Peer-review report of

Henry, T., & Ye, A. (2024). The effects of omitted variables and measurement error on cross-sectional network psychometric models. *advances.in/psychology, 2*, e335225. https://doi.org/10.56296/aip00011

Round 1

Dear Authors, good afternoon.

I have now obtained the review of two expert methodologists. A summary of their recommendations are presented below. Reviewers one wrote a detailed review of your paper (see the PDF attached), while reviewer two pointed out minor issues in the manuscript (available below).

The first reviewers of the manuscript "The Effects of Omitted Variables and Measurement Error on Cross-Sectional Network Psychometric Models" raised several major concerns and suggestions, summarized as follows:

1. Clarity on Omitted Variables: The reviewers note that the problem of omitted variables in the network is not clearly explained. They suggest adding a small example with a figure to illustrate the effect of missing variables and recommend including important references to the boundary problem, such as Laumann Marsden & Prensky (1989) and Neal & Neal (2023). Additionally, they advise explaining the severity of the omitted variable problem to highlight its commonality and importance.

2. Relationship Between Networks and Latent Variable Models: The relationship between networks and latent variable models is not clearly articulated in the paper. The reviewers mention that these relationships provide full statistical but not conceptual or causal equivalence, as explained in Marsman et al. (2018) and Waldorp & Marsman (2022). The paper should make clear that the current issues (boundary problem and measurement error) apply to both networks and latent variable models.

3. Gaussian Graphical Models (GGMs): The reviewers point out that GGMs, stated to be sparse representations of conditional relations between pairs of variables, can also be defined for dense (fully connected) networks. This aspect needs clarification in the manuscript.

4. Structure of the Manuscript: The reviewers find that some sections, such as "Gaussian Graphical Models" and "Sources in Bias of the Gaussian Graphical Models," do not seem to align with the overall topic of "Latent Variable vs. Network Psychometric Approaches" under which they are categorized.

5. Alignment of Research Question and Results: The manuscript's research question focuses on the effect of omitted variables and measurement error on psychometric networks, but the simulation and results section is more about comparing methods (EBICGLasso and LoGo-TMFG) under these conditions. The reviewers suggest rephrasing the problem statement in the introduction to better align with the findings presented in the results.

These points highlight the need for the paper to clarify its concepts, improve its structure, and better align its research questions with its findings.

Reviewer two points out that the paper is interesting and timely, interesting and useful but points out several areas needing clarification or improvement, that I summarize below:

1. Clarification on how measurement error is defined in the data generating model, particularly the differences in noise per variable and consistency in the notation of simulated variables.

2. A definition of network density, along with a discussion of different ways it can be defined.

3. Explanation of the rationale behind fixing the network density to a specific value.

4. Suggestion to cite relevant literature on the impact of measurement error on network estimation and clarify the novel contributions of this manuscript.

5. Elaboration on why omitted variables are generated in a specific manner and discussion on other potential setups and their impacts.

6. Definition and application of performance evaluation metrics, specifically specificity and sensitivity, to centrality measures.

7. Clarification on how centrality, a node-level metric, is reported for the network.

8. Inclusion of both absolute and relative values of sensitivity and specificity for edges.

9. Consideration of using a single network as an example to simplify the understanding of the methodology.

10. Addition of an empirical dataset to illustrate the methodology.

Overall, the reviewer acknowledges the paper's contributions while suggesting significant enhancements to improve clarity and robustness.

Please, review your manuscript addressing each one of the points raised by the reviewers. If you have any trouble accessing the PDF submitted by reviewers one, please let me know.

Best wishes,

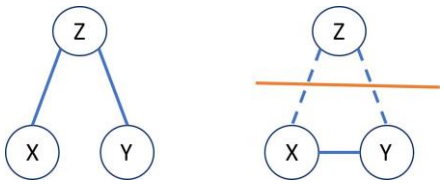
Hudson Golino

Reviewer 1

We are happy to have read the manuscript *The effects of omitted variables and measurement error on cross-sectional network psychometric models*. We think the topic is timely. However, we have some concerns with the way that the concepts and issues are explained, and miss crucial references to relevant material in the current network psychometric literature. We give concrete suggestions for each of them. Below, we also raise some minor concerns that we believe are easy to address.

The first major concern we have is that the problem of omitted variables in the network is not clearly explained, and relevant references to the boundary problem that this is are not listed. We suggest adding a small example with a figure (see below) to

illustrate the effect of missing variables. Important references for the boundary problem that we suggest to include are Laumann, Marsden, & Prensky (1989) and Neal & Neal (2023). In addition to the lack of an explanation of the concept of the problem, we also lack an explanation of the severity of the problem to make clear how common the omitted variable problem is and why it is important.



In the example above, you would expect X and Y to be (partially) correlated when Z is omitted from the model or analysis. Instead of looking for methods that are sensitive to omission, why not rephrase the question to look for methods that are sensitive to picking up this partial correlation?

Our second major concern is that the relationship between networks and latent variable models is not clearly explained. As explained in Marsman et al. 2018, but see also Waldorp & Marsman (2022), these relationships provide full statistical but not conceptual or causal equivalence. By not making these connections clear to the reader, it appears as if the two current issues, boundary problem and measurement error, apply only to networks and not to the latent variable model. This is not correct and should be explained.

The boundary problem: The latent variable model (i.e., an IRT model) is closed under marginalization. This means that dropping one of the indicators does not affect the rest of the model in any meaningful way. In theory, that is. The key assumption here is that the indicators are exchangeable proxies for the latent variable (e.g., Ellis and Junker, ..). Say I test your math ability with ten questions, it should not really matter which math questions I use, they are exchangeable and my inferences based on them would be the same. But in network psychometrics, the variables are clearly not exchangeable. As a result, if I were estimating a multidimensional IRT model on a set of symptoms, but missing a crucial symptom, adding that symptom would definitely result in a different IRT model. In the example above, it is likely that an additional latent variable is needed to explain the zero partial correlation in the network.

The measurement error problem: The situation is that you are assessing one of the nodes with error. In principle, you could solve this with a latent variable model. However, due to the statistical equivalence with network models, it is not clear what that would look like here. In principle, you want to add a latent variable to the network that you measure with

some latent variable model (IRT or factor model). In the statistically equivalent latent variable model, you would have one of the indicators measured with error, and by assuming a measurement model for it, you would have a latent variable as an indicator for a higher order latent variable.

We believe it would be beneficial to the reader to explain these concepts in full.

p3: It is stated that GGMs are sparse representations of the conditional relations between pairs of variables. Although they often are used in that way, this is not necessarily true. The GGM is also defined for dense (i.e., fully connected) networks.

p2-6: Section 2 has the heading "Latent Variable vs. Network Psychometric Approaches". However, the subsections "Gaussian Graphical Models" and "Sources in Bias of the Gaussian Graphical Models" do not seem to fall under this topic, although they are still in this section.

p7: The research question is the effect of omitted variables and measurement error on psychometric networks. The simulation and results section focuses on comparing the methods (EBICGLasso and LoGo-TMFG) and how they perform under omitted variables and measurement error. This does not directly answer the research question as stated in the introduction. This could be resolved by rephrasing the problem statement in the introduction to align it with the findings in the results.

Best wishes,

Maarten Marsman and Sara Keetelaar

References

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Reviewer 2

Advances.in Special Issue: Network Psychometrics (SP_network_psych)

Review of The Effects of Omitted Variables and Measurement Error on Cross-sectional Network Psychometric Models

The paper aims to evaluate the impact of omitted variables and measurement error on the estimation of network psychometrics, e.g., centrality, by conducting a comprehensive simulation study. Specifically, this paper evaluated two network estimation techniques, e.g., EBICglasso and LoGo-TMFG, and concluded EBICglasso tends to be more robust to the impacts of omitted variables and measurement error. Overall, I think the paper is interesting and useful in informing researchers about the potential shortcomings of applying network estimation methods, but there are several questions that need to be addressed (listed below) to ensure the data generating model and evaluation metrics are clearly defined:

1. P9 line 379, it is unclear how the measurement error in the data generating model is defined. It is stated in the manuscript “we add differing amounts of independent normal noise to each variable”, but in Eq (5), the noise is denoted as gamma for each x_i. It is unclear what is different per variable here. Additionally, the notation of simulated variable switched from z (p8) to X (p9), so please make sure the notation is consistent throughout the manuscript for the same variables.

2. P8 line 334, please add a definition of network density d, as the psychometric network density could be defined in various ways, e.g., taking absolute values of negative edges, magnitude vs. count.

3. Please clarify the rationale of fixing the density to a certain value (e.g., 0.2), e.g., whether fixing the density would guarantee any desired property.

4. There seems to be some publication evaluating the impact of measurement error on network estimation (see the following reference as an example), please

considering citing relevant literature and clarify how this manuscript makes a novel contribution to the existing literature.

a. de Ron, Robinaugh et al., 2022. Quantifying and addressing the impact of measurement error in network models.

5. P6, “omitted variable bias” section. Please explain why omitted variable needs to be generated in the specified way in Eq (2) and (3). Please discuss other possible ways to set up the omitted variables in the data generating model and their impact on estimation, e.g., the omitted variable is correlated with multiple variables in the network. Additionally, there is a typo on P6 line 249, it should be X_2 = gamma * X_1 + epsilon_2.

6. P11 to 12. It is not obvious how the performance evaluation metrics, namely specificity and sensitivity, are applied to centrality, as they are typically applied in classifications (e.g., presence or absence of an edge). Please add the definition of specificity and sensitivity of the centrality measures.

7. Centrality is a node-level metric, but it was reported as if it’s for the network. Please clarify the computation of the reported performance metric, e.g., averaged across all nodes in Table 1 to 3.

8. Please also add the absolute value of sensitivity and specificity for edges, in addition to the relative value, in a separate Table (or consider comment #9 below).

9. I appreciate the motivation to simulate various networks based on density, instead of simulating one network based on a set of fixed edge or one adjacency matrix, but the multitude of definition clarifications seem to suggest that there is some advantage of using one network as an example to illustrate the simulation, the parameter estimation results, and the performance, as a starting point. Please consider adding one such example to ease the readers into the complex methodology.

10. Please consider adding an empirical dataset as an illustration.

Round 2

Dear Dr. Henry and Dr. Ye,

Thank you for providing a detailed response letter addressing the comments and suggestions raised by the reviewer. After carefully considering the your responses and the revisions made to the manuscript, I recommend accepting the paper for publication.

In my view, you have satisfactorily addressed the major concerns raised by the reviewer, including:

1. Clarifying the explanation of omitted variables and their impact on network models, adding relevant references, and connecting the issue to the boundary problem.

2. Improving the discussion on the relationship between network models and latent variable models, emphasizing that both are affected by omitted variables and measurement error.

3. Reorganizing the manuscript structure to better align with the overall topic and research question.

4. Providing clarifications on the data generating model, particularly regarding the definition of measurement error and the rationale behind fixing network density.

5. Expanding the literature review to cite relevant work on the impact of measurement error on network estimation and highlighting the novel contributions of the study.

6. Adding a visual flowchart to illustrate the simulation procedure in the context of a single network, improving the readability of the methodology.

7. Including a brief empirical example to demonstrate the issues addressed in the study.

You have also addressed various minor concerns, such as clarifying the use of terminology, ensuring consistent notation, and providing additional details in the supplementary materials.

Given the thoroughness of your responses and the improvements made to the manuscript, I believe the paper is now suitable for publication. The study makes a valuable contribution to the field of network psychometrics by investigating the effects of omitted variables and measurement error on cross-sectional network models, and the findings will be of interest to researchers applying these methods in their work.

At the same time, I know the paper will receive some level of criticism from the field, and I think that’s a good thing. We should always strive for an open debate, and I hope that our journal can be used as the venue for hosting any debates in the future.

In conclusion, I recommend accepting the paper for publication, as you have adequately addressed the reviewer's comments and have made the necessary revisions to enhance the clarity, robustness, and overall quality of the manuscript.

Your paper will now enter a phase of production, and the journal might contact you if any modifications are necessary.

Best wishes,

Hudson

Reviewer 1

The authors did a commendable job addressing my comments, this version has significantly improves from the last one.