Problems and Solutions with Many Indicators and Latent Variables in CFA-SEM Models An Empirical Study of Marketing Research Effectiveness in the Enterprises Piotr Tarka, Poznan University of Economics and Business

Introduction

The problems that appear in practice of measurement (CFA) and structural equation modeling (SEM) pertain to exceeding:

- * number of indicators per factor,
- * number of parameters per factor and in model
- * number of latent variables in CFA-SEM models.

Large number of indicators cause also problems associated with:

the strength of association between the indicators and latent variables (Bandalos, 1997; Boomsma, 1982; Gerbing & Anderson, 1985; MacCallum et al., 1999; Velicer & Fava, 1998) - the degree of multivariate normality of latent variables (Anderson, 1996; West, Finch, & Curran, 1995)

- the estimation method (Fan, Thompson, & Wang, &Wang, 1998; Tanaka, Fan 1999; 1987)

Method

PROPOSED SOLUTION:

In the present study, in order to obtain satisfying solution in the model fit and parameter estimates, author reduced a number of indicators for each latent variable by adding particular indicators in data set.

The other alternatives: index reliability, parceling strategy, submodels (Kenny & McCoach, 2003).

SUBJECT OF EMPIRICAL STUDY:

The author's research objective was to diagnose the relationships between two general conditions (organizational and methodological determinants) which affect the level of the marketing research effectiveness in the enterprises.

DATA:

Survey (through the two social networking sites: LinkedIn and Golden Line) was conducted, with a direct link to the online questionnaire which was sent via personal emails. *Empirical research*: March 1 - August 31 in 2014 in Poland Sample structure:

- Marketing Directors (45%), Product Managers (27%), Managing Directors, CEO (20%), Marketing Executives (8%) in the Enterprises.

- Employment levels: less than 15 (9%), 16-99 (17%),

- Employment levels: less than 15 (9%), 16-99 (17%), 100-249 (16%), 250-490 (8%), above 499 (50%).

MEASURES:

Latent variables were operationalized by items which were expressed in the form of statements, and measured on Likert 7-point scale.

CFA-SEM MODEL STRUCTURE

F_1 - General factor - **organizational determinants**: Factor 1: Decision makers' personal attitudes to marketing research and its results (items: 111, 112, 113) Factor 2: Benefits of wide communication in structural organization on the basis of marketing research (items: 122, 131, 132, 134)

Factor 3 - Informational culture and firm' identity derived from marketing research (items: 133, 141, 142).

F_2AF_2 - General factor - **methodological determinants**:

Factor 4: Orientation on models, methods and techniques resulting from scientific norms (items: 211, 212) Factor 5: Methodological pragmatism during the ongoing *marketing research* (items: 213, 214) Factor 6: Proper conditions of defining the research problem (items: 221, 222, 224)

Factor 7: Predisposition of researchers to identify important research questions and articulate decision makers' *information needs* (items: 223, 225)

METHOD OF ESTIMATION: ML

	SECOND-ORDER CFA MODEL				SECOND-ORDER CFA MODEL				CFA MODEL (SINGLE INDEX METHOD)				CFA MODEL (SINGLE INDEX METHOD)				SEM MODEL (HIERARCHY)				SEM MODEL (SINGLE INDEX METHOD)			
	(LATENT VARIABLE – F1)			(LATENT VARIABLE – F2_A)				(LATENT VARIABLE – F1)				(LATENT VARIABLE – F2A)				(LATENT VARIABLES – F1 on F2A)				(LATENT VARIABLES – F1 on F2A)				
SAMPLE	347	694	1388	2776	347	694	1388	2776	347	694	1388	2776	347	694	1388	2776	347	694	1388	2776	347	694	1388	2776
PARAMETERS	23				22				5				Q			46				16				
DF	32			23				1				1				144				12				
	245.27	491.26	983.22	1967.15	246.01	492.74	986.20	1973.10	2 67	5 36	10.72	21 45	2 39	4 78	9.57	19.16	1620.07	3244.82	6494.31	12993.31	106.77	213.85	428.01	856.32
χ (p)	p = .00	p = .00	p = .00	p = .00	p = .00	p = .00	p = .00	$\rho = .00$	n = 10	n = 02	n = 00	n = 00	n = 12	n = 03	n = 00	n = 00	<i>p</i> = .00	<i>p</i> = .00	<i>p</i> = .00	<i>p</i> = .00	<i>p</i> = .00	<i>p</i> = .00	<i>p</i> = .00	<i>p</i> = .00
γ / DF	7 66	15 35	30.73	61 47	10 70	21 42	<u>47 88</u>	85 79	267	5 26	p = .00	p = .00	p = .12	$\frac{p}{1.79}$	ρ = .00 0 57	p = .00	11.25	22.53	45.10	90.23	8.90	17.82	35.67	71.36
	1.00	11	15	1	10.70	21.72	17	05.75	2.07	J.50	10.72	21.45	2.59	4.70	9.57	19.10	.17	.18	.18	.18	.15	.16	.16	.16
RIVISEA	.14 .14 .15 .15				.1/				.07 .08 .08 .09			.06 .07 .08 .08			.40				.14					
RMR	.23			.26				.11				.04				.70				.92				
GFI	.87			.87				.99				.99				60				80				
AGFI	.77			.74				.97				.96				.00								
NFI	.77				.75			.99				.98				.49			10.					
CEL	79	78	77	77	77	76	75	75			99				99		.51	.50	.4	.9	.83	.82		.81
				.,, .,, .,, .,, .,, .,, .,, .,, .,, .,,							.55				.41				.46					
				.40				.55				.10				.42				.47				
PCFI	.55		1	.49 .48		.48			.33			.16				1712.07	3336.82	6586.31	13085.31	138.77	245.85	460.01	888.32	
AIC	291.27	537.26	1029.22	2013.15	290.01	536.74	1030.20	2017.10	12.67	15.36	20.72	31.45	20.39	22.78	27.57	37.16	1889.14	3545.77	6827.15	13358.03	200.36	318.53	543.78	983.18
BIC	379.81	641.73	1149.64	2149.51	374.40	636.68	1145.38	2147.54	31.92	38.07	46.90	61.09	55.03	63.67	74.70	90.52	2016 Modern Modeling Methods Conference (Storrs CT)							



Results

Figure 1 SEM path diagram for the Marketing Research Effectivenes model - complex solution



- simplified solution single index strategy with parameter estimates



of constructed CFA-SEM "meta" Most models in a number of important modern applications (as social sciences research) due to high complexity level of the researched phenomena, are overloaded variables simultaneously and with parameters.

In consequence they generate: *problems with models identification *unacceptable levels of model fit *misleading values of the parameter estimates and standard errors, *unreliable and invalid research results.

An appropriate solution to prevent such problems comes along with strategies such as: single index, index reliability, parceling and construction of submodels.

Contact: piotr.tarka@ue.poznan.pl

plified solutions

2010 Modern Modering Methods Comerence (Storrs, CT)