Chapter 10
Variance-Based Structural Equation Modeling:
Guidelines for Using Partial Least Squares in Information Systems Research

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ABSTRACT

Partial Least Squares (PLS) is an efficient statistical technique that is highly suited for Information Systems research. In this chapter, the authors propose both the theory underlying PLS and a discussion of the key differences between covariance-based SEM and variance-based SEM, i.e., PLS. In particular, authors: (a) provide an analysis of the origin, development, and features of PLS, and (b) discuss analysis problems as diverse as the nature of epistemic relationships and sample size requirements. In this regard, the authors present basic guidelines for the applying of PLS as well as an explanation of the different steps implied for the assessment of the measurement model and the structural model. Finally, the authors present two examples of Information Systems models in which they have put previous recommendations into effect.

INTRODUCTION

During the last twenty-five years, the use of structural equation modeling (SEM) with latent variables has become widespread in information systems (IS) research (Gerow et al., 2010; Urbach & Ahlemann, 2010). In a single, systematic, and comprehensive analysis, SEM allows assessing measurement and structural models, taking measurement error into account. The holistic analysis that SEM is capable of performing can

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be carried out via one of two distinct statistical techniques: On the one hand, covariance-based SEM (CBSEM), as represented by software such us LISREL, EQS and AMOS; on the other hand, variance-based (or components-based) SEM, i.e., partial least squares (PLS). Although CBSEM has until recently been the most well-known SEM approach, PLS has also been gaining increasing interest among IS researchers (Gefen, Strabu, & Boudreau, 2000). In fact, compared with other scientific disciplines, the information systems area has been the object of a significant number of studies using PLS, the article by Rivard and Huff (1988) being the first study to ever use PLS for data analysis. This outstanding situation is due to, among other factors, the contributions of researchers such as Wynne Chin (University of Houston), who developed PLS-Graph, the first graphical software for PLS path modeling. In addition, much of IS research is constrained by either small sample sizes and/or nascent theoretical development, which encourage the use of PLS.

However, some limitations of this approach have recently been the cause of concern among scholars (Marcoulides & Saunders, 2006; Marcoulides, Chin, & Saunders, 2009). Our position is that PLS is an appropriate approach to SEM when the research problem presents certain conditions and this methodology is properly applied. Thus, the aim of this contribution is to shed light on the use of partial least squares (PLS) as a variance-based SEM approach. Consequently, we provide a discussion of the key differences between CBSEM and variance-based SEM, indicating the rationale upon which researchers can base their use of PLS. We present basic guidelines for the applying of PLS, as well as an explanation of the different steps implied for the assessment of the measurement model and the structural model. We describe our recommendations using two examples from the discipline of information systems.

STRUCTURAL EQUATION MODELING IN INFORMATION SYSTEMS RESEARCH

From a philosophical position, research that applies Structural equation modeling (SEM) usually follows a positivist epistemological belief (Urbach & Ahlemann, 2010). In this vein, SEM emerges as a result of the conjunction of two traditions (Chin 1998a). On the one hand, an econometric perspective (linear regression models), on the other hand, a psychometric approach (factor analysis). SEM thus combines the usage of latent (unobserved) variables that represent the concepts of theory, and data from measures (indicators or manifest variables) that are used as input for statistical analysis that provides evidence about the relationships among latent variables (Williams, Vandeberg, & Edwards, 2009). SEM is particularly useful in IS research, where many if not most of the key concepts are not directly observable. Indeed, a large portion of IS research during recent years has mainly applied SEM as an analytical methodology for theory testing (Gefen, et al., 2000; Gerow et al., 2010). In turn, an expansion to the breadth of application of SEM methods can be also noted, including exploratory, confirmatory and predictive analysis, as well as the generating of an increasing diversity of *ad hoc* topics and models (Westland, 2010).

In a single, systematic, and comprehensive analysis, SEM evaluates (Gefen et al., 2000) (Figure 1): (1) The measurement model. That is, the relationships between the latent variables and their indicators. (2) The structural model. I.e., the part of the overall model that proposes relationships among the latent variables. Such relationships reflect substantive hypotheses based on theoretical considerations.

The holistic analysis that SEM is capable of performing is carried out via one of two distinct statistical techniques (Barroso, Cepeda, & Roldán, 2010): (1) Covariance-based SEM (CBSEM) and (2) a variance-based (or components-based)

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