

HOW I  
[ BECAME A ]  
QUANT

*Insights from 25 of*  
*Wall Street's Elite*

Featuring Bruce I. Jacobs and Kenneth N. Levy

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# Bruce I. Jacobs and Kenneth N. Levy

*Principals, Jacobs Levy Equity Management*

**O**ur adventures in quantitative equity have been a joint endeavor since 1986, when we cofounded Jacobs Levy Equity Management, now a \$20 billion institutional asset management firm. Even before then, however, our separate paths seemed destined to converge. Perhaps it was inevitable, given our mutual interest in quantitative finance and the narrowness of the quantitative equity field at the time. In any event, our story begins with two separate voices that eventually merge into one.

## Portraits of Two Investors

**Bruce:** As a teenager interested in the stock market, I convinced my parents to let me open a brokerage account to test my own method of investing. I read mutual fund reports to identify which stocks the funds were buying or selling in common. I then did some fundamental and technical analysis on these names and bought two shares each of six different companies to diversify my portfolio. I didn't know it at the time, of course, but this little hobby would ultimately develop into a career.

At Columbia College, I decided to enroll in its three-two program, which meant that I spent three years studying the contemporary civilization and humanities core curriculum, as well as the hard sciences, and then two years at the Columbia School of Engineering. There, I found a home in operations research, which allowed me to study computer science and applied mathematics, including differential equations, stochastic processes, statistical quality control, and mathematical programming. While studying for my master's in operations research at Columbia, I had the opportunity to work at the Rand Institute, where math and computer science were applied to real-world problems. There I was involved in developing a large-scale simulation model designed to optimize response times for the New York City Fire Department.

My interest in applied math led me to Carnegie-Mellon's Graduate School of Industrial Administration, which had a strong operations research faculty. There I studied applications of management sciences in accounting, finance, marketing, and production. I quickly became enthralled with finance, given its mathematical content and emphasis on economic decision making over time and under uncertainty. I earned an MBA at Carnegie-Mellon, and went on to further my graduate education in finance at the Wharton School of the University of Pennsylvania. I eventually earned my master's and PhD there and served on the finance faculty for several years, teaching both undergraduates and MBA candidates. Little did I know that one person in the PhD program was to become a very important part of my future in quantitative equity.

**Ken:** I followed a different path. When I was in my teens, I began investing my earnings from summer jobs in individual stocks, basing investment decisions on fundamental data provided by my father's broker

and on my own handmade price charts. While the stock market moved sideways for the next 15 years, my interest in the market continued to grow.

I had always assumed I would end up working in my family's wholesale distribution business. With that future in mind, I focused my education at Cornell on economics and related liberal arts disciplines. I had a strong quantitative aptitude, however, and my favorite courses were the computer science and operations research offerings from the engineering college. I went on to earn an MBA from the Wharton School, with a major in general management.

MBA in hand, I joined the family business, using my quantitative skills and knowledge to design systems for sales forecasting and inventory control, writing computer code for the entire operation. (This was in the days before off-the-shelf software for these tasks was available at the local office supply store.) After five years of this, I was out of challenges and needed a change. My father—who was also my boss—encouraged me to pursue my passion for finance and the stock market.

I enrolled in the doctoral program at Wharton, where I earned a master's upon completing the coursework and qualifying exams for the doctoral program. At that point, I decided I had gained enough skills to test the waters back in the real world. The Wharton School's job placement center had little experience placing PhD students in the financial industry. One of my professors, however, noted that another Wharton faculty member, Bruce Jacobs, was exploring a similar path.

## New Concepts, Foggy Ideas

**Bruce:** I remember coming home from my first semester at Wharton and being asked by my father, "What did you learn so far?" I responded, "I've learned three things, and this is all there is to know about finance. First, there's something called the *efficient market hypothesis*, which says that the markets are efficient and it's impossible for an investor to outperform the market. Second, there's something called the *capital asset pricing model*, which says that all you need to know about stocks to be an investor is a stock's beta, its sensitivity to market moves. Third, there's something called *Modigliani-Miller*, which says that the choice of a firm's capital

structure, its debt to equity ratio, doesn't matter." My father then asked me what I was going to do with this knowledge. "I haven't the foggiest idea," I said.

The efficient market hypothesis was, of course, all the rage in academia at the time. Way back in the 1930s, Benjamin Graham and David Dodd began to systematize security valuation, spawning the thought that investing had more in common with science than with the local numbers racket. By the 1950s, Harry Markowitz was turning portfolio construction into a disciplined endeavor. The academic scene exploded in the 1960s with seminal ideas like the capital asset pricing model, and in the 1970s with arbitrage pricing theory and the Black-Scholes-Merton option pricing formula.

In 1965, the University of Chicago's Eugene Fama published "The Behavior of Stock Prices," which laid the foundation of the efficient market hypothesis. Fama theorized that stock prices fully and instantaneously reflect all available information. In the same year, Paul Samuelson at MIT published his "Proof that Properly Anticipated Prices Fluctuate Randomly," which showed that, in an efficient market, price changes are random and thus inherently unpredictable. Burton Malkiel at Princeton later popularized these views in *A Random Walk Down Wall Street*, published in 1973.

Academic analyses of the burgeoning amount of available data seemed to support market efficiency. Computer-enabled dissections of actual market prices suggested that price changes followed a random walk. Furthermore, Michael Jensen, one of Fama's doctoral students, analyzed mutual fund performance from 1945 to 1964 and found that professional managers had not outperformed the market.

If one could not predict security prices, active management was futile. The solution seemed to be to shift the emphasis from security selection to constructing portfolios that offered the market's return with the market's risk. Requiring no security research and little trading, these portfolios could capture the long-term upward trend in overall stock prices. Low-cost, passive index funds were born.

The efficient market hypothesis prevailed in academia during the 1970s, and Wharton was no exception. Many of the school's faculty held doctorates from the University of Chicago and had been students of Fama. They tended to discourage doctoral theses that contradicted

the theory. I cast my own thesis in efficient market terms. (Much later, I realized that this thesis constituted the beginnings of my thinking on the earnings accrual anomaly, which would be modeled and put to work at Jacobs Levy Equity Management.)

The prevalence of this ivory tower thinking made it difficult for quants to find jobs on Wall Street in the early 1980s. This was many years before Fischer Black and other “rocket scientists” became fixtures on the scene, and the Street didn’t know what to do with PhDs. Security analysis was still largely the realm of fundamental analysts parsing accounting reports and visiting companies. Fortunately, Prudential Insurance Company was willing to hire quants in asset management.

I did not know that, after leaving Wharton, Ken had landed a job in the equity management department at Prudential. We quickly reconnected. In our early days at Prudential, we found the organization as a whole reluctant to use quantitative methods and averse to innovation. Over time, there was more tolerance and, eventually, even support. I was able to carve out a new Prudential affiliate focused solely on quantitative investing, and this gave Ken and me the opportunity to work together.

***Bruce and Ken:*** In this affiliate, we used commercially available tools, such as those provided by Barra, to construct equity portfolios. At the time, most of these tools were directed toward risk management. Portfolio risk management is a critical aspect of consistent performance, and one we have emphasized a great deal in our own work. It does not address, however, the burning issue of how to identify securities that will outperform in the first place.

Neither of us believed in the efficient market hypothesis and the impossibility of superior performance. We knew the power of quantitative methods. We were familiar with the statistical tools needed to analyze security prices and market behavior. And by the early 1980s, cracks were beginning to develop in the wall of market efficiency, cracks that hinted at the promise of superior performance.

New academic studies showed that certain types of stocks did perform better than the market average. Higher returns seemed to accrue to firms with smaller-than-average market capitalizations. Analysts tend to neglect such stocks, compared with larger-cap securities, and neglected stocks also tended to outperform.

Stocks with lower price/earnings ratios were found to perform better than stocks with higher price/earnings ratios, while stocks with lower price/book ratios performed better than those with higher price/book ratios. In some studies, low price itself seemed to herald high returns.

Empirical evidence indicated that stocks whose earnings estimates had recently been upgraded by analysts tended to produce above-average returns, perhaps because of behavioral reasons such as analysts' tendency to herd or their aversion to making substantial revisions in estimates. Researchers also found that earnings surprises tended to produce excess returns, and that negative surprises had a greater effect on stocks with high expected earnings growth than on those with low expected earnings growth.

These findings were anomalies within the context of the efficient market hypothesis. Not only did they suggest that beta alone was insufficient to understand stock returns, they also indicated patterns of stock price behavior that investors could have exploited to earn above-average returns. But if profits were to be had simply by buying low-price/earnings stocks or small-capitalization stocks, why weren't smart investors able to perform better than the market on a consistent basis?

We founded Jacobs Levy Equity Management in 1986 because we thought we had some unique answers to this question and might be able to develop the means to take advantage of our insights for the benefit of clients. To accomplish this, we needed an environment that would be conducive to the type of dedicated, deep research we had previously done at Wharton. This required giving up our responsibilities at Prudential, and our incomes.

## **The Jacobs Levy Investment Approach**

Our investment approach is based on a philosophy of *market complexity*. We believe the equity market is not simple or ordered in such a way that a simple rule such as "buy low price/earnings stocks" or "buy small-cap stocks" delivers consistent profits; nor is the market totally random, hence unpredictable. Rather, equity market returns are driven by complex combinations of company fundamentals, economic conditions, and behavioral factors.

We believe security prices respond to numerous fundamental factors, including price/earnings ratios, expected growth rates, and analysts' earnings estimates, and to economic factors such as interest rates. Prices also respond to behavioral elements such as investors' tendencies to overreact to news, their desire to seek safety in numbers, and their selective memories. It is possible to detect these responses and to design stock selection models that can exploit them in order to deliver superior returns.

Doing so is not easy, however. Return-predictor relationships are likely to differ across different types of stocks. Because there are more financial firms among value stocks than growth stocks, for example, value stocks can be more sensitive than growth stocks to changes in interest rate spreads. Earnings estimate revisions and earnings surprises, by contrast, are more important for growth than for value stocks. So Google shares can take a nosedive when earnings come in a penny under expectations, while Bank of America shares are hardly affected by such a disappointment.

Once modeled, return-predictor relationships are likely to change over time. The world is constantly evolving, and old inefficiencies can disappear, giving way to new ones. Merely tilting a portfolio toward historical anomalies does not produce consistent performance. It takes ongoing research on new inefficiencies, new sources of data, and new statistical techniques to keep an investment approach in synch with evolving opportunities.

Finally, return-predictors are often correlated with each other. Small-cap stocks tend to have low price/earnings ratios, and low price/earnings ratios are correlated with high yield. Also, certain attributes may be correlated with industries. A simple high-yield screen will select a large number of bank and utility stocks. Such correlations can distort naïve attempts to relate returns to potentially relevant variables. Our seminal insight was *disentangling*: by modeling numerous potential return-predictor relationships in a way that takes interrelationships into account, a more accurate picture of the return predictors emerges.

## **Benefits of Disentangling**

Perhaps we should have called our firm Jacobs Levy Equity Research, since we spent the first three years alone, doing just research, in what a



future client referred to as a “Class D” office building. We were asked: “How are you two living? You don’t have any assets under management yet and are too busy writing articles to do any marketing.” “Not a problem,” Bruce replied, “Ken pays my salary and I pay his.” We had only limited access to a DEC VAX cluster, so our programs often ran all night on our own slow PCs. We made Saturday runs to the post office, waiting anxiously for a reply from the *Financial Analysts Journal*, where we had submitted our first article. In those early years, every call we received was from our wives, and the mail was easy to open—there was none.

Nevertheless, we persisted with our research. Our aim was to investigate *all* the market inefficiencies in the literature, and to uncover new ones. Other researchers were looking at one effect at a time, at most two or three. No one else was looking at all the effects simultaneously, to discover which ones survived in a multivariate setting.

The standard approach for measuring a return effect at that time entailed grouping a universe of stocks by, say, their price/earnings ratios and calculating the average return to the quintile or decile of stocks with the lowest ratios. Comparing this average with the average for the entire universe yielded a measure of the low-price/earnings effect. But this simple approach fails to account for correlations between return predictors or for the possible effects of industry affiliations.

We went way beyond the standard approach, disentangling return-predictor relationships via a simultaneous analysis of a multitude of relevant effects. With a multidimensional, simultaneous analysis, returns to each equity characteristic are purified by neutralizing the impact of all other measured effects. For example, the *pure* payoff to low price/earnings is disentangled from returns associated with related attributes such as high yield. Conceptually, the pure return to low price/earnings accrues to a portfolio that has lower-than-average price/earnings but is marketlike in all other respects; that is, it has the same industry weights, average yield, capitalization, and so on as the market.

Several aspects of our research surprised us. The research itself turned out to be far more difficult than we initially imagined, taking years rather than months. Looking back, of course, that’s not so surprising. We were dealing with very complex issues, examining dozens of attributes of companies, investors, and the economy, and thousands of stocks in different market environments. And we were the first in the world to do so.

We were pleasantly surprised by the strength of our findings. In short, they strongly contradicted the efficient market hypothesis. We found the stock market rife with inefficiencies, consistent with our belief that investment opportunities can be detected and exploited to offer superior performance. As our philosophy and some of our findings began to be publicized, other quantitatively oriented money managers asked us to consult or to sell them our proprietary databases and disentangling code. We remained steadfastly committed to developing our own money management business. (Some years later, quantitative consulting firms such as Barra and Vestek began to develop products that managers could use to test various return predictors.)

Gaining our first clients was not an easy task. The eventual publication of our research helped a great deal, as it elicited a lot of interest from the investment community. What didn't help was that, in the early 1990s, quants were tertiary managers, considered by potential clients only after several fundamental managers were in place. Nor could we count on consultants to recommend our strategies, because they typically required three-year live track records. We finally found a few courageous pension officers willing to take some maverick risk for the benefit of their plans. We remain deeply grateful to these clients and are delighted that many of them are still our clients today.

We have been not exactly surprised but certainly heartened by the continuing robustness and success of our research. Over the past 20 years, Jacobs Levy has grown from a two-man research effort into a strong team of 60 with top industry talent in all functional areas. The firm has earned a spot on *Pensions & Investments'* list of Top 25 Managers of Active Domestic [U.S.] Equity, managing more than \$20 billion for an international roster of over 50 clients. These include many of the world's largest and most sophisticated corporate pension plans, public retirement systems, multiemployer funds, endowments, and foundations.

The firm's success reflects the trust our clients have placed in us, and their trust in turn reflects the ability of our research, beginning with disentangling, to deliver value added. Disentangling distinguishes real effects from mere proxies, real investment opportunities from spurious ones. For example, the small-firm effect, measured naively, arises from a bundle of related attributes. Our research has shown that the January small-firm seasonal effect vanishes when disentangled from related effects; it proves to be a mere proxy for year-end tax-loss selling. As

not all small firms will benefit from a January rebound, indiscriminately buying small firms at the turn of the year is not the best approach.

Disentangling reveals the true nature of the various return-predictor relationships. For example, stocks with low price/earnings are usually considered defensive. But pure returns to low price/earnings perform no differently in down markets than in up markets. The defensiveness of low price/earnings in naïve form arises because it is a proxy for defensive attributes such as high yield and defensive industries such as utilities. Disentangling can also reveal hidden opportunities. Small-cap stocks, for instance, may be characterized by low price and analyst neglect, as well as capitalization. Only a multivariate analysis can distinguish the extent to which returns accrue to each of these characteristics separately. Also, the pure returns that result from disentangling are additive. If analysis shows that positive returns accrue to both small capitalization and analyst neglect, the investor may benefit from both attributes by investing in small-cap stocks that are covered by relatively few analysts.

Pure returns also tend to be much less volatile than their naïve counterparts, because they capture more signal and less noise. Consider a naïve analysis of returns to low price/book. As most utilities have low-price/book ratios, a naïve return to low price/book will be affected by events such as oil-price shocks, which are relevant to the pricing of utility stocks but not necessarily to the pricing of other stocks with low-price/book ratios. By contrast, a pure return to price/book controls for the noise introduced by industry-related effects. By providing a clearer picture of the precise relationships between stock price behavior, company fundamentals, and economic conditions, disentangling improves return predictability.

We were delighted with the richness of our findings and hopeful that the *Financial Analysts Journal* would have an interest in them. In 1988, the journal published our paper, "Disentangling Equity Return Regularities: New Insights and Investment Opportunities," which introduced the concept of disentangling. This article won a Graham and Dodd Award as one of the best articles of 1988 and was subsequently translated into Japanese for the *Security Analysts Journal of Japan*. *Financial Analysts Journal* went on to publish "On the Value of 'Value'," "Calendar Anomalies," and "Forecasting the Size Effect." The *Journal of Portfolio Management*

published “The Complexity of the Stock Market,” introducing the notion of market complexity, in 1989. Editors Peter Bernstein and Frank Fabozzi later selected the article for the collection *Streetwise: The Best of The Journal of Portfolio Management*.

University of Washington Professor Charles D’Ambrosio, editor of the *Financial Analysts Journal* at that time, noted in the *Wall Street Journal* (“How Jacobs and Levy Crunch Stocks for Buying—and Selling,” March 20, 1991) that we were “the first to bring so much of this anomaly material together.” At his invitation, we presented our findings on complexity and disentangling at the CFA Institute’s 1988 conference on continuing education. We also later presented them to the Institute for Quantitative Research in Finance (“Q Group”).

## **Integrating the Investment Process**

Our research laid the groundwork for our investment approach. Statistical modeling and disentangling of a wide range of stocks and numerous fundamental, behavioral, and economic factors results in a multidimensional security selection system capable of maximizing the number of insights that can be exploited while capturing the intricacies of stock price behavior. This, in turn, allows for construction of portfolios that can achieve consistency of performance through numerous exposures to a large number of precisely defined profit opportunities.

To preserve the insights gained from our security selection models, we realized from the beginning that we would need to build our own tools to implement those insights. We have developed customized, quantitative systems not only for security selection but also for portfolio construction, compliance, trading, and performance attribution. Integrating every step of the investment process across the same proprietary factors helps to ensure that the portfolio construction process fully exploits all detected investment opportunities and controls for all known risk exposures. Furthermore, with an integrated process, actual portfolio results can be used to evaluate security selection and provide input to the research process.

Insights can also be eroded by transaction costs, but we hold several advantages in the trading arena. First, because of our disentangling

approach, we can profit from multiple inefficiencies for each security that we trade. Second, with our integrated systems, transaction costs are estimated and fed back to the portfolio construction process, helping to ensure that only economical trades are made. Third, we were early advocates and users of low-cost electronic trading venues. Finally, we maintain strict capacity limits to ensure that our trading remains nimble and cost effective. In 2006, *Institutional Investor's* ranking of investment managers cited us as having the lowest costs for NYSE trading and the third lowest for Nasdaq trading.

Our thoughts on the importance of unifying the investment approach and integrating the investment process are outlined in two articles published in 1995, "Engineering Portfolios: A Unified Approach" (*Journal of Investing*) and "The Law of One Alpha" (*Journal of Portfolio Management*).

One of the great advantages of a quantitative approach is that it allows us to follow a very large universe of securities—virtually every U.S. stock with sufficient information flow and liquidity for institutional investors—and a multitude of attributes. We look at firm and market-based attributes such as earnings, accruals, value, growth, size, momentum, price reversals, and volatility; managements' informed actions and analysts' influential opinions; investor sentiment and other behavioral effects including investor underreaction and overreaction; industry affiliations; and a number of economic factors. This provides a basis for constructing portfolios that can meet a variety of client needs.

When we began our research process, we expected to offer portfolios that contained the best stocks according to our stock selection system; the client could measure the portfolio's return without regard to any particular benchmark. But as our research progressed, new market indices were being developed based on capitalization (large, mid, and small) and style (growth and value). Consultants began advancing the notion of constructing portfolios relative to given indices so that clients could better benchmark manager performance. The breadth of our investment universe and our customized, quantitative portfolio construction methods have allowed us to design portfolios for any number of mandates; new portfolios tied to new underlying indices emerge on a regular basis.

## Relaxing Portfolio Constraints

We were acutely aware of the costs associated with constraints on portfolio construction, including constraints on the selection universe and on risk-taking. In the early 1990s, we found a client willing to relax the universe constraint and fund a full-universe portfolio. Later, we resisted the push toward *enhanced indexing*, with its tightly controlled residual risk limits. Our 1996 article, “Residual Risk: How Much Is Too Much?” (*Journal of Portfolio Management*), delineated the advantages of being more opportunistic with respect to residual risk taking.

We were also fully aware of the cost of constraints on short selling, but we did not think short selling would be acceptable to pension fund clients. Soon after we began managing portfolios, however, some clients asked about shorting stocks. With their encouragement, we ran analyses on the stocks at the bottom of our return prediction rankings and found that they did underperform the market.

Jacobs Levy soon became one of the first money managers to exploit the potential of short selling within a disciplined framework when we began offering long-short portfolios in 1990. Engineered long-short portfolios offer the benefits of shorting within the risk-controlled environment of quantitative portfolio construction. The ability to sell stocks short can benefit both security selection and portfolio construction. To begin with, short selling expands the list of implementable ideas to include both “winning” and “losing” securities. Portfolios that cannot sell short are restricted in their ability to incorporate insights about losing securities. For example, a long-only portfolio can sell a loser if it happens to hold one, or it can refrain from buying a loser. In either case, the potential impact on portfolio return is limited by the absolute weight of the security in the benchmark.

Consider that the typical stock in a broad market index such as the Russell 3000 constitutes about 0.01 percent (one basis point) of that index’s capitalization. Not holding the stock (or selling it from a portfolio) gives the portfolio a 0.01 percent underweight in the stock, relative to the underlying benchmark index. This is unlikely to give the portfolio’s return much of a boost over the benchmark, even if the stock does perform poorly. It also does not give the manager much leeway to

distinguish between degrees of negative opinions; a stock about which the manager holds an extremely negative view is likely to have roughly the same underweight as a stock about which the manager holds only a mildly negative view.

Short selling removes this constraint on underweighting. Significant stock underweights can be established as easily as stock overweights. The ability to short thus enhances the manager's ability to implement all the insights from the investment process, insights about potential losers as well as winners.

Short selling also improves the ability to control risk. Benchmark weights are the starting point for determining a long-only portfolio's residual risk. Departures from benchmark weights introduce residual risk, so a long-only portfolio tends to converge toward the weights of the stocks in its underlying benchmark in order to control risk. The need to converge toward benchmark weights necessarily limits the portfolio's potential for excess return, as returns in excess of benchmark accrue only to positions that are overweighted or underweighted relative to their benchmark weights. In a portfolio that can sell securities short, the risks of the securities held long can be offset in part or in full by the risks of the securities sold short.

We described the benefits of shorting and long-short portfolios in several articles, the earliest being "Long/Short Equity Investing," which appeared in the *Journal of Portfolio Management* in 1993 and was later translated into Japanese for the *Security Analysts Journal of Japan*. This was followed by "20 Myths About Long-Short" (*Financial Analysts Journal*, 1996) and other articles. We presented our long-short research to the CFA Institute's 1993 and 1998 conferences on continuing education and to the Q-Group in 1995.

Short selling can be used not only to enhance the implementation of insights from the stock selection process and to control portfolio risk, but also to expand the range of risk-return tradeoffs available from the portfolio construction process. With short sales, it is possible to construct *market neutral portfolios* that balance the market value and overall market sensitivity of long positions against the market value and market sensitivity of short positions. The balanced long and short positions neutralize the portfolio's exposure to the underlying market, so the portfolio incurs no systematic market risk and earns no market return.

A market neutral portfolio can be *equitized* by purchasing stock index futures. The equitized portfolio will reflect the equity market's performance in addition to the performance of the long-short portfolio. As we discuss in "Alpha Transport with Derivatives" (*Journal of Portfolio Management*, 1999), the long-short portfolio's return from security selection can be "transported" to virtually any asset class that has viable derivatives.

## Integrated Long-Short Optimization

We recognized early on that simply combining a portfolio of short positions with a separately optimized portfolio of long positions would not create an optimal long-short portfolio. Only if all potential positions were considered together, in a single *integrated optimization*, would the risk-reducing and return-enhancing benefits of short selling be maximized. We built a long-short optimizer that could integrate proposed long and short positions to take into account cross-hedging of positions.

Along with our work on complexity and on disentangling return-predictor relationships, our insights on integrated optimization are some of the most important work we have done. In "On the Optimality of Long-Short Strategies" (*Financial Analysts Journal*, 1998), we showed that long-short portfolios with any given exposure to the underlying market benchmark should be constructed with an integrated optimization that considers simultaneously both long and short positions and the benchmark asset. Rather than combining a long-only portfolio with a market neutral portfolio, it is better to blend active long and short positions so as to obtain a desired benchmark exposure. That article laid the foundation for the development of 120-20 and other *enhanced active equity strategies*, deriving precise formulas for optimally equitizing an active long-short portfolio when exposure to a benchmark is desired. "Long-Short Portfolio Management: An Integrated Approach" (*Journal of Portfolio Management*, 1999) provides another look at integrated long-short portfolios.

Once new prime brokerage structures were available to facilitate these strategies, we began to manage these types of portfolios, taking advantage of our insights into integrated long-short optimization. An enhanced active equity portfolio includes long and short positions and



maintains a full exposure to an underlying market benchmark. In an enhanced active 120–20 portfolio, for example, an amount equal to 20 percent of the portfolio’s capital is sold short, with the proceeds from the short sales plus the initial capital being invested long. The portfolio thus provides 100 percent net exposure to the equity market, along with many of the benefits that short selling allows in the pursuit of return and the control of risk.

In “Enhanced Active Equity Strategies: Relaxing the Long-Only Constraint in the Pursuit of Active Return” (*Journal of Portfolio Management*, 2006), we discussed these strategies and compared them with long-only and other long-short strategies. This article also highlighted 200–100 enhanced active portfolios. In contrast with equitized long-short strategies, which achieve market exposure with passive overlays of stock index futures or exchange-traded funds (ETFs), these 200–100 strategies hold active positions in selected individual equities.

We took a closer look at the relationship between enhanced active 200–100 portfolios and equitized long-short portfolios in “Enhanced Active Equity Portfolios Are Trim Equitized Long-Short Portfolios” (*Journal of Portfolio Management*, 2007) and demonstrated that an enhanced active portfolio is equivalent to an equitized long-short portfolio, with the two having the same active security weights and returns. The enhanced portfolio has the advantage, however, of being more compact and requiring less leverage. In “20 Myths About Enhanced Active 120–20 Strategies” (*Financial Analysts Journal*, 2007), we shed some light on this and other characteristics of enhanced active equity strategies that are frequently misunderstood by investors, including how the strategies increase investors’ flexibility both to underweight and overweight securities and the potential benefits of using short selling and leverage to improve the risk–return trade-off.

## Books and an Ethical Debate

**Bruce:** Back in 1999, I finally saw the fruition of a project I had been working on for years—the publication of my book *Capital Ideas and Market Realities: Option Replication, Investor Behavior, and Stock Market Crashes*. The seeds of this work had been planted in the 1980s, during

some heated debates and discussions I'd had with Hayne Leland, John O'Brien, and Mark Rubinstein of Leland O'Brien Rubinstein Associates. (Rubinstein and Leland were also professors at the University of California, Berkeley.) They had devised a dynamic hedging product based on the Black-Scholes-Merton option pricing formula. When I had first joined Prudential Insurance, I had been asked to analyze this *portfolio insurance* strategy. I warned then that the strategy, although workable in theory, contained its own self-destruct mechanism. The strategy's automatic, trend-following trading could destabilize markets, causing the synthetic insurance to fail. Prudential had followed my advice, and even though in the short term they missed out on the management fees associated with a burgeoning portfolio insurance industry, they avoided the embarrassment and difficult client discussions after the strategy failed—when it was needed most—during the 1987 crash.

My insight was later recognized in *Pensions & Investments* by Editorial Director Michael Clowes, who noted that I was “one of the first to warn that portfolio insurance . . . probably would be destabilizing” (“More to say about crash,” July 12, 1999), and in the *Wall Street Journal*, where Roger Lowenstein (“Why Stock Options Are Really Dynamite,” November 6, 1997) said that I had “predicted before the 1987 crash that portfolio insurance would trigger chain-reaction selling.”

After the crash, I saw the same dynamics behind portfolio insurance roiling the markets over and over again in other guises, including synthetic put options and the relative value arbitrage strategies pursued by hedge funds such as Long-Term Capital Management (LTCM). Prior to the collapse of LTCM, I had expressed my concerns in two *Pensions & Investments* pieces (Barry Burr, “Nobel-Winning Strategy Criticized,” December 8, 1997, and Bruce Jacobs, “Option Replication and the Market's Fragility,” June 15, 1998), taking issue with Nobel laureates Merton Miller and Myron Scholes (an LTCM partner). I last debated Rubinstein on the subject as a participant in *Derivatives Strategy's* “2000 Hall of Fame Roundtable: Portfolio Insurance Revisited.”

Apparently, many still fail to realize the limits of risk reduction and the potential effects of risk-shifting on market fragility. Systematic risk can be shared (with diversification) and it can be shifted (with options), but it cannot be eliminated. When too many investors forget this, risk in the market tends to build up, sometimes with explosive results. I

discuss this problem in “Risk Avoidance and Market Fragility” (*Financial Analysts Journal*, January/February 2004).

In “A Tale of Two Hedge Funds,” Ken and I describe in detail how the supposedly low-risk strategies of LTCM and another infamous hedge fund, Granite, came apart in spectacular fashion when they had exhausted the market’s liquidity. “A Tale of Two Hedge Funds” appears in our edited volume, *Market Neutral Strategies* (2005), which brought together some of the industry’s most successful practitioners to discuss long-short equity strategies, convertible bond hedging, and merger arbitrage, as well as sovereign fixed income and mortgage arbitrage. It serves as a cautionary reminder of how such strategies, when not managed carefully, can blow up, threatening the very markets in which they operate.

I had taken the liberty of sending a draft of *Capital Ideas and Market Realities* to Nobel laureate Harry Markowitz, who not only liked the work, but offered to write the foreword to the book. In Harry’s subtle and piercing way, the foreword makes the distinction between portfolio insurance and portfolio theory and their effects on financial markets. Harry also wrote the foreword to a collection of Ken’s and my most important articles, *Equity Management: Quantitative Analysis for Stock Selection* (2000) (also available in Chinese translation from China Machine Press). There he notes that our optimization work builds on his mean-variance theory and that some of his later work builds on what he calls our “seminal work” on disentangled expected return estimation procedures. In fact, we were surprised to learn that he had used our disentangling approach in researching and managing Japanese equities for Daiwa Securities Trust Company.

Harry’s foreword to *Equity Management* echoes certain themes found in his foreword to *Capital Ideas and Market Realities*, in particular how the translation of investment ideas into products and strategies must involve trade-offs between theory and practice. Harry discusses why investors might want to add constraints on position sizes and sectors to the portfolio optimization solution, despite the theoretical cost of these constraints. Harry notes that our work on integrated portfolios and the estimation of security expected returns is “to be acknowledged for bridging the gap between theory and practice.”

In the early years of the new millennium, it became apparent that the translation of theory into practice was fraught with other kinds of

difficulties. In particular, the bursting of the Internet bubble revealed that Wall Street research, which in theory was objective and undertaken to benefit client portfolios, was in practice often conducted for the direct benefit of analysts and their employers rather than their clients. The CFA Institute proposed conflict-of-interest standards for security analysts' research and solicited comments from Institute members.

My response (August 12, 2002) noted: "Just as the research conducted by analysts at brokerage firms and investment banks is susceptible to the influence of commercial interests that may conflict with the best interests of their clients, so too the work done for and by [the CFA Institute] and its professional publications and conferences is susceptible to being influenced by interests that may conflict with the best interests of members and investors in general. I believe that the Research Objectivity Standards as proposed should be expanded to deal with these conflicts of interests." My proposal received substantial industry support, and the January/February 2003 issue of the CFA Institute's premier research publication, *Financial Analysts Journal*, announced new conflict-of-interest policies.

## **Portfolio Optimization and Market Simulation with Shorting**

**Bruce and Ken:** After the publications of *Capital Ideas and Market Realities* and *Equity Management*, we collaborated with Harry on two projects of mutual interest. First, we investigated a tricky problem affecting the optimization of long-short portfolios. The optimization problem in general is tractable because certain shortcuts can be taken. Some models in wide use for long-only portfolios—for example, factor and scenario models—allow the investor to apply fast algorithms that greatly simplify the optimization problem. It is not readily apparent, however, that such models are applicable when portfolios hold short as well as long positions.

"Portfolio Optimization with Factors, Scenarios, and Realistic Short Positions" (*Operations Research*, 2005) and the less technical "Trimability and Fast Optimization of Long-Short Portfolios" (*Financial Analysts Journal*, 2006), which we coauthored with Harry, show that the same

algorithms used for optimizing long-only portfolios can be used for portfolios that contain short positions—provided a certain condition holds. This condition, which we term *trimability*, often holds in practice.

We also began a longer-term project with Harry. This one also had roots in an area of past interest—the Black-Scholes-Merton option-pricing model that formed the basis of portfolio insurance. The model allows for the solution of option prices by assuming that underlying security prices change randomly and continuously over time. Such continuous-time models are useful because they can often be solved analytically. They are not useful, however, when investment actions or changes in the underlying environment alter the price process. Nor can they tell us whether microtheories about the behavior of investors can explain the observed macrophenomena of the market.

We developed a model of the overall market that has the potential to address these problems. The Jacobs-Levy-Markowitz Simulator, or JLM Sim, allows users to model financial markets, employing their own inputs about the numbers and types of investors, traders, and securities. The JLM Sim is an *asynchronous-time* simulation. It assumes that changes reflect events, which can unfold in an irregular fashion. Price changes may be discontinuous, gapping up or down in reaction to events.

The *Journal of Portfolio Management* article “Financial Market Simulation” (2004), coauthored with Harry, describes the JLM Sim. Those interested in finding out more about the simulator, or experimenting with it, can access JLM Sim at the Jacobs Levy Web site. We believe an asynchronous-time market simulator such as JLM Sim, which is capable of modeling the agents and market mechanisms behind observed prices, is much better than continuous-time models at representing the reality of markets.

Asynchronous models may also be superior when analyzing whether microtheories about investor behavior can explain market macrophenomena. From time to time, the market manifests *liquidity black holes*, which seem to defy rational investor behavior. One extreme case was the stock market crash on October 19, 1987. When prices fell precipitously and discontinuously on that day, rational value investors should have stepped in to pick up bargain stocks, but few did. Asynchronous models are able to explain both the abundance of sellers and the dearth of buyers.

Our experiments with the simulator show that only a relatively small proportion of momentum investors can destabilize markets, overwhelming value investors. Similarly explosive behavior can result when traders don't anchor their bid/offer prices to existing market prices. Using JLM Sim, we are currently examining the intriguing question of what conditions give rise to a stable equilibrium in the capital markets.

JLM Sim provides researchers with the means to create dynamic models of financial markets. It is our hope that their experiments will lead to more and more refinements in the JLM Sim, bringing its predictions into even closer alignment with observed investor and market behavior. In the long run, JLM Sim may become a powerful and reliable tool for testing the effects on security prices of real-world events such as changes in investment strategy or regulatory policy.

Looking back, the long days and weeks we have dedicated to our business have been more than adequately rewarded. We have produced 20 years of published research on our investment philosophy and, more importantly, 20 years of proprietary research for the benefit of our clients' portfolios. We have also given back to the investment community by supporting research that moves it forward. We were founding sponsors of the Research Foundation of CFA Institute and the Fischer Black Memorial Foundation. In 1998, we established the Bernstein Fabozzi/Jacobs Levy Awards for outstanding articles published annually in the *Journal of Portfolio Management*.

We feel fortunate that we can pursue our passion for equity research and portfolio management. We love being quants!

## About the Contributors

**Bruce I. Jacobs** is cofounder and principal of Jacobs Levy Equity Management, a leading provider of quantitative equity strategies. The firm, which celebrated its 20<sup>th</sup> Anniversary in 2006, serves a prestigious global roster of more than 50 clients with over \$20 billion in institutional assets under management. Dr. Jacobs is cochief investment officer, portfolio manager, and codirector of research. Dr. Jacobs has written numerous articles on equity management and received the *Financial Analysts Journal* Graham and Dodd Award in 1988, a Bernstein

Fabozzi/Jacobs Levy Award for his article published in *The Journal of Portfolio Management* in 1999, and an award from *The Journal of Investing* in 1998. Many concepts introduced in these articles have become industry terms, including “market complexity,” “disentangling,” “pure returns,” “law of one alpha,” “integrated long-short optimization,” and “trimability.” Dr. Jacobs is author of *Capital Ideas and Market Realities: Option Replication, Investor Behavior, and Stock Market Crashes* (Blackwell), coauthor with Ken Levy of *Equity Management: Quantitative Analysis for Stock Selection* (McGraw-Hill), coeditor with Ken Levy of *Market Neutral Strategies* (Wiley), and coeditor of *The Bernstein Fabozzi/Jacobs Levy Awards: Five Years of Award-Winning Articles from the Journal of Portfolio Management* (Institutional Investor). Formerly he was first vice president of the Prudential Insurance Company of America, where he served as senior managing director of a quantitative equity management affiliate of the Prudential Asset Management Company and managing director of the discretionary asset allocation unit. Prior to that, he was on the finance faculty of the University of Pennsylvania’s Wharton School and consulted to the Rand Corporation. Dr. Jacobs has a BA from Columbia College, an MS in Operations Research and Computer Science from Columbia University’s School of Engineering and Applied Science, an MSIA from Carnegie Mellon University’s Graduate School of Industrial Administration, and an MA in Applied Economics and a PhD in Finance from the University of Pennsylvania’s Wharton School. He is an associate editor of *The Journal of Trading* and on the Advisory Board of *The Journal of Portfolio Management*.

**Kenneth N. Levy** is cofounder and principal of Jacobs Levy Equity Management, a leading provider of quantitative equity strategies. The firm, which celebrated its 20<sup>th</sup> Anniversary in 2006, serves a prestigious global roster of more than 50 clients with over \$20 billion in institutional assets under management. He is cochief investment officer, portfolio manager, and codirector of research. He has written numerous articles on equity management and is a recipient of the *Financial Analysts Journal* Graham and Dodd Award in 1988 and a Bernstein Fabozzi/Jacobs Levy Award for his article published in *The Journal of Portfolio Management* in 1999. Many concepts introduced in these articles have become industry terms, including “market complexity,” “disentangling,” “pure returns,”

“law of one alpha,” “integrated long-short optimization,” and “trimability.” Mr. Levy is coauthor with Bruce Jacobs of *Equity Management: Quantitative Analysis for Stock Selection* (McGraw-Hill) and coeditor with Bruce Jacobs of *Market Neutral Strategies* (Wiley), and coeditor of *The Bernstein Fabozzi/Jacobs Levy Awards: Five Years of Award-Winning Articles from the Journal of Portfolio Management* (Institutional Investor). Formerly he was managing director of a quantitative equity management affiliate of the Prudential Asset Management Company. Before that, he was responsible for quantitative research at Prudential Equity Management Associates. He has a BA in Economics from Cornell University and MBA and MA degrees in Applied Economics from the University of Pennsylvania’s Wharton School. He has completed all requirements short of the dissertation for a PhD in Finance at Wharton. He is a CFA and has served on the CFA Candidate Curriculum Committee, the POSIT Advisory Board, and the investment board of a community foundation.