

The Challenges of Risk Management in Diversified Financial Companies

- Although the benefits of a consolidated, or firmwide, system of risk management are widely recognized, financial firms have traditionally taken a more segmented approach to risk measurement and control.
- The cost of integrating information across business lines and the existence of regulatory barriers to moving capital and liquidity within a financial organization appear to have discouraged firms from adopting consolidated risk management.
- In addition, there are substantial conceptual and technical challenges to be overcome in developing risk management systems that can assess and quantify different types of risk across a wide range of business activities.
- However, recent advances in information technology, changes in regulation, and breakthroughs in risk management methodology suggest that the barriers to consolidated risk management will fall during the coming months and years.

In recent years, financial institutions and their supervisors have placed increased emphasis on the importance of consolidated risk management. Consolidated risk management—sometimes also called integrated or enterprisewide risk management—can have many specific meanings, but in general it refers to a coordinated process for measuring and managing risk on a firmwide basis. Interest in consolidated risk management has arisen for a variety of reasons. Advances in information technology and financial engineering have made it possible to quantify risks more precisely. The wave of mergers—both in the United States and overseas—has resulted in significant consolidation in the financial services industry as well as in larger, more complex financial institutions. The recently enacted Gramm-Leach-Bliley Act seems likely to heighten interest in consolidated risk management, as the legislation opens the door to combinations of financial activities that had previously been prohibited.

This article examines the economic rationale for managing risk on a firmwide, consolidated basis. Our goal is to lay out some of the key issues that supervisors and risk management practitioners have confronted in assessing and developing consolidated risk management systems. In doing so, we hope to clarify for a wider audience why the ideal of consolidated risk management—which may seem uncontroversial or even obvious—involves significant conceptual and practical issues. We also hope to suggest areas where research by practitioners and academics could help resolve some of these issues.

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The approach we take is to review the arguments made by supervisors and the financial industry in favor of consolidated risk management. While both parties agree on the importance of this type of risk management, this support seems to be motivated by quite different concerns. Supervisors appear to support it out of a safety-and-soundness concern that significant risks could be overlooked or underestimated in the absence of firmwide risk assessment.¹ In contrast, financial institutions appear willing to undertake significant efforts to

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develop consolidated risk management systems because they believe that those systems will help them assess the risk and return of different business lines and thus allow them to make more informed decisions about where to invest scarce resources to maximize profits.² While these two views may reflect quite different underlying motivations for supporting consolidated risk management, we argue below that they result in a common emphasis on the importance of accurate assessments of risk.

Although both supervisors and financial institutions support the concept of consolidated risk management, few if any financial firms have fully developed systems in place today. The absence thus far of fully implemented consolidated risk management systems suggests that there are significant costs or obstacles that have historically led firms to manage risk in a more segmented fashion. We argue that both information costs and regulatory costs play an important role here by affecting the trade-off between the value derived from consolidated risk management and the expense of constructing these complex risk management systems. In addition, there are substantial technical hurdles involved in developing risk management systems that span a wide range of businesses and types of risk. Both of these factors are evolving in ways that suggest that the barriers to consolidated risk management are increasingly likely to fall over the coming months and years.

The remainder of this article is organized as follows. In the next section, we describe the concept of consolidated risk management in greater detail and provide a more in-depth discussion of the views of supervisors and the financial industry about this process. We then offer a critical analysis of these

views, using a simple portfolio model to help illustrate the economic rationale behind consolidated risk management. Next, we discuss the constraints that have slowed many financial institutions in their implementation of consolidated risk management systems. We conclude with a discussion of the major technical challenges and research questions that will need to be addressed as an increasing number of financial firms implement firmwide risk management systems.

Consolidated Risk Management: Definitions and Motivations

At a very basic level, consolidated risk management entails a coordinated process of measuring and managing risk on a firmwide basis. This process has two distinct, although related, dimensions: coordinated risk assessment and management across the different types of risk facing the firm (market risk, credit risk, liquidity risk, operational risk), and integrated risk evaluation across the firm's various geographic locations, legal entities, and business lines. In theory, both dimensions must be addressed to produce a consolidated, firmwide assessment of risk. In practice, few financial firms currently have in place a

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consolidated risk management system that fully incorporates both dimensions, although many large institutions—both in the United States and overseas—appear to be devoting significant resources to developing such systems (Joint Forum 1999a).³

To understand consolidated risk management, it is important to recognize the distinction between risk measurement and risk management. *Risk measurement* entails the quantification of risk exposures. This quantification may take a variety of forms—value-at-risk, earnings-at-risk, stress scenario analyses, duration gaps—depending on the type of risk being measured and the degree of sophistication of the estimates. *Risk management*, in contrast, refers to the overall process that a financial institution follows to define a business

strategy, to identify the risks to which it is exposed, to quantify those risks, and to understand and control the nature of the risks it faces. Risk management is a series of business decisions, accompanied by a set of checks and balances—risk limits, independent risk management functions, risk reporting, review and oversight by senior management and the board of directors—in which risk measurement plays an important, although not all-encompassing, role. Thus, consolidated risk management involves not only an attempt to quantify risk across a diversified firm, but also a much broader process of business decision making and of support to management in order to make informed decisions about the extent of risk taken both by individual business lines and by the firm as a whole.

Recent trends in the financial services industry have increased the challenges associated with this process. To begin, financial institutions increasingly have the opportunity to become involved in a diverse range of financial activities. In the United States, bank holding companies have been able to combine traditional banking and securities activities since the late 1980s, when the Federal Reserve permitted the creation of “Section 20” securities subsidiaries. The Gramm-Leach-Bliley Act will now enable affiliations involving banking, securities, and insurance underwriting in so-called financial holding companies (FHCs). Such combinations of diverse financial activities present significant challenges to consolidated risk management systems, as greater diversity often means that the system must encompass a wider range of risk types.⁴

Consolidation in the financial services industry has produced institutions with operations spanning large geographic areas, both domestically and internationally. Such wide geographic dispersion, especially across time zones, can make it difficult for a firm’s management to keep track of the activities across all of its operating centers. Financial institutions have responded to this situation by increasing the resources devoted to information systems designed to track and monitor exposures worldwide. Indeed, the development of coordinated information systems is one of the most important steps in consolidated risk management.

The supervisory community has advocated that financial institutions adopt consolidated risk management procedures in the guidance it has published in the 1990s, especially guidance for banking companies. In the United States, these efforts began in 1993 with guidelines for supervisors evaluating risk management in derivatives and trading activities, and have continued to date, most recently with a 1999 Federal Reserve paper containing broad conceptual guidelines for evaluating capital adequacy in light of the full range of risks facing the bank or bank holding company.⁵ Internationally, the Basel Committee on Banking Supervision extended the framework

for describing the risk management process to encompass the role of business strategy and the activities of business line decision makers.⁶ The Committee also set out an approach to the supervisory review of a bank’s internal assessment of capital adequacy in light of a firm’s overall risks as the second pillar of the proposed new capital adequacy framework (Basel Committee on Banking Supervision 1999b).

Recently, an international forum of banking, securities, and insurance supervisors issued a report containing principles that supervisors should follow to ensure that financial conglomerates are adequately identifying and managing risk. The report’s lead recommendation is that “supervisors should take steps . . . to provide that conglomerates have adequate risk management processes in place to manage group-wide risk concentrations” (Joint Forum 1999a).

The rationale offered by supervisors for the importance of consolidated risk management seems to be a concern that, in the absence of a firmwide assessment, significant risks could be

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overlooked or underestimated. The Joint Forum report, for instance, argues that “the additive nature of concentrations and the risk of transmission of material problems within a conglomerate point to the value of both conglomerate management and supervisors conducting a group-wide assessment of potential concentrations” (Joint Forum 1999a). The underlying concern is that such underestimated or overlooked risks receive insufficient management attention and have the potential to produce unexpectedly large losses that could threaten the firm’s financial health.

Financial market practitioners also cite the interdependent nature of risks within an organization as a motivation to develop consolidated risk management systems. For instance, echoing sentiments in the supervisors’ Joint Forum report, Lam (1999) argues that “managing risk by silos simply doesn’t work, because the risks are highly interdependent and cannot be segmented and managed solely by independent units” in the

firm. Similarly, a senior executive at a major U.S. bank asserts that “the careful identification and analysis of risk are, however, only useful insofar as they lead to a capital allocation system that recognizes different degrees of risk and includes all elements of risk” (Labrecque 1998).

In contrast to the supervisors, however, the primary implication that Lam and others draw from this finding concerns the role that consolidated risk management systems can play in helping firms to make better-informed decisions about how to invest scarce capital and human resources. For instance, Mudge (2000) stresses that a consistent framework for evaluating firmwide risk and return across diverse financial activities is a key to evaluating the benefits of potential mergers among banking and insurance firms. Similarly, Lam (1999) argues that consolidated risk management systems can help firms understand the risk/return trade-offs among different business lines, customers, and potential acquisitions. Furthermore, consolidated risk management may allow a firm to recognize “natural hedges”—when one entity within the firm has positions or is engaged in activities that hedge the

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positions or activities of another part of the firm—that may become apparent only when risk is examined from the perspective of the consolidated institution. Firms that fail to recognize the diversification effects of such natural hedges may waste resources on redundant hedging by individual units within the organization.

Thus, while both supervisors and financial institutions agree on the importance of consolidated risk management and point to the same driving factors, their conclusions about the role that these systems can play emphasize quite different concerns. At one level, this difference is not surprising, given the different objectives of supervisors and financial institutions (safety and soundness, on the one hand, and profit maximization, on the other). On another level, these concerns are not necessarily mutually exclusive. Indeed, in the next section, we argue that supervisors’ emphasis on underestimation of firmwide risk

and financial institutions’ emphasis on enhanced understanding of the risk/return trade-off among different activities reflect a common emphasis on the importance of accurate assessments of risk.

Understanding the Role of Consolidated Risk Management

The discussion above reflects a well-established belief on the part of financial institutions and supervisors in the importance of consolidated risk management. But what economic fundamentals underlie this belief? In this section, we assess the views of supervisors and financial institutions and try to place them in a common framework. We do not attempt to address the question of why firms choose to manage risk at all.⁷ Instead, we try to understand why it matters whether risk is managed on a consolidated basis or at the level of individual businesses or risks within a firm.

The Supervisors’ View: Spillover Effects

We first consider the view expressed by supervisors in the Joint Forum paper (1999a), namely, that in the absence of consolidated risk management, significant risks could be overlooked or underestimated. To gain some insight into this view, it is helpful to consider a simple portfolio approach to assessing the risk of a diversified financial firm. This approach helps illustrate how the perception of the overall risk facing the firm would differ if institutions managed their risk in an integrated way instead of by individual businesses or legal entities within the larger organization.

To begin, suppose that a financial firm has two business lines, each of which earns profits that vary uncertainly over time. Application of standard portfolio theory suggests that the risk of the overall firm will depend on the variation in each unit’s profits and the extent to which variation in these profits is correlated between the two units. In particular, the risk facing the consolidated firm will be less than or equal to the sum of the risks facing the individual business units within the firm whenever this correlation is less than perfect. In this situation, the profit variation in one unit diversifies the risk of the other.⁸

The importance of this observation for our purposes is that it suggests that establishing risk monitoring and control (such as limits) at the business level and then summing up across business lines would be a *conservative* approach to managing

and assessing the overall risk facing the firm, since it ignores any potential diversification effects across business lines. This conclusion stands in marked contrast to the arguments advanced by supervisors in favor of consolidated risk management. How can we reconcile these two outcomes?

The answer, of course, is that the simple portfolio example misses some important “real world” aspects of financial risk and risk management. Perhaps the most significant of these is the assumption that the risks facing each business unit are fixed and known. In fact, these risks are functions of many factors that can vary significantly over time. In particular, the simple portfolio example assumes that the risk profile of one business

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line can be measured without regard to the risks undertaken by the other. This assumption is not a statement about the degree of correlation between the risks faced by the two business units, but rather the idea that the underlying volatility of one business line’s profitability may be affected by the actions of another business line.

An example of this relationship might be when two or more geographic centers within a global financial firm have similar positions that they have each hedged in a particular security or market. In the absence of a consolidated risk management system, the various units could be unaware of the positions that other units within the firm have taken.⁹ Each unit assumes that its position is small enough that it would be able to roll over its hedges or otherwise take steps to reduce its risk even in the event of market stress. However, when the various business units try to take these steps simultaneously, their combined activity reinforces the liquidity problems facing the market, resulting in sharp, adverse moves in the market prices of the hedging and/or underlying instruments. Thus, losses at individual units exceed the risk assumptions made in each unit’s individual risk management plans and the aggregate position of the firm is therefore riskier than the sum of the *assumed* individual risks of the business units. In essence, the

firm faces the “portfolio insurance” problem in that the actions of one unit affect the risks facing another.¹⁰

These spillover effects can be enhanced during times of crisis or severe market disruption. A firm that manages risk on a unit-by-unit basis may have to spend valuable time simply determining what its aggregate position is in the affected markets, rather than being able to react to quickly developing market conditions. Since nimbleness in responding to problems can affect outcomes favorably, such firms may be at a disadvantage compared with smaller firms (for instance, compared with a series of smaller firms that are comparable in the aggregate to the diversified financial institution) and compared with large firms with consolidated risk management systems. Such a situation is an example of how the structure of the risk management system—as distinct from any ex ante risk-mitigating actions taken by the firm’s risk managers—may affect the aggregate risk facing the firm. Nimbleness is especially important if market disruption spreads rapidly from market to market in a hard-to-anticipate pattern, as it did in 1997-98.

In fact, the financial crisis in the fall of 1998 provides some interesting insights into the importance of consolidated risk management and measurement systems when there are linkages across markets. International bank supervisors conducted a study of the performance during the market upheaval of banks’ risk management systems and the value-at-risk models used to calculate market risk capital requirements (Basel Committee on Banking Supervision 1999c). The study examined information on the stress testing done by large banks in several G-10 countries and found that ex ante stress test results provided a better picture of actual outcomes during the third quarter of 1998, when those tests were based on actual historical experience or hypothetical scenarios that incorporated simultaneous movements in a range of rates and prices, rather than on large movements in a single market risk factor. Thus, firms whose stress testing and risk management systems recognized potential linkages across markets had more realistic estimates of the way events in the fall of 1998 were likely to affect their firms.

Another way in which spillover effects can result in aggregate risk exceeding the sum of the individual risks of business units within the firm concerns what might be called reputational or contagion risk. As discussed in the Joint Forum report (1999a), this is the idea that problems in one part of a diversified firm may affect confidence in other parts of the firm. The situation that the Joint Forum paper appears to have in mind is one in which such problems cause acute, near-term funding or liquidity problems across the firm, due to questions about whether the losses in the troubled business unit are evidence of as-yet-unrevealed losses in other business lines.¹¹

Aside from such near-term concerns, spillover effects can also have a longer run dimension. For example, innovative businesses or those involving massive technology investments can engender what some analysts call “strategic risk.” Failure in such ventures may be highly visible and thus likely to have spillover effects on other businesses through the cost of capital, the cost of funding, and revenue effects through the loss of customer approval. Thus, other business lines associated with the troubled entity may see their franchise value erode as a result of difficulties in an affiliated unit. Such strategic risk may be particularly important for institutions for which customer trust is a key competitive advantage. Adverse publicity, legal

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judgments against the firm, evidence of fraud or internal theft, or high-profile failed business ventures may erode customer confidence in an institution. In the extreme, such concerns may reach the point where the affected firm is no longer viable as an ongoing concern, even though it may technically be solvent.¹²

This discussion of spillover effects suggests that supervisors’ concerns that disaggregated risk management systems understate the risks facing diversified financial institutions may not be without foundation. Certain important risks may be very difficult, if not impossible, to incorporate into risk management systems that focus on individual business units or types of risk alone within a diversified firm. Consolidated risk management systems therefore may be necessary to obtain an accurate picture of the risks facing a firm and to have in place the procedures needed to manage those risks, both on a day-to-day basis and in stress situations. In this light, supervisors’ concerns can be seen not so much as a desire for firms to have risk management systems that are conservative, but instead for firms to have risk management systems that are accurate.

Consolidated Risk Management and the Theory of the Firm

Concerns about understating firmwide risk exposures notwithstanding, disaggregated risk management systems may also miss instances in which the risks from different units

within a diversified firm offset one another. The consolidated firm would appear to have incentives to manage its risk on an aggregate basis whenever these diversification benefits are non-negligible. At its heart, this is the logic that Lam and others in the financial services industry have applied in support of consolidated risk management: the idea that a diversified financial firm should be viewed as a “portfolio” comprising its different units and business lines.

This view is closely related to the broader question of how firms decide which activities are coordinated within the firm and which activities are coordinated through markets. This question has long interested economists, and we can draw on the insights of this “theory of the firm” literature to enhance our understanding of the role of consolidated risk management. Coase (1937) first noted that the efficiency of markets might be expected to lead firms to rely on markets and contracts with third parties to conduct their activities, but that in fact many decisions are made, coordinated, and executed by internal mechanisms such as reporting hierarchies, production organization, and compensation plans. Coase’s insight was that a firm carries out inside the firm those activities that it can manage internally at a cost lower than the information and transaction costs involved in purchasing corresponding services or goods outside the firm.

Since the mid-1970s, economists have further developed and extended the Coase analysis by elaborating more fully on the roles of contracting for goods and services and the ownership of assets in determining what is coordinated within the firm and what is coordinated by markets. Grossman and Hart (1986) noted that the combination of uncertainty and complexity makes contracting with inside or outside parties difficult. In the presence of less than fully specified contracts, ownership and control of assets is synonymous with ownership of the rights not otherwise covered by contract. Thus, the ease or difficulty of contracting plays a major role in determining what occurs inside the firm. Ownership demarcates the boundary of the firm’s internal activities, which often involve the “noncontractible” aspects of the firm’s activities. In the Grossman and Hart analysis, bringing activities under common ownership (integration) makes economic sense whenever efficiency gains from improved information and coordination within the firm exceed the efficiency losses resulting from the reduced entrepreneurial incentive of the manager who is no longer an owner.

The basic implication of this literature is that activities will be performed inside the firm when the complexity or costs of performing them outside the firm are high. For a diversified financial firm, these insights can be applied to interactions between the various units within the firm. In this setting, we can think of activities conducted by a corporate parent on a

firmwide basis as coordination “inside” the firm, while activities conducted independently by separate units of the firm are analogous to the “market” activities discussed in Coase and in Grossman and Hart. Following this logic, risk management and other corporate control activities will be conducted on a consolidated basis when it is too difficult or costly for the individual business units to contract among themselves.

The type of spillover effects and interrelated risks discussed above arguably create just such a situation. When the actions of one business unit in a diversified firm potentially affect the risks faced by others, the contracting problem—in this case, what risk exposures may be undertaken by the various business units within the firm—becomes very complex to solve on a bilateral basis. In such circumstances, the incentives to create a centrally run, consolidated risk management system may be strong.

Fungibility of Financial Resources

That consolidated risk management allows the firm to allocate capital efficiently further reinforces the interdependence between a firm’s business units. The fungibility of capital within the firm—what some have called a firm’s internal capital market—means that the risks undertaken by one unit can affect the resources available to another through the workings of the internal capital market. In considering risk in relation to the capital resources available to back that risk, then, an additional dimension is that those resources may also be called into play to back the activities of other units within the firm.¹³

The financial institution’s internal capital market is itself an example of coordination within the firm potentially being more efficient than external markets. Gertner, Scharfstein, and Stein (1994) attribute the efficiency of internal capital markets to the strong incentive that owners have to monitor capital use relative to debtholders, especially if many aspects of the firm’s capital use are not limited by the debtholders’ contract. In addition, capital allocated to an unsuccessful project can be shifted to another use within the firm at less cost than would be involved in liquidating the assets of the project in the market, if capital and resources in one use are close enough substitutes for those in other activities. As discussed earlier, these benefits are offset by a reduction in incentives to managers who no longer act like owners.

Froot and Stein (1998) offer a model of capital allocation and capital structure for financial firms that develops the relationship between risk management and capital allocation

formally.¹⁴ In their model, financial institutions fully hedge risks for which liquid markets are available. Financial institutions have incentives to engage in risk management whenever they face risks that cannot be traded in liquid markets because they need to hold capital against the nontradable positions according to the amount of risk in the

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portfolio.¹⁵ The desirability of any given investment depends on the extent to which its nontradable risk is correlated with the nontradable risks of the firm’s other portfolio positions. Drawing this point to its logical conclusion, Froot and Stein argue that “this line of reasoning suggests that the right question is not whether or not the bank should centralize its decisionmaking, but rather how often headquarters should gather information and use this pooled information to help guide investment decisions.”

The firm’s liquidity resources (assets that can be liquidated as well as funding sources that can be tapped) can be viewed as fungible across the firm in much the same way that capital is fungible (in the absence of regulatory or other constraints). For this reason, liquidity resources virtually always are coordinated centrally for the firm as a whole (Basel Committee on Banking Supervision 2000a). These resources are available to provide cash needed to meet obligations, especially in contingency situations such as market distress.

This interdependency suggests that consolidated risk management systems should take liquidity considerations into account. Liquidity risk assessment requires knowledge of the size and nature of the firm’s risk positions, while the firm’s liquidity risk position should influence the amount and type of risk that business managers choose to take. One approach to recognizing this connection is to extend the concept of capital adequacy to encompass the ability to liquidate assets or easily fund them, as is intended by the Securities and Exchange Commission’s capital rule for registered broker-dealers. Alternatively, an integrated risk assessment approach could consider liquidity risk along with market, credit, and other risks in scenario analyses intended to test the impact of the scenario on capital adequacy (and ultimately solvency) and liquidity, in a test of dual constraints.

Finally, the risks introduced by leverage reinforce the need to evaluate risk on a firmwide basis. Most financial firms are leveraged, and over the course of the 1990s analysts in financial institutions and their supervisors have recognized that many methods can be used to increase leverage in addition to increasing balance sheet debt to equity, such as taking positions through the use of derivatives and imbedded optionality. Since leverage increases the risk supported by capital, a sophisticated risk assessment should incorporate the combined effects of all sources of market and credit risks, of liquidity risk, and of leverage on capital. This point was made by the Counterparty Risk Management Policy Group (1999) in its private sector report on lessons learned from the 1998 de facto failure of Long-Term Capital Management, a large hedge fund. The report suggests several measures that can be used to conduct a risk and capital or liquidity adequacy analysis.

Debtholders and Other Creditors

Financial institutions may have additional incentives to engage in consolidated risk management because of the concerns of debtholders and other creditors.¹⁶ In agreeing to extend credit, these parties must take into account the moral hazard incentive that the firm has to increase its risk exposure—to the benefit of the firm's shareholders and the detriment of its creditors—once the credit has been extended. This situation is particularly acute for financial firms, which can change their risk profiles relatively rapidly using derivatives and other liquid financial instruments. In the face of this uncertainty, creditors may charge higher rates or offer less favorable nonprice terms (for instance, shorter maturity or higher collateral) than they would if this incentive could be addressed.

Consolidated risk management systems provide a way for financial institutions to make a credible commitment against such behavior. In particular, these systems facilitate better disclosure by providing a consistent and comprehensive assessment of the firm's true risk exposure that can be used by creditors to monitor the institution's activities. In the absence of such systems, it can be significantly more difficult for analysts to draw an accurate picture of the firm's overall risk exposure, even if the individual units within the firm make extensive disclosures of their risk profiles. Furthermore, the centralized and independent risk management units that nearly always are a key feature of consolidated risk management systems provide an internal check against any incentives for individual units or employees within the firm to hide risk exposures from senior management. Finally, the enhanced disclosure made possible by consolidated risk management systems may mitigate some of the spillover effects described

above by providing meaningful information about the true extent and nature of linkages between various businesses within the consolidated firm.¹⁷ Thus, these systems can provide an important tool for management to address the moral hazard concerns of creditors and to obtain better borrowing terms as a result.

Spillover effects, the fungibility of resources, and the concerns of debtholders and creditors suggest that firms have strong incentives to measure risks well, to take advantage of

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diversification benefits, and to manage capital and liquidity efficiently. In the next section, we examine why firms have not been faster to adopt consolidated risk management to take advantage of even small diversification effects and why both industry and supervisory efforts have been necessary to encourage its use.

Obstacles to Creating Consolidated Risk Management Systems

That firms have not immediately adopted consolidated risk management systems suggests that there are significant costs or obstacles that historically have led firms to manage risk in a more segmented fashion. While the firm can invest in two business activities, as discussed above, it finds the two activities to be in some sense segregated, so that taking advantage of diversification effects engenders costs. The segregation can be geographical (such as New York versus London) or conceptual (for example, loans versus over-the-counter options).

Information Costs

Segregation creates two kinds of costs. The first is information costs—the costs of integrating and analyzing information from the two business lines. Those costs involve both the resources

involved in transmitting, recording, and processing the information and the amount of decay in the time value of the information, reflecting the lags in assembling and verifying information. At any given moment, there may be competing information technologies with similar scale effects, but a different mix of costs in terms of monetary outlays and time to assemble information (for instance, a highly automated process versus a manual one).

Information costs are shaped largely by technology. Information systems tend to have substantial fixed costs that usually increase with the size of the information system, but low marginal costs until the particular system approaches capacity. To reflect that, we consider the total information cost

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function to be a step function increasing discretely as the scale of the business increases. For a given volume of information, then, the value of recognizing the impact of diversification—which is a function of the amount of diversification inherent in the firm’s activities—needs to exceed the information costs for the scale of the firm’s business in order for the firm to invest in the information infrastructure. In essence, the firm maximizes its expected profits subject to a capital constraint by choosing the business mix, the scale of business, and the information technology (or none) to manage risk.¹⁸

Information costs will tend to limit the size of the business for a given level of capital. If the firm finds the cost of information high relative to the diversification benefit, the firm will manage each business separately, and in doing so, it will assign relatively high amounts of capital to each business line as if there was no diversification benefit. As a result, the scale of the firm’s overall business will be lower than it would be when diversification effects can be realized.¹⁹

Improvements in technology reduce fixed information costs, make it possible for firms to take greater advantage of diversification benefits, and increase the scale on which certain businesses can be conducted. For example, improvements in information technology permit banks and securities firms to manage single “global books,” in contrast to the regional

approach used to manage most international businesses in the 1970s and 1980s.

Finally, the value of information has risen as the pace of developments has picked up and the complexity of financial relationships among markets and counterparties has increased. If we interpret the increased speed of events as an increase in the variability of the risks and correlations associated with a financial firm’s different business lines, then, *ceteris paribus*, firms would tend to set necessarily more conservative limits on their activities—perhaps in line with the maximum possible values of the risk exposures of their various units.²⁰ Since these maxima would rarely be observed together in practice, there would appear to be substantial opportunities for gains from identifying and responding to changes in the diversification benefit. But greater volatility in the underlying risk relationships also changes the set of relevant information technologies, since at any scale of activity most “low-tech,” time-intensive techniques become unacceptably costly, reflecting the rapid decay in the value of information. Thus, in a more volatile environment, we might expect the ability to design and implement effective technology-intensive risk management information systems to represent a significant dimension of competitiveness for financial institutions seeking to operate in a large number of markets.²¹

Regulatory Costs

Regulatory barriers to moving capital and liquidity within a financial organization impose another cost that inhibits the use of consolidated risk management. These barriers can take the form of business line capital and liquidity requirements set by regulators, prohibitions or limits on capital and funds that can be transferred from one business line to another, or the necessity of seeking prior approval or giving prior notice to move funds between business lines. Most commonly, business lines segregated from one another by such regulatory requirements are in different locations or different legal entities, subjecting the two business lines to different regulations. However, similar types of costs can be imposed by rating agencies, creditors, or even investors when the requirements or expectations they set differ across individual entities.

As with information costs, we can consider the regulatory costs to reflect both monetary outlays to manage or circumvent regulatory barriers and the waiting period or decay in profit opportunities in the time needed to comply with or overcome regulatory costs. While in some cases regulatory requirements can make it virtually impossible to move capital or liquidity

from one business line to another in the short run, in many cases regulatory requirements can be satisfied at some cost. The cost of managing and circumventing regulatory requirements appears to have dropped substantially through the use of derivatives, securitization techniques, and other financial engineering. Indeed, a recurring pattern in financial regulation is the erosion of regulatory requirements through financial innovation and regulatory arbitrage and their eventual repeal. That pattern dates back at least to the creation of the Eurodollar market in the 1960s and the subsequent slow removal of deposit ceilings and many reserve requirements. If regulatory circumvention is not possible, in the longer term the firm can plan its organization and its capital and funding strategy to create more flexibility in managing regulatory requirements, usually at the cost of holding excess capital and liquidity in some units.

Therefore, for a given scale of its various businesses, there are regulatory costs that the firm can minimize to some extent. Once again, the firm will invest in information technology and management of regulatory requirements only if the diversification benefits (taking into account the ability to manage capital and liquidity on a very short-term basis under contingencies) are seen to exceed the information and regulatory costs. Moreover, the reduction of regulatory barriers to moving capital and liquidity within the firm enables the development or enlargement of the firm's internal capital market and increases the gains from pooling risk measurement information within the firm as well as the firm's overall efficiency.

Financial Condition

Intensive work on consolidated risk management has coincided with the rebuilding of the financial strength of many banking organizations following the difficulties of the late 1980s and early 1990s. For instance, a 1998 Federal Reserve study of credit risk models (Federal Reserve System Task Force on Internal Credit Risk Models 1998) notes that large U.S. banks have begun to develop both advanced credit risk modeling and internal capital allocation systems only since the mid-1990s—just the period over which these institutions recovered from the financial stresses of the earlier part of the decade. These internal capital allocation systems are one of the key elements in banks' attempts to evaluate the risk-adjusted performance of their various business units. As such, they represent an important step in the progress toward full-fledged consolidated risk management systems.²²

This financial rebuilding may also have contributed to the growing emphasis on consolidated risk management systems.

As argued above, one key motivation for consolidated risk management is to enable firms to make more informed judgments about where to invest their scarce capital resources, in particular, about where to expand through acquisition or internal growth. Firms in weakened financial condition are unlikely to be in a position to fund such growth—even into lines of business where the institution's risk/return trade-off is

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highly favorable—so they have less incentive to invest in the consolidated risk management systems that would permit them to identify such opportunities. The improved financial condition of many institutions since the early part of the 1990s therefore may have provided an additional incentive for firms to develop and implement consolidated risk management systems.

Declining information costs, eroding regulatory barriers, and stronger financial condition present fairly stylized explanations for increased attention by financial institutions to consolidated risk management and internal capital allocation activities. However, the optimization problem faced by firms is more complex than we have described. Holmstrom and Roberts (1998) provide many examples of the rich variety of mechanisms used to coordinate activities within and among firms and the multiplicity of factors that influence the coordination decision. The examples particularly illustrate the roles that incentives in internal (implicit) and external contracts and information flows play in resolving complex coordination problems, including overcoming regulatory barriers.²³ The implication is that coordination mechanisms used by individual firms may change as a wide variety of factors change. The current importance of consolidated risk management as a goal for many financial institutions could be enhanced or complemented by further advances in information technology and monitoring techniques, new designs for incentive contracts with employees and outside agents, better public and private information flows, and greater liquidity of financial markets.

Even so, the decline of information costs and the erosion and repeal of regulatory barriers have been so great that many

of the principal hurdles to consolidated risk management within a financial conglomerate involve problems in measuring, comparing, and aggregating risks across business lines. The ability to merge banks and insurance companies under the Gramm-Leach-Bliley Act provides financial institutions with new opportunities to diversify risks and expand internal capital markets and creates further impetus to develop consolidated risk management techniques for financial conglomerates. Thus, both firms and supervisors are probably closer today in their common interest in accurate and precise risk measurement than they were just five years ago.

Major Technical Challenges and Research Questions

The previous sections discussed the economic rationale behind consolidated risk management and some of the costs facing diversified financial firms in constructing such systems. In this section, we turn to some additional practical problems associated with this overall goal. Our goal is to highlight a series of practical issues where additional research by risk management practitioners and by academics would be especially beneficial. In particular, we describe some of the technical challenges involved in actually estimating an aggregate measure of risk for a diversified financial institution and suggest some areas where further research could help both financial institutions and supervisors understand the strengths and weaknesses of such aggregate risk management.

At a very general level, there does appear to be an emerging consensus about how various forms of risk should be quantified. Most risk measurement methods used by major financial institutions are intended to capture potential losses over some future horizon due to the risk in question. These methods can use a probability-weighted approach to estimating potential losses (as in a value-at-risk or earnings-at-risk system, where the distribution of future earnings is calculated) or can provide point estimates of potential losses under certain extreme circumstances (as in a stress test or scenario analysis approach or in an “expected tail loss” estimation). The common thread is the focus on potential future losses, either to earnings or economic value.²⁴

Beyond this general consensus, however, the picture is considerably more complex. As noted above, an aggregate risk measure must incorporate different types of risk (market, credit, operational) and must bring together risks across different business lines (banking, insurance, securities). Although the broad risk concept applied within and across

these two dimensions may be similar, the details differ considerably, making simple “bottom-up” aggregation approaches difficult, if not impossible, to implement.

Aggregating across business lines presents challenges because firms and functional supervisors in the different business lines have tended to approach risk management and measurement from quite different perspectives. For instance, banks traditionally have emphasized the risks arising from the asset side of the balance sheet (credit risk) and from the interaction of assets, liabilities, and off-balance-sheet positions (interest rate risk, liquidity risk). Insurers, in contrast, have tended to place emphasis on the risks arising from the liability side of their business (underwriting risk, catastrophe risk). Securities firms have tended to emphasize the combination of market risk and liquidity (meaning both the ability to fund or to sell an asset) in their portfolios. Of course, advances in financial theory and market practice have eroded these distinctions somewhat, and many firms now attempt to

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measure the way in which risks can interact and affect an entire institution.²⁵ Nonetheless, one of the key challenges of consolidated risk management is to integrate these different perspectives on risk into a coherent framework.

A related set of challenges arises when aggregating across different types of risk. These challenges reflect the fact that at many financial institutions, risk measurement and management began as a bottom-up process, with different types of risk measured separately. A particular business area would develop risk measurement approaches to capture the most important risks facing that unit: credit risk for lending activities, market risk for trading, interest rate risk for the treasury/asset-liability management function. This risk-by-risk approach has resulted in industry standards of risk measurement that differ significantly across risk types, and sometimes across activities with similar risks, both in the way that risk is measured and in the extent to which it is quantified at all.

To a large extent, the state of development of modeling technology across the various risks reflects the availability of data and the nature of the risk itself, which can affect the ease or difficulty involved in accurately modeling the risk. At one end of the spectrum, the banking and securities industry has a

now fairly long history of measuring market risk through value-at-risk models. The fact that value-at-risk models were among the first statistical risk models developed reflects the high-frequency and largely continuous nature of market risk and its management,²⁶ the mark-to-market environment in which most trading activities occur, and the resultant ease of modeling (normality has often been assumed) and availability of comparatively long historical data series around which to calibrate the models.

Credit risk tends to exhibit somewhat lower frequency variation, as changes in credit status tend to evolve over weeks or months rather than on a day-to-day basis. Thus, fewer

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historical data are available to aid in model calibration, and the modeling process itself is more complex, as the distribution of credit losses is quite asymmetric with a long right-hand tail.²⁷ Financial institutions have made considerable progress over the past two or three years in credit risk modeling, but it is fair to say that these models are at an earlier stage of development than the value-at-risk models used for market risk assessment.²⁸

Even further down the spectrum is operational risk—the risk stemming from the failure of computer systems, control procedures, and human error—which captures a mixture of events, some of which involve relatively frequent small losses (settlement errors in a trading operation, for instance) and others that are characterized by infrequent but often large losses (widespread computer failure). Consistent data sources on this form of risk are difficult to obtain, especially for the less frequent events; statistical modeling is in its early stages; and the computational requirements may be substantial, given the number of “control points” in most operational processes.

Liquidity risk measurement involves many similar issues of sorting the frequency of different types of events and developing appropriate data. Liquidity risk measurement has long involved scenario analysis focused on stress events and based on subjective probabilities of how depositors, other creditors, and borrowers would respond to the stress event. As risk measurement techniques have advanced, some financial institutions are examining the potential for cash-flow-at-risk analysis, based on more formal measurement of the probability

of events and the sensitivity of cash flows to these events, both to enhance day-to-day liquidity management and to strengthen the underpinnings of liquidity stress scenarios. Finally, at the far end of the spectrum, other risks—such as legal, reputational, and strategic risk—are rarely quantified, as both the data and theoretical techniques for capturing these risks have yet to be developed extensively.

Even for those risks that are measured, important differences exist in the assumptions and techniques used to estimate potential losses. One key issue is the time horizon over which potential losses are to be measured. As noted above, the risks facing financial institutions vary in the extent to which they are continuous or discrete, in how quickly new events develop, and in the size of events when they occur (many small events versus a few large ones). These differences imply the need for different horizons to capture different risks effectively. In fact, we see these differences in the assumptions underlying the risk estimates made by financial firms, with market risk typically measured over a one-day horizon, credit risk typically measured over a one-year horizon, and operational risk measured over a variety of short and long horizons (an industry standard has yet to emerge).

These differences present a challenge for calculating consolidated risk exposures that span several risk types. Should a single horizon be chosen for all risks and, if so, which one? Should the time dimension be explicitly factored into the risk assessment, with paths of risk over time? More generally, issues

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such as differing horizons suggest that there is an important set of research questions concerning methods for calculating aggregate risk measures. At a very basic level, can the different individual risk measurement approaches typically used within financial firms be meaningfully aggregated? If so, how? If not, is it possible to develop a “top-down” approach that somehow blends the risks facing the firm without measuring them separately, such as an analysis of income volatility? Is there some way of combining “top-down” with “bottom-up” approaches to consolidated risk measurement? And how does the growing attention to evaluating performance against risk in rewarding managers at all levels of the organization factor into these decisions?

A related set of issues concerns the mathematical aggregation of risk measures across businesses and risk types. In most cases, this process would involve estimating correlations between various risk exposures. An important challenge in this regard is measuring the degree of correlation between risks in businesses that are distinct in terms of the sources and frequency of variability (for instance, between insurance underwriting and trading). The data demands of producing accurate estimates are likely to be enormous. Even when aggregate risk measures can be calculated, a related challenge is how to apportion the benefits of diversification across various business lines. That is, if less-than-perfect correlation across distinct business lines results in a decrease in the overall risk facing the firm, how should these benefits be allocated back to the various business units in the internal capital allocation process?

This discussion assumes that to produce a consolidated measurement of risk exposure, it is necessary to develop risk measures that are highly comparable across risk types. However, perhaps a more fundamental question is whether a consolidated risk *management* system needs to have a fully consolidated risk *measurement* methodology at its core. In other words, how much comparability across risk measures is strictly necessary to have an effective consolidated risk management system? If risk measures cannot be made perfectly compatible across risk types and business lines, are there still benefits to imperfectly comparable measures?

Our sense is that the answer to this question is likely to be a resounding yes, largely because the ability to evaluate results against risks taken has become a major feature of financial institution management in the 1990s. Some important issues would need to be explored before understanding the full implications of this conclusion. For instance, what kind of

biases might enter the assessment of aggregate risk if this assessment is based on disparate risk measures? How might comparisons of risk and return across business lines be affected? How can we relate the results of stress scenario analysis to statistical measures of risk exposure? Are there limits to how different the various risk measures can be, yet still be useful in a consolidated risk management system? These are important, unresolved issues.

Conclusion

As the above discussion suggests, there is considerable scope for further research to enhance our understanding of the benefits and shortcomings of consolidated risk management. Many of the key research questions involve technical issues in risk measurement and financial series modeling. While these questions are vital to understanding how to calculate a consolidated measure of risk exposure spanning all of a financial institution's businesses and risk factors, they are not the only questions of interest. Further research into the main question of this article—the economic rationale for consolidated risk management—could produce findings that would be of clear use to supervisors and financial institutions. In addition, this work could provide insight into such diverse topics as the theory of the firm, the costs/benefits of diversification, the linkages among financial markets, and the impact of product and geographic deregulation. Our study presents some initial ideas, but clearly much more work needs to be done. We hope that this article can serve as a starting point for further discussion.

Endnotes

1. It can also be argued that supervisors may place somewhat greater weight on the risk of severe downside scenarios, given the nature of the supervisory role, but the private sector appears to be closing any gap as a result of the insight gained from experiences such as the market disturbances in 1998.

2. Firms vary in how they use the risk management process to maximize profits. Some firms use risk-and-return measures in the selection of their medium-term business mix in order to maximize long-run expected profits. Firms also use risk management systems to assist in managing expected profits over short horizons, by seeking to identify changes in risk and loss potential and adjusting their portfolios accordingly.

3. In large measure, these efforts are an extension of a longer term trend toward enhanced risk management and measurement in the financial services industry. Many of these efforts have focused on developing risk measurement and management systems for individual risk types or businesses (for instance, market risk in a securities firm or credit risk in a bank's loan portfolio). In consolidated risk management, however, the focus is on an expansion of these single-risk-management systems to span diverse financial activities, customers, and markets.

4. Mergers may occur for many reasons, including the desire to benefit from exactly the sort of diversification that presents challenges to risk management and measurement systems. In this discussion, we distinguish between the broad diversification that may occur when firms comprise business units involved in distinct business activities (such as banking, insurance, or securities activities) or geographic locations and the type of portfolio diversification that occurs when risk management units take steps to hedge portfolio- or business-level risk exposures. It is the first type of diversification—which has become much more feasible given the regulatory and technical developments discussed in the text—that presents the sort of challenges we discuss in this article.

5. The evaluation of the adequacy of risks in light of a full risk assessment is discussed in Federal Reserve SR Letter 99-18. Earlier in the decade, the Federal Reserve issued SR Letter 93-69, on the management of trading activities; SR Letter 97-32, on information security; SR Letter 00-04, on outsourcing; and a series of papers on the management of credit risk in both primary and secondary market activities (SR Letters 99-3, 98-25, and 97-21). The Office of the Comptroller of the Currency and the Federal Deposit Insurance Corporation have issued guidance using a comparable framework for a similar range of topics.

6. This framework is best developed in "Principles for the Management of Credit Risk," published in September 2000. The Committee has also published work on interest rate risk, in 1997; operational risk, in 1998; and liquidity risk, in 2000.

7. The work of Modigliani and Miller (1958) and Miller and Modigliani (1961) suggests that any risk-altering actions taken by a firm's management are redundant and resource-wasting because shareholders can achieve their optimal degree of diversification independently. See Cummins, Phillips, and Smith (1998) for a discussion of the factors—such as bankruptcy costs, taxes, and costly external financing—that may make it worthwhile for firms to engage in risk management.

8. This relationship can be expressed mathematically as

$$\sigma_{FIRM} = \sqrt{\sigma_A^2 + \sigma_B^2 + 2\rho\sigma_A\sigma_B} \leq \sigma_A + \sigma_B,$$

where σ_A and σ_B are the profit volatilities of business units A and B and ρ is the correlation between them.

9. This situation was not uncommon among globally dispersed institutions prior to the introduction of enhanced information systems in the early-to-mid-1990s. Later in this article, we discuss the role of information costs and information systems in diversified financial institutions.

10. Morris and Shin (1999) describe this problem in the context of multiple firms operating in a single market. They describe the errors in risk assessment that can occur when risk management systems assume that the firm's activities are similar to playing roulette (gambling against nature), when in fact the risks are more like those in poker (where the actions of the other players matter). The same analogy can be applied to risks within a firm.

11. Or, as discussed below, such contagion fears may arise because market observers believe that the resources of all of the firm's business units will be used to "rescue" a troubled unit, calling into question the solvency of all of the businesses within the firm.

12. The large investments that many financial institutions are making in electronic trading and banking are examples of strategic risk related to establishing the competitive position of a firm in a fast-changing and greatly contested market. The problems many financial institutions experienced in the mid-1990s—when customers experienced large losses in connection with derivatives and complex trading strategies—are examples of strategic risk related to damage to the firm's reputation.

Endnotes (Continued)

13. Froot and Stein (1998) consider a variant of this risk—the bankwide cost of capital effect—that involves the impact of increased capital costs on all units within a firm when one unit takes on large amounts of risk.

14. In the Froot and Stein analysis, banks choose their capital structure, risk management policies, and investment policies jointly, rather than impose a short-run capital constraint. However, when capital is costly, banks economize on the amount of capital they hold and therefore take risk management concerns into account in their investment policies.

15. The example Froot and Stein give is the counterparty risk on a foreign exchange swap. With the advent of credit derivatives and other credit risk management techniques, such risks are increasingly tradable, by which Froot and Stein mean that the risks can be offset to achieve a zero net present value. Nontradable risks can include unhedged proprietary positions premised on subjective expected rates of return deviating from those of the market. Note that the reliance on markets for hedging for liquid risks and internal capital allocation for nontradable risks is another version of the contractible/noncontractible distinction discussed earlier.

16. Other creditors here could include suppliers, consultants, and other contractors who provide products or services in return for the promise of future payment.

17. This would be especially true if there were meaningful disclosures about intrafirm exposures, as called for in a recent report by the Joint Forum (1999b).

18. As information systems become more “scalable,” the step function may become flatter, in effect making it easier to realize and manage the diversification benefits from combining activities.

19. This is also consistent with the analysis of Holmstrom and Milgrom (1994), which derives analytically that enhancements to performance measurement tend to permit greater employee freedom (such as higher limits), although the authors caution that their analysis requires a careful specification of the exact problem.

20. Correlations and volatilities have changed substantially over time. Examples include the sharp drop in volatilities in short-term interest rates associated with the decline in inflation in the 1980s and early 1990s; sharp increases in the correlations and short-term volatilities of U.S. long-term fixed income instruments in times of distress; and a

rise in the idiosyncratic risk of equities in the 1990s, the last example documented in Campbell, Lettau, Malkiel, and Xu (2001).

21. Gibson (1998) derives similar conclusions about the impact of declining information costs. In his approach, risk measurement is a means to monitor risk-taking by employees when information about the managerial effort of those employees (or outside agents, such as mutual fund managers) is not observable by the employer.

22. Typically, these internal capital allocation systems fall short of a full-fledged consolidated risk measurement system, either because they incorporate only a limited range of the risks facing a financial institution (for example, just credit risk or market risk, but not operational or other forms of risk) or because they are applied only to a subset of the institution’s activities.

23. The specific regulatory barrier they cite is the limitations on foreign ownership of domestic airlines.

24. Other potential definitions of risk could involve pure volatility measures, such as standard deviations of earnings or economic value, or sensitivity measures that capture the derivative of earnings or economic value with respect to particular risk factors, such as the “value of a basis point.”

25. Lewis (1998), for instance, describes how one insurance company examines stress scenarios that affect all aspects of the firm, such as an earthquake that simultaneously causes extremely high insurance claims and disrupts financial markets—and thus the firm’s investments and investment income—for some period of time.

26. Of course, some market price series exhibit sharp, discontinuous jumps, such as those associated with emerging market developments and unexpected changes in exchange rate regimes. These factors have tended to be incorporated into value-at-risk models after the initial phases of model development.

27. To some extent, both the lack of data and the lower frequency variation reflect the current GAAP (Generally Accepted Accounting Principles) accounting standards, which do not require the daily marking-to-market to which trading account positions are subject. Thus, shorter term variation in value may not be reflected in the accounting data typically available for use in credit risk models.

28. See Basel Committee on Banking Supervision (1999a) for a discussion of the state of development of credit risk models.

References

- Basel Committee on Banking Supervision*. 1999a. "Credit Risk Modeling: Current Practices and Applications." April. Basel, Switzerland: Bank for International Settlements.
- . 1999b. "A New Capital Adequacy Framework." June. Basel, Switzerland: Bank for International Settlements.
- . 1999c. "Performance of Models-Based Capital Charges for Market Risk." September. Basel, Switzerland: Bank for International Settlements.
- . 2000a. "Sound Practices for Managing Liquidity in Banking Organizations." February. Basel, Switzerland: Bank for International Settlements.
- . 2000b. "Principles for the Management of Credit Risk." September. Basel, Switzerland: Bank for International Settlements.
- Board of Governors of the Federal Reserve System*. 1993. "Examining Risk Management and Internal Controls for Trading Activities of Banking Organizations." SR Letter 93-69. December 20.
- . 1997a. "Risk Management and Capital Adequacy of Exposures Arising from Secondary Market Credit Activities." SR Letter 97-21. July 11.
- . 1997b. "Sound Practice Guidance for Information Security for Networks." SR Letter 97-32. December 4.
- . 1998. "Sound Credit Risk Management and the Use of Internal Credit Risk Ratings at Large Banking Organizations." SR Letter 98-25. September 21.
- . 1999a. "Supervisory Guidance Regarding Counterparty Credit Risk Management." SR Letter 99-3. February 1.
- . 1999b. "Assessing Capital Adequacy in Relation to Risk at Large Banking Organizations and Others with Complex Risk Profiles." SR Letter 99-18. July 1.
- . 2000. "Outsourcing Information and Transaction Processing." SR Letter 00-04. February 29.
- Campbell, John, Martin Lettau, Burton Malkiel, and Yexuai Xu*. 2001. "Have Individual Stocks Become More Volatile: An Empirical Exploration of Idiosyncratic Risk." *Journal of Finance* 56, no. 1 (February): 1-43.
- Coase, Ronald*. 1937. "The Nature of the Firm." *Economica* 4, no. 4 (November): 386-405.
- Counterparty Risk Management Policy Group*. 1999. "Improving Counterparty Risk Management Practices." June.
- Cummins, J. David, Richard D. Phillips, and Stephen D. Smith*. 1998. "The Rise of Risk Management." *Federal Reserve Bank of Atlanta Economic Review*, first quarter: 30-40.
- Federal Reserve System Task Force on Internal Credit Risk Models*. 1998. "Credit Risk Models at Major U.S. Banking Institutions: Current State of the Art and Implications for Assessments of Capital Adequacy." May.
- Froot, Kenneth A., and Jeremy C. Stein*. 1998. "Risk Management, Capital Budgeting, and Capital Structure Policy for Financial Institutions: An Integrated Approach." *Journal of Financial Economics* 47, no. 1 (January): 55-82.
- Gertner, Robert H., David S. Scharfstein, and Jeremy C. Stein*. 1994. "Internal versus External Capital Markets." *Quarterly Journal of Economics* 109, no. 4 (November): 1211-30.
- Gibson, Michael S.* 1998. "The Implications of Risk Management Information Systems for the Organization of Financial Firms." Board of Governors of the Federal Reserve System International Finance Discussion Paper no. 632, December.
- Global Derivatives Study Group*. 1993. "Derivatives: Practices and Principles." July. Washington, D.C.: Group of Thirty.
- Grossman, Sanford J., and Oliver D. Hart*. 1986. "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration." *Journal of Political Economy* 94, no. 4: 691-719.
- Holmstrom, Bengt, and Paul Milgrom*. 1994. "The Firm as an Incentive System." *American Economic Review* 84, no. 4 (September): 972-91.
- Holmstrom, Bengt, and John Roberts*. 1998. "The Boundaries of the Firm Revisited." *Journal of Economic Perspectives* 12, no. 4 (fall): 73-94.

References (Continued)

- Joint Forum (Basel Committee on Banking Supervision, International Organization of Securities Commissioners, International Association of Insurance Supervisors)*. 1999a. "Risk Concentration Principles." December. Basel, Switzerland: Bank for International Settlements.
- . 1999b. "Intra-Group Transactions and Exposures Principles." December. Basel, Switzerland: Bank for International Settlements.
- Labrecque, Thomas G.* 1998. "Risk Management: One Institution's Experience." *Federal Reserve Bank of New York Economic Policy Review* 4, no. 3 (October): 237-40.
- Lam, James.* 1999. "Enterprise-Wide Risk Management: Staying Ahead of the Convergence Curve." *Journal of Lending and Credit Risk Management* 81, no. 10 (June): 16-9.
- Lewis, Robert.* 1998. "Capital from an Insurance Company Perspective." *Federal Reserve Bank of New York Economic Policy Review* 4, no. 3 (October): 183-5.
- Miller, Merton H., and Franco Modigliani.* 1961. "Dividend Policy, Growth, and the Valuation of Shares." *Journal of Business* 34 (October): 411-33.
- Modigliani, Franco, and Merton H. Miller.* 1958. "The Cost of Capital, Corporation Finance, and the Theory of Investment." *American Economic Review* 48 (June): 261-97.
- Morris, Stephen, and Hyun Song Shin.* 1999. "Risk Management with Interdependent Choice." *Bank of England Financial Stability Review*, no. 7 (November): 141-50.
- Mudge, Dan.* 2000. "The Urge to Merge." *Risk Magazine*. February, p. 64.

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