

**LONG-TERM CAPITAL MANAGEMENT:  
THE DANGERS OF LEVERAGE**

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## Introduction

One of the most important theories in modern finance is the idea that markets are efficient. Put simply, the efficient markets hypothesis states that financial instruments are virtually always priced correctly, and that the only way one can achieve increased returns is by taking on additional systematic risk. One of the key assumptions that underlies this theory is the idea that there are a large number of agents with small, well-diversified portfolios in the economy who would undertake arbitrage operations if excess returns were available. This arbitrage activity would, in turn, decrease the excess returns available until they no longer existed.

In their 1997 paper, “The Limits of Arbitrage”, Andrei Shleifer and Robert Vishny argue that this assumption is implausible. They claim that arbitrage is a specialized activity undertaken by a few large investors whose portfolios tend to be undiversified. Their reasoning for this is that “millions of little traders are typically not the ones who have the knowledge and information to engage in arbitrage.”<sup>2</sup> Instead, they claim that arbitrage tends to be conducted by large funds managed by individuals with highly specialized knowledge of the particular markets in which they invest. These funds, they claim, are often composed of money from “wealthy individuals, banks, endowments, and other investors with only a limited knowledge of individual markets.”<sup>3</sup> Shleifer and Vishny claim that this feature of the arbitrage vehicles can cause agency problems, which in turn can limit the effectiveness of arbitrage in maintaining market efficiency.

The separation of investor and portfolio manager, they claim, can cause a situation which they call “performance-based arbitrage” in which investors allocate funds based upon past performance, but portfolio managers invest on the basis of expected returns. They state that it is perfectly rational for investors to use past returns as an indicator of future performance when judging fund allocation because poor performance in the past may indicate incompetence on the part of the fund manager. Shleifer and Vishny argue that performance-based arbitrage may be ineffective in maintaining market efficiency, particularly when arbitrageurs “have the best opportunities, i.e., when the mispricing they have bet against gets even worse.”<sup>4</sup> That is, they claim that during such periods investors might have the incentive to remove their money from the fund manager’s control because recent returns have been poor. This, in turn, might cause the fund manager to liquidate some positions in order to

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<sup>2</sup> Shleifer, p.36

<sup>3</sup> Shleifer, pp. 36-37

<sup>4</sup> Shleifer, p. 37

return the investor's funds, an action that could cause even greater market inefficiencies to arise. Shleifer and Vishny also show that funds in which withdrawals are limited, but which have some debt could experience a similar scenario in which they are forced to liquidate positions as a result of margin calls by their creditors.

The sum total of these effects is a model in which slight inefficiencies caused by what Shleifer and Vishny call "noise traders" (those trading on somewhat irrational trends) can lead to the liquidation of arbitrage fund assets, which in turn can greatly weaken the stabilizing effect of arbitrage. Shleifer and Vishny do not claim that arbitrage activity is destabilizing, relying on the observation by Milton Friedman that "to say that arbitrage is destabilizing is equivalent to saying that arbitrageurs lose money on average"<sup>5</sup>. Instead, they claim that when prices are driven farthest from fundamentals, "arbitrageurs have the weakest stabilizing effect"<sup>6</sup>.

In this paper, I will argue that the events of August and September 1998, in which the hedge fund Long-Term Capital Management (LTCM) lost \$5 billion, provide an empirical example of the phenomena described by Shleifer and Vishny. In particular, I will attempt to show that LTCM typifies the type of performance-based arbitrage fund which Shleifer and Vishny described. Furthermore, I will attempt to show that market gyrations that occurred in the weeks following Russia's implementation of a debt moratorium are an example of the type of market events which can have a negative effect on the ability of such funds to enforce market efficiency. I will also discuss the circumstances surrounding LTCM's eventual bailout by a consortium of banks and why this action was so crucial for world financial markets.

### **The origins of LTCM**

Long-Term Capital Management was a type of investment vehicle known as a hedge fund. Hedge funds are essentially large unregulated private investment pools for wealthy individuals and institutions. Specifically, hedge funds "are exempt under sections 3(c)(1) and 3(c)(7) of the 1940 Investment Company Act."<sup>7</sup> This means that hedge funds are not limited by the restrictions put on other types of investment vehicles with regard to their leverage and the composition of their portfolio. Hedge funds are allowed to take short positions in securities and are also allowed to concentrate their investments in a particular firm, industry,

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<sup>5</sup> Shleifer, p. 46

<sup>6</sup> Shleifer, p. 46

<sup>7</sup> Edwards, p. 190

or sector, if they so choose. In exchange for the removal of these restrictions, hedge funds must have “either fewer than 100 investors (or partners) or have all of their investors meet the eligibility requirements for exemption under section 3(c)(7).”<sup>8</sup> In other words, hedge funds must limit the number of investors to less than 100, or limit the investors to those who are ‘qualified purchasers’ when they invest. Qualified purchasers are defined as “individuals with at least \$5 million in investments and institutions with at least \$5 million under management.”<sup>9</sup> Presumably, the logic behind these restrictions is that wealthy individuals and large institutions are sophisticated enough to understand the risks involved with the investments that the hedge fund is undertaking, and that they would not be devastated by large losses.

The unregulated nature of hedge funds means that very little is known about their actions. In fact, even the exact number of such funds in operation is unknown. What is known, however, is that there has been an explosive growth in the number of hedge funds. In 1998, there were believed to be approximately 3000 such funds in existence, a number which had ballooned up from less than 1000 at the end of 1992.<sup>10</sup> In fact in 1968, there were only 215 hedge funds in the world.<sup>11</sup> According to Managed Accounts Reports (MAR), one of the largest vendors of hedge fund data, the average size of these funds is approximately \$92 million<sup>12</sup>, but this number is believed to be biased upwards by the fact that MAR contains listings of only 1300 of the larger funds. In total, hedge funds are believed to control \$300 Billion worth of assets.<sup>13</sup>

This tremendous growth in the number of hedge funds can be in part attributed to growth in number of high net worth individuals over the course of the 1990’s. The tremendous appreciation of U.S. equity markets during the 1990’s has helped increase the number of millionaires in the world to approximately 6 million. These wealthy individuals are said to have an aggregate net worth of approximately \$17 trillion.<sup>14</sup> This wealth creation had increased the number of investors who are eligible to invest in hedge funds. However, the growth in the number of hedge funds can also partly be attributed to their tremendous track record over the course of the 1990’s. A study by Edwards shows that the value-weighted return (after fees) on the 1500 funds that he tracked from 1989 to August 1998

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<sup>8</sup> Edwards, p. 190

<sup>9</sup> Edwards, p. 190

<sup>10</sup> Edwards, p. 192

<sup>11</sup> Lowenstein, p. 26

<sup>12</sup> Edwards, p. 192

<sup>13</sup> Lowenstein, p.26

<sup>14</sup> Edwards, p. 193

(including those that didn't survive for the whole period) was approximately 18.3% per year. This compares favorably with the S&P 500, an index of large capitalization stocks, which returned 16.47% per annum over that period and the Russell 2000, an index of small capitalization stocks, which returned 12.55% per year. Long-term corporate bonds returned only 10.39% per year over the duration of the study.<sup>15</sup>

The funds were also looked upon favorably because their returns seemed to be less risky than the returns of equity and bond markets. According to the study by Edwards, a value-weighted hedge fund portfolio tracked monthly over the period he studied would have had a 0.46 correlation with the S&P 500 and a 0.38 correlation with long-term corporate bonds. In an absolute sense, the standard deviation of returns for the portfolio of hedge funds he tracked was 8.94%, which compares favorably with the 13.20% and 16.64% standard deviations of return that he found on the S&P 500 and Russell 2000 respectively.<sup>16</sup>

This track record of consistent, high growth rates made hedge funds a very attractive investment during the 1990's, and helps to explain why Long-Term Capital Management was such an attractive fund for potential investors. The launch of long Long-Term Capital was, by all accounts, one of the most successful starts to hedge fund. Founded in 1994, the fund was run by some of the brightest minds from academia, finance, and the government. LTCM was founded by John Meriwether, one of the most famous bond traders on Wall Street. He bolstered the reputation of his firm by bringing along some of the best traders from the arbitrage group that he had helped to found at Solomon Brothers. Furthermore, he brought aboard Robert Merton and Myron Scholes – two of the creators of the famous Black-Scholes options pricing formula. Both Merton and Scholes would win the 1997 Nobel Prize in Economics for this contribution to finance. Meriwether also coaxed David Mullins, the vice-chairman, or second-highest ranking officer of the Federal Reserve Board to join his fund. This array of talent allowed Long-Term to raise \$1.25 Billion, the most money ever collected to start a hedge fund.

The amount of money raised by the founders of the fund is even more impressive when the demanding requirements of the fund managers are taken into account. Reportedly, LTCM would not allow its investors withdraw any of their capital until the investor had been in the fund for at least three years. This requirement allowed Long-Term to invest in illiquid securities without worrying about being forced to liquidate its positions by its equity holders. LTCM also had unusually high fees. Long-Term's managers took an annual fee of 2% of the

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<sup>15</sup> Edwards, p. 194

<sup>16</sup> Edwards, p. 194

fund's net asset value and 25% of its profits. This was substantially higher than the industry's standard fee of 1% of assets and 20% of profits. Finally, Long-Term set the minimum investment in its fund at \$10 million, a level that further restricted the number of potential participants. Regardless of these rigorous demands, Long-Term was able to raise a tremendous initial amount of funding.

### **Trading Strategies**

The term "hedge fund" is a bit of a misnomer. In fact, it is a blanket term used to describe the class of unregulated funds described in the previous section. There are several types of investment strategies that are common among hedge funds, and typically each hedge fund specializes in one of these strategies. For example, George Soros's Quantum Fund exemplifies the type of funds known as "macro-funds". These funds tend to make large bets on sweeping movement in foreign currency and bond markets. In other words, these macro-funds take on the risk of particular macroeconomic events occurring.

Long-Term Capital, on the other hand, was a relative-value fund. Long-Term's basic strategy was to find what it felt were inefficiencies in the bond markets and take positions that it believed would become profitable when these perceived inefficiencies were eliminated. The success of this strategy was predicated upon other arbitrageurs finding the same inefficiencies and exploiting them, which in turn would move the market in the direction of the trades LTCM had placed. If Long-Term had a long position and others were buying, this buying would raise the price of the security and create a profit. Likewise, if Long-Term had sold short a security, sales by other trading firms would result in profits for LTCM.

The key factor that differentiates relative-value funds such as LTCM from other types of funds is that relative-value funds try to immunize themselves completely from general market movements. Unlike macro-funds, relative-value funds do not take positions on the general movements of securities prices. Rather, these funds try to find securities that they believe are mispriced with respect to each other. These relative value-funds then try to capitalize on that difference by buying the security that they believe is underpriced and selling the security that they believe is overpriced. The managers of relative-value funds such as LTCM believe that such a strategy immunizes them from general movements in the class of securities in which they invest, but allows them to profit from the relative movements of two particular securities.

For example, assume that there are two types of securities that are very similar. Each security will pay \$100 in one year's time. However, the price of the securities is not the same

today. If, for example, security A trades at \$100, but security B trades for only \$98, then this is an inefficiency which could be taken advantage of by a relative-value trade. It would be profitable for a trader to buy security B and sell short security A. Regardless of what the efficient price of these securities should be today, the trader can profit from the spread between the two securities. The trader is not, then, betting that the price of B will rise, that the price of A will fall, or that the securities' prices would both go in a certain direction. Instead, he is simply betting that the prices of the two securities must eventually converge.

If the trader undertook the trade described above, he could hold the securities until the maturation date upon which he would receive \$100 from his long position in security B, and would owe \$100 on security A. These two positions would cancel each other out, and the trader would be left with his initial \$2 spread as a profit. Regardless of what happens to the securities prices in the intervening year, it would be profitable for the trader to hold onto the securities until expiration. If, however, the prices converged more quickly, it would be more profitable for the trader to close out his position and recover whatever capital he needed to put up as collateral when financing the trade.

Strictly speaking, the above trade would be an example of a convergence trade – a type of relative-value trade in which two securities' prices are virtually guaranteed to converge because they have the same payoff on their date of maturity. While LTCM participated in such trades, it was much more common for them to invest in relative-value trades in which the securities' prices were expected to converge, but were not guaranteed this by a common payoff. In these trades it was imperative that other market agents found the value in the trade in order to push prices back together. Regardless of whether the specific trade was a convergence or general relative-value trade, however, funds such as Long-Term felt confident that they were not taking risks on the general movements of the markets. Instead, they believed that any general movements in the price of the securities would be canceled out by their opposing positions.

### **Convergence Trade**

An example of a convergence trade that was popular among the traders at LTCM was a trade involving the spread between “on-the-run” treasury bonds and “off-the-run” treasury bonds. “On-the-run” treasuries are those treasuries that are newly issued and highly liquid. For example, a newly issued thirty-year bond tends to be heavily traded and is therefore considered “on-the-run”. An “off-the-run” treasury, on the other hand, is one that is slightly older than an “on-the-run” treasury. For example a 29 ½ year bond is a bond that was “on-



the-run” six months ago, but is now less highly traded simply because it does not have a round number of years to maturity. These bonds are considered by some investors to be more risky than “on-the-run” treasuries because they are less commonly traded. Certain investors, who are very risk averse, would pay a slight “liquidity premium” in order to be invested in on-the-run bonds rather than off-the-runs so that they could quickly move into or out of bonds. To LTCM, however, these two types of bonds were essentially the same. Over the course of the lifetime of the bonds, each would pay the same coupon, and as they approached expiration, the prices of the two bonds would have to converge.

The traders at Long-Term, therefore, felt that the spread between on-the-run and off-the-run treasuries was an irrational difference on which they could make a profit. Long-Term was unconcerned about the liquidity, since it felt comfortable that it would not be forced to liquidate its positions unexpectedly. It therefore thought this strategy to be a very low-risk method of generating profits.

In order to profit off of this trade, Long-Term bought the cheaper off-the-run bond, while simultaneously selling the more expensive on-the-run bond. This allowed it to lock in the spread between the two bonds while immunizing it from interest rate movements. LTCM didn't want to bet on the future of interest rates, instead, it wanted to make a very specific bet on liquidity. By creating a long position in one bond and a short position in another similar bond, LTCM knew that any losses from interest rate movements in one bond would be wiped out by equivalent gains in the other bond.

One problem with this trade, however, was that the spread between the two types of treasuries tended to be very small. For example, in August 1993, before Long-Term entered the market, 30-year bonds yielded 7.24%, while 29 ½ year bonds yielded 7.36%. This 12 basis point spread would not allow it to earn the type of returns that its investors expected, so the traders at LTCM needed to leverage their trade in order to magnify this return. On this particular trade, such magnification was very easy. LTCM received cash when it shorted the on-the-run bond, and it could then use that cash to buy the off-the-run. This meant that it needed to put up very little cash in order to finance this pair of transactions, and could easily leverage the tiny arbitrage profit into large gains. This type of trade was reportedly often leveraged thirty to forty times in order to generate high returns on equity.

### **Relative Value Trade**

LTCM also took on a number of trades that were characterized as relative value trades. An example of this type of trade was a position Long-Term took on the Italian swap

spread in 1994. In this trade, like all other relative value trades, LTCM felt confident that the market had misjudged the relative prices of two types of securities, and that it could arbitrage the difference in price while taking on minimal risk. In this particular scenario, Long-Term felt that investors were irrationally bearish on a type of Italian treasury bond known as a BTP. Specifically, LTCM noticed that the Italian swaps curve, which represents the fixed rate at which companies can enter into interest rate swaps was below the Italian yield curve. In this unusual configuration, Italian treasury bonds actually provided a higher yield than Italian corporate swaps of comparable duration. This irregularity in the Italian swap spread meant that investors in the Italian bond market felt that there was a greater likelihood that the Italian government would default on its bonds than there was that Italian companies with high credit ratings would default.

LTCM felt that the default risk on these BTP's was being exaggerated in the market, and therefore created a strategy that would immunize themselves from changes in Italian interest rates, but would still allow them to take advantage this perceived inefficiency. This transaction was structured in such a way that Long-Term received Italian Treasury coupon payments from one bank in exchange for Lira Libor. In essence, they were long Italian treasuries without actually holding the treasuries on their books. The other side of this transaction allowed them to be short Italian swaps. In this trade, LTCM received Lira Libor in exchange for the fixed swap rate from a different bank. The net effect of these transactions, then was for LTCM to be receiving Italian treasury coupon payments in exchange for paying the fixed swap rate. This allowed them to lock in the spread between the BTP and swap rates, while taking no position on the future direction of Italian interest rates. In order to hedge the credit default risk inherent in this position, LTCM took default insurance against an Italian government default, as well as default insurance against the company providing them with default insurance.

## **Leverage**

The perceived inefficiencies that LTCM found, however, tended to be quite small in magnitude. As mentioned above, the spread on a convergence trade could be as small as 12 basis points. It was therefore necessary for the firm to take very large, highly leveraged positions in order to generate meaningful returns.

Specifically, LTCM built up a balance sheet of assets worth over \$125 billion that was balanced on a sliver of equity worth approximately \$5 billion in early 1998. This meant that it was leveraged at the astonishing level of 30 to 1. This level of leverage is high even

for hedge funds. According to Edwards, a third of hedge funds don't borrow at all, while 54% limit themselves to borrowing no more than the equity value invested in the fund. Even among the remaining funds, few borrow at a greater than 10:1 ratio.<sup>17</sup>

The \$125 billion in assets that LTCM controlled doesn't accurately describe Long-Term's position in the markets, however. Many of LTCM's trades were conducted through the use of off-balance sheet assets such as swaps and futures. These contracts are created based on an underlying "notional" value that doesn't change hands during the course of the contract. It is necessary, however, for investors to make payments based upon the notional value of the contract.

For example, in an interest rate swap contract based upon a notional value of \$100 million, if one party is to pay a fixed interest rate of 5%, while the other party is to pay a flexible interest rate, the two parties have essentially made \$100 million loans to each other. However, because these cash flows cancel each other out, there is no need for the notional value to be exchanged. Similarly, at the end of the contract there is no need for the notional value of an interest rate swap to change hands, since the cash flows would exactly cancel each other. The only time cash will change hands is when the flexible exchange rate differs from 5%. If the interest rate rises to 6%, for example, then the party that pays the flexible rate would pay the difference between what it would have paid if it had borrowed at 6% and what it would have received had it lent at 5%. In this case that would be \$1 million on an annualized basis. Likewise, if the interest rate becomes 4%, the party that pays the flexible rate receives the difference between what it would have paid if it had borrowed at 4% and what it would have received had it lent at 5%.

LTCM had \$1.2 trillion dollars worth of these off-balance sheet assets under its control at the beginning of 1998, a number that shows more accurately the enormous size of the positions that it undertook in order to generate profits. It seems that Long-Term had undertaken a large number of trades that required its traders to take positions in the swaps market. Furthermore, the notional value of the swaps Long-Term was involved with were inflated by the fact it often didn't close out the positions that it wanted to unwind. Instead, LTCM often took on another swap contract that exactly negated the first. The combined effect of these two contracts was to effectively close out the position, as the cash flows in from one contract paid for the cash flows out to the counterbalancing contract. The benefit to this approach was that it avoided the mark-to-market cash payment required to close out such

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<sup>17</sup> Edwards, p. 198

a contract and potentially helped delay capital gains. This approach, however, also added significantly to the notional value of swaps contracts that Long-Term controlled. Of the \$1.2 trillion in off-balance sheet assets controlled by LTCM, \$697 billion were reported to be invested in swaps, with the remaining \$471 billion invested in exchange traded futures contracts.<sup>18</sup>

This enormous amount of leverage had an effect on the risk of Long-Term's portfolio. Just as leverage tends to increase the expected return on a portfolio by magnifying the return on assets, it can increase the variance of returns by magnifying changes in asset value. The assets in Long-Term's portfolio, however, were carefully chosen in order to minimize this increase. So even though LTCM was tremendously leveraged, this did not lead to a large increase in the amount of variance on its portfolio. In a sense, the effect of LTCM's leverage on its variance could have been a bit overstated. As Michael Lewis points out "what was important was not the gross amount of the positions but the amount of risk in them....A portfolio might be leveraged 50 times and have almost no risk. A portfolio might be leveraged five times and be perfectly mad."<sup>19</sup>

Although LTCM was tremendously leveraged, this leverage did not necessarily lead to an unreasonable amount of risk in terms of the variance of its positions. In fact, the according to its calculations, LTCM's hedged positions always resulted in a variance of return lower than that of the market. What LTCM may not have accounted for, however, was the liquidity risk in having such a highly leveraged portfolio of thinly traded securities.

While the firm reportedly did not have more than a dozen types of trading strategies, it executed these strategies in a wide variety of countries and on a large variety of securities. It felt that this strategy diversified its portfolio, and that this diversification combined with hedging against larger macroeconomic risks greatly reduced the risk inherent in its positions. In fact, LTCM was so confident in its ability to reduce risk while maintaining excess returns that it wrote the following statement regarding its risk-return relationship in its prospectus:

"The reduction in the Portfolio Company's volatility through hedging could permit the leveraging up of the resulting position to the same expected level of volatility as an unhedged position, but with a larger expected return."<sup>20</sup>

Long-Term's strategy, then, was to magnify slightly excessive returns by leveraging its positions, and to hedge its positions to reduce the fund's volatility. The combined effects

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<sup>18</sup> Edwards, p. 198

<sup>19</sup> Lewis

<sup>20</sup> Dunbar, p. 140

of these two actions, it claimed would allow it to earn a return in excess of the market's return while taking on only the same amount of risk. In a letter to its investors, LTCM claimed that it was expecting typical returns to be as high as 30% per year, with this figure varying between 80% and -20%,<sup>21</sup> but it didn't expect the variance of the fund to be any higher than that of the market.

## Returns

The result of these and the other positions that LTCM took was an impressive record of returns in its first few years. In 1994-1996 its raw return figures (before fees) were 28%, 59%, and 57% respectively. As one can see in Chart 1, LTCM greatly outperformed the S&P 500 index over this period. A dollar invested in LTCM over this time period would have resulted in a net position of approximately \$3.50, whereas a dollar invested in the S&P index over that period would have produced a position of only \$1.60.

LTCM's strong returns were largely the result of the leverage that it had assumed. For example, in 1995, LTCM was leveraged at a ratio of 28 to 1. This ratio meant that although its return on equity was 59%, its return on assets was a paltry 2.11%. As mentioned earlier, Long-Term's strategy was to find very small inefficiencies in markets and generate returns through tremendously leveraged positions.

This strategy worked for the first 3 years of Long-Term's existence. However, the fund showed a dramatic drop-off in 1997, when it only returned 17%. In fact, during 1997, the fund did not even outperform the benchmark S&P 500, which returned 31%. This underperformance was unsatisfactory to the managers of Long-Term who searched for reasons why their fund had lost its Midas touch, and who explored new opportunities for investment.

The explanation that Long-Term came up with for its diminished returns was that its own tremendous presence in the markets combined with copycat strategies from other hedge funds and investment banks had led to a decrease in the spreads that it had been profiting from. In order to remedy this problem, Long-Term took two steps that would eventually contribute to its downfall. First, they gave back \$2.7 billion of their investor's equity. This strategy was intended to boost returns by increasing the overall leverage of the fund. Secondly, Long-Term branched away from its trademark investment strategies into new strategies in which its expertise was less valuable.

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<sup>21</sup> Sprio

Traditionally, Long-Term had invested mainly in what it felt were market inefficiencies in the fixed income markets. In fact, fixed income markets are where the majority of such activity takes place since the cash flows from investments in these markets are known with much greater certainty than in the equity markets. After its poor performance in 1997, however, LTCM explored a number of new investment opportunities. One of the markets that LTCM entered into after 1997 was the equity volatility market. Here Long-Term took the position that historical volatility in the equity markets was an accurate indicator of future volatility. However, oftentimes their traders found that options traded at a price, which according to the Black-Scholes formula would imply a volatility well above the historical volatility of the underlying. The explanation that LTCM came up with for this divergence was that there was a greater demand for options than there was a supply. Long-Term felt that many investors, who were perhaps unsophisticated, were eager to obtain insurance for their portfolios, and therefore bid up the prices of equity options. According to the Black-Scholes formula, the volatility of the underlying asset and the price of an option on that asset are directly correlated. Therefore, increases in the prices of options due to the high demand for these securities were implicitly increasing the volatility implied by the options prices. Long-Term therefore sold options, which meant that they were implicitly selling volatility, a commodity that they believed had become overpriced.

Long-Term also started investing in trades known as equity pairs. In these trades, LTCM found that stocks were sometimes listed on two different exchanges or had multiple classes listed on the same exchange. Long-Term's traders found that sometimes these stocks would trade at different prices even though they received the same cash flows. For example, Royal Dutch/Shell was jointly owned by Royal Dutch Petroleum, which traded in the Netherlands, and Shell Transport, which traded in England. Although the two companies received their income from the same source, Shell Transport had historically traded at an 8% discount to Royal Dutch Petroleum. LTCM bet that as the European economy converged, these two stock prices would converge as well. Even though there was no guarantee of convergence, LTCM was confident enough in this trade to place \$2.3 billion on it – half of which was long on Shell, the other half of which was short on Royal Dutch.<sup>22</sup>

Long-Term also began investing in risk arbitrage opportunities in the equity markets. These trades essentially sought to take advantage of investor doubt about the likelihood of certain mergers and acquisitions occurring. For example, one trade that Long-Term invested

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<sup>22</sup> Lowenstein, p. 99

in was the proposed merger of two telecommunications concerns - Ciena Corporation and Tellabs Inc. According to the terms of the deal, Ciena was to be acquired by Tellabs for \$47 per share. However, Ciena traded below that value as doubts arose about the completion of this merger. Long-Term therefore bought Ciena shares while shorting Tellabs in order to capture the spread. This too, was a much riskier trade than those trades that they had undertaken in the fixed income markets. In fact, profits on these risk arbitrage trades were predicated on intimate knowledge of the companies involved, their industry and anti-trust law – competitive advantages that Long-Term Capital didn't have.

LTCM also began taking directional bets on developing markets and individual equities. On June 30, 1998 LTCM filed a document with the SEC that it had equity stakes in 77 companies, and that these stakes were worth some worth \$541 million. Another report claims that during this same period “Russia was ‘8% of its book’ which would come to \$10 billion”<sup>23</sup>

## **Risk**

In order to judge their level of returns, LTCM needed to measure their returns against the risks of their portfolio's positions. For Long-Term, the measure of risk used was a method known as Value-at-Risk (VaR) - which measures “a loss that will not be exceeded at some confidence level.”<sup>24</sup> In other words, VaR measures the maximum loss that would be expected to some statistical degree. For example, in one of its investor newsletters, LTCM claimed that its VaR analysis showed that, “investors may experience a loss of 5% or more in about one month in five, and a loss of 10% or more in about one month in ten...only one year in fifty should it lose at least 20% of its portfolio.”<sup>25</sup> Furthermore, LTCM calculated that a 45% drop in its equity value over the course of a month was a 10 standard deviation event. In other words, this scenario would never be likely to occur in the history of the universe. Unfortunately for Long-Term Capital Management and its investors, this event did happen – in August 1998.

This reliance on Value-at-Risk may also indicate one of the problems that eventually led to Long-Term's demise. LTCM's creators included some of the greatest minds in finance. In fact, Institutional Investor called the founders of this fund “the best finance

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<sup>23</sup> Shireff

<sup>24</sup> Hull, p. 761

<sup>25</sup> Lowenstein, p.63

faculty in the world”<sup>26</sup>. The founders didn’t simply believe in the models that they were using – they had helped to create them. This reportedly led to a tremendous amount of faith in the models behind Long-Term’s investments. The founders of this fund believed that historical trends in securities movements were an accurate predictor of future movements. For example, as stated above, the founders believed that historical volatility was a good proxy for the future volatility of stocks. Their faith in this belief led them to sell options in which the implied volatility was higher than the historical volatility. In the words of Victor Haghani, one of LTCM’s primary strategists, “[w]hat we did is rely on experience. And all science is based on experience. And if you’re not willing to draw any conclusions from experience, you might as well sit on your hands and do nothing.”<sup>27</sup>

Similarly, the Value-at-Risk models used by LTCM rely on historical data to project information about future price movements. These models project the probability of various losses based on the prior history of similar events. Unfortunately, the past is not a perfect indicator of the future. On October 18, 1987, for example, two-month S&P futures contracts fell by 29%. Under a lognormal hypothesis, with annualized volatility of 20% (approximately the historical volatility on this security), this would have been a  $-27$  standard deviation event. In other words, the probability of such an event occurring would have been  $10^{-160}$ . This is such a remote probability that it would be virtually impossible for it to happen. Similarly, on October 13, 1989 the S&P 500 fell about 6%, which under the above assumptions would be a five standard deviation event. A five standard deviation event would only be expected to occur once every 14,756 years.<sup>28</sup> There are many other examples of abnormal market events happening with greater frequency than these models would lead one to expect. It would appear then, that lognormal models for expected returns do not fully account for these large losses, and that prior estimates of volatility may not be able to accurately predict future price movements. This reliance on a risk model that tends to underestimate the probability of large downward movements in securities prices may have led Long-Term Capital to be overconfident in its hedging strategies.

## **Meltdown**

Given LTCM’s tremendous expertise in the markets and its risk hedging strategies, how could it lose \$5 billion over the course of just a few months? According to Michael

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<sup>26</sup> Lowenstein, p. 40

<sup>27</sup> Lewis

<sup>28</sup> Jackwerth, p.1611-1612



Lewis, the big losses started on July 17 when Salomon Smith Barney began liquidating its dollar interest arbitrage positions. "For the rest of the that month, the fund dropped about 10% because Salomon Brothers was selling all the things that Long-Term owned."<sup>29</sup> More importantly, however, an unexpected event one month later roiled world markets. On August 17, 1998 Russia devalued the ruble and declared a moratorium on 281 billion rubles (\$13.5 billion) of its Treasury debt. This default sent shock waves through financial markets as many Russian banks and securities firms exercised *force majeure* clauses on their derivative contracts that allowed them to terminate these contracts.<sup>30</sup> Many customers who had been using these contracts to hedge their Russian currency and debt positions were now left with unprotected positions that had lost much of their value.

These actions caused a massive flight to quality in worldwide financial markets that worked against Long-Term on many of the positions that it had taken. Long-Term had undertaken many trades in which it felt that "quality" liquid investments were overpriced with respect to less liquid or less creditworthy investments. When Russia defaulted, the enormous demand for high quality investments caused spreads between high quality and lower quality investments to widen. These were the exact spreads that Long-Term had bet would narrow. Furthermore, this phenomenon was not isolated to one country or region. Instead, it seemed that investors all over the world were in a stampede to quality investments. This removed the stabilizing effect of being diversified across many markets that LTCM had been in part relying on for its risk management.

The flight-to-quality caused investors to sell riskier investments and move into safer ones. For example, in the aftermath of the Russian default, investors rushed into "on-the-run" treasury bonds. This rush increased the spread between on-the-run and off-the-run bonds to 19 basis points from the 6 basis points it was at in the previous month. It also caused the JP Morgan emerging market bond index to show these "risky" emerging market bonds trading at a spread of 17.05 percentage points above Treasuries. This was a sharp increase from a 6 point spread in July and 3.3 point spread in October 1997<sup>31</sup>. This flight to quality caused Long-Term Capital to lose an astonishing \$550 million on August 21, four days after the Russian default.

Furthermore, amidst this market turmoil investors rushed to buy options that would allow them to hedge their positions in the equity markets. This, in turn, caused a tremendous

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<sup>29</sup> Lewis

<sup>30</sup> Edwards, p. 199

<sup>31</sup> Edwards, p,199

increase in equity volatility. According to Lewis's article LTCM's portfolio had its second biggest single day loss (\$500 million) on September 21, 1998 primarily due to losses in five-year equity options. Lewis reports that LTCM's traders claim that American International Group (AIG) intervened in a thin market to drive up the option's price. AIG was at the same time part of a consortium of financial institutions negotiating to buy LTCM, so its actions may in part have been to profit from LTCM's weakness

It is interesting to note that the types of trades that created the biggest problems for LTCM were its positions in swaps and equity volatility. As one can see from Chart 2, these two types of trades accounted for 35% and 29% of LTCM's losses respectively. Losses in both swaps and equity volatility dwarf LTCM's losses in other types of trades, such as equity pairs and yield curve arbitrage. Interestingly enough, Long-Term lost very little in some of its riskier trading strategies, such as merger arbitrage and pure directional trades compared with its losses in swaps and equity volatility.

The net effect of these losses, however, was to decrease LTCM's equity to less than \$1 billion on September 21, a sharp decrease from the \$4.5 billion in equity that the fund had in April. This \$1 billion in equity supported over \$100 billion worth of assets on its balance sheet and over \$1.2 trillion worth of off-balance sheet assets such as swaps. Now, only a small 1% decline Long-Term's balance sheet asset value would cause the bankruptcy of one of the world's largest financial institutions.

## **Bail-out**

The large nature of LTCM's positions in the markets meant that a bankruptcy might have caused major disruptions to the markets. According to securities laws, counterparties are allowed to liquidate the assets of parties that are in default on derivatives contracts. A liquidation of Long-Term's assets might have caused a downward spiral in markets that could have affected many of the world's largest economies.

Since LTCM had large positions in illiquid markets, the selling of LTCM's positions would most likely have driven the spreads between high and low quality investments even further apart. This in turn would have caused the remaining positions on LTCM's books to lose their value. There would, therefore, have been a great incentive to be the first of LTCM's counterparties to liquidate its assets. Given that Long-Term Capital reportedly dealt with as many as 36 counterparties, the first few liquidators would receive a much greater proportion of their investments back than those further back in the line.

A liquidation of LTCM's assets would also have meant that other hedge funds and investment banks who had taken on similar trades would have lost a large amount of money as LTCM's liquidation widened spreads. These losses could have caused bankruptcy among some of these firms. This, in turn, might have started another round of liquidations. In order to avoid this scenario, a consortium of 14 banks, led by the Federal Reserve Bank of New York bought 90% of LTCM on September 23 for \$3.65 Billion. The funds from this bail-out, combined with the equity remaining in the fund (which had now fallen to \$350 million), brought the total equity value to approximately \$4 Billion, and the leverage ratio back to a more comfortable 25:1.

This buyout also finalized enormous losses for some of the major investors in LTCM. As Chart 3 shows, the biggest losers in the LTCM fiasco were the managing partners of Long-Term Capital, who lost 1.5 billion and Union Bank of Switzerland, which lost nearly \$700 million. Both of these parties had large, concentrated positions in the fund, and were hammered by its downfall. Most other parties were spared this devastation when Long-Term forced them to take back the \$2.7 billion the previous year when it was trying to increase its leverage. Most losses for these other parties came out of their profits, not their initial capital.

## **Conclusions**

It seems as though Long-Term Capital Management epitomizes the type of performance-based arbitrage vehicle that Shleifer and Vishny described in their article "The Limits of Arbitrage". LTCM was a large fund that specialized in particular types of relative value trades. Although this is not "arbitrage" in the textbook sense, Shleifer and Vishny acknowledge that "[u]nlike in the textbook model ... arbitrage is risky and requires capital."<sup>32</sup> LTCM did, however, tend to act as one of the specialized funds which generally move the market towards efficiency.

The events of August and September 1998, then, similarly epitomize the adverse market forces that can cause the liquidation of a performance-based arbitrage fund. Although LTCM attempted to limit its susceptibility to performance-based liquidations by limiting the ability of its investors to remove their money from the fund, its high degree of leverage eventually caused these liquidation pressures to arise from debt-holders. The sharp movement of securities away from the relative direction in which LTCM had predicted they would move caused tremendous losses for the fund. These losses, combined with the fund's

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<sup>32</sup> Shleifer, p. 36

tremendous leverage, nearly caused the bankruptcy and liquidation of LTCM's assets. If not for the intervention of a team of banks that bailed-out LTCM, it almost certainly would have been forced to liquidate its assets. This in turn would have pushed the securities in which it had invested even further from the fundamental relationships that Long-Term had predicted. The destabilizing effect that this would have had on world markets necessitated that LTCM be bailed out by a consortium of banks.

This irony of this near-performance-based liquidation was noted presciently by Shleifer and Vishny. LTCM was nearly forced to liquidate its assets when the potential gains available for its investment style were the greatest. The spreads that Long-Term had been betting against were now incredibly wide, which meant that the trades that Long-Term had been making would now, presumably, have been more profitable than ever to undertake. Unfortunately for LTCM it didn't have the liquidity to take on such trades. This inability of performance-based arbitrage vehicles to move the markets towards efficiency when they are needed the most gives an empirical basis for Shleifer and Vishny's hypothesis that arbitrage funds are not highly effective at creating market efficiency.

The primary lesson to be learned from the Long-Term Capital debacle is that the combination of tremendous leverage and illiquid markets is a very dangerous one. A fund such as Long-Term Capital can be highly leveraged if it is in highly liquid markets, since the liquidation of assets for the purpose of meeting margin calls would not have a great effect on the market. Similarly, a fund can operate in highly illiquid markets if it is not highly leveraged, since it could never be forced to liquidate its positions. However, the combination of the two factors is a risky one. Even if LTCM had perfect foresight about the future value of its investments, it could not judge the intermediate steps that its securities would take on their path towards their end state. As Ayman Hindy, an LTCM strategist, put it "[t]he models tell you where things will be in five years. But they don't tell you what happens before you get to the moment of certainty."

A highly volatile market, such as the one seen in August and September of 1998 can cause an increase in the anomalies that funds like Long-Term believed were inefficient and were betting against. Even a short-term deviation from the path to efficiency that a hedge fund manager has planned out can cause tremendous problems such as those experienced by LTCM in 1998.

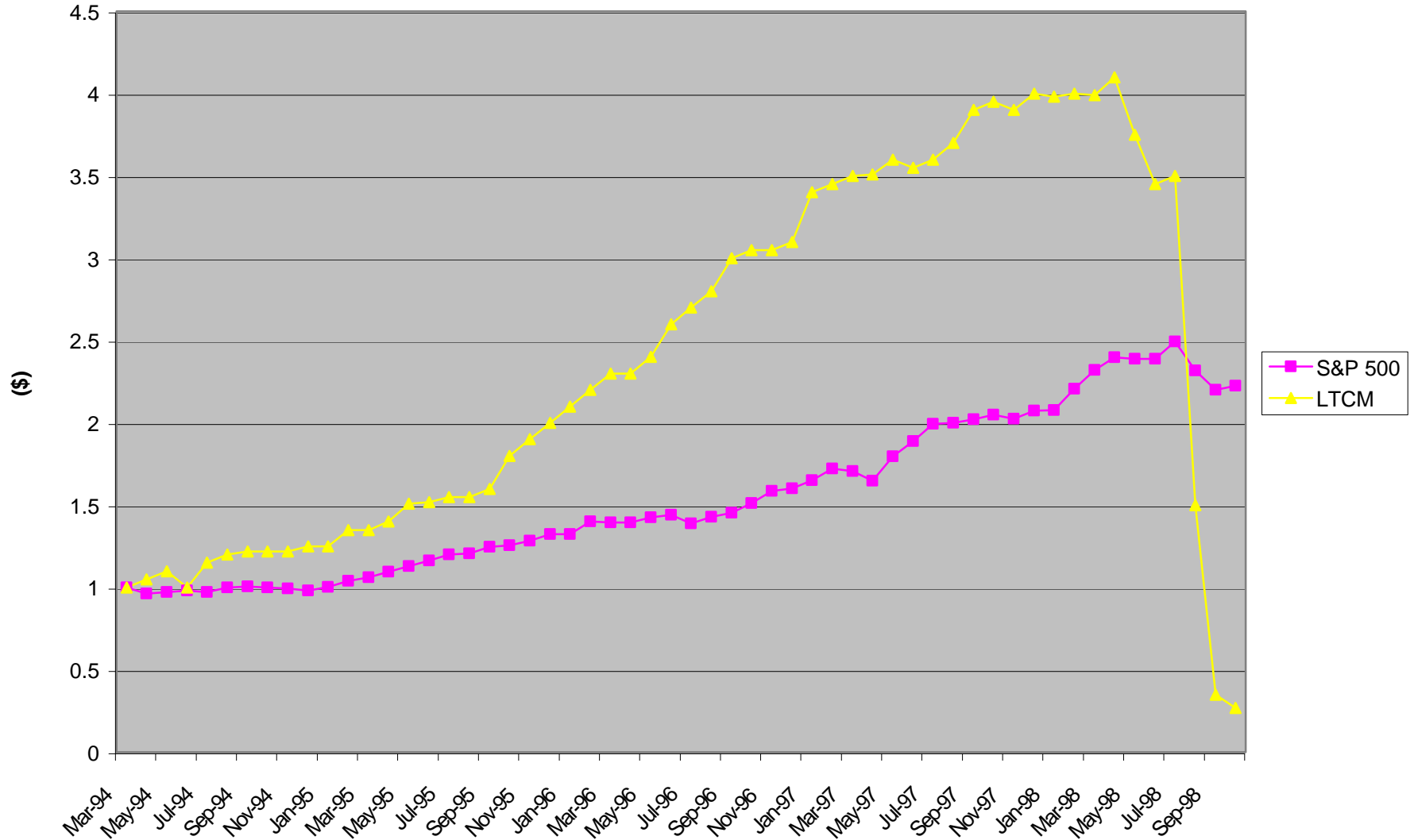
The LTCM debacle also points to the need for a greater role for game theory in trading models. Long-Term Capital appears to have believed too fervently in its models of rational markets and options pricing. What these models did not account for, apparently, was

that trading is, in part, a game against rational agents. LTCM's models seemed to have ignored the possibility that it could be perfectly rational for another trader, such as AIG, to trade against LTCM in order to weaken Long-Term's position. While in the short-term, such actions may move prices away from their "rational" levels this may be a more profitable strategy than waiting for the return to the long-run equilibrium price.

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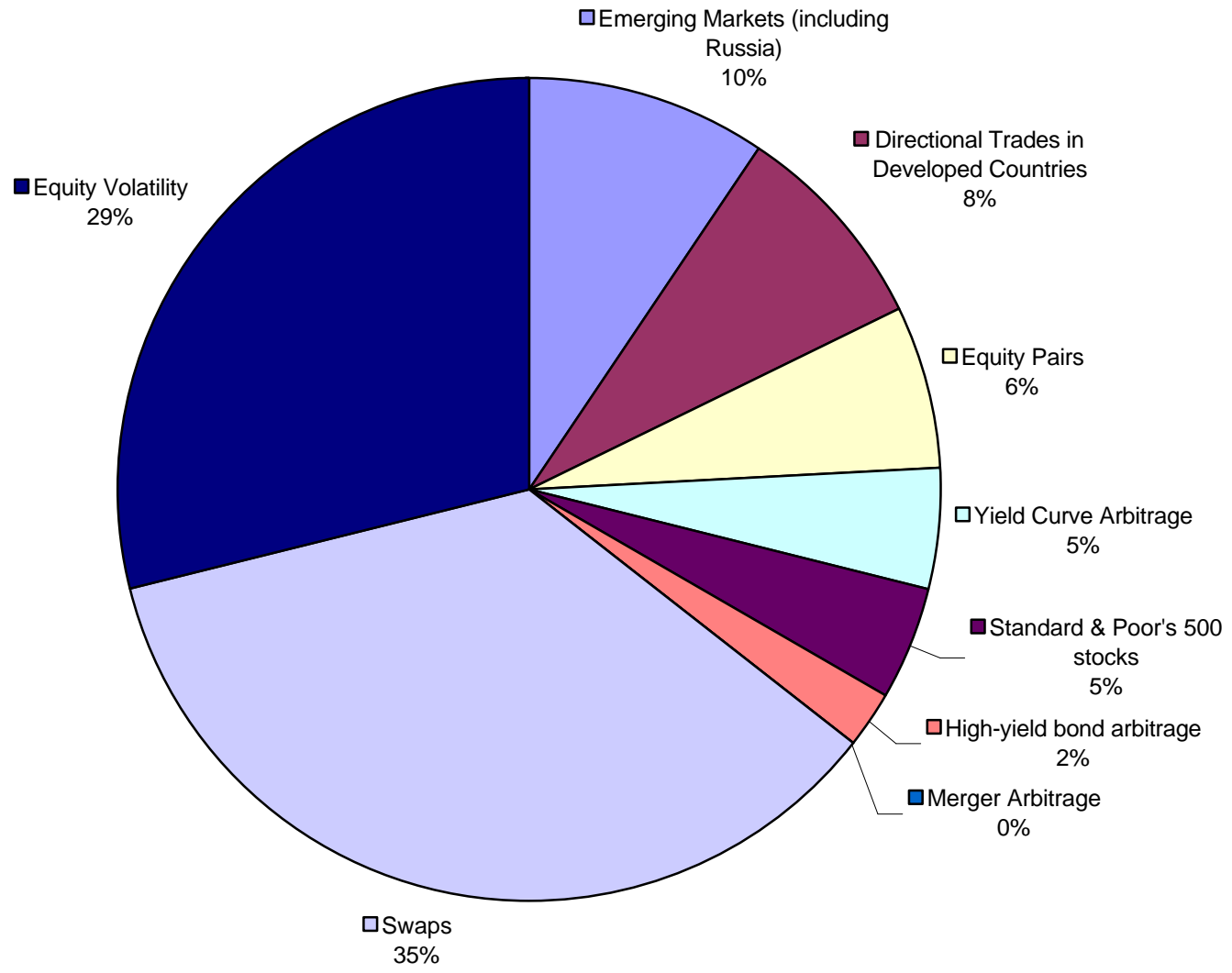
Chart 1: Value of \$1 invested in LTCM vs. S&P 500 (March 1994-October 1998)



LTCM data from Lowenstein, p. xv

Standard and Poors 500 data provided by Bloomberg

**Chart 2: LTCM's Losses by Trade Type**





**Chart 3 - Losses by Financial Institution**

