

SURVEY ON TRENDS IN
EQUITY PORTFOLIO MODELING
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TRENDS IN EQUITY PORTFOLIO MODELING – 2006 SURVEY

Frank J. Fabozzi and The Intertek Group undertook research to reveal trends in the role of modeling in equity portfolio management and the modeling methods being used. The research looks at modeling in return forecasting and portfolio construction, risk management and optimization.

This study follows on the 2003 study *Trends in Quantitative Methods in Asset Management* and attempts to register changes that have occurred since then. In all, managers at 38 asset management firms participated in the 2006 study; of these, 21 or 55% also participated in the 2003 study (*Trends in Quantitative Methods in Asset Management – 2003 Update*, The Intertek Group, 2003). The home market of participating firms is: North America 15 (of which 14 USA, 1 Canada) and Europe 23 (of which the UK 7, Germany 5, Switzerland 4, Benelux 3, France 2, and Italy 2). Equities under management by participating firms range from €bn to €800bn.

While most firms whose use of quantitative methods is limited to performance analysis or risk measurement declined to participate in this study (only 5 of the 38 participating firms reported no equity funds under quantitative management), the study does reflect the use of quantitative methods in equity portfolio management at firms managing a total of €3.3 trillion (\$4.3 trillion) in equities; nearly two thirds (63%) of the participating firms are among the largest asset managers in their respective countries. It is fair to say that these firms represent the way a large part of the industry is going with respect to the use of quantitative methods in equity portfolio management.

METHODOLOGY

This 2006 report is based on survey responses and conversations with industry representatives. Conversations with the latter helped upfront in defining the issues to be covered by the survey and, with survey results in, contributed to a greater understanding of the results. Participants include persons responsible for quantitative equity management and quantitative equity research at large and medium-sized firms in North America and Europe.

Of the 38 participants in this survey, 2 responded only partially to the questionnaire. For some questions, there are therefore 36 (not 38) responses.

MANAGEMENT SUMMARY : KEY FINDINGS AMONG THE SOURCES

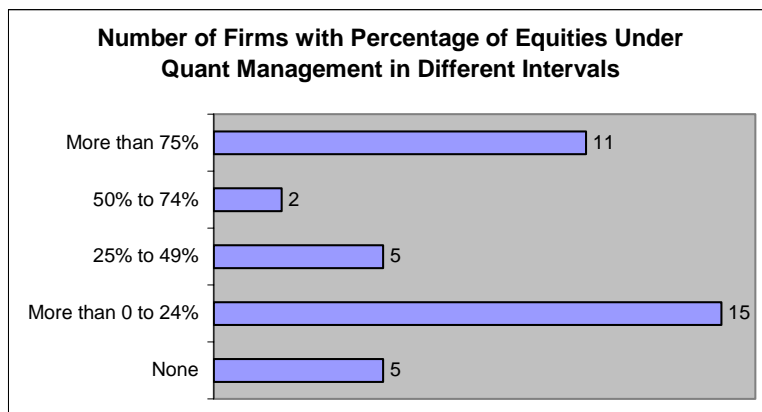
- ❑ Almost 30% of the survey participants (11/38) report that more than 75% of their equity assets are being managed quantitatively; this includes a wide spectrum of firms, with from € billion to over €500 billion in equity assets under management.
- ❑ 84% of the survey respondents (32/38) report that the percentage of equity assets under quantitative management has either increased with respect to 2004-2005 (25/38) or has remained stable at about 100% of equity assets (7/38). The percentage of equities under quantitative management was down at only one firm.
- ❑ One significant change with respect to the 2003 study: quantitative methods are now being widely used in active equity management, to find alpha.
- ❑ With the use of quantitative methods now so prevalent, participants say that it is getting hard 1) for long-established quant funds to differentiate themselves and 2) to improve on performance or find alpha given that everyone is using the same data, the same intuition, and the same modeling methods.

- ❑ 55% of the respondents (21/38) report that at least part of the equity assets are now being managed automatically with quantitative methods; another 3 plan to automate at least a portion of their equity portfolios within the next 12 months.
- ❑ The most important factor contributing to a wider use of quantitative methods in equity portfolio management is the positive results obtained with these methods; the prevailing in-house culture is cited as the most important factor holding back a wider use of quantitative methods.
- ❑ Phenomena most widely modeled are momentum and/or reversal (86% or 31/36) and trends (78% or 28/36).
- ❑ With assets under quantitative management and trading volumes up, modeling both the impact of trades and fund capacity have gained in importance: 67% (24/36) of the respondents model the impact of trades and 56% (20/36) model fund capacity.
- ❑ Modeling methodologies most widely used include regression on common factors and company-specific predictors (100% or 36/36), momentum and/or reversal modeling (78% or 28/36), cash flow analysis (47% or 17/36) and behavioral modeling (44% or 16/36). The increased use of behavioral modeling is perhaps the most significant development in return modeling; factor models and momentum and/or reversal models were adopted earlier.
- ❑ Modeling methods such as cointegration and non-linear methods are being used at roughly 20% of the firms (7/36 each). While these techniques have not been widely implemented, the use of these methodologies has grown with respect to the 2003 study.
- ❑ A greater use of multiple models for return forecasting is behind an increased awareness of the need to mitigate model risk: model averaging/shrinkage are used at one fourth (9/36) of the participating firms.
- ❑ 14% of the respondents (5/36) use high-frequency data (HFD), to identify profit opportunities and improve return forecasts; another 3 plan to use HFD within the next 12 months.
- ❑ Risk is measured at all firms: Risk measures most widely used include variance (97% or 35/36), VaR (67% or 24/36) and downside risk measures (39% or 14/36). Conditional VaR and extreme value theory (EVT) are used at 4 (11%) and 2 (6%) firms, respectively.
- ❑ Over 90% (92% or 33/36) of the respondents use some form of optimization: this is a significant development with respect to previous studies where most firms said they eschewed optimization. Among the optimization methods used, 83% of the respondents (30/36) perform optimization with mean-variance; 42% (15/36) use utility optimization and 25% (9/36) robust optimization methods. The use of optimization (together with return forecasting) is central to automating fund management, which 55% of the respondents have implemented for at least part of their equities under management.
- ❑ Stochastic optimization is being used at only 1 participating firm: Asset management firms wanting to play a role in asset allocation will have to master this technique.
- ❑ While investments in the IT infrastructure (data, computers, storage devices, software) are company-specific, three quarters of the respondents (28/38) report that they have increased the number of quantitative equity researchers.
- ❑ The profile of the portfolio manager is increasingly quant-oriented, but what is required is a skill set that also encompasses finance and economics.

1. EVOLUTION IN EQUITY ASSETS UNDER QUANTITATIVE MANAGEMENT

Quantitative methods are now being widely used to manage equity assets. 29% (11/38) of the survey participants report that more than 75% of their equity assets are being managed quantitatively; this includes a wide spectrum of firms, with from € billion to over €500 billion in equity assets under management. Another 58% (22/38) report that they have some equities under quantitative management, though for most of these (15/22) the percentage of equities under quantitative management is less than 25% - often under 5% - of total equities under management. 13% (5/38) reported no equities under quantitative management.

Equities under quantitative management exceed 75% of all equities under management at 29% of the survey participants; another 58% report that at least some equities are being managed quantitatively.



With respect to the 2003, there has been a considerable development of quantitative management, in particular, in the UK.

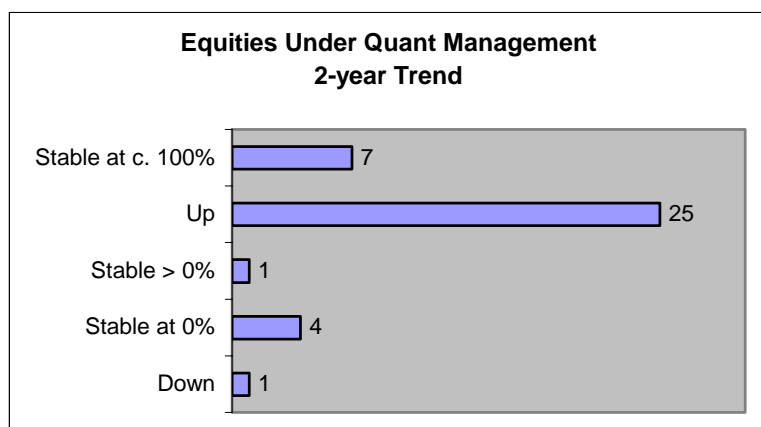
The trend towards quantitative management is expected to continue. A source from Germany with some €10 billion (\$13bn) in equities under management remarked, “In the near future, portfolio construction will be done almost exclusively with quantitative methods.”

The trend towards quantitative management is expected to continue.

Even when firms have a more traditional approach to asset management, quantitative methods are now playing an important role. A source at a UK firm remarked, “Whilst only a very small portion of our assets are managed purely quantitatively, quantitative methods are incorporated in a much higher proportion – about 50% - of our mandates as part of a wider fund management process.” At such firms, quantitative methods are typically used to build quantitative screens for stock selection or for structured risk control. In these cases, a set of rules generally fixes the constraints imposed on traditional fund managers in function of the modeling results. The wide adoption of screens is considered by market participants to represent a major change for fundamentally-oriented managers.

Quantitative methods are playing an important role even where funds are managed traditionally.

Over the past two years, the amount of equities under quantitative management has grown at most firms participating in the survey. 84% of the respondents (32/38) report that the percentage of equity assets under quantitative management has either increased with respect to 2004-2005 (25/38) or has remained stable at about 100% of equity assets (7/38). The percentage of equities under quantitative management was down at only one firm and stable at five.



One reason given by respondents to explain the growth in equity assets under quantitative management is the flows into existing quantitative funds. A source at a large U.S. asset management firm with more than 50% of its equities now under quantitative management said, “The firm has three distinct equity products: value, growth and quant. Quant is the biggest and is growing the fastest.”

Another reason given to explain the growth in equity assets under quantitative management is the extension of quantitative methods to new investment strategies. The good results obtained with quantitative methods have not only led more firms to embrace quantitative management – they have allowed firms to enlarge the range of equity products managed quantitatively. Once associated with passive management and indexed or enhanced index funds, quantitative methods are now being applied to execute a wider range of strategies.

A source in northern Europe where the portion of equity assets under quantitative management is up said, “Next to our enhanced indexing quantitative product, we have added active quant and long/short quant.”

Quantitative equity management has now become so widespread that a source at a long-established quantitative investment firm remarked, “There is now a lot of competition from new firms entering the space [of quantitative investment management]. The

84% of the participants say that the amount of equities managed quantitatively is either stable at about 100% of equity assets or up.

Inflows into existing quant funds are pushing up the amount of equities under quantitative management.

The extension of quantitative methods to new investment strategies is also behind the growing amount of equities under quantitative management.

The challenge to long-established quant firms is to distinguish themselves from the competition.

challenge is to continue to distinguish ourselves from competition in the minds of clients.”

Sources report that client demand is behind the launching of (new) pure quantitative funds. A source at a large continental investment management firm said, “We have been managing our global equity portfolios with quantitative methods for a long time. The novelty is that these portfolios are now being sold as such, as one of the many strategies that we offer.”

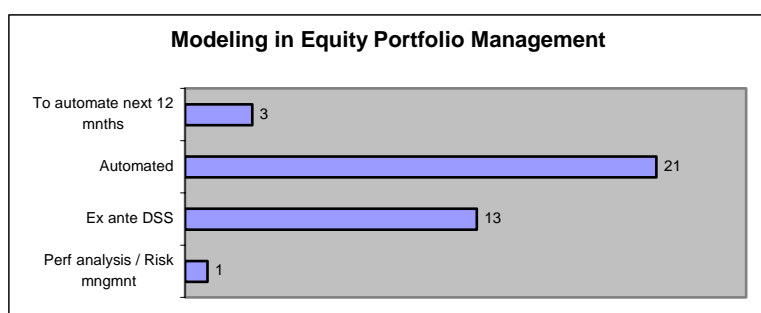
Client demand – especially institutional – is behind the launching of new quantitative products.

However, several sources mentioned that quantitative funds might be something of a hard sell. A source at a medium-sized asset management firm servicing both institutional clients and high-net worth individuals said, “Though clearly the trend towards quantitative funds is up, quant approaches remain difficult to sell to private clients: They remain too complex to explain, there are too few stories to tell, and they often have low alpha. Private clients do not care about high information ratios.”

2. ROLE OF MODELING IN EQUITY PORTFOLIO MANAGEMENT

The once futuristic vision of machines running funds automatically without the intervention of a portfolio manager is becoming a reality on a large scale: 55% of the respondents (21/38) report that at least part of their equity assets are now being managed automatically with quantitative methods; another 3 plan to automate at least a portion of their equity portfolios within the next 12 months.

55% of the respondents report that at least part of their equity assets are being managed automatically with quantitative methods.



This represents a significant change relative to 2003 when the last study was done. Back then, most firms reported that they were using multi-factor risk models as an ex ante decision-support system for index/enhanced index funds or to develop stock ranking systems for active fundamental managers; few had automated the investment process.

A source at a large European asset management firm illustrates the evolution in automating investment management: “We started developing quantitative models about eight years ago, to assist the traditional equity fund managers in their decision-making

Firms have moved from using quantitative methods in decision support system to fully

process. A couple of years and a number of upgrades later, we observed that we could apply these models in a fully automated manner, without the intervention of the traditional fund manager. In early 2003 we launched two quantitatively managed funds, one investing in large cap US stocks, the other in large cap European stocks. The good performance of these funds generated client demand and we have since launched several other fully automated funds.”

automated fund management.

The role of modeling has also undergone another significant change: once limited to indexed/enhanced indexed funds under passive management or screening systems and risk control in active management, quantitative methods are now being widely used in active management, to find new alpha sources. A source at a mid-sized investment firm said, “The real issue is finding alpha sources and separating alpha factors from unidentified risk factors.”

Quantitative methods are now being widely used in active management, to find alpha...

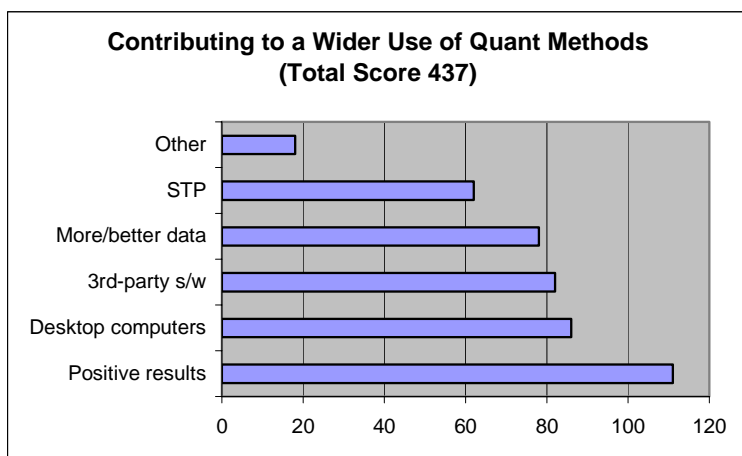
More in general, quantitative methods are now being used to achieve a number of different and well-articulated goals, including high information ratios (i.e., low volatility compared with returns) and limited drawdowns.

... or to achieve goals such as high information ratios and limited drawdowns.

3. FACTORS WORKING FOR / AGAINST A GREATER USE OF QUANTITATIVE METHODS

Sources report that the most important factor contributing to a wider use of quantitative methods in equity portfolio management is the positive results obtained with these methods. Half of the participants rated positive results as the single most important factor contributing to the widespread use of quantitative methods.

Positive results are driving a wider use of quant methods.



A source at a large European asset management firm remarked, “Thanks to the good performance of our quant funds, we have seen a 75-fold increase in assets under management in quantitative equity strategies since these funds were first

launched three years ago.”

Other factors contributing to a wider use of quantitative methods in equity portfolio management are, in order of importance attributed to them by participants, the computational power now available on the desktop, the availability of third-party analytical software and visualization tools, and more and better data.

A source at a large firm that describes itself as “quant” remarked, “From our point of view, the sheer presence of computational power on the desktop is the biggest issue: it is this that will increase the depth and breath of the data that will be used and will therefore impact the whole modeling process.”

Another source at a large international firm said, “Portfolio managers now have Internet-based solutions to run risk and alpha analytics and price derivatives. This everyday use of simple desktop tools has had more impact than any change in modeling methods themselves.”

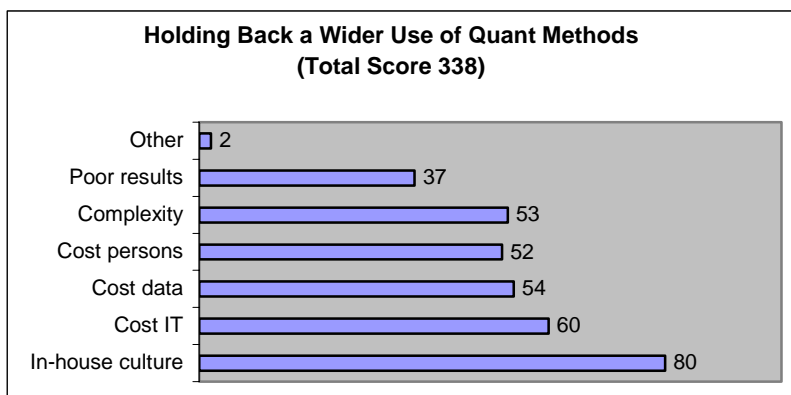
Other factors cited as working in favor of a wider use of quantitative methods include their contribution to risk control and the fact that they allow a transparent and more scalable investment process. A few sources remarked that they are being nudged towards quantitative methods by their corporate parent firms or by institutional investors who require a more repeatable process

The most important factor holding back a wider use of quantitative methods identified by respondents is the prevailing in-house culture (this evaluation obviously does not hold for firms that can be described as quantitative): more than one third (10/27) of the respondents at other than quant-oriented firms considered this the major blocking factor.

More than any new modeling technique, desktop computational power, 3rd-party software, and more and better data have contributed to a wider use of quantitative methods.

Other factors working in favor of a wider use of quant methods: their contribution to better risk control and a more transparent, scalable process, pressure from the parent firm and institutional investors.

Prevailing in-house culture is the biggest factor holding back a wider use of quant methods.



However, a few sources from traditionally managed firms mentioned that their structure isolates the quantitative teams from

pressure from traditional managers. According to a source at a large European firm, “Because the two investment teams – quant and traditional – are independent of each other, the use of quantitative techniques in the quant team is not influenced by any in-house culture issues such as the resistance of traditional managers to adopting quantitative models or techniques.”

Other factors perceived to be holding back a wider use of quantitative methods include, in order of importance, the cost of the IT infrastructure, the cost of data and of qualified persons, and the complexity of the modeling process.

In ranking the cost of data and the IT infrastructure as major factors holding back a wider use of quantitative methods, one respondent remarked, “Data vendors’ pricing behavior is close to monopolistic. As a quant shop, this is of concern for the future.”

Concerns about cost of data are growing as modelers try to improve forecasts using data at higher frequencies. Presently most modelers work with daily closing data; if, in a search for profit opportunities, modelers begin to work with intraday or high-frequency data, the amount of data increases more than a thousand fold, driving the cost of data and the requisite IT infrastructure way up.

Complexity of the process was ranked high by some participants. A source at a firm that has built up one of the industry’s largest quant teams commented, “New efforts take longer; the easy stuff has been done.”

Poor results obtained with modeling played only a minor role in slowing down a wider use of quantitative methods in equity portfolio modeling. Only 5 of the 36 sources ranked this factor 3 or above on a scale of 1 to 5 and only one respondent mentioned this factor as responsible for a downward trend in the percentage of equities under quantitative management.

However, one complaint – even among firms with a consolidated experience in modeling – is that models have not been consistently successful. A source at a large continental firm with some 15% of the equity assets under quantitative management remarked, “A major challenge in using quantitative methods is to diversify over more quant equity strategies in order to be able to survive periods of poor performance for a single strategy.”

4. PHENOMENA BEING MODELED

Phenomena most widely modeled are momentum and/or reversal (86% or 31/36) and trends (78% or 28/36). The distinction between momentum and reversals and trends is one of the time

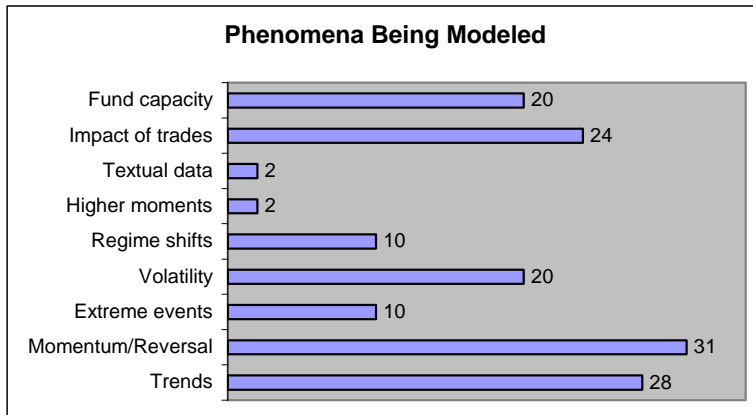
Cost (of the IT infrastructure, of data, of qualified personnel) is another important factor holding back a wider use of quantitative methods.

Poor results from modeling played only a minor role in holding back a wider use of quant methods...

... but consistency in performance is an issue.

Phenomena most widely modeled are momentum and/or reversal and trends.

horizon. Momentum and reversals are respectively trends and inversion of trends at specific time horizons.



One source modeling momentum commented, “While the fundamental part of the model is designed to capture the quality of the business, the momentum component reflects market sentiment. Price momentum can act as a buy or sell catalyst and improves the efficiency of trade implementation.”

“While the fundamental part of the model is designed to capture the quality of the business, the momentum component reflects market sentiment.”

A source at another firm that is modeling momentum but not reversal explained, “We do not use reversal as it is impossible for a portfolio to catch up. Reversal might just be a manifestation of microstructure.”

Among the sources modeling trends (i.e., long-term averages), some model fundamental trends such as consistent growth, others model technical trends such as prices. Still others model trending patterns in analyst earnings estimates to produce a sentiment/growth model component trends in returns.

Modeling the impact of trades and fund capacity has become more important as the amount of assets under quantitative management and the volume of trades has grown. Modeling both phenomena is now quite widespread: 67% (24/36) of the respondents model the impact of trades and 56% (20/36) model fund capacity.

Modeling the impact of trades and fund capacity has become more important as the amount of assets under quantitative management and the volume of trades has grown.

A source at a large continental firm said, “Initially we did not pay much attention to the impact of trades but because of the large inflows into our quant funds we were forced to deal with this problem.”

Another source listed capacity as one of the outstanding challenges going forward in quantitative equity portfolio management.

Some firms that are not modeling transaction costs put trading constraints on admissible stocks. One such firm with more than

75% of its equity assets under quantitative management mentioned that they use exclusion criteria such as trading volume and market capitalization.

Extreme events and/or tail behavior are being modeled at 27% (10/36) of the participating firms. A source that is modeling extreme events commented, “Modeling tail behavior is a differentiator: it provides a better trap for capturing abnormal returns.”

“Modeling tail behavior provides a better trap for capturing abnormal returns.”

Only 2 of the participating firms report that they are modeling higher moments. This reflects the fact that, though conceptually well defined, in practice modeling higher moments and using them in portfolio construction is a tricky and data hungry task.

“We consider higher moments to be too technical, too price-related; our focus is fundamental analysis.”

One quant firm that is not modeling higher moments said, “We consider higher moments to be too technical, too price-related; our focus is fundamental analysis.”

Another firm not modeling higher moments remarked, “Institutional clients are concerned with down-side protection, so we concentrate here”.

Attempts to use textual data to forecast equity price movements remain limited to only the largest players (2 according to this survey). One source that is working with academia on natural language processing remarked, “The sheer volume of textual data is a problem: how do you process it? And then there is the problem of turning the data into signals, which is a major challenge.”

Only 2 sources are trying to model textual data: the challenge continues to be considered to be formidable.

In the 2003 Intertek study, it was precisely the difficulty of relating textual data to price movements that caused one firm to abandon their efforts in text mining. Smaller firms continue to find the requisite investment too high. A source at a mid-sized quant shop commented, “We might look at textual data in the future – but the data and computer infrastructure cost is quite prohibitive.”

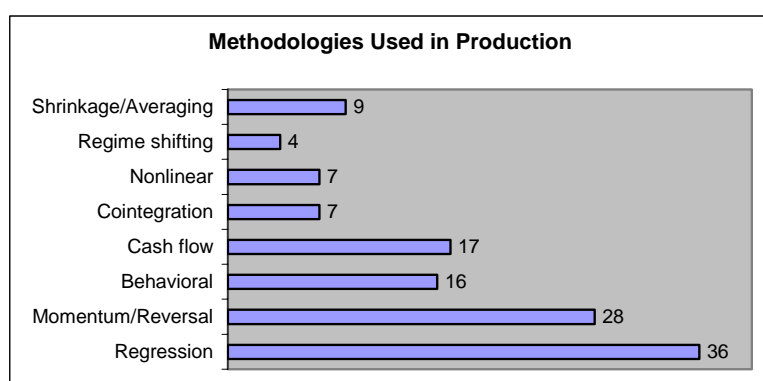
As for some of the other phenomena, 55% (20/36) of the respondents model volatility, 50% currency, and 44% (16/36) derivatives.

One source that is modeling derivatives and currency said. “We use futures to reduce risk and more efficiently manage cash and derivative structures as potential alpha sources. We also model currency to understand if we should hedge our currency exposures or use currency as an additional alpha layer.”

5. MODELING METHODOLOGIES BEING USED

With respect to the 2003 study, asset managers are using a wider range of methodologies to model equity price returns. While regression analysis and momentum modeling continue to be the most widely used techniques (respectively 100% and 78% of the participants use these techniques), cash flow analysis and behavioral modeling have now been widely adopted. 47% (17/36) model cash flows; 44% (16/36) of the respondents use behavioral modeling. Modeling methods such as model averaging/shrinkage, cointegration, and non-linear methods are being used at roughly one fifth of the firms; other techniques are rarer.

The most widely used techniques are regression and momentum modeling.



Regression on factors and on company-specific predictors is the bread-and-butter of return modeling. Common implementations forecast future returns by regressing them on current corporate financial ratios. All respondents, including those with no equities under quantitative management, report that they are using these models.

Regression remains the bread-and-butter of return modeling...

Sources at traditional asset management firms typically use factor models to control risk or build stock screening systems. A source doing regression on factors to capture the risk-return trade-off of assets said, “Factor models are the most intuitive and most comprehensive models for explaining the sources of risk.” Another source at a firm with no equity assets under quantitative management remarked, “Factor models are powerful for quantitative stock ranking modeling and for portfolio risk modeling.”

The use of factor models as forecasting models, with factors being used as predictors, was an important conceptual and practical shift: it opened the quest for new and different (alpha-generating) factors with greater predictive power.

A source at a quant shop using regression to forecast returns said, “Regression on factors is the foundation of our model building. Ratios derived from financial statements serve as one of the most important components for predicting future stock returns. We use

these ratios extensively in our bottom-up equity model and categorize them into five general categories: operating efficiency, financial strength, earnings quality (accruals), capital expenditures, and external financing activities.”

While most respondents using factor models in return forecasting mentioned that they were a fundamental part of their modeling exercise, a few sources stated that they are reducing or have reduced the weighting attributed to factor models. These firms are now giving more weight to momentum/reversal models.

... though a few firms are reducing the weighting attributed to factor models.

While all respondents use regression models, more than three quarters, as mentioned above, also use a momentum and/or reversal component. Momentum models model the persistence of local trends such as rising prices; reversal models model the inversion of local trends, such as price reversals. The need to combine regression on predictors which capture value and momentum/reversal models which capture sentiment is behind the coupling of these two modeling techniques.

More than 3/4ths of the participants use a momentum component in their return modeling.

A source at a quantitative investment firm sums up the consensus: “We use momentum models extensively together with regression. We believe that one needs a bit of both fundamental value and market sentiment.”

Respondents mentioned that there are problems in using momentum and/or reversal strategies. One problem is identifying the time horizons of both momentum and reversals. Some firms commented that performance based on these strategies can be erratic: changes in the momentum/reversal horizon can turn profits to losses. One firm said that it is handling this problem by averaging on different time horizons.

Problems in using momentum and/or reversal strategies include the long times series required and the resultant high turnover. Reversal strategies present the added difficulty of timing the reversal.

Another problem is the high turnover of momentum and reversal strategies. Sources with experience with both remarked that the problem with high turnover is more acute with reversal strategies, and there is the additional difficulty of the precise timing of reversals. For this reason, some firms are limiting the application of reversal models.

However, a source where momentum and reversal models are the main drivers of the quant equity process commented, “Turnover is high, but we use turnover constraints (i.e., a penalty function) to reduce trading.”

A third problem is that momentum/reversal is often used as a mechanistic strategy (buy winners, sell losers) while a better understanding of the econometrics behind these strategies would be beneficial. One source suggested that autoregressive models might be used to explain the econometrics behind momentum/reversal phenomena: these models make forecasts at

the aggregate (e.g., index) level as opposed to the individual stock level. According to this source, “Autoregressive models might be considered an extension of momentum models, but they are a step ahead.”

Just about half the survey participants (47% or 17/36) model cash flows. A number of sources attributed the better performance of valuation models to the use of discounted cash flow models. One source said, “We are placing more and more emphasis on discounted cash flow models rather than the traditional earnings analysis.”

One of the biggest changes in return forecasting with respect to the 2003 study is a greater use of behavioral modeling. As mentioned, 44% (16/36) of the respondents report that they are using behavioral models.

A source at a large investment firm that has incorporated behavioral modeling into its active equity strategies commented, “The attraction of behavioral finance is now much stronger than it was just five years ago. Everyone now acknowledges that markets are not efficient, that there are behavioral anomalies. In the past, there was the theory that was saying that markets are efficient while market participants such as the proprietary trading desks ignored the theory and tried to profit from the anomalies. We are now seeing a fusion of theory and practice.”

Behavioral modelers attempt to capture phenomena such as departures from rationality on the part of investors (e.g., belief persistence), patterns in analyst estimates, and corporate executive investment/disinvestment behavior. A source at a firm that has recently implemented behavioral finance concepts in their active equity funds commented, “Behavioral finance research has identified and documented departures from rationality that many investors tend to exhibit.”

A major difficulty in using behavioral modeling is that of translating departures from rationality into a set of rules for identifying the stocks as well as the entry and exit points for a quantitative stock selection process.

Cointegration is being used by 19% (7/36) of the respondents; this is up from the 2003 study, which found that cointegration was largely ignored by the investment management community, though it was being used by brokers in pairwise trading. Cointegration models the short-term dynamics (direction) and long-run equilibrium (fair value).

A perceived plus of cointegration is the transparency that it provides: the models are based on economic and finance theory and calculated from economic data. A difficulty in using

Cash flow analysis is improving the performance of valuation models.

One of the biggest changes in return forecasting with respect to the 2003 study is a greater use of behavioral modeling.

One problem in using behavioral finance is translating the insight into investment and trading rules.

Once largely ignored by investment managers, cointegration is now being used at almost one fifth of the participating firms.

cointegration is that cointegrating processes apply not only to pairs of assets but also to portfolios: finding cointegrating portfolios is a computationally complex task.

A source at a firm that has applied co-integration remarked, “Applying cointegration is difficult: it requires a lot of time and patience as well as long data samples, from 100 to 200 monthly observations.”

Nonlinear methods are being used to model return processes at 19% (7/36) of the responding firms. The nonlinear method most widely used among participants is CART (classification and regression trees). The advantage of CART is its simplicity and the ability of CART methods to be cast in an intuitive framework.

CART is the most widely used of the nonlinear modeling techniques.

A source using CART as a central part of the portfolio construction process in enhanced index and longer-term value-based portfolios said, “CART compresses a large volume of data into a form which identifies its essential characteristics, so the output is easy to understand. CART is non-parametric - which means that it can handle an infinitely wider range of statistical distributions - and nonlinear – so as a variable selection technique it is particularly good at handling higher-order interactions between variables.”

While the number of investment firms actually using nonlinear methods is limited (lack of requisite skills in-house, the lack of an economic explanation, the danger of overfitting, and client reluctance were cited as the main causes), there continues to be considerable interest in nonlinear methods. Some firms that are not using nonlinear methods in production are exploring their potential.

Not widely used in production, nonlinear methods are being experimented with at many firms.

A source at a mid-sized quant firm that has found that nonlinear approaches (CART) can be useful in creating screens that filter buy candidates in the optimization process but is not implementing these techniques said, “We may continue to explore nonlinear methods, but we are very cautious about the interpretability.”

Another source at a firm that has tested various nonlinear methods for stock selection within an economic sector commented, “The results were stable and superior to those of our existing models. The problem with a nonlinear approach is that it is perceived to be a black-box approach and it is more difficult to convince potential clients of the merits of these techniques.”

Only 11% (4/36) of the respondents use regime shifting models; at most firms, judgment is used to assess regime change. Obstacles to modeling regime shifts include the difficulty in detecting the precise timing of a regime switch and the very long

Most firms use judgement, not models, to assess regime change.

time series required to estimate regime shifts.

A source at a firm where regime shifting models have been experimented with commented, “Everyone knows that returns are conditioned by market regimes, but the potential for overfitting when implementing regime switching models is great. If you could go back with fifty years of data – but we have only some ten years of data and this is not enough to build a decent model.”

42% (15/36) of the respondents report that they do advanced balance sheet analysis. A source at quant firm said, “Advanced analysis of not just the balance sheet but the whole of financial statements is the foundation of our modeling process.”

Firms are taking a closer look at corporate balance sheets in an effort to identify new sources of alpha.

The need to identify new factors as a source of alpha is behind the efforts at some firms to take a closer look at corporate balance sheets. One source commented, “We are considering how to add accounting and balance sheet data beyond the obvious easy data. This would call for a combination of skills including accounting, math, and programming. The researcher would have to understand how to apply statistical techniques - including eventually nonlinear statistical techniques - to a lot of bulk data.”

Note that most asset management firms are now routinely using at least simple regressive models. Regression is a statistical technique used to represent an unknown variable(s) in function of a known variable(s) plus noise (i.e., error). The quest for different and more powerful predictors (rather than for more powerful models) has become the key modeling challenge. To a certain extent, this is also reflected in the expected evolution of the profile of portfolio managers (see below), with many firms putting the accent on a skill set encompassing not only mathematics and finance but also accounting and programming abilities.

With most firms now using several return forecasting techniques, the problem of model risk can be mitigated by model averaging and shrinkage. One fourth (9/36) of the survey participants report that they are now using these techniques; this is up on previous studies.

One fourth of the participants are using model averaging & shrinkage to mitigate model risk.

Model averaging and shrinkage diversify model risk by averaging forecasts. Based on the principle that the errors made by the various return forecasting models are uncorrelated or only slightly correlated, they are the model risk equivalent of diversification. Other techniques to mitigate model risk, such as random coefficient models that average the models themselves and not the model forecasts, are not being used in the industry. A survey done in 2005 for the CFA Institute’s monograph *Trends in Quantitative Finance* found that only 1 in 21 firms was using this technique.

6. MODELING WITH HIGH-FREQUENCY DATA

14% of the respondents (5/36) use high-frequency data (HFD), to identify profit opportunities and improve forecasts; another 3 plan to use HFD within the next 12 months.

5 out of 36 respondents use HFD, to identify profit opportunities and improve forecasts.

A source at a large investment firm that is using HFD said, “We use high-frequency data in event studies. The objective is to gain an understanding of the mechanisms of the market.”

A source which is planning to use high-frequency data in the coming 12 months remarked, “We believe that high-frequency data will allow us to evaluate exactly when it is optimal to trade, for example at close, VWAP, or mid-day, and to monitor potential market impact of our trades and potential front running of our brokers.” (VWAP stands for volume weighted average price.)

Among the sources not using high-frequency data, the drawbacks are considered to be an unattractive noise-to-signal ratio or resistance to HFD-based strategies on the part of institutional investors.

7. PERFORMANCE ISSUES

Among the outstanding challenges to modelers, survey participants cited the problem of the persistence of model performance. One possible remedy is to reparameterize models. A source at a quant firm said, “The problem is one of balancing the need to update models versus the robustness of results. When, over several months, performance is better in backtesting than in the real-world, one has to evaluate the need to change the model.”

Persistence of model performance remains a challenge.

Another challenge to modelers is the need to wring more performance out of the models. The head of active equities at a large quantitative firm with more than a decade of experience in quantitative management remarked that a major challenge going forward is to improve on model performance: “Everyone is using the same data and reading the same articles: it’s tough to differentiate.”

Wringing out more performance from existing models is another challenge.

The use of quantitative methods in passive funds where turnover is typically low and the goal is to reduce the number of stocks in the fund, did not present problems of performance: passive management does not suffer a significant reduction in performance if many funds use the same techniques. However, with many participants now using quantitative methods in active equity portfolio management, a new problem emerges: to ensure that models continue to generate alpha, one must do something different from the competition – otherwise there is the risk that

model performance decays. The reluctance of many quantitatively managed asset management firms to discuss the models they use is tied to this belief.

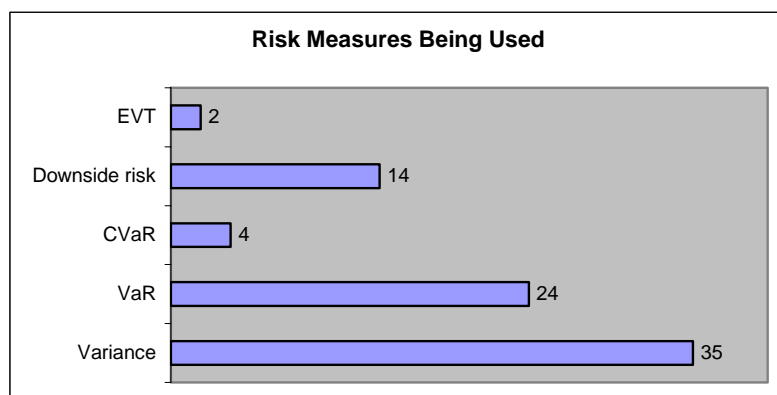
The ability to find new areas of profitability, new aspects of market inefficiency is increasingly difficult. The head of active equities at a quant firm said, “Once you have something that works reasonably well, it is hard to find a new addition that is a statistically significant improvement.”

Performance can also be measured by other parameters, such as in engineering high information ratios or limited drawdowns. These are increasingly of interest to institutional investors.

8. RISK & RISK MODELING

Risk is being measured at all the responding firms. Risk measures most widely used include variance (97% or 35/36), Value at Risk (VaR) (67% or 24/36) and downside risk measures (39% or 14/36); Conditional VaR (CVaR), and extreme value theory (EVT) are used at 4 (11%) and 2 (6%) firms, respectively. Many firms compute several risk measures: the challenge here is to merge the different risk views into a coherent risk assessment.

The risk measure most widely used is variance followed by VaR and downside risk. Only 4 firms use CVaR and 2 EVT.



To a certain extent, risk has also been redefined. In previous studies, risk was typically defined as tracking error risk: market risk was considered the investor’s risk while the investment firm’s risk was limited to the risk of underperformance relative to a given benchmark. Several things have changed. First, investors are seeking protection against market risk. Second, institutional investors are increasingly concerned about covering future liabilities.

Risk is being redefined. Retail investors are seeking protection against market risk; for institutional investors, the focus has shifted to the need to cover future liabilities.

One source commented, “We have large institutional investors whose interest is in protection against market downside, not the downside of individual companies, so we concentrate on this. A focus on liabilities and downside risk is what the consultants

prescribe.”

In response to investor demand for returns while protecting against volatile equity markets, investment firms are proposing products such as total-return/absolute-return funds and VaR products. Because firms offering these products have effectively accepted a transfer of market risk from the investor to the investment firm, the latter need to protect themselves with investment strategies that eliminate or at least minimize the risks inherent in the guarantees they offer. Thus the need to hedge the risk by creating replicating strategies similar to those used by investment banks.

A source at a mid-sized continental investment firm said, “We are now confronted with the need to manage market risk, and not just tracking error risk. We are engineering asymmetric total-return strategies using options or the replication of option payoffs. In blending concave and convex strategies with options, we use modeling to find multiple alphas, replicate them without return forecasting, and perform the risk budgeting exercise.”

Another risk: institutional investors in some markets are embracing performance-based remuneration, adding an additional risk that investment firms will need to control. A source in the UK said, “Performance-based remuneration is gaining favor and has grown rapidly over the past two years. This has drawn finance directors into the picture; they are beginning to take a greater interest in portfolio risk. The problem is: it is very difficult to get a stable risk model.”

Growing favor of performance-base remuneration is leading to a greater interest in portfolio risk by finance directors.

9. OPTIMIZATION

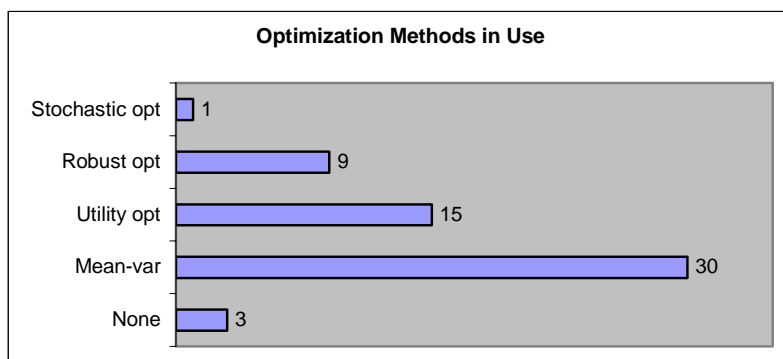
According to sources, optimization is now performed at 92% (33/36) of the participating firms. This is a significant development compared to just a few years ago when many sources reported that they eschewed optimization: the difficulty of identifying the forecasting error was behind the then widely held opinion that optimization techniques were too brittle and prone to “error maximization.”

An important development over several years ago is the increased use of optimization: More than 92% of the participants use some optimization technique at least some of the time.

A greater use of optimization is due to advances in large-scale optimization coupled with the ability to include constraints and robust methods for estimation and optimization itself. It is significant: portfolio formation strategies rely on optimization. With optimization now feasible, the door is open to a fully automated investment process. In this context, it is noteworthy that 55% of the survey respondents mentioned that at least of portion of their equity assets is being managed by a fully automated process.

Among the sources performing optimization, mean-variance is the most widely used technique: it is being used by 83% (30/36) of the respondents. Follow utility optimization (42% or 15/36) and, more recently robust optimization (25% or 9/36). Only one firm mentioned that they are using of stochastic optimization.

Mean-variance is the most widely used optimization technique; only 1 firm uses stochastic optimization.



It is likely that robust optimization, and robust techniques in general, will become increasingly important with the growing diffusion of quantitative methods. It is also likely that, if asset managers want to win broader mandates with institutional investors, they will have to master stochastic optimization, the only optimization technique that allows to optimize investments subject to a stream of consumption.

A number of firms use alternative techniques. One source at firm that has eschewed stochastic optimization remarked, “Our evaluation is that stochastic optimization is too complex: we make multi-stage decisions using ranking models rather than stochastic optimization.”

10. ORGANIZATIONAL ISSUES

Investments in the IT infrastructure to support the modeling effort are up compared to 2004/2005 at 61% (or 23/38) of the responding firms, stable at 34% (13/38) and down at 5% (2/38). A variety of firm-specific situations explain this result.

Investments in the IT infrastructure to support the modeling effort are up at 61% of the firms.

A source at one firm that is seeing its quant funds outpace other funds in terms of growth in assets under management commented, “Our investments in the IT infrastructure are up significantly over 2004/2005: the investment is required to support scalability and further business growth.”

A source at a US firm with a strictly quantitative approach remarked, “We have doubled the number of investment professionals. Since most products are licensed per person, our IT and data costs have risen significantly. We also continue to see substantial price increases from the IT and data vendors.” Other

sources remarked that while the costs of hardware have dropped, the cost of data and software licenses has increased.

Several sources where quantitative methods are used essentially in risk management mentioned that investments in the IT infrastructure were being driven by new regulatory requirements for risk monitoring.

The number of persons engaged in quantitative equity research is up at almost 3/4ths of the responding firms (74% or 28/38), stable at 18% (7/38) and down at 8% (3/38).

The motivating factors at firms reporting an increase in the number of quantitative equity analysts include business growth at quantitative firms, an increase in the number of quant products at firms with mixed traditional/quant management or a strategic decision to grow the quant equity business at traditional firms, the need to maintain a competitive edge in research, and new regulatory requirements for risk monitoring.

A source at a US quant firm that has significantly increased its quantitative equity research team said, “Existing strategies have attracted substantial inflows. We are building on this success by launching many additional strategies. These new strategies require additional staff.”

A source at a firm where both investments in the IT infrastructure and in the number of persons engaged in quantitative research are up significantly remarked, “We consider these good investments because quantitative investment processes are transparent and back-testable, and allow for better risk control.”

55% of the of the respondents (21/38) said that the profile of the equity portfolio manager at their firms is more math-oriented than two years ago or, for quant firms, stable with a high level of math skills. 39% of the respondents (15/38) reported that the profile of their portfolio managers was stable: this includes all participating firms with that can be described as essentially traditional managers. 5% of the respondents (2/38) said that they were hiring fewer math types, either due to a reorganization or to the poor performance of quant-run funds.

A source at a firm that is hiring more math types as portfolio managers commented, “When using a systematic investment process, skills other than just stock picking abilities are relevant from a risk management perspective.”

Another source at a traditional management firm where the profile of the portfolio manager is increasingly math-oriented explained, “There is much more risk control; quantitative portfolio construction techniques are being used; there is a greater use of

The number of persons engaged in quantitative equity research is up at 3/4ths of the participating firms.

More than half (21) of the respondents said that the profile of portfolio managers at their firms is now more quant-oriented than two years ago or, for quant firms, stable with a high level of math skills; it is less quant-oriented at 2 firms and stable at 15 of the participating firms.

quantitative screening techniques and of pure quant management.”

Among the 55% mentioning that they are hiring more math types as portfolio managers, nearly half mentioned that they were looking for a combination of skills: an understanding of economics, finance and accounting combined with good math skills is widely considered to be a requisite. As one source summed it up, “We have better tools and more data, but do we have an economic rationale?”

A source at a firm that is beefing up its quantitative team added, “We will be hiring more of the math types as portfolio managers because the nonlinear techniques that we would like to test and eventually implement are becoming more and more complicated. At the same time, it is essential that we understand what we are doing and where our performance is coming from. This is the reason why the majority of our portfolio managers will continue to have a background in finance.”

A source from another firm that puts the accent on creativity and innovation and expects to hire more math types but also persons with a background in econometrics, (corporate) finance, and accounting, said, “Diverse backgrounds bring better innovation and richer diversification.”

9. CHALLENGES GOING AHEAD

The phase of experimentation with sophisticated statistical and mathematical methodologies such as chaos theory, machine learning, evolutionary programming and genetic algorithms might well be over, but this survey indicates that modeling and, in particular, techniques such as regression analysis and momentum/reversal strategies have been widely adopted throughout the industry.

Though mathematically simple, these techniques can be difficult to deploy. Regression requires a judicious – even innovative - choice of predictors; momentum and reversal strategies depend on accurately optimizing the momentum estimation window and the timing of reversals. The mathematical simplicity of the models calls for more economic insight behind return forecasting. It is significant that survey participants mentioned the need for a combination of skills: an understanding of economics, finance, accounting, and good math skills.

Two main challenges for asset managers emerge from this survey: differentiating quant-based products and stabilizing (or improving on) model performance.

The need to offer innovative products - essentially portfolios with specific risk-return profiles - calls for the use of real-world utility functions: real-world utility functions are the engineering tool required for flexibility in designing products with a determined risk-return profile.

Firms with the ambition to play an asset/liability management (ALM) consulting role with institutional investors will also have to adopt some form of stochastic multistage optimization. Institutional investors typically need to invest to meet a stream of future liabilities; optimizing investments when liabilities are present requires stochastic optimization.

As for the second challenge - stabilizing (or improving on) model performance -the problem is difficult to formulate. Do the market inefficiencies that the models are intended to exploit disappear as more players try to exploit them? Or does the wide use of models eliminate some inefficiencies and contemporaneously create others? In any case, there is the need for more research on how prices are formed in markets whose actors can be classified in broad categories with defined strategies.

A related question is the use of High Frequency Data (HFD). Because HFD offer a two-thousand fold increase in data, they offer the possibility of adopting much richer modeling strategies – which might help address the problem of performance decay. The advantages of using HFD have been demonstrated in areas such as volatility, where the use of HFD allows a high-precision measurement. Survey participants using HFD (only 5 out of 36) cite the ability to identify profit opportunities and improved forecasts as the benefit.

About Frank J. Fabozzi

Frank J. Fabozzi is an Adjunct Professor of Finance and Becton Fellow in the School of Management at Yale University. Prior to joining the Yale faculty, he was a Visiting Professor of Finance in the Sloan School at MIT. Frank is a Fellow of the International Center for Finance at Yale University and on the Advisory Council for the Department of Operations Research and Financial Engineering at Princeton University. He earned a doctorate in economics from the City University of New York in 1972.

About The Intertek Group

The Intertek Group is a Paris-based firm providing field research, training, and consulting to the financial services sector and its suppliers. Intertek partners co-authored the CFA Institute's recent monograph *Trends in Quantitative Finance* (co-authors F.J. Fabozzi and P.N. Kolm), the award-winning books *The Mathematics of Financial Modeling and Investment Management* (co-author F.J. Fabozzi, Wiley, 2004) and *Financial Modeling of the Equity Market: CAPM to Cointegration* (co-authors F.J. Fabozzi and P.N. Kolm, Wiley, 2006) as well as the forthcoming *Financial Econometrics* (co-authors Rachev, Mittnik, Fabozzi, and Jasic, Wiley).

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