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PCA-BP Based Analysis of the Evaluation of Computerized Accounting Information

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Abstract

It is unclear to what extent accounting information can reduce capital risks related to the expected return on a firm's stock, this is a nonlinear problem; meanwhile, PCA-BP method is suitable for nonlinear problem. This study evaluates accounting information' effect on listed companies' capital cost at Stock Exchange based on PCA-BP method. Results show that implementation of accounting information at listed companies can evaluate the cost of capital by the internal controls, the quality of the financial reports and the process of the company's transactions. Our finding provides a direct link between the evaluation of a firm's accounting information and its cost of capital.

Keywords: *Accounting information, Evaluation, PCA-BP, Stock*

1. Introduction

Accounting information is defined as a computer-based technology that processes financial information and supports decision tasks in the context of coordination and control of organizational activities; and an important question in the field of accounting and management decision-making concerns the fit of accounting information with organizational requirements for information communication and control(Nicolaou,2000).It is unclear to what extent accounting information can reduce capital risks related to the expected return on a firm's stock. Asset pricing models, such as the Capital Asset Pricing Model (CAPM) emphasize the importance of difference between risks that are diversifiable and those that are not. Thus, the research question is to demonstrate whether and how firms' accounting information can affect their cost of capital.

The link between accounting information and the cost of capital of firms is one of the most fundamental issues in accounting (Lambert *et al*.,2008). Many researches frequently refer to it. For example, Levitt (1998) suggested that high quality accounting standards can reduce capital costs. Similarly, Foster (2003) claimed that more information always equates to less uncertainty, and people pay more for certainty. Barry and Brown (1985) and Coles *et al*. (1995) compared two information environments: in one environment the same amount of information is available for all firms in the economy, whereas in the other information environment there are more observations for one group of firms than another. They found that the betas of the "high information" securities are lower than they would be in the equal information case. Lambert *et al*. (2008)showed that information quality directly influences a firm's cost of capital and that improvements in information quality by individual firms unambiguously affect their non- diversifiable risks. These findings suggest that a firm's beta factor is a function of its information quality and disclosures. These researches is appealing, while there is little theoretical work on the accounting information' effect on listed companies' capital cost.

This paper defines the cost of capital as the expected return on a firm's stock. This definition is consistent with standard asset pricing models in finance (Fama and Miller,

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1972), many studies in accounting that use discounted cash flow to infer firms' cost of capital (Botosan, 1997; Gebhardt *et al*., 2001), as well as benefits of accounting information, which can be evaluated by its impacts on improvement of decision-making process, quality of accounting information, performance evaluation, internal controls and facilitating company's transactions(Sajady *et al*.,2008).

The study is organized as follows: in the following section, it presents the evaluation system of accounting information. In section 3, it introduces the PCA-BP method, which forms the theoretical foundation of this study. In section 4, it takes empirical researches on accounting information' effect on listed companies' capital cost, as well as the results through which we verify the model. Finally we conclude the whole study.

2. The Evaluation System

Generally, accounting information can 1) provide financial reports on a daily and weekly basis and; 2) provide useful information for monitoring decision-making process and performance of the organization(Sajady *et al*.,2008).Accounting information provides primary data for decision-making, the characteristics of accounting information can help decision-makers seek more alternatives to the solution of the problem in hand. Accessibility to information related to the main transactions of an organization leads to a categorized detailed information which facilitates decision making in any difficult situation(Mia *et al*.,1994).

The Delphi method is especially useful in reducing ambiguity through the use of expert panels of both practitioners and experts and informing relevant and timely issues facing organizations. In essence, the Delphi method has potential to provide both rigor and relevance to accounting information researchers(James *et al*.,2013).

So the accounting evaluation system will be developed to analyze the cost of capital(the expected return on a firm's stock) based on Delphi method. According to the accounting implications of various indicators, the criteria is given 0-25, 25-50, 50-75, 75-100 four intervals to determine indicators score. The details are shown in Table 1.

Table 1. Scoring Criteria

	Scoring criteria			
Indicators	0~25points (not important)	25~50points (common)	50~75points (important)	75~100 points (very important)
Net profit growth				
Asset growth				
Capital growth				
Earnings per share growth				
Earnings per share				
Assets liability ratio				
Debt on capital				
Equity ratio				
Current Ratio				
Quick Ratio				
net assets per share				
Return on Net Assets				
The rate for long-term				

assets				
Cash flow per share				
Cash flow from operations and debt ratio				
Cash flow ratio				
Net cash content				
Sales growth				
capital reserves per share				
the main revenue growth				
Accounts receivable turnover				
Inventory growth				
Operating cycle				
Total profit				
Net profit rate				
Return on Assets				
Return on capital				
net profit growth				

According to the principle of Delphi method, we can identify the evaluation system of accounting information. The evaluation system are shown in Table 2.

Table 2. Evaluation System

Accounting evaluation system	Net profit growth
	Asset growth
	Capital growth
	Earnings per share growth
	Assets liability ratio
	Debt on capital
	Equity ratio
	Current Ratio
	Quick Ratio
	The rate for long-term assets
	Cash flow per share
	Cash flow from operations and debt ratio
	Cash flow ratio
	Net cash content
	Sales growth
	Accounts receivable turnover
	Inventory growth

	Operating cycle
	Total profit
	Net profit rate
	Return on Assets
	Return on capital

3. The Method

A number of indicators will be taken to study the evaluation of accounting information, but there are overlaps of information for these indicators. PCA method is a reduction to high-dimensional variable space under the principle of minimal loss of information; and the new linear combination can reflect the information of original, meanwhile, it can keep most of information of the original variations.

The cost of capital can be calculated by the expected return on a firm's stock. Stock selection is a very complex process, nonlinear methods are also increasingly underlined, BP neural network algorithm is gradually showing its unique position due to its great capacity to deal with nonlinear problems in the study of firm's stock.

Therefore, this paper uses PCA-BP method to study the evaluation of accounting information, so as to analyze the relations between accounting information and expected return on a firm's stock.

3.1. The Principle of PCA Method

Assuming n samples and each sample has p variables, so a matrix of $n \times p$ is constituted:

$$\mathbf{X} = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \cdots & \cdots & \cdots & \cdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{bmatrix}$$

When p is relatively large, it is difficult to calculate in p -dimensional space. To overcome this problem, it needs to reduce the dimensions. Consequently, fewer and comprehensive indexes are extracted from the original ones, and these independent indexes can reflect most of the information of original variables.

Definition: $x_1, x_2, ..., x_p$ is the original variables, $z_1, z_2, ..., z_m (\mathrm{m} \le \mathrm{p})$ is the new variables.

$$\mathbf{X} = \begin{bmatrix} z_1 = l_{11}x_1 + l_{12}x_2 + \cdots + l_{1p}x_p \\ z_2 = l_{21}x_1 + l_{22}x_2 + \cdots + l_{2p}x_p \\ \vdots \quad \vdots \quad \vdots \quad \vdots \\ z_m = l_{m1}x_1 + l_{m2}x_2 + \cdots + l_{mp}x_p \end{bmatrix}$$

Constrains:

(a) z_i is independent with $z_j (i \ne j; i, j = 1, 2, \cdots m)$;

(b) z_1 is the largest variance of a linear combination of $x_1, x_2, ..., x_p$; z_2 is also the largest variance of a linear combination of $x_1, x_2, ..., x_p$;in the same way, z_m is the largest variance of a linear combination of $x_1, x_2, ..., x_p$ .So New variables $z_1, z_2, ..., z_m$ is the principal component.

Based on the analysis above, the essence of PCA method is to determine the original variables' $x_j (j=1,2,3,\cdots,p)$ loading $l_{ij} (i=1,2,\cdots,m; j=1,2,3,\cdots,p)$ on the principal components $z_i (j=1,2,3,\cdots,m)$ .The loadings are the corresponding eigenvectors of the eigenvalues.

3.2. The Principle of BP Method

BP(Back Propagation)neural network is introduced,which belongs to feedforward network. For more details in Figure1.

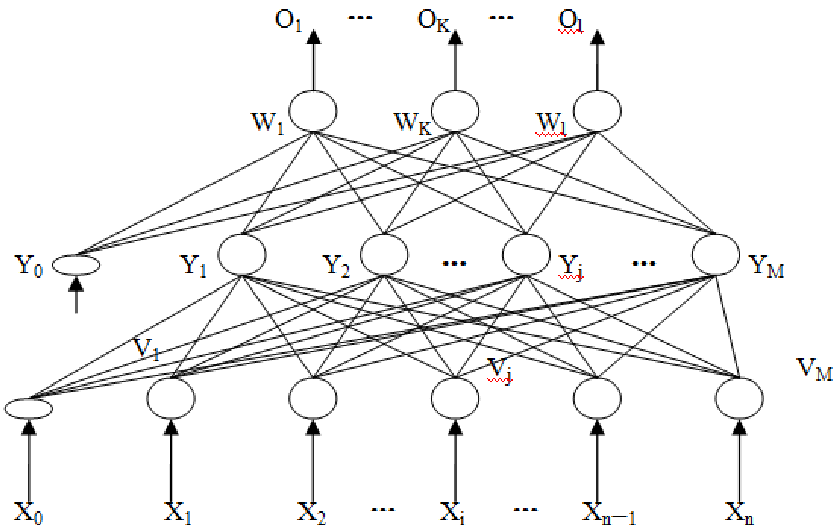

Figure 1. Neural Network Model

In Figure 1, the input vector is $X=(x_1,x_2,\cdots,x_i,\cdots,x_n)^T$;the output vector of the hidden layer is $Y=(y_1,y_2,\cdots,y_j,\cdots,y_m)^T$;the output vector of the output layer is $O=(o_1,o_2,\cdots,o_k,\cdots,o_l)^T$;the desired output vector is $d=(d_1,d_2,\cdots,d_k,\cdots,d_l)^T$ .The connection weights between the input layer and the hidden layer are represented with v, $V=(v_1,v_2,\cdots,v_j,\cdots,v_m)$, column vector v_j of which is the corresponding weights vector of the j-th neuron in the hidden layer. The connection weights between the hidden layer and the output layer are represented with W, $W=(w_1,w_2,\cdots,w_k,\cdots,w_l)$, column vector w_k of which is the corresponding weights vector of the k-th neuron in the output layer. The mathematical model is as follows:

For the output layer:

$$o_k = f(net_k) \qquad k=1,2,\cdots,l \qquad (3.1)$$

$$net_k = \sum_{j=0}^{m} w_{jk} y_j \qquad k=1,2,\cdots,l \qquad (3.2)$$

For the hidden layer

$$y_j = f(net_j) \qquad j=1,2,\cdots,m \qquad (3.3)$$

$$net_j = \sum_{i=0}^{n} w_{ij} x_i \qquad j=1,2,\cdots,m \qquad (3.4)$$

In the two equations above, the transformation function is unipolar sigmoid function:

$$f(x) = \frac{1}{1+e^{-x}}$$

$f(x)$ is continuous and differentiable, and

$$f'(x) = f(x)[1-f(x)] \qquad (3.5)$$

(3.1)-(3.5) constitute the three-layer BP neural network mathematical model. BP neural network algorithm is formed on the basis of the gradient descent,and its learning process (training) is comprised by the forward propagation and back propagation. If the outcome of the output layer is not the desired, then back propagation process begins, recursively calculating the error of the actual value and the desired value layer by layer. PCA-BP method will be developed to analyze accounting information' effect on listed companies' capital cost.

4. The Empirical Research

Data is got from the listed companies in the Shanghai stock market, the sample is 100 stocks ,and the firm is selected according to the internal controls, the quality of the financial reports and the process of the company's transactions. Due to the confidentiality of raw data, they are standardized by expert scoring method.

4. 1. Principal Component Analysis

This paper use SPSS software to do principal component analysis of raw data, the results are seen in Table 3. Four principal components are extracted which can explain 85.17% of the total variance, so the result is acceptable.

Table 3. Variance Contribution Rate

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.294	33.029	33.029	3.960	30.458	30.458
2	2.104	16.185	49.215	2.024	15.569	46.027
3	1.546	11.890	61.105	1.931	14.854	60.881
4	1.179	9.072	85.177	1.208	9.296	85.177

Table 4.The Coefficient Matrix of Principal Component

	Component			
	1	2	3	4
Net profit growth(x1)	.252	-.066	.045	.038
Asset growth(x2)	.248	-.198	.051	.035
Capital growth(x3)	.214	-.009	.020	-.008
Earnings per share growth(x4)	-.080	.273	-.171	.300
Assets liability ratio(x5)	.170	.024	-.037	-.145
Debt on capital(x6)	.193	.008	-.019	-.069
Equity ratio(x7)	.165	.037	-.047	.254
Current Ratio(x8)	-.006	.064	.479	.032
Quick Ratio(x9)	-.057	.468	.027	-.046
The rate for long-term assets(x10)	.013	-.089	.507	.055
Cash flow per share(x11)	-.033	.448	-.018	-.059
Cash flow from operations and debt ratio(x12)	-.020	-.037	.022	.473
Cash flow ratio(x13)	.076	-.015	.065	.648
...	...	...	...	...

So the function of principal component can be got below(Table 4):

F1=0.252x1+0.248x2+0.214x3-0.080x4+0.170x5+0.193x6+0.165x7-0.006x8-0.057x9 +0.013x10-0.033x11-0.020x12+0.076x13

F2=-0.066x1-0.198x2-0.009x3+0.273x4+0.024x5+0.008x6+0.037x7+0.064x8

+0.468x9-0.089x10+0.448x11-0.037x12-0.015x13

F3=0.045x1+0.051x2+0.020x3-0.171x4-0.037x5-0.019x6-0.047x7+0.479x8+

0.027x9+0.507x10-0.018x11+0.022x12+0.065x13

F4=0.038x1+0.035x2-0.008x3+0.300x4-0.145x5-0.069x6+0.254x7+0.032x8-0.046x9+ 0.055x10-0.059x11+0.473x12+0.648x13

And the scores of four principal components can be calculated in Table 5.

Table 5. The Standardized Sample Data

Stock	F1	F2	F3	F4
1	0.69	0.62	0.29	0.03
2	0.76	0.38	0.39	0.05
3	0.68	0.22	1.00	0.16
4	0.39	0.22	0.31	0.07
5	0.81	0.26	0.39	0.02
6	0.65	0.43	0.25	0.13
7	0.41	0.50	0.27	0.09

8	0.76	0.51	0.40	0.04
9	0.74	0.92	0.38	0.08
10	0.69	0.47	0.46	0.00
11	0.72	0.61	0.34	0.02
12	0.61	1.00	0.27	0.09
13	0.53	0.44	0.40	0.03
14	0.67	0.56	0.38	0.14
15	0.73	0.23	0.51	0.14
16	0.65	0.25	0.35	0.15
17	0.41	0.35	0.27	0.13
18	0.67	0.07	0.39	0.04
19	0.89	0.09	0.32	0.04
20	0.93	0.09	0.23	0.00
21	0.88	0.16	0.16	0.19
...	...	...	...	...
100	0.14	0.26	0.29	0.08

The expected return on a firm's stock is positively related with the internal controls, the quality of the financial reports and the process of the company's transactions ,so 100 stocks are chosen as the samples, in which, 50 stocks can get good return, 50 stocks cannot get good return. the value of four principal components is set as the inputs of neural network, 0 and 1 are set the output of the model(if stocks can get good return,1 is set; if stocks cannot get good return, 0 is set).

4.2. Network Training

```
net=newff(minmax(P),[2,1],{'tansig','tansig'},'traingdx')

net.trainParam.show=50;
net.trainParam.epochs=1000;
net.trainParam.mc=0.9;
net.trainParam.goal=0.05;
lr=0.01;
lr_inc=1.05;
lr_dec=0.7;
err_ratio=1.04;

[net,tr]=train(net,P,T);
A = sim(net,P)

E =A-T
MSE=mse(E)

save net1212 net
```

So the error curve is got by the code above (Figure 2).

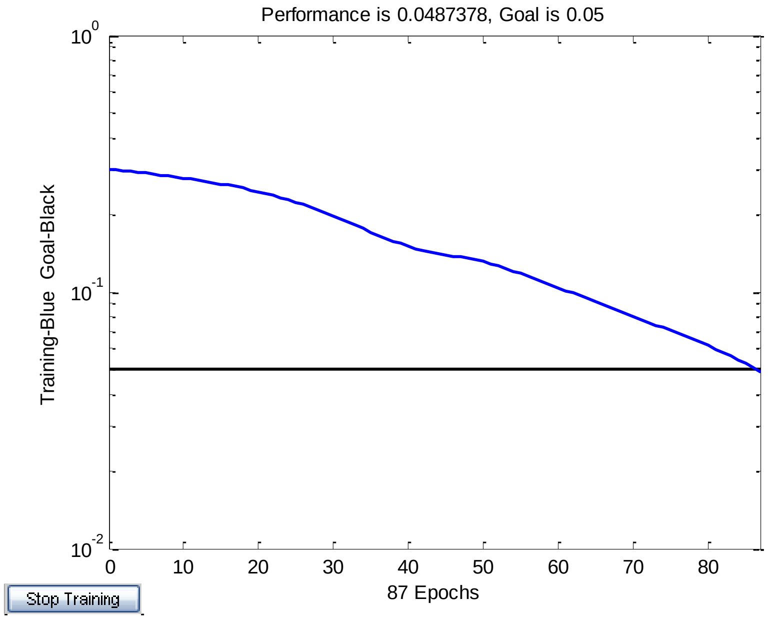

Figure 2.The Error Curve

[net,tr]=train(net,P,T);
TRAINGDX, Epoch 0/1000, MSE 0.300223/0.05, Gradient 0.450795/1e-006
TRAINGDX, Epoch 50/1000, MSE 0.131003/0.05, Gradient 0.210675/1e-006
TRAINGDX, Epoch 87/1000, MSE 0.0487378/0.05, Gradient 0.05998/1e-006
TRAINGDX, Performance goal met.
In Figure 2,the precision of error is meet after 87 times.

4.3. Network Testing

load net1212 net

P1;
A = sim(net,P1)

Load the trained network, input the testing samples,then do network testing after writing the code above.The simulation results are

Columns 1 through 12: 0.9165 0.8136 0.9260 0.7744 0.8959 0.9145 0.9531 0.9502 0.7832 0.9110 -0.5159 -0.1326

Columns 13 through 20:-0.6104 -0.3298 -0.0763 -0.2905 0.3229 -0.1107 -0.1718 -0.2761 0.3229 -0.1107 -0.1718 -0.2761

Convert the results value into 0 or 1 due to the network output setting. The conversion is got according to the distance between the simulation results and 0/1. So the conversion results are:1,1,1,1,1,1,1,1,1,1, 0,0,0,0,0,0,0,0,0,0. The simulation results are summarized in Table 6.

Table 6. Simulation Results

Stock	Forecasting		
	Actual value	**Forecasting value**	**Conversion of Forecasting value**
41	1	0.9165	1
42	1	0.8136	1
43	1	0.9260	1
44	1	0.7744	1
45	1	0.8959	1
46	1	0.9145	1
47	1	0.9531	1
48	1	0.9502	1
49	1	0.7832	1
50	1	0.9110	1
91	0	-0.5159	0
92	0	-0.1326	0
93	0	-0.6104	0
94	0	-0.3298	0
95	0	-0.0763	0
96	0	-0.2905	0
97	0	0.3229	0
98	0	-0.1107	0
99	0	-0.1718	0
100	0	-0.2761	0

Note: the stocks in Table 4 are developed to train the network, the others are used to learn the network.

In Table 6,it can be seen that the simulation results are fully accurate. As we know, more indicators needs more corresponding samples. In the case of less samples but more indicators, the simulation results are still satisfying. Therefore, the model is satisfying, and the topological graph of evaluation can be carried out based on the simulation process and results.

Save the trained network, and by the normalization of the new input(Net profit growth, Asset growth, Capital growth, Earnings per share growth, Assets liability ratio, Debt on capital, Equity ratio, Current Ratio, Quick Ratio, The rate for long-term assets, Cash flow per share, Cash flow from operations and debt ratio, Cash flow ratio, Net cash content, Sales growth, Accounts receivable turnover, Inventory growth, Operating cycle, Total profit, Net profit rate, Return on Assets and Return on capital), then we can get the value of four principal components which is set as the inputs of network,at last, we can get the new output(the new assessment value)based on the well-established model.

The research shows that the neural network-based model can realize the learning, feeding back and intelligent analysis toward a variety of information (including the uncertainties); The results also shows that implementation of accounting information at listed companies can evaluate the cost of capital by the internal controls, the quality of the financial reports and the process of the company’s transactions.

5. Conclusions

This paper builds a framework that links the development of accounting information to the cost of capital,which can be assessed by the internal controls, the quality of the financial reports and the process of the company's transactions. Specifically, we examine whether and how the quality of listed firm's accounting information can manifest its cost of capital.On one hand, by developping the learning and feeding back mechanism for neural network, not only can BP neural network algorithm overcome the slow convergence problem,but increase the precision of evaluation. On the other hand, using the framework, it demonstrates that the quality of accounting information affect listed firm's cost of capital. Actually, based on PCA-BP, increasing the quality of accounting information can generally reduce the cost of capital for listed firm.

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