

Beyond Factor Analysis: Can the Results Be Validated?

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ABSTRACT

This presentation explores using different techniques to validate an initial set of factor analysis results. All of the factor analyses discussed are produced using the SAS® System's PROC FACTOR procedure. An understanding of how to use the SAS® System to run a basic factor analysis is needed, since this presentation will focus on how to interpret and compare PROC FACTOR results. First, the output from the original factor analysis solution is presented; this solution uses Principal Factor Analysis as the initial extraction method with a VARIMAX rotation. In an attempt to validate these original findings, they are compared to four different factor solutions obtained by: 1) changing the initial factor extraction method, 2) changing the rotation method, 3) changing the number of factors analyzed, and 4) splitting the data set in half and running the same initial factor extraction method and rotation on both halves. The results of each factor analysis first will be displayed as the original PROC FACTOR output and then summarized in tables. All of the results discussed utilize Base SAS and SAS/STAT® software.

INTRODUCTION

Factor analysis can be performed for various reasons, such as:

- ♦ Exploratory data analysis prior to further analysis
- ♦ Broad explanation of the data
- ♦ Testing hypothesized explanations of the data
- ♦ Data reduction

Regardless of what the particular motive is for conducting a factor analysis, the results of a factor analysis identify the factors, or dimensions, that are responsible for the covariation in the data. The SAS System's PROC FACTOR provides an efficient manner in which to perform a factor analysis, no matter what the specific interests are of the user.

In addition to running and interpreting a factor analysis, verification of the results obtained from running the SAS System's PROC FACTOR are often desired. Since factor analysis is a descriptive statistical technique, there is no definitive "correct" factor analysis solution. However, what this paper will discuss is a series of steps that can be taken, utilizing the SAS System, in the attempt to validate the findings of a factor analysis. The paper discusses the detail of the results obtained from running a total of five different types of factor analyses, including the original factor analysis solution. The assumption is made that the reader is aware of all preliminary issues that should be addressed prior to running a factor analysis. This paper analyzes data from an energy services provider, as did the Goldberg paper referenced at the end of this paper.

ORIGINAL FACTOR ANALYSIS

PROGRAM DETAILS

The original SAS System's PROC FACTOR program is detailed in Table 1 below. This original factor analysis was run using the Principal Factor Analysis method with a VARIMAX rotation. Through preliminary runs of the PROC FACTOR program, it was determined that four factors were the optimal number of factors to retain for the final solution (see the eigenvalues subsection below for more details).

Table 1

```
PROC FACTOR DATA = SAVE.EXAMP
  METHOD = PRINCIPAL PRIORS = SMC SCREE
  NFACTOR = 4 PREPLOT ROTATE = VARIMAX
  REORDER PLOT OUT = SAVE.EXAMPFAC;
VAR X43 -- X78;
RUN;
```

EIGENVALUES OUTPUT

PROC FACTOR was initially run by allowing all of the variables entered into the procedure to be possible factors. Determining how many factors would be included in the final factor program partially was based on the analysis of the eigenvalues. Thus, for the first factor analysis solution discussed in this paper, NFACTOR=4 was specified after analyzing, among other criteria, the eigenvalues. The eigenvalues for the first five factors, including the four factors retained for the final solution, are shown below in Table 2.

Table 2

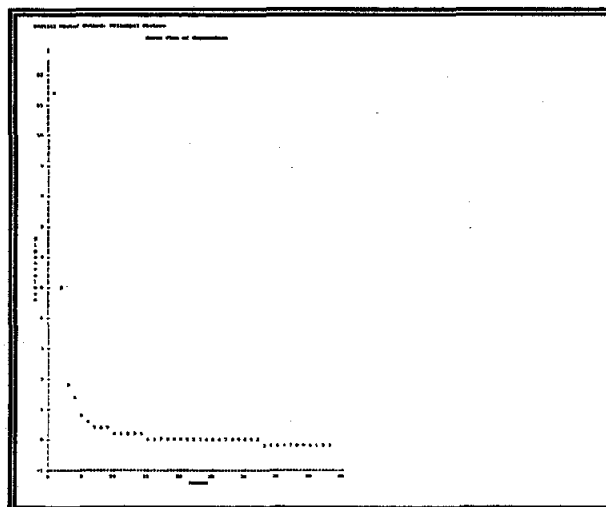
EIGENVALUES OF THE CORRELATION MATRIX

	1	2	3	4	5
Eigenvalue	11.3937	4.9335	1.7807	1.3238	0.7417
Difference	6.4602	3.1529	0.4568	0.5822	0.0955
Proportion	0.5482	0.2374	0.0857	0.0637	0.0357
Cumulative	0.5482	0.7856	0.8713	0.9350	0.9707

Based on the eigenvalues displayed in Table 2, factors were kept that contributed to a total summed CUMULATIVE proportion of explained variance of at least 90%, and that demonstrated the factor explained at least a five percent (5%) PROPORTION of the variance. Thus, the last factor that had an eigenvalue PROPORTION greater than or equal to five percent (5%) and contributed to the 90% total summed CUMULATIVE proportion of explained variance was Factor 4.

SCREE PLOT OF EIGENVALUES

Table 3



The SCREE PLOT displayed in Table 3 shows the slope starting to level off after the fourth eigenvalue and really leveling off after the sixth eigenvalue. Therefore, Factors 4, 5, and 6 were all candidates for analysis to determine which one should be the last factor retained. For this original solution, four factors were kept for several reasons. First, the eigenvalue matrix showed that four factors should be kept in order to obtain a solution in which at least 90% of the total summed CUMULATIVE proportion of the variance was explained and each factor accounted for at least five percent (5%) PROPORTION of the variance. Secondly, it was decided that the simplest solution would be the best for implementation of the factor analysis results.

FACTOR PATTERN OUTPUT

Because a rotated factor analysis was specified, two factor patterns were output, one based on the initial method, Principal Factor Analysis, and one based on the rotated method, Varimax. In Table 4 below, both factor patterns are shown for a sample of four of the variables for the first four factors. The factor analysis was rotated to ease the interpretability of the solution. Ideally, each variable only will have a high loading in one factor, not in multiple factors. As the Varimax rotated factor pattern shows, this objective was closer to being reached than it was prior to rotating the factors.

Table 4

FACTOR PATTERN OUTPUT EXAMPLES

Principal Factor Analysis:

Variables	Factor 1	Factor 2	Factor 3	Factor 4
X44	0.77897	-0.28202	0.10369	-0.16988
X30	0.59214	0.58449	-0.03765	0.04250
X14	0.23676	-0.16273	0.07417	0.49655
X97	-0.06465	0.24475	0.58551	0.10443

Varimax Rotation:

Variables	Factor 1	Factor 2	Factor 3	Factor 4
X44	0.81762	0.18743	0.14570	-0.03302
X30	0.16019	0.81256	0.03465	0.09147
X14	0.08204	0.03074	0.56851	0.06097
X97	-0.08128	0.05088	0.01105	0.63914

To visually see this same affect of rotating the factor pattern, a review of the preplots and plots is beneficial. While these plots are not displayed in this paper, they were specified in this PROC FACTOR program (See Table 1).

DESCRIBING THE FACTORS

A review of the rotated factor pattern results shows the variables that loaded highly in just one factor each. By analyzing the meaning of each variable that loaded highly into one factor, a definition of that factor can be derived. By performing such an assessment, a factor explanation table can be produced as shown in Table 5 below.

Table 5

FACTOR EXPLANATION TABLE (ORIGINAL)

Factors	Explanation
1	Performance in Customer Service Areas
2	Importance of Customer Service Areas
3	Utility Company's Performance Compared to Other Service Providers
4	Household Affluence Level

To determine whether or not this original factor analysis solution can be verified, comparisons of the rotated factor pattern, the ease of interpretability, and the explanations of the final four factors will be made to the four validation factor analyses. In order to verify the original factor analysis results, only one option was changed in each validation test.

VALIDATION ONE: CHANGE THE INITIAL EXTRACTION METHOD

PROGRAM DETAILS

The first validation factor analysis program using the SAS System's PROC FACTOR is detailed in Table 6 below. In this first validation test, the initial extraction method was changed from Principal Factor Analysis to Maximum-Likelihood. However, the rotation method was kept the same: VARIMAX rotation. Also, the same number of factors were retained: four factors.

Table 6

```
PROC FACTOR DATA = SAVE.EXAMP
  METHOD = ML PRIORS = SMC SCREE
  NFACTOR = 4 PREPLOT ROTATE = VARIMAX
  REORDER PLOT OUT = SAVE.EXMFAC3A ;
VAR X43 - X78 ;
RUN ;
```

EIGENVALUES OUTPUT

The eigenvalues for the first five factors, including the four factors retained for the final solution, are shown below in Table 7.

Table 7

EIGENVALUES OF THE CORRELATION MATRIX

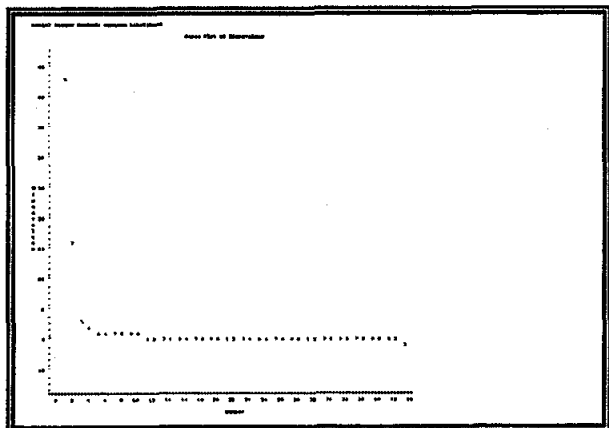
	1	2	3	4	5
Eigenvalue	43.1649	16.4690	3.1518	2.1188	1.3666
Difference	26.6959	13.3173	1.0330	0.7522	0.2402
Proportion	0.6400	0.2442	0.0467	0.0314	0.0203
Cumulative	0.6400	0.8841	0.9308	0.9623	0.9825

Since the only option changed from the original factor analysis to this first validation factor analysis was the initial extraction method, four factors were still kept. However, based on the eigenvalues displayed in Table 7, the first four factors contributed to a total summed CUMULATIVE proportion of explained variance of at least 95% and explained under a five percent (5%) PROPORTION of the variance. If the same eigenvalue analysis criteria had been used here as with the original solution [eigenvalue PROPORTION greater than or equal to five percent (5%) and contributed to the 90% total summed CUMULATIVE proportion of explained variance], only three factors would have been kept.

SCREE PLOT OF EIGENVALUES

The SCREE PLOT displayed in Table 8 shows the slope starting to level off after the third eigenvalue and really leveling off after the fourth eigenvalue. Therefore, Factors 3 and 4 were both candidates for analysis to determine which one should be the last one retained. However, as previously stated, four factors were kept for this first validation solution.

Table 8



FACTOR PATTERN OUTPUT

Again, as with the original factor analysis solution, because a rotated factor analysis was specified, two factor patterns were output. The first was based on the initial method, Maximum-Likelihood, and the second was based on the rotated method, Varimax. In Table 9 below, both factor patterns are shown for the same sample of four of the variables for the first four factors. As with the original factor analysis solution, this first validation's Varimax rotated factor pattern shows an easier interpretability than the non-rotated, Maximum-Likelihood extracted method.

Table 9

FACTOR PATTERN OUTPUT EXAMPLES

Maximum-Likelihood:

Variables	Factor 1	Factor 2	Factor 3	Factor 4
X44	0.80646	-0.27391	0.04697	-0.08811
X30	0.56349	0.61098	0.03089	0.03382
X14	0.21690	-0.11754	-0.03821	0.52499
X97	-0.05670	0.16946	0.59877	0.17094

Varimax Rotation:

Variables	Factor 1	Factor 2	Factor 3	Factor 4
X44	0.82461	0.18690	0.13714	-0.04082
X30	0.16174	0.80840	0.04004	0.10787
X14	0.09456	0.02809	0.57003	0.05714
X97	-0.07612	0.04788	0.00675	0.64151

DESCRIBING THE FACTORS

Table 10

FACTOR EXPLANATION TABLE (VALIDATION 1)

Factors	Explanation
1	Performance in Customer Service Areas
2	Importance of Customer Service Areas
3	Utility Company's Performance Compared to Other Service Providers
4	Household Affluence Level

The review of the rotated factor pattern results showed the variables that distinctly loaded highly in just one factor each. As the Factor Explanation Table (Table 10) above shows, the same definitions were derived for the four final factors. The final rotated solution actually placed the same variables in exactly the same order as did the original factor analysis solution. Also, the validation solution showed the same variables to be weak and not useful as did the original factor analysis solution. The option of

retaining just three factors could have been explored. However, at this point, it is concluded that the four factor solution results were validated and stable.

VALIDATION TWO: CHANGE THE ROTATION METHOD

PROGRAM DETAILS

The second validation factor analysis program using the SAS System's PROC FACTOR is detailed in Table 11 below. In this second validation test, the rotation method was changed from VARIMAX to PROMAX. However, all other options remained the same as in the original factor analysis solution. Again, as previously stated, in order to verify the original results, only one option was changed in each validation test.

Table 11

```
PROC FACTOR DATA = SAVE.EXAMP
  METHOD = PRINCIPAL PRIORS = SMC SCREE
  NFACTOR = 4 PREPLOT ROTATE = PROMAX
  REORDER PLOT OUT = SAVE.EXMFAC3B ;
VAR X43 -- X78 ;
RUN ;
```

EIGENVALUES OUTPUT and SCREE PLOT

Since the original extraction method was not changed in this second validation, the eigenvalues and the scree plot are the same as those in the original factor analysis solution. To review those values, see Tables 2 and 3. Four factors were kept for this second validation for comparison purposes. Again, this accounted for an eigenvalue PROPORTION greater than or equal to five percent (5%) and a contribution to the 90% total summed CUMULATIVE proportion of explained variance.

FACTOR PATTERN OUTPUT

In Table 12 below, two factor patterns are shown for the same sample of four of the variables for the first four factors: the non-rotated Principal Factor Analysis factor pattern and the PROMAX rotated factor pattern. As with the original factor analysis solution, this second validation's Promax rotated factor pattern shows an easier interpretability than the non-rotated, Principal Factor Analysis extracted method.

Table 12

FACTOR PATTERN OUTPUT EXAMPLES

Principal Factor Analysis:

Variables	Factor 1	Factor 2	Factor 3	Factor 4
X44	0.77897	-0.28202	0.10369	-0.16988
X30	0.59214	0.58449	-0.03765	0.04250
X14	0.23676	-0.16273	0.07417	0.49655
X97	-0.06465	0.24475	0.58551	0.10443

Proximax Rotation:

Variables	Factor 1	Factor 2	Factor 3	Factor 4
X44	0.86840	0.00442	-0.04372	0.01571
X30	0.00695	0.82306	0.00335	0.05557
X14	-0.00470	0.02551	0.58644	0.10176
X97	0.00498	-0.01605	0.06748	0.65731

DESCRIBING THE FACTORS

As with the first validation, the review of the rotated factor pattern results showed the variables that distinctly loaded highly in just one factor each. The Factor Explanation Table (Table 13) below shows that the same definitions were given again to the four final factors. The final rotated solution actually placed exactly the same variables in the same order as did the original factor analysis solution and the first validation solution. Also, the validation solution showed the same variables to be weak and not useful. Thus, at this point, it still is concluded that the results of the original factor analysis solution were validated and stable.

Table 13

FACTOR EXPLANATION TABLE (VALIDATION 2)

Factors	Explanation
1	Performance in Customer Service Areas
2	Importance of Customer Service Areas
3	Utility Company's Performance Compared to Other Service Providers
4	Household Affluence Level

VALIDATION THREE: CHANGE THE NUMBER OF FACTORS

PROGRAM DETAILS

The third validation factor analysis program using the SAS System's PROC FACTOR is detailed in Table 14 below. In this third validation test, all options remained the same except for the number of factors that were retained: six factors. Due to requiring six final factors, the results obviously would be different than the original factor analysis solution. However, the hope was that the same underlying dimensions would be reflected in the six factor solution as were reflected in the four factor solution.

Table 14

```
PROC FACTOR DATA = SAVE.EXAMP
METHOD = PRINCIPAL PRIORS = SMC SCREE
NFACTOR = 6 PREPLOT ROTATE = VARIMAX
REORDER PLOT OUT = SAVE.EXMFAC3C ;
VAR X43 -- X78 ;
RUN ;
```

EIGENVALUES OUTPUT

The eigenvalues for the first six factors are shown in Table 15 below.

Table 15

EIGENVALUES OF THE CORRELATION MATRIX

	1	2	3	4	5	6
Eigenvalue	11.3937	4.9335	1.7807	1.3238	0.7417	0.6461
Difference	6.4602	3.1529	0.4568	0.5822	0.0955	0.1583
Proportion	0.5482	0.2374	0.0857	0.0637	0.0357	0.0311
Cumulative	0.5482	0.7856	0.8713	0.9350	0.9707	1.0018

This validation specifically changed the number of final factors to be kept to six. Therefore, based on the eigenvalues displayed in Table 15, the first six factors contributed to a total summed CUMULATIVE proportion of explained variance of at least 100% and each explained at least a three percent (3%) PROPORTION of the variance.

SCREE PLOT OF EIGENVALUES

Since the only option that changed in this third validation from the original factor analysis solution was the number of factors to retain, the SCREE PLOT of the eigenvalues remained the same. To review the original scree plot, see Table 3. As the scree plot shows, the slope starts to level off after the fourth eigenvalue and really levels off after the sixth eigenvalue. Therefore, Factors 4, 5, and 6 were all candidates for analysis to determine which one should be the last one retained. This validation will review the results of keeping the first six factors.

FACTOR PATTERN OUTPUT

Again, as with the original factor analysis solution, because a rotated factor analysis was specified, two factor patterns were output. The first was based on the initial method, Principal Factor Analysis, and the second was based on the rotated method, Varimax. In Table 16 below, both factor patterns are shown for a sample of six of the variables for the first six factors. Four of the variables listed in Table 16 are the same example variables that have been displayed in the original factor analysis solution and the first two validations. As with the original factor analysis solution, this third validation's Varimax rotated factor pattern shows an easier interpretability than the non-rotated, Principal Factor Analysis extracted method.

Table 16

FACTOR PATTERN OUTPUT EXAMPLES

Principal Factor Analysis:

Vars	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
X44	0.77897	-0.28202	0.10369	-0.16988	0.08061	-0.03503
X30	0.59214	0.58449	-0.03765	0.04250	-0.00865	-0.05287
X93	-0.29775	0.27494	0.12667	-0.15908	0.28276	-0.02941
X14	0.23676	-0.16273	0.07417	0.49655	0.23309	-0.03900
X97	-0.06465	0.24475	0.58551	0.10443	0.02591	0.16534
X108	-0.18674	0.27853	0.41589	0.06460	-0.15487	-0.33079

Varimax Rotation:

Vars	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
X44	0.80686	0.19203	0.16169	0.12152	-0.02730	-0.06413
X30	0.16636	0.80968	0.00671	0.03178	0.05841	0.10312
X93	-0.18353	0.00115	-0.46078	-0.15156	0.13087	0.01778
X14	0.11303	0.03148	0.01040	0.61357	0.00652	-0.00781
X97	-0.06091	0.04346	-0.13266	0.07116	0.62961	0.14544
X108	-0.15664	0.01703	-0.13052	-0.04673	0.26476	0.55575

DESCRIBING THE FACTORS

The review of the rotated factor pattern results showed the variables that distinctly loaded highly in just one factor each. The factor definitions that were derived are shown in the Factor Explanation Table (Table 17) below. While the first two factors were defined basically the same as in the original factor analysis solution, the specific customer service attributes that dealt with the *Utility Company's Value to the Community* moved out separately to become factor three. The new factor four was the original factor three, the *Utility Company's Performance Compared to Other Service Providers*. Finally, the original factor four, the *Household Affluence Level*, broke out into two factors in this validation factor analysis, factors five and six. These last two factors are more specific about the household affluence level; one is comprised more of the general demographics of the household while the other comprises the household's income and education levels.

Table 17

FACTOR EXPLANATION TABLE (VALIDATION 3)

Factors	Explanation
1	Performance in General Customer Service Areas
2	Importance of General Customer Service Areas
3	Utility Company's Value to the Community
4	Utility Company's Performance Compared to Other Service Providers
5	Demographics of the Household
6	Age and Income of the Household

Because six factors were requested to be kept, the results were going to be different for this validation. Factor 3, which had only moderate factor loadings of around 0.5, may indicate that a six factor solution is not ideal. As to whether the ideal number of factors should be the original four, these six, or possibly five, is a decision that should be made based on further analysis and the issues surrounding the implementation and usage of the factor analysis results.

The analysis of this third validation's results showed the same variables as weak or not useful as were indicated in the original factor analysis solution. Also, no new dimension was discovered in the data. While the first four factors were not exactly the same as they were for the original factor analysis, the total six factors simply broke out the information into a more specific level of explanation. At this stage of the validation analysis, it is concluded that the overall dimensions being described in the data were validated.

VALIDATION FOUR: SPLIT THE DATA IN HALF

PROGRAM DETAILS

The fourth validation of the original factor analysis solution simply performed the same factor analysis as was performed in the original factor analysis solution, only on two different halves of the data. The data was randomly split into two halves. This final validation's factor analysis program using the SAS System's PROC FACTOR used the same initial extraction method (Principal Factor Analysis), the same rotation method (VARIMAX), and the same number of final factors (four). To review this program, please refer to Table 1.

EIGENVALUES OUTPUT

The eigenvalues for the first five factors of both halves of the data, including the four factors retained for the final solution, are shown below in Table 18.

Table 18

EIGENVALUES OF THE CORRELATION MATRIX

Data Half One:

	1	2	3	4	5
Eigenvalue	11.2031	5.2153	1.7604	1.3686	0.7907
Difference	5.9878	3.4549	0.3918	0.5778	0.1195
Proportion	0.5158	0.2401	0.0810	0.0630	0.0364
Cumulative	0.5158	0.7559	0.8370	0.9000	0.9364

Data Half Two:

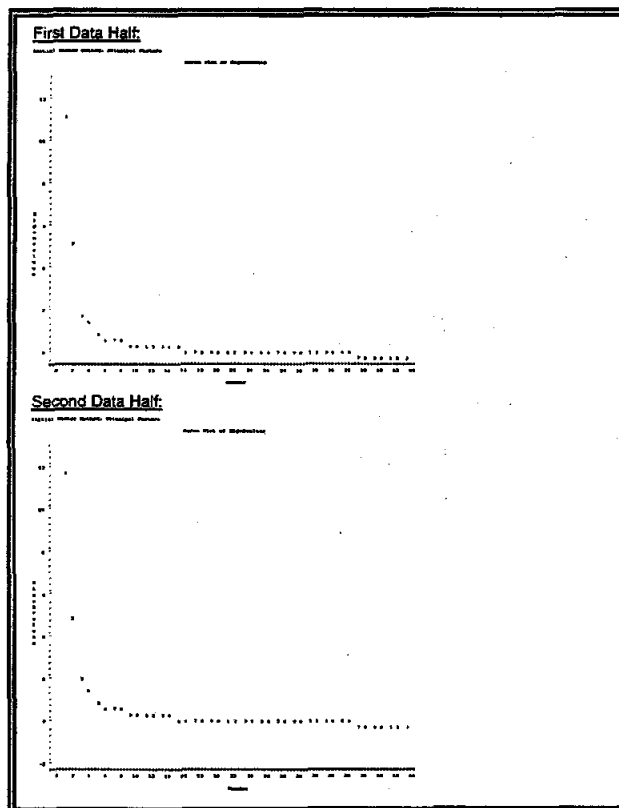
	1	2	3	4	5
Eigenvalue	11.6578	4.7653	1.9253	1.3836	0.8182
Difference	6.8924	2.8400	0.5417	0.5654	0.1153
Proportion	0.5318	0.2174	0.0878	0.0631	0.0373
Cumulative	0.5318	0.7492	0.8370	0.9002	0.9375

Based on the eigenvalues displayed in Table 18 for the First Half of the Data, the first four factors contributed to a total summed CUMULATIVE proportion of explained variance of 90% and explained at least a five percent (5%) PROPORTION of the variance. The same is true for the Second Half of the Data. Also, when these two halves of the data are compared to the original results, the eigenvalue analysis is identical.

SCREE PLOT OF EIGENVALUES

The SCREE PLOTS displayed in Table 19 show the slopes starting to level off after the fourth eigenvalue and really leveling off after the sixth eigenvalue, for both halves of the data. Therefore, as with the original factor analysis solution, Factors 4, 5, and 6 were all candidates for analysis to determine which one should be the last one retained. However, as previously stated, four factors were kept for this fourth and final validation solution.

Table 19



FACTOR PATTERN OUTPUT

Again, as with the original factor analysis solution, because a rotated factor analysis was specified, two factor patterns were output. For both halves of the data, the first factor pattern was based on the initial method, Principal Factor Analysis, and the second was based on the rotated method, Varimax. In Table 20 below, both factor patterns are shown for the same sample of four of the variables for the first four factors, for both halves of the data. As with the original factor analysis solution, this final validation's Varimax rotated factor patterns, for both halves of the data, show an easier interpretability than the non-rotated, Principal Factor Analysis extraction method.

Table 20

FACTOR PATTERN OUTPUT EXAMPLES

Principal Factor Analysis

Data Half One:

Variables	Factor 1	Factor 2	Factor 3	Factor 4
X44	0.77782	-0.27142	0.10517	-0.18715
X30	0.57768	0.64272	-0.03280	0.05033
X14	0.18751	-0.21859	0.20645	0.48563
X97	-0.13622	0.24131	0.60467	-0.01066

Data Half Two:

Variables	Factor 1	Factor 2	Factor 3	Factor 4
X44	0.78056	-0.29171	0.08323	-0.19135
X30	0.60513	0.53254	-0.03755	0.03201
X14	0.28404	-0.11487	-0.00415	0.46540
X97	0.00023	0.24226	0.56971	0.15375

Varimax Rotation

Data Half One:

Variables	Factor 1	Factor 2	Factor 3	Factor 4
X44	0.82257	0.17105	0.13530	-0.02385
X30	0.14510	0.85092	-0.00855	0.07225
X14	0.07648	-0.03025	0.59115	0.07194
X97	-0.11721	0.03037	0.00709	0.65408

Data Half Two:

Variables	Factor 1	Factor 2	Factor 3	Factor 4
X44	0.79139	0.22293	0.22312	-0.11014
X30	0.16408	0.78055	0.06963	0.10576
X14	0.04037	0.09415	0.54265	0.07433
X97	0.01180	0.05779	-0.02151	0.63479

DESCRIBING THE FACTORS

The review of the rotated factor pattern results showed the variables that distinctly loaded highly in just one factor each. The Factor Explanation Table (Table 21) below shows the same definitions were given to the four final factors for both halves of the data as were given to the original solution. While the factors for each data half could be defined the same as each other and the same as the original factor analysis solution, they were not identical. The variables were in a slightly different order between the two data halves and between those halves and the original solution. However, despite this different order, the same variables loaded highly in the same factors, and each data halves' validation solution showed the same variables to be weak and not useful as did the original factor analysis solution. Thus, it still was safely concluded that the results of the original solution were validated by this final test and remained stable.

Table 21

FACTOR EXPLANATION TABLE (VALIDATION 4)

Both Data Halves:

Factors	Explanation
1	Performance in Customer Service Areas
2	Importance of Customer Service Areas
3	Utility Company's Performance Compared to Other Service Providers
4	Household Affluence Level

CONCLUSIONS

Validations one, two and four successfully verified the results obtained in the original factor analysis solution. The only validation with slightly different results was Validation three, in which the final number of factor was changed. Because of the

nature of the third validation, choosing a different number of final factors, it would have different results. However, as discussed in the Validation three output and description, the same basic underlying dimensions were found in the data. The only difference was that two dimensions were broken out more specifically than they were with just four final factors. Hence, the only decision that must be made based on the validations, is how many final factors should be kept in the final solution. While this decision hopefully was made prior to beginning the first iteration of the first factor analysis, it still can be addressed at this stage. In this example, four factors were kept. Therefore, the series of four validations that were performed in the attempt to verify the findings of the original factor analysis solution were conclusive in mimicking the original results.

After the original factor analysis solution was determined, the results needed to be verified. First, the initial extraction method was changed. Second, the rotation method was altered. Next, the final number of factors was increased. Finally, the data set was large enough to randomly split in half and have a factor analysis performed on each data half. Based on the ability to conduct this series of factor analyses validations successfully, it appears to be one methodology that can be employed to attain a "comfort level" with the results of a factor analysis.

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