Georg Quaas (Leipzig)

Measurement Models of Power – the Way down from Bad to Worse.

Basic Data: Correlates of War Project, National Material Capabilities, Version 3.02; Starting point for the following analyses is the following

Correlation Matrix, Whole Period, All States:

Correlations

		IRST	ENERGY	MILEX	MILPER	TPOP	UPOP	CINC
IRST	Pearson Correlation	1	.864(**)	.704(**)	.518(**)	.419(**)	.735(**)	.447(**)
	Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000
	N	13020	13020	13020	13020	13020	13020	13020
ENERGY	Pearson Correlation	.864(**)	1	.863(**)	.507(**)	.418(**)	.662(**)	.471(**)
	Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000
	N	13020	13020	13020	13020	13020	13020	13020
MILEX	Pearson Correlation	.704(**)	.863(**)	1	.418(**)	.266(**)	.493(**)	.293(**)
	Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000
	N	13020	13020	13020	13020	13020	13020	13020
MILPER	Pearson Correlation	.518(**)	.507(**)	.418(**)	1	.579(**)	.571(**)	.546(**)
	Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000
	N	13020	13020	13020	13020	13020	13020	13020
TPOP	Pearson Correlation	.419(**)	.418(**)	.266(**)	.579(**)	1	.809(**)	.437(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000
	N	13020	13020	13020	13020	13020	13020	13020
UPOP	Pearson Correlation	.735(**)	.662(**)	.493(**)	.571(**)	.809(**)	1	.399(**)
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000
	N	13020	13020	13020	13020	13020	13020	13020
CINC	Pearson Correlation	.447(**)	.471(**)	.293(**)	.546(**)	.437(**)	.399(**)	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.
	N	13020	13020	13020	13020	13020	13020	13020

** Correlation is significant at the 0.01 level (2-tailed).

First, I made a

Principal Component Analysis:

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.976	66.270	66.270	3.976	66.270	66.270
2	1.065	17.751	84.020	1.065	17.751	84.020
3	.500	8.340	92.360			
4	.287	4.789	97.149			
5	.103	1.719	98.868			
6	.068	1.132	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix(a)

	Component	
	1	2
IRST	.886	-.248
ENERGY	.899	-.365
MILEX	.779	-.514
MILPER	.721	.315
TPOP	.699	.640
UPOP	.876	.312

Extraction Method: Principal Component Analysis.
a 2 components extracted.

The PCA yields the following rotated parameter values:

Rotated Component Matrix(a)

	Component	
	1	2
IRST	.826	.404
ENERGY	.914	.326
MILEX	.924	.135
MILPER	.328	.715
TPOP	.096	.943
UPOP	.446	.816

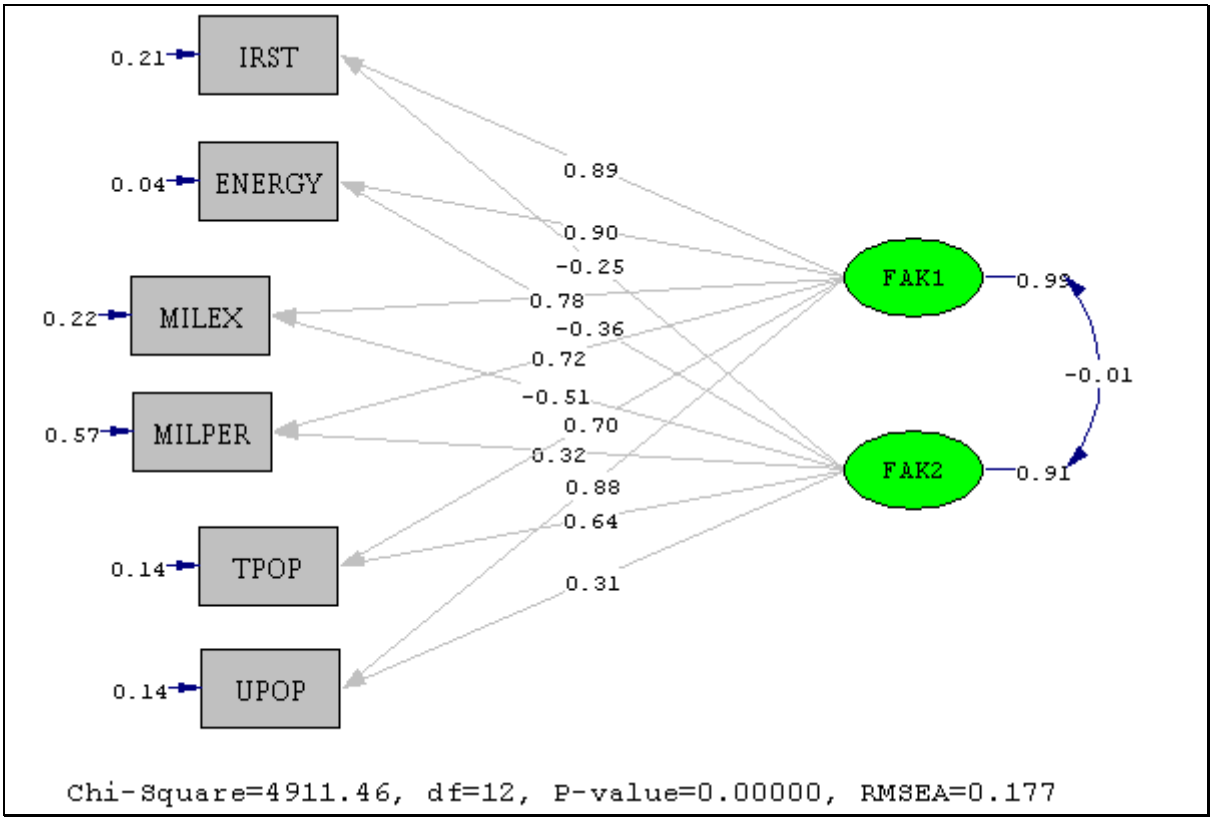
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 3 iterations.

Next, I carried out 7 tests to determine the fit of the following measurement models of "power" – interpreted as the communality of the NMC-indicators:

1. PCA-Results, Congeneric model
2. Varimax-Results, Congeneric model
3. Confirmatory Factor Analysis, 3 Factors
4. Second-order Factor Analysis
5. Confirmatory Factor Analysis, 1 Factor
6. A Regression of the Indicators on CINC
7. Regression on CINC_W

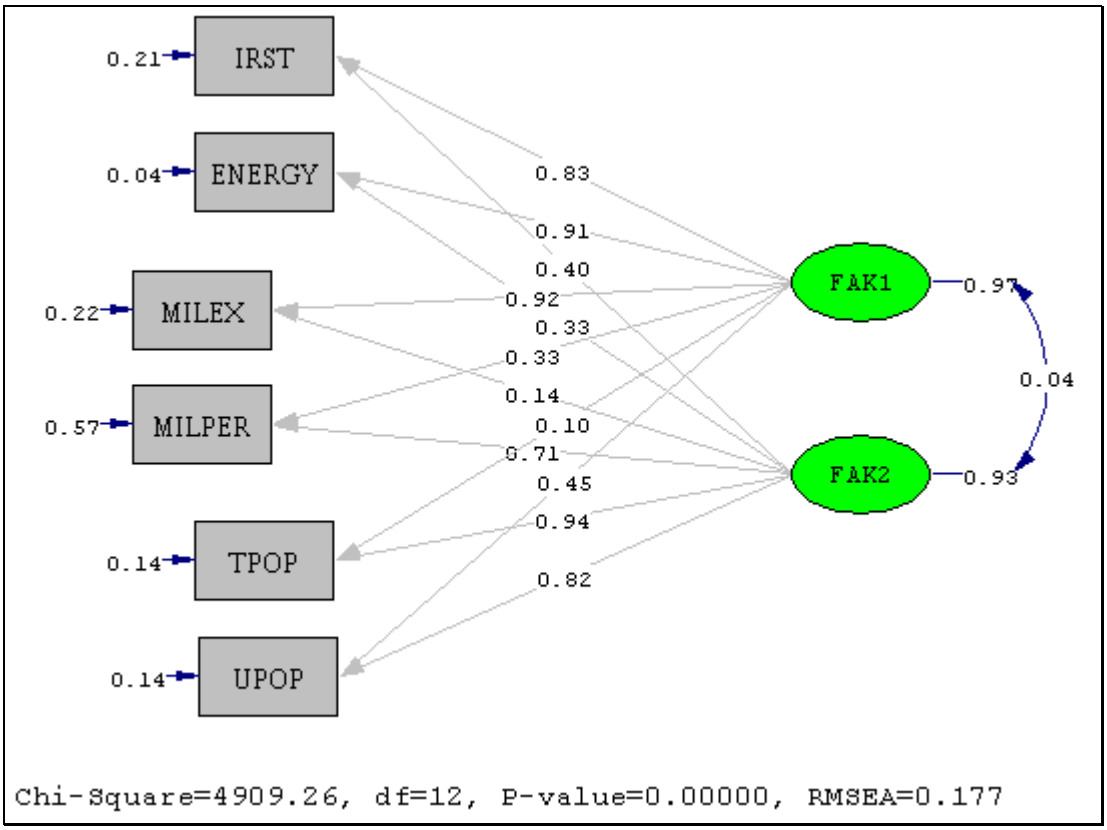
1. **PCA-Results tested by the help of LISREL**

The results of the Principal Component Analysis – be it rotated or not – can be interpreted as two sets of congeneric measurments (Jöreskog & Sörbom 2001:123-135). A speciality of PCA is that every factor is linked to every indicator. I tested the model with the factor loadings computed by the PCA-procedure implemented in SPSS.



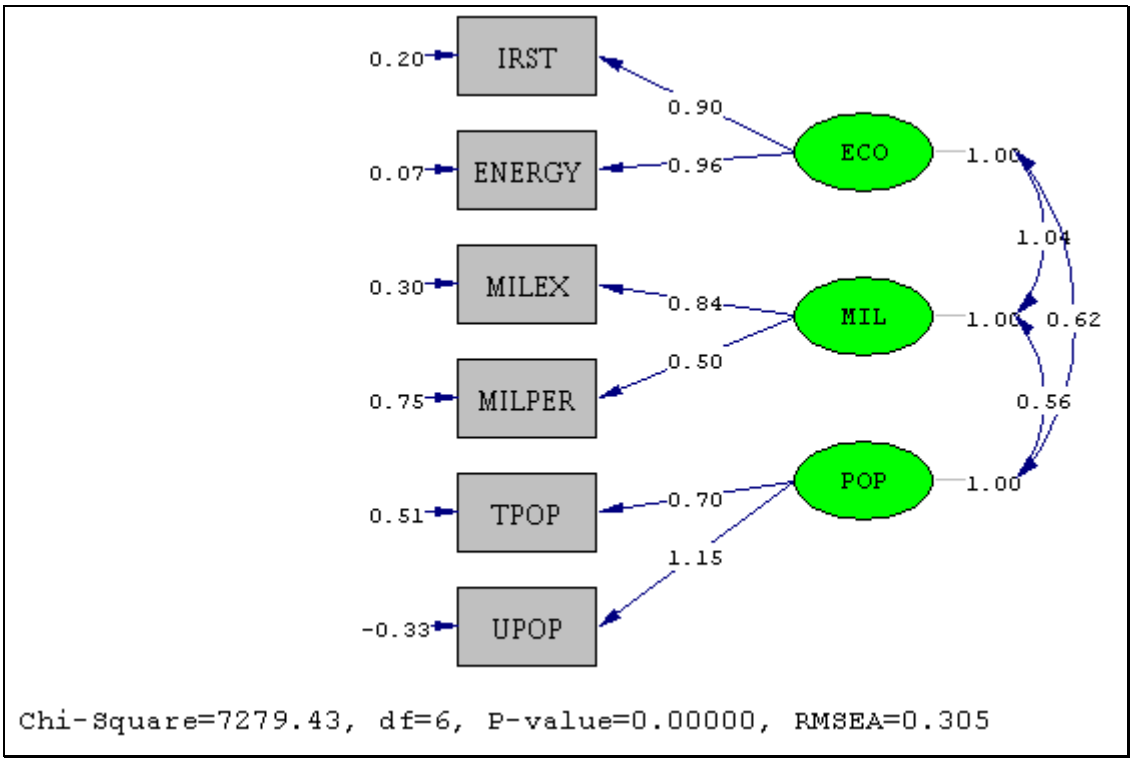
As easily can be seen, the model is far from the ideal of a fitting measurement model. The same can be said to the rotated solution of PCA:

2. **PCA-Results, Rotated by Varimax**



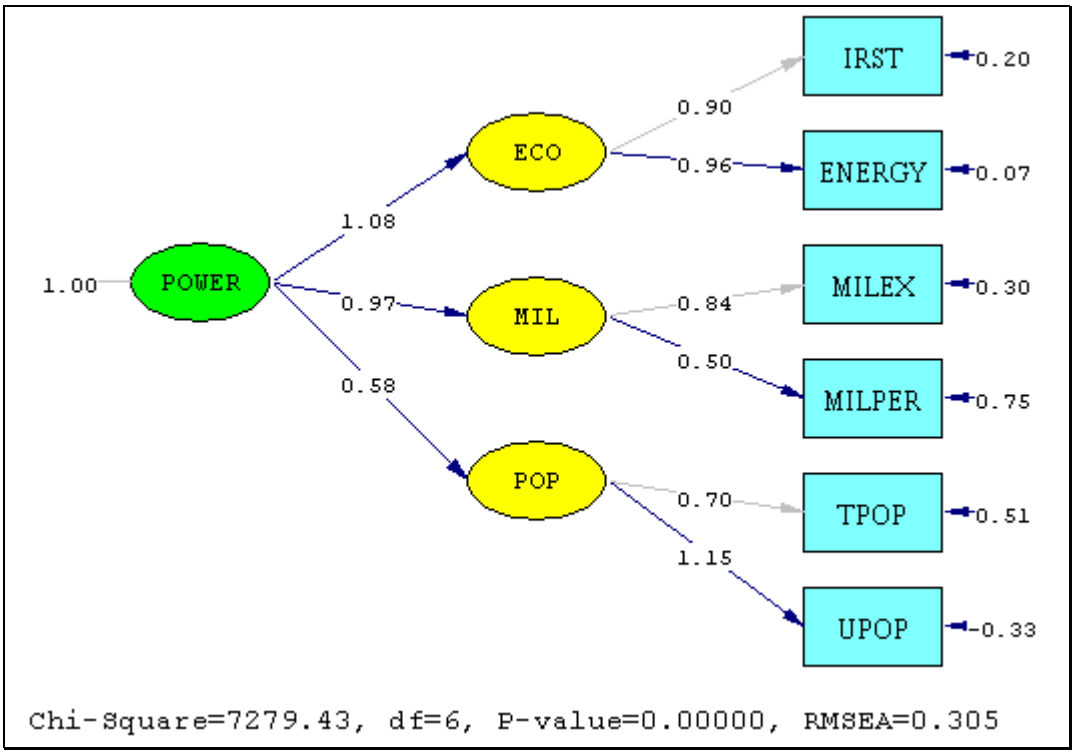
3. **Confirmatory Factor Analysis**

According to the construction of the six indicators of National Material Capabilities (CoW, NMC-Manual 2005), there are three dimensions: the industrial, the military and the demographic. The following model combines the two indicators of every dimension into one factor – altogether a three factor measurement model. In addition we allowed the model to compute the correlations between the three latent factors.



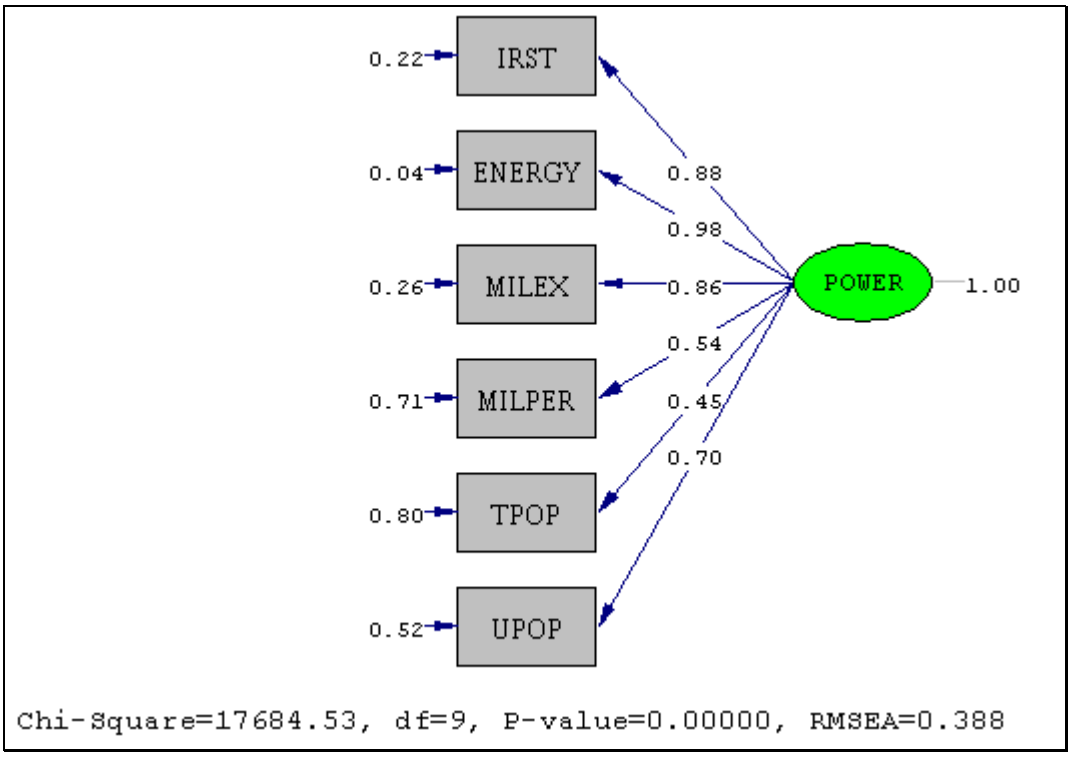
There is an extreme misfit of Urban Population into the model, which is indicated by a negative variance of the error term. This may be the reason for the exaggerated correlation between the true factors of Economy and Military. Regardless to these problems, the whole model does not fit to the data. Even the PCA-model fits better. Nevertheless, the correlations between the three factors are high enough to hypothesize a deeper factor that stands for – power as such.

4. **Second Order Factor Analysis**



The model has the same fit like the model above. Beside the bad fit problem and a not plausible (negative) variance of the one error term and an exaggerated correlation, it would be a reasonable measurement model for power. - Let us see whether or not there is a „common cause“ or a „latent factor“ of all six indicators at all.

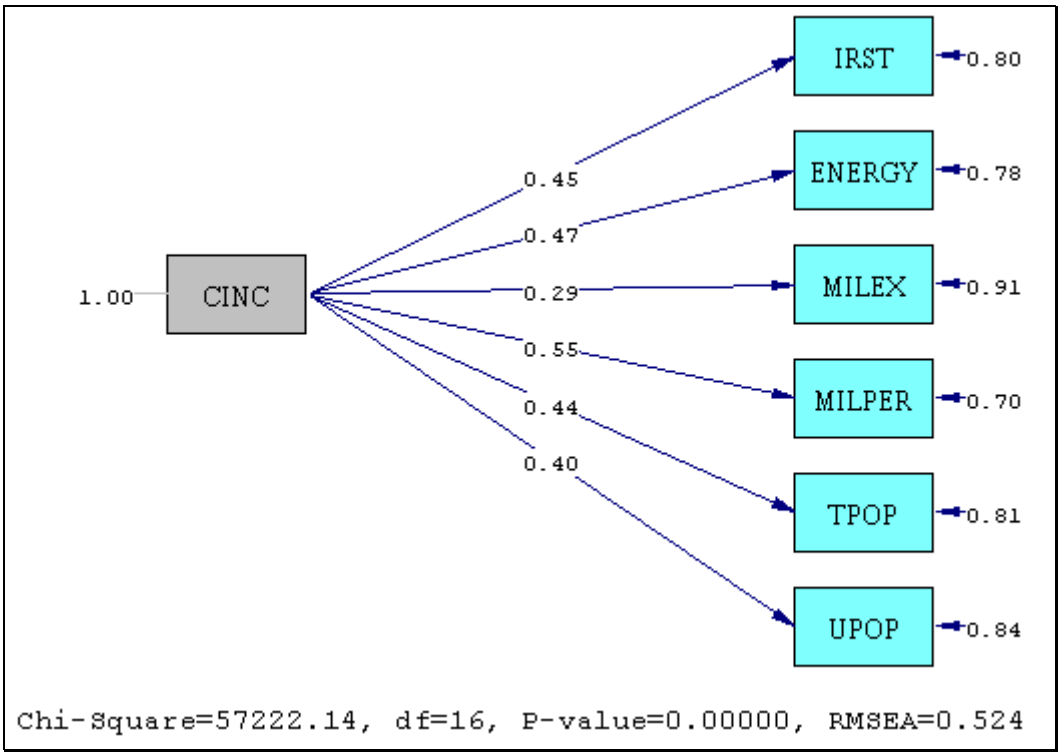
5. **Confirmatory Factor Analysis – One Factor Only (Power)**



By now this model has the worst fit of all. If we ignore the fit-problem for a moment, all other aspects seem to be very plausible. The model is producing the weights of the different indicators to the common factor. The last may be called „power."

The Correlates of War has developed an Combined Indicator of National Capabilities. How does it fit to the data? The corresponding measurement model is very similar to the last one.

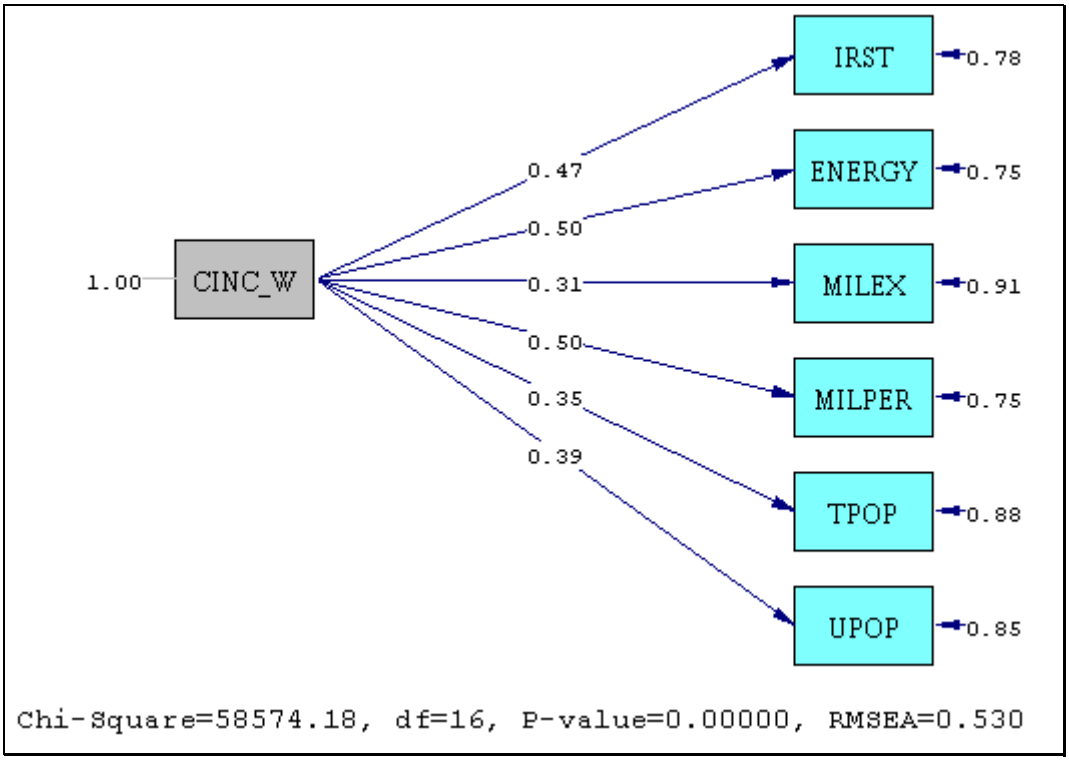
6. **A Regression of the Six Indicators to CINC**



The model with CINC as the „common cause“ of the six indicators is even worse than the fit of the last discussed model. It seems to me that CINC does not fulfill the simplest expectations one has in mind, for instance, that power has something to with „Military Expenditure“ (this indicator has the lowest weight in the model). For a measurement model, all path coefficients seem to be low, not to say, too low.

7. **Regression on a weighted CINC**[1]

The last test used a CINC that was weighted by the results of the 5-th model. Here is what I got:



The weights made things not just better. The extremes are not so salient in this model.

Summary

Beside a general fit problem, which is not solved so far, the model that resulted from the PCA-procedure seems to be the best we can get. It leads us not to a proxy of "power," but discloses two dimensions of power that cannot be interpreted very easily.

[1] I used the Capability Data Version 3.01 for this model.

Literature

Jöreskog, Karl; Sörbom, Dag (2001): LISREL 8. User's Reference Guide. Uppsala and Lincolnwood.

Correlates of War Project (2005): National Material Capabilities Data Documentation. Version 3.0