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Leland O'Brien Rubinstein Associates Incorporated: Portfolio Insurance

The months following the market crash of October 19, 1987 were marked by uncertainty in the U.S. financial community. Both the S&P 500 Index and the Dow Jones Industrial Average had declined by almost one-third during a six-day period, representing a loss of approximately $1 trillion in the value of all outstanding United States stocks.[1] Many securities firms and portfolio managers were coping with losses and reevaluating their investment strategies. The mood was distinctively sober at the firm of Leland O'Brien Rubinstein Associates Incorporated (LOR), whose three principals were reassessing their firm's continued survival in the postcrash world. LOR's principal product, portfolio insurance, which accounted for more than 95% of its revenues and had brought the firm not only economic success but also notoriety, had not performed up to investors' expectations during the crash. Even more devastating, portfolio insurance had been vilified as a contributor to the crash, by both the press and the Presidential Task Force appointed to study the events of mid-October 1987. Some observers were so harsh in their criticism that they blamed "the mad scientists at LOR for blowing up the market."[2]

Portfolio insurance is a trading strategy that uses dynamic hedging technology from option-pricing theory to produce investment returns that allow investors to protect their portfolios against declines in the equity market.[3] LOR's success in the early and mid-1980s was inextricably linked to this trading strategy, whose use LOR had pioneered in 1981. Throughout the decade, LOR developed and promoted the strategy and, by October 1987, either directly or indirectly managed portfolio insurance for $50 billion worth of assets. Portfolio insurance generated an estimated $8 million in fees for LOR in 1987 alone and fostered the firm's growth from just 3 employees in 1981 to 35 by September 1987. (See **Exhibit**

1. See **Exhibit 1** for a graph of the return and volatility of the S&P 500 Index from 1973 to 1987.
2. Hal Lux, "LOR's Big Gamble on SuperShares," *Investment Dealers' Digest*, November 30, 1992, p. 14.
3. LOR prefers the phrase "dynamic hedging," or more formally Dynamic Asset Allocation[SM], to distinguish the trading strategy from a traditional insurance policy in which an insurer acts as a principal.

Research Associate Barbara Kyrillos prepared this case under the supervision of Professor Peter Tufano as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

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2 for a description of LOR's size, the assets under its management, and the fees generated by its portfolio insurance business.) This $50 billion business evaporated to $10 billion soon after the crash and looked as though it would continue to decline further. In late 1987, the three principals faced the choices of folding up shop, trying to defend portfolio insurance against its detractors and resurrect the product, or developing a new product to sustain the firm into the 1990s and beyond. They did not want to close the firm's doors, but, given the public outcry, portfolio insurance could not easily be resurrected. They hoped their experience gained from providing portfolio insurance to investment managers, as well as the technical skills that had enabled them to succeed in creating and marketing a complicated financial product, would be valuable in helping them develop new investment vehicles to meet these investors' ongoing demands.

Leland O'Brien Rubinstein Associates Incorporated[4]

The firm of Leland O'Brien Rubinstein Associates Incorporated was formed in February 1981 by Hayne Leland, John O'Brien, and Mark Rubinstein, for the purpose of using the latest financial technologies to deliver new investment vehicles to institutional investors. LOR differed from most money management firms in that it did not offer products intended to outperform the market; its products permitted investors to adjust the risk/return characteristics of their portfolios. Leland and Rubinstein, professors at the University of California at Berkeley, were prominent academics well versed in the relatively new technology of option pricing. The two academics had joined forces earlier in 1976 to form Leland-Rubinstein Associates, a venture intended to capitalize on this new technology and augment their academic salaries.

The inspiration for this commercial venture came from a chance conversation between Leland and his brother, a San Francisco investment counselor who was ruminating on the 1974 equity market doldrums, which had scared some investors out of the market. He lamented, "it's too bad there is no way to buy insurance on your portfolio. Then people wouldn't have to sell out at the very worst time and have no way to participate in the subsequent market rally."[5] Leland recognized that the fledgling option-pricing theory, developed by Myron Scholes, Fischer Black, and Robert C. Merton in 1973, could provide a solution to his brother's problem as well as to many other problems faced by institutional investors.

Leland and Rubinstein agreed to collaborate on the project and, over the next few years, worked out the details of a product they would call "dynamic asset allocation," but which was more popularly called "portfolio insurance." In 1979, Leland began a marketing campaign to sell the product, holding seminars with portfolio managers around the country. While all seemed very interested, none were convinced by the complicated strategy promoted by the pair of professors. Leland and Rubinstein recognized their need to bring in a full-time professional marketer, but they knew few practitioners.

4. For a lengthy and colorful description of the origins of LOR, see Peter L. Bernstein, *Capital Ideas: The Improbable Origins of Modern Wall Street* (New York: The Free Press, 1992), Chapter 14.
5. See Ibid., p. 270.

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At one of his presentations, Leland had been impressed by the questions asked by John O'Brien, whom he sensed had a feel for the concept they were trying to market. O'Brien had worked on Wall Street since the early 1970s and founded a well-known pension advisory firm, which he sold in 1975. In 1981, O'Brien was a successful vice president at the pension division of A.G. Becker, but because of a reorganization of the firm, was interested in finding a new entrepreneurial venture. The new and exciting ideas proposed by Leland and Rubinstein immediately appealed to him, and he agreed to join the two men to form LOR. John O'Brien's marketing skills complemented Hayne Leland and Mark Rubinstein's technical skills:

> O'Brien tosses around academic theory like his professorial partners, but he is also a born salesman. He is especially effective as an up-front man for a hard-sell, hard-to-understand product.... Some people have said that he is the ultimate salesman, but he is really a patient teacher. He is willing to go and spend literally hours to describe all of the details in plain English to get to the root of what is being innovated without using complex math.[6]

O'Brien refocused LOR's marketing efforts away from money managers, hired to select securities, and toward pension administrators, entrusted as fiduciaries to oversee the assets of employees' retirement plans. The pension administrators seemed more concerned with controlling their portfolios' risks than were the fund managers. This adjustment in the firm's marketing plan, along with the addition of a full-time professional marketer, initiated the commercialization of the ideas Leland and Rubinstein had been developing for the past five years.

Marketing and Manufacturing Portfolio Insurance Theory

What united the principals of LOR was their belief that financial technology could be used to create any return pattern sought by investors, especially by pension plan investors. Because fund managers were unfamiliar with the possibilities of using new technologies to produce customized returns, LOR focused its marketing efforts on educating potential investors on the diverse investment returns they could construct. An early seminar, titled "Sculpting Investment Returns," demonstrated the various exposures that managers could manufacture. Of the various returns, managers were most interested in products that would control the risk of their equity portfolios.

During the late 1970s and early 1980s, the pension fund community could measure the risk of their portfolios, but, consistent with Leland's brother's lament, apparently could do little to alleviate it. Fund managers would often select and hold a stock and bond mix whose worst-case projected return was tolerable. Of course, the managers could systematically adjust the composition of the portfolios in response to the relative prices of various investments, but regular rebalancing was not the norm.[7] Investors seemed to demand a payoff with limited risk of declines in value while maintaining most of the portfolio's upside potential. LOR's

6. Hal Lux, "LOR's Big Gamble on SuperShares," *Investment Dealers' Digest* (November 30, 1992), p. 14.
7. The systematic adjustment of a portfolio's composition in response to relative prices of assets is sometimes called tactical asset allocation.

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discussions with practitioners confirmed their belief that there was a large unsatisfied demand for this type of insurance on their portfolios. In 1981, there were $266 billion worth of pension assets invested in equities. An investment product that protected managers from declines in their equity portfolios might attract a sizable fraction of these assets.

An investor seeking to manage the risk of holding an asset has three fundamental alternatives: diversification, hedging, or insurance. By holding a diversified portfolio, the investor can minimize risks attributable to only one asset. For example, by holding a broad portfolio of equities, such as the S&P 500 Index, an investor can reduce her exposure to idiosyncratic or nonsystematic risk. However, the investor with a diversified portfolio still has to cope with fluctuations in value common to all assets, in this instance, exposure to the equity market in general. One solution would be to completely eliminate this exposure through hedging, either by selling the portfolio immediately or selling it for future delivery, using either forward or futures contracts. Hedging eliminates the investor's exposure to downward and *upward* subsequent moves. Unfortunately, in 1981, neither index futures nor forward contracts on the S&P 500 were available.[8]

Investors seeking to maintain exposure to upward moves, but also to shed exposure to downward moves, would be attracted to *insurance* strategies. The functional product—insurance—could be delivered in a variety of forms. Firms could serve as principals, selling an "insurance" policy contract to portfolio managers and guaranteeing a floor value of the portfolio in exchange for the advance payment of an insurance premium. An important insight to understanding portfolio insurance is the recognition that these contracts could be structured as put options. By combining an underlying portfolio, such as the S&P 500, with a put on the portfolio in a "protective put strategy," the investor could establish a floor on the value of the portfolio's position. This method would work well—if the investor could find a counterparty willing to sell the precise put he sought (in terms of index, exercise price, maturity, and style) at a reasonable price, without the investor's bearing significant credit risk to the put writer. In 1981, the market for puts on the S&P 500 was virtually nonexistent.

In 1980, Leland wrote an academic article demonstrating which classes of investors would benefit from using portfolio insurance.[9] He identified two classes of investors who should buy portfolio insurance:[10]

1. Investors who have average expectations, but whose risk tolerance increases with wealth more rapidly than average, will wish to obtain portfolio insurance.

8. In April 1982, the Chicago Mercantile Exchange started trading S&P 500 index futures.
9. Hayne Leland, "Who Should Buy Portfolio Insurance," *Journal of Finance* 35 (1980): pp. 581-594.
10. *Casewriter's note*: The term "average expectations" is used to imply that the investor has the same expectations of future returns as the average investor, or has no anticipation that she can outperform a risk-adjusted benchmark. A portfolio's alpha (α) is a quantitative measure—derived from an asset-pricing model such as the Capital Asset-Pricing Model—of the degree to which a portfolio earns a return larger than that of a risk-adjusted benchmark. "Risk tolerance" is a measure of an investor's unwillingness to pay in order to reduce the variability of a future outcome. The more a person can tolerate risk, the less he is willing to pay to eliminate it.

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2. Investors who have average risk tolerance, but whose expectations of returns are more optimistic than average, will wish to obtain portfolio insurance.

Institutional investors falling into class (1) might include pension or endowment funds which at all costs must exceed a minimum value, but thereafter can accept reasonable risks. "Safety first" investors would find portfolio insurance attractive on this basis.

Institutional investors falling in class (2) would include well-diversified funds that their managers believe to have positive "α's"—that is, funds that are expected on average to achieve excess returns by virtue of superior stock selection. To exploit these excess returns to equities, but at the same time keep risk within tolerable levels, insured-type strategies are optimal.

Given the large holdings of equities by pension plans, which were charged and regulated as fiduciaries to invest prudently to meet the needs of retirees, portfolio insurance would seem an easy product to sell. Furthermore, continuing appreciation of their equity portfolios would likely drive fund managers to seek to protect themselves against unanticipated declines of their positions. With the peace of mind afforded by portfolio insurance, investors could hold a greater share of their portfolios in equities than they would without insurance.

Even with the large latent demand for portfolio insurance, to profit from selling it, LOR would have to devise a way to produce the insurance. "Insurance" is normally associated with policies to compensate individuals and firms for losses due to death, ill health, fire, accidents, and other calamities. Most "insurers" produce their product through risk sharing and diversification among a large pool of policyholders whose exposures are unrelated to one another. By writing a large number of policies against uncorrelated risks, the insurer can statistically ensure that it can satisfy the demands of its policyholders.

However, sellers of portfolio insurance could not depend on the law of large numbers and diversification to produce their brand of insurance. The insurance policy that investors sought protected them from marketwide movements, systematic risks common to all investors that could not be diversified away. However, new financial technologies, specifically option-pricing technology, initially developed in the academic work of Fischer Black, Myron Scholes, and Robert Merton in the first half of the 1970s, provided the key to manufacturing the insurance policies. Mr. Leland and Mr. Rubinstein, as academics studying option pricing, were poised to refine these technologies to meet their perceived demand for portfolio insurance.

Hayne Leland recognized that the insurance that investors demanded was merely a put, and that option-pricing technology had developed a set of instructions whereby puts--as well as calls--could be manufactured. The insight that led to option-pricing models was that an option could be reproduced with a constantly adjusted portfolio of primitive assets (a risk-free asset and the risky underlying asset upon which the option is written.) The models provided a recipe by which a "replicating portfolio" could be created through the continuous adjustment of the portfolio, called "dynamic hedging." Anyone who understood the relatively

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new science of option pricing could follow an investment strategy that could reproduce the payoff to the puts demanded by investors, although the practical issues involved in constructing portfolio insurance were more complicated, as the climate of the late 1980s would demonstrate. The Appendix discusses a simple example of how options could be created by combining stock and Treasury bill investments.

Marketing and Manufacturing Portfolio Insurance in Practice

Despite its elegant rationale, portfolio insurance was difficult for John O'Brien to sell in the early 1980s. LOR's portfolio insurance product allowed its clients to pay to determine the level of risk they would bear. LOR's risk-return engineering differed sharply from traditional investment management products, which tried to outperform the market without a commensurate increase in risk. All the LOR principals, in particular John O'Brien, spent an enormous amount of time between 1981 and 1984 educating pension fund managers. LOR faced hurdles selling its product even to those investors with an interest in averting a drop in their portfolio's value. Some potential buyers were skeptical of the complex mathematics underlying the concept and feared that the dynamic trading strategy just would not work. Others claimed that portfolio insurance was too expensive and, in its initial form, cumbersome for fund managers because of the need to frequently rebalance stocks. Still others were skeptical of making a major nontraditional investment with a new untested firm.

"Perfect" replication of an option demands continuous adjustment of a portfolio in response to changes in stock price and the remaining time of the option, among other variables. Practically, however, continuous adjustment and the infinite number of buy and sell transactions entailed made *perfect* replication prohibitively expensive because of transaction costs. Managing these transaction costs created a situation in which skill and computer algorithms regarding the timing of rebalancing became critical. LOR monitored the parameters of its clients' portfolio to determine risk and weighed the costs associated with the necessary adjustments against the value of having the portfolio continuously match the characteristics of the clients' desired option.

Even with imperfect replication, dynamic hedging required frequent rebalancing. In its initial implementation, LOR's portfolio insurance programs involved buying and selling shares as described in part (3) of the Appendix. For example, a fall in stock prices would trigger LOR's program to call for the portfolio to sell shares. LOR would transmit this information to its client, who would then be required to buy or sell a fraction of his or her portfolio in order to continue to produce the desired put. These adjustments were a practical nuisance and costly (because of bid-ask spreads and other transaction costs) to potential clients of LOR. LOR could not execute the transactions to create the put itself because it was impractical to maintain a massive short position, called for by its models, in a basket of 500 stocks.

The business took off slowly because of the complications in producing and marketing LOR's portfolio insurance product. In early 1984, the firm was running pilot programs that provided portfolio insurance against approximately $350 million in equity assets.

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A significant turning point in LOR's business came in 1984, when two events dramatically altered the manufacturing and marketing of portfolio insurance. First, a forward-thinking vice president at Kidder Peabody, R. Steven Wunsch, urged Hayne Leland and Mark Rubinstein to use futures for their dynamic hedging techniques. Index futures had started trading on the Chicago Mercantile Exchange in April 1982 and investors were still learning their potential applications.[11] Both Leland and Rubinstein knew that, in theory, futures could be used as part of the dynamic replication strategy, but they were hesitant to market portfolio insurance as a product dependent on the relatively new index futures products. Index futures could be used in dynamic hedging to substantially reduce the transaction costs associated with adjusting exposures. It was believed that the cost of using futures to adjust a portfolio was considerably less than the cost of buying and selling stocks.[12] In addition, the use of index futures would allow LOR to control clients' equity exposure in a noninvasive overlay fashion, without having to ask the client to buy or sell stocks.[13] The client would deliver to LOR cash equivalent to a fraction, say 4%, of the insured portfolio's value. LOR could then use this pool of funds to dynamically create puts by adjusting its portfolio of index futures. This implementation of portfolio insurance implied a subtle change in the LOR product: it would now almost exclusively insure against moves in major indices such as the S&P 500 and not write puts against clients' particular baskets of stocks.

The second significant event in 1984 occurred when the Manville Corporation requested that LOR set up a portfolio insurance program for its pension fund. Until this date, LOR had implemented only small pilot programs for clients. The Manville Corporation was involved in bankruptcy proceedings in 1984 related to its asbestos liabilities.[14] It had a talented group of portfolio managers who had successfully built up a surplus of assets in its pension fund. The Creditor's Committee for the bankruptcy proceedings wanted to lock in this surplus by selling the stock and investing the entire pension fund in Treasury securities. The creditors were concerned that if the pension fund was kept in equities, the surplus could be lost through a potential market decline. Manville's management, however, did not want to dismantle their successful portfolio management system. They asked LOR if they could use a portfolio insurance strategy on the fund as a whole to protect the surplus against drops in the broad market, yet still afford them the ability to actively manage the fund for positive

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11. A futures contract is similar to a forward contract in that it is an agreement to buy or sell an asset for a specified price on a specified date. Trading takes place on organized exchanges. A futures contract is different from a forward contract in that parties to a futures contract must deposit an initial margin or deposit margin as soon as the contract is executed. The contract is then marked to market each day, and a variation margin is calculated. This variation margin is paid to the exchange's clearinghouse by the party showing a loss and credited to the party showing a gain. Index futures are futures contracts based on the performance of an underlying stock index, such as the S&P 500 Stock Index. The S&P 500 Index futures contracts are priced at 500 times the value of the S&P 500 Index and are settled in cash, not by the delivery of the underlying asset.

12. LOR estimated that bid/ask spreads on S&P 500 Index futures were 1 to 2 ticks (5-10 cents on an underlying value of $250, or 2-4 basis points), in contrast to spreads of about $.25 on an average $40 stock (60 basis points). Commissions were about 3-5 cents per share for stocks (10 basis points) and $20 to $30 round trip (2 basis points) for a futures contract.

13. Buying a portfolio of stocks that is comparable to the index and simultaneously selling an index futures contract creates a hedged portfolio because the futures contract fixes the selling price. When setting up a synthetically hedged portfolio using short futures, the portfolio manager holds the entire amount of the portfolio in the index and then sells index futures to replicate the desired portfolio of Treasury bills and the index. When the index rises, the investor reduces his synthetic bill position by buying futures contracts. When the index falls, the investor increases his synthetic bill position by selling futures contracts.

14. Until the mid-1980s, Manville mined and sold asbestos for use in insulation, building, aerospace, and other industries. Throughout the 1980s, Manville was enmeshed in substantial litigation brought by asbestos workers with claims on the effects of working with the material. This litigation as well as poor operating performance led the company to file for protection under Chapter 11 of the U.S. Bankruptcy Code on August 26, 1982.

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appreciation. LOR implemented a program for the entire $350 million portfolio, using S&P 500 Index futures. This program doubled the value of assets under LOR management from $350 million to $700 million.

When Manville's management announced to their bankers that they had hired LOR to implement a portfolio insurance program on the entire pension fund, the response was lukewarm. Manville's lead banker, J.P. Morgan, was particularly displeased that Manville, a long-standing client (since the early 1900s), would hire a relatively unknown firm to provide this new investment service. Despite their displeasure, J.P. Morgan was sufficiently impressed with the concept of portfolio insurance that it sought and received a mandate to supply 20% of Manville's portfolio insurance needs.

The LOR principals could do little to prevent rivals from producing similar portfolio insurance products. The basic ideas underlying the product were well described in the academic literature and could not be patented.[15] Furthermore, because potential customers were hesitant to entrust their assets to an unknown trading strategy, LOR's marketing presentations included a great deal of detailed information on their trading strategies. Hayne Leland recalled in one instance, watching in dismay as a competing firm used slides and a precise example virtually identical to those used in LOR's presentation.[16]

Nevertheless, the entry of prominent firms into the portfolio insurance business lent credibility to the concept and permitted LOR to enjoy a share of the rapidly growing business. LOR would benefit not only from the entry of large firms into the portfolio insurance business but from their exit as well. One large financial institution made a strategic decision to stop selling portfolio insurance and to concentrate on other businesses instead, referring many of its portfolio insurance customers to LOR.

From 1984 to 1987, as the equity market essentially doubled, portfolio insurance grew explosively, reaching an estimated $75 billion to $100 billion in insured assets in precrash 1987 (see **Exhibit 3**). It was one of the hottest money management products of the mid-1980s. An investment program manager at one company said, "You can't help but be familiar with it if you answer your phone."[17] Although it did receive some criticism for being too expensive a strategy, the argument for portfolio insurance was that with dynamic hedging, a portfolio can hold riskier securities and therefore reap higher returns than before. One fund manager explained that, "Since you're protecting yourself from severe market losses, you can take on additional risk with respect to asset allocation, increase your equity exposure and increase your beta."[18]

As the competition accelerated and firms like Morgan Stanley, Bankers Trust, Chase Investors Management, and Kidder Peabody entered the business, LOR's principals knew that

15. For the most part, the intellectual property underlying new financial products can not be patented. For a discussion of protecting intellectual property in the financial services sector, see C. Petruzzi et al., "Patent and Copyright Protection for Innovations in Finance," *Financial Management* 17 (1989), pp. 66-71.
16. See Bernstein (1992), pp. 283-284.
17. Barbara Donnelly, "Is Portfolio Insurance All It's Cracked Up To Be?," *Institutional Investor*, November 1986, p. 125.
18. Trudy Ring, "Cash, Futures Methods Used: Hedging Growth 'Dynamic.' " *Pensions & Investment Age*, November 25, 1985, p. 22.

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their small firm did not have the distribution power to fully benefit from the product they had commercialized. Consequently, in 1985, they decided to license their portfolio management systems to other financial services firms and found two willing licensees: Aetna Life Insurance Co. and Wells Fargo Investment Advisors, among others. LOR provided software, substantial employee training, and assistance in the preparation of marketing presentations. Aetna used this information to market its own branded version of portfolio insurance, Guaranteed Equity Management (GEMs), and Wells Fargo referred to its product as its Hedged Core Strategy. LOR received advance fees as well as fees based on the size of its licensees' assets under portfolio insurance. Licensing grew in importance for LOR and, by 1987, $45 billion worth of assets was covered under portfolio insurance through these arrangements, as compared with $5 billion in assets covered directly by LOR programs.

Initially, the standard portfolio insurance contract provided its purchasers with protection over a fixed period (typically, three years). LOR would set up a trading strategy to produce a three-year at-the-money put on a broad index, such as the S&P 500 Index. LOR estimated the total cost of hedging to be 3% to 4% of the client's portfolio for a three-year period. They would not request the full amount up front, but rather a line of credit for the total cost that could be used as needed. This cost was akin to the premium on a traditional insurance policy or equal to the premium on a put. The funds would be used either to invest in Treasuries or to cover margin requirements on futures positions. In addition, the client would pay LOR an annual fee based upon a declining scale related to asset size for managing the portfolio insurance trading strategy portfolio.[19]

Over time, LOR developed a variety of alternative portfolio insurance products. Although three years was the standard fixed-term product, they sold insurance for other terms. Clients would sometimes choose an out-of-the-money exercise price for their insurance protection levels, in effect having a "deductible" on their insurance policies in order to reduce the premiums they would need to pay. Furthermore, clients would often ask LOR to adjust the insurance level, or strike price, of their protection as the market moved. For example, if a portfolio insurance contract was written at-the-money, but, later in the year, the equity market rose by 20%, the holder of the contract would have no protection against the drop in the market from the existing level to the previously set protection level. Therefore, as the equity market rose, as it did through most of the 1980s, clients routinely asked LOR to change the protection level. This new level of protection would typically require a larger deposit by the clients (a higher premium), but the LOR management fee normally would not change.

Perhaps the most important innovation was the creation of perpetual portfolio insurance. In a fixed-term portfolio insurance contract, the buyer has full protection for the life of the contract and then no protection afterward. For most pension fund sponsors, which face very long-lived liabilities consisting of future payments to pensioners, fixed-term insurance is less attractive than policies that promise perpetual protection. Leland and Rubinstein devised a perpetual policy to meet the needs of these equity investors and, by 1987, perpetual policies accounted for approximately half of the firm's portfolio insurance business.

19. For example, the annual fee schedule for a $100-million account would be $150,000 (15 basis points), whereas for a $200-million account the schedule would be $250,000 (12.5 basis points). The average LOR account prior to 1987 was approximately $275 million and the average annual management fee was about $225,000 (8.2 basis points).

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In addition, LOR offered portfolio insurance customers an optional product called "jump protection," which in effect protected the investor against large sudden shifts in the index's value. This additional insurance typically gave LOR's customers protection against 3% to 5% jumps in the S&P 500, which would have reflected relatively large daily jumps—before 1987.

The Market Crash of October 1987

Although portfolio insurance enabled fund managers to manufacture a customized insurance product, the manufacturing process was not flawless, as Mr. Rubinstein's and Mr. Leland's own academic writings recognized. If there were very large jumps in stock prices, discontinuous adjustment became a significant concern because the replicating portfolio would fail to mimic a protective put. In the extreme, the dynamic replication process would break down altogether if the fund manager did not have access to an active and orderly market. Furthermore, it was critical that the futures market and the stock market move systematically together, because the futures contracts were traded as a substitute for buying and selling stocks.

Many of these problems became critical on October 19, 1987, "Black Monday," when the Dow Jones Industrial Average plunged a record 508 points, or 22%, and the S&P 500 dropped 57.6 points, or 20.5%. On this chaotic market day, portfolio insurers could not execute all of the necessary trades called for by their computer models. LOR, on October 19, was able to execute perhaps a third of its program's instructions. Furthermore, it discovered at the end of the trading day that its execution was only a fraction of the planned levels. As a result, the replicating positions deviated from those of the puts it had sought to create. The users of portfolio insurance therefore had only partial protection against the crash. LOR estimated that its clients were protected against 80% of the drop, but because of imperfect dynamic replication, they were forced to bear 20% of the decline in the market.[20]

Portfolio insurance was implicated in the crash by a wide circle of critics, ranging from members of the press to the Presidential Task Force on Market Mechanisms, which produced the Brady Report. Hayne Leland was called before the Brady Commission to testify. Almost instantly, LOR and portfolio insurance--the darlings of the 1980s' investment community--became scorned. The press carried overwhelmingly negative reports, including comments such as: "I suppose portfolio insurance is O.K., if you put a sign on it saying, `Beware: causes cancer'" and "Portfolio insurance has replaced [index arbitrage] as everyone's favorite scapegoat [for the crash]."[21]

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20. Hayne Leland recounted that the rapid rebound of the markets on Tuesday and Wednesday was as trying for portfolio insurance accounts as the drops in the equity market. In particular, as the index rose on Wednesday, the large short futures positions in their clients' portfolio insurance accounts, which LOR was finally able to place on Tuesday, demanded that the clients post additional margin. To raise funds to post these margins within one day (the standard settlement in futures markets), fully invested clients would need to sell shares to raise funds. Because equity transactions settle in five days, immediate sales of equity would not generate cash soon enough to meet the timing of needs generated by the futures program. Investors were forced either to find other sources of cash or to settle on special terms and receive lower prices for their equity sales.
21. Evan Sminoff, "If You Have to Point a Finger, Aim It At Portfolio Insurance," *Investment Dealers Digest*, March 7, 1988.

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The Brady Report claimed that during October 14 to 16, the Dow fell by over 250 points because of news regarding foreign trade and proposed tax legislation, yet it maintained that the market's decline was accelerated by portfolio insurers and others that were selling in reaction to the price-insensitive mechanical dictates of their models.[22] In addition to the pressure directly created by portfolio insurers, a small number of aggressive trading-oriented institutions such as hedge funds and investment banking houses created downward pressure by profiting from the portfolio insurers' situation. The aggressive trading institutions understood that the portfolio insurers and mutual funds were falling behind in their selling programs, thus presenting an opportunity for the traders to sell in anticipation of the forced selling by portfolio insurers and mutual funds, with the prospects of repurchasing at lower prices. The Brady Report claimed that when the market opened on Monday, October 19, these forces combined to create massive selling pressure.

Like LOR, most portfolio insurers adjusted their stock-cash ratios by trading index futures. In fact, several portfolio insurers were authorized to trade only futures and had no access to their clients' stock portfolios. The Brady Report found that throughout the morning of October 19, index arbitrage had succeeded in transmitting the heavy futures selling by portfolio insurers and others back to the stock market. In the early afternoon, however, index arbitrage slowed because of concerns about delays in the DOT (Designated Order Turnaround) System (the New York Stock Exchange's automated transaction system used by index arbitrageurs to link the stock and the futures markets) and the consequent ineffective execution of basket sales. The result of this reduction in index arbitrage was that enormous discounts of futures relative to stocks were free to develop as the futures market plummeted, disconnected from the stock market (See **Exhibit 3** for the prices of the S&P 500 Index and Index futures contracts on October 19, 1987, and the purchases and sales by portfolio insurers). The appearance of this dysfunctionally large discount inhibited buyers in the stock market. With these stock buyers gone, the Dow sank almost 300 points in the last 75 minutes of trading, to close down 508 points. Portfolio insurance futures selling continued, even after stocks closed.

In conclusion, the Brady Report claimed that reactive selling by institutions, which followed portfolio insurance strategies and sought to liquidate large fractions of their stock holdings regardless of price, played a prominent role in the market break. It further claimed that the formulas used by portfolio insurers dictated the sales of $20 billion to $30 billion in equities throughout the week.

Mark Rubinstein responded in print to the criticism of portfolio insurance.[23] After establishing that the crash undermined the preconditions of low transactions costs and price continuity, Rubinstein argued that the dependency of portfolio insurance strategies on these preconditions should have been well known to both those marketing the strategy and those using the strategy on their own portfolios. He added that users of portfolio insurance lost less than those without insurance and rebutted claims that portfolio insurance caused or exaggerated the decline.

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22. The typical portfolio insurance model called for stock sales in excess of 20% of a portfolio in response to a 10% decline in the market. With the market already down 10%, portfolio insurance models dictated that, at a minimum, $12 billion (20% of the estimated minimum of $60 billion in assets covered by portfolio insurance) in equities should already have been sold. Less than $4 billion in aggregate had in fact been sold.

23. Mark Rubinstein, "Portfolio Insurance and the Market Crash," *Financial Analyst's Journal*, 1988.

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Despite Rubinstein's defense, the harsh criticism that portfolio insurance received wrought severe damage to LOR's business and to the careers of some of its clients. Because portfolio insurance was generally thought to be destabilizing to the market, few firms wanted to be associated with it. Within a few months, LOR's assets under management and through licensing arrangements shrank from approximately $50 billion to $10 billion. Immediately after the crash, litigation seemed imminent, and John O'Brien recalled that "we felt a little like the witches of Salem." The thought of just "folding up shop" even crossed the minds of the principals at LOR.[24]

LOR's Next Chapter

While LOR was considering its alternatives after the crash, it quickly focused on three observations: (1) pension fund managers were trading entire portfolios more frequently than individual stocks (see **Exhibit 4** for the growth in pension funds and investment index funds); (2) investors had serious credit concerns regarding using the futures markets (during the crash, a number of people were frightened when the index futures market disconnected from the stock market and futures discounts of up to 20 index points developed); and (3) the crash may have actually increased institutional *desire* for insurance, but reduced its appetite for the manufacturing of this insurance through a dynamic trading strategy.

Based on these observations, LOR was confident that the postcrash investment community would buy two products. The first was an index security that an investor could use to trade an entire investment portfolio at once without making hundreds of separate trades and without using the futures markets. Reinforcing LOR's observed demand for an index product was the Brady Report's challenge to exchanges to develop a basket security that would allow trading without engaging in the futures markets. Second, the continued demand for the functional product of insurance would likely be satisfied by another type of manufacturing process. It was clear that this new product could not involve futures or dynamic trading and it could not depend on the creditworthiness of a particular financial intermediary, whose future appeared tenuous at times in October 1987. Instead, the product would best be delivered in the form of a collateralized put option, that is, a put option backed by a buy-and-hold portfolio.

The principals at LOR believed that if they could create a system whereby an investor could trade an index security and *also* trade collateralized puts on the market, investors would flock to it and the firm would once again flourish. When attempting to design a set of securities to satisfy the perceived needs of institutional investors, two related equity-index security designs attracted their attention. In both, a pool of assets was assembled against which a variety of securities were carved out, much as if pools of mortgages were bundled together and then broken apart to form collateralized mortgage obligations.

24. Hal Lux, "LOR's Big Gamble on SuperShares." *Investment Dealers' Digest*, November 30, 1992, p 12.

The first idea was suggested by a Berkeley colleague, Professor Nils Hakansson. In a 1976 article in the *Financial Analysts Journal*, Hakansson proposed a new type of financial intermediary, a purchasing power fund, which offered a "novel, simple, apparently feasible and above all flexible means for smaller investors especially to own the kind of slice of their nation's real assets that they perhaps always wanted to have--but were afraid to ask for."[25] The assets of this purchasing power fund, the superfund, would consist of a portfolio of basic securities (e.g., S&P 500 stocks), against which the superfund would issue "supershares." Mark Rubinstein describes Hakansson's elegant supershare design as follows:

> A supershare is a security, which on its expiration date entitles its owner to a given dollar value proportion of the assets of the superfund, provided the value of those assets on that date lies between a lower and an upper value. Otherwise, the supershare expires worthless.[26]

With a supershare, an investor could buy a security that would pay off approximately $1.00 if the S&P 500 was in a narrow band, say 400 and 410, and nothing if the S&P was outside of this band. By combining various patterns of supershares, an investor could create virtually any payoff desired, including default-free bonds, a stock market index, a short position in an index, calls, and puts. Mark Rubinstein and co-author John Cox wrote about the superfund concept in glowing terms:

> The superfund is an exciting financial concept. Its successful introduction might dramatically alter and streamline existing financial markets. We would be delivered from the chaos of existing securities to their natural building blocks. Hakansson has compared the investment positions in supershares to chemical formulas relating molecules to their constituent elements.[27]

The superfund was an elegant, but untested, financial product. A more mundane but successful financial set of securities that bore some resemblance to the supershares were "Primes" and "Scores," which were issued in the 1980s. The Americus Trust program deposited shares of common stock of firms into trusts that would be terminated at a pre-specified date, with each trust holding only the shares of one firm. Against each of these trusts, Americus Trust issued two separate claims. Holders of "Primes" received all of the dividends over the life of the trust, plus a payoff at the termination of the trust equal to the lesser of a pre-specified termination claim and the market value of the stock as of the termination date. For example, Primes on Merck common stock were scheduled to receive the dividends paid on Merck common stock through the expiration of the Trust. On April 14, 1992 (the termination date) the holder of the Prime would receive the lesser of $200 (the termination claim) or a share of Merck common stock. The holder of "Scores" received no payment until the termination date, at which time the Score-holder received the excess of the stock price over the termination claim of the Prime, if any. Primes and Scores were traded on the American Stock Exchange.

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25. Nils H. Hakansson, "The Purchasing Power Fund: A New Kind of Financial Intermediary," *Financial Analysts Journal*, (November-December 1976): pp. 49-59.
26. Mark Rubinstein and John C. Cox, *Options Markets* (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1985) pp. 461-468.
27. Ibid. pp. 461-468.

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By 1987 an unfavorable tax ruling had shut down any attempts to create new Americus Trusts, because the dividends paid to the Trusts were deemed taxable both to the Trust and to the Prime-holders. Nonetheless, the popularity of the existing grandfathered Score and Prime securities--in effect, collateralized calls and covered calls--provided inspiration to the LOR principals. Where Hakansson's superfund concept was elegant, it was likely to be impractical to execute. The Americus Trust example could be implemented, but did not quite deliver the full set of securities that the principals felt the market demanded.

As they ruminated about the design of the product that would, they hoped, reestablish LOR as the preeminent vendor of sophisticated investment management products, the three men recounted the change in competition in the six years they had worked together. In 1987, index futures and index options were traded on major exchanges. Equity-derivative desks of major investment banks were eager to create customized products for their clients. The financial technology that had formed the base for LOR's success was now widely disseminated throughout Wall Street. Investors had become increasingly sophisticated and insisted that costs not be excessive. Nevertheless, with the technical skills of Hayne Leland and Mark Rubinstein, the marketing savvy of John O'Brien, and the contacts they had made in the six years of doing business—if combined with a good idea and no major obstacles--the principals were optimistic that they could get LOR back on track. The task at hand was to brainstorm about what products to offer and how LOR could create them.

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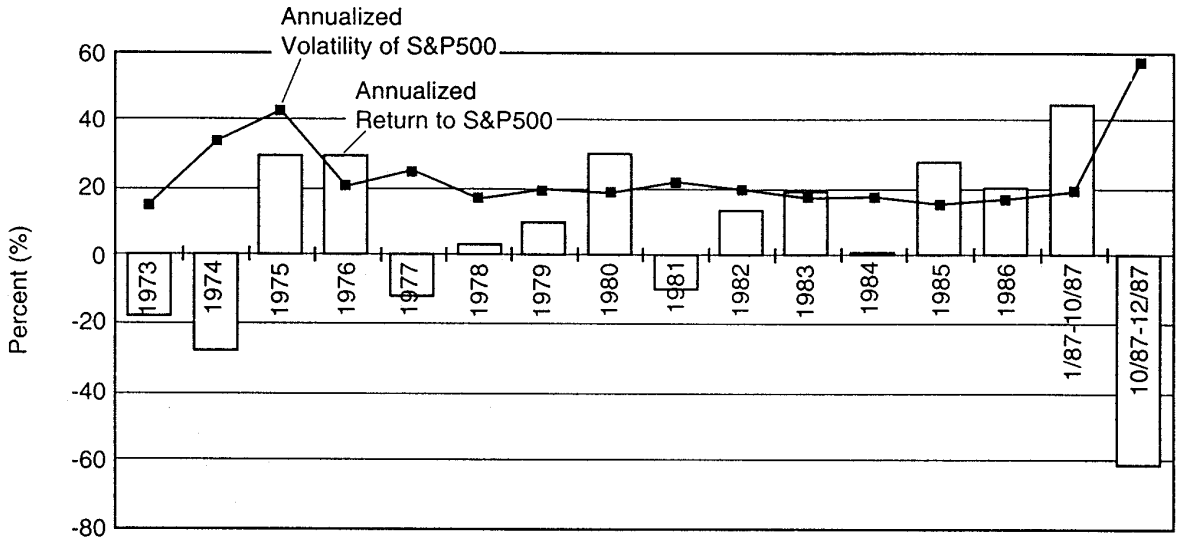
Exhibit 1 Return and Volatility of the S&P 500 Index (1973-1987)



Source: Annualized return on S&P calculated by casewriter. The negative 63% return for 10/1/87-12/31/87 period is an annualized return; the actual decline in the Index for the 3-month period was approximately 16%. Volatility is taken from Report of the Presidential Task Force on Market Mechanisms, January, 1988, p. 11-6. Volatility represents an average of 60-day annualized volatilities.

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Exhibit 2 LOR Portfolio Insurance Programs

Year End	1981	1982	1983	1984	1985	1986	1987 through September
Total LOR employees	3	5	5	9	15	25	35
Assets protected directly by LOR portfolio insurance programs (millions of dollars)	30	250	350	850	1,500	3,000	5,000
Assets protected by LOR-licensed portfolio insurance programs (millions of dollars)	0	0	0	0	13,500	27,000	45,000
LOR fees generated from direct portfolio insurance programs[a] (thousands of dollars)	24	247	629	983	1,300	2,600	4,000
LOR fees generated from licensing programs[b] (thousands of dollars)	0	0	0	0	250	2,000	4,000

a. The approximate formula used to calculate fees for direct programs was based on a percentage of the market value of the portfolio's assets. The annual fees were .2% of a $0- to $50-million portfolio, .1% of a $50- million to a $250- million portfolio, .05% of a $250- to a $500- million portfolio, and .025% of portfolios greater than $500 million.
b. Licensee rates were essentially half the schedule for direct accounts.

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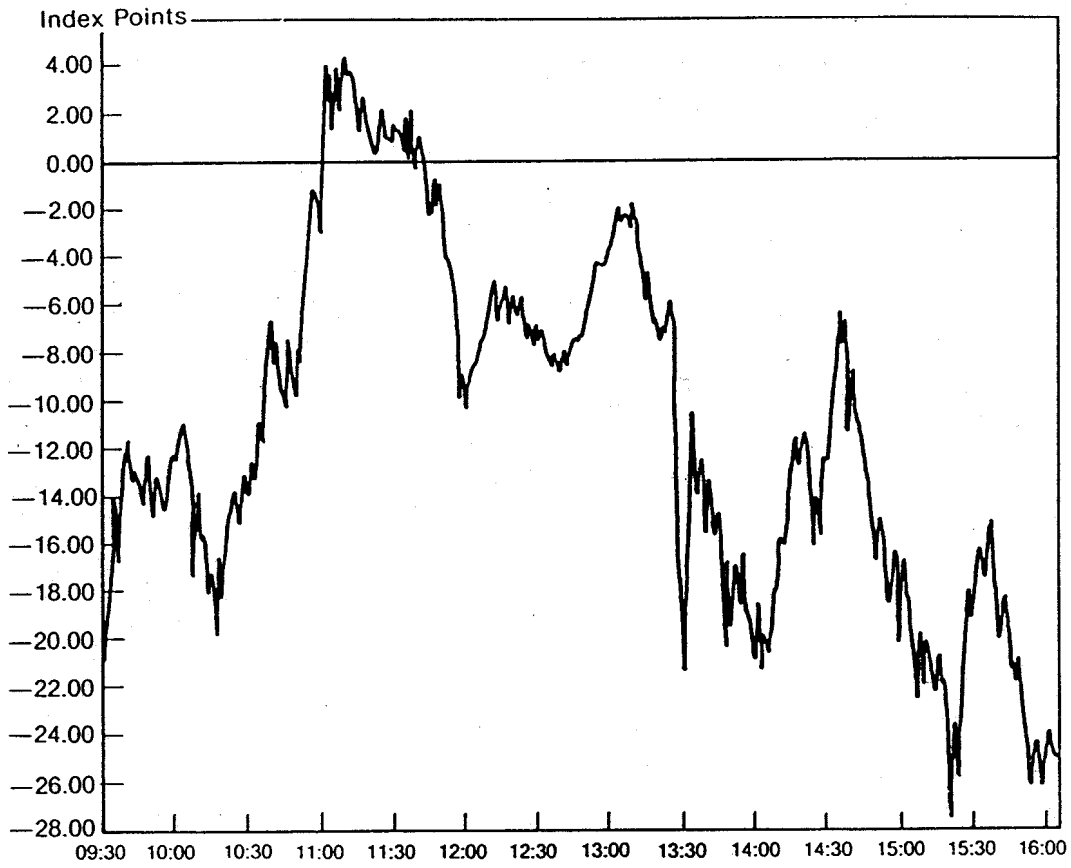
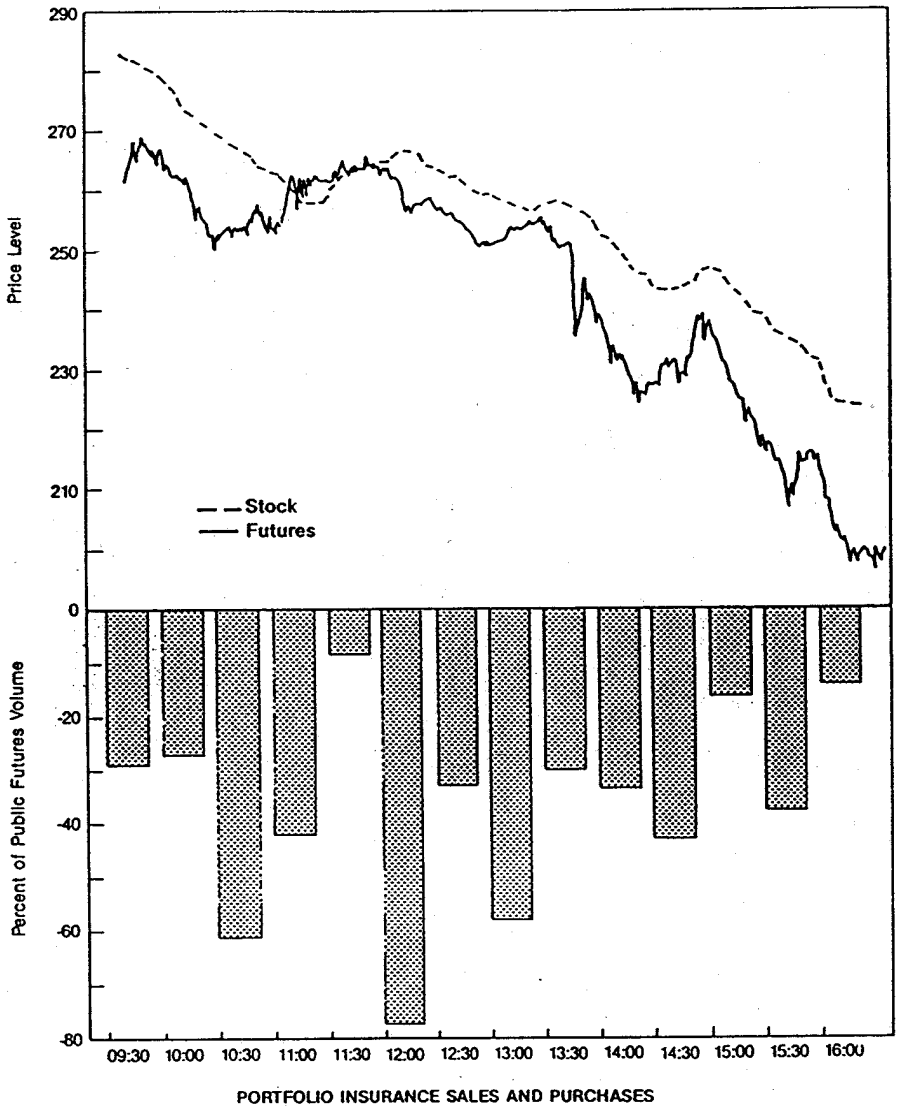
Exhibit 3 Panel A: S&P Index and Futures Contract Spread: Monday October 19, 1987[a]



Source: Report of The Presidential Task Force on Market Mechanisms, January 1988.

a. The above chart depicts the index point spread between the S&P 500 futures contract and the S&P 500 cash index (futures contract less the cash index) throughout the day of Monday, October 19, 1987. Normally, the price of a futures contract exceeds the price of the underlying portfolio by an amount reflecting the "cost of carry," which relates to the difference between the Treasury bill rate and the dividend yield on the portfolio. The initial drop of the futures contract beneath the S&P Index was largely due to many large stocks that opened late on Monday and whose prices therefore were quoted as the previous day's closing price. Once stocks opened, the futures market tracked the Index relatively closely until about 1:30 p.m., at which point the tremendous delays in the DOT system led to a continuous and "real" discount of the futures versus the S&P 500 Index.

Exhibit 3 Panel B: S&P Index and Futures Contract Price Levels and Portfolio Insurance Sales and Purchases as a Percent of Public Futures Volume: Monday, October 19, 1987.



Source: Report of The Presidential Task Force on Market Mechanisms, January 1988.

The above chart depicts the divergence of the S&P 500 Index from the S&P 500 Futures throughout October 19, 1987. Additionally, it emphasizes the magnitude of portfolio insurance sales and purchases of S&P 500 Index futures as a percentage of total S&P 500 Index futures volume. The Brady Report maintained that the market's decline was accelerated by portfolio insurers selling in reaction to the price-insensitive mechanical dictates of their models.

Exhibit 4 Selected U.S. Equity Markets (1981-1987)

Years	1981	1982	1983	1984	1985	1986	1987
Estimated corporate equities directly held by pension funds (billions of $)[a]	266.3	366.9	458.3	462.0	582.7	703.9	744.0
Estimated value of pension fund equities invested in index funds (billions of $) [b]	6.0	9.9	25.3	26.2	46.6	76.4	92.9
Estimated value of total assets covered by portfolio insurance strategies[c] (billions of $)	.03	.25	.35	1.0	20.0	50.0	100.0
Yearly average open interest in S&P 500 index futures contracts (number of contracts)[d]	-	6,899	25,238	36,312	62,176	100,535	120,632
Yearly average open interest in S&P 500 index options (number of contracts)[e]	-	-	2,230	743	521	86,019	343,642
Yearly average open interest in options on S&P 500 index futures contracts (number of contracts)[f]	-	-	10,829	27,850	38,374	51,220	62,729

a. Federal Reserve, Flow of Funds
b. *The Money Market Directory of Pension Funds and Their Investment Managers*, McGraw Hill, 1982-1988.
c. LOR Estimates.
d. IDC Data Sheet. Each futures contract represents 500 times the S&P 500 Index. Index futures started trading on 4/21/82. Open interest equals the amount that investors with short positions are currently obligated to deliver. It also equals the amount that investors with long positions are currently obligated to receive.
e. Chicago Board Options Exchange. Each contract settles on 100 times the S&P 500 Index. Index options started trading on 7/1/83.
f. Chicago Mercantile Exchange. Each contract settles on one futures contract. Options on Index futures started trading on 1/28/83.

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Appendix

Insuring Portfolios

Suppose an institutional investor held a $100-million portfolio consisting of the S&P 500 stocks, in the same proportion as the index. If this investor wanted to guarantee that at the end of three years the value of the portfolio would be no lower than $100 million but would enjoy rises in the equity market, she could pursue any number of strategies:

1. *Buy a put*: The most straightforward solution would be to buy a three-year at-the-money put on the S&P 500 index for a notional amount of $100 million. Unfortunately, the first exchange-traded S&P 500 options with maturities of three years were not listed until January 1991. An investor could seek to obtain a quote for an over-the-counter put from a financial institution, such as the equity derivatives trading desk of a major investment bank.

2. *Sell the stocks, and buy Treasury notes and calls*: Put-call parity suggests that the combination of a long investment in stocks plus a European put has the same payoff as an investment in riskless assets plus a call on the S&P 500. To execute this strategy, the investor would have to find a counterparty willing to sell long-dated calls.

3. *Manufacture the put, using stock and Treasury bills*: The Black-Scholes model provides instructions for manufacturing options using the underlying instrument (in this example, the S&P 500 stocks) and investments in risk-free assets (such as Treasury bills). A trader can manufacture the put called for by the first strategy[28] by adding to its existing long stock position an incremental short position in stocks and an incremental long position in risk-free assets, and by adjusting this position continuously (in a process called dynamic replication) to ensure that the replicating portfolio has the same change in value in response to changes in small movements in stock price (defined as a position's delta) as does the put being manufactured.[29] As the stock price rises (the put becomes increasingly out of the money), the replicating portfolio contains a smaller short stock position. In effect, the replicating portfolio, like a put, has no equity exposure if stock prices are very high relative to the strike price. However, as the stock price falls (the put becomes increasingly in the money), the replicating portfolio contains a larger short stock position and has greater equity exposure.

   Suppose a client wanted a three-year European-style put, on $100 million of the S&P 500 with an exercise price struck at the existing S&P level. Option-pricing models suggest that this put would cost $3.42 million and could be constructed by setting up an initial short position of $15.9 million worth of stock,

28. This financial technology would also allow the investor to create the call option integral to the second strategy.
29. In the extreme, the entire portfolio of stocks would be sold; however, the investor would never have a net short position in stock.

with $19.3 million invested in Treasury bills, for an initial net investment of $3.42 million in the put position. In the next instant, suppose stock prices were to move either up or down 1%.[30] The put value would change, as shown in **Exhibit A-1**. The new replicating portfolios and the change in the replicating portfolio are also shown on the diagram. Changes in the value of the stock--as well as changes in the life of the option and the risk-free rate--necessitate continuous adjustment of the replicating portfolio.[31] By "delta hedging," the replicating portfolio would be maintained so that at all times it has the same delta as does the put to be manufactured.[32]

To create the put, an investor who did *not* hold the index would sell short $15.9 million of the portfolio's value and invest $19.3 million in Treasuries. As the index falls, and the put becomes more in the money and more valuable, the total investment in the replicating portfolio increases. To maintain the delta of the replicating portfolio equivalent to that of the put, the manufacturer would need a larger short position and an even larger long investment in Treasuries.

An investor with a *preexisting long position* in the S&P would not need to short shares, but could merely sell part of the existing portfolio and invest it in Treasuries (along with additional funds). Market conditions would dictate that, over time, other shares would need to be bought or sold, with the risk-free investment correspondingly adjusted. As a practical matter, portfolios are rebalanced infrequently, with the size of transaction costs influencing rebalancing.[33]

4. *Manufacture the put using stocks and index futures*: The manufacturing process outlined above requires that stocks be bought and sold, necessitating high transaction costs (commissions, bid-ask spreads, and market impact costs.) Furthermore, it requires coordination between the investment manager overseeing the stock portfolio and the advisor running the manufacturing process.

An alternative to manufacturing puts by using short positions in stock and long positions in risk-free securities would be to maintain the entire portfolio in stocks and short index futures. Selling index futures against a long stock position produces a long position in riskless assets called for by the manufacturing strategy given in (3). Using futures, which have transaction costs considerably less than stocks, lowers the manufacturing costs and allows the insurance to be

30. This simplified example ignores dividends paid on the S&P 500 and assumes risk-free rates of 10% per annum and volatility of 20% per annum.
31. For a more thorough description, see Mark E. Rubinstein and Hayne E. Leland, "Replicating Options with Positions in Stock and Cash," *Financial Analysts Journal*, 1981.
32. Other hedging schemes attempt to adjust other exposures. Gamma is the rate of change of the portfolio's delta with respect to the stock price; vega is the rate of change of the portfolio's value with respect to the asset's volatility. By making a porfolio's gamma equal to zero, an investor can reduce the sensitivity of the portfolio delta to fairly large changes in the stock price. By making its vega equal to zero, an investor can reduce the sensitivity of the portfolio to changes in the underlying asset's volatility.
33. For a discussion, see Hayne Leland, "Option Pricing and Replication with Transaction Costs," *Journal of Finance* 40 (1985), pp. 1283-1301.

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manufactured with less coordination between the stock portfolio manager and the insurance program. The insurance program can serve as a transparent overlay to the stock portfolio.

To use futures to manufacture the put, an initial amount of index futures is sold against the entire portfolio. This amount is equal to the delta of the put to be manufactured times a factor equal to exposure of the futures contract for small changes in the change in the stock contract. As the stock index falls (rises), the investor would sell (buy) additional index futures contracts.

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Exhibit A-1: Stylized Replication of a Put Option Using Stock and Treasury Bills

Initial Position

Value of S&P	$ 100.00
Value of Put	$ 3.42
Delta	(0.1590)
Actions Taken to Create Replicating Portfolio	
Short 0.159 shares	$ 15.90
Long Treasuries	$ (19.32)
Net Investment	$ (3.42)

The next instant: S&P Rises 1%

Value of S&P	$ 101.00
Value of Put	$ 3.26
New Delta	(0.1521)
Value of Replicating Portfolio	
-Short stock position	$ (16.06)
-Long treasury position	$ 19.32
	$ 3.26
New Replicating Portfolio	
Short .1521 shares	$ (15.36)
Long treasuries	$ 18.62
	$ 3.26
Actions Taken to Adjust Portfolio	
Buy .0069 shares & deliver against short position	$ (0.70)
Liquidate portion of treasuries	$ 0.70
Net cash outflow	$ 0.00

The next instant: S&P Falls 1%

Value of S&P	$ 99.00
Value of Put	$ 3.58
New Delta	(0.1661)
Value of Replicating Portfolio	
-Short stock position	$ (15.74)
-Long treasury position	$ 19.32
	$ 3.58
New Replicating Portfolio	
Short .1661 shares	$ (16.44)
Long treasuries	$ 20.02
	$ 3.58
Actions Taken to Adjust Portfolio	
Short additional .0071 shares	$ 0.70
Buy additional treasuries	$ (0.70)
Net cash outflow	$ 0.00