Chapter 20: CFA II: Invariance & Latent Means

Evaluating Invariance via McDonald's NCI

In this chapter I recommended using change in CFI (ΔCFI smaller than -.01) to test for measurement invariance in CFA models. A colleague has since pointed out to me a study (Kang, McNeish, & Hancock, 2016) that showed that ΔCFI can vary considerably when measurement quality is low (as shown by low factor loadings of items on factors). This condition likely does not apply to the example in this chapter, given the generally high level of the factor loadings, but it likely does apply to many other invariance analyses.

The article also showed that change in McDonald's noncentrality index (ΔMNCI) performing much better for assessing measurement invariance. "Results show that ΔMcDonald's NCI is minimally affected by loading magnitude and sample size when testing invariance in the measurement model…" (p. 533). The authors suggested it could also be used to assess structural invariance, what I refer to in the text as testing substantive research questions about the nature of the constructs across groups. Kang and colleagues suggested that this use of ΔMNCI needs additional research, however. A difference of -.01 suggests a lack of invariance when going from one step of invariance testing to the next.

MNCI is calculated as $m_k = \exp[-(l/2)(v_k - q_k)/n]$ (McDonald & Marsh, 1990), or $= \exp[-(l/2)(\chi^2 - df)/n]$. The MNCI is a transformation of the population noncentrality index, often symbolized as F*, transformed so it will be within the range of 0 to 1. You can calculate F* (and MNCI) from the χ^2, *df,* and *N.*

A revised version of Table 20.2 from page 480 is shown on the next page. I've added to it a column for MNCI and ΔMNCI, as well as a column for ΔCFI. Using the ΔMNCI, all levels of measurement invariance were supported except for the invariance of subtest residuals (step 4). Structural invariance was also supported for factor variances and covariances, but not for means (as was the case when we used $\Delta\chi^2$ to make this judgement).

I have seen the MNCI referred to as the McDonald *centrality* (as opposed to noncentrality) index, and indeed the McDonald & Marsh publication refers to it as "McDonald's measure of centrality" (p. 249), but I think it is most commonly referred to as McDonald's noncentrality index.

References

Kang, Y., McNeish, D. M., & Hancock, G. R. (2016). The role of measurement quality on practical guidelines for assessing measurement and structural invariance. *Educational and Psychological Measurement, 76*(4), 533-561. doi: 10.1177/0013164415603764

McDonald, R. P., & Marsh, H. W. (1990). Choosing a multivariate model: Noncentrality and goodness of fit. *Psychological Bulletin, 107*, 247-255.

I am grateful to Matt Reynolds for sharing the Kang et al., 2016 article with me, and to Chris Niileksela for sharing a excel sheet with me for calculating NMCI.

Revised Table 20.2

Model	χ^2	*df*	$\Delta\chi^2$	Δ*df*	*p*	RMSEA	RMSEA*	SRMR	CFI	ΔCFI	AIC	MNCI	ΔMNCI
1. Configural	161.282	136				.025	.035	.047	.988		365.282	.959	
1a. Male	83.047	68				.039	.039	.047	.987		185.047	.975	
1b. Female	78.234	68				.031	.031	.043	.990		180.234	.983	
2. Metric	172.236	147	10.954	11	.447	.024	.034	.051	.988	.000	354.236	.959	.000
3. Intercept (means vary)	181.305	157	9.069	10	.526	.023	.033	.051	.989	.002	343.305	.960	.001
4. Subtest residuals	204.322	173	23.017	16	.113	.025	.035	.050	.986	-.004	334.322	.949	-.011
5. Factor variances	208.217	177	3.895	4	.420	.024	.034	.056	.986		330.217	.949	.000
6. Factor covariances	214.034	183	5.817	6	.444	.024	.034	.055	.986		324.034	.950	.000
7. Factor means	243.743	187	29.709	4	.000	.032	.045	.057	.974		345.743	.910	-.040
7a. Gc means equal	214.347	184	0.313	1	.576	.024	.034	.055	.986		322.347	.951	
7b. Gv means equal	220.222	184	6.188	1	.013	.026	.037	.055	.983		328.222	.941	
7c. Glr means equal	218.091	184	4.057	1	.044	.025	.035	.055	.984		326.091	.945	
7d. Gsm means equal	217.654	184	3.62	1	.057	.025	.035	.056	.985		325.658	.945	
7e. Gc and Gsm means equal	221.081	185	7.047	2	.029	.026	.037	.056	.984		327.081	.942	