis.

In our discussion all variables are assumed to be standardized; i.e., scaled to have a mean of zero and standard deviation of one. This has no impact on the generality of the discussion. Standardization of any variable is accomplished by subtraction of its mean and division by its standard deviation. A standardized variable can be rescaled back to its original scale by reversing these operations.

WHAT IS COMMON METHOD BIAS?

Common method bias, in the context of PLS-SEM, is a phenomenon that is caused by the measurement method used in an SEM study, and not by the network of causes and effects in the model being studied. For example, the instructions at the top of a questionnaire may influence the answers provided by different respondents in the same general direction, causing the indicators to share a certain amount of common variation. Another possible cause of common method bias is the implicit social desirability associated with answering questions in a questionnaire in a particularly way, again causing the indicators to share a certain amount of common variation.

A mathematical understanding of common method bias can clarify some aspects of its nature. The adoption of an illustrative model can help reduce the level of abstraction of a mathematical exposition. Therefore, our discussion is based on the illustrative model depicted in Figure 1, which is inspired by an actual empirical study in the field of e-collaboration (Kock, 2005; 2008; Kock & Lynn, 2012). The illustrative model incorporates three latent variables, each measured through six indicators. It assumes that the unit of analysis is the firm.

The latent variables are: collaborative culture ($F_1$), the perceived degree to which a firm’s culture promotes continuous collaboration among its members to improve the firm’s productivity and the quality of the firm’s products; e-collaboration technology use ($F_2$), the perceived degree of use of e-collaboration technologies by the members of a firm; and competitive advantage ($F_3$), the perceived degree of competitive advantage that a firm possesses when compared with firms that compete with it.
Gráinne Conole, Patrick McAndrew and Yannis Dimitriadis (2011). *Techniques for Fostering Collaboration in Online Learning Communities: Theoretical and Practical Perspectives* (pp. 206-223).

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