EDITOR'S COMMENTS – SUPPLEMENT

A Critical Look at the Use of PLS-SEM in *MIS Quarterly*

Appendix A: PLS-SEM Studies in MIS Quarterly (1992–2011)

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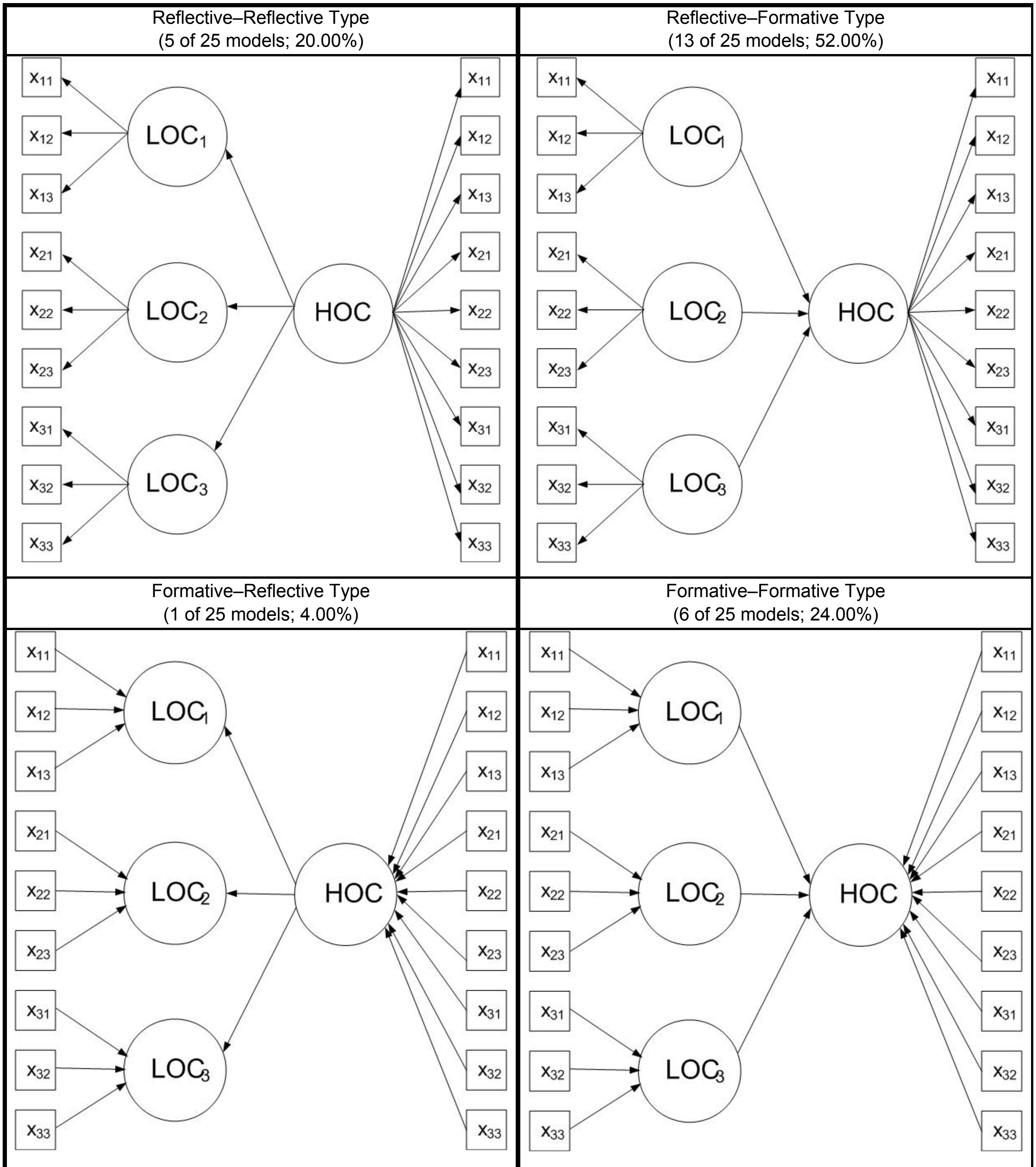
Appendix B: Hierarchical Component Models

In total, 15 studies (23.08%) included 25 hierarchical component models. Only 7 of these 15 studies (46.67%) state exactly how the hierarchical component analysis, which researchers often call second-order construct analysis, was carried out. While two studies used factor scores, the authors of the other five studies stated that they applied the indicator reuse technique that Wold (1982) proposed for this kind of analysis. The majority of studies (8 of 15 studies, 53.33%) provide no detailed information on how the analysis was carried out. Thus, more specific knowledge about the use of hierarchical component models in PLS-SEM remains scant.

When using the PLS-SEM method for model estimation, all latent variables—which includes higher order components—must have a measurement model with at least one indicator. Technically, Lohmöller (1989) showed that the indicator reuse approach is suitable for the analysis of hierarchical component models in PLS-SEM (i.e., the higher order component uses all indicators of the lower order components; Figure B1). This approach works best when all lower order components have the same number of indicators. Otherwise, the interpretation of the relationships between the lower and the higher order components must account for the bias of unequal numbers of indicators in the lower order components. Even though some of the five studies that apply the indicator reuse technique have highly unbalanced numbers of indicators in their lower order components, none of them accounts for this important issue when interpreting the path coefficients. A potential solution to this problem is the computation and comparison of total effects between the lower order component indicators and the higher order component.

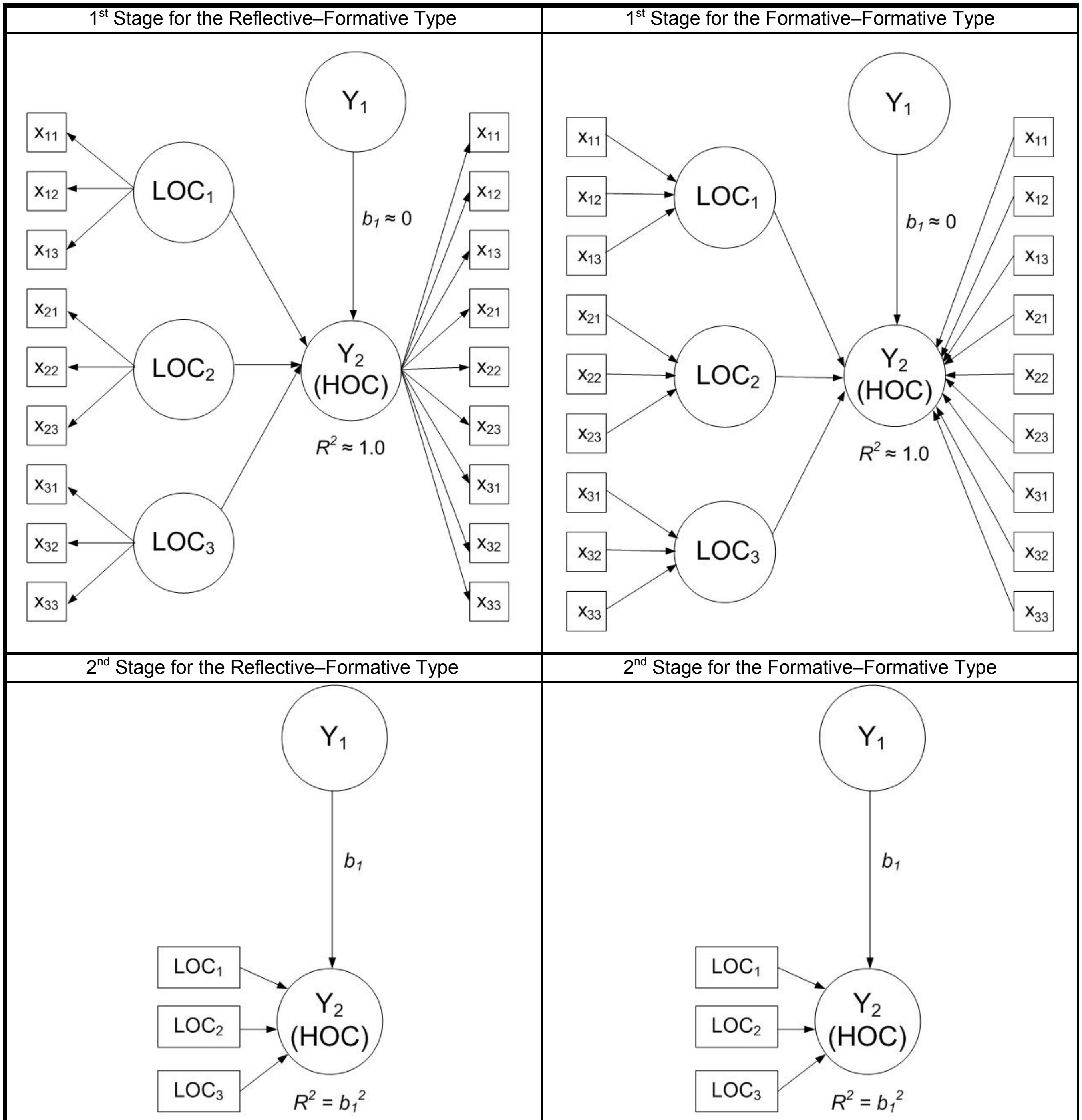
Generally, four types of hierarchical component models (Figure B1) appear in the extant literature, with their naming differing largely (Wetzels et al. 2009). While the formative–reflective type has only been used in a single case, reflective–formative hierarchical component models represent the most popular type in *MIS Quarterly* PLS-SEM applications.

With two exceptions, the majority of studies (13 of 15 studies, 86.67%) relate the higher order component to other latent variables in the nomological net that are not part of the hierarchical component model—as required by Chin (1998). In three studies (20%), the higher order component is endogenous (i.e., it has at least one latent variable as a predecessor in the structural model which is not an element of the hierarchical component model), while, in contrast, the higher order component explains other latent variables in five studies (33.33%). In the remaining five studies (33.33%), the higher order component has other latent variables in the structural model as both predecessors and successors.



Legend: LOC = lower order component; HOC = higher order component

Figure B1. Hierarchical Component Models in PLS-SEM



Legend: LOC = lower order component; HOC = higher order component; Y_1 = exogenous latent variable in the structural model (its measurement model is not further specified in this illustration); Y_2 = endogenous latent variable in the structural model; b_1 = standardized path coefficient for the structural model relationship between the latent variables Y_1 and Y_2.

Figure B2. Two-Stage Approach for the Hierarchical Component Analysis

In half of the formative–formative type and in a quarter of the reflective–formative type of hierarchical component model applications, the higher order component is endogenous. These model set-ups require particular attention when the repeated indicators approach is used since almost all variance of the higher order component is explained by its lower order components ($R^2 \approx 1.0$; Figure B2). As a consequence, the path relationship from the latent variable (predecessor) to the endogenous higher order component is always approximately zero and nonsignificant.

In this kind of situation, a mixture of the repeated indicators approach and the use of latent variable scores in a two-stage approach—which is similar to the two-stage approach in moderator analyses in PLS-SEM (Henseler and Chin 2010)—is appropriate. In the first stage, one uses the repeated indicators approach to obtain the latent variable scores for the lower order components which then, in the second stage, serve as manifest variables in the measurement model of the higher order component (Figure B2). Thereby, the higher order component is embedded in the nomological net in a way that allows other latent variables as predecessors to explain some of its variance, which may result in significant path relationships.

Even though these explications further substantiate the use of hierarchical component models in PLS-SEM from a technical perspective, more knowledge is needed to integrate the theoretical and technical underpinnings. Future research on the appropriate use of formative measurement models in PLS-SEM must also address the use of formative–reflective, reflective–formative, and formative–formative types of hierarchical component models.

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