Risk management in the global economy: A review essay

William C. Hunter [a], Stephen D. Smith [b,c,*]

[a] *Federal Reserve Bank of Chicago, Chicago, IL, USA*
[b] *Department of Finance, Georgia State University, 35 Broad Street, Atlanta, GA 30303, USA*
[c] *Federal Reserve Bank of Atlanta, Atlanta, GA, USA*

Abstract

This paper provides a review of developments in the area of risk management at both the firm level and the macro-economy. We review rationales regarding why firms choose to manage risk, as well as new developments in measuring and managing risk in a dynamic setting. We also consider current risk sharing arrangements in light of the theory regarding optimal risk sharing. The paper concludes with some suggestions for additional research that emphasizes the importance of incorporating market incompleteness in an equilibrium setting. We also discuss the role of incompleteness at the macro-level and speculate on how derivatives markets may influence macro-economic stabilization policy. © 2002 Published by Elsevier Science B.V.

JEL classification: D84; G28; G38
Keywords: Risk management; Portfolio theory; Incomplete markets

1. Introduction

The first paper regarding the relevance of financial risk management was arguably written over forty years ago by Modigliani and Miller (1958). In that paper they show that in frictionless markets with no taxes, the value of the

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[*] Corresponding author. Tel.: +1-404-651-1236; fax: +1-404-651-2630.
E-mail address: sdsmith@gsu.edu (S.D. Smith).

corporation is independent of how it manages it's financial risk on the balance sheet. The choice of financial leverage cannot influence the value of the firm if individuals can engage in homemade risk management. The key idea used was the concept of arbitrage. An extension to the irrelevancy of off-balance sheet risk management is straightforward, using similar arguments. Therefore, from the point of view of the firm's shareholders, corporate risk management can only matter if there are imperfections of some sort in capital markets (e.g., differential tax treatment across instruments or institutions or some sort of cost of financial distress).

In another area of financial economics, Markowitz (1952) and Tobin (1958) were developing algorithms that, given certain assumptions, reduced the dimensionality of the risk/return problem facing economic agents to two; mean and variance of returns or payoffs. This provided the minimum level of dimensionality that one could have in order to study choice under uncertainty.

The 1960s provided important extensions to the literature on choice under uncertainty and market equilibrium. On the pricing side, Borch (1962), Lintner (1965), and Sharpe (1964) extended the work of Markowitz and Tobin by studying the (partial) equilibrium pricing of risk. They showed, in somewhat different settings, that only systematic (or common) risk is priced in an otherwise frictionless market, be it for re-insurance or stocks. Importantly for later work, Borch views his agents as "firms" in the reinsurance market, while Lintner and Sharpe view their agents as individuals participating in security markets. In both cases, agents were assumed to have objective functions that are concave in wealth.

Another key element of what is now viewed as the field of risk management came about in the early 1970s with the development of option pricing models by Black and Scholes (1973) and Merton (1973). These authors used the idea that two portfolios with the same cash flows in every state of the world must sell for the same price in order to avoid arbitrage. [1] Ross (1978) and Harrison and Kreps (1979) added an important link for purposes of future developments in asset pricing by providing general conditions under which the lack of arbitrage is equivalent to the existence of a unique "risk neutral" pricing operator for the economy under consideration.

The late 1960s and early 1970s also brought extensions to the work on the theory of the firm under uncertainty. In particular, Leland (1972) and Sandmo (1971) utilized earlier results by Arrow (1963) and Pratt (1964) to study investment and financing decisions by firms that possessed "utility" functions. This was one way to deal with the question of incompleteness and these

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[1] One immediate application beyond the pricing of exchange traded options involved the pricing of other corporate securities, such as stocks and bonds. Once again, the assumption that all of the relevant risks can be "spanned" was an important element of their solution.

authors derived a number of interesting results regarding, for example, whether or not individual firms would increase their investment levels as uncertainty increased.

In the late 1970s and early 1980s Ederington (1979) and Rolfo (1980) published important papers that combined ideas from the theory of the firm literature and mean variance analysis. In particular, they examined the problem of ''hedging'' or off-balance sheet risk management in a world where the firm, for whatever reason, takes positions in off-balance sheet instruments to maximize some mean/variance objective function or expected utility. A special case – namely that where the firm minimizes the variance of cash flows – occurs in cases where the price of financial insurance is essentially zero (so-called unbiased forward rates or prices).

The 1980s yielded a number of breakthroughs in the analysis of risk sharing at both the macro- and micro-levels. At the macro-level, Bryant (1981) and Diamond and Dybvig (1983) analyzed problems of incomplete information and inter-temporal risk sharing. For example, Diamond and Dybvig showed that a ''bank'' would possibly be able to improve on autarky in a world where investors have private information concerning their consumption preferences. However, they also showed that there could also exist a bad equilibrium where depositors run on the bank even though they themselves do not prefer to consume early.

Without aggregate uncertainty, suspension of convertibility eliminates this bad equilibrium. In the case of aggregate uncertainty, they showed that government intervention in the form of the provision of deposit insurance is necessary to achieve the first best allocation. [2]

Work in the 1980s at the level of the firm focused on the fundamental question of what frictions might cause a firm to engage in risk management. Doherty and Tinic (1981) was one of the earliest papers to examine why firms might want to manage risk in equilibrium. The case they considered involved the demand for corporate insurance but the point is, of course, more general than that example. Later papers (Stulz, 1984; Smith and Stulz, 1985) also discussed why firms might have a demand for risk management. These motivations ranged from costly financial distress to agency problems (Jensen and Meckling, 1976) and non-linear tax rates. At another level, MacMinn (1987) provided a general equilibrium model of risk management (via forward contracting) by value maximizing firms in markets that are complete except for the fact that some tax credits are not tradable.

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[2] Jacklin (1987), on the other hand, showed that the particular model of Diamond and Dybvig could be solved without bank runs by using a mutual fund. However, the general idea of these papers is that there may exist coordination problems when there is private information and non-tradable deposit contracts are used for purposes of risk sharing over time.

During this time, researchers were also realizing that multiple sources of risk (Anderson and Danthine, 1981) and/or less than perfectly competitive markets (Morgan and Smith, 1987) complicated the firm's management problem and generated results where full hedging was not necessarily optimal even if hedging had no impact on the mean cash flows of the firm. These so-called "macro"-hedging models were the original work in what has come to be known as enterprise risk management.

Later models of corporate risk management, popularized by Froot et al. (1993) (FSS), appeal to costly external finance arguments (Myers and Majluf, 1984) or other frictions (Stulz, 1984; Smith and Stulz, 1985) for motivation. This approach has become well established in the work on corporate risk management. However, from our point of view the major differences between these models and those developed in the 1980s revolve around the question of what is identified as the (unmodeled) factors that make costs convex and the objective function concave in its argument(s). Indeed, this point is illustrated in the next section, that contains an *example* drawn from Morgan and Smith (1987), that illuminates the general types of solutions to the problem of optimally hedging future investment opportunities when the "value" (utility) function is concave and costs are convex.

2. Optimally hedging investment opportunities

In this section we provide a very simple and straightforward example of why firms may need to hedge current and future investment opportunities and how they should choose their hedges optimally in a partial equilibrium setting. The model in Morgan and Smith (1987) was among the first to extend the firm's (in their case a bank) macro-hedging problem to a dynamic setting. In their model the firm not only must co-ordinate current investment and financing decisions, but also must manage risk in a way that improves the firm's options with regard to future investment and financing decisions.

Morgan and Smith solve this dynamic programming problem by focusing on specific investments (bank loans) and using an "expected utility" approach to the firm's maximization problem. However, as we show below, it is clear that at this level of partial equilibrium analysis, there is little or no formal distinction between models of this type and those popularized by FSS.

The Morgan and Smith model is a three-date model where a bank must choose to make long and short-term loan decisions as well as hedging decisions at date 0. Short-term lending and financing decisions must also be made at date 1. Consider the following *very simplified* case of that model.

First, set two period lending at date 0 equal to zero ($L_2 = 0$ in the notation of their paper). Furthermore, let current (i_1) and future (I) deposit rates be known in advance and equal to unity (i.e., $I = i_1 = 1$). In this case we are free

to replace the deposit forward contract with one on the future loan rate, R (unknown at date 0) with a futures price of r_f. [3] It follows that Eqs. (1a) and (1b) in their paper is specialized as follows:

$$P_1 = (r_1 - 1)L_1 - C_1, \tag{1a}$$

$$P_2 = (R - 1)\iota + f(r_f - R) - C_2, \tag{1b}$$

where L_1 is the current lending, ι is the future lending (unknown at date 0) and r_1 is the current one period loan rate. The value of "f" is the position in the loan rate forward market and P_1 and P_2 represent bank profits at date 1 and date 2. In the above equations, $C_1 = \gamma L_1^2/2$ and $C_2 = \gamma \iota^2/2$ are the real resource costs functions for loans.

Suppose we consider a utility or "value" function of the form

$$\begin{aligned}
U(P_1, P_2) &= P_1 + P_2, & \text{if } P_2 \geqslant \widehat{P}, \\
U(P_1, P_2) &= P_1 + P_2 - \lambda(\hat{P} - P_2), & \text{if } P_2 < \widehat{P},
\end{aligned} \tag{2}$$

where λ is a risk aversion parameter. [4] Clearly, at this level of partial equilibrium analysis, λ could just as well be defined as an indicator of financial distress costs for a risk neutral value-maximizing firm. [5]

In this case, Eq. (2) in their paper is specialized to

$$\max_{\iota, f, L_1} E(U(P_1, P_2)).$$

It follows immediately that $L_1^* = (r_1 - 1)/\gamma$ is the equilibrium level of lending at date 1. Solving for ι^* and f^* is a straightforward dynamic programming problem. At date 2, $\iota^* = 0 \ \forall \ R \leqslant 1$ and $\iota^* = (R - 1)/\gamma$ for $R > 1$. Therefore, we can write Eq. (1b) as

$$(P_2^*|f) = \frac{(R - 1)^2}{2\gamma} + f(r_f - R) \quad \text{for } R > 1, \tag{3a}$$

$$(P_2^*|f) = f(r_f - R) \qquad\qquad \text{for } R \leqslant 1. \tag{3b}$$

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[3] We could just have easily let R be known, $R > 1$ and let the deposit rate vary.

[4] We use this specification of the problem rather than modeling the problem as one with "fixed" costs to utility if $P_2 < \widehat{P}$ since this latter approach creates problems with "smooth pasting" conditions. That is, there is a discontinuity to the optimization problem at $P_2 = \widehat{P}$.

[5] The irrelevance of such semantics can be most easily seen in situations where authors are trying to draw sharp distinctions between these types of models. For example, Stulz (1996) argues that protecting downside risk due to fixed distress costs for value maximizing firms may lead to quite different risk management policies than one where the objective function is to minimize variance, a popular objective in the "expected utility" framework. However, it is quite straightforward to show that if (a) hedging on average is costless and (b) there is no basis risk, then these two approaches yield exactly the same optimal hedging strategy for the firm.

Let us assume that $r_\mathrm{f} = E(R) = \mu > 1$. It follows immediately that $(P_2^*|f) > z\widehat{P} \; \forall \; R \leqslant 1$ if $f(\mu - 1) > \widehat{P}$. Next, consider Eq. (3a) (when $R > 1$). In this case we have, upon differentiating $(P_2^*|f)$ with respect to R,

$$\frac{\partial(P_2^*|f)}{\partial R} = \frac{R - 1}{\gamma} - f. \tag{4}$$

Now, Eq. (4) achieves a minimum at

$$R^* = f\gamma + 1. \tag{5}$$

Substitute Eq. (5) into Eq. (3a) to yield

$$\min(P_2^*|f) = \frac{f^2\gamma}{2} + f(\mu - 1 - f\gamma) = f(\mu - 1) - \frac{f^2\gamma}{2}.$$

As a last step, choose $f = f^*$ so that $\widehat{P} - \min(P_2^*|f) = 0$. Using Eq. (3a), f^* solves

$$\widehat{P} + \frac{f^{*2}\gamma}{2} - f^*(\mu - 1) = 0. \tag{6}$$

There is one real solution to this quadratic equation if $\mu > 1 + \sqrt{2\gamma\widehat{P}}$, which is

$$f^* = \frac{(\mu - 1) - \sqrt{(\mu - 1)^2 - 2\gamma\widehat{P}}}{\gamma}. \tag{7}$$

Eq. (7) clearly represents the optimum since for $R \neq R^*$, $P_2^*|f^* > \widehat{P}$ and the firm never suffers a utility (financial distress) cost. Thus, the existence of a futures contract at an unbiased rate completely solves the "coordination" problem between investment and financing. The first best is achieved. [6]

Notice that at the optimum

$$\frac{\partial f^*}{\partial \mu} = \frac{1 - \dfrac{(\mu - 1)}{\sqrt{(\mu - 1)^2 - 2\gamma\widehat{P}}}}{\gamma} < 0, \tag{8}$$

so that higher expected future loan rates require less hedging, since there is a lower probability that $P_2 < \widehat{P}$ for a given level of f. Moreover $\partial f^*/\partial\widehat{P} > 0$. Finally, it can be shown that $\partial f^*/\partial\gamma > 0$, so firms with higher marginal costs have a higher demand for hedging. [7]

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[6] We have not explicitly considered the constraint that utility ("value") be non-negative. But with some additional complications, this could be incorporated into the analysis.

[7] To prove this, define $x = (\mu - 1)/\gamma$ so that $f^* = x - (x^2 - K)^{1/2}$, where $K = 2\widehat{P}$. So $\partial f^*/\partial x = 1 - (x/(x^2 - K)^{1/2}) < 0$ (since $x > 0$) and $\partial x/\partial\gamma < 0$, so $\partial f^*/\partial\gamma > 0$.
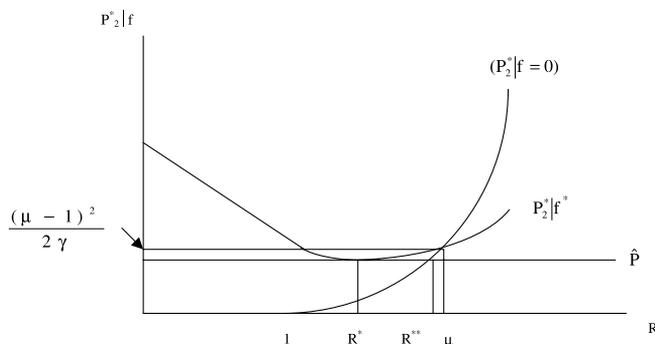
Fig. 1. Optimal hedging of investment opportunities.

Fig. 1 provides a graphical summary of the analysis. It provides plots of $P_2^*|f^*$ (optimally hedged) and $P_2^*|f = 0$ (unhedged). The value of R^{**} solves $(R^{**} - 1)^2/2\gamma = \widehat{P}$, or $R^{**} = \sqrt{2\gamma\widehat{P}} + 1$.

Clearly, from Eq. (5), $R^* > 1$. It is straightforward to show that $\mu > R^{**} > R^*$. [8]

A final interesting point of this example is that the expected return on the growth opportunity is assumed to be large enough to cover funding costs (1 unit) and some notion of the "marginal cost" of financial distress $\left(\sqrt{2\gamma\widehat{P}}\text{ in this case}\right)$. That is, if marginal production costs are very low, for example, a given opportunity may be able to support high levels of financial distress costs. At $\mu = 1 + \sqrt{2\gamma\widehat{P}}$, $f^* = (\mu - 1)/\gamma$, so that $R^* = R^{**} = \mu$. For $\mu < 1 + \sqrt{2\gamma\widehat{P}}$ the first best will not be achievable. [9]

While the above example is a common one in the area of corporate risk management, it ignores the importance of equilibrium in the behavior of agents. That is, since $\sum_i^N f_i = 0$ over N traders, someone must bear the downside risk (when $R < 1$) in equilibrium. The model used here can be thought of as one where risk neutral speculators provide insurance at a zero premium. However, in a model where all agents are risk averse (or are risk neutral but may encounter some costs of financial distress), costless hedging is not typically the equilibrium outcome. [10] We feel that this difference between essentially an analysis of individual demand functions versus equilibrium

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[8] Proof is as follows. Using Eqs. (5) and (8), $R^* = \mu - ((\mu - 1)^2 - 2\gamma\widehat{P})^{1/2}$. Now, $R^* < R^{**}$ since $(\mu - 1)^2 < (\mu - 1)^2 + 2\gamma\widehat{P} - 2\gamma\widehat{P} + 2((\mu - 1)^2 - 2\gamma\widehat{P})^{1/2}(2\gamma\widehat{P})^{1/2}$. Finally $R^{**} < \mu$ by assumption.

[9] This example could be extended to incorporate hedging current as well as future risks.

[10] See, for example, Lin et al. (2001) who look at the properties of an equilibrium model of value maximization with "costly" financial distress.

specifications that yield endogenous futures prices has important implications regarding discussions of optimal hedging/risk management at the level of the corporation.

More recently, other authors have focused on the simultaneous decisions regarding hedging and leverage in the context models that are similar to earlier work on the corporate demand for hedging. Leland (1998) studied the joint problems of investment, hedging and leverage within a dynamic value maximization framework. He shows that hedging permits more leverage and that the benefits of hedging are often highest for firms that have low agency costs. Mello and Parsons (2000) have argued that the optimal hedge for a firm facing constraints is one that minimizes the variability in the marginal value of cash balances. However, we note that both Leland and Mello and Parsons use a particular type of financial distress cost (i.e., fractional recovery of value when the firm is in financial distress). Thus, these papers provide solutions for the optimal demand for hedging given this particular form of concavity and an assumption that essentially amounts to the existence of a set risk neutral traders that provide free insurance since they (implicitly or explicitly) face no costs of financial distress.

3. Review of the papers in this issue

The papers and essays in this special issue represent an interesting cross-section of the work in risk management at the firm level as well as at the level of macro-economics and systemic risk. The issue is structured as follows. The papers have been grouped into five broad sections or areas of study: Leverage and rationales for corporate risk management; modeling value at risk (VaR); stability of risk measures across models and time; trade, credit and systemic risk; and insurance and related issues. In the remainder of this review essay we provide some brief remarks of our own on each of the papers and essays and conclude with suggestions for additional research.

3.1. Leverage and rationales for corporate risk management

Three papers in this issue broadly deal with the question of measuring leverage and the rationales for how and why firms may choose to manage their risk exposure. The paper by Peter Breuer provides a nice discussion of the difference between leverage and risk. He notes that sometimes these notions are confused when considering such issues as best practices for measuring VaR. What is also important about this paper is that the author uses well-known equivalence results (e.g., the payoff on a short position in a forward is the same as that from borrowing and purchasing the stock) to develop estimates of

on-balance sheet equivalence values for off-balance sheet positions. He then develops a leverage measure that incorporates the on- and off-balance sheet positions for financial institutions.

As Fig. 5 in his paper clearly shows, such an adjustment tremendously increases the estimated total leverage of the top 25 commercial banks in the United States. More generally, the Breuer measure, when it can be calculated, is a superior (assuming no systematic measurement error) estimate of leverage for purposes of empirical work in corporate finance and banking than are the traditional proxies of on balance sheet debt (or conversely capital) to assets ratio. Indeed, the standard measure is simply a special case of the Breuer measure, with all of the off-balance sheet positions assumed to have zero market value.

The paper by Tim Adam provides a theoretical model that aims to explain why firms, even though seemingly operating in the same line(s) of business, engage in very different risk management policies. Like earlier authors studying this issue, Adam assumes that the cost of external finance is greater than the cost of internal finance and that the firm faces some deadweight costs of bankruptcy should its value fall to zero. He then shows that the optimal hedging strategy is convex (e.g., write puts) if the problem is primarily one of securing financing for future investment opportunities, while it is concave (e.g., write calls on output from current investment) if the problem is primarily to raise funds for current investment. Less extreme cases can generate contracts with convex and concave segments (e.g., a collar).

These results are intuitively appealing to the extent that, in the first case, cash will be raised next period when payoffs from existing investments are low. On the other hand, the firm can raise current cash (by writing the calls) to fund current investment. If there is little need for capital for future investments the firm can then afford, from a valuation point of view, to have their some of its future cash flows "called away" should output prices turn out to be high in the next period. Thus, this paper extends earlier work on *why* firms should manage risk to *how* they should manage this risk, given a certain dynamic risk/return profile. Moreover, since the analysis is couched in terms of differences in credit risk premiums, the work should provide the basis of interesting future empirical work.

The paper by Daniel Rogers tests some implications of the work on managerial risk aversion as a rationale for corporate risk management, first popularized by Stulz (1984), Smith and Stulz (1985) and Tufano (1996). In particular, Rogers examines the incentive of managers to take on risk as a function of risk management activity at the firm level. Given that these decisions are made simultaneously, Rogers models the problem as a simultaneous equation system.

Like earlier authors, Rogers finds that there is little relationship between risk taking by managers and risk management at the firm level using a single

equation set-up. However, he finds a strong negative correlation between the two when a system of equations is employed. He interprets these results as providing strong evidence that managers with high-risk taking incentives do not choose to hedge and vice versa. Moreover, his data cut across industry lines and therefore can be viewed as a confirmation and generalization of earlier results for gold mining firms (Tufano, 1996) and Savings and Loan Associations (Schrand and Unal, 1998).

3.2. Modeling value at risk

VaR is a concept that originated with the desire of market practitioners to have a summary measure of their risk exposure at the end of the trading day. It has now evolved into one of the mainstays for measuring risk in the financial services industry. Moreover, there is widespread discussion of which types of VaR models should be used in the industry and whether these models are measuring what users think they are.

The paper by Michel Dietsch and Joël Petey develops a VaR model using data from small and medium-sized French businesses. They use an ordered probit model that incorporates a single systematic credit risk factor as well as an idiosyncratic risk factor for each firm. Using over 200,000 observations from the 1996–1999 time period, Dietsch and Petey provide evidence that there are major benefits from the existence of idiosyncratic risk across firms. Indeed, the capital ratios implied by their model are of an order of magnitude lower than those required under the current Basle regulation (see their Table 1). Whether such results are time specific is not yet clear. However, the cross-sectional differences in required capital across rating categories implied by their model makes a strong case for re-examining the relatively uniform capital requirements for credit risk requirements that are now being advocated by regulatory bodies.

The paper by Alfred Lehar, Martin Scheicher, and Christian Schittenkopf examines at a slightly different question regarding the usefulness of alternative models for pricing options as well providing input for VaR calculations. The authors consider two extensions of the Black/Scholes model; a GARCH pricing model and a model that incorporates stochastic volatility. Interestingly, using FTSE 100 option prices they find that the GARCH model is far superior (as measured by relative pricing errors) to either of the other two models for purposes of fitting option prices. However, there appears to be little difference between the models in the area of risk management as measured by a proportion of failures test and a distribution test.

Lehar et al. argue that this divergence between pricing and risk management is important to note and that it probably results from the fact that the VaR calculations (unlike option pricing) requires as input a forecast of the *future stock price*. In their set-up this comes from a Monte Carlo simulation which

assumes normality. If such results continue to hold using other data, the profession may need to reconsider the question of whether simple VaR models (that do not, for example, include the possibility of jumps) are really useful from a risk measurement or management point of view.

The paper by Theodore Barnhill and William Maxwell considers the problem of simultaneously modeling credit and market risk in the context of a fixed income portfolio. The authors specifically simulate interest rate, spread and exchange rate risk into a model of credit risk and provide evidence, similar to that provided by Dietsch and Petey, that there is a substantial amount of credit risk that is diversifiable. Alternatively, the evidence presented by Barnhill and Maxwell suggests that ignoring risk like that associated with exchange rates can cause large underestimates in the value of a bond or bond portfolio. More generally, this paper provides an initial analysis of the importance of incorporating multiple sources of risk into one risk assessment framework.

We note that, while the actual results from their simulations may not cause large changes in VaR, more general enterprise risk models of this type may well show that there exist ways to combine these multiple risks to significantly reduce the overall risk exposure of financial and non-financial firms.

3.3. Stability of risk measures across models and time

The papers in this session have a common theme in that they look at the stability of risk measures either across models or time. The contribution by Peter Vlaar provides a thoughtful analysis and critique of the papers in this section as well as a brief overview of some key issues related to the statistical analysis and measurement of risk across models and time. The paper by Robert Bliss and Nicolaos Panigirtzoglou examines the stability of implied risk neutral density measures across alternative models used to extract these measures. In particular, the authors compare the stability of measures derived from the double log-normal and smoothed implied volatility methods when there is the possibility of measurement error due to the bid–ask spread. Using data from the FTSE 100 they provide strong evidence that the more commonly used double log-normal method has a high degree of instability when compared to the smoothed volatility smile approach. More generally, their results suggest that there is a great deal of noise in estimating the higher order moments of the distribution, regardless of which method is used. Thus, researchers need to use caution in interpreting day-to-day movement in these statistics. Moreover, future work may uncover yet an alternative method that provides even more stable estimates, particularly if we are willing to tradeoff some degree of average fit to achieve additional stability.

The paper by David Lando and Torben Skødeberg provides an extension to the standard historical based approach to estimating credit rating transition matrices over time. In particular, by focusing on a method that allows for

continuous observations, the authors significantly extend the ability of researchers to exploit historical data on credit ratings. An important example that they discuss in detail involves the fact that the standard discrete time approach will never give a positive probability to an event that has not happened (e.g., going from AAA to C in a given sample). However, because the continuous time approach calculates transition probabilities based on continuously observed histories, such ''non''-events historically can still have positive probability when looking forward in time. Using 17 years of ratings history (1981–1997) from S&P, they provide some interesting results concerning the stability of their transition probabilities. For example, they show that in this sample the longer a firm is in a given ratings category, the more likely it is they will not move out of that category; either up or down.

The paper by Anil Bangia, Francis Diebold and Til Schuermann also addresses the issue of ratings migration over time. However, the authors focus on the end product of credit stress testing in different economic environments. They first show (using S&P data from 1981–1998) that there is clear path dependency in credit migration matrices and that the coefficient estimates are much more stable during times of recession than on average. The paper also provides an example of how this information could be used in a VaR framework. The authors examine the amount of required capital to meet some VaR target (say 99%) and then provide simulation evidence that this required capital is much higher (25–30% in some cases) if it is estimated that the coming year will be a recession versus an expansion year. Such results are clearly of some importance to both regulators and practitioners who use VaR analysis.

3.4. Trade, credit and systemic risk

Three papers in this special issue are extensions to the work on risk sharing and credit at the macro-level initiated by Bryant (1981) and Diamond and Dybvig (1983). The paper by John Bryant models trade and credit in a way that systemic risk can arise due to coordination problems in production. In particular, in his model final good output is zero if any of the intermediate goods are not produced. It turns out that if any of the intermediate goods producers believe that they will not be paid, there can be market failure. We note that while Bryant introduces a banking system into the model, the systemic risk that arises here could happen even in the absence of banking (e.g., through trade credit).

The paper by Bruno Amable, Jean-Bernard Chatelain, and Oliver de Bandt studies the optimal capacity of the banking sector in the context of a growth problem. Essentially, their model provides a tradeoff between increasing welfare through a reduction in excess capacity versus increasing costs to the deposit insurance agency. While paper provides an interesting analysis of market structure and growth, it should be noted that the results depend on a critical

assumption regarding how banks are made to "behave". In particular, the authors use an assumption popularized by Diamond (1984), that allows for "non-pecuniary" costs in the event of failure to pay. This makes the problem fairly special in the sense that limited liability has been effectively eliminated. Without this assumption there will be no interior solution to the problem at hand. While this assumption is common in much of the literature, we note that limited liability itself provides a powerful motive for risk taking in the banking sector and elsewhere (see, e.g., John et al., 1991).

The paper by Michael Chui, Prasanna Gai, and Andrew Haldane studies a somewhat different problem in that it focuses on lending to developing countries and the possibility of "runs". Importantly, in the model developed in the paper lenders either continue to lend or run. That is, there is no intermediate decision where the lending line remains open but the quantity of funds made available is reduced. However, the paper does provide some interesting results regarding the factors that encourage lenders to stay and take their risks or to flee.

We close this section by noting that the short paper by David Marshall does an excellent job of discussing the commonalties of these three papers in terms of general coordination problems. He also provides additional detailed comments on both the results and public policy implications of these three papers.

3.5. Insurance and related issues

The final set of papers in this issue address insurance related issues. The first paper, by David Cummins, Neil Doherty and Anita Lo examines the capacity of the insurance market to respond to catastrophic losses. The authors specifically look at the ability of the industry to cover a so-called "big one" (i.e., a loss in the $100 billion range) for property losses. Using an extension of ideas presented in Borch (1962), they first show that all optimal re-insurance portfolios should be perfectly correlated with aggregate losses. While it is a well known result in the risk sharing literature that optimality requires that only non-diversifiable risk be carried by all participants, this theoretical work highlights the idea that one can use such benchmarks to define things like industry capacity. Moreover, their empirical results suggest that coverage capacity dramatically increased after Hurricane Andrew and that as of 1997 insurers would have been able to cover over 9% of a $100 billion "big one". However, efficiency measures for higher levels of losses are in only in the 70–80% range.

These results suggest, at least to us, a further need for expanding either private market alternatives such as catastrophe bonds or some public/private re-insurance program with the government acting as the "insurer of last resort".

This issue also contains some remarks by Gregory Neihaus on general questions regarding risk sharing in the insurance industry and some comments on the Cummins et al. paper in particular.

Using the same basic theme as Cummins et al., i.e, that in theory only common risks are carried in a first-best equilibrium, Giuseppe Grande and Luigi Ventura examine a very different problem in risk management. In particular, their paper examines Italian data and investigates whether there is evidence that the agents in their sample are insured against various types of risk. Grande and Ventura find that on average Italians are well insured against medical ''big ones'' (illnesses) but not perfectly insured against job losses. They also find some evidence of a weak but noticeable relationship between particular asset holdings and the variability of consumption across the households in their sample. This suggests that there may be idiosyncratic distress costs incurred by households much like the financial distress costs incurred by private firms. At a more general level we would argue that these types of imperfections would seem to be more prevalent in the consumer sector than the corporate sector. Further work on the capacity of individuals to engage (or not) in ''home made'' risk management should help private and public sector decision makers in the design of products and programs that could better capture the potential welfare gains associated with improved risk management for human and financial capital.

4. Concluding remarks and recommendations for future research

Over the past four decades there have been major developments in the area of risk management at the level of the individual, the corporation, and the economy as a whole. In this article we have briefly and selectively reviewed this literature. We have also provided a simple example that outlines what we see as the important factors that justify risk management at the corporate level. Finally, we have given a brief overview of the papers in this issue as well as outlined how we think they fit into and expand on the existing literature on risk management.

These papers cover such seemingly disparate topics as corporate risk management, aggregate risk sharing in financial and banking markets, computational issues related to VaR, and the stability of risk estimators across models and time. However, as we have argued, these topics are very much related in the sense that risk management at the micro- or managerial level ultimately must be aggregated or (more appropriately) netted at the aggregate level in financial and banking markets.

Going forward, we hope that research in this area will focus on a number of important but unresolved issues. The results presented in the papers in this issue and in the broader literature suggest that VaR measures are not particularly

good forecasters of actual future losses. While this is likely due to a number of factors, we feel that additional research into the implications of jump risk is sorely needed. If asset returns are assumed to have both a normal and Poisson jump component, one can calculate VaR, albeit in a more complex fashion.

A second potential problem associated with ignoring jumps in VaR analyses is that during stressful times it is often the case that liquidity dries up. One can imagine modeling the VaR problem by adding "liquidity premiums" during times where jumps occur. Of course, other approaches to considering liquidity problems "in the tails" might prove useful as well. We would also argue that in order to motivate the inclusion of such liquidity premiums one would ideally develop an equilibrium valuation model that includes an explicit "value of liquidity" component. Sealey (1983) has provided an interesting start in this direction. However, in our view there has been a scarcity of extensions and empirical tests in this area of finance. [11]

At a more macro-level, we see the need for more work in the area of incomplete markets, monetary policy, and financial structure. An argued by Hunter and Marshall (1999), there is much disagreement on the overall effectiveness of monetary policy in a world of sophisticated financial derivatives and risk management activities. On one hand, it is generally agreed that the sources of monetary non-neutrality lie in economic frictions such as informational imperfections and transactions costs. On the other, it is also agreed that derivatives trading tends to increase the liquidity, depth, flexibility, and transactional efficiency of financial markets. This should increase the speed with which monetary policy actions are transmitted throughout the financial system.

This conclusion follows from the fact that lower transaction costs and reduced frictions resulting from derivatives activities should increase the rate at which new information, including policy actions, is impounded into market prices. Since derivatives markets reduce these sorts of frictions, they provide a more efficient mechanism for price discovery, speed up information transmission, and reduce informational asymmetries. It follows that by reducing frictions, derivatives markets may actually reduce the real effects of monetary policy actions. Thus, to the extent that derivatives reduce the force of monetary policy, monetary policy may become a weaker tool for counter cyclical stabilization policy. However, if derivatives do provide the economy with the benefits cited by their proponents, i.e., a more efficient, self-correcting, and shock resistant economy, then there may actually be less of a need for counter cyclical monetary policy to begin with since markets will be "more complete".

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[11] We would also argue that the extension of financial distress based models of risk management to an equilibrium setting is, as noted earlier, also an important area for future research. As noted in the text, that the empirical hypotheses and policy prescriptions from such expanded models may be sharply at odds with those from essentially looking at one firm in isolation.

Clearly, more research is needed on this potentially important relationship between the efficiency of monetary policy and financial structure in an equilibrium setting when markets are incomplete.

Acknowledgements

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