UNIVERSITAT ROVIRA I VIRGILI

How to determine the number of common factors using the Hull method

Urbano Lorenzo-Seva

Tarragona 2013

Please reference this document as:

Lorenzo-Seva, U. (2013). *How to determine the number of common factors using the Hull method. Technical Report*. Department of Psychology, Universitat Rovira i Virgili, Tarragona.

Document available at: http://psico.fcep.urv.cat/utilitats/factor/

Hull is very much like a typical scree test: it looks for an elbow in a scree graph. Please note that we represent the scree graph in an inverted position (i.e., the graph represents increasing fit values) with respect to the classical Cattle scree test. When looking for an elbow, the idea is to discard (1) the most complex solutions, and (2) the solutions that cannot be considered an "elbow"even if they are not too complex. For the first decision, Hull uses Parallel Analysis (PA): Hull looks for an elbow between 1 and the number of dimensions suggested by PA. The second decision is trickier and is based on the idea that an elbow is to some extent a salient solution. For example, in this graph:

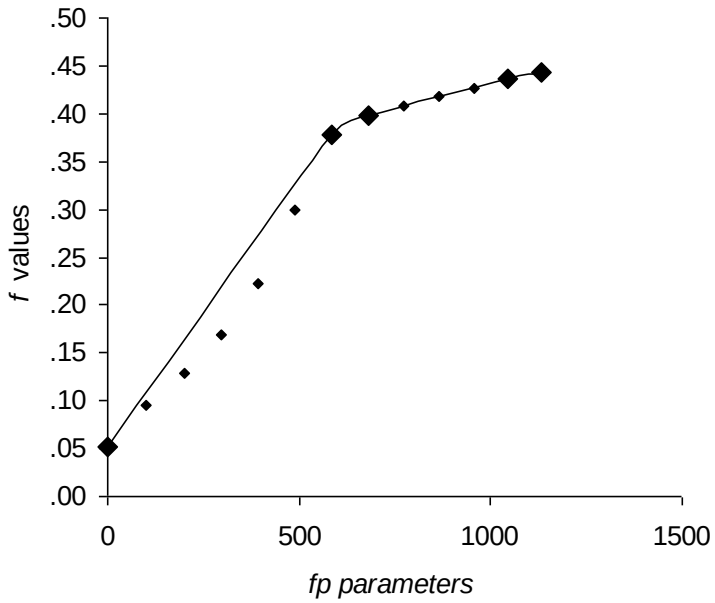

Figure 1. Graphical representation of the Hull method's outcome

an imaginary line (which must be as straight as possible) is drawn between the points that represent each solution. Note that solutions between 2 and 5 are below this imaginary straight line: in this sense, they are not at the "top of the hull" defined by this imaginary line. As they are not at the top of the hull, they cannot be an elbow, and they are immediately discarded as the possible elbow in the scree graph. When the solutions at the top of the hull have been identified, the solution that shows the best compromise between good fit and low complexity is selected as the "elbow".

As a consequence, only a few solutions are considered as "possible" elbows. The outcome in Factor reports the selected elbow, and the solutions at the top of the hull in

case the researcher wants to inspect whether any of the other solutions at the top of the hull turn out to be more advisable using substantive criteria (for example, a more interpretable rotated loading matrix).

The Hull method can be based on different goodness-of-fit indices, which yield different Hull variants. Hull-CFI (i.e., Hull based on CFI) and Hull-CAF (i.e., Hull based on KMO) were the most successful methods in our study. Hull-CFI can be applied only when ML and ULS factor extraction are used, whereas Hull-CAF can be used with any factor extraction method. The performance of the Hull variants seems to improve as the sample size increases, and the number of observed variables per factor increases. As a consequence, Hull is suitable approach when large datasets are analysed: with this kind of dataset, it outperforms such classical methods as Parallel Analysis.

For a detailed explanation of the Hull method, see Lorenzo-Seva, Timmerman, and Kiers (2011).

References

Lorenzo-Seva, U.; Timmerman, M.E.; Kiers, H. A. L. (2011). The Hull method for selecting the number of common factors. *Multivariate Behavioral Research*, *46*(*2*), 340-364. ISSN: 0027-3171.