DC-level essay in Statistics, Fall 2006

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Characterizing Solvency for the Chinese Life Insurance Company: A Factor Analysis Approach

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Abstract:

This paper focus on analysing factors affecting the solvency of Life Insurance Company in China. Through choose 8 indexes and apply factor analysis this paper get the latent three factors which play important role in solvency, and using the factor scores this paper attain the rank of the 19 Life Insurance Companies in China. From this ranks people can have a glancing on Chinese insurance companies' status.

Introduction:

This paper tries to build a model to evaluate the solvency of Chinese Life Insurance Company (LIC). For LIC solvency is the ability of compensation and entity to pay its debts, which reflects a relation of the funds and debts [7].

Solvency is related to the occurring of the accidents. While there is huge uncertainty of the accidents, so the solvency of the company contains large randomness.

In china, the number of life insurance companies and the speed of their business mount up quickly. And, they are important to the national economic and financial security. Especially, in recent years, there is an expansion in trade and scale of Chinese insurance. It has reached today's progress only spending nearly one tenth time compared to European countries. But the high speed development also has its disadvantage, for the insufficient experience of capital management some companies pay high price to their growth[1]. Because of the intensely competition some apply risk investment to increase their return ratio which bring large cluster of customers and of course huge risk. All these makes an inflation in compensation responsibility that makes the insurance companies have the risk of solvency.

The important task of an insurance company is the liability management. Most of its capital is insurants' only a minor proportion of the fund is owned by the company. Keeping sufficient solvency is necessary for subsistence and development of insurance companies. Therefore solvency evaluation and ensuring sufficient solvency

[1] In the early time of Chinese insurance company the system was not complete and the regulations were fewer. so many companies took the insurance premium on the stock market which brought huge risk, and always can not have enough money to pay for their customers[7].

become the key issue of China Insurance Regulation.

Different country has different supervision system, and it must base on its own background. Example of system are the British system、the Australian system and North American system. China Insurance Regulatory Commission also promulgates a series of laws and rules to make the solvency assessment of insurance companies more scientific. But, comparing with those mature companies of the west Chinese insurance is just a young market.

According to the developed counties' experience and the situation of china we know that the better way for the insurance companies to avoid the crisis of solvency is to find standard to regulate their developing. So this paper pays more attention on the solvency supervision of Chinese insurance companies. To do this we first should explore some indexes to form the frame of reference. Based on the system [5] and regulations, having browsed paper [7] in point, this article chooses a set of regulatory indexes.

These indexes are listed below:

1) Net assets ratio = Owner's equity / total assets* 100%

2) Payable ratio of company-reserved = Owner's equity / company-reserved premium* 100%

3) Actual assets- liabilities ratio= (total assets –ungratified assets) / liabilities* 100%

4) Net profit ratio = net profit / total revenue * 100%

5) Return on investment– premium revenue ratio = Return on investment / premium revenue * 100%

6) Current assets ratio = current assets / total assets * 100%

7) Life insurance reserve sufficiency = accrual of reserve for life insurance / premium revenue * 100%

8) Premium market share = premium revenue of the company / domestic total premium revenue * 100%

Through these regulatory indexes this paper is trying to find the main factors which affect the solvency of Chinese life insurance companies. Base on the business data of

19 Chinese insurance companies [1], we hope to get a set of effective factors to evaluate the solvency of life insurance companies. That may give some information on the research of solvency supervision. By using the method of Factor Analysis, this paper analyze the regulatory indexes and get main factors such as efficiency of management, strength and size of company which, we think, influence their solvency most.

Data:

This paper uses the data of 19 Chinese life insurance companies in 2003. The index data shown in Table 1 are calculated with the original data which is shown in Appendix A. The explanation of the original data is as:

All the original data are from year book [1], [2]. Among them, the data of current assets and owner's equity and other companies' data are obtained from each life insurance company [1], [2].

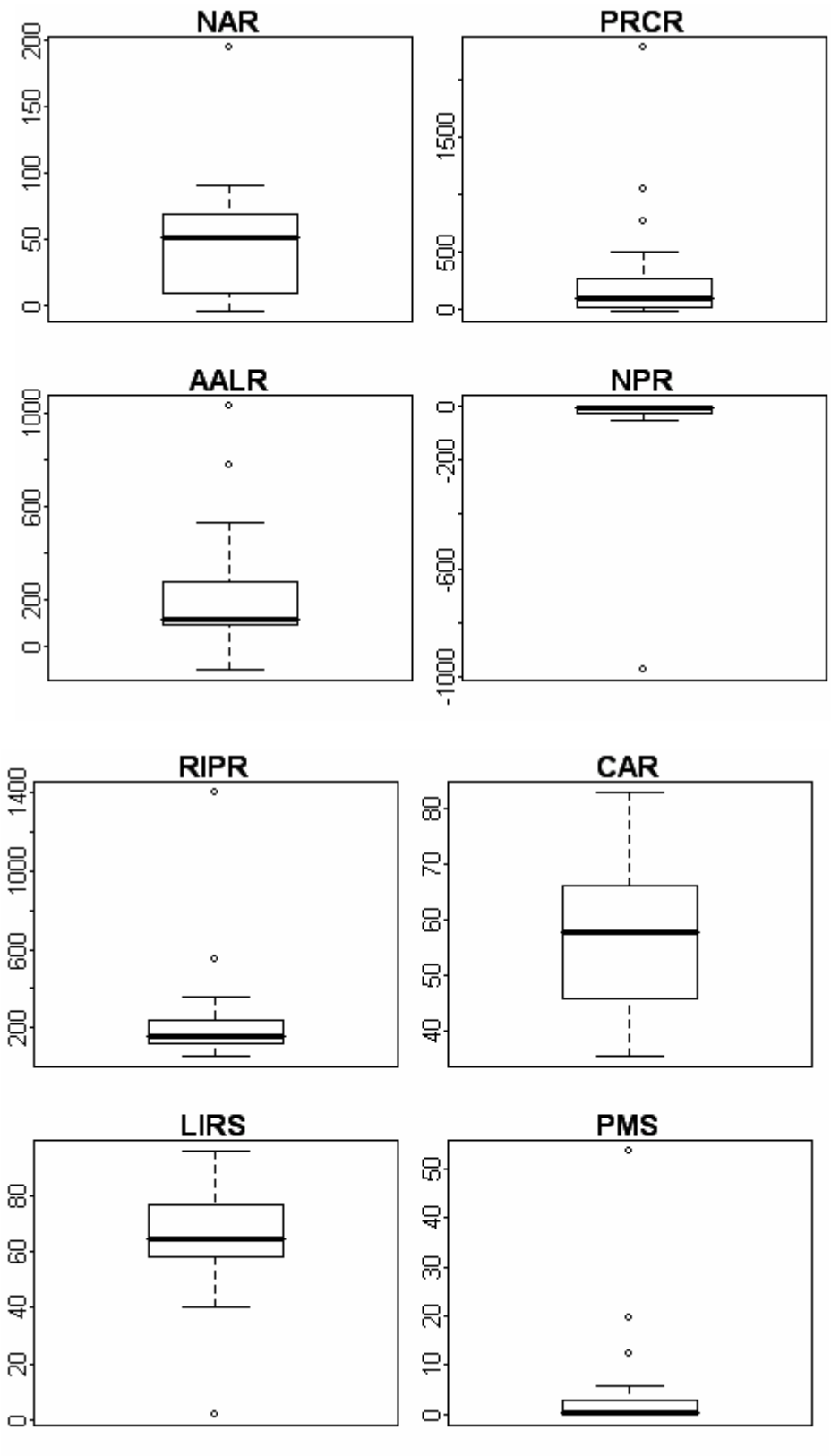
The data of Life Insurance Company A in 2002 are calculated by the equation as below:

The value of Life Insurance Company A in 2002=the value of Insurance Company A in 2002*(The value of Life Insurance Company A in 2003 / the value of A Insurance (Group) Company of China in 2003)

The data of Life Insurance Company A in 2002 come from year book [4].

The total Premium Incomes (Operating Incomes) is ￥301,099 million, which come from year book [1], [2].

The boxplots of data is show as below:


NAR
0
50
100
150
200
PRCR
0
500
1500
AALR
0
200
600
1000
NPR
-1000
-600
-200
0
RIPR
200
600
1000
1400
CAR
40
50
60
70
80
LIRS
0
20
40
60
80
PMS
0
10
20
30
40
50

Statistical method:

Sometimes we encounter the situation that many variables have correlation or high relationship which can together give an explanation to the phenomena. So, it is reasonable for us to use a few combined variables instead of original variables. This process is called data reduction or summarization [3]. Factor analysis and Principle component analysis are used for data reduction and summarization. Factor analysis is a mathematical model which attempts to explain the co-relation among a large set of variables in terms of a small number of underlying factors. It was originally developed by psychologists. The subject was first put on a respectable statistical footing in the early 1940s by restricting attention to one particular form of factor analysis [6]. Nowadays this statistical method is widely used in many fields such as Physic, Economics, Psychologists and Social Science [6].

Factor analysis is a model based technique. It divides original variables into two parts, one is the common factors part which is the portion owned by all observed variables and the other is the unique part which is the portion of each variable. The model of factor analysis is:

$$Z_k = l_{k1}F_1 + l_{k2}F_2 + l_{k3}F_3 + ... + l_{kJ}F_J + u_k$$

Where, k denotes the variable and j denotes the factor (J<K), and

Z_k : Observed values

F_j : Common factors

u_k : Unique factors, residual

l_{kj} : Factor loadings on each of the j factor. Factor loading is the coefficient of the linear relationship between original variables and each factor (or component). It can be used to explain and name the factors or components.

Assumption:

$$E(F_i) = 0, \qquad V(F_i) = I,$$

$$E(u) = 0, \qquad Cov(u_i, u_j) = 0, \qquad i \neq j,$$

And $Cov(F_i, uu_j) = 0.$

Using the composite variables we get many linear combinations of original variables to express the factors, which is factor scores, it is the coefficients in the regression of factors on variables [4].

The criterion of choosing components is based on the variance of the components. If the cumulative variance takes a large proportion of the total variance then there is no need to select more components. In factor analysis we can also apply the method of extracting the numbers of factors we mentioned; on the other hand there are many other ways which can extract factors either.

For our topic, we have eight indexes which have interrelation and are highly related to each other, some of them explain the same phenomena, or have some overlaps in explanation. So we try to use the method of factor analysis to find the latent factors which may give a more reasonable interpretation of our topic.

The Result of Factor Analysis:

This paper uses software SAS to analysis the data of 19 Chinese life insurance companies. The results are showed below.

Table1

Correlation Matrix								
correlation	NAR	PRCR	AALR	NPR	RIPR	CAR	LIRS	PMS
NAR	1.000	0.647	0.290	-0.241	0.426	-0.014	-0.337	-0.391
PRCR	0.647	1.000	0.597	-0.875	0.953	0.035	-0.298	-0.238
AALR	0.290	0.597	1.000	-0.503	0.692	0.011	-0.591	-0.238
NPR	-0.241	-0.875	-0.503	1.000	-0.928	0.044	0.088	0.125
RIPR	0.426	0.953	0.692	-0.928	1.000	0.122	-0.338	-0.118
CAR	-0.014	0.035	0.011	0.044	0.122	1.000	-0.461	0.330
LIRS	-0.337	-0.298	-0.591	0.088	-0.338	-0.461	1.000	0.182
PMS	-0.391	-0.238	-0.238	0.125	-0.118	0.330	0.182	1.000

Table 1 describes the correlation coefficients among the variables from it we can see

that variable 1 and 2 has the highest relationship the coefficient is 0.647.

Total variance explained is presented in table 2, which shows the percentage of total variance explained by each index. Then by the rule of Eigen values over 1, it is better to choose 3 factors, see Table 2. According to Table 2 which indicates that 90.061% of total variance was cumulatively explained by the first 3 factors. Thus, we choose 3 factors in this analysis.

Table 2

Eigen-value and Variance			
	Eigen-value	Proportion	Cumulative
1	3.77446432	0.5702	0.5702
2	1.19367347	0.1803	0.7506
3	1.02968663	0.1556	0.9061
4	0.62446207	0.0943	1.0005
5	0.13522136	0.0204	1.0209
6	-.00694931	-0.0010	1.0199
7	-.01900472	-0.0029	1.0170
8	-.11250462	-0.0170	1.0000

Table 3

Factor Pattern(before rotation)			
Variables	Factor1	Factor2	Factor3
NAR	0.60540	-0.02911	-0.61927
PRCR	0.96701	-0.14396	0.05280
AALR	0.75154	0.20396	-0.07260
NPR	-0.83265	0.30015	-0.42040
RIPR	0.96006	-0.03164	0.28028
CAR	0.07537	0.75565	0.23479
LIRS	-0.45744	-0.64158	0.25041
PMS	-0.27945	0.23828	0.51480

The Factor Pattern shows the factor loadings, which are the correlation coefficients

between the factor and variable. We can see that the first five variables are highly loaded on factor 1.

Rotation is a way to find an easy way to explain the factors, because there is always the situation that one variable significant to more than one factor; it is difficult to identify which variable focus on some factor.

Because factors in this paper are related, we apply the oblique rotation, and try to get a better result to explain. Appendix B describes the inter-factor correlations, for example, values: 0.415 can be seemed to be significant coefficients of the relation between two factors. Table 4 shows rotated pattern matrix, which is the result of the rotation, with the method of Promax.

Table 4

Rotated Factor Pattern (Standardized Regression Coefficients)			
	Factor1	Factor2	Factor3
NAR	0.06409546	0.81149906	0.08624399
PRCR	0.86703304	0.21858274	0.0028234
AALR	0.49246465	0.21330262	0.33403355
NPR	-1.0670226	0.16529899	0.19275
RIPR	0.98544151	-0.0508382	0.1110733
CAR	-0.0162797	-0.4129404	0.78955663
LIRS	0.01152416	-0.2221812	-0.7476011
PMS	0.05936007	-0.6711508	0.18640565

The variables loaded significantly on factor 1 are 2, 3, 4, 5; variables loaded significantly on factor 2 are 3, 6, 7; variables loaded significantly on factor 3 are 6, 8;

The equation of factor scores' can be written as below (see Appendix C)

$$Y_1 = -0.074X_1 + 0.076X_2 - 0.090X_3 + 0.114X_4 + 1.126X_5 - 0.109X_6 - 0.011X_7 - 0.044X_8$$

$$Y_2 = 0.208X_1 + 2.382X_2 + 0.796X_3 - 0.513X_4 - 3.048X_5 + 0.055X_6 - 0.099X_7 - 0.058X_8$$

$$Y_3 = 0.329X_1 - 1.834X_2 - 0.312X_3 + 1.494X_4 + 3.451X_5 + 0.185X_6 - 0.278X_7 - 0.137X_8$$

$$\text{Total score} = 0.5702Y_1 + 0.1803Y_2 + 0.1556Y_3$$ [1]

According to the factor scores we can get the ranks of these companies on each

[1] The three values 0.5702, 0.1803 and 0.1556 are the proportions of total variance explained by factor 1, 2 and 3, respectively. These 3 values can be found in Table 2.

factor (see Appendix D) of and on the total factor scores of each index (see Appendix G). Here we just list the first nine companies in Table 6.

Table 6

Total Rank								
Rank	1	2	3	4	5	6	7	8
Company(with R)	R	Q	J	M	H	P	N	G
Company(without R)	J	Q	M	H	N	P	G	S

To test this model we use sensitivity analysis and observe the relative change in model. Firstly, remove the company R which is the most unstable one among all the companies. Secondly redo the factor analysis with the data of 18 companies. Then get the following results (see Appendix E&F). These results show that the Standardized scoring Coefficients matrix and rotated pattern matrix are changed a lot. And the variables loaded significantly on factor 1 are 1, 2; factor 2 are 3, 5, 7; factor 3 are 4, 6, and 8.

The equation of factor scores' can be written as below;

$$Y_1 = 0.601X_1 + 0.379X_2 + 0.010X_3 + 0.010X_4 + 0.026X_5 + 0.071X_6 - 0.029X_7 + 0.024X_8$$

$$Y_2 = 0.001X_1 - 0.331X_2 + 0.327X_3 - 0.050X_4 + 0.774X_5 + 0.032X_6 - 0.146X_7 - 0.108X_8$$

$$Y_3 = 0.645X_1 - 0.126X_2 - 0.956X_3 + 0.155X_4 + 1.262X_5 + 0.222X_6 - 0.148X_7 + 0.026X_8$$

$$\text{Total score} = 0.5929Y_1 + 0.2402Y_2 + 0.1341Y_3$$

Thirdly, by these we rank these 18 companies again. Although the coefficients of these equations are different, the ranks do not change a lot (see Table 6 and Appendix G&H). This shows that the model is insensitive to the input data variation.

Explanation of the results:

From the above statement and tables, we can find the 1st index Net Profit Ratio has large loadings on Factor 2 in Rotated Factor Pattern (FP, see Table 5), So we the 1st

index Net profit ratio significant on Factor 2. For the 2nd index Payable Ratio of Company-Reserved has large loadings on Factor 1, so we decide this index focus on Factor 1. Using this procedure, we find that the 3rd，4th，5th indexes focus on Factor 1; the 6th ，7^{th} focus on Factor 3; And the 8th index Premium Market Share focuses on Factor 2.

So the indexes focused on the Factor 1 are Payable Ratio of Company-Reserved (PRCR), Actual assets- liabilities ratio (AALR), Net Profit Ratio (NPR) and Return on Investment– Premium Revenue Ratio (RIPR). The 4th index NPR reflects the general profitability of the companies. And the 5th index RIPR is the profitability of investment against premium revenue which is the fund source of investment. So these two indexes reflect the abilities of managing to get income. The other two indexes are got by income or equity items divided by liability or asset item. Company-Reserved Premium is an income item, but means responsibility as well. Companies decide how much premium itself reserves and responsibilities it affords against its net assets owner's equity. On the other hand, the AALR reflects the degree of operation on borrowings (operating companies with some amount of liabilities). Both of these two indexes are up to operation decision of companies. So we name the Factor 1 as Ability of Earning and Operation level.

The Factor 2 is identified by the 1st index Net Assets Ratio (NAR) and the 8th index Premium Market Share (PMS). NAR is obtained from owner's equity divided by total assets. It is the proportion of own funds in total assets and indicates the abundance of capital of companies. PMS is the result of long-term development of one company, and shows the general advantage of one company, including capital, service, products and marketing strategy and so on. So we name the Factor 2 as Strength and Size of companies.

For Factor 3, the 6^{th} and 7^{th} indexes focus on it. The 6^{th} index Current Assets Ratio (CAR) indicates the proportion of current assets in total assets. The current assets evaluate the short-term debt paying ability. The 7^{th} index Life Insurance Reserve Sufficiency (LIRS) is calculated through Reserve for Life Insurance Portfolio divided

by premium revenue, and it reflects the sufficiency of reserve for life insurance portfolio against premium. When risk occurs, current assets and reserve for life insurance portfolio are all the short-term payable money for creditors and insurants, and they reflect the ability against reimburse risk in short term. So Factor 3 can be named as the Short-term Reimburse Ability.

The Factor 1, Ability of Earning and Operation level, which explained 57.02% (see table 2) of the total variance, is the most influential factor. On one hand, having enough income is essential for companies to exist. Companies must get enough revenue to pay the debt, afford the running expenses and fund the development of companies. The more income and profit the company has, the more powerful it becomes to compete and develop. And the life-insurance companies have higher ability to avoid the solvency risk. So the insurance companies must master the technique of investment and keep it enough marketable and profitable. At the same time, the companies should keep large amount income and reduce the running expenditure by efficient management. On the other hand, the company should make most use of liabilities and reinsurance tools in certain limit. Operation with borrowing can reduce the capital cost and expand the size of companies. At the same time insurance companies must control the amount of liabilities and company-reserved premium. Premium income means responsibility of paying or service for the insured as well. More liabilities and company-reserved premium mean more risks. Too much of them can bring serious reimburse risk.

Factor 2, the Strength and Size of companies, is indicated by net assets ratio and premium market share. The net asset is all the assets payable and solvency capital of one company. It shows the whole solvency ability of one company. On the other hand, having more net assets will enable the company to carry more liabilities. As result, the company will have abundant capital to operate. Holding large market share is the result of the long-term development of one company. High market share not only shows the advantage of product and service as a whole, but also indicate the good credit standing and customer loyalty. These not only take the company premium, also itself is excellent tools against solvency risk. So the life-insurance companies should

take effort to increase the market share, and guarantee large amount of premium income, which will also increase the net assets of companies. These two items, net assets and premium market share, can be promoted by each other.

Factor 3, the Short-term Reimburse Ability is identified by the current assets ratio and Life insurance reserve sufficiency. The current assets evaluate the short-term debt paying ability, which will ensure and enhance the solvency. Reserve for life underwriting portfolio is reserved capital against compensation pay-outs. So the companies must have enough current assets to avoid financial risks and sufficient reserve for life underwriting portfolio to satisfy compensation. These two are basic capital for running company. If a company cannot pay the creditor or compensate the insured, this company will fail at once.

Conclusion:

This paper has combined the eight indexes in to three related factors. All of them can be calculated by some original indexes. The equations of these calculations are shown above. Based on this result some advanced research on the given data of Chinese insurance companies can be employed, such as ranking the insurance companies in their solvency, giving the evaluation on some of the abilities of these companies, namely Earning, Reserve sufficiency, Premium Income Level and Net Assets Ratio. These three latent factors can also be employed to seek the relationship between the original indexes. From the table of total rank, given a reference to the table we can see that company R has the highest scores, so it is the best among the 19 life insurance companies. Because it really a complicated job to improve the evaluation model on the solvency of the Chinese Life Insurance Companies, this paper can provide a useful guideline on this work.

Finally, by comparing the result of ranking with company R and without company R (see Table 6 and Appendix G&H) we find that the total rank changed slightly. It shows that our model can get a generalized conclusion people can be confident with it.

Reference:

[1] China insurance year book，(2002), China Year Book Press, Beijing

[2] China insurance year book (2003), China Year Book Press, Beijing

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[5] American Insurance Regulatory Information System

[6] Mardia, K.V., Kent, J.T., Bibby, J.M., (1989), *Multivariate Analysis*, Academic Press Limited, London.

[7] Yanping Wang, (2005), To consummate Chinese life insurance companies' solvency, www.cnki.net

Appendix A **Data**

Insurance Companies	Net assets ratio (%)	Payable ratio of company-reserved (%)	Actual assets-liabilities ratio (%)	Net profit ratio (%)	Return on investment–premium revenue ratio (%)	Current assets ratio (%)	Life insurance reserve sufficiency (%)	Premium market share (%)
A	4.318	12.166	93.380	0.060	195.721	69.439	72.355	53.705
B	5.416	10.009	95.595	0.226	106.218	57.767	75.213	4.431
C	3.392	9.378	94.026	2.926	142.246	51.496	81.413	19.581
D	-3.617	-7.409	92.197	0.298	157.877	83.147	58.393	12.512
E	6.133	8.922	97.614	0.170	100.795	71.051	77.381	5.707
F	20.778	49.973	114.962	-11.728	110.369	46.451	67.099	0.055
G	69.938	231.563	308.885	-26.398	167.413	51.272	62.348	0.056
H	57.374	234.711	217.678	-23.661	280.000	70.707	40.800	0.042
I	50.777	100.891	187.617	-8.387	129.756	66.426	40.447	0.127
J	194.876	1048.010	-95.398	-22.732	332.749	64.337	60.048	0.012
K	13.008	21.062	103.920	-4.317	57.239	35.369	87.872	1.086
L	19.515	36.337	113.636	-7.723	80.802	44.913	64.686	0.202
M	82.552	504.344	531.595	-33.415	355.482	59.617	66.813	0.029

N	69.304	291.623	301.143	-35.782	173.852	42.019	55.942	0.015
O	17.808	45.567	111.255	-7.184	147.541	58.018	64.549	0.162
P	59.627	252.896	235.011	-6.593	190.460	44.906	95.888	0.115
Q	90.922	767.389	1033.068	-21.624	550.839	65.610	2.090	0.020
R	87.963	2282.131	777.822	-972.640	1404.160	55.453	57.600	0.002
S	63.850	205.432	255.492	-49.817	123.655	38.727	83.924	0.027

Appendix B

Inter-Factor Correlations			
	Factor1	Factor2	Factor3
Factor1	1.00000	0.41538	0.27249
Factor2	0.41538	1.00000	0.24682
Factor3	0.27249	0.24682	1.00000

Appendix C

Standardized Scoring Coefficients			
	Factor 1	Factor 2	Factor 3
NAR	-0.07353	0.20764484	0.32906843
PRCR	0.07609528	2.38170335	-1.8387401
AALR	-0.0901368	0.79621989	-0.3120708
NPR	0.11434129	-0.5133385	1.49429516
RIPR	1.12593482	-3.0479648	3.45076107
CAR	-0.1088471	0.05519709	0.18502462
LIRS	-0.0119526	-0.0989497	-0.2775717
PMS	-0.0443416	-0.0578494	-0.1371432

Appendix D

Ranks of the first 9 companies on each factor									
Rank	1	2	3	4	5	6	7	8	9
Factor 1	R	Q	J	M	H	A	P	N	G
Factor 2	R	J	Q	M	N	S	G	P	I
Factor 3	A	D	H	C	O	D	E	F	I

Appendix E

Rotated Factor Pattern (Standardized Regression Coefficients)

	Factor1	Factor2	Factor3
NAR	**1.03330305**	-0.1468645	-0.1521214
PRCR	**0.92976686**	0.09358757	-0.0292993
AALR	-0.2068521	**1.01489447**	-0.2710984
NPR	-0.4026854	-0.1923286	**0.57565786**
RIPR	0.44618599	**0.64724954**	0.17866265
CAR	0.09059951	0.21806412	**0.77654657**
LIRS	-0.0978031	**-0.7238246**	-0.1785058
PMS	-0.2119614	-0.0939026	**0.52827402**

Appendix F

Standardized Scoring Coefficients			
	Factor1	Factor2	Factor3
NAR	0.600854	0.001295	-0.64488
PRCR	0.378832	-0.33056	-0.12642
AALR	0.010166	0.326717	-0.95576
NPR	0.009857	-0.04973	0.154742
RIPR	0.025574	0.774239	1.261832
CAR	0.071014	0.032483	0.221859
LIRS	-0.02905	-0.14567	-0.14843
PMS	0.023888	-0.10835	0.02584

Appendix G

Ranks on each factor						
	Factor 1		Factor 2		Factor 3	
Company	With R	Without	With R	Without	With R	Without
A	6th	14th	19th	4th	1st	2nd
B	16th	16th	15th	13th	6th	7th
C	12th	17th	17th	10th	4th	4th
D	10th	18th	18th	6th	2nd	3rd
E	17th	15th	14th	15th	7th	8th
F	15th	10th	13th	14th	8th	9th
G	9th	6th	7th	5th	15th	15th
H	5th	7th	12th	3rd	3rd	5th
I	13th	9th	9th	11th	9th	12th
J	3rd	1st	2nd	18th	18th	1st
K	19th	13th	10th	17th	13th	11th
L	18th	12th	11th	16th	11th	10th
M	4th	3rd	4th	2nd	14th	17th
N	8th	4th	5th	7th	16th	14th
O	11th	11th	16th	9th	5th	6th
P	7th	5th	8th	8th	12th	13th
Q	2nd	2nd	3rd	1st	10th	18th
R	1st		1st		19th	
S	14th	8th	6th	12th	17th	16th

Appendix H

Total rank		
With Company R		Without Company R
Rank	Company	Company
1	R	J
2	Q	Q
3	J	M

4	M	H
5	H	N
6	P	P
7	N	G
8	G	S
9	A	A
10	S	I
11	I	O
12	O	D
13	D	C
14	C	F
15	F	B
16	B	E
17	E	L
18	L	K
19	K	