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R^2-BASED DIVERSIFICATION AND INCENTIVES OF BANKS

Seok Weon Lee

Abstract

In this study, we find that the banks with high degree of risk diversification, and therefore, which are presumed to have low probability of bankruptcy and for which the market discipline of being imposed higher cost of capital (or, mainly deposit interest rate) with the increase in risk taking is not efficiently imposed, tend to have the moral-hazard incentives to connect such advantages of better risk diversification to higher risk taking, especially market-related systematic risk taking to increase profit. The result of this study suggests a very important policy implication for the stability of banking industry. If advantage of risk diversification of large banks' asset portfolio composition, following lack of creditors' motive for surveillance of large banks' risk-taking behavior, and following large banks' moral hazard is an inevitably occurring phenomenon, increase of simple asset size by mergers and acquisitions without additional monitoring system for the risk-taking behavior of these large banks has a high possibility to bring about another moral hazard of large banks and cannot be expected to surely contribute to the structural stability of banking industry.

Key words: Banking industry, Risk diversification, Moral hazard, Risk-taking, Capital-market risk measures.
JEL classification: G21

I. Introduction

In banking literature, researchers predict that the larger the bank's asset size is, the higher the degree of risk diversification of the asset-portfolio composition will be. Banking literature also predicts that large banks, with higher degree of risk diversification, will have the moral-hazard incentives to connect such advantages of better risk diversification to higher risk taking. Because the larger the asset size is, the higher the degree of risk diversification of the asset portfolio appears to be, thus, investors believe that the possibility of bankruptcy of large banks would be very low. Thus, in the case of large banks, positive sensitivity of investors' required return to taking high risk would be very low. The market mechanism of higher cost of capital for greater risk taking may not operate as an effective restraint factor for large bank's risk-taking behavior. Liang and Rhoades (1991) found that as bank's asset size increases, the degree of risk diversification on balance sheet increases and capital-to-asset ratio decreases. Demsets and Strahan (1997) found a significantly positive correlation between the degree of risk diversification in banks measured by R^2 in the market model and asset size. Also, they found that large banks have moral-hazard incentives to connect such advantage of better risk diversification to maintenance of low capital-to-asset ratio and taking risky projects concentrated on commercial and industrial loans. Akhavein, Berger and Humphrey (1997) argued that the main cause of bank mergers is the motivation of high risk-taking and increase of profit through it due to increase of asset size. Saunders, Strock and Travlos (1990) found that positive correlation exists between asset size and risk taking of which is measured by the systematic risk of stock return.

However, direct study between the degree of risk diversification of banks and risk-taking behavior is insufficient in the literature. Most researches first show that the positive correlation exists between bank's asset size and degree of risk diversification. Then, based on such relation, by showing the positive correlation between bank's asset size and risk taking, actually, it wasn't all direct study between the degree of risk diversification and risk-taking behavior. Supplementing the logical weakness in the precedent studies, this research directly examines the relationship between the degree of risk diversification in banks and risk taking employing 76 banks from 1988 to 1997 listed in U.S. stock market.

In this study, using the three capital market-related risk variables measured from the daily stock returns and those on the balance sheet, we directly examined the relationship between the risk diversification and risk taking. We found that banks with high degree of risk diversification in period *t* have significantly higher incentives to connect such advantage of better risk diversification to pursuit of highly risky policy in next period *t*+1.

Also, in comparison of group of banks with high degree of risk diversification and group of banks with low degree, we found that the increase in degree of risk taking with one unit of increase in risk diversification is more significant in the former group than in the latter one. Furthermore, we examined the risk-taking behavior of banks in more detail by dividing the risk-taking variable into market-related variable and firm-specific variable. We found that the degree of increase in (market-related) systematic risk taking with respect to the increase in one unit of the risk diversification is significantly higher in the group of banks with higher degree of risk diversification than in the group of bank with low degree of risk diversification. In regard to unsystematic risk-taking variable, no significant difference could be found between the two groups.

Overall, the results in this study show that the banks with high degree of risk diversification, and therefore, which are presumed to have low probability of bankruptcy and for which the market discipline of being imposed higher cost of capital (or, mainly deposit interest rate) with the increase in risk taking is not efficiently imposed, tend to have the moral-hazard incentives to connect such advantages of better risk diversification to higher risk taking, especially market-related systematic risk. The result of this study suggests a very important policy implication for the stability of banking industry. If advantage of risk diversification of large banks' asset portfolio composition, following lack of creditors' motive for surveillance of large banks' risk-taking behavior, and following large banks' moral hazard is an inevitably occurring phenomenon, increase of simple asset size by mergers and acquisitions without additional monitoring system for the risk-taking behavior of these large banks has a high possibility to bring about another moral hazard of large banks and cannot be expected to surely contribute to the structural stability of banking industry.

In the next section, we describe the sample of banks. Section 3 describes the variables that are employed in this study to examine the relationship between the degree of risk diversification and risk taking, giving the correlations for the variables. Section 4 presents the hypotheses to be tested and the basic regression model used to test them. Section 5 provides a robustness test. Section 6 offers concluding comments.

2. Sample and Data

The sample for this research consists of 76 bank holding companies for which data are available on both the Standard & Poor's Stock Report and the Center for Research in Security Prices (CRSP) data tapes during the period of 1988-1997. The Standard & Poor's Stock Report contains year-end balance sheets and other financial data for the bank holding companies which are publicly traded in New York Stock Exchange (NYSE), American Stock Exchange (ASE) and National Association of Securities Dealers Automated Quotations (NASDAQ). From the Standard & Poor's Stock Report, we obtain the data of capital-to-asset ratio, book value of share, asset size and loan-to-asset ratio. Our analysis is based on those bank holding companies that traded every day (except for holiday) of each year's 4th quarter for the whole sample period. Daily stock return data are obtained from the CRSP data base. Daily returns are adjusted to account for dividend payouts and stock splits.

3. Variables and Correlation Tests

In this research, as the measure for bank's risk taking, three kinds of capital market-related risk-taking variables (standard deviation, systematic and unsystematic risk of stock returns) are used. If the capital market operates quite efficiently, the change of bank's risk taking activity will sensitively be reflected in the change of stock price. Many precedent research used these capital market

risk variables; for example, Saunders, Strock and Travlos (1990), Demsetz and Strahan (1997), Demsetz, Saidenberg and Strahan (1997), Galloway, Lee and Roden (1997) and Esty (1998), etc.

In this study, capital-to-asset ratio and q-ratio (market-to-book ratio of stock price) are used as main explanatory variables influencing bank's risk-taking as well as R^2, which is estimated form one-factor market model as the measure for risk-diversification of bank's asset portfolio. With limited liability, stockholders of a corporation can walk away without further losses when the net worth of the firm falls below zero. Stockholders can thus increase their wealth at the expense of debtholders by pursuing risky strategies. With high level of risk, it is more likely that the return from assets will turn out to be very high. High level of risk also increases the possibility of an extremely low return. Limited liability, however, protects stockholders from incurring additional losses when once net worth falls below zero. In other words, with limited liability, it is more likely that losses from high risk-taking will be borne ultimately by debtholders, while the benefit from it will be captured by stockholders. Thus, the lower the capital-to-asset ratio is, the greater the level of risk-taking is. We use the bank's book value of capital-to-asset ratio since this is the leverage measure most commonly monitored by regulators. There are a number of previous studies that discovered the negative relationship between capital-to-asset ratio and risk-taking including Galloway, Lee and Roden (1997), Gunther and Robinson (1990), Mckinzey, Cole, and Brown (1992). Market-to-book equity ratio of a bank is used as a measure of its charter value reflecting the economic value of future growth opportunity. A bank with a high charter value has an incentive to avoid risky strategies, since the owners of the bank cannot sell the charter if the bank is declared insolvent. Thus, the lower the charter value is, the greater the level of risk-taking will be. Keeley (1990) argued that increased competition in the banking sector in the 1980s reduced the charter value of banks and thus increased their incentives to take risk.

In this study, the coefficient of determination (R^2) of (one factor) market model is used as the measure of the degree of risk diversification to examine the relationship between the degree of risk diversification and risk-taking of the bank. There are several studies that used R^2 of market model as a measure of degree of risk diversification including Barnea and Logue (1973), Roll (1988), and Demsetz and Strahan (1997). Insofar as the market index reflects the entire economy, R^2 of the market model in which the return on market index is the explanatory model and the individual firm's stock return is the explained variable should reflect the degree to which a given firm is related to the economy in the aggregate – how well the firm mirrors the diversity of the economy and the relative importance attaching to each segment of the firm's activity within the context of the whole economy. In other words, if a variation of market portfolio as an explanatory variable in market model properly reflects a variation of the entire economy, the goodness of fit between the stock return of a firm with a large degree of asset portfolio's risk-diversification and the return on market portfolio, (R^2), will appear high compared to a firm with a small degree of risk-diversification.

As a preliminary test, correlation coefficients among the capital-to-asset ratio, q-ratio (market-to-book ratio of stock price), and R^2 are estimated first. R^2, the measure of the bank's degree of risk diversification, is estimated from one-factor market model that uses the S&P 500 as a market portfolio. Capital-to-asset ratio and q-ratio are each bank's year-end values. As shown in Table 1, there is a significantly negative correlation between capital-to-asset ratio and R^2. Thus, the degree of risk-diversification is higher for the banks with lower capital-to-asset ratio. Considering that large banks generally have low capital-to-asset ratio, and also are believed to have better diversification in asset portfolio, this result may be understood. On the other hand, between q-ratio and capital-to-asset ratio, there exists a significantly positive correlation. This means that the lower the capital-to-asset ratio is, the more negative evaluation on future growth possibility by investors in the stock market is made.

Table 1

The Pearson correlations among the explanatory variables that are known to affect the risk-taking behavior of banks

	Capital-to-asset ratio	q ratio	R^2
Capital-to-asset ratio	1		
q ratio	0.1882***	1	
R^2	-0.1453**	0.0429	1

Note: One, two, or three asterisks indicate statistical significance at the 10, 5, or 1% significance level, respectively.

To examine the relationship between the bank's asset size and the degree of risk diversification, Pearson and Spearman correlation coefficients are estimated between asset size and R^2. As shown in Table 2, these coefficients are consistently significantly positive over 1988-1996 period. Thus, the degree of risk-diversification is higher for the banks with larger asset size. This result is consistent with that of Barnea & Logue (1973), and Demsetz & Strahan (1997).

Table 2

The Pearson and Spearman correlations between the bank's asset size and the degree of risk diversification

	Pearson correlation	Spearman correlation
1988	0.19**	0.23*
1989	0.52**	0.47***
1990	0.37***	0.35**
1991	0.48**	0.43**
1992	0.30**	0.38**
1993	0.18**	0.17*
1994	0.46**	0.41**
1995	0.38**	0.26**
1996	0.28***	0.30*
1997	0.36**	0.26**

Note: One, two, or three asterisks indicate statistical significance at the 10, 5, or 1% significance level, respectively.

4. Testable Hypotheses and testing Models

To examine the relationship between the bank's risk diversification and moral hazard, we regress the following pooled cross-sectional and time-series model over the period of 1988-1997 and estimate the coefficient b_3. We estimate lagged regression equation between the degrees of risk diversification and risk taking.

$$\sigma_{i,t+1} = b_0 + b_1(\text{Capital-to-asset})_{i,t} + b_2(q \text{ ratio})_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t} . \quad (1)$$

The result of the above estimation is presented in Table 3. As shown in the table, coefficient b_3 is significantly positive at 1% significance level. Thus, as the degree of risk diversification at current period (t) increases, the risk-taking of the bank at next period (t+1) increases. For the q ratio, the coefficient is significantly negative, which is consistent with the implication of the literature. However, the coefficient on the capital-to-asset ratio is not negative.

Table 3

The coefficients and t-statistics from pooled cross-sectional, time-series regression over the period of 1988-1997

	Whole sample	Group of the banks with higher degree of risk diversification	Group of the banks with lower degree of risk diversification
Intercept	-0.0042 (-0.76)	0.0112 (0.96)	-0.0053 (-1.43)
$(\text{Capital-to-asset})_{i,t}$	0.0428 (1.35)	-7.6×10^{-5} (-0.81)	0.0270 (1.12)
$(\text{q ratio})_{i,t}$	-0.0075 (-1.38)	-0.0319*** (-2.82)	-0.0102 (-0.12)
$(R^2)_{i,t}$	0.0491*** (3.91)	0.0470*** (2.28)	0.0413* (1.63)
F-statistic Adjusted R^2 No. of observations	4.95*** 0.08 684	6.40*** 0.07 342	2.53* 0.06 342

Note: One, two, or three asterisks indicate statistical significance at the 10, 5, or 1% significance level, respectively. $\sigma_{i,t+1} = b_0 + b_1(\text{Capital-to-asset})_{i,t} + b_2(q \text{ ratio})_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t}$.

As an additional analysis about bank's risk diversification and moral hazard, whole samples are divided into two groups: banks with high degree of risk diversification and banks with low risk diversification. For each group, the above equation (1) is estimated. In each sample year, if the risk diversification index R^2 was larger than the median for all banks, a bank was classified as bank with high degree of risk diversification, if lower, classified as bank with small degree of risk diversification. The result is also presented in Table 3. As shown in the table, the increase of risk taking given one unit of increase of risk diversification is significantly greater for the group of banks with high degree of risk diversification than group of banks with low degree of risk diversification. Thus, the motivation for moral hazard to connect the advantage of higher risk diversification to higher risk-taking is greater for the group of banks with high degree of risk diversification

The relationship between bank risk diversification and moral hazard is tested further by decomposing the standard deviation of stock returns into two components, systematic risk (β) and unsystematic or firm-specific risk ($\sigma^2(\varepsilon)$). Both β and $\sigma^2(\varepsilon)$ are estimated from the one-factor market model using the S&P 500 as the market portfolio.

$$\beta_{i,t+1} = b_0 + b_1(\text{Capital-to-asset})_{i,t} + b_2(q \text{ ratio})_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t}, \quad (2)$$

$$\sigma^2(\varepsilon_{i,t+1}) = b_0 + b_1(\text{Capital-to-asset})_{i,t} + b_2(q \text{ ratio})_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t}. \quad (3)$$

As shown in Table 4, the coefficient on R^2 is significantly positive for the systematic risk-taking variable, β, however, not significant for the unsystematic risk-taking variable, $\sigma^2(\varepsilon)$, though positive. This result indicates that the banks have moral hazard incentives to connect the advantage of higher risk diversification to, especially, higher systematic risk-taking. This result may be very important if our general belief is that systematic risk may be a more appropriate one for measuring the bank's risk status than unsystematic risk. Many researchers argue that the bank's riskiest assets are loan to large businesses, and the default risk of these loans largely depends on the economic fluctuations, and therefore, bank's risk may well be reflected by its stock-return beta. Also, as shown in Table 5, the group of banks with higher degree of risk diversification has significantly more incentives for taking systematic risk than the group of banks with lower degree of risk diversification. However, for the unsystematic risk-taking measure, the difference between the two groups is not significant.

Table 4

The coefficients and t-statistics from pooled cross-sectional, time-series regression over the period of 1988-1997

	Dependent variable: $\beta_{i,t+1}$	Dependent variable: $\sigma^2(\varepsilon)_{i,t+1}$
Intercept	0.0882 (0.70)	-0.0042 (-0.03)
$(\text{Capital-to-asset})_{i,t}$	1.3854 (0.43)	0.1107 (0.28)
$(\text{q ratio})_{i,t}$	-2.2843 (-1.50)	-0.1073 (-1.25)
$(R^2)_{i,t}$	0.3012*** (2.76)	0.0709 (1.37)
F-statistic Adjusted R^2 No. of observations	5.34*** 0.08 684	4.42*** 0.05 684

Note: One, two, or three asterisks indicate statistical significance at the 10, 5, or 1% significance level, respectively. $\beta_{i,t+1} = b_0 + b_1(\text{Capital-to-asset})_{i,t} + b_2(q \text{ ratio})_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t}$, $\sigma^2(\varepsilon_{i,t+1}) = b_0 + b_1(\text{Capital-to-asset})_{i,t} + b_2(q \text{ ratio})_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t}$.

Table 5

The coefficients and t-statistics from pooled cross-sectional, time-series regression over the period of 1988-1997

	Dependent variable: $\beta_{i,t+1}$		Dependent variable: $\sigma^2(\varepsilon)_{i,t+1}$	
	Group of the banks with higher degree of risk diversification	Group of the banks with lower degree of risk diversification	Group of the banks with higher degree of risk diversification	Group of the banks with lower degree of risk diversification
Intercept	0.0483 (1.42)	0.0359 (0.95)	-0.0438 (-0.24)	0.0017 (0.13)
$(\text{Capital-to-asset})_{i,t}$	0.9853 (0.15)	0.1127 (0.75)	-0.0725 (-0.13)	0.0347 (0.88)
$(\text{q ratio})_{i,t}$	-1.8829 (-1.35)	-0.9537 (-1.28)	-0.0273 (-0.43)	-0.0528 (-0.42)
$(R^2)_{i,t}$	0.3173*** (2.69)	0.0881* (1.82)	0.107 (0.43)	0.0588 (0.42)
F-statistic Adjusted R^2 No. of observations	4.88*** 0.06 342	5.27*** 0.04 342	4.07** 0.5 342	4.75*** 0.04 342

Note: One, two, or three asterisks indicate statistical significance at the 10, 5, or 1% significance level, respectively. $\beta_{i,t+1} = b_0 + b_1(\text{Capital-to-asset})_{i,t} + b_2(q \text{ ratio})_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t}$, $\sigma^2(\varepsilon_{i,t+1}) = b_0 + b_1(\text{Capital-to-asset})_{i,t} + b_2(q \text{ ratio})_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t}$.

5. Robustness Test

The robustness of the previous results is tested employing several balance sheet risk characteristics: loan-to-asset ratio, commercial loans-to-total loans, real estate loans-to-total loans, and consumer loans-to-total loans. The higher the loan-to-asset ratio is, the greater the degree to which the bank's performance is exposed to economic fluctuation, which would increase the risk of the bank. Also, commercial loans and real estate loans are considered to be very risky loans, while consumer loans are safer. The previous researches that used balance sheet risk-taking variables include Gunther and Robinson (1990), Demsetz, Saidenberg and Strahan (1997), and Bernanke and Lown (1991).

Table 6

The coefficients and t-statistics from pooled cross-sectional, time-series regression over the period of 1988-1997

	Whole sample	Group of the banks with higher degree of risk diversification	Group of the banks with lower degree of risk diversification
Intercept	0.879*** (7.27)	0.4545*** (6.35)	0.4386** (7.28)
(Capital-to-asset)$_{i,t}$	0.4286 (0.42)	0.5587 (0.43)	0.1683 (1.08)
(q ratio)$_{i,t}$	-0.0788* (-1.66)	-0.0725* (-1.72)	-0.0775* (-1.67)
(R^2)$_{i,t}$	0.7288*** (4.28)	0.7575*** (3.69)	0.4835** (2.27)
F-statistic	7.25***	5.17***	4.28***
Adjusted R^2	0.07	0.06	0.05
No. of observations	684	342	342

Note: One, two, or three asterisks indicate statistical significance at the 10, 5, or 1% significance level, respectively. (Loan-to-asset)$_{i,t+1} = b_0 + b_1$(Capital-to-asset)$_{i,t} + b_2$(q ratio)$_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t.}$

As shown in Table 6, the banks with high degree of risk diversification have greater risk-taking incentive by maintaining higher loan-to-asset ratio and increasing the risk of business. In comparison of two groups, the coefficient on R^2 is more significant and greater for the group of banks with high degree of risk diversification. Also, as shown in Table 7, we have similar result when the risk-taking is proxied by commercial loans-to-total loans ratio, which is another appropriate measure capturing the degree to which the bank's operation is exposed to economic fluctuation.

Table 7

The coefficients and t-statistics from pooled cross-sectional, time-series regression over the period of 1988-1997

	Dependent variable: Commercial loans/Total loans		Dependent variable: Real-estate loans/Total loans		Dependent variable: Consumer loans/Total loans	
	Group of the banks with higher degree of risk diversification	Group of the banks with lower degree of risk diversification	Group of the banks with higher degree of risk diversification	Group of the banks with lower degree of risk diversification	Group of the banks with higher degree of risk diversification	Group of the banks with lower degree of risk diversification
Intercept	0.4356*** (4.25)	0.4359*** (4.16)	0.4619*** (4.16)	0.3469*** (3.85)	0.2138*** (3.81)	0.4315*** (3.81)
(Capital-to-asset)$_{i,t}$	0.4561 (0.31)	0.4216 (0.28)	0.2769 (1.26)	0.8266 (1.08)	0.4267 (0.42)	0.7216 (1.13)
(q ratio)$_{i,t}$	-0.2135* (-1.66)	-0.7216 (-1.52)	0.0943 (0.81)	-0.1276 (-0.13)	0.1935 (0.43)	-0.1038 (-0.81)
(R^2)$_{i,t}$	0.1038** (2.13)	0.1628* (1.63)	0.1637 (0.98)	0.3472 (1.08)	0.1623 (0.82)	0.3416 (1.10)
F-statistic	4.26***	5.28***	3.67**	7.28***	6.37***	5.19***
Adjusted R^2	0.08	0.06	0.07	0.05	0.03	0.05
No. of observations	342	342	342	342	342	342

Note: One, two, or three asterisks indicate statistical significance at the 10, 5, or 1% significance level, respectively.
(Commercial loans/Total loans)$_{i,t+1} = b_0 + b_1$(Capital-to-asset)$_{i,t} + b_2$(q ratio)$_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t,}$
(Real-estate loans/Total loans)$_{i,t+1} = b_0 + b_1$ (Capital-to-asset)$_{i,t} + b_2$ (q ratio)$_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t,}$
(Consumer loans/Total loans)$_{i,t+1} = b_0 + b_1$ (Capital-to-asset)$_{i,t} + b_2$ (q ratio)$_{i,t} + b_3(R^2)_{i,t} + \varepsilon_{i,t.}$

6. Conclusion

In this study, we find that the banks with high degree of risk diversification, and therefore, which are presumed to have low probability of bankruptcy and for which the market discipline of being imposed higher cost of capital (or, mainly deposit interest rate) with the increase in risk taking is not efficiently imposed, tend to have the moral-hazard incentives to connect such advantages of better risk diversification to higher risk taking, especially market-related systematic risk taking to increase profit. The result of this study suggests a very important policy implication for the stability of banking industry. If advantage of risk diversification of large banks' asset portfolio composition, following lack of creditors' motive for surveillance of large banks' risk-taking behavior, and following large banks' moral hazard is an inevitably occurring phenomenon, increase of simple asset size by mergers and acquisitions without additional monitoring system for the risk-taking behavior of these large banks has a high possibility to bring about another moral hazard of large banks and cannot be expected to surely contribute to the structural stability of banking industry.

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