# Synthesizing Contextual Effects: A Comparison of the Two-Stage Meta-Analytic and One-Stage Multilevel Modeling Approaches in the presence of Individual Participant Data

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# Introduction
## Group Composition Effects

Contextual effects: evaluate whether group-level characteristics contribute to outcomes beyond what can be explained by individual-level characteristics.

- Socioeconomic status
- School climate
- Big-Fish-Little-Pond-Effect

The models that include the same variable at both individual and group levels

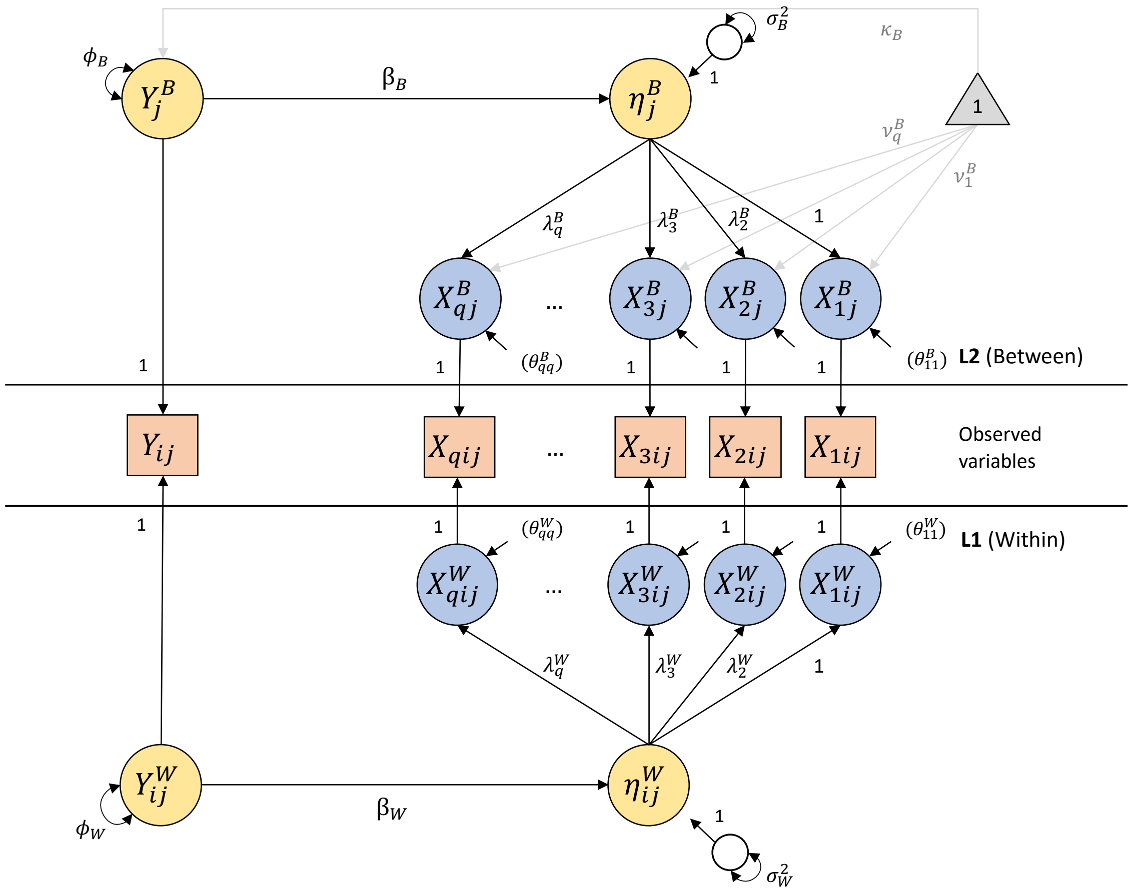
Blömeke et al., 2021; Guo et al., 2021; Konstantinidou & Scherer, 2022; Lüdtke et al., 2008; Marsh et al., 2012; Scherer et al., 2021

# Introduction
## Group Composition Effects

### Manifest Approach

- Group compositions are often uncertain and must be inferred from the scores of individuals in the sample.
  - Measurement error
  - Sampling error
  - Decomposing within and between effects

### Latent Approach

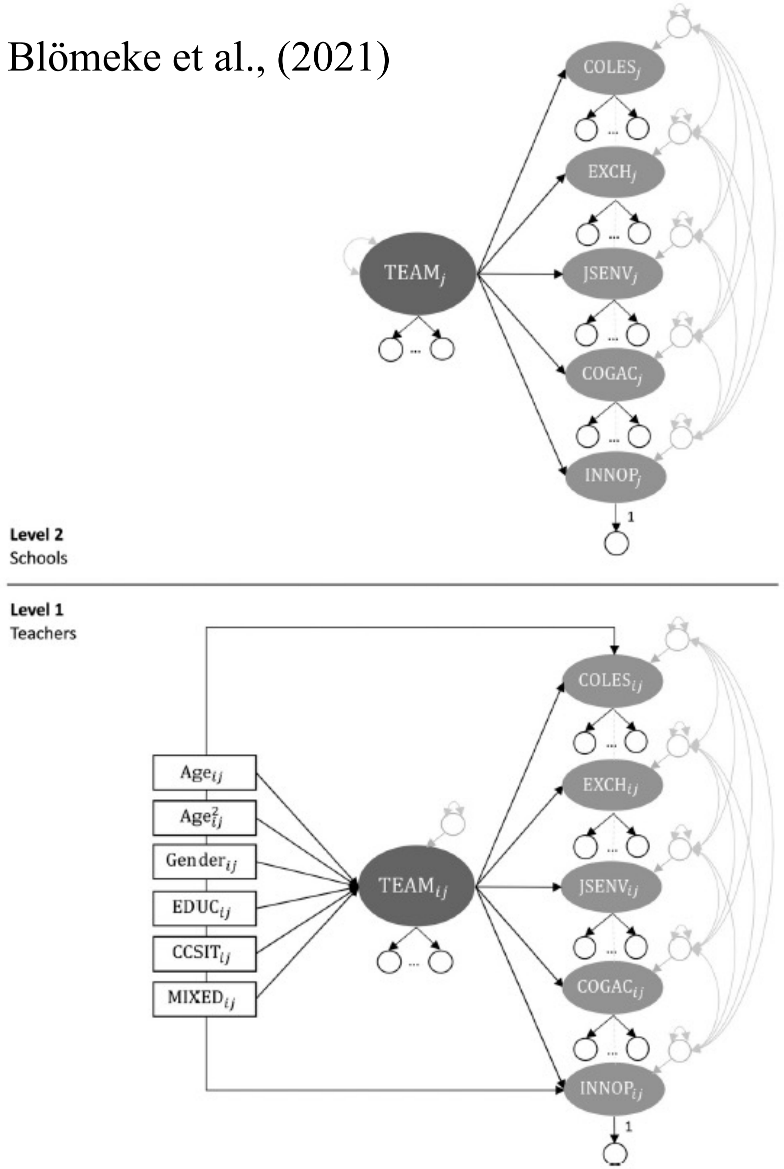



Asparouhov & Muthén, 2019; Lüdtke et al., 2008; Marsh et al., 2009; Preacher et al., 2015

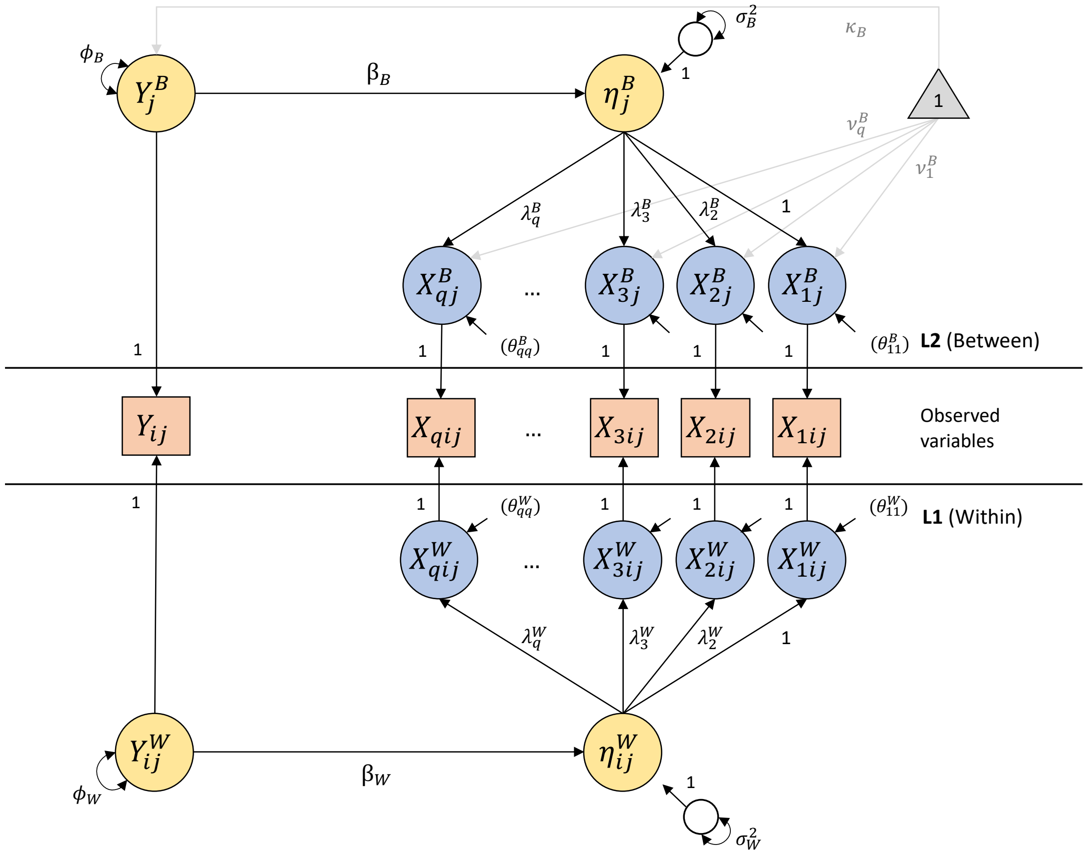
# Introduction

## Synthesizing Group Composition Effects from Complex Survey Data (ILSA)

Blömeke et al., (2021)



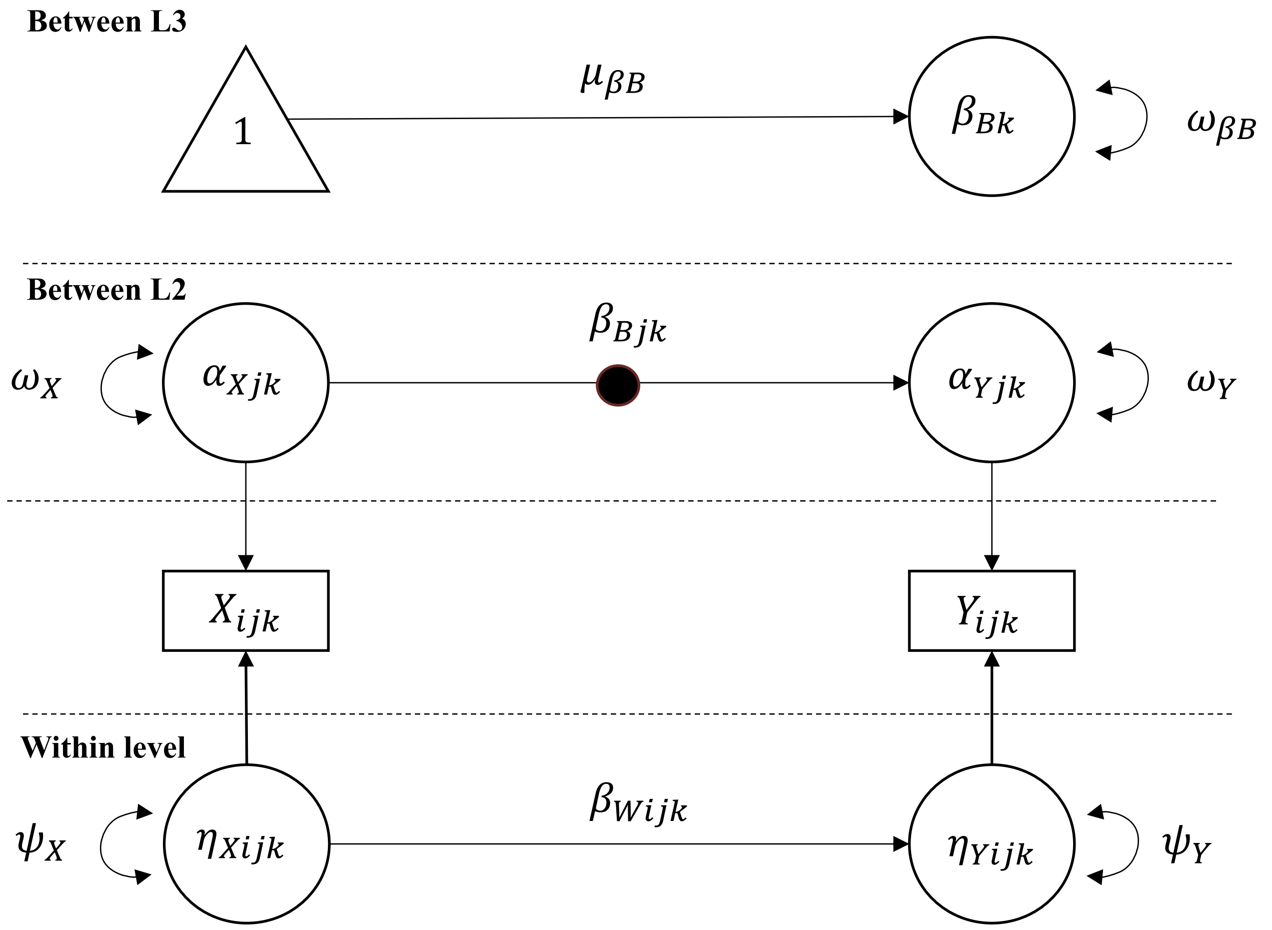

Marsh et al., (2009)




(Campos & Scherer, 2022; Keller et al., 2021; Strello, et al., 2022)

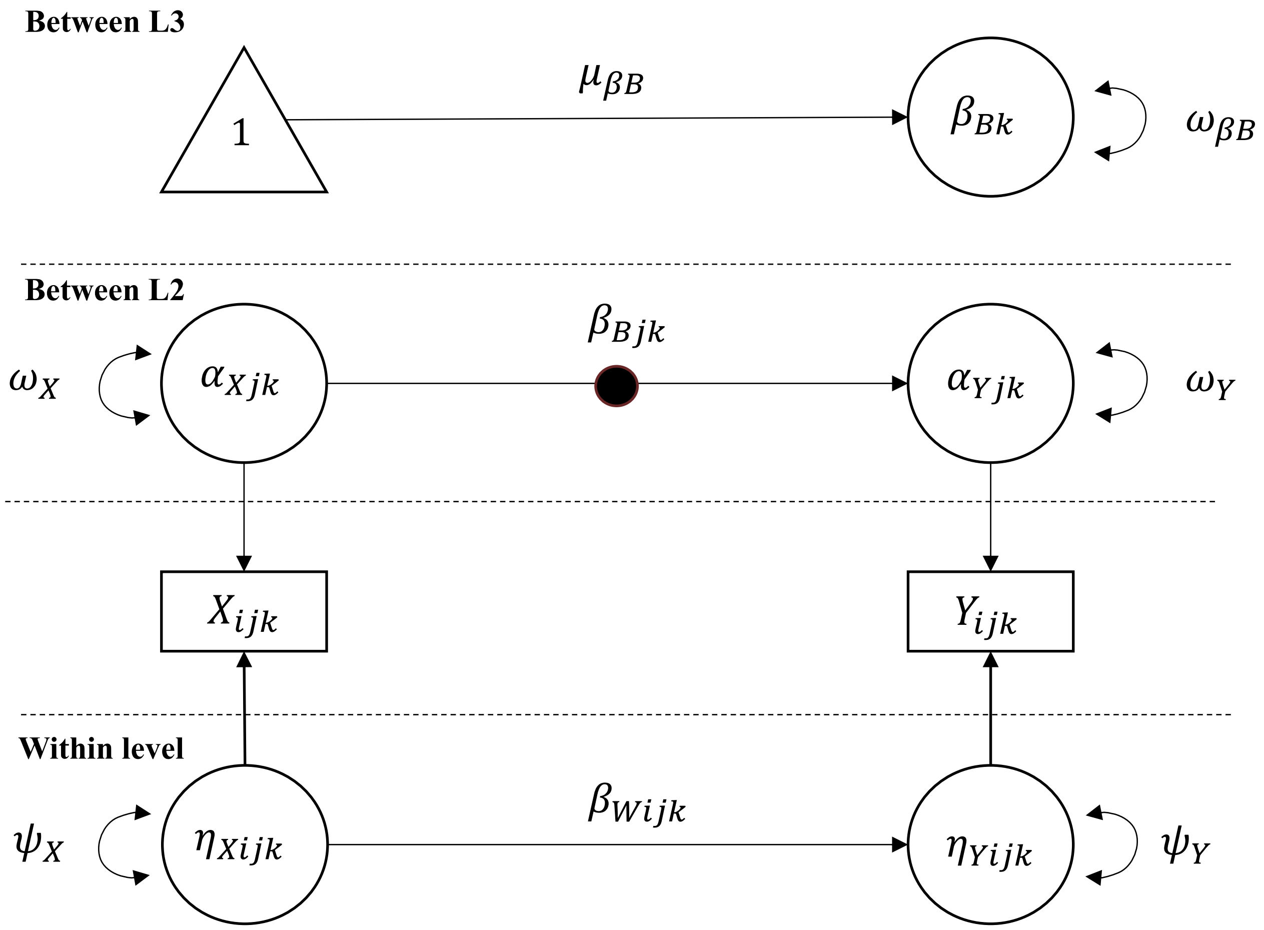
# Introduction
## Synthesizing Group Composition Effects from Complex Survey Data (ILSA)

The contextual effect of school socioeconomic (SES) composition on student achievement



# Introduction

## Synthesizing Group Composition Effects from Complex Survey Data (ILSA)



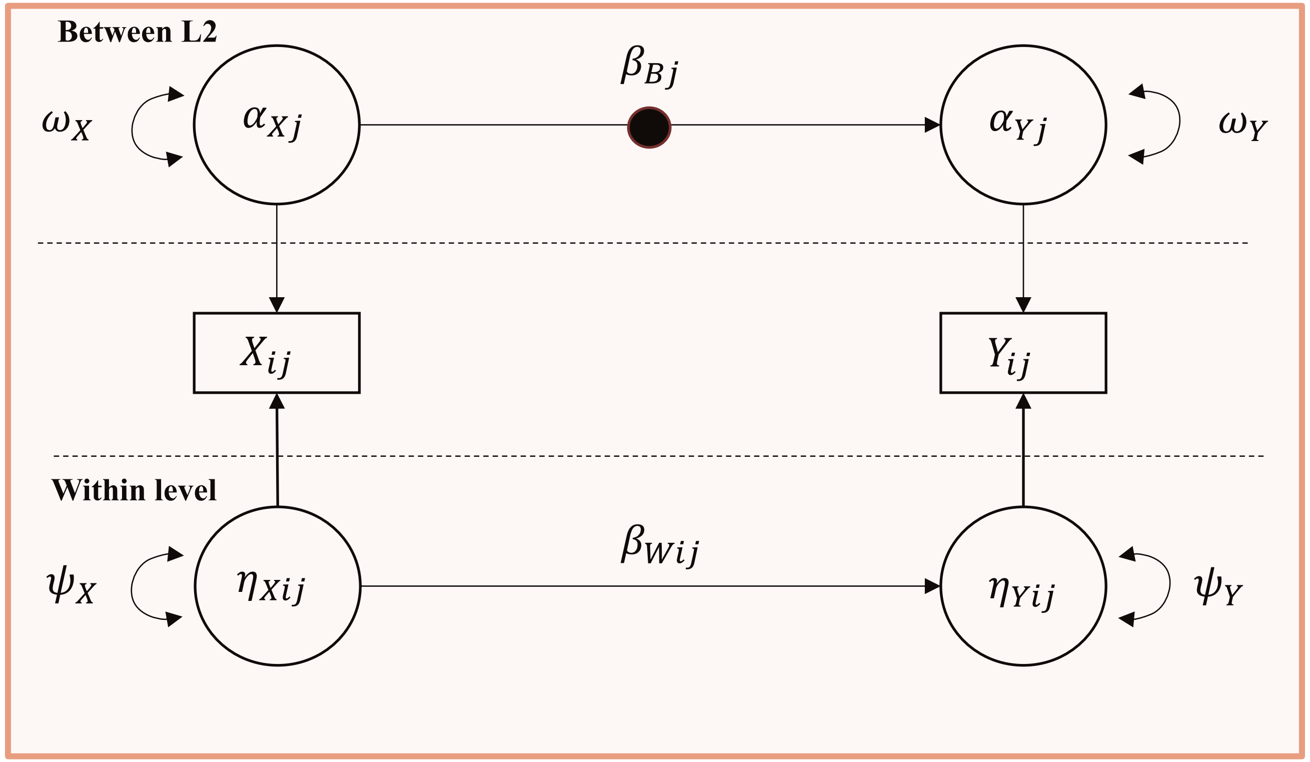

- Models are not currently available
  - Model fit
  - Model evaluation
- Computational intensive

Preacher, (2011).; Rockwood, (2020)

# Introduction

## Two-Stage IPD Meta-Analyses: Synthesis of SES composition effects

### Stage 1: Raw Data Analysis




### Stage 2: Meta-Analysis

- Multivariate meta-analysis
- Multilevel meta-analysis
- Mixed-effects meta-regression

# Introduction
## Two-Stage IPD Meta-Analyses

1. Standardized analyses across studies

2. Direct and model-based generation of the effect sizes of interest

3. Appropriate handling of statistical dependencies in primary and meta-analytic data sets

Brunner, et al., 2022; Campos, et al., 2022; Scherer, et al., 2021

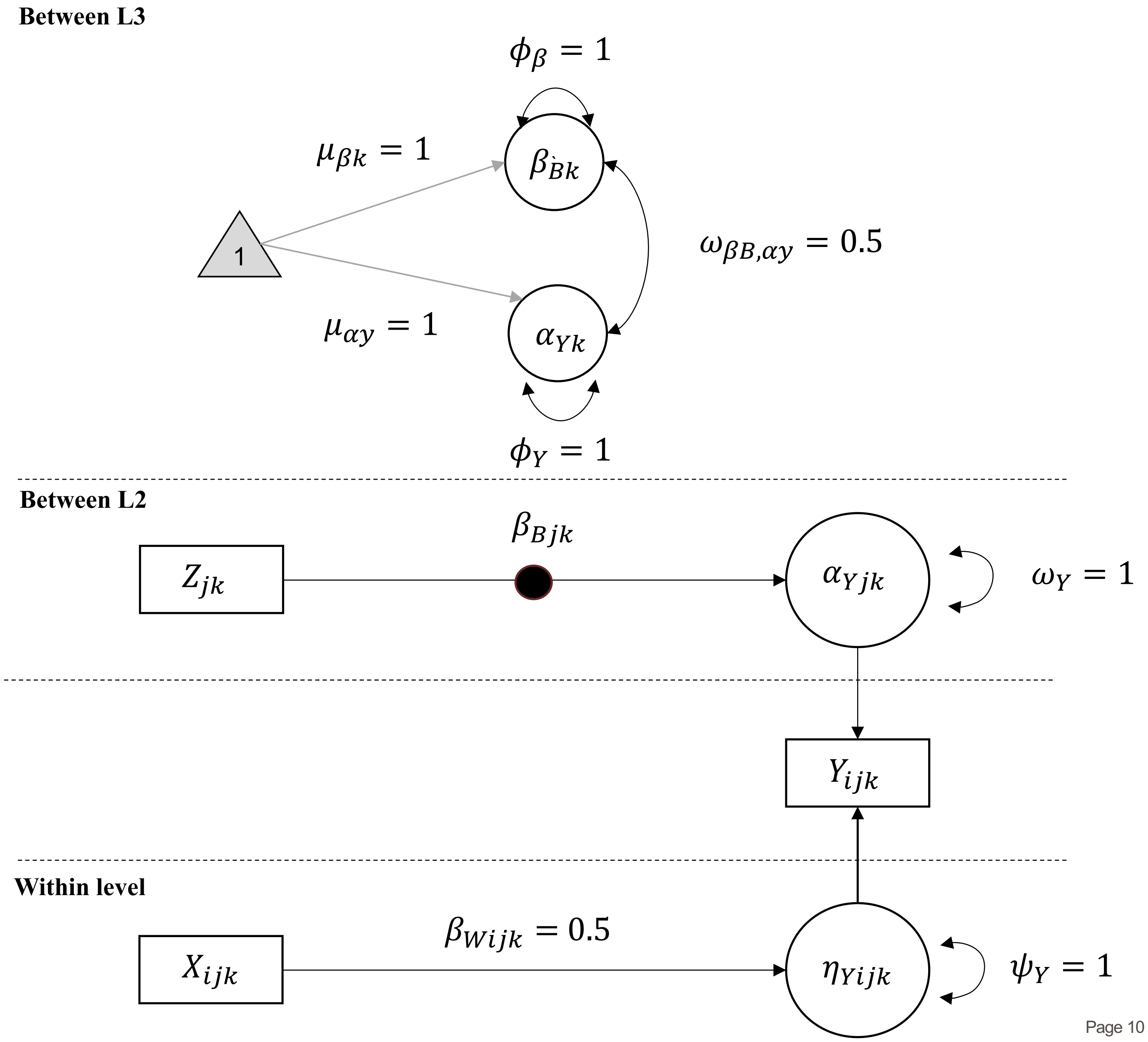
# Research Goals

How well the two-stage parameter-based MASEM approach can approximate the “gold standard” (three-level random-slopes model) in the analysis of a level-2 direct effect that varies across level-3 units?

- Compare the convergence rates and estimates of the two-stage IPD meta-analysis and three-stage MSEM models for estimating contextual effects with random slopes.

# Methodology

- 3-Level MSEM Model
- Two-stage IPD
  - Two-Level MSEM
  - Random-efects meta-analysis

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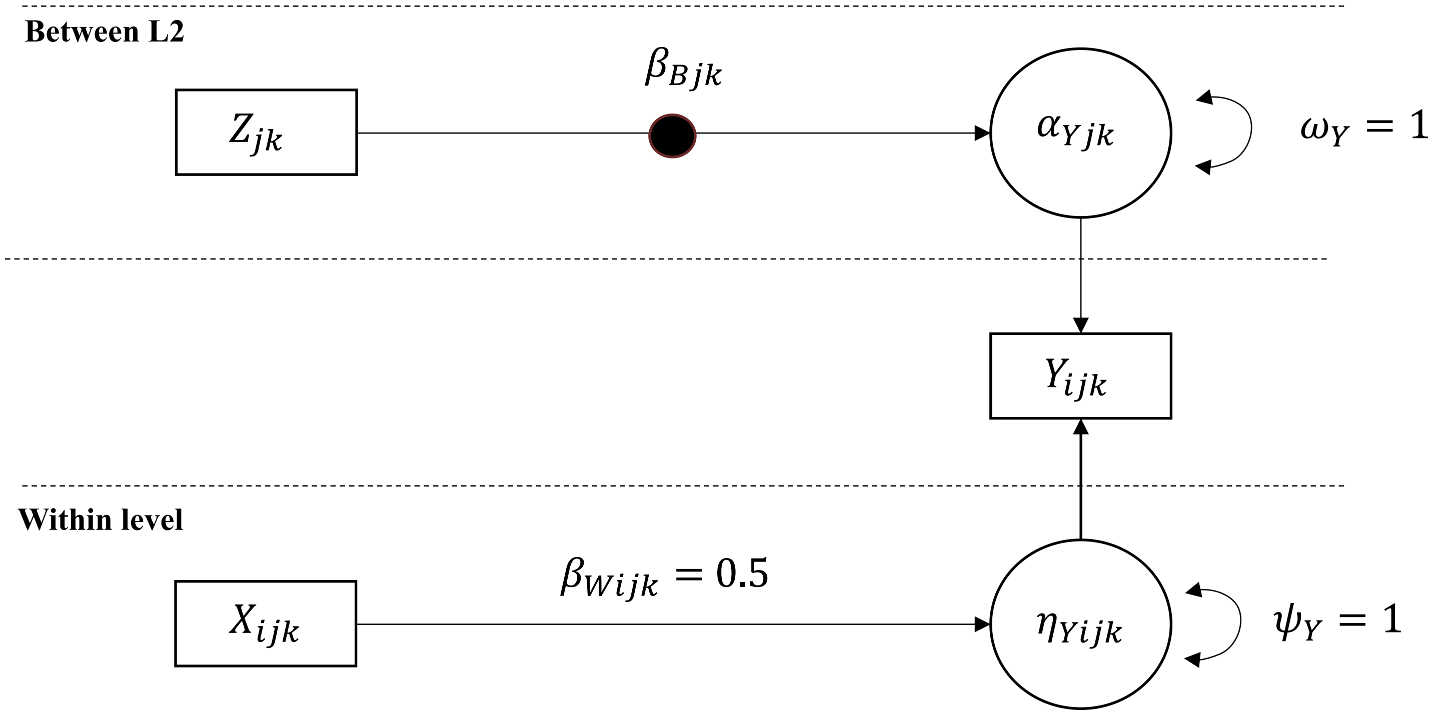
# Methodology

- 3-Level MSEM Model
- Two-stage IPD
  - Two-Level MSEM
  - Random-efects meta-analysis

## Step 1 – MSEM




## Step 2 – Meta-analyse

$$y_i = \beta_0 + u_i + e_i$$

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# Methodology

| L3 | L2 | L1 | MISSING (Y) |
|---|---|---|---|
| 25 | 50 | 5 | 0 |
| 50 | 100 | 10 | 0.1 |
| 75 | 200 | 15 | 0.2 |
| | | 30 | |

- 1000 datasets were simulated from each of the $3\ X\ 3\ X\ 4\ X\ \ 3\ \ = 108$ simulation conditions, resulting in a total of 108.000 datasets

Guo et al., 2021; Lüdtke et al., 2008; Preacher et al., 2011; Rockwood, 2020.

# Methodology

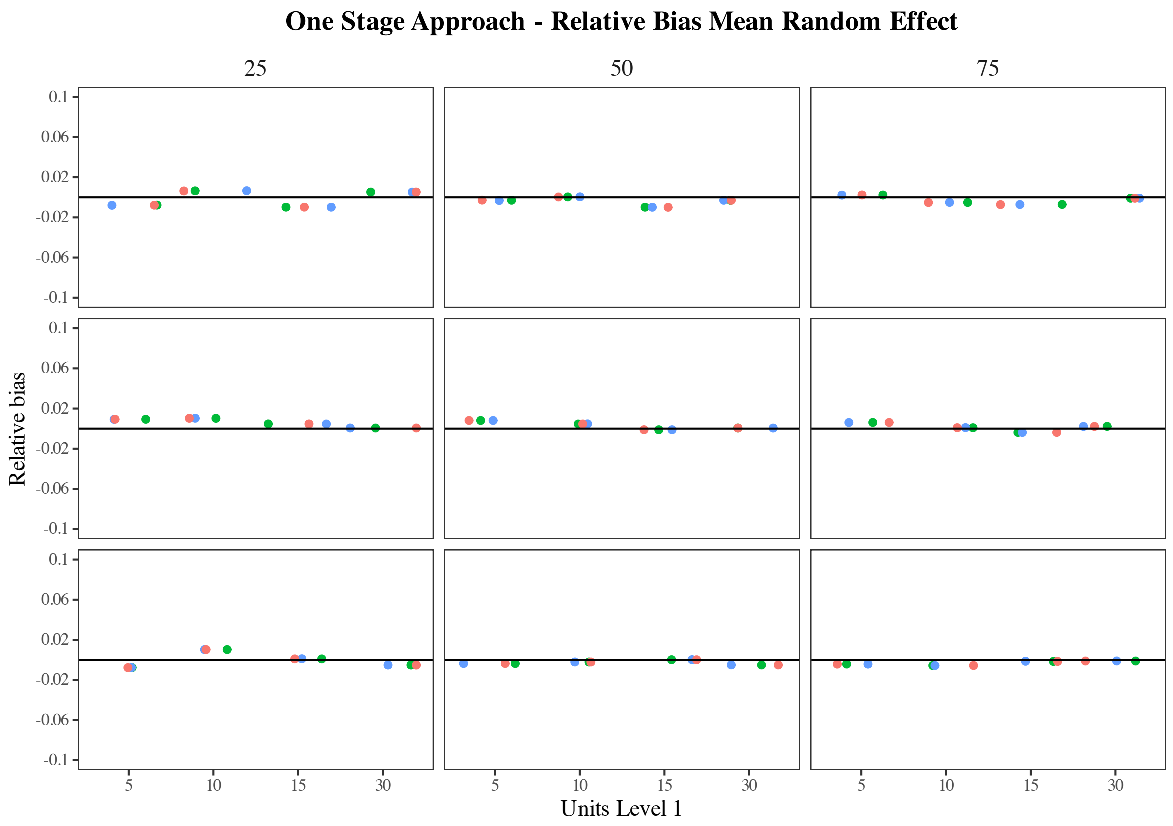
## Evaluation Criteria

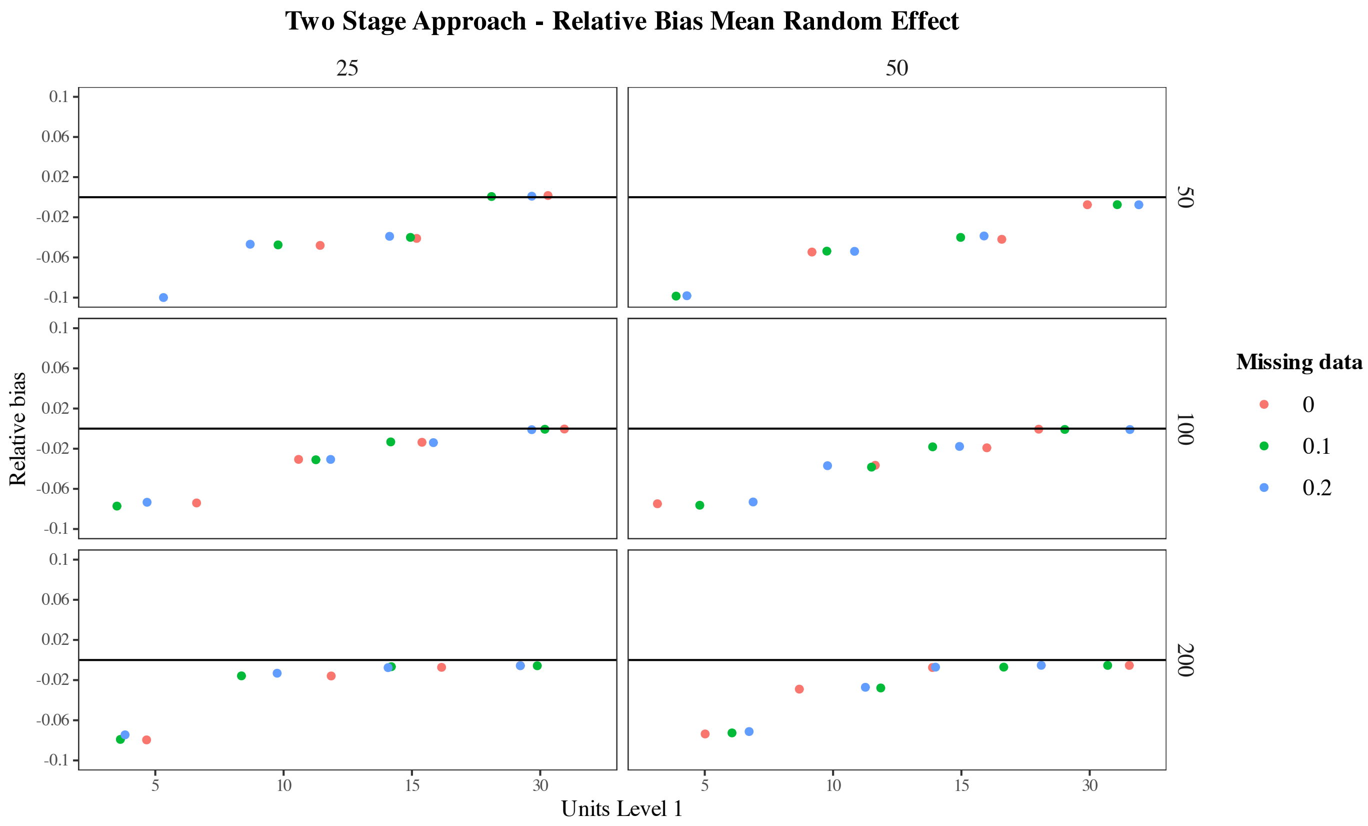
- **Convergence rate:** Output containing an error
- **Relative bias:** Average difference between the estimate and the population parameter
- **RMSE:** The average square difference between the model predicted estimates and the obtained parameter values
- **Coverage rate:** The proportion of times in which the true parameter is in the estimated 95% CI under each condition

# Results

## Comparison: Three-level MSEM and Two-Stage IPD MSEM

## Relative Bias:

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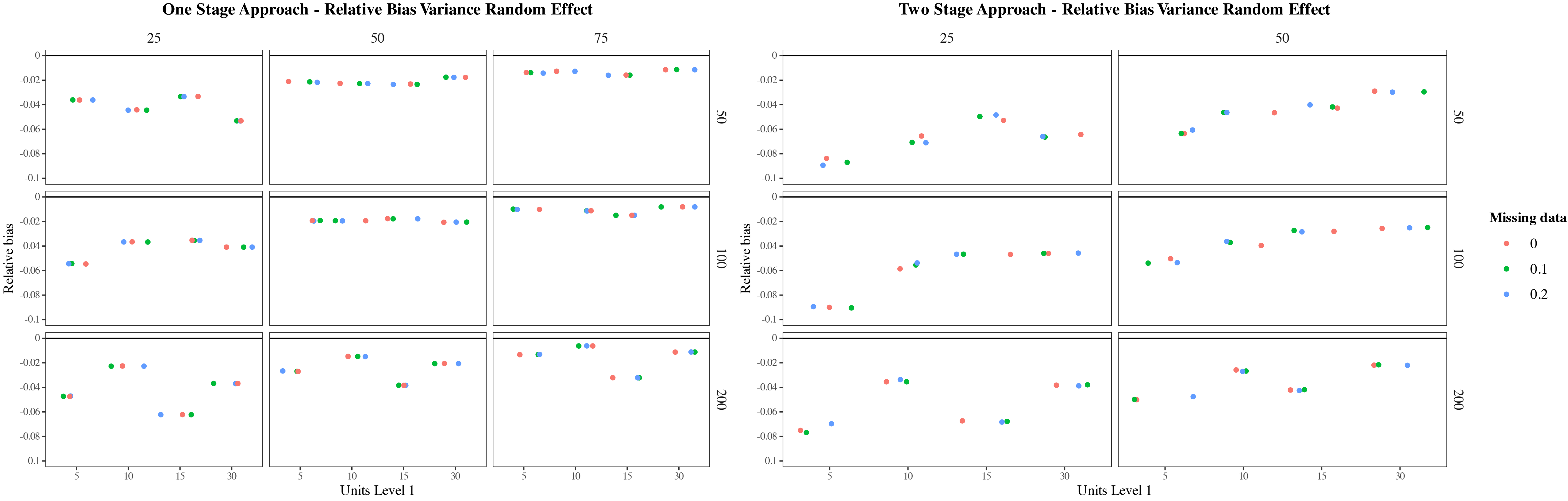
# Results
## Comparison: Three-level MSEM and Two-Stage IPD MSEM

## Relative Bias:

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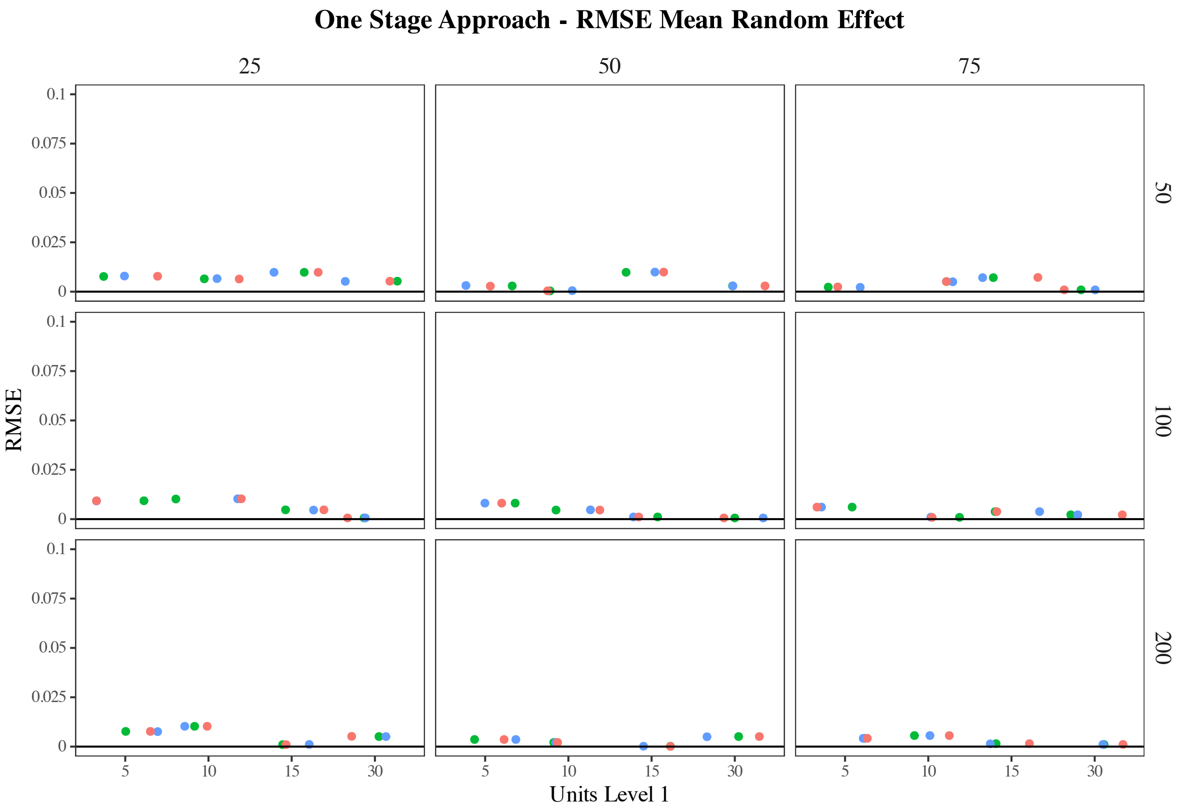
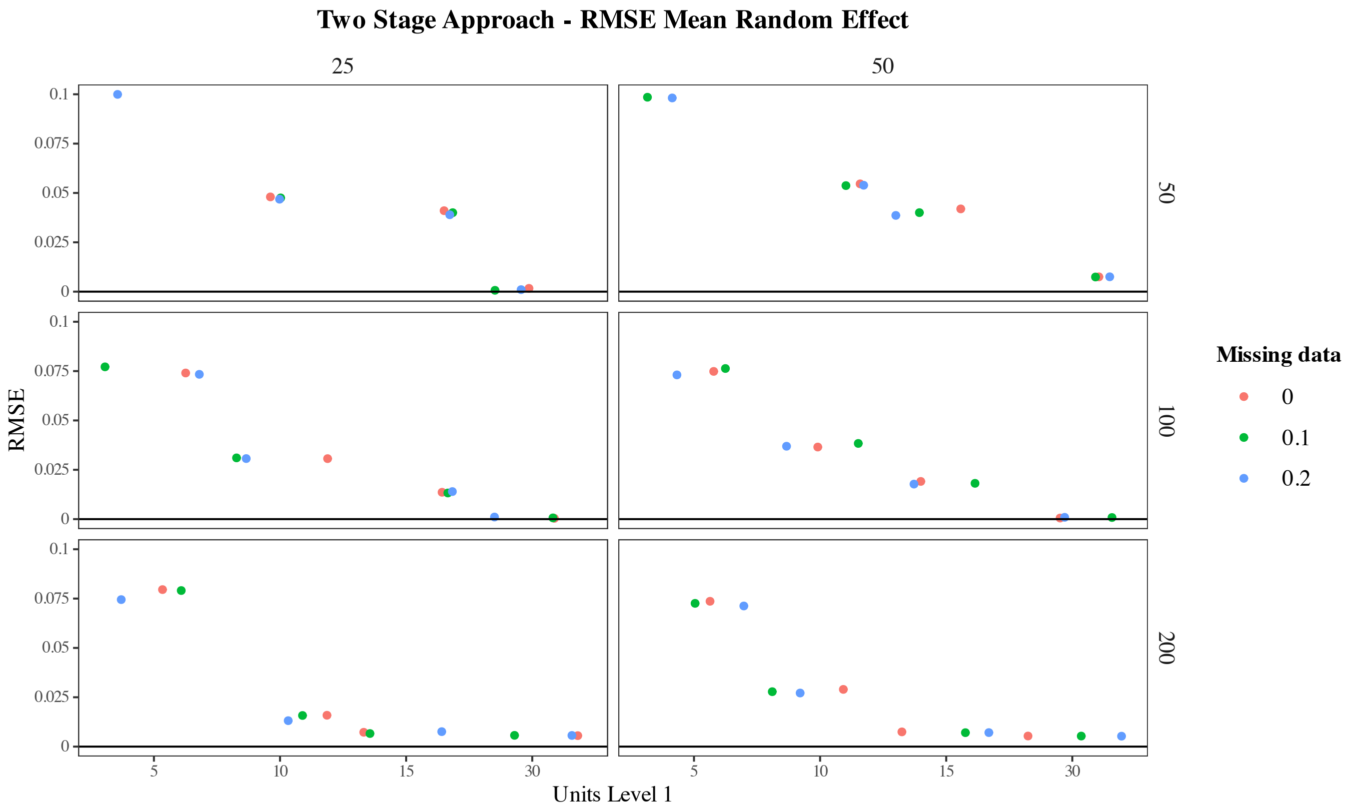
# Results

## Comparison: Three-level MSEM and Two-Stage IPD MSEM

## RMSE:

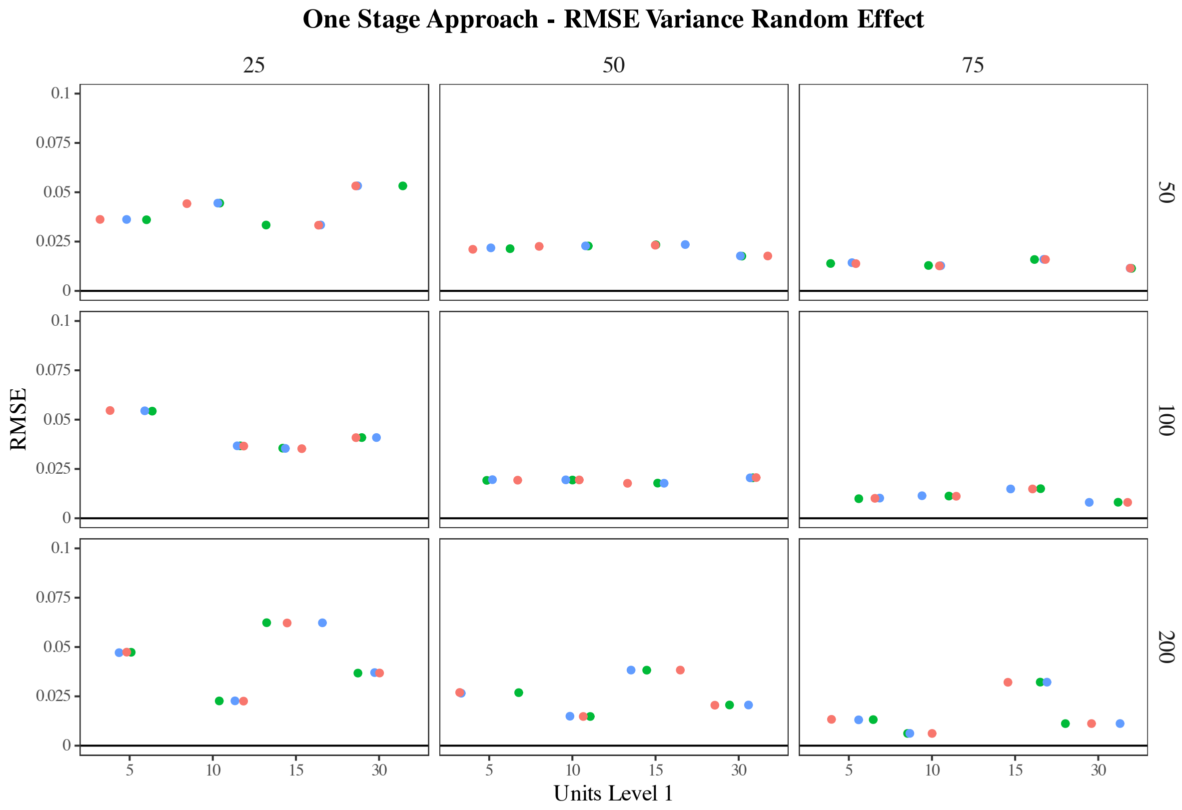


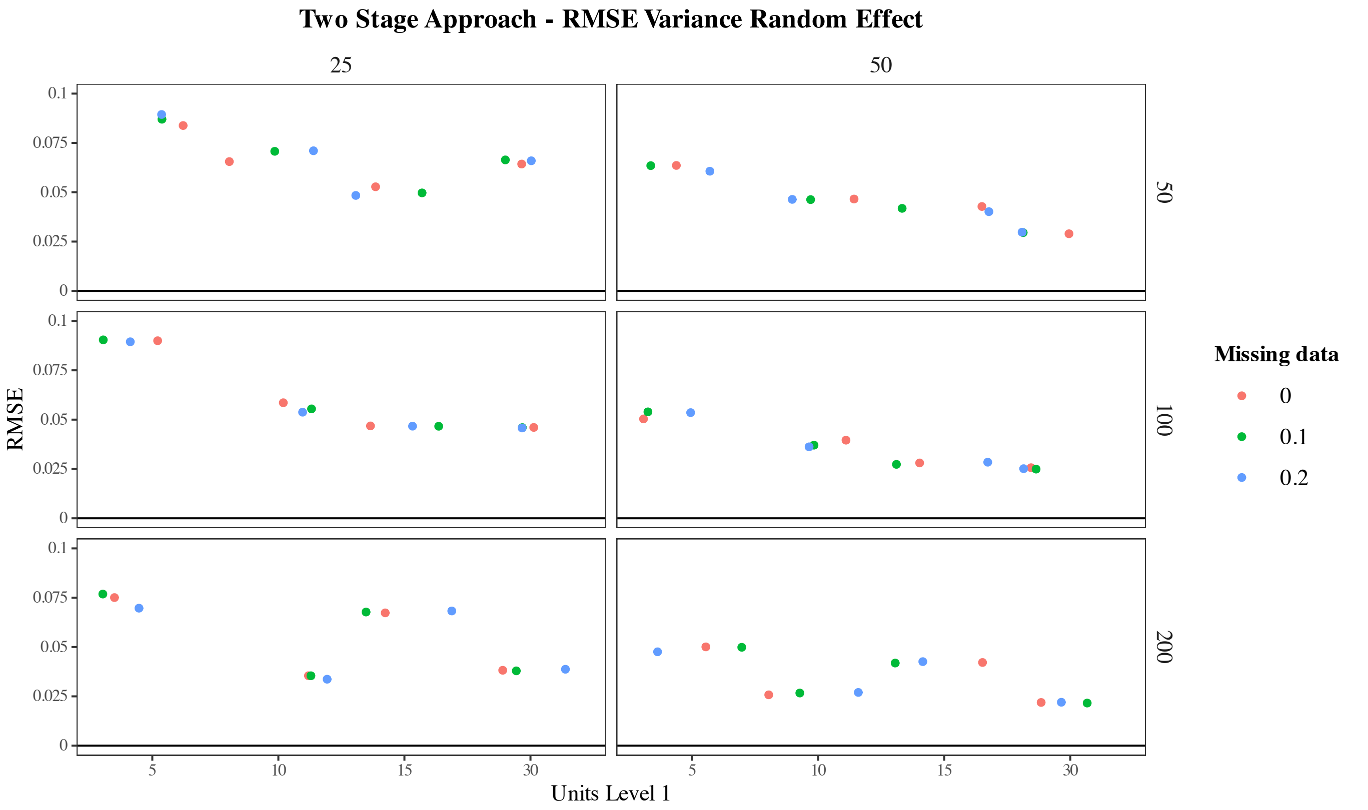



# Results

## Comparison: Three-level MSEM and Two-Stage IPD MSEM

## RMSE:

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# Conclusions

- Estimates from the one-stage and two-stage IPD approach closely resamble the estimates from the population model.
  - In the two-stage IPD approach, the higher number of L3 units the closer estimate to the population parameter.

- The two-stage IPD approach is a viable alternative for the synthesis of group effects that overcomes the convergence problems, systematic bias, and computational issues of three-level MSEM models.

- Explore whether there are conditions under which the two-stage IPD would outperform the gold standard.

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# Thank You

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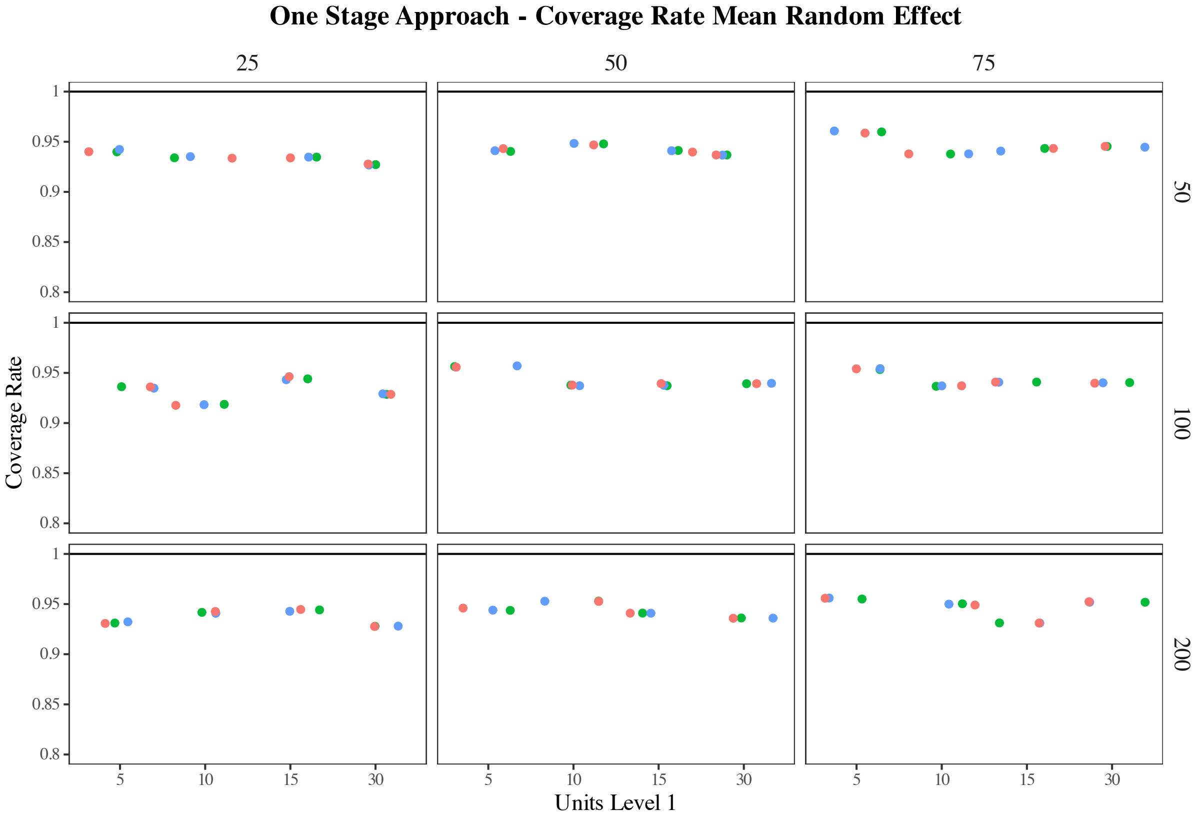
# Methodology

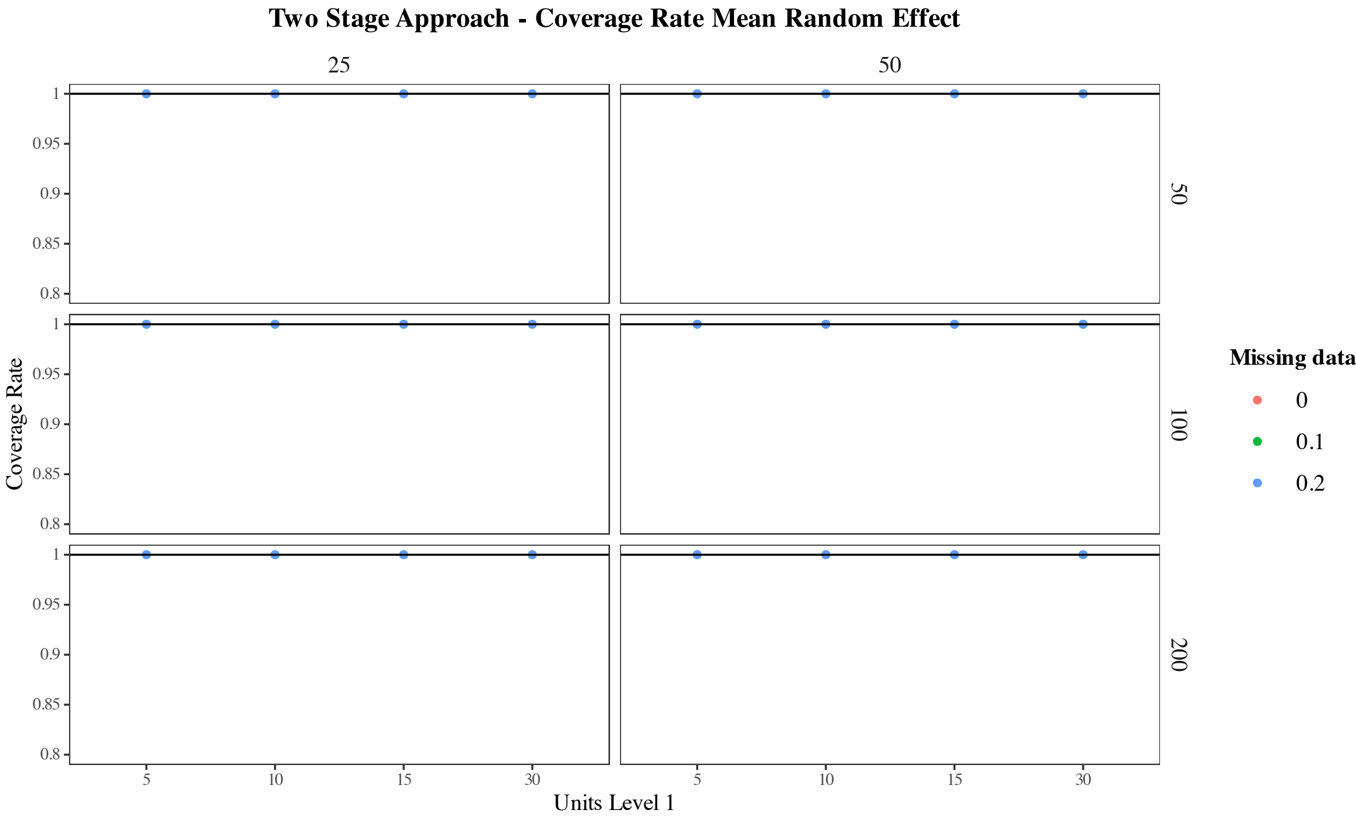
- Study 1: How close is the performance of the two-stage IPD to the gold standard?
- Study 2: Are there conditions in which the two-stage IPD would outperform the gold standard?
- Application study: Example

# Results

## Comparison: Three-level MSEM and Two-Stage IPD MSEM

## Coverage Rate:



# Results

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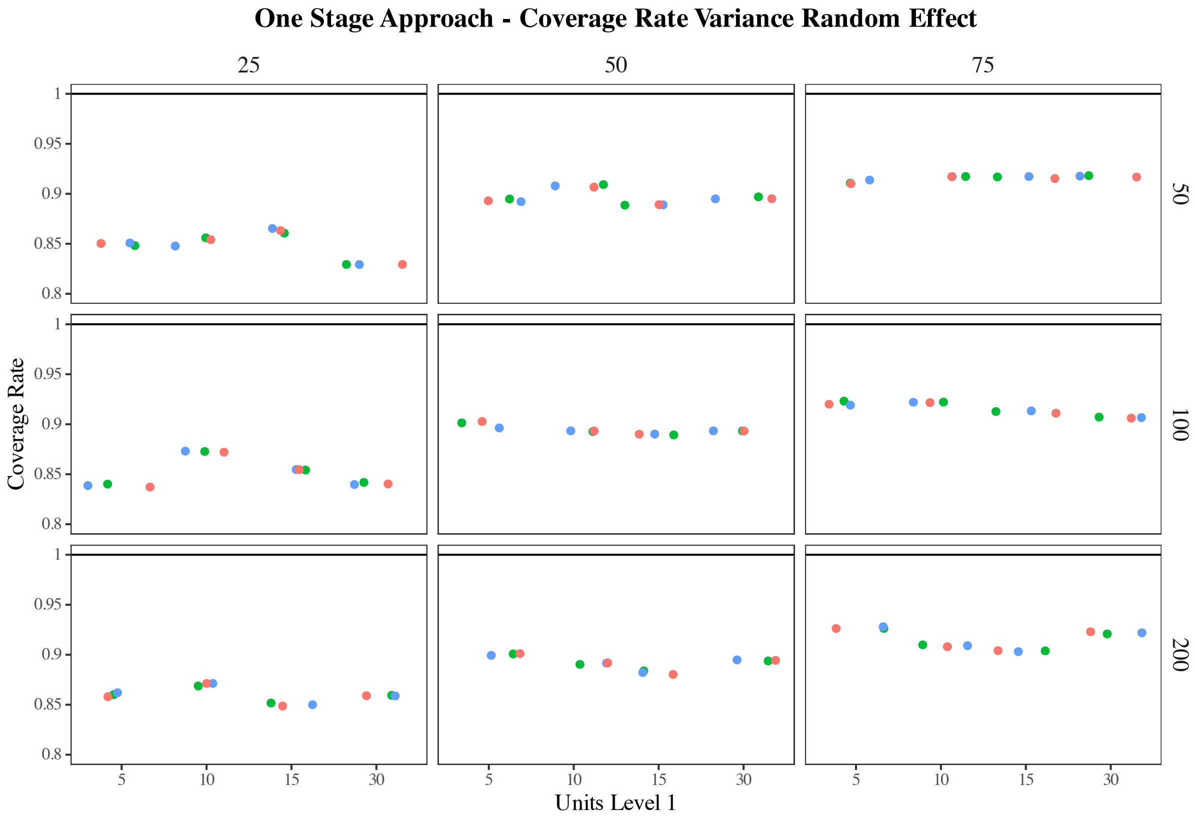


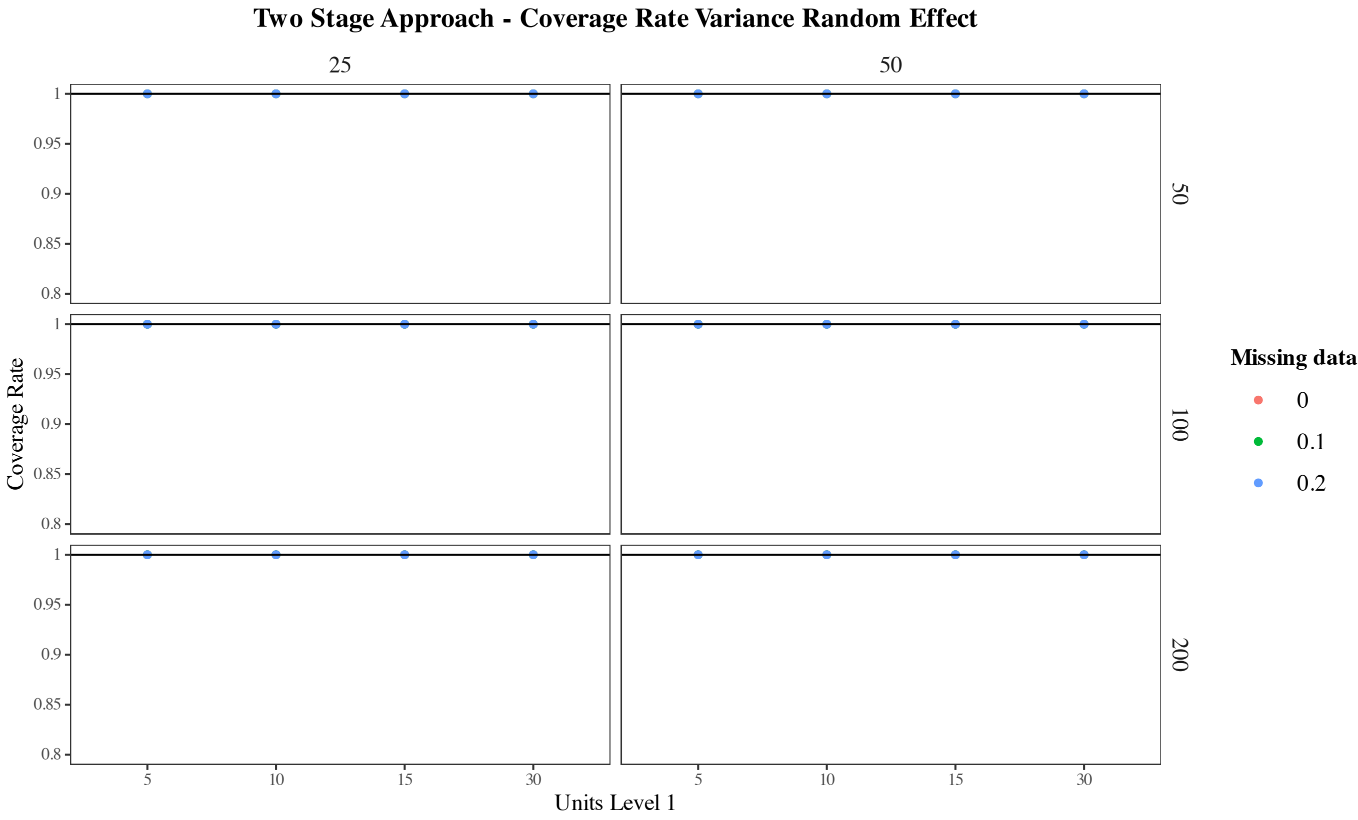


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