**use "/Users/artbangert/Desktop/Engineering Seminar/SAQ.dta"**

**Testing Assumptions for Factor Analysis**

. correlate q01 q02 q03 q04 q05 q06 q07 q08 q09 q10 q11 q12 q13 q14 q15 q16 q17 q18 q19 q20 q21 q22 q23

(obs=2,571)



**Testing Assumptions for Factor Analysis**

. **factortest** q01 q02 q03 q04 q05 q06 q07 q08 q09 q10 q11 q12 q13 q14 q15 q16 q17 q18 q19 q20 q21 q22 q23

Determinant of the correlation matrix

Det = 0.001

Bartlett test of sphericity **-** Bartlett’s test of sphericity tests whether the data comes from multivariate normal distribution with zero covariances. Tests for matrix singularity.

Chi-square = 19334.492

Degrees of freedom = 253

p-value = 0.000

H0: variables are not intercorrelated

Kaiser-Meyer-Olkin Measure of Sampling Adequacy

 The KMO is used to test amount of overlap or shared variance between pairs of variables (remember we are trying to identify items that are related but yet provide unique information to the factors we are attempting to identify). **Values should be greater than .5.**

KMO = 0.930

**Conducting the Principal Components Factor Analysis**

. factor q01 q02 q03 q04 q05 q06 q07 q08 q09 q10 q11 q12 q13 q14 q15 q16 q17 q18 q19 q20 q21 q22 q23, pcf

(obs=2,571)

Factor analysis/correlation Number of obs = 2,571

 Method: principal-component factors Retained factors = 4

 Rotation: (unrotated) Number of params = 86

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**Eigenvalue** – The portion of the total variance of a correlation matrix that is explained by a linear combination of items in a factor

**Eigenvector** – the linear combination of variables identified using principal-component analysis, that maximize the amount of total variance in a correlation matrix that is explained

**Eigenvalue** – components with eigenvalues greater than 1 should be retained. This criteria is reliable when the number of variables is **< 30** and the communalities are **> .70**, or the number of individuals is **> 250** and the mean communality for all variables is **> .60**

 Factor | Eigenvalue Difference Proportion Cumulative

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 Factor1 | 7.29005 5.55122 0.3170 0.3170

 Factor2 | 1.73883 0.42208 0.0756 0.3926

 Factor3 | 1.31675 0.08955 0.0573 0.4498

 Factor4 | 1.22720 0.23932 0.0534 0.5032

 Factor5 | 0.98788 0.09255 0.0430 0.5461

 Factor6 | 0.89533 0.08977 0.0389 0.5850

 Factor7 | 0.80556 0.02274 0.0350 0.6201

 Factor8 | 0.78282 0.03185 0.0340 0.6541

 Factor9 | 0.75097 0.03401 0.0327 0.6868

 Factor10 | 0.71696 0.03337 0.0312 0.7179

 Factor11 | 0.68359 0.01409 0.0297 0.7476

 Factor12 | 0.66950 0.05750 0.0291 0.7768

 Factor13 | 0.61200 0.03426 0.0266 0.8034

 Factor14 | 0.57774 0.02855 0.0251 0.8285

 Factor15 | 0.54919 0.02604 0.0239 0.8524

 Factor16 | 0.52315 0.01475 0.0227 0.8751

 Factor17 | 0.50840 0.05246 0.0221 0.8972

 Factor18 | 0.45594 0.03214 0.0198 0.9170

 Factor19 | 0.42380 0.01601 0.0184 0.9355

 Factor20 | 0.40779 0.02831 0.0177 0.9532

 Factor21 | 0.37948 0.01546 0.0165 0.9697

 Factor22 | 0.36402 0.03096 0.0158 0.9855

 Factor23 | 0.33306 . 0.0145 1.0000

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 LR test: independent vs. saturated: chi2(253) = 1.9e+04 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances

**Uniqueness** - percentage of variance for the variable (item) that is not explained by the common factors.

Uniqueness could be pure measurement error, or it could represent something that is measured reliably in that particular variable, but not by any of the others. The greater the uniqueness, the more likely that it is more than just measurement error. Values more than 0.6 are usually considered high. If the uniqueness is high, then the variable is not well explained by the factors.

**Communality** – indicates the variance which a variable (item) has in common with other variables (items) in the analysis. Communalities for each variable can also be interpreted as the squared multiple correlation (*R2*) of the variable (item) predicted from the combination of extracted factors. The communality is equal to the sum over all factors of the square factor loadings.

**In Stata the communalities for each variable (item) are equivalent to 1-uniqueness. So the communality for q01 would be 1-.565 = .435**

I have calculated those and inserted them in the output.

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 Variable | Factor1 Factor2 Factor3 Factor4 | Uniqueness **Communality**

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**.4346**

**.4138**

**.5297**

**.4686**

**.3430**

**.6539**

**.5453**

**.7395**

**.4845**

**.3348**

**.6896**

**.5133**

**.5358**

**.4883**

**.3780**

**.4871**

**.6828**

**.5973**

**.3432**

**.4840**

**.5499**

**.4635**

**.4122**

 q01 | 0.5861 0.1751 -0.2153 0.1189 | 0.5654

 q02 | -0.3026 0.5483 0.1464 0.0100 | 0.5862

 q03 | -0.6289 0.2902 0.2131 -0.0674 | 0.4703

 q04 | 0.6345 0.1435 -0.1488 0.1527 | 0.5314

 q05 | 0.5555 0.1009 -0.0741 0.1369 | 0.6570

 q06 | 0.5619 0.0974 0.5713 -0.0483 | 0.3461

 q07 | 0.6852 0.0391 0.2521 0.1035 | 0.4547

 q08 | 0.5489 0.4006 -0.3228 -0.4165 | 0.2605

 q09 | -0.2838 0.6270 -0.0083 0.1033 | 0.5155

 q10 | 0.4371 0.0345 0.3631 -0.1034 | 0.6652

 q11 | 0.6525 0.2454 -0.2089 -0.4000 | 0.3104

 q12 | 0.6687 -0.0477 0.0507 0.2476 | 0.4867

 q13 | 0.6730 0.0758 0.2777 -0.0076 | 0.4642

 q14 | 0.6558 0.0230 0.1983 0.1353 | 0.5117

 q15 | 0.5929 0.0103 0.1172 -0.1126 | 0.6220

 q16 | 0.6793 0.0142 -0.1381 0.0797 | 0.5129

 q17 | 0.6431 0.3295 -0.2096 -0.3416 | 0.3172

 q18 | 0.7012 0.0334 0.2981 0.1251 | 0.4027

 q19 | -0.4268 0.3896 0.0954 -0.0131 | 0.6568

 q20 | 0.4358 -0.2052 -0.4045 0.2973 | 0.5160

 q21 | 0.6575 -0.0553 -0.1870 0.2820 | 0.4501

 q22 | -0.3016 0.4654 -0.1159 0.3775 | 0.5365

 q23 | -0.1439 0.3665 -0.0212 0.5067 | 0.5878

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**Rotating Factors (power point)**

. **rotate**

Factor analysis/correlation Number of obs = 2,571

 Method: principal-component factors Retained factors = 4

 Rotation: orthogonal varimax (Kaiser off) Number of params = 86

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 Factor | Variance Difference Proportion Cumulative

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 Factor1 | 3.67824 0.65866 0.1599 0.1599

 Factor2 | 3.01958 0.01412 0.1313 0.2912

 Factor3 | 3.00546 1.13592 0.1307 0.4219

 Factor4 | 1.86954 . 0.0813 0.5032

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 LR test: independent vs. saturated: chi2(253) = 1.9e+04 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances

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 Variable | Factor1 Factor2 Factor3 Factor4 | Uniqueness

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 q01 | 0.2378 0.4071 0.4532 0.0838 | 0.5654

 q02 | -0.0203 0.0372 -0.3665 0.5269 | 0.5862

 q03 | -0.2113 -0.2379 -0.5586 0.3411 | 0.4703

Stevens (2009) suggests that items with factors loading greater than .40 are important and worth retaining.

 q04 | 0.3197 0.3710 0.4741 0.0625 | 0.5314

 q05 | 0.3205 0.2887 0.3947 0.0345 | 0.6570

 q06 | 0.7916 0.1394 -0.0465 -0.0751 | 0.3461

 q07 | 0.6394 0.2159 0.2918 -0.0684 | 0.4547

 q08 | 0.0887 0.8498 0.0962 0.0145 | 0.2605

 q09 | -0.1062 0.0920 -0.2387 0.6386 | 0.5155

 q10 | 0.5413 0.1599 -0.0257 -0.1244 | 0.6652

 q11 | 0.2262 0.7751 0.1424 -0.1319 | 0.3104

 q12 | 0.4849 0.1629 0.4978 -0.0614 | 0.4867

 q13 | 0.6410 0.2814 0.1934 -0.0912 | 0.4642

 q14 | 0.5824 0.1959 0.3276 -0.0585 | 0.5117

 q15 | 0.4485 0.3340 0.1831 -0.1783 | 0.6220

 q16 | 0.3333 0.3714 0.4791 -0.0924 | 0.5129

 q17 | 0.2360 0.7763 0.1534 -0.0301 | 0.3172

 q18 | 0.6866 0.1906 0.2919 -0.0667 | 0.4027

 q19 | -0.1566 -0.0693 -0.3816 0.4102 | 0.6568

 q20 | -0.0177 0.1198 0.6763 -0.1093 | 0.5160

 q21 | 0.3007 0.2287 0.6366 -0.0435 | 0.4501

 q22 | -0.1815 -0.1107 0.0190 0.6465 | 0.5365

 q23 | -0.0044 -0.1883 0.1604 0.5924 | 0.5878

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Factor rotation matrix

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 | Factor1 Factor2 Factor3 Factor4

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 Factor1 | 0.6283 0.5237 0.5331 -0.2161

 Factor2 | 0.1043 0.4745 -0.2494 0.8377

 Factor3 | 0.7605 -0.4011 -0.5102 -0.0194

 Factor4 | 0.1261 -0.5828 0.6271 0.5011

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**Sorting the Factor loadings (from high to low)**

. **sortl**

Rotated factor loadings (pattern matrix) and unique variances sorted

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 Variable | Factor1 Factor2 Factor3 Factor4 | Uniqueness

 -------------+----------------------------------------+-------------

 q06 | 0.7916 0.1394 -0.0465 -0.0751 | 0.3461

 q18 | 0.6866 0.1906 0.2919 -0.0667 | 0.4027

 q13 | 0.6410 0.2814 0.1934 -0.0912 | 0.4642

 q07 | 0.6394 0.2159 0.2918 -0.0684 | 0.4547

 q14 | 0.5824 0.1959 0.3276 -0.0585 | 0.5117

 q10 | 0.5413 0.1599 -0.0257 -0.1244 | 0.6652

 q15 | 0.4485 0.3340 0.1831 -0.1783 | 0.6220

 q08 | 0.0887 0.8498 0.0962 0.0145 | 0.2605

 q17 | 0.2360 0.7763 0.1534 -0.0301 | 0.3172

 q11 | 0.2262 0.7751 0.1424 -0.1319 | 0.3104

 q20 | -0.0177 0.1198 0.6763 -0.1093 | 0.5160

 q21 | 0.3007 0.2287 0.6366 -0.0435 | 0.4501

 q03 | -0.2113 -0.2379 -0.5586 0.3411 | 0.4703

 q12 | 0.4849 0.1629 0.4978 -0.0614 | 0.4867

 q16 | 0.3333 0.3714 0.4791 -0.0924 | 0.5129

 q04 | 0.3197 0.3710 0.4741 0.0625 | 0.5314

 q01 | 0.2378 0.4071 0.4532 0.0838 | 0.5654

 q05 | 0.3205 0.2887 0.3947 0.0345 | 0.6570

 q22 | -0.1815 -0.1107 0.0190 0.6465 | 0.5365

 q09 | -0.1062 0.0920 -0.2387 0.6386 | 0.5155

 q23 | -0.0044 -0.1883 0.1604 0.5924 | 0.5878

 q02 | -0.0203 0.0372 -0.3665 0.5269 | 0.5862

 q19 | -0.1566 -0.0693 -0.3816 0.4102 | 0.6568

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**Reliability Analysis**

**Entire Scale**

. alpha q01 q02 q03 q04 q05 q06 q07 q08 q09 q10 q11 q12 q13 q14 q15 q16 q17 q18 q19 q20 q21 q22 q23

Test scale = mean(unstandardized items)

Reversed items: q02 q03 q09 q19 q22 q23

Average interitem covariance: .2559683

Number of items in the scale: 23

Scale reliability coefficient: 0.8896

**Factor 1**

. alpha q06 q18 q13 q07 q14 q10 q15

Test scale = mean(unstandardized items)

Average interitem covariance: .4150414

Number of items in the scale: 7

Scale reliability coefficient: 0.8234

**Factor 2**

. alpha q08 q17 q11

Test scale = mean(unstandardized items)

Average interitem covariance: .4651336

Number of items in the scale: 3

Scale reliability coefficient: 0.8194

**Factor 3**

. alpha q20 q21 q03 q12 q16 q04 q01 q05

Test scale = mean(unstandardized items)

Reversed item: q03

Average interitem covariance: .336523

Number of items in the scale: 8

Scale reliability coefficient: 0.8208

**Factor 4**

. alpha q22 q09 q23 q02 q19

Test scale = mean(unstandardized items)

Average interitem covariance: .2390614

Number of items in the scale: 5

Scale reliability coefficient: 0.5699

# Stevens, J.P.(2009). Applied multivariate statistics for the social sciences(5th ed).Abington, UK: Taylor & Francis