When to Use Synthetic Linking Functions in Small-Sample Equating

Kylie N. Gorney

University of Wisconsin-Madison

National Council on Measurement in Education (NCME)
Annual Meeting · 2021

Random Equating Error

- Whenever samples are used to estimate an equating relationship, **random equating error** is present
- Especially concerning in small-sample situations
- Minimize by using the **identity function**, which is analogous to not equating at all
  - The standard error of equating (SEE) is zero
  - Produces very biased results when test forms differ markedly in difficulty

Synthetic Linking Functions

Synthetic Linking Functions
Gorney (2021)
Background
Purpose
Method
Results & Discussion
Differences in Test Form Difficulties
Differences in Group Abillties
Conclusion
References

A **synthetic linking function** computes a weighted average of the identity function and a second equating function (Kim, von Davier, & Haberman, 2008).

$$syn_Y(x) = we_Y(x) + (1 - w)id_Y(x) \tag{1}$$

where w is a weight between 0 and 1, e is an equating function other than the identity function, and id is the identity function.

Purpose

Synthetic Linking Functions

Gorney (2021)

Background

Purpose

Method

Results & Discussion

Differences in Test Form Difficulties

Differences in Group Abillties

Conclusion

References

The purpose of this study was to identify which, if any, small-sample situations are best handled by synthetic equating.

- Treated the difference in test form difficulties as a random effect
- Treated the difference in group abilities as a random effect
- Used weights that satisfy the symmetry property of equating (Holland & Strawderman, 2011)

Data

- Simulated a 100-item test containing 30 anchor items
- Sample sizes: $N = 10, 25, 50, 100$
- 1,000 replications

Equating Design and Methods

Synthetic Linking Functions

Gorney (2021)

Background

Purpose

Method

Results & Discussion

Differences in Test Form Difficulties

Differences in Group Abillties

Conclusion

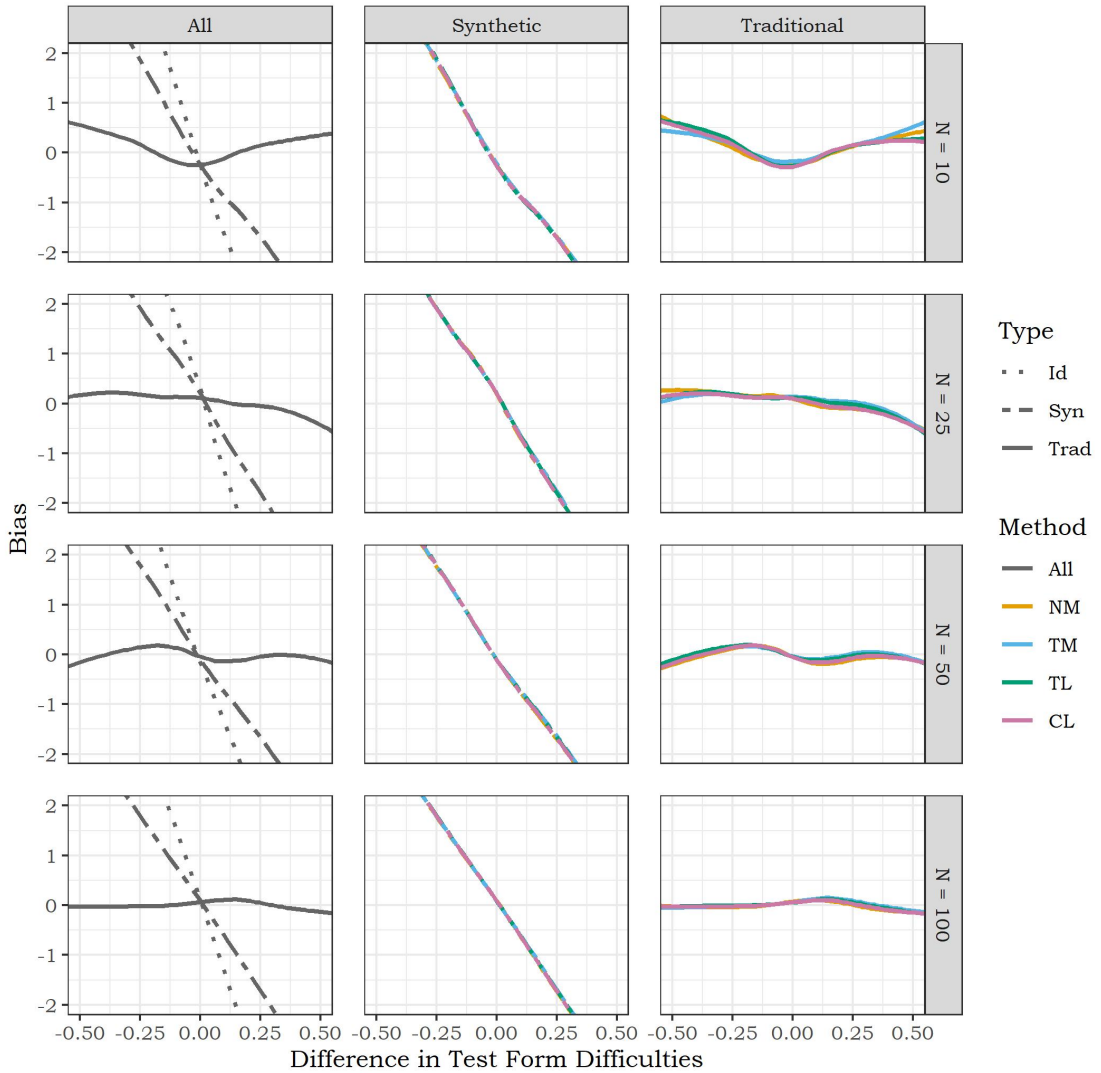
References

- Common-item nonequivalent groups design
- Equating methods
  1. Nominal weights mean (NM)
  2. Tucker mean (TM)
  3. Tucker linear (TL)
  4. Chained linear (CL)

Differences in Test Form Difficulties

Bias

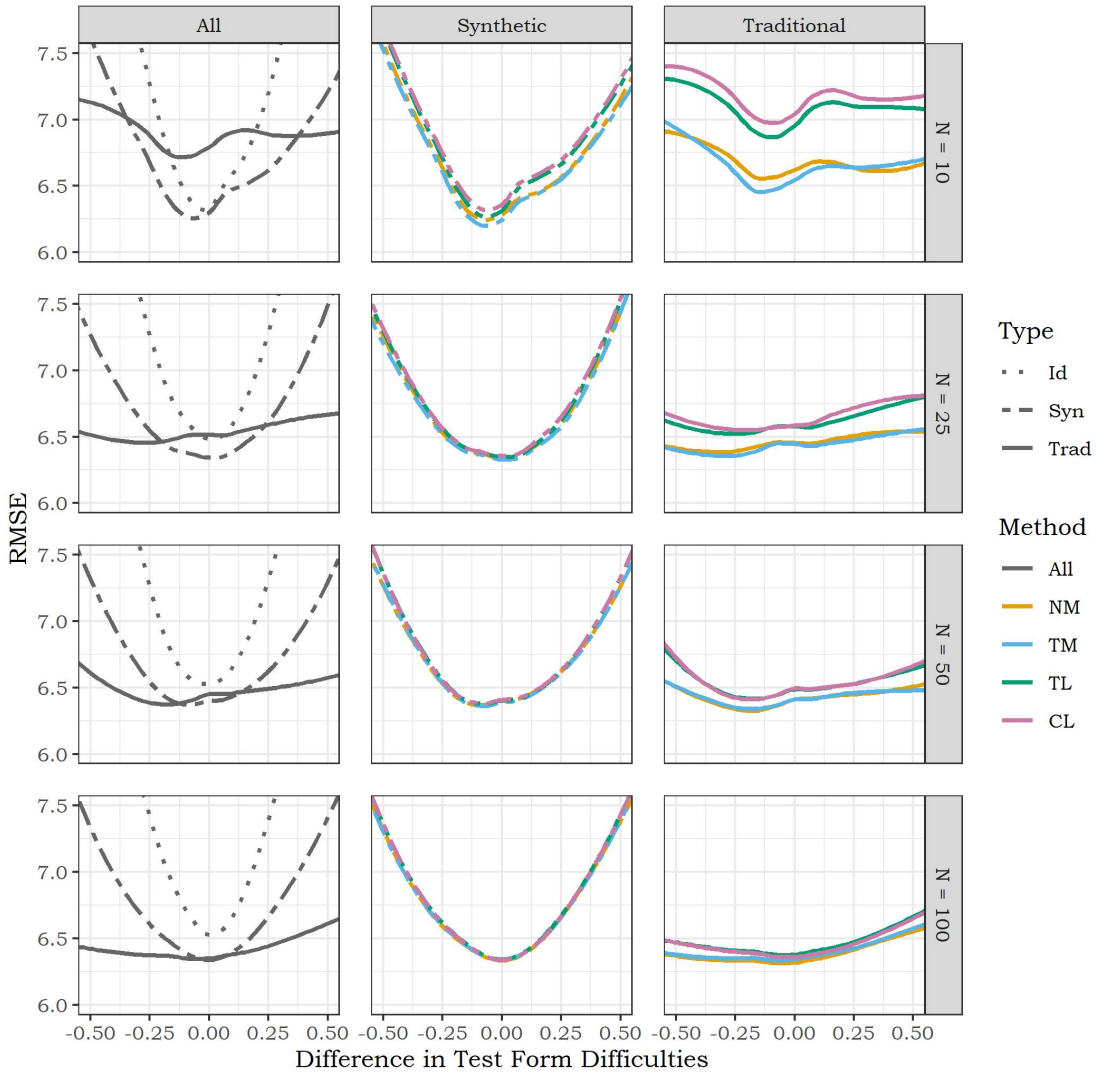
- Identity and synthetic equating were very biased when the test forms differed even slightly in difficulty
- Traditional equating displayed small amounts of bias overall



Differences in Test Form Difficulties

Root Mean Squared Error (RMSE)

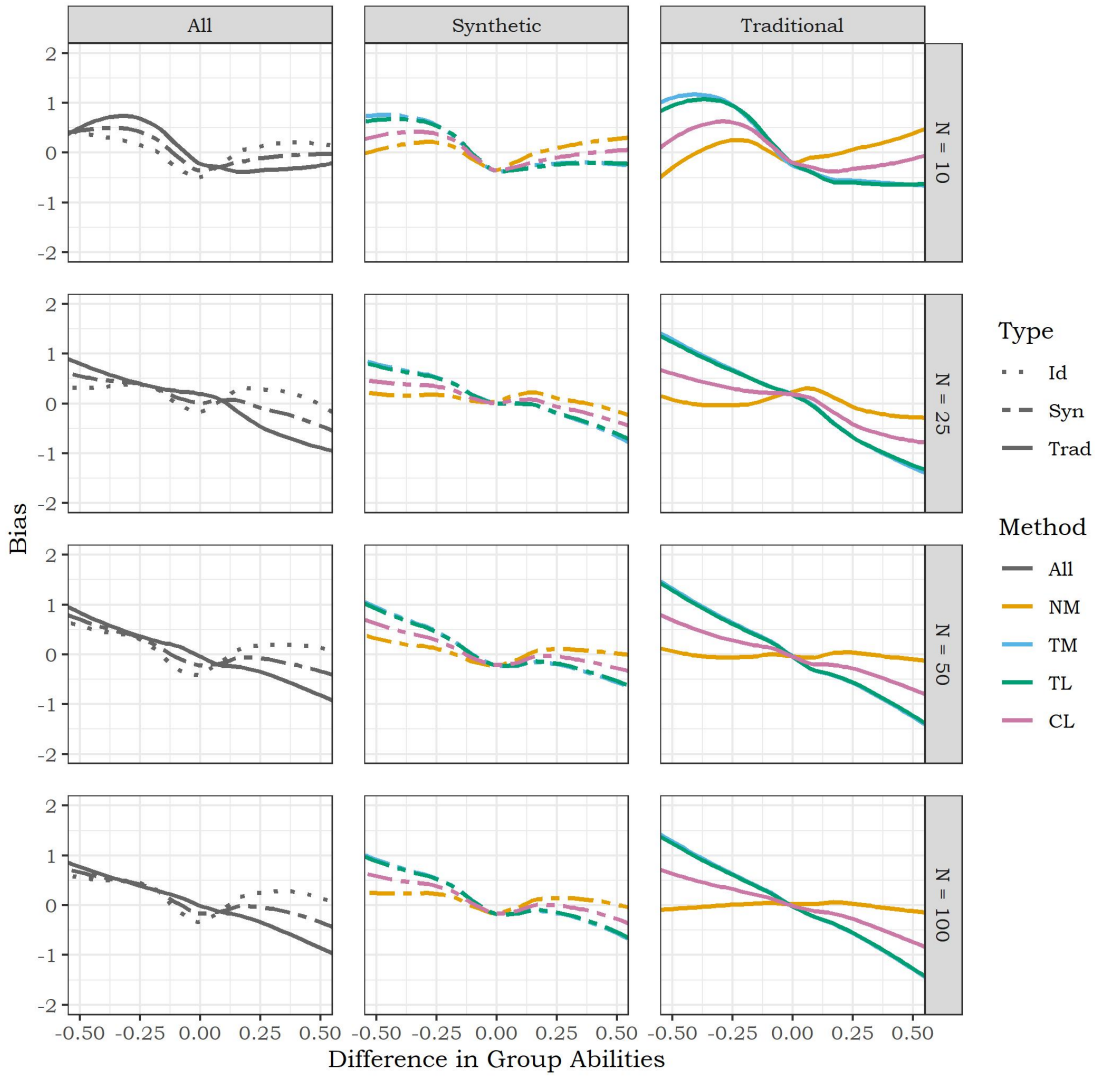
- Synthetic equating preferred when the test forms were similar in difficulty and sample sizes were small
- Traditional equating preferred in all other cases
- NM and TM equating tended to yield the lowest RMSEs



Differences in Group Abilities

Bias

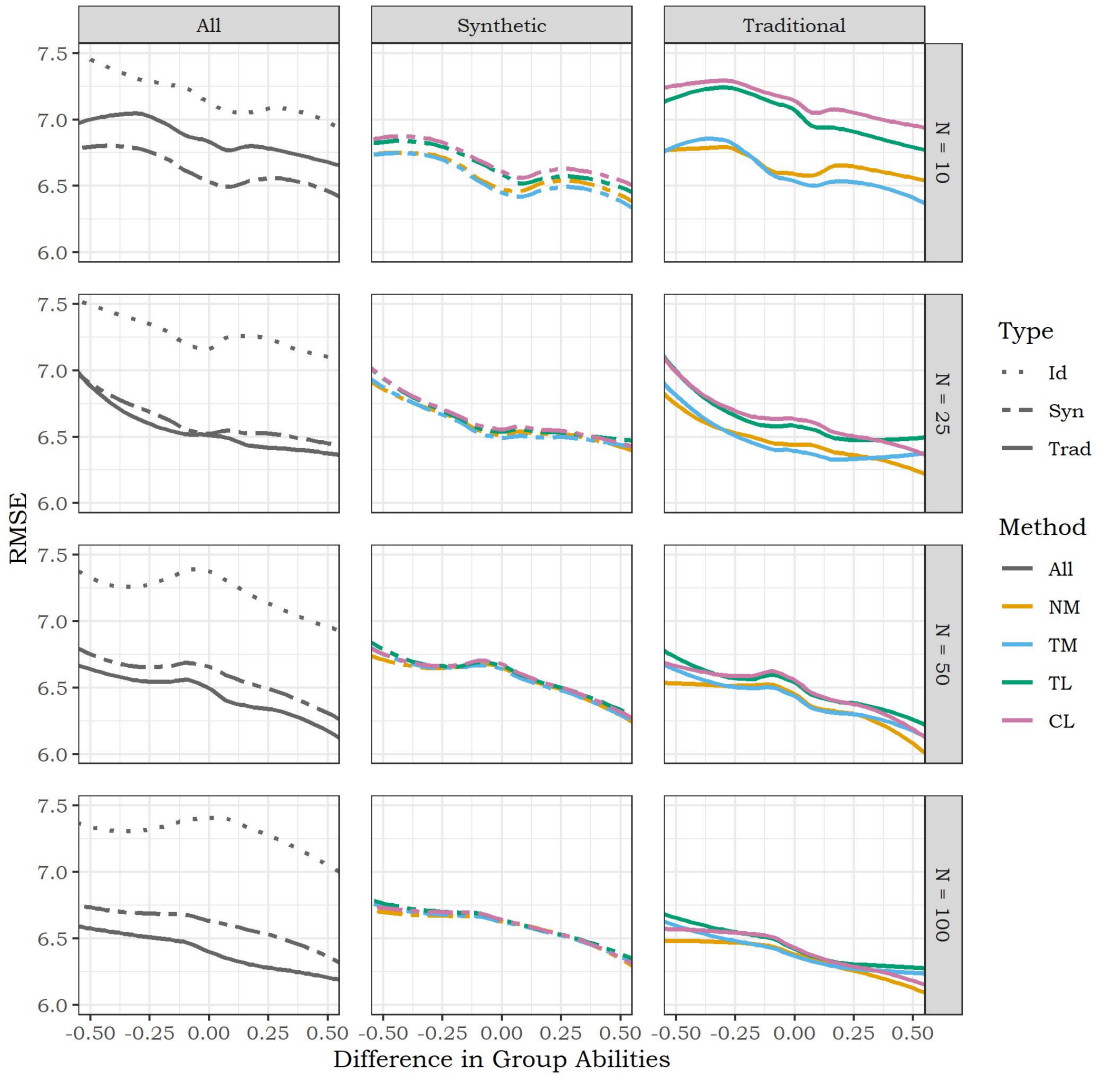
- When groups were similar in ability, all equating types yielded similar amounts of bias
- Traditional equating displayed more bias in the extreme cases
- NM equating was the least biased, on average



Differences in Group Abilities

Root Mean Squared Error (RMSE)

- Synthetic equating preferred when the sample size was 10
- Traditional equating preferred for larger sample sizes
- NM and TM equating tended to yield the lowest RMSEs



Conclusion

Synthetic Linking Functions
Gorney (2021)
Background
Purpose
Method
Results & Discussion
Differences in Test Form Difficulties
Differences in Group Abillties
Conclusion
References

- Synthetic equating may be considered when the sample size is 25 or smaller and when it is known that the test forms do not differ markedly in difficulty
- In all other cases, use traditional equating functions
- For very small samples, NM and TM equating tended to be the most effective
- Future research: different test or group characteristics, weights, and equating methods

Thank you!

Synthetic Linking Functions

Gorney (2021)

Background

Purpose

Method

Results & Discussion

Differences in Test Form Difficulties

Differences in Group Abillties

Conclusion

References

For more information, please contact kyliengorney@gmail.com.

References

Synthetic Linking Functions

Gorney (2021)

Background

Purpose

Method

Results & Discussion

Differences in Test Form Difficulties

Differences in Group Abillties

Conclusion

References

- Holland, P. W., & Strawderman, W. E. (2011). How to average equating functions, if you must. In A. A. von Davier (Ed.), *Statistical methods for test equating, scaling, and linking* (pp. 89–107). Springer. https://doi.org/10.1007/978-0-387-98138-3_6
- Kim, S., von Davier, A. A., & Haberman, S. (2008). Small-sample equating using a synthetic linking function. *Journal of Educational Measurement*, *45*(4), 325–342.