

## DERIVATIVES, RISK MANAGEMENT AND FINANCIAL DISASTERS

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Volume 67, numéro 4, 2000

SYMPOSIUM SUR LA GESTION DES RISQUES  
RISK MANAGEMENT SYMPOSIUM

URI : <https://id.erudit.org/iderudit/1105293ar>  
DOI : <https://doi.org/10.7202/1105293ar>

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Éditeur(s)

HEC Montréal

ISSN

0004-6027 (imprimé)  
2817-3465 (numérique)

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Citer cet article

Boyle, P. (2000). DERIVATIVES, RISK MANAGEMENT AND FINANCIAL DISASTERS. *Assurances*, 67(4), 577–593. <https://doi.org/10.7202/1105293ar>

Résumé de l'article

Cet article constitue une introduction aux produits dérivés, comme garanties financières. L'auteur discute de leur rôle et de leur allocation dans le système économique. Les produits dérivés peuvent être utilisés pour accroître l'exposition à des types particuliers de risque. Il examine en particulier trois exemples déterminants de désastres financiers associés à l'utilisation des produits dérivés. Ces cas concernent la déconfiture de la banque Barings, la faillite du comté d'Orange en Californie et l'effondrement récent de la société de gestion Long Term Capital Management. L'auteur tente de mettre en évidence, à partir de ces divers cas, les éléments qui sont communs. Il dessine enfin une structure attribuable à David Emanuel suggérant que le système métrique traditionnel de performance génère un travail de piètre qualité lorsqu'il s'agit de mesurer la performance des stratégies liées aux produits dérivés.

# DERIVATIVES, RISK MANAGEMENT AND FINANCIAL DISASTERS

Phelim P. Boyle\*

## ABSTRACT

This paper provides a brief introduction to derivative securities and discusses their role in providing efficient allocations of risk within an economic system. Derivatives can be used to increase exposure to particular types of risk. We discuss three recent prominent financial disasters which have been associated to some extent with derivatives usage. These cases concern the demise of Barings Bank, the bankruptcy of Orange County, California and the near collapse of Long Term Capital Management. We emphasize the common elements in each case. We draw on a framework due to David Emanuel to suggest that traditional performance metrics do a poor job of measuring performance of derivative strategies.

*Keywords* : Derivative securities, allocation of risk, financial disasters, measuring derivative strategies.

## RÉSUMÉ

*Cet article constitue une introduction aux produits dérivés, comme garanties financières. L'auteur discute de leur rôle et de leur allocation dans le système économique. Les produits dérivés peuvent être utilisés pour accroître l'exposition à des types particuliers de risque. Il examine en particulier trois exemples déterminants de désastres financiers associés à l'utilisation des produits dérivés. Ces cas concernent la déconfiture de la banque Barings, la faillite du comté d'Orange en Californie et l'effondrement récent de la société de gestion Long Term Capital Management. L'auteur tente de mettre en évidence, à partir de ces divers cas, les éléments qui sont communs. Il dessine enfin une structure attribuable à David Emanuel suggérant que le système métrique traditionnel de performance génère un travail de piètre qualité lorsqu'il s'agit de mesurer la performance des stratégies liées aux produits dérivés.*

*Mots clés* : Produits dérivés comme garanties financières, allocation du risque, désastres financiers, mesure de performance des stratégies liées aux produits dérivés

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\* The author wish to thank Feidhlim Boyle for research assistance in preparing this paper.

## ■ I INTRODUCTION

Derivatives are widely used financial instruments that have attracted a great deal of attention in the last few years. In the popular press, this publicity has arisen from the association of derivatives with some high profile financial disasters such as Barings Bank, Orange County and more recently Long Term Capital Management. We begin this paper with a brief description of derivatives and their uses in risk management. We discuss some major recent disasters and show that they have pervasive common themes.

We begin with a definition of a derivative. A derivative instrument is a security whose value depends on some other security or asset known as the underlying security. A call option is an example of a derivative security. The owner of a call option has the right, but not the obligation, to purchase an underlying asset for a fixed amount within a fixed time period. A put option on the other hand gives its owner the right to sell an underlying asset for a fixed price within a fixed time period. We see that a put option provides price protection to its owner in case the price of the underlying asset falls.

Derivatives enable us to trade particular types of risk and they can be used to reduce risk or to increase risk. For example consider a Saskatchewan wheat farmer who is worried about a fall in the price of wheat when the crop is harvested. If the farmer buys a put option and the price of wheat falls then he receives a payment from the option contract to compensate for the loss. If the price of wheat rises there is no payment under the option contract. Like an insurance contract the option contract only makes a payment if certain outcomes occur. The farmer who buys the put option is said to have hedged the price risk. However if some other agent were to buy a put option, without owning the underlying commodity, he or she would be speculating.

The distinguishing characteristics of derivatives stem from their capacity to unbundle risks and the availability of liquid markets to trade these contracts. Derivative contracts provide agents with a convenient mechanism for altering their exposure to different types of risks. Thus, an agent can either reduce or increase his exposure to a given risk using a derivative contract. There are large secondary markets for many derivative instruments where these contracts are traded in standardised units. In principle these markets provide a mechanism for trading derivatives at competitive prices. Derivatives markets have the potential to provide a more efficient allocation of risk bearing within an economy and thus lead to welfare gains. The intuition is that an efficient market for these risks

enables those agents who are most willing and able to assume the risks to do so.

In the last 25 years there has been an explosive growth in the use of derivative securities especially by corporations. Contracts are now available to manage stock price risk, currency risk, interest rate risk and the price risk of a large number of commodities. The range of risks that can be handled in this way continues to expand. For example credit derivatives represent a recent innovation to securitize credit risk or default risk. These instruments make specified payments in the event that a particular entity defaults on its obligations. The definition of default has to be carefully specified at the time the contract is drawn up.

Other new types of risk that are being packaged as derivative instruments include earthquake risks, weather risks and energy price risks. We provide examples of situations where the first two of these could be used. For example, the annual revenues of the state of California will be affected if there is an earthquake in the state. The state of California can take this into account in the design of its securities. If there is a major earthquake in the Bay Area then the state will be under severe financial pressure and may have difficulty meeting the coupon payments or repaying the principal on its bonds. A so-called catastrophic bond can ease this pressure since it has a provision to reduce the amount of the payment in the event of an earthquake. The California Earthquake Authority in conjunction with an investment bank planned such a bond issue of 1.5 billion (US) to come to the market at the end of 1996. However at the last minute the deal was canceled because an insurance company, National Indemnity offered better terms through a traditional insurance program.<sup>1</sup> Weather derivatives can be used to hedge the risks that agents or firms are exposed to because of weather conditions. For example, the profits of an Austrian brewing company from domestic sales during the summer will depend on the local weather during this period. It would be possible to design a derivative security that could be used by the brewing company to hedge this risk.

We can identify several reasons that have contributed to the spectacular growth in derivatives during the last two decades.

- The growth and globalization of financial markets.
- The deregulation of financial markets that has taken place in many jurisdictions.
- Major increases in the volatility of exchange rates and interest rates in the last two decades.

- Advances in computing and information technology.
- Intellectual breakthroughs in the finance discipline and in particular the development of the Black Scholes (1973) Option Pricing formula.

Derivatives can and do perform an important function in the redistribution of risk within an economy. In the terminology of economics they serve to complete the market. A corporation can use derivatives to manage particular types of risk such as exchange rate risk or interest rate risk. In Canada the available evidence indicates that derivatives are used in a prudent fashion. The Centre for Advanced Studies of Finance at the University of Waterloo has carried out two comprehensive surveys of derivatives usage by Canadian non-financial corporations. The corporations surveyed indicated that their main reason for using derivatives was to reduce risks and especially to reduce the volatility of their cash flows. However there have been spectacular financial failures in which derivatives played an important role and we will discuss these in the next section.

Warnings against the use of derivatives and options are not new. Consider the following quotation from the *Economist* of May 2<sup>nd</sup>, 1885.

From what we have said, it will be seen that those who advise people to buy “options,” without taking any other measures, are simply considering their own interests, the more especially as the securities so often recommended are those which are extremely unlikely to fluctuate to the extent of the given premium – the latter frequently remaining in the hands of the broker, or so-called “broker,” as something of a much more satisfactory nature than any commission.

From the standpoint of business morality, two things may be adduced in connection with “options,” one for and one against. In the first place, they foster a form of speculation which already flourishes too abundantly. They do this not only directly, but also indirectly, as, owing to the way in which they limit loss, they encourage people to speculate in stocks and shares who otherwise would be restrained, not so much by a positive prudence as by a negative timidity.

## ■ 2. A TRILOGY OF FINANCIAL DISASTERS

Derivatives can be used to increase risk instead of reducing risk. By virtue of their leverage derivatives can increase volatility and increase the scale of profits as well as losses. In this section we will discuss three examples of dramatic financial failures which have been associated with derivatives. The first is the collapse of Barings Bank, Britain's oldest merchant bank. The second is the bankruptcy of one of the most prosperous counties in the USA, Orange County. The third concerns the failure and subsequent rescue of Long Term Capital Management a large US based hedge fund. Derivatives have been assigned a considerable part of the blame in each case. Our analysis of these disasters will show that there are common characteristics in each case.

### □ 2.1 Barings Bank

Barings Bank was established in 1762 and until its demise was the oldest merchant bank in London. Barings financed British armies during the American revolution and the Napoleonic wars. It collapsed in 1995 with a loss of \$1.4 billion (US). Many commentators put the blame for the failure on Nick Leeson the then 28 year old head trader in the bank's Singapore office. While Leeson certainly played an important role it seems simplistic to saddle him with all the blame. The Economist provided a more balanced view and suggested that he would be set up "as the fall guy of the century."

As the Bank of England report makes clear Leeson's activities were amazingly free from supervision and control. His trading activities went undetected as a consequence of the failure of management and the failure of internal controls. In 1992 Leeson created a special account numbered 88888 to hide his trading losses. Table 1 gives the balance in this account for the four years preceding the collapse.

In 1994 the official accounts of Barings Bank indicated that Leeson's trading activities generated some 28.5 million pounds in

**TABLE 1**  
**DETAILS OF NICK LEESON'S ACCOUNT 88888**

Year	1992	1993	1994	1995
Loss for the year (in millions of UK pounds)	2	21	185	219
Cumulatives loss	2	23	208	427

profit which represented some 71 per cent of the profits of the Bank group within Barings. Of course this did not represent an accurate view of the bank's financial situation since Leeson was concealing much larger losses in account 88888. Even though Leeson was daily accumulating large trading losses he was apparently able to conceal his needs for funds to cover margin calls because the bank's accounting procedures did not distinguish between funds related to its proprietary trading activities and its other client accounts.

The availability of derivatives no doubt enabled Leeson to take on riskier positions than might have been the case in other markets. However it was his freedom from supervision and control coupled with the powerful incentive of his bonus arrangement that ultimately brought down the bank. The actual securities that Nick Leeson used were fairly basic as derivatives go. He used derivatives to take big bets on the Japanese market and he was able to use the bank's capital to finance these bets. Leeson assumed that the Japanese market would rise. He invested heavily in futures contracts on the Japanese market index. The value of these futures would rise if the price of the underlying index went up and their value would fall if the price of the underlying index went down. Futures contracts provide an investor with powerful leverage. This means that one can take very large positions with very little capital. The Japanese market fell by 13.5% during the first two months of 1995. Part of the fall was due to the Kobe earthquake which occurred in January 17 1995. To try to recoup some of his losses Leeson took on additional risky positions. The particular strategy he used was selling short straddles. We will explain this strategy in more detail shortly. Under this strategy he was betting that the market would remain stable. If the market moves this strategy loses money. In Nick Leeson's case the market continued to fall and his doubling up strategy only served to increase his losses.

Now we show in some more detail the underlying mechanics of Leeson's strategy. Figure 1 shows the profit (loss) from a long position in a standard call option. The parameters used to generate Figure 1 were:

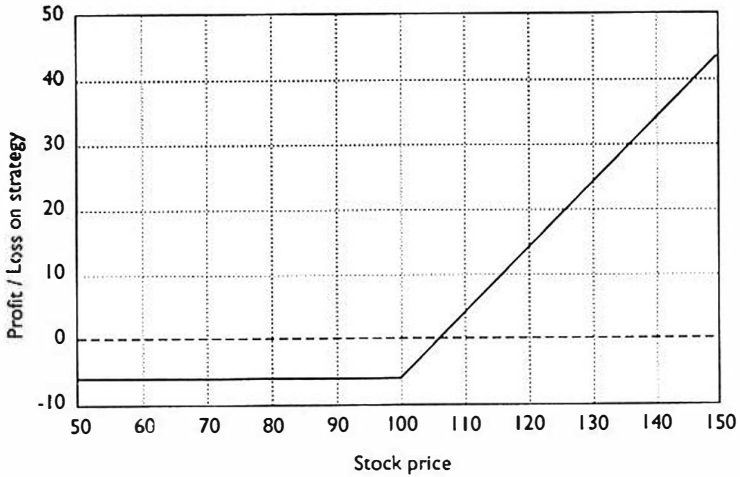
- Initial stock price  $S_0 = 100$ ,
- Strike price  $K = 100$ ,
- Time to expiry  $T = \text{Six Months}$ ,
- Volatility  $\sigma = 20\%$ ,
- Riskfree rate  $r = 6\%$ .

The Black Scholes European call price for these parameters is 7.16. To compute the profit we have taken the difference between

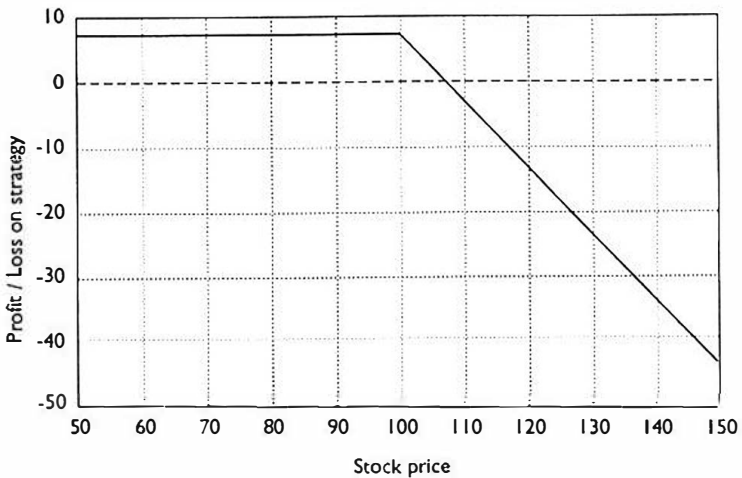
the value of the call at expiration and the initial call price. Hence we have ignored the interest element for simplicity.

Figure 2 shows the profit (or loss) under a *short* call option at its expiry. The profit in this case is the exact opposite of that under

**FIGURE 1**  
**PROFIT (LOSS) ON LONG CALL POSITION**



**FIGURE 2**  
**PROFIT (LOSS) ON SHORT CALL POSITION**





a long call position. The holder of short call position makes money if the asset price falls and loses money if the asset price rises.

Figure 3 shows the profit (or loss) under a long put option at its expiry. The parameters correspond to those in the previous two Figures. The Black Scholes price of the put option with a six month expiration is 5.82.

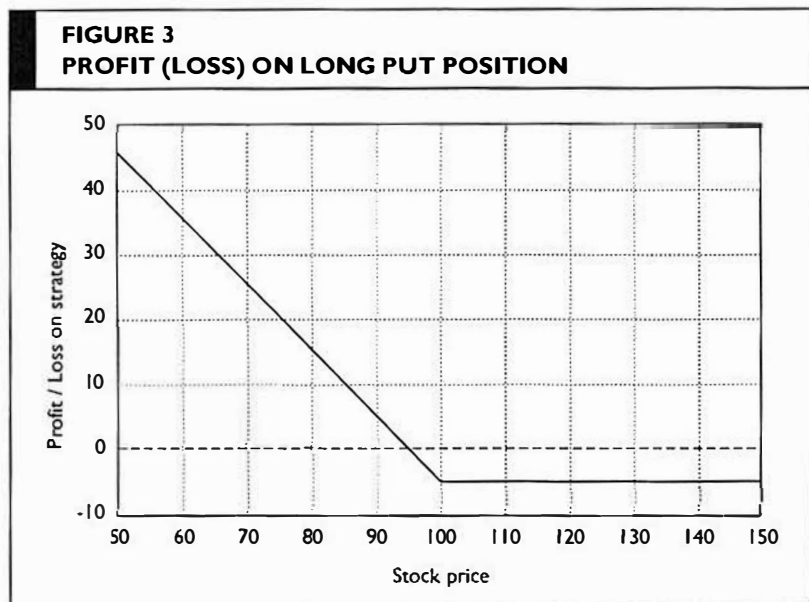
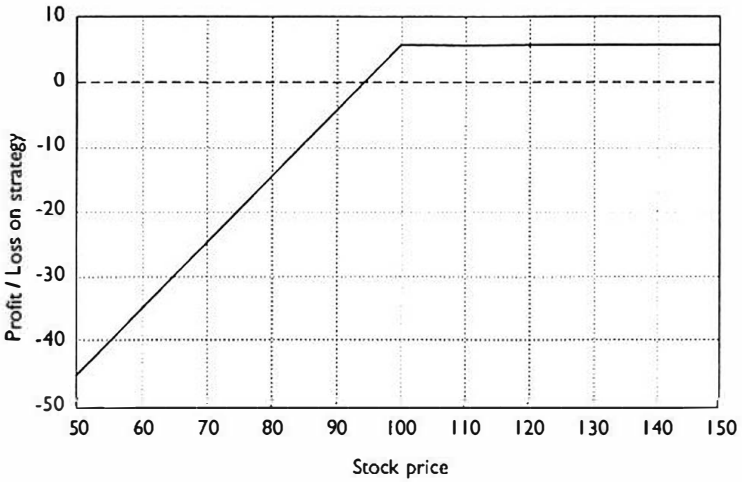


Figure 4 shows the profit (loss) under a *short* put option at its expiry. The profit in this case is the exact opposite of that under a long put.

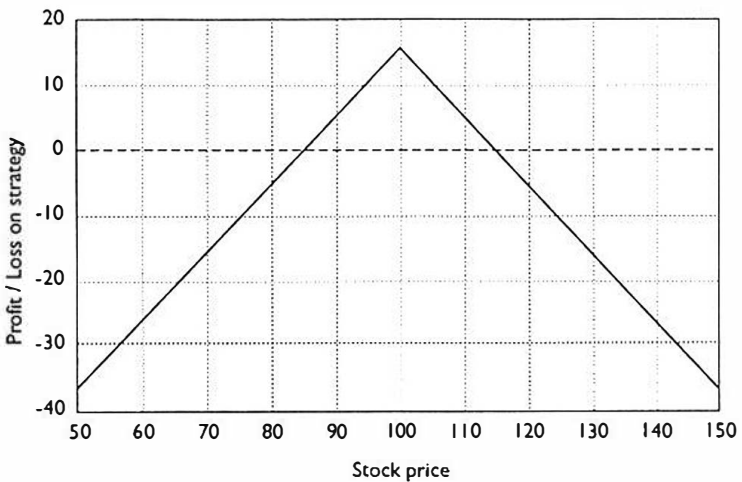
A long straddle position consists of a long call plus a long put. Hence a short straddle position consists of a short call plus a short put. We display the profit (loss) profile of a short straddle position in Figure 5. We see that this strategy is profitable when the market makes modest moves but it loses money if there are large moves. Nick Leeson used this type of strategy on the Nikkei Index.

Nick Leeson sold straddles on The Nikkei 225 Index known in large volumes during 1994. As we can see from Figure 5 he stood to make money if the level of the Japanese market remained fairly constant and of course he would lose money if the market moved violently either upwards or downwards. This strategy was not only highly vulnerable to any large movement in the Japanese market

**FIGURE 4**  
**PROFIT (LOSS) ON SHORT PUT POSITION**



**FIGURE 5**  
**PROFIT (LOSS) ON SHORT STRADDLE POSITION**



but also vulnerable to any increase in the volatility of the market. As it happened the position suffered very huge losses and eventually brought down the entire bank. It is noteworthy that Leeson did not take any prudent steps to hedge his position nor did he use widely available techniques to do so.

We turn now to the issue of incentives. Leeson and indeed the senior members of the bank's management team were paid mainly by bonuses. In the Barings Group about 50% of pre tax profits were earmarked for bonuses. In 1994, Leeson's proposed bonus was some half a million pounds and four other members of the Bank were allocated higher bonuses of two to three times that of Leeson.

To summarize it appears that the main reason why Barings fell is that several individuals did not do their jobs properly. In particular management failed to institute a proper system of internal controls. The Bank of England report suggested that the main lessons from Barings are:

- Management teams have a duty to understand fully the businesses they manage.

- Responsibility for each business activity has to be clearly established and communicated.

- Clear segregation of duties is fundamental to any effective control system.

- Relevant internal controls, including independent risk management, have to be established for all business activities.

- Top management and the Audit Committee have to ensure that significant weaknesses identified to them by internal audit or otherwise are resolved quickly.

One of the salutary effects of the Barings crisis was that it highlighted the importance of risk management and internal controls for financial institutions dealing in derivatives.

## □ **2.2 Orange County**

The central character in this case is Robert Citron, the then 69 year old treasurer of Orange County. Even though it is only a county within the state of California Orange County is a very wealthy county. Its Gross Domestic Product in 1993 was \$74 billion dollars (US) ranking it ahead of Portugal or Israel. Jorion (1994) reckons that by itself Orange County is the 30th largest economic power in the world. On December 2nd 1994 Robert Citron announced that the value of the county's investment fund had fallen by \$1.5 billion dollars (US) and resigned. The actual loss turned out to be closer to \$1.7 billion (US) and the county declared itself bankrupt. Derivatives were widely believed to be the cause of the bankruptcy but in fact the instruments generally used by Citron

were not very complicated. The New York Times in a December 15 1994 Editorial advanced an alternative explanation.

The fiasco raises two questions. What caused the bankruptcy and how can we prevent similar episodes across the country? The county fund lost money by buying complex, volatile securities known as derivatives... Many observers have leapt to the presumption that money-losing derivatives caused the bankruptcy. The presumption is unwarranted. The fund's flagrant mistake was not which securities it bought, but its choice of an irresponsible risk investment strategy. Robert Citron, the County treasurer, brazenly borrowed billions of dollars at low short term rates of interest in order to buy higher yielding long-term bonds and other securities. The strategy amounted to a risky gamble that interest rates would fall. For years he racked up fabulous gains, becoming a local hero by earning profits of 7 per cent when other county funds settled for half as much. It is a matter of detail which securities- derivatives or plain vanilla stocks and bonds – Mr Citron chose to trade. The strategy not the securities proved fatal.

Citron did use derivatives in his portfolio and they made it easier for him to assume riskier positions. However it was because he made an incorrect call on the direction of interest rate movements that he lost money. Because of his reputation as a financial wizard he was allowed to operate with remarkable freedom and negligible supervision. The parallels with the Leeson case are striking.

To describe what happened to the Orange County investment fund it is useful to describe aspects of bond pricing. A bond is a security that makes known payments over its remaining lifetime. For example it might pay \$40 every six months for the next ten years and a final face amount of \$1,000. We say that this bond matures in ten years. Bonds are issued by governments and corporations. As interest rate change so do the prices of bonds. As interest rates go up the current value of future payments becomes less valuable and so bond prices fall. Conversely as interest rates rise bond prices fall.

The essence of Robert Citron's investment strategy was to borrow short term and invest long term. This strategy will provide good results as long as interest rates keep falling. As interest rates drop the gain in value of the long term investment more than compensates for the cost of borrowing. However if interest rates rise

this strategy loses money because of the losses on the riskier long term investments.

Citron also purchased large volumes of so called inverse floaters. An inverse floater is a derivative security whose payments fall as interest rates rise. Typically the payments are expressed as the difference between a fixed interest rate (say seven percent) and a well known interest rate known as LIBOR. Libor stands for London Interbank Offer Rate and is a reference rate used in the financial markets for loans in international markets.

The key point is that if interest rates rise this strategy also loses money. In the Orange County case both of Citron's investment strategies would lose money if interest rates rose. In February 1994 there was a dramatic change in US interest rates triggered by the action of the US Federal Reserve. Interest rates rose steadily throughout 1994. This environment proved lethal for Mr. Citron's two investment strategies.

How did Citron assume such a powerful position and what other forces were at play? Citron had consistently produced good returns on the portfolio in the past. Under his direction the fund had averaged very impressive returns. When he was first elected there were much stricter guidelines on the allowable investments for municipal funds. Citron lobbied successfully to relax these restrictions so that he could invest in more exotic instruments. Because of his high returns he gained the reputation of being a financial wizard. His accomplishments were especially welcome because at a time of increased demand on public services the revenues from the traditional tax sources were declining. The reduction in property taxes originated with the famous Proposition 13 introduced by Jarvis and Gann in 1978 in the state of California. This legislation dramatically changed the property tax system in California and severely reduced the property tax revenues that could be collected. As Philippe Jorion puts it:

In Orange County (Citron) could do no wrong; in a militantly tax averse political environment, he produced enormous revenues "painlessly" thus allowing government to function and expand.

The County Supervisors generally left him alone although afterwards they claimed they were not given enough information. The most prescient criticism of Citron's strategy was delivered during the 1994 election campaign. The unlikely prophet was John Moorlach a certified public accountant and Citron's opponent in the election. Moorlach stated:

Mr. Citron believes he can accurately anticipate the market all the time and also outperform everyone. That's impossible. The incumbent has structured the portfolio on the premise that interest rates would continue to decline.

Moorlach's predictions were dramatically vindicated in December 1994.

There are strong similarities between this case and the Barings collapse. In both cases the incentives and pressures for high returns were present. The attendant risks were neither properly measured nor monitored. We had two individuals whose past record accorded them special status. They were viewed as financial wizards and were given widespread latitude in their investments and immune from any prudent controls. Another similarity is that both Leeson and Citron operated using seat of the pants judgements and ignored the scientific techniques available for risk control. The availability of derivatives made it easier for them to take on increasing risky positions.

### □ 2.3 Long Term Capital Management

Long Term Capital Management, (LTCM) started operations as a hedge fund in the USA in 1994. Hedge funds are subject to very little regulation. The minimum investment in a hedge fund is large and the presumption is that investors in hedge funds are sophisticated agents who understand risk and return and do not require protection. Long Term Capital Management was founded by John Meriwether a trader with a legendary reputation on Wall Street. Meriwether assembled a *dream team* consisting of distinguished academics such as Robert Merton and Myron Scholes<sup>2</sup> former Federal Reserve vice Chairman David W. Mullins, together with a very strong team of other experts.

Hedge funds have a requirement that the partners put in a significant investment to demonstrate their faith in the investment strategy. The partners pledged to put up one hundred million of their own personal wealth to start the fund. The conditions for outside investors to join the fund were extremely demanding. The initial deposit was a minimum of ten million dollars (US). In addition investors had to commit to leave their funds with LTCM for a minimum of three years. The fees were also very high by industry standards. The annual management charge was two percent of assets plus 25% of profits. The normal fees for the industry were one percent of assets plus 20% or profits.

LTCM began operations by exploiting bond arbitrage trades. For example it would seek out two similar bonds whose prices had become temporarily out of line. By buying the cheaper instrument and selling the more expensive one LTCM could generate arbitrage profits. Even after accounting for its high fees LTCM produced significant profits and it attracted investments from leading firms such as Merrill Lynch and Union Bank of Switzerland and the foreign exchange department of the Bank of Italy. The fund made very impressive returns as can be seen from Table 2.

<b>YEAR</b>	<b>RETURN (after expenses)</b>
1995	42.8%
1996	40.8%
1997	17.1%

The excellent results, the mystique of its methods, the highly quantitative, complex trading strategies it employed and the prestige of its partners allowed LTCM to become regarded as a force in the global financial markets along the lines of a George Soros or Warren Buffet. This mystique allowed LTCM to operate without many of the capital requirements normally foisted upon similar funds by its lenders. In addition it operated within a strict veil of secrecy. LTCM began to expand well beyond its core strategy of bond arbitrage and started taking positions in companies that were rumoured to be involved in takeovers and mergers. The hedge fund also began to invest in the bonds of emerging markets such as Russia and simultaneously taking short positions on US bonds. The thinking here was that the demand for emerging market bonds would increase and their price would rise. LTCM also took a number of positions in European markets based on assumptions about convergence of European currencies. Many of the fund's major strategies in 1998 were predicated on the assumption that the demand for risky bonds would increase and the demand for stable US bonds would drop: in fact the opposite happened. In addition the fund altered the nature of the investments by including more directional bets. In August 1998 Russia defaulted on part of its debt and let the ruble fall triggering a flight to quality. This was disastrous for some of LTCM's major bets and the fund lost half a billion dollars on a single day (August 21, 1998). One of the key factors in LTCM's investment strategy had been leverage. With a relatively small equity investment this leverage gave the fund control over very large returns. It was this leverage that permitted the fund to chalk up such impressive returns in its first three years. However when the bets went wrong the excessive leverage magnified the losses.

The fund was headed straight for financial collapse at the end of August. On September 2, 1998 LTCM disclosed the fund had lost 44 percent or 1.8 billion in August. The fund was in dire financial trouble and was facing severe liquidity constraints in meeting margin calls. There was a fear of systemic collapse if LTCM went down because of its transactions with many leading investment banks. The New York Federal Reserve engineered a rescue operation supported by 14 major US and foreign banks. The consortium of banks injected 3.6 billion dollars to bail out the hedge fund and no public funds were committed to the rescue. This consortium of banks now oversees all trading and can veto decisions made by the partners.

In the case of Barings and Orange County both Leeson and Citron were relatively unsophisticated in terms of investment expertise but LTCM had on board some of the finest academic talent in the field. Some observers have suggested that the fall of LTCM brings the value of the quantitative approach to finance into disrepute. The LTCM *dream* team was viewed as invincible and the large banks that made significant investments in the fund abandoned prudent monitoring and risk controls. The high returns of 40 percent per annum should have suggested that risk was being taken on. We have commented on the fund's excessive leverage. Bill Sharpe, another Nobel laureate, sums it up as follows:

Most of academic finance is teaching that you cannot earn 40 percent a year without some risk of losing a lot of money. In some sense what happened is nicely consistent with what we teach.

### ■ 3. ANALYSIS OF FINANCIAL COLLAPSES

It is evident that there are some common features to these financial disasters. In each case an individual or group as in the LTCM case acquires the reputation of being invincible. More funds are entrusted to the strategy. Oversight and regulation are relaxed because no one has the incentive to challenge the producer. David Emanuel (1996) provides a perceptive diagnosis of financial failures and we draw on his analysis in this section. Emanuel argues that conventional performance risk measures can be very misleading for potentially catastrophic trading strategies. To highlight this point he provides an example of an apparently very successful strategy.



The proposed strategy is as follows. You give an investment management firm a million dollars to manage. You find that the firm produces a steady return of \$2,000 per day. Assume 250 trading days. This gives a total return of \$500,000 per annum (ignoring interest). This return amounts to 50% per annum. If you verify that the firm makes two thousand dollars every day some conventional risk measures (such as standard deviation) would suggest that there is zero risk. If the investment firm can achieve returns like this you might be tempted to increase the scale of your investment by giving the firm more money to invest. It seems perhaps farfetched<sup>3</sup> that you would give money to an investment manager without any details of what investment strategy the firm was using.

The trading strategy that generated the high return turns out to be a little surprising. Every day the head trader of the firm goes to a casino and bets \$2,000 on red in roulette. If he wins he is done for the day. If he loses he doubles the bet to \$4,000. If he wins this bet he is now ahead \$2,000 and he stops for the day. The head trader keeps doubling until he wins. He will be able to continue doubling unless there are nine consecutive losses at which point the capital of one million dollars is gone. The chances of nine consecutive losses in a single day are

$$\frac{1}{2^9} = .001953 = 0.2\%.$$

The probability that in one year there is a run of nine consecutive losses is  $.387 = 38.7\%$ . The standard deviation of the returns will be zero. The results of such a strategy will appear excellent until the inevitable collapse. We can see some striking parallels with the LTCM case.

Emanuel also notes that impressive track records can be generated by writing out of the money options. If you sell such options then even if the market moves you will make money most of the time. He notes that option writing strategies tend to overstate performance and understate risk. The basic idea in this analysis of the relationship between options and risk was noted in the paper by Boyle and Emanuel (1980).

#### ■ 4. SUMMARY

We have argued that derivatives provide a powerful mechanism for redistributing risk. At the same time they provide a mecha-

nism for increasing risk exposure. We have analysed three recent large financial collapses which were in some way or another associated with derivatives. These cases were Barings Bank, Orange County and Long Term Capital Management. We saw that in each case there were some very consistent common themes. Leeson, Citron and the Meriwether team established impressive track records of returns. In each case they were viewed as financial wizards. The structure of incentives was such that they were given more funds to invest. Little attention was paid to the underlying investment strategy and the establishment of appropriate risk performance measures. The LTCM case in particular shows that so called sophisticated investors can be mesmerized by a strong track record of performance and pay scant attention to the risks taken. We used Emanuel's model to show that certain strategies are deceptively impressive. Given the common elements in each case one might hope that society would learn from these experiences. It seems as if this is a remarkably slow process.

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## □ Notes

1. National Indemnity is owned by the well known financier Warren Buffet.
2. Merton and Scholes were awarded the Nobel prize in 1997 for their pioneering work in developing the Black Scholes option pricing formula. It is clear that Fischer Black, had he survived, would also have been awarded the prize.
3. The Wall Street Journal, November 1998 notes that in the case of LTCM some of the most sophisticated investors on Wall Street were *falling over themselves to do business with LTCM*.