Investors' Perception of Bank Risk Management: Multivariate Analysis Techniques

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ABSTRACT

According to the nature of their activities, banks are exposed to various types of risks. Hence, risk management is at the heart of financial institutions management. In this study, we intend to summarize the information content of bank financial statements on diverse risks faced by banks and then determine how stock markets react to bank's risk management behavior. The methodology used in this study is the Principal Component Analysis (PCA) and Discriminant Analysis (DA). In this research, we evaluate the status of risk management in listed banks on Tehran Stock Exchange through financial statements analysis and then investigate its relationship with banks' stock returns to determine whether capital market participants take the status of risk management into account in their pricing decisions or not. The results show that provisions taken by banks have a meaningful relationship with the banks' stock returns. However, capital adequacy, net interest margin, and net margin of non-interest income have no significant relationship with stock returns.

Keywords:

Bank Risk Management, Discriminant Analysis, Principal Component Analysis, Financial Reporting.

1. Introduction

Risk arises due to uncertainty about the occurrence of future events and the higher the uncertainty, the higher the risk. Although the concept of risk and methods of dealing with it are considered important in a comprehensive framework of risk management for all enterprises and organizations but the global financial crisis in 2007-2008 showed that risk management has a crucial role in financial institutions management. The same applies to Iranian banks. Iran banking system is also under a lot of pressure. Iranian banks are facing with many risks and Central Bank of Iran is taking more rigorous supervisory actions on banks. As a result, listed banks on Tehran Stock Exchange have dramatically decreased their profit expectations for 2017.

Hence, investors should give more attention to banks risk management status, because the future of the banks' health and profitability depends on it. Therefore, we have conducted our analysis from the perspective of investors and the information they can access about the bank's risk management status. In other words, the importance of banks risk management has been studied from their shareholders point of view to determine if shareholders recognize the importance of risk management in banks or not?

2. Literature Review

Commercial banks deal with various types of risks including credit risk, interest rate risk, liquidity risk, solvency risk, and operational risk. Risk management is the process that the bank takes to identify, quantify, and control the risks that it encounters.

After the global financial crisis, bank risk management attracted a lot of attention from researchers, each emphasizing on different aspects of banks risk management. Jawadi and Louhichi (2017) focused at the recent developments in banks risk management with a particular focus on empirical analyses about banks' regulation and financial risk. they describe a financial atmosphere whereby, in response to the US subprime mortgage crisis and the continuing stress in financial markets, policymakers developed alternative monetary policies to overcome the effects of this crisis. they develop new insights about methodologies and quantitative risk management techniques that assess the effects of the financial crisis and explain its different challenges, and

suggest some solutions. In another study, Buston (2016) found that banks with active risk management were less likely to become insolvent during the crisis of 2007–2008, even though their balance sheets displayed higher risk-taking. Hryckiewicz and Kozłowski (2017) analyzed the banking sector risk structure during the 2007-2008 financial crisis and demonstrated that during the financial crisis, the funding structure was responsible for the systemic effect of the financial crisis. Further, they demonstrated that countries with systemically important banks that rely on investment activities experience a greater, but more short-lived decline in GDP, when compared with countries that have predominantly traditional banking activities. Williams (2016) also found that the 2007-2008 financial crisis changed some aspects of the relationship between bank risk and revenue composition. Non-interest income is generally found to be risk increasing, but some types of non-interest income are risk reducing when bank specialization effects are considered.

Generally, we can categorize studies on banks risk management into two broad categories: studies conducted from bank mangers' perspective (internal perspective) and studies conducted from investors' perspective (external perspective).

Researchers who study bank risk management from internal perspective call for a deeper understanding of how risk and control processes occur and change inside organizations. Therefore, they believe that more longitudinal studies are needed to investigate the dynamics of risk management and identify the drivers that affect its implementation over time (Giovannoni, Quarchioni, & Riccaboni, 2016). Viewing risk management systems as a series of connected paradoxes rather than a set of assured, robust practices, requires a fundamental switch in emphasis away from a normative, standards-based approach to risk management to one which gives greater recognition to its behavioral dimensions (Lim, Woods, Humphrey, & Seow, 2017). Banks governance also has a great impact on bank risk management. Banks with low formal governance target lower default risk. High managerial ownership, not formal governance, is associated with greater reliance on cash instead of equity to limit risk (Calomiris & Carlson, 2016).

Studies conducted from investors' point of view tend to rely on information content of banks financial

statements and try to determine the relationship between bank's risk management status and different aspects of bank's performance. Sensarma and Jayadev (2009) investigated the status of risk management in Indian banks through financial statements analysis and examined the banks stocks sensitivity to their risk management status. They showed that there is a direct relationship between Indian banks risk management status and their stock returns. Moreover, Caner, Ozyilidirim and Ungan (2007) examined the sensitivity of the various stakeholders on the types of risks associated with the bank, and their impact on the risk management of bank. They showed that if shareholders recognize an increased risk in the bank based on published financial statements, they expect that the management will revise its risk management and of course, it will be costly.

Studies conducted on Iranian banks do not answer the question that which kind of risk is perceived to be more important from the investors point of view. However, Motameni *et al.* (2011) explained that merely having good profitability could not lead to a better bank performance. Amirhosseini (2014), also asserts that the ratio of financial facilities to total assets and the ratio of total deposits to total assets has no significant relationship with the profitability but there is a significant and inverse relationship between the ratio of costs to total assets and profitability. Liquidity management has direct and significant relationship with profitability; however, credit risk management has no significant relationship with profitability. Finally, Saeedi and Kamali (2016) investigated the relationship between banks shares return and banks risk-taking condition through an ordinary regression and did not differentiate between more important and less important risk factors.

In this paper, we take the external perspective. Our main hypothesis is whether there is a meaningful relationship between the status of bank risk management and its stock returns.

3. Methodology

Our statistical population includes all fifteen banks listed in the Tehran Stock Exchange in the period from 2004 to 2015. We take all of the statistical population as our sample.

The most important measure of performance of any company from its shareholders is its ROE. Hence,

we use the DuPont equation to decompose the ROE of banks:

ROE=

(Net profit/Total assets) × (Total assets /Equity)
(1)

In equation *(1)*, we express the net profit to total assets ratio as return on assets (ROA). Ratio of total assets to equity becomes equity multiplier (i.e., inversed ratio of capital to assets). In other words, it evokes the concept of capital adequacy. We can further decompose the net profit in ROA ratio to profit from interest margin and commission margin. Therefore, ROA will consist of interest and commission margins minus banks provisions divided by total assets. In this manner, the bank's ROA will break down as follows:

ROA=

[(Interest Revenue-Interest expense) / Total assets] +
[(Commission Revenue – Commission costs) / Total assets] -
[provisions/Total assets]
(2)

Now we can rewrite Equation *(2)* as follows:

ROA=

Net Commission Margin+Net Interest Margin-Ratio of
Provisions to Total Assets
(3)

By replacing Equation *(3)* in Equation *(1)*, we obtain the following equality:

ROE =

(Net Commission Margin + Net Interest Margin - the Ratio of
Provisions to Total Assets) × Equity Multiplier
(4)

Equation *(4)* indicates that a bank can achieve its goal of maximizing shareholder returns through each of the following method:

- Maximizing the net of interest margin
- Maximizing net of commission margin
- Minimizing the ratio of provisions to total assets
- Minimizing the ratio of equity to assets

Now we can look at the risk aspects of our DuPont identity. We determine different bank risk factors by

shows how ROE is related to four indicators of risk management. ROE measures banks profitability from shareholder's perspective and since we aim to evaluate bank's risk from investors point of view it is a suitable measure for starting our analysis.

We consider the following ratios as indicators of different risks associated with banks:

- The ratio of net interest margin to total assets, as an indicator of bank income sensitivity to interest rate changes, or bank's interest rate risk management. Interest rate risk refers to the risk of decline in net interest income of a bank due to change in interest rates (Sensarma & Jayadev, 2009).

- The ratio of provisions to total assets, as an indicator of credit risk status of bank. Credit risk indicates the failure of a bank to receive interest and/or the principal amount from loans. Although, higher provisions reduce the profitability of a bank but higher provisions as percentage of total assets also signal a bank's efforts towards mitigating credit risk. Thus, provisions as percentage of total assets can provide an indication of the extent of credit risk management (Sensarma & Jayadev, 2009).

- The ratio of capital adequacy, as an indicator of solvency risk status of bank. Solvency risk arises out of lack of sufficient funds to pay

breaking down the DuPont identity.

depositors in the event of a run. Capital to assets ratio indicates the cushion available to a bank against unexpected losses and implicitly protects the interests of uninsured depositors. Higher capital to assets ratio builds confidence of bank depositors but may reduce shareholder value due to reduction in ROE (Sensarma & Jayadev, 2009).

- Net margin of commission income to the total assets, as indicators of strategic status of Natural Hedging against the other risks. Banks can adopt a strategy of natural hedging against all types of risks by increasing the proportion of non-interest income out of total income. Non-interest income is generated out of various activities, e.g. through services such as transfer of funds or other payment services, letters of credit, usage of derivative contracts such as forwards, futures, swaps, etc. which increase ROA without any corresponding increase in risks (Sensarma & Jayadev, 2009).

The question here is how to combine these four measures of bank risk status into one comprehensive risk indicator and study its relationship with bank's stock returns in capital market.

We estimate the comprehensive indicator of bank risk status through Discriminant Analysis (DA) and Principal Component Analysis (PCA).
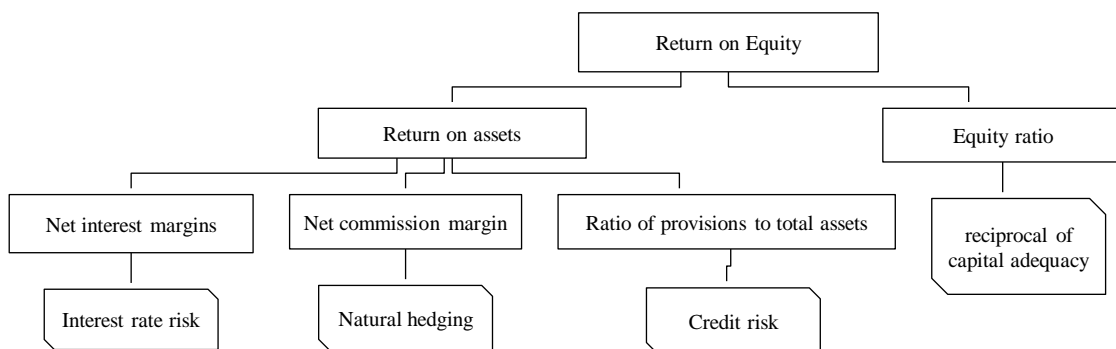

Figure 1: Decomposition of ROE into various measures of risk management using DuPont identity

We classify banks into good and poor risk managers through DA and based on this classification we estimate the Fisher's linear discriminant function whose corresponding values we use as our risk measurement score. In order to investigate the discriminating power of different risk measure (different financial ration in our case) we will use the *t* test. This test allows us to check for the existence of statistically significant differences in the mean values of ratios between the two groups. The null hypothesis states that the mean values of the two groups are equal (M_1=M_2) which means that the two samples come from the same population. If the null hypothesis cannot be accepted then we say that the samples are coming from different populations and they significantly differ with respect to that ratio. The t statistic is given in Equation *(5)*:

$$t = \frac{|M_1 - M_l|}{S_{M1-M2}} \qquad (5)$$

M_1 - M_2 = the difference in means of the two groups;
S_{M1-M2} = the standard deviation of the difference in means;
The standard deviation (S_{M1-M2}) is determined from the variance of the statistic (S^2_{M1-M2}) and from the average dimension of the sub-samples determined as harmonic mean (n_h) as in Equation *(6)*.

$$S_{M1-M2} = \sqrt{\frac{2*S^2_{M1-M2}}{n_b}} \qquad (6)$$

This empirical value of the statistic is compared with the theoretical value for the number of the degrees of freedom (*df = (n_1-1) (n_2-1)*, where n_1 and n_2 represent the dimensions of the two sub-samples) and the significance level (usually 5% but also 1% or even 10%).

On the other hand, PCA transforms the data into lower dimensions such that maximum variation can be explained by a few "principal components". PCA is primarily employed as a dimensionality reduction technique in situations where we have a large number of closely related variables and where we wish to allow for the most important influences from all of these variables at the same time. Factor models decompose the structure of a set of series into factors that are common to all series and a proportion that is specific to each series (idiosyncratic variation). PCA is a technique that may be useful where explanatory variables are closely related -- for example, in the context of near multicollinearity. Specifically, if there are *k* explanatory variables in the regression model, PCA will transform them into *k* uncorrelated new variables. To elucidate, suppose that the original explanatory variables are denoted x_1, x_2 ... x_k, and denote the principal components by p_1, p_2 ... p_k. These principal components are independent linear combinations of the original data

$$p_1 = \alpha_{11}x_1 + \alpha_{12}x_2 + \cdots + \alpha_{1k}\, x_k$$
$$p_2 = \alpha_{21}x_1 + \alpha_{22}x_2 + \cdots + \alpha_2k_{\,xk}$$
$$\dots \dots \dots \dots$$
$$p_k = \alpha_{kl}x_1 + \alpha_{k2}x_2 + \cdots + \alpha_{kk}\, x_k$$

where α_{ij} are coefficients to be calculated, representing the coefficient on the *jth* explanatory variable in the *ith* principal component. It is required that the sum of the squares of the coefficients for each component is one, i.e.

$$\alpha^2_{11} + \alpha^2_{12} + \cdots + \alpha^2_{1k} = 1$$
$$\dots\dots$$
$$\alpha^2_{kl} + \alpha^2_{k2} + \cdots + \alpha^2_{kk} = 1$$

This requirement could also be expressed using sigma notation

$$\sum_{j=1}^{k} \alpha^2_{ij} = 1 \quad \forall \quad i = 1,\dots,k$$

Constructing the components is a purely mathematical exercise in constrained optimization, and thus no assumption is made concerning the structure, distribution, or other properties of the variables. The principal components are derived in such a way that they are in descending order of importance. Although there are k principal components, the same as the number of explanatory variables, if there is some collinearity between these original explanatory variables, it is likely that some of the (last few) principal components will account for so little of the variation that they can be discarded. However, if all of the original explanatory variables were already essentially uncorrelated, all of the components would

be required, although in such a case there would have been little motivation for using PCA in the first place.

Now to study the relationship between the mentioned risk measures and banks stock returns we will use the below model. As theoretically we know that there is a great relationship between the changes in bank's earnings and its stock price, we consider the changes in banks announced earnings as an independent variable that can explain a portion of banks stock return in capital market. We also consider the systematic risks of the market by taking into account the market return in our model. Therefore, our model for studying the relationship between banks risk management status and their stock returns is as follows:

$$RET_{it} = \alpha + \beta RET_{market(t)} + \gamma UE_{it}$$
$$+ \delta RISKMGMT_{it} + \varepsilon_{it}$$
$$(7)$$

Where:

RET_{it}: Bank i stock return in year t

RET_{market}: Market return

UE_i: Bank i earnings changes

$RISKMGMT_i$: Bank i measure of risk management

ε: error term

To select the criteria for placement as RISKMGMT, we refer to four parameters that we determined before and the comprehensive indicators of risk that we can obtain through DA and PCA.

4. Results

We extracted the following data from financial statements of each bank in each year:

- NII: non-interest income or net commission income
- II: interest income or net banking interest
- NIE: non-interest expense or commission costs
- IE: interest expense
- UE: changes in banks announced earnings
- TA: total assets

Then by using these data, we calculated the following indicators of the risk management status in banks:

- NETIM: net interest margin
- PROVTA: provisions to total assets
- NONIM: non interest margin
- EM: equity multiplier

Figure **2** shows the overall trend of these indicators during the studied period:

As the above figure shows, the capital adequacy ratio, and net interest margin of banks had a notable upward trend from 2009 to 2011 but then decreased afterward. Therefore, we can see that their risk management indicators do not show positive signs in the recent years. Moreover, according to meeting dated 21/02/2010, the Money and Credit Council ratified that the minimum capital requirement for the establishment of private banks is 115 million dollars, which is why we observe that the capital adequacy average of banks has experienced significant growth during the mentioned period.

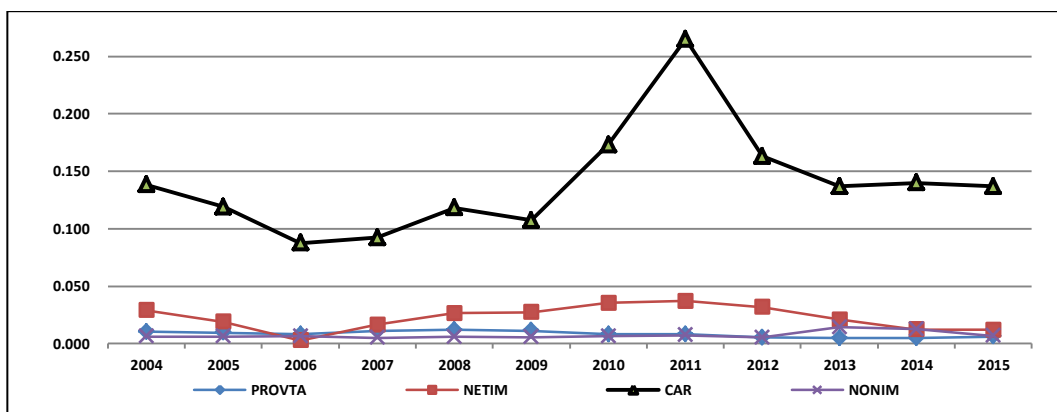Figure **3** shows the status of stock return and market return.

Figure 2: The trend of changes of banks risk management status indicators
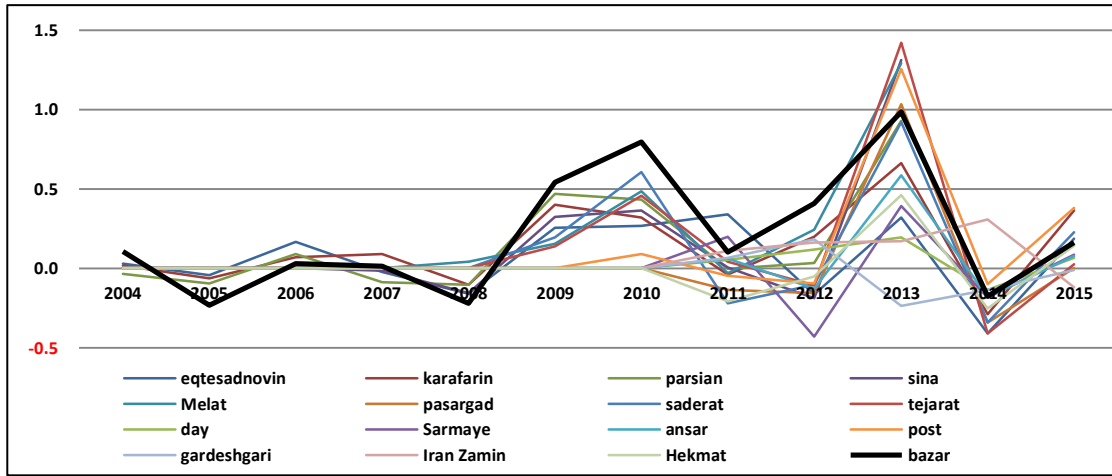
Figure 3: The trend of changes of banks stock returns and market return

As Figure 3 demonstrates, banks stock returns tend to co-move with market return, which indicates the significant impact of market return on banks stock returns (i.e. high systematic risk).

Now, we start with PCA as a technique for developing a summary measure of risk management.

Table 1: Results of Principal Component Analysis (PCA)

	Principal Component Analysis	
	PRIN1	**PRIN2**
CAR	-0.091	0.82
NETIM	-0.53	0.65
PROV	0.57	0.64
NONIM	0.92	0.08

As

Table 1 indicates, the effect of independent variables on return of shares includes two components.

Results of the DA are presented in

Table 2. Since the principal components explain only the maximum variation in the data, we try to use DA, which would classify banks into good risk management and poor risk management categories thereby resulting in an overall risk score. However, we are constrained by the absence of any a priori classifying variable. We attempt to resolve this problem in two ways. First, we take the mid-point of

the AVERAGE as the cut-off and classify all banks with higher AVERAGE value than the mid-point (median value) as lower risk banks and those below as higher risk banks. The justification for using the mid-point is that any bank with "average" risk indicators above the mid-point should be at least better than the centrally located bank. Thus, this can be a simple way to classify banks into risky and safe groups. Using this classification, we estimate the Fisher's linear discriminant function whose corresponding values we use as our risk measurement indicator.

Table 2: Results of Discriminant Analysis (DA)

With mid -point of average score as cut-off	Zscore= 0.65NETIM-0.49N0NIM + 0.25CAR + 0.52PROV Wilk's λ F statistic=0.63 (p=.0145)

Table 2 indicates that DA is an appropriate method because λ is more than 0.5.

Table 3: Regression of Stock Returns on all Risk Management Variable

	Estimate of coefficient	P-Value
intercept	-35.80	0.38
RET$_{market}$	3.68	0.02
UE	31.68	0.03

NETIM	475.08	0.67
NONIM	-5317.32	0.57
CAR	-370.35	0.64
PROV	16.29	0.03
Adjusted R^2	0.3	
F-statistic	0.03	0.03
Durbin Watson test statistic	2.64	

As Table 3 indicates, stock returns and earning changes (UE) have a significant relationship because its P-value is less than 5 percent. In risk management indicators, the ratio of provisions to total assets (PROV) has a significant relationship with stock return.

Table 4: Regression of Stock Returns on Average Risk Management Score

	Estimate of coefficient	P-Value
intercept	-24.10	0.23
RETmarket	2.72	0.002
UE	27.31	0.04
average	-594.57	0.79
Adjusted R2	0.53	
F-statistic	7.35	0.002
Durbin Watson test statistic	2.76	

As

Table 4 indicates, stock returns and the average of risk management measures do not have a meaningful relationship because P-value is more than 5 percent.

Table 5: Regression of Stock Returns on Principal Components

	Estimate of coefficient	P-Value
intercept	-12.99	0.34
RETmarket	2.19	0.00
UE	22.55	0.06
PRIN1	-37.25	0.45
PRIN2	-5.67	0.68
Adjusted R2	0.47	
F-statistic	5.59	0.003
Durbin Watson test statistic	2.78	

As

Table 5 indicates, stock returns and Principal components do not have a significant relationship because P-value is more than 5 percent.

Table 6: Regression of Stock Returns on Total Principal Components

	Estimate of coefficient	P-Value
intercept	-24.88	0.24
RETmarket	3.82	0.002
UE	38.3	0.07
PRINtotal	-13.22	0.58
Adjusted R2	0.48	
F-statistic	7.57	0.002
Durbin Watson test statistic	2.66	

Moreover, as demonstrated in the above table, stock returns and total Principal component (situation of the risk management in total banks) do not have a meaningful relationship.

Table 7: Regression of Stock Returns on Z SCORE

	Estimate of coefficient	P-Value
intercept	-25.14	0.24
RETmarket	2.83	0.003
UE	28.10	0.07
z-score	-174.03	0.72
Adjusted R2	0.47	
F-statistic	7.24	0.03
Durbin Watson test statistic	2.59	

Finally, as Table 7 indicates, stock returns and discriminate factor (z-score) do not have a meaningful relationship because P-value of z-score is more than 5 percent.

5. Discussion and Conclusions

In this paper, we studied banks risk management from investors' point of view and therefore we used ROE as an important financial ratio for investors. We decomposed this ratio to several measures of various bank risks. Then we used DA and PCA to obtain a comprehensive indicator of bank risk status.

Our results show that the ratios comprised of net margin of banking interest, capital adequacy and non-interest margin, which respectively represent banks' interest rate risk, solvency risk and finally its strategic status of natural hedging against the other risks, do not have a meaningful relationship with banks stock

returns. However, our results show that investors in their investing decisions only rely on bank's provisions as an indicator of bank risk status. Therefore, because we found the relationship only holds for one measure of bank risk management, there was no meaningful relationship between comprehensive indicators of banks risk management, derived through DA and PCA, and banks stock returns.

The aim of this study is to provide a criterion for investors on their investment decisions about banks stocks so they can decide about buying or selling stocks of banks and evaluate them based on the assessment of their risk management status, along with consideration of other factors affecting banks stock returns. Each of the mentioned variables can be considered as a measure of bank risk management status. In this regard, investors should use financial ratios that have a meaningful relationship with stock returns, in other words, they should pay attention to the signals of financial ratios.

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