Hi all,
About 1-2 weeks ago John conducted a small simulation study and claimed based on its results that chi square (CS) was more sensitive to deviations from the true population model than the other fit indices (OFI). I disagreed (not on the legitimacy of the study) that the claims john made were supported by the results he got. So I agreed to pursue this further and to get back to SEMNET. This is what I am doing. The first part of my agreement was to start from John's path analysis simulated data set (I posted the results some time ago). The second part was to generate another simulated data set including latent variables. I am now reporting on the second part. But I will keep this post short. Les, I will not answer any of your posts on this thread unless they are based on data.

PART 1. POPULATION MODEL
So as to make sense for applied readers, I decided to name the latent variables from my population model and use what is known about these constructs to specify a "realistic" population model.
All latent are based on 10 indicators. Many of those (between 3 and 7) have cross loadings.
I first estimated two constructs that I coined depression-somatic symptoms and depression-psychological symptoms.
I then did the same for anxiety-somatic and anxiety-psychological.
I also estimated two factors that I called neuroticism and extraversion according to the big five factor model.
Cross loadings are either .1, .2 or .3
Main loadings are either .6 or .7
Cross loadings were estimated according to theory on these variables: between the big five factors, between the somatic factors (i.e. insomnia, etc.); between the psychological factors, between the psychological factors and neuroticism (i.e. emotional instability, etc.).
I then specified a meditational path model between the latents, as well as additional paths. For the paths, what I specified does not necessarily reflect what is known about these constructs, except that personality is seen as a determinant (rather than a consequence) of psychopathologies.

<u>Input to generate this model is here:</u>

```
TITLE: Simulated data for SEM model;
MONTECARLO:
Names are n1-n10 e1-e10 ds1-ds10 dp1-dp10 as1-as10 ap1-ap10;
nobservations = 10000;
nreps = 1;
save = SEMModel.dat;
MODEL POPULATION: !population generating model
  [n1-ap10@0]; !mean centered variables
!target factor loadings
  N by n1@.7 n2-n5@.7; N BY n6-n10@.6;
  E by e1@.6 e2-e5@.6; E BY e6-e10@.7;
  DS by DS1@.7 DS2-DS5@.7; DS BY DS6-DS10@.6;
  DP by DP1@.6 DP2-DP5@.6; DP BY DP6- DP10@.7;
  AS by AS1@.7 AS2-AS5@.7; AS  BY AS6-AS10@.6;
```

```
  AP by AP1@.6 AP2- AP5@.6; AP BY AP6- AP10@.7;
  N@1;
  E@1;
  DS@1;
  DP@1;
  AP@1;
  AS@1;

!cross loadings
  N by DP2@.1; N BY DP4@.2; N BY DP8@.3;
  N by E3@.3; N BY E4@.1; N BY E6@.2;
  N BY AP4@.2; N BY AP9@.3; N BY AP10@.1;
  E by N4@.1; E BY N6@.2; E BY N8@.3;
  DP by AP9@.2; DP BY AP2@.3; DP BY AP5@.1;
  DP by N2@.2; DP BY N7@.3; DP BY N10@.1;
  DP by DS2@.2; DP BY DS7@.3; DP BY DS10@.1;
  AP by DP3@.2; AP BY DP4@.3; AP BY DP9@.1;
  AP by N2@.2; AP BY N4@.3; AP BY N10@.1;
  AP by AS3@.2; AP BY AS4@.3; AP BY AS8@.1;
  DS by AS2@.2; DS BY AS4@.1; DS BY AS7@.3;
  DS BY DP2@.3; DS BY DP5@.2; DS BY DP10@.1;
  AS by DS2@.1; AS BY DS3@.3; AS BY DS8@.2;
  AS BY AP4@.1; AS BY AP5@.2; AS BY AP8@.3;
!Item Residual Variances
  n1-n4@.50;   n5-n8@.54;   n9-n10@.60;
  e1-e4@.59;   e5-e8@.53;   e9-e10@.48;
  dp1-dp4@.45;   dp5-dp8@.52;   dp9-dp10@.61;
  ds1-ds4@.53;   ds5-ds8@.49;   ds9-ds10@.38;
  as1-as4@.49;   as5-as8@.51;   as9-as10@.43;
  ap1-ap4@.60;   ap5-ap8@.57;   ap9-ap10@.39;
!Path model
  DS ON DP@.44 AS@.38;
  DP ON AP@.35 N@.42;
  AS ON N@.41;
  AP ON AS@.38 E@-.2 N@.33;
  E WITH N@.5;
```

When this full model is estimated, the fit is perfect:
Chi-Square Value 1633.031 (df = 1659) P-Value 0.6707
CFI 1.000 / TLI 1.000/ RMSEA 0.000/ SRMR 0.007

When this model is estimated as a CFA (without the paths, replaced by correlations) with cross loadings, the fit is again perfect.
Chi-Square Test of Model Fit 1631.176 (df 1653) P-Value 0.6442
RMSEA 0.000/ CFI 1.000/ TLI 1.000 / SRMR 0.006

When a simple CFA model without cross loadings is estimated, the fit is suboptimal according to the chi square, CFI, TLI). Some would interpret it as adequate however based only on fit indices (and the cross loadings are small after all). But with that many cross loadings, I would have expected the CFI and TLI to be higher than .95.
Chi-Square Test of Model Fit 23342.542 (df 1695) P-Value 0.0000
RMSEA 0.036 / CFI 0.940 /TLI 0.937/ SRMR 0.051
Anyway, when an ESEM model is estimated, the fit is again perfect.

Chi-Square Test of Model Fit 1392.689 (1425) P-Value 0.7249
RMSEA 0.000 / CFI 1.000/ TLI 1.000 / SRMR 0.004

This model includes many non significant cross loadings that could then be taken out but does a better job a recovering the factor correlations. This clearly confirms suggestions made by many that EFA models should be estimate as a first step or systematically compared to CFAs (see the Marsh papers on ESEM). Now, with ESEM, fit indices are available for EFA solutions. Following these suggestions would have ensured that anyone would have end up on the correct model, even without the chi square. Alternatively, HERE, one could argue that by strictly following the chi square one would have seen that the CFA model was misspecified. BUT, didn't the chi square react perhaps too strongly to the presence of some small cross loadings?

PART 2: Some repetitions:

Now, going back to my preceding post on path models let me repeat part of it here: "*With real life data, we never have access to the full set of variables involved in explaining the reality we are studying. […] my alternative proposal was that if we picked up a subsample of variables from a simulated data set, this would be highly similar to what we do with real life data. With real life data, our objective is to come up with the closest possible approximation of the reality on the basis of the variables available in our data set. So, a good indicator of model fit should say that this "best approximation" does provide a good fit to the data.*"

The same argument applies to the psychometric measurement model.

The domain sampling model inherent in the development of psychometric measures specifies that the items will be drawn from a larger "universe" of possible indicators of constructs. So it is directly built in the psychometric theory that we will never have all possible indicators of the constructs.

So let's suppose the population model estimated previously represent the WORLDLY TRUTH about the question we are investigating (we are probably working on a very simple phenomenon, but at least here we can play god with access to the true population model) and also reflect the UNIVERSE of possible indicators for the constructs (or you can rather assume that the 10 items reflect the results for the long forms of the instruments from which short forms can be built).

Let's now suppose that we are dealing with a study in which we are measuring only depression and anxiety (2 factors each) and that we are using only the items 1 to 5 from each construct. Lets assume that the only objective of this study is to validate the instrument. So this is only a CFA study. We ALL know that depression, anxiety, etc. are determined by many factors. But here, we are working with a SIMPLE CFA study.

SO, from the population generating parameters, the best approximation would be:

```
    DS by DS1* DS2-DS5
          AS2 AS4  DP2 DP5  ;
    DP by DP1* DP2-DP5
        AP2 AP5     DS2 ;
    AS by AS1* AS2-AS5
          DS2 DS3 AP4 AP5 ;
```

```
    AP by AP1* AP2-AP5
        DP3  DP4   AS3  AS4  ;
```

DS@1;
DP@1;
AP@1;
AS@1

When I estimate this model:

Chi-Square Test of Model Fit 258.249 (DF = 149) P-Value 0.0000
RMSEA 0.009
CFI 0.999
TLI 0.999
SRMR 0.008

RMSEA, CFI, TLI, SRMR all say that the model fit well. Chi square is HIGHLY significant.

This is what many of us have been saying repeatedly: CS is often significant RIGHT from the start, right at the level of the measurement model. So this is why we don’t rely only on it when paths are added on top of the measurement model.

I think I will stop here… For those who want more: Feel free to use the first input I posted. This will generate you a similar data set.

ALEX