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Advancing many groups comparisons: Mixture multigroup approach for latent variable analysis

Symposium title

Advancing many groups comparisons: Mixture multigroup approach for latent variable analysis

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Abstract

The growing availability of large-scale international surveys has provided new opportunities for social scientists to examine relations between latent variables (e.g., how perceived economic threat affects political ideology), which are measured by questionnaire items, and to compare them across many groups (e.g., countries). Structural Equation Modeling (SEM) is the state-of-art method for analyzing and comparing these relations –often called 'structural relations'. When comparing structural relations among many groups, they likely differ across the groups. However, it is equally likely that some groups share the same relations so that clusters of groups emerge. In this context, mixture modeling is a straightforward solution to find these clusters. Notably, before comparing relations across different groups (or clusters), it is important to establish that the latent variables are measured in the same way across the groups –also known as measurement invariance. Otherwise, differences in the measurement models may be mistaken as differences in the structural relations. In this symposium, we discuss new avenues to use mixture modeling to compare structural relations across many groups while accounting for measurement (non-)invariance. First, we present an empirical application of the novel Mixture Multigroup Structural Equation Modeling (MMG-SEM) method, which identifies clusters of groups with equivalent structural relations while accounting for measurement non-invariances through group-specific measurement parameters. In the second presentation, MMG-SEM is extended to deal with ordinal data properly. Next, we shift our attention to the measurement model. In the third presentation, Mixture Multigroup Factor Analysis (MMG-FA) is discussed, which clusters groups based on specific subsets of measurement parameters (i.e., loadings), and its performance is evaluated when it comes to analyzing ordinal data with underlying non-normal distributions. The fourth presentation introduces Double-Mixture Multigroup Structural Equation Modeling, which builds on MMG-FA and clustering groups based on both their measurement parameters and structural relations using. This extension of MMG-SEM is most useful when some groups are too small to estimate group-specific measurement parameters. In the fifth presentation, we examine multigroup SEM when the measurement model is exploratory rather than confirmatory and discuss some potential challenges when extending the model to cluster groups based on their structural relations. In the final presentation, we shift to longitudinal data and discuss how to cluster individuals based on their dynamic structural relations.

Keywords

mixture-modeling; structural-equation-modeling; structural-relations; measurement-invariance

Number of communicatios

6

Communication 1

Mixture Multigroup Structural Equation Modeling: An empirical application revealing cross-national patterns in how human values predict climate change beliefs

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Abstract

The increasing accessibility of large-scale international surveys has provided new opportunities for social scientists to conduct comparative research. Such studies frequently examine relations between latent constructs (e.g., how perceived economic threat affects political ideology) and compare them across groups (e.g., countries) to reveal cultural variations in value priorities, attitudes and behavioral patterns. Structural Equation Modeling (SEM) is the state-of-art method for analyzing and comparing these complex relations. While these relations often differ across groups, similarities may emerge among certain groups, leading to the formation of clusters, especially in the case of many groups.

Latent constructs are measured indirectly by multiple questionnaire items. To enable valid comparisons of their relations across groups, the measurement of latent constructs should be invariant. However, when dealing with multiple groups, there are often some differences (or non-invariances) in the measurement models (MM). It is important to capture them in the SEM model to avoid biased estimations of the structural relations. Mixture Multigroup Structural Equation Modeling (MMG-SEM) has recently been proposed as a novel method for identifying clusters of groups with equivalent structural relations, while accounting for measurement non-invariances through group-specific measurement parameters. To demonstrate its application in empirical research, we apply MMG-SEM to European Social Survey Round 8 (ESS8) data, uncovering cross-national differences and similarities in the relations between human values, climate change belief, and support for climate change policies across 23 countries.

Keywords

Mixture-Multigroup-Structural-Equation-Modeling; human-values; climate-change; cross-national analysis

Communication 2

Extending Mixture Multigroup Structural Equation Modeling to deal with ordinal variables.

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Abstract

The recently proposed Mixture Multigroup Structural Equation Modeling (MMG-SEM) efficiently compares groups by clustering them based on their structural relations while accounting for the reality of measurement (non-)invariance. Currently, MMG-SEM relies on maximum likelihood (ML), which assumes continuous and normally distributed observed indicators. However, this can introduce bias when applied to ordinal data, which is often used in social sciences. In this paper, we extend MMG-SEM to accommodate ordinal data relying on the Structural-After-Measuremt stepwise estimation approach. In the first step, we implement a multigroup categorical confirmatory factor analysis (MG-CCFA) with diagonally weighted least squares (DWLS) to estimate the measurement model (MM). The second step uses ML to estimate structural relations and perform clustering. A simulation study evaluates the performance of this approach compared to traditional ML-based MMG-SEM under various conditions. The results show a better recovery of MM parameters with DWLS, particularly with fewer response categories, whereas both approaches perform similarly in structural model recovery.

Keywords

structural-equation-modeling; structural-relations; ordinal-data; mixture-modeling

Communication 3

Evaluating the Efficacy of Mixture Multigroup Factor Analysis in Handling Non-Normal and Ordinal Data: A Simulation Study

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Abstract

In the social sciences, a common research objective is the comparison of latent variables among different groups, such as in cross-cultural studies. For making valid comparisons measurement invariance (MI) is required, which implies that constructs are measured consistently across populations. When dealing with many groups, MI often does not hold, requiring pairwise comparisons between the groups to identify the sources of non-invariance. However, such comparisons can become impractical when dealing with many groups.
Mixture multigroup factor analysis (MMG-FA) offers a solution by clustering groups based on their measurement parameters. This method captures between-group differences and similarities in measurement parameters without requiring extensive pairwise comparisons. It combines cluster-specific and group-specific parameters to cluster groups on specific subsets of measurement parameters, for instance, on factor loadings to achieve metric invariance within each cluster of groups. An EM algorithm was developed for MMG-FA to drastically lower the computation time, but this is specific to maximum likelihood estimation. However, the use of maximum likelihood estimation in MMG-FA assumes continuous items and underlying multivariate normality—assumptions that are not always tenable in real-life settings. Using simulations, we investigate MMG-FA's performance with ordinal data and underlying non-normal distributions when clustering based on factor loadings, to examine the robustness of MMG-FA to violations of the previously mentioned assumptions.

Keywords

measurement-model; mixture-clustering; ordinal-data; non-normal distributions

Communication 4

MixMG-SEM with double mixture modeling to capture similarities in measurement model and in structural relations across many groups

Authors

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Abstract

Comparing relations between latent constructs across groups is essential for understanding social phenomena in different contexts. A key assumption for valid comparisons of such relations is that the constructs are measured equivalently across the groups, referred to as "measurement invariance". Specifically, partial metric invariance is sufficient –meaning that at least some factor loadings are invariant across groups –provided that non-invariant measurement parameters are appropriately accounted for in the model. To address this, we propose double-mixture multigroup structural equation modeling (2MixMG-SEM), which applies a mixture clustering of the groups to capture differences in the measurement model (measurement clusters) and another mixture clustering to capture differences in the structural relations (structural relations clusters). 2MixMG-SEM thus captures measurement non-invariance with cluster-specific measurement parameters, as opposed to mixture multigroup SEM (MixMG-SEM), which captures them with group-specific parameters. We therefore expect 2MixMG-SEM to perform better than MixMG-SEM when some groups are too small for group-specific parameters to be accurately estimated. Through a simulation study, we evaluate 2MixMG-SEM's performance, addressing key challenges such as classification uncertainty and selecting the cluster numbers for both layers of clustering.

Keywords

mixture-modeling; structural-equation-modeling; structural-relations; measurement-invariance

Communication 5

Evaluating (Mixture) Multigroup Structural Equation Modelling with Exploratory Measurement Models

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Abstract

Structural equation modelling (SEM) is the state-of-the-art method for analysing relations between latent variables (e.g., attitudes or behaviours), also called 'factors'. SEM consists of a measurement model (MM), which specifies how questionnaire items measure the factors, and a structural model (SM), which captures the relations of interests. Traditionally, SEM estimates the MM and the SM simultaneously, whereas the structural-after-measurement (SAM) approach estimates the MM first, and then the SM. When comparing relations across multiple groups (e.g., countries), measurement invariance (MI) is a prerequisite. When MI fails, it is crucial to model the measurement non-invariances to avoid biasing the comparisons. Multigroup exploratory factor analysis (MG-EFA) estimates all factor loadings, and thus allows to identify all kinds of loading non-invariances. The choice of rotation in MG-EFA can, however, affect the MM. Also, rotation per group affects the detection of loading non-invariance, as it disregards the loading agreement between groups. But this is accounted for by multigroup alignment (MG-A) and multigroup factor rotation (MG-FR). In this talk, I will present the results of a simulation study that evaluates how well MG-A and MG-FR perform to recover the measurement parameters and loading (non-)invariances (when using different rotations) in the first step of multigroup exploratory SAM (MG-ESAM), and how this, in turn, affects the recovery of the relations in the second step. We examine how MG-ESAM can be used to tackle the challenge of finding the most optimal rotation before comparing the relations across groups. Finally, I will present some specific challenges to consider when extending MG-ESAM into Mixture Multigroup ESAM to find clusters of groups based on their structural relations.

Keywords

multigroup-exploratory-structural-equation-modelling; multigroup-group-alignment; multigroup-factor-rotation; factor-loading-invariance; similarity-rotation

Communication 6

Mixture Three-Step Latent Vector Autoregression to Find Individuals With Similar Dynamic Processes

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Abstract

Researchers often use vector autoregressive models to study dynamic processes of latent variables in daily life, such as the extent to which positive and negative affect carry over and interact with each other from one moment to the next. Mixture modeling allows finding clusters of individuals that are similar to each other in their dynamic processes. However, applying MMG-SEM to vector autoregressive models is not straightforward. For example, not only metric, but also (partial) scalar invariance has to hold. To validly cluster individuals based on their dynamic processes while accounting for partial measurement non-invariance, we present an extension of the recently proposed Three-Step Latent Vector Autoregression (3S-LVAR). We discuss challenges that arise when applying the idea of MMG-SEM to intensive longitudinal data and how to tackle them.

Keywords

intensive-longitudinal-data; measurement-error; reliability-adjustment; vector-autoregressive-model

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