ESTIMATING RISK IN BANKS: WHAT CAN ACADEMIC RESEARCH TELL US?

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ABSTRACT

It is generally agreed that like other types of insurance, deposit insurance premiums should be proportional to risk. A failure to do so can introduce economic inefficiencies in the sense that low risk-takers would, in effect, be subsidizing high risk-takers. Deposit insurance that is not responsive to risk-taking also introduces moral hazard in the sense that managers might take on excessive risk knowing that deposit insurance provides protection, but does not discipline the manager through higher insurance premiums. The decision to operate deposit insurance with premiums that are responsive to risk carries with it a need to determine risk levels across insured institutions. This article summarizes the academic research on measures of risk in banking with a focus on the areas that would be of primary interest to bank deposit insurers, regulators and supervisors.

INTRODUCTION

Deposit insurance has been implemented in numerous countries, as it is commonly believed to prevent bank runs and thereby stabilize the financial system. As long ago as the 1980s it has been recognized that charging a flat rate to banks for deposit insurance, often as a percentage of deposits, has two major drawbacks. First it encourages bank risk-taking to maximize profits and second it means that lower-risk banks are subsidizing higher-risk banks (Bloecher et al, 2003). The question of how best to set the price of bank deposit insurance has become of increasing importance since the onset of the global financial crisis as the potential huge costs of bank bailouts have become apparent. It is generally agreed therefore that like other types of insurance, deposit insurance premiums should be proportional to risk. This article summarizes the academic research on measures of risk in banking with a focus on the areas that would be of primary interest to bank deposit insurers, regulators and supervisors. It is therefore not a comprehensive summary of all available research.

In attempting to quantify differential risk across financial institutions, one is attempting to find differentiation in a phenomenon that is very similar across banks and also very small. In addition, bank risk is not directly observable as is the case with measuring a distance or a weight and is not necessarily particularly well defined: there are many possible future outcomes including eventualities that are not necessarily even imagined today, and it is difficult to pin down the probabilities of those outcomes.

Rather, bank risk is a construct: an idea containing various conceptual elements not based on empirical evidence. Since bank risk is not directly observable there is no empirical evidence for bank risk directly. Instead there is empirical evidence of the proxies that stand in for the not-directly-measurable 'bank risk'. Since these proxies inform us about bank risk only approximately: a) it is difficult to pin down an exact absolute level risk; and, b) it is difficult to correctly rank order the banks by level of risk.

There may be additional complications depending on how well or poorly defined risk is. This is often discussed in terms of the difference between risk and uncertainty (Knight, 1921). Imagine that through clever use of proxies one is able to develop a pretty good understanding of things like expected default frequency, the probability of default given a particular fact situation, or the statistical properties of things like the size and arrival pattern of shocks that are likely to destabilize a bank. In such a circumstance, one is dealing with risk – essentially, there is plenty of information available for decision-making. In situations where such things are not reasonably quantifiable one is dealing with uncertainty and the analytic tools available in the context of risk are not fully available.

While the question of how to estimate risk in banks is therefore not a straightforward one, this article is intended to assist deposit insurers to use what is in the academic literature to guide them in premium setting. Getting premiums 'right' is important both for the deposit insurer to ensure the fund and the insurance scheme functions properly, but also for the financial system so that they don't introduce perverse incentives of some kind through imperfections in pricing. It is important to preserve the link between the fee setting process and the risk behaviour of members because doing otherwise can distort competitiveness. Imposing higher premiums when there is no incremental risk – in other words, where premiums become disconnected from risk – penalizes the affected bank and would typically impede that bank's ability to compete.

THEORETICAL UNDERPINNINGS OF THE FEE SETTING PROCESS

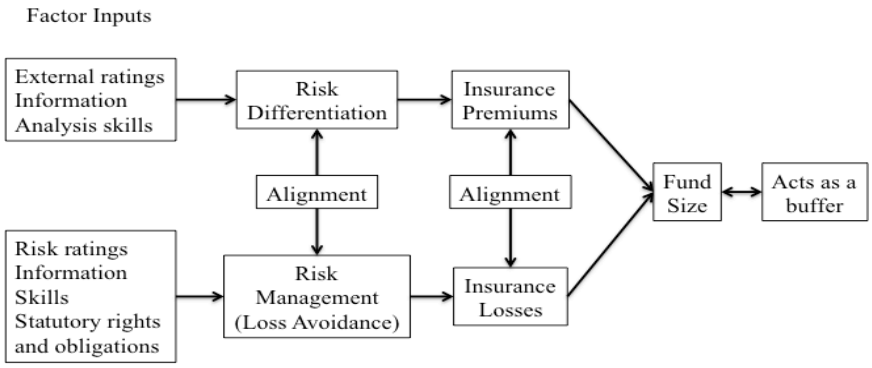
The Link Between Premiums Charged and Expected Losses

One approach to financial management of an insurer is to charge for risk in a way that covers losses over time. In addition to the obvious benefit of helping the insurance scheme achieve self-funding status, it also addresses the moral hazard that arises if the price of the insurance is insensitive to the risk taking behaviour adopted by the insured parties.

In this kind of paradigm the way in which one measures risk, manages risk and charges for risk are interlinked. A key measure in such a case is the potential contribution of risk to future losses. Also key is the risk management approach of the deposit insurer or supervisor. For example, if the premium for a particular risk level is to be small, then the risk managers have to organize themselves to manage risk and intervene in such a way as to keep insurance losses related to that risk commensurately small. The following graphic attempts to depict the idea.

Figure 1

Deposit Insurance System View



An implication of thinking in this way is that risk factors that are interesting for one reason or another, but not linked to insurance losses, are relatively less important in a system that assesses risk for the purpose of setting fees. A good example here is liquidity risk. Table 1 suggests that there may be a link between liquidity and potential insurance losses, but there is not necessarily always a link. In Table 1, an up arrow indicates an elevated level and a down arrow indicates a depressed level. A horizontal arrow indicates a middling level – neither elevated nor depressed. Problem areas are italicized. The implication of this is that while liquidity itself, and liquidity measures might be important for many reasons, they are not necessarily closely linked to expected losses, and are therefore not necessarily linked to a rational premium-setting process.

Table 1
Scenario Analysis
With Suggested Effects

	Strong Competitive Advantage		Weak Competitive Advantage	
	Good Asset Coverage	Bad Asset Coverage	Good Asset Coverage	Bad Asset Coverage
Good Liquidity Coverage	LGD ⇓ EDF ⇓	*lgd* ⇑ EDF ⇓	LGD ⇒ EDF ⇒	*lgd* ⇑ EDF ⇒
Bad Liquidity Coverage	LGD ⇓ *edf* ⇑	*lgd* ⇑ *edf* ⇑	LGD ⇒ *edf* ⇑	*lgd* ⇑ *edf* ⇑

This being said, liquidity problems can be an indicator of deeper underlying problems such that a risk-based differential premium system might benefit by including a measure of this risk factor such as a Liquidity Coverage Ratio ("LCR").

COGNITIVE DISSONANCE IN PREMIUM SETTING

It is possible in considering the matter of risk and premium levels that, despite sensible analysis, the premium simply seems too small, which may lead to the pursuit of risk indicators that result in a premium level that has more face validity. There are some reasons why an analytically determined premium level may lack face validity:

Human beings are notoriously bad heuristic statisticians. For example, it is difficult at a heuristic level to accept that one can estimate the general attitude of a multimillion person population quite accurately by a sample of only a few thousand people. Similarly, it is difficult to accept the analytic result that the insurance premium for organizations as large and subjectively risky as banks can be so small;

The context within which risk is to be measured and premiums are to be set is qualitatively more similar to uncertainty than risk – that is, although there are quantitative attempts to deal with risk, it is difficulty to avoid an underlying concern that there are issues beyond those that can be captured in the quantitative analysis – in other words, 'uncertainty'; and,

There is a misalignment between how expected losses are viewed in the premium calculation on the one hand, and the heuristic view of the losses that the insurer is likely to face in a resolution on the other hand. Target funds are often determined based on EDFs and estimated Loss Given Default ("LGD") on an individual bank basis.

Cognitive dissonance concerning the premium levels can occur if the LGD estimate imagines the unfolding of a resolution – who gets protected, how they get protected, and to what extent – in one way and an observer of the premium scheme imagines it unfolding in a different way.

MARKET-BASED RISK INDICATORS

Market-based measures either based on stock market prices or interest rates are theoretically appealing as they are more forward-looking than historical accounting measures. One such method that has been applied to the pricing of deposit insurance draws on the Black-Scholes model of option pricing. Under this structural approach deposit insurance is modeled as a put option written on the bank's assets by the deposit insurer and held by bank shareholders. Bankruptcy is assumed to occur when the market value of the bank's assets declines below that of its liabilities (Merton, 1977). Moodys-KMV has developed a commercial product that uses a similar approach to this to predict probabilities of default. While theoretically interesting this method is only feasible for publicly traded banks. Since deposit insurance premiums must also be set for privately held institutions this is a significant drawback.

An alternative methodology, often known as the reduced form approach, treats default as a stopping point whose distribution depends on covariates such as leverage, economic conditions and credit rating (Duffie et al, 2003). Once again, though, estimates of market-based credit spreads are needed which makes this method difficult to apply to banks without observable credit spreads.

Another market-based risk measure that has been used frequently is equity market volatility which measures total risk and can easily be subdivided into systematic and idiosyncratic components (Stiroh, 2006). Laeven & Levine (2008) used the volatility of equity returns to measure risk in their study of the relationship of risk-taking by banks to their ownership structure and national bank regulations. Brewer (1998) used a similar measure to show that diversification into non-banking activities was negatively correlated with risk for bank holding companies. Demsetz (1997) relied on the annualized standard deviation of the weekly stock return to measure risk and found that higher franchise value is correlated with lower levels of risk taking. Further, when franchise value is low ownership structure was related to risk but if it was high there was no link. Imai (2007) used a different market-based risk measure in the form of the interest rate spread on subordinated debt to examine the correlation of risk with four key accounting ratios measuring asset quality, liquidity, earnings and capital. He found correlation

did exist but it was not strung. Further details on market-based measures and how they have been used to measure risk are summarized in Appendix 1.

In addition to the fact that the market-based data needed for all of these methods is only available for certain banks, they also are somewhat complex for the user to understand. Bloecher et al's (2003) criteria for an ideal deposit insurance pricing system include five factors: accuracy, simplicity, flexibility, appropriate incentives, and fairness; these market-based measures fail to meet the criteria of simplicity. Accounting-based measures of risk might better meet these criteria and have also regularly been investigated by academic researchers. While admittedly having drawbacks of their own, they have the advantages of greater simplicity and availability for all banks. In the following sections we discuss the main types of these measures that have been used in research on bank risk.

RISK INDEX

A commonly used accounting-based risk measure is what is known as the risk index. It is calculated as:

$$Risk\ Index = \frac{\left(\left(\frac{\Pi}{A}\right)+\left(\frac{K}{A}\right)\right)}{\sigma\Pi/_A} \tag{1}$$

In (1) Π is net income, A is total assets and K is total regulatory capital held by the bank. Returns are measured relative to total assets rather than relative to equity to eliminate the impact of leverage, which for banks can be very substantial. Further, they are a direct measure of management's ability to generate returns on a portfolio of assets (Rivard & Thomas, 1997). The asset measure typically includes both on and off-balance sheet assets.

The higher the risk index, the greater is the equity capital and average level of returns available to cushion against a loss relative to volatility of returns. This means the probability of failure is lower. The risk index has the advantage of combining, in a single measure, profitability, leverage and return volatility. It increases when profitability and the capital held by the bank relative to assets go up and decreases when profit volatility increases.

Hannan & Hanweck (1988) explained their derivation of the risk index by pointing out that insolvency for banks occurs when current losses exhaust capital or, equivalently, when the return on assets is less than the negative capital-asset ratio. They go on to show that the probability of insolvency is:

$$p \leq \left(1/2\right)\frac{\sigma^2}{\left(E\left[\frac{\Pi}{2}\right]+\frac{K}{A}\right)^2} \tag{2}$$

The ½ in this inequality accounts for the fact that failure occurs only in one tail of the distribution. If profits follow a normal distribution then the risk index is the inverse of the probability of insolvency. It measures the number of standard deviations that a bank's return on assets has to drop before equity is wiped out (Beck & Laeven, 2006). Because of this relationship, the risk index has sometimes been referred to as the probability of failure (see, for example, Kwan & Laderman, 1999).

Even if returns on assets are not normally distributed, the risk index is still useful for relative comparisons (Boyd & Gertler, 1994). It likely underestimates the true probability of

bankruptcy since, by definition, it assumes failure only if one-period losses exceed a bank's total capital. Realistically though, banks experiencing losses of a much smaller scale could experience liquidity problems, creditor runs and regulatory interventions (Boyd & Graham, 1986).

While the risk index has its advantages shortcomings must also be noted. First, it measures risk in a single period of time and therefore does not take into account that higher levels of risk resulting from a sequence of losses over more than one period. It also relies on the accuracy of accounting data, which may not be a well-founded assumption since the literature indicates that banks tend to smooth earnings (Beck & Laeven, 2006). Notwithstanding these concerns, the risk index still can be a useful measure of relative risk between groups of banks at a point in time as is required in the setting of deposit insurance premiums.

The risk index has been widely and regularly used as a proxy for risk in the financial and non-financial literature since Roy (1952). It has commonly been referred to as the distance-to-default and the z-score, but differs from Altman's (1968) z-score which is a predictor of corporate financial distress based on accounting ratios. Studies utilizing the risk index include: Boyd & Graham (1986) who looked at the relationship between risk and the degree of involvement in non-bank activities; Hannan & Hanweck (1988) who investigated whether there was, as they expected, a positive relationship between bank risk-taking and the spreads over the default free rate and Kimball (1997) who compared banks specializing in small business micro-loans with a mixed peer group matched by size and location and found that the focused group was riskier than the diversified group. Modified versions of the risk index have also been tried. Ianotta et al (2007) for example calculated the index using the stock market value of equity rather than accounting book value in the numerator and Wall (1987) used return on equity rather than return on assets in his research. Further examples of the use of the risk index in the academic research are summarized in Appendix 2.

OTHER RISK MEASURES

Standard Deviations of Return on Equity and Assets

Various other accounting-based measures have also been used as a proxy for risk as described in Appendix 3. Standard deviations of returns measured relative either to equity or assets have also been commonly used as a proxy measure of risk in academic research. Liang (1989) used the standard deviation of net income relative to assets to study the effects of market concentration on firm profits and found that the effects of market concentration on firm profits become larger when risk is controlled for and that market concentration for banks and firm risk are positively related. She attributed this to local market uncertainty leading to higher concentration and risk levels. De Young et al (2004) measured risk through the excess of the return on equity over the risk-free rate divided by the standard deviation of the return on equity and found that medium-sized community banks exhibited higher levels of risk than their larger counterparts. Berger & Mester (2003) used the standard deviations of returns on gross total assets to show that bank risk decreased during the 1986 to 1997 time period while returns increased substantially. Similarly, earnings volatility relative to both total assets and common equity was employed by Nicholas et al (2005) to examine the risk of publicly-traded versus privately-held banks Contrary to their thesis, they did not find that the two types of banks differed in terms of their risk measures. They did however find that public ones had lower capital ratios. De Young (2007) measured risk by standard deviations of returns on equity and found that

small banks engaged in traditional bank lending with high levels of core deposits exhibited the lowest risk profile while large transaction-oriented banks had the highest. This latter group also engaged in substantial loan securitization and had a high degree of non-interest income.

While commonly-used and having the virtue of simplicity, it should be noted that the return on assets ratio is simply the denominator of the risk index and thus does not also include information on the banks' leverage and profitability in the way the risk index does. Therefore it may not be optimal for use in setting deposit insurance premiums.

Dimensions of Capability

One could estimate bank risk by examining the individual banks' capabilities along important dimensions and where differences in capabilities are identifiable, find a measurable phenomenon that acts as a proxy measurement for the capability (see Appendix 4). For example, lenders are supposed to be skilled at deal origination, deal screening and deal monitoring. A reasonable conceptual starting point, therefore, is that banks more skilled along these dimensions are more stable than banks that are less skilled. The idea is that:

Weak deal origination capability leads a bank to acquire the relatively less attractive customers, or to find deals that are relatively less favorable than do the more capable banks;
Weak deal screening leads to completion of relatively more deals on inappropriate terms so book value of the loan exceeds intrinsic value at the outset;
Weak screening leads to relatively more loan degradation after booking so that as time goes by the shortfall of intrinsic value against book value widens on average.

An indicator of these skills would be the tendency for the value of booked loans to fall below initial booked value. This approach depends on the availability of data on such matters, which is sparse given that accounting standards are still relatively tightly tied to transacted values rather than intrinsic value. While this is so at the moment, this may not always be the case – see the Milburn article on so-called market-value accounting (Milburn, 2012). Also, many studies of bank risk use observable measurements that stand in for accounting for loans at intrinsic value such as provisioning, loan write-offs, and the levels of under-performing or non-performing loans. Acharya et al (2002) used doubtful and non-performing loans relative to assets and their standard deviations in their study of the relationship between loan diversification and risk-return trade-offs.

Capital

It is typically assumed that financing by way of equity capital contributes to financial stability by:

Providing a buffer between the level of assets and liabilities – in theory, the greater the asset coverage the safer the holders of issued liabilities feel; and,
Providing a buffer between the level of income collected and the level of fixed, committed payments that have to be made to the bank's financiers.

Theory also holds that capital strengthens bank's incentive to monitor its relationship borrowers and lessens the attractiveness of riskier assets (Berger & Bouwman, 2013). There is an open question about whether a bank that holds total capital comprised only of Tier 1 capital is

more risky or less risky than a bank whose capital includes Tier 2 capital with fixed committed payments (e.g. subordinated debt, preferred shares). If these kinds of differences in the composition of capital signal differences in overall bank risk, then this is a possible risk-differentiating measure. One's view of this may depend on a number of factors, but one of them would be whether one regards the following three things, or combinations of them, as different or the same:

A common share dividend cut or suspension;
A preferred share dividend cut or suspension; or,
A failure to pay subordinated debt interest in full.

A possible influencer in the matter is the probable behaviour of the issuing bank: that is, would a bank in financial difficulty cut payments to all three financing tranches or would it cut them sequentially depending on its financial ability? In this vein, if earnings are down is there a different signal to the financial markets between:

For a bank with total capital that includes preferred shares and subordinated debt, suspending the common share dividend while continuing to pay the preferred share dividend and the subordinated debt interest; versus,
For a bank with total capital comprised only of common equity, reducing the common share dividend to bring it into line with its reduced earnings.

The academic literature on the direction of the relationship between risk and levels of capital is not unanimous though. Certain researchers (e.g. Flannery, 1989) have found a positive association as higher capital levels may induce banks to increase asset portfolio risk in search of profitability and thus also raise the probability of default. Overall though academic research shows 'the scales are tilted in favor of the prediction that capital has a salutary effect on the probability of survival' (Berger & Bouwman, 2013, p.147).

Asset Mix

It may be appropriate to differentiate among banks based on the mix of asset types in a bank. This approach recognizes that some assets, and their respective income streams are risker than others. It also recognizes that recovery rates, costs of recovery, and time to recovery likely differ by asset type leading to the possibility that some banks' assets may tend toward desirable mixes whereas for others the converse may be true. In addition, there may be differential ability to realize on assets held domestically relative to those held outside the home country of the bank in a resolution situation. Table 2 presents a stylized example of the relationship between asset mix and risk of loss. On the left hand side most assets are in the 'difficult to recover' category whereas the reverse holds on the right hand side. Analysis of differences across banks may be difficult to implement due to data limitations.

Table 2

Hypothetical Liquidation Comparison

	Bank A: Unfavorable asset mix			Bank B: Favorable asset mix		
Liquidation:		**Recovery Rates**	**Recoveries**		**Recovery Rates**	**Recoveries**
Difficult	40,000	75%	30,000	10,000	75%	7,500
Easy	10,000	90%	9,000	40,000	90%	36,000
Net Recoveries			39,000			43,500
Insured Deposits			40,000			40,000
		Shortfall	-1000		Surplus	3500

Bank Size

There is some suggestion that the size of a bank relative to local GDP is a useful risk differentiator – certainly some jurisdictions have ended up with banks that are very large in relation to their local economy, or more to the point, that have relatively small populations in relation to the size of the bank. In considering this issue it is important to differentiate between problems that arose exclusively due to the size of the bank, versus problems that arose because the bank had substantial obligations in a currency in other than the currency the local central bank controls.

CONCLUSIONS

In general any system of setting deposit insurance premiums would require multiple measures in order to capture the multiple sources of risk for banks. In practice this is reflected by the systems of certain existing deposit insurance systems such as those of the CDIC and the FDIC, however the risk measures used by these agencies differ from those typically employed in the academic literature such as the risk index.

APPENDIX 1

SUMMARY LITERATURE REVIEW OF MARKET-BASED RISK MEASURES

Author	Observed Effect	Explanatory Variables	Finding
Brewer (1989)	Volatility of bank holding company stock market returns.	Diversification into non-banking activities.	Showed that diversification into non-banking activities was negatively correlated with risk for bank holding companies.
Gallo et al (1996)	A two factor model including market risk and financial services industry risk variables was used to estimate systemic risk.	Diversification into mutual fund activities.	Diversification into mutual fund activities was linked to a decline in systemic risk after the mid-point of the 1987 to 1994 period. The sample of 47 bank holding companies was divided into three categories: money centre, super-regional and regional banks, with all three demonstrating the same shift but with the money centre banks demonstrating it one year earlier. Unsystematic risk did not decline.
Demsetz et al (1997)	The annualized standard deviation of the weekly stock return.	The relationship between franchise value, ownership structure and risk. Franchise value is measured as the ratio of the sum of market value of equity plus book value of liabilities divided by the book value of tangible assets is	They found that higher franchise value is correlated with lower levels of risk taking. Further, when franchise value is low ownership structure was related to risk but if it was high there was no link.
Imai (2007)	The spread on subordinated debt	The relationship of risk to accounting ratios measuring asset quality, liquidity, earnings and capital.	He found risk was correlated, although not strongly, to the four key accounting ratios.
Schrand & Unal (1998)	Total firm risk was measured by stock return volatility while credit risk was measured by the accounting ratio of commercial loans to total loans.	Are stock institutions more risky than mutual associations?	They found that the stock companies engaged in higher levels of hedging to decrease interest rate risk but this was more than offset by higher credit risk. The authors found a link between higher credit risk and incentives such as stock options given to management after the demutualization.
Stiroh (2004)	Based on portfolio theory; empirically-based using accounting results as the measures of risk; market-based proxies for risk.	Relationship between diversification and risk.	Research seems to lean towards the view that there is a negative correlation between diversification and bank risk.

Author	Observed Effect	Explanatory Variables	Finding
DeYoung & Roland (2001)	The earliest research based on portfolio theory used industry-level data from the 1950's to the 1970's to compare the volatilities and correlations of earnings of banks with other financial industries such as securities firms, insurance companies, real estate brokers, leasing companies and thrift institutions.		Since the correlations were very low or sometimes even negative, diversification, defined as adding non-bank financial services to their existing banking business was assumed to lower risk.
Allen & Jagtiani (1999)	Standard deviation of monthly stock market returns.	Synthetic universal banks consisting of a bank, a securities firm and an insurance company to test the relationships with bank risk.	They found that the resultant entity had lower levels of overall risk but higher systematic risk when compared to undiversified banks. The securities firm exposed the merged entity to the additional risk while the insurance company had no significant effect. They pointed out that the higher systemic risk meant the diversified banks were more prone to a common economic shock which could impact the entire banking system.
Stiroh (2006)	Total risk was measured by the variance of the bank's stock returns and idiosyncratic risk was quantified by the variance of the residuals from a market model.	The impact of diversification into non-interest based banking segments such as fees, fiduciary services and trading.	He found that risk increased while average equity returns did not. This finding persisted even after controlling for bank size and equity ratios which the author felt in turn controlled for management skills, internal diversification and leverage. He concluded that the largest US banks may have become overexposed to activities that generate non-interest income possibly due to internal agency problems or managerial incentives to expand into newly allowed business segments.
Templeton & Severiens (1992)	Variance of shareholder returns; regression coefficient for the market factor in their two factor model; and, regression coefficient for the interest rate factor in their two factor model.	Diversification and its relationship with bank risk.	They found support for a link between diversification and lower risk levels although they noted that a small amount of diversification into non-bank activities provided most of the benefits with diminishing marginal benefits quickly becoming apparent. In order to answer the question as to the direction of causality or whether diversification leads to lower levels of risk or risk averse management choose to diversify the authors divided the sample into two halves, one with higher risk levels and one with lower. Regression equations were recalculated for both groups with only the higher risk group reaching significant levels indicating that diversification decreases risk.

Author	Observed Effect	Explanatory Variables	Finding
Eisenbeis et al (1984)	Abnormal stock market returns	Announcements by banks that they were adopting a legal structure known as a one bank holding company.	The authors found that those announcing the adoption of this structure generated excess returns in the few weeks surrounding the announcement date. They attributed this finding to investors favouring the diversification it allowed, presumably because it enhanced the banks' risk-return potential.
Bhargava & Fraser (1998)	Variance in total stock market returns for sixty days before and after the announcement date.	The impact of announcements that the Federal Reserve Bank would allow certain banks to diversify into investment banking.	Their data supported the hypothesis of increased risk following the announcement.

APPENDIX 2

SUMMARY LITERATURE REVIEW FOR THE RISK INDEX

Author	Observed Effect	Explanatory Variables	Finding
Roy (1952)	The risk index	Various	
Boyd & Graham (1986)	The risk index	The degree of involvement in non-bank activities; the amount of non-bank assets relative to total assets.	No statistically significant link
Hannan & Hanweck (1988)	The risk index and its component parts.	Spreads over the default free rate on uninsured deposits.	Return on assets and the asset to capital ratio have a negative relationship with deposit account spreads while variability in returns was positively related.
Eisenbeis & Kwast (1991)	The risk index; standard deviation of return on assets	Real estate (more than 40% of assets in real estate loans) concentration versus diversified	They found little difference in results between the two but found that real estate banks had higher returns with less risk.
Liang & Savage (1990)		Focused versus diversified	Risk is related to concentration. Kimball (1997) explained this apparent contradiction by pointing out that Eisenbeis and Kwast (1991) included low risk residential real estate categories that Liang and Savage (1990) did not.
Kimball (1997)	The risk index and other accounting measures	Specialization in small business micro-loans versus a diversified peer group	The focused group was riskier than the diversified group.
Sinkey & Nash (1993)	The risk index	Focus on credit cards (75% of assets in credit cards) versus diversified	Card banks were riskier but generated higher returns than their more diversified counterparts
Boyd et al (1993)	The risk index; the median standard deviation of return on equity	Whether simulated mergers resulted in riskier combined entities.	They found that mergers with life insurance and property and casualty companies were linked to lower risk but mergers with securities or real estate firms were related to higher levels of risk. Both the accounting and market based measures provided similar results giving credence to the use of accounting ratios as measures of risk.
Lown et al (2000)	The risk index; standard deviation of returns on equity	Simulated mergers of banks with life insurers	A similar study using the risk index but covering a later period 1984-98 found simulated mergers of banks with life insurers linked to lower risk levels while those with securities or property and casualty insurers showed slightly higher levels of risk.
Craig & Santos (1997)	The risk index	Risk of merged banks versus risk of the individual merger partners	The risk index of merged banks was higher than that of the individual merger partners prior to their amalgamation. They concluded that mergers therefore are on average related to lower levels of risk, possibly reflecting diversification benefits.

Author	Observed Effect	Explanatory Variables	Finding
Whalen (1998, 1999a, 1999b)	The risk index	Whether the existence of foreign subsidiaries engaged in the securities and insurances businesses was related to the risk of their domestic parents.	In the first of these he found that the overseas subsidiaries were riskier than their domestic bank parents but that a combination of the two exhibited lower levels of overall risk. In the second of the series he reported similar findings for insurance subsidiaries although these were less risky than the securities entities. In the most recent of these studies he again focused on foreign securities subsidiaries but examined the relationship between risk and organizational structure. He found that bank-owned subsidiaries were not riskier than those owned by holding companies.
Emmons et al (2004)	The risk index along with the Federal Reserve Bank's risk rank model	Simulated mergers of small community banks	They found that the strongest relationship between risk and type of merger was related to increases in the size of the merged banks rather than from geographic diversification. They attributed this finding to the pooling of idiosyncratic risk being more important than local market risk. Other observers commented that this study may not be representative as it was based on a period of time, 1989-1993, when the level of risk facing banks was very high (Furlong, 2004).
De Nicolo et al, (2004)	The risk index	Study of the relationships between bank consolidation, internationalization, conglomeration and financial risk.	They found that large conglomerate banks exhibited higher levels of risk in 2000 than smaller and more focused firms. In contrast risk levels were equal five years earlier. Countries where the banking sector was highly concentrated measured by market share held by the five largest banks in each country in the study were also riskier than in less concentrated ones. This trend was evident in 1993 to 2000 but accelerated during 1997 to 2000.
Demirgüc-Kunt et al (2006)	Moody's financial strength rating along with the risk index	Measure bank soundness and assess whether it was related to compliance with the Basel Banking Committees Core Principles for Effective Banking Supervision.	They found that there was a positive and statistically significant correlation between it and Moody's Financial Strength Ratings.
Beck & Laeven (2006)	The risk index	Examined the link between measures of deposit insurance and the institution responsible for bank failure resolution and bank fragility during the period 1997-2003.	They found that in countries where the deposit had responsibility of intervening and resolving failures banks tended to be less risky.
Laeven & Levine (2008)	The risk index along with the volatility of equity returns and the volatility of earnings	Assessment of the relationship of risk-taking by banks to their ownership structure and national bank regulations.	They found that regulation has different effects on bank risk-taking depending on the bank's corporate governance structure.

Author	Observed Effect	Explanatory Variables	Finding
De Nicolo & Loukoianova (2007)	The risk index	Bank concentration	They found a positive and significant relationship between the risk index and measures of bank concentration. Further they found this relationship was stronger when type of ownership was considered. They divided their sample into three types of owners: private domestic, state-owned, and foreign and also found that foreign banks were riskier than both private domestic and state-owned institutions. They attributed the higher risk levels of the private domestic banks to the larger market shares of the other two types.
Iannotta et al, 2007)	The risk index with the capital ratio in the numerator calculated using the stock market value of equity	The relationship between ownership and bank risk-taking and performance	The ownership types serving as the independent variables included public sector banks, mutual banks and privately-owned banks. The researchers found that public sector banks had higher levels of default risk and mutual banks had lower levels of risk as measured by this variation on the z-score.
Rajan (2005)			"Among practitioners risk in banking is typically defined in terms of earnings volatility"
Wall (1987)	The risk index except with return on equity rather than return on assets in the numerator	Investigation of the effect of non-bank subsidiaries on the risk of banking organizations.	He found that this form of diversification was risk-moderating in the sense that it tended to increase the risk of less risky banks but decrease it for riskier ones.
Boyd & Graham (1988)	The risk index and the standard deviation of the return on equity.	Simulated results of merging bank holding companies with other financial firms including those in the life insurance, property and casualty insurance, insurance brokerage, securities, real estate development and other real estate businesses.	His data indicated that certain mergers were linked with reduced risk but others such as between banks and securities or real estate firms were not.
Laderman (2000)	The risk index and variability of return on assets.	Simulated mergers and risk.	Her data indicated that substantial diversification into life insurance underwriting, casualty insurance underwriting and securities brokerage was related to reduced overall risk.

APPENDIX 3

SUMMARY LITERATURE REVIEW FOR THE OTHER RISK MEASURES

Author	Observed Effect	Explanatory Variables	Finding
Liang (1989)	Standard deviation of net income relative to assets	The effects of market concentration on firm profits	She found that the effects of market concentration on firm profits becomes larger when risk is controlled for and that market concentration for banks and firm risk are positively related which she attributed to local market uncertainty leading to higher concentration and risk levels.
Esty (1997)	The standard deviation of the time series quarterly return on assets and of the cross-sectional cumulative return on assets	Linkage of corporate structure to risk in the savings and loan industry during 1982 to 1988.	
Reichert & Wall (2000)	The coefficient of variations of return on equity and assets calculated as the standard deviations of the two measures divided by their mean		
DeYoung et al (2004)	The excess of the return on equity over the risk-free rate divided by the standard deviation of the return on equity	Size and risk	They found that medium-sized community banks exhibited higher levels of risk than their larger counterparts.
Berger & Mester (2003)	Standard deviations of returns on gross total assets		Risk decreased during the 1986 to 1997 time period while returns increased substantially.
Nichols et al (2005)	Earnings volatility relative to both total assets and common equity	Risk of publicly-traded versus privately-held banks	Contrary to their thesis, they did not find that the two types of banks differed in terms of their risk measures. They did however find that public ones had lower capital ratios.
Kuritzkes & Schuermann (2006)	The standard deviation of pre-tax net income divided by risk-weighted assets as specified in the Basle I Capital Accord.	They hypothesized that bank risk arises from two major categories, financial and non-financial, further subdivided into five sub-groups: market, credit, structural asset/liability in the first and operational and business risk in the second.	They found that credit was linked to almost half of all risk with market sources relating to about 5%. The diversified banks' level of risk was about one-third lower than their focused counterparts.
DeYoung (2007)	Standard deviations of returns on equity	Examined safety and soundness in US banking	He found that small banks engaged in traditional bank lending with high levels of core deposits exhibited the lowest risk profile while large transaction-oriented banks had the highest. This latter group also engaged in substantial loan securitization and had a high degree of non-interest income.

Author	Observed Effect	Explanatory Variables	Finding
Dick (2006)	Loan losses as a measure of risk	Examined the link between charged-off losses and loan loss provisions relative to total loans and deregulation in the form of liberalized interstate banking	As measured by both ratios the level of risk increased: increased diversification opportunities presented by the deregulation allowed banks to take higher levels of credit risk. Alternatively the higher risk level may have been caused by the increased competition deregulation allowed. These findings were in contrast to Jayaratne and Strahan (1996) who found a decrease in risk followed a slightly earlier period of deregulation.
Berger & Udell (1990)	The risk premium (the annualized loan interest rate minus the rate for a treasury security of equal duration) and the net charge-off rates of loans relative to the total amount of commercial and industrial loans.	Investigated the relationship between collateral and bank risk.	Banks with a higher proportion of secured lending also tended to display higher levels of risk.
Gorton & Rosen (1995)	Non-performing loans as a percentage of total loans.	Their study tested a model that explained excessive risk-taking by bank management as resulting from management entrenchment due to their ownership of shares in the bank.	They found support for their hypothesis.
O'Hara (1981)	The percentage of real estate owned relative to average assets; borrowed funds relative to average assets.	Are stock companies riskier than mutual associations?	As she expected stock companies were riskier than mutual associations.
Fraser & Zardkoohi (1996)	Nine different accounting ratio risk proxies. These included investments in various types of risky real estate and loans along with measures of liquidity, leverage and profitability.	Examined the relationship between corporate structure and risk	Found evidence that the corporate structure was linked to higher levels of risk.
Cordell et al (1993)	Proportional holdings of higher risk real estate, above-average asset growth and low capital.	Examined the relationship between corporate structure and risk	Found evidence that the corporate structure was linked to higher levels of risk.
Valnek (1999)	Risk was measured by loan loss provisions and reserves and by standard deviation of return on assets.	Are banks owned by stockholders riskier than mutual building societies?	He found evidence that banks owned by stockholders were riskier than mutual building societies. The author concluded that while corporate-form banks do not take undue risk, they are not sufficiently compensated for the risks they do take.

Author	Observed Effect	Explanatory Variables	Finding
Kwan (2004)	a) the ratio of past due and non-accrual loans to total loans; b) the standard deviation of returns on assets; c) the ratio of total capital including preferred and common stock and retained earnings to total assets.	Are public banks riskier than private?	After controlling for firm size, risk was found to be essentially the same at the public and private banks but the public banks held significantly greater amounts of capital.
Rhodes & Rutz (1982)	The coefficient of variation of profit rates which was calculated as the standard deviation of return on assets divided by the return on assets; equity capital, total loans and net loan losses all measured relative to total assets.	The relationship between market power and bank risk.	They found support for their "quiet life" hypothesis which held that banks with a high degree of market power measured by their market share pursued a lower risk strategy.
Hirtle (2003)	The standard deviation of daily trading profits and losses; the average of the three largest daily trading losses each quarter.	Relationship of regulatory capital to future market risk levels.	She showed that the regulatory capital required to be held against market risk was predictive of future levels of market risk as she defined it.
Rose (1987)	Net loan losses relative to equity capital; total liquid assets to total assets; interest-sensitive liabilities to earning assets.	The relationship between mergers and risk.	He did not show a decrease in overall risk following the mergers and many of the more specific risk types actually increased. Further, banks that engaged in more than one merger during the period showed even higher levels of increased financial risk than those that participated in a single merger.
Keeley (1990)	The margin of the interest rate spread on uninsured deposits.	The relationship of market power, defined as those with higher market to book value ratios, to capital and risk.	He found that banks with substantial market power held more capital and were less risky than their counterparts with low market power. This tendency was attributed to managements' reluctance to risk losing their valuable banking charter offsetting the attraction of the deposit insurance put option.
Acharya et al (2002)	Doubtful and non-performing loans relative to assets, the standard deviation of doubtful and non-performing loans relative to assets and the annualized stock return volatility for the publicly-traded banks	Loan diversification and risk-return efficiency.	They found that greater loan diversification did not lead to an efficient risk-return trade-off.

Author	Observed Effect	Explanatory Variables	Finding
Schrand & Unal (1998)	Total firm risk was measured by stock return volatility while credit risk was measured by the accounting ratio of commercial loans to total loans.	Are stock institutions more risky than mutual associations?	They found that the stock companies engaged in higher levels of hedging to decrease interest rate risk but this was more than offset by higher credit risk. The authors found a link between higher credit risk and incentives such as stock options given to management after the demutualization.
Smoluk et al (2003)	Standard deviation of return on equity.	Simulated expansions	They found that New England banks that expanded into various other regions of the US exhibited lower levels of risk.
Rosen et al (1989)	Standard deviation of return on assets.	Simulated bank diversification by direct equity investment in real estate.	Found marginal benefits at low levels but higher levels of risk when the investment exceeded fairly low levels of concentration The authors found that a trend toward higher risk emerged when the investment in real estate rose above 4% of total assets.
Kwast (1989)	Standard deviation of return on assets.	Diversification gains from adding dealing and underwriting of securities to traditional bank powers.	He found that some potential gains were possible but that these were limited in size.
Kwan (1997)	Standard deviation of return on equity.	Used portfolio theory to evaluate the potential risk implications of the addition of securities activities to traditional banking organizations.	He found that securities subsidiaries were riskier but not necessarily more profitable than their banking parents. For securities firms that were primary dealers of government securities the higher risk levels were associated with higher leverage while for those that were not the higher risk was correlated with aggressive trading behaviour. The subsidiary securities firms appeared to provide possible diversification benefits overall because of low return correlations between them, regardless of primary dealer status, and the banks.
Reichart & Wall (2000)	The ratio of standard deviation of return on assets to the mean return on assets.	Based on a portfolio approach, combined banking industry results with those of six other related industries such as insurance, real estate and securities.	While diversification gains were possible, the amount possible varied over time. The authors tried to explain this variability by pointing to the influence of changes in the macroeconomic environment or technology.

Author	Observed Effect	Explanatory Variables	Finding
Laderman & Kwan (1999)			In general the studies of diversification that are based on simulations of bank mergers with various types of related non-banking activities have shown mixed results. They indicate that securities activities and insurance agency, and insurance underwriting are riskier than banking but still have the potential to provide diversification benefits to banking organizations because of low levels of correlation between the banking and non-banking businesses and because they are more profitable. While real estate agency, title abstract activities, and real estate operation are also more profitable than banking, real estate development may not be. Real estate activities are riskier than banking activities in general and the literature provides inconsistent evidence about their diversification benefits for banking organizations (Laderman and Kwan, 1999).
DeYoung & Roland (2001)	Earnings volatility	The relationship between diversification and bank risk.	They found that increased levels of non-interest income was linked with higher levels of risk. The increase in risk was at least partially compensated for by increased levels of profits.
Sinkey & Nash (1993)		Compared credit card banks with their more diversified counterparts.	They found that credit card banks were riskier but also generated higher returns. This seems to indicate benefits from diversification.
Rivard & Thomas (1997)	Standard deviation of return on assets and the reciprocal of the risk index	Compare interstate banks with their less diversified counterparts.	They found that this type of geographic diversification was linked to higher profits and lower levels of both insolvency and volatility risk.
Rogers & Sinkey (1999)	They infer the banks' risk levels from capital ratios, levels of liquid assets, exposure to interest rate risk, and the levels of loan loss provisions.	Bank involvement in non-traditional activities	One of the motivations for their study was to determine whether banks were using non-traditional activities to take on more risk to exploit government guarantees. They find that larger banks tend to be relatively more involved in non-traditional activities and appear to be relatively less risky. While Rogers and Sinkey (1999) make the case that banks don't seem to using non-traditional activities to take on more risk, they do not make a direct statement concerning the relative riskiness of non-traditional activities.

Author	Observed Effect	Explanatory Variables	Finding
DeYoung & Rice (2004a) DeYoung & Rice (2004b)	Volatility of earnings	Reliance on fee-based activities	They find that increased reliance on fee-based activities tends to increase the volatility of earnings and that banks with large fee-based net income appear to be more profitable on an ROA basis because of the lack of balance sheet effects associated with the activities. They find the co-existence of high risk-high return and low risk-low return strategies and conclude that there is a range of financially viable business strategies. Interestingly, they find that very small banks operate at a financial disadvantage regardless of their competitive strategy.
DeYoung & Rice (2004c)	Variation in profits	Non-interest income	They find that for U.S. commercial banks**,** increases in non-interest income occur alongside higher profitability and higher variation in profits, and that his leads to a worsened risk-return trade-off. Similar to Rogers and Sinkey (19990, they find that large banks generate relatively more non-interest income.
Stiroh & Rumble (2006)	Risk-return trade-off; volatility of income	Determining if diversified banks outperform more concentrated financial institutions.	While they find that non-traditional income makes financial holding companies relatively more diversified, the benefits to diversification are more than offset by the increased volatility of such income. In other words, financial holding companies are more diversified, but they are diversified in a relatively riskier source of income.
Acharya et al, (2002)	Their risk measures included both accounting measures related to bad and doubtful loans as well as annualized stock return volatility.	Diversification and its relationship with bank risk.	They found that in certain cases there was a positive correlation. They concluded that there are diseconomies of scale of diversification for certain banks. Both industrial and sectoral diversification caused increases in risk while geographic diversification caused decreases. There was no difference between moderately and highly risky banks.
Baele et al (2006)	Risk-return trade-off	Diversification and its relationship with bank risk.	They found that the markets favoured more diversified banks. Diversity of revenue streams was measured in terms of the ratio of non-interest income to total operating income and the loan to asset ratio. They concluded that "the stock market anticipates that functional diversification can improve future bank profits".

APPENDIX 4

DIMENSIONS OF CAPABILITY; MANIFESTATION OF WEAKNESSES

Dimensions

Board and executive leadership
Branding: brand recognition and reputation
Customer service
Relationship management
Credit analysis
Problem resolution
Screening
Monitoring
Deal origination
Syndication
Cost control
Credit process specification and implementation
Trading rules; monitoring, reporting and intervention
Investor relations
Structuring
Relationships with credit ratings agencies
Specialized skills: real estate, mining, communications, M&A, PPP, etc.
Staff training
Staff remuneration policies and implementation
Composition of portfolio of businesses
Composition of portfolios of assets
Locational choices; regional choices – geographic diversification

Weaknesses manifest as:

Lower returns
Higher costs
Reduced credit quality; variation in credit quality through time; poor risk-return balance; credit losses
Trading losses or poor return on capital devoted to trading
Trading profit variability
Fewer fee opportunities; fees out of line with service provision cost

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