Volume VI • Issue 1

VISION

THE EVOLVING ROLE OF TECHNOLOGY IN FINANCIAL SERVICES

STATE STREET

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Foreword

by Christopher Perretta
Executive Vice President and Chief Information Officer

Since the advent of the earliest adding machines and mainframe computers, technology, and the innovations it has helped to bring about, have played an increasingly important role in the evolution of the financial services industry. Traditionally, the pace and impact of these technological advances has been gauged using easily quantifiable metrics such as storage capacity and processing speed. Today, however, when it comes to the application and potential of technology in the financial services industry, we're witnessing the emergence of a number of new and rapidly accelerating trends that promise to usher in an entirely new paradigm — one in which Information Technology (IT) is not simply an "add-on" at the periphery of the business function, but rather deeply embedded at its very core.

The lines between what we've traditionally viewed as the "technology" part of an organization and the rest of the business are blurring like never before. For industry players, the business implications of this convergence will be impossible to ignore.

In response to clients' demands for more and faster information, greater transparency and improved risk management, providers are applying the vast computing power at their disposal toward an increasingly complex, sophisticated and integrated array of tasks. As a result, today's investors are able to see detailed, nearly instantaneous views of their exposures and portfolios at any time. They're able to consider billions of scenarios for millions of investment positions. And the models they're considering are being built by an entirely new breed of financial practitioner — one who possesses a keen understanding not only of critical business processes, but also of the technology that drives them.

And underlying all of these changes is a fundamental shift in the industry's perception of the intrinsic value of the raw data itself. Rather than a mere commodity, this data is increasingly viewed as the invaluable business asset it truly is. The reason for this significant shift in perception is that new technological innovations are empowering us to slice, dice, process, manage and correlate data in ways that give it exponentially greater value in the eyes of our clients, allowing them to make more informed investment decisions than ever before.

Looking ahead, continuing advances in technology will allow the financial services industry to deploy increasingly sophisticated, forward-looking analytics to help clients make more informed investing decisions. Even at their most detailed, the financial reports of today can only provide the industry with a glimpse in the rearview mirror. The financial reports of tomorrow, however, promise to help the industry better understand the actual precursors of performance. In the not-too-distant future, rather than simply providing clients with a simple description of their risk position, we will be able to provide them with detailed insights into the actual factors contributing to those risk positions. The implications of this shift cannot be overemphasized, as they will have reverberating effects on the habits, business processes and decision-making processes of institutional investors around the globe.

Another critical advancement fueling innovation in the industry is the deployment of cloud computing. Although cloud computing is not new, and has a well-established track record in other industries, it is just beginning to take hold in financial services. Operating in a cloud environment brings a range of client benefits, from automation and capacity on demand, to accelerated time to market, real-time data infrastructure and strengthened client service. Cloud environments are also advanced platforms for product and service innovation, including custom analytics and data, as well as risk and control, performance, compliance and advisory services. Importantly, working in a private cloud environment also ensures data security.

In this Vision report, we examine technology's increasing role in the financial services industry by bringing together the expertise of four of our executives across our investment servicing, investment research and trading, and investment management businesses. The report spans three distinct areas of the use of technology in financial services: analytics, electronic trading and regulation, and portfolio allocation and modeling.

William Pryor is senior vice president and head of State Street Investment Analytics (SSIA), which provides our clients services including performance measurement, attribution, universe comparison, ex-post and ex-ante risk, transaction analytics, compliance, information delivery and data warehousing. In "Technology with a Purpose: The Next Generation Today," he describes asset managers and asset owners' increasing need for more detailed portfolio analytics, process transparency, risk management systems and dashboards to improve the kind of information they are receiving and their access to it. He explains that by integrating risk and return technology, investment service providers can give their clients the information they need to invest successfully and better manage their portfolios.

Clifford Lewis is executive vice president and head of State Street's eExchange business, which provides electronic trading solutions for foreign exchange, precious metals, cash, US treasury securities, futures, money markets and exchange traded funds. In "Adapting to the New Regulatory Environment" he explores the growth of electronic trading, highlighting some of the key regulatory implications. Clifford characterizes technology as "the great equalizer," and outlines the vital role it has to play in effectively meeting the challenges inherent in the Dodd-Frank Act and MiFID II.

Jessica Donohue is senior managing director and head of State Street Associates (SSA), State Street Global Markets' industry and research partnership with academia, and is responsible for developing the entire complement of SSA's innovative research on behalf of State Street Global Markets' clients and businesses. Mark Hooker is senior managing director of State Street Global Advisors (SSgA) and head of its Advanced Research Center (ARC), and is responsible for the worldwide development and enhancement of SSgA's quantitative investment models. In "Portfolio Allocation and Modeling — A Technological Arms Race?," Jessica and Mark talk about the increasing reliance on technology to solve today's leading global asset management challenges, including market crowding, pricing inefficiencies, risk and rebalancing.

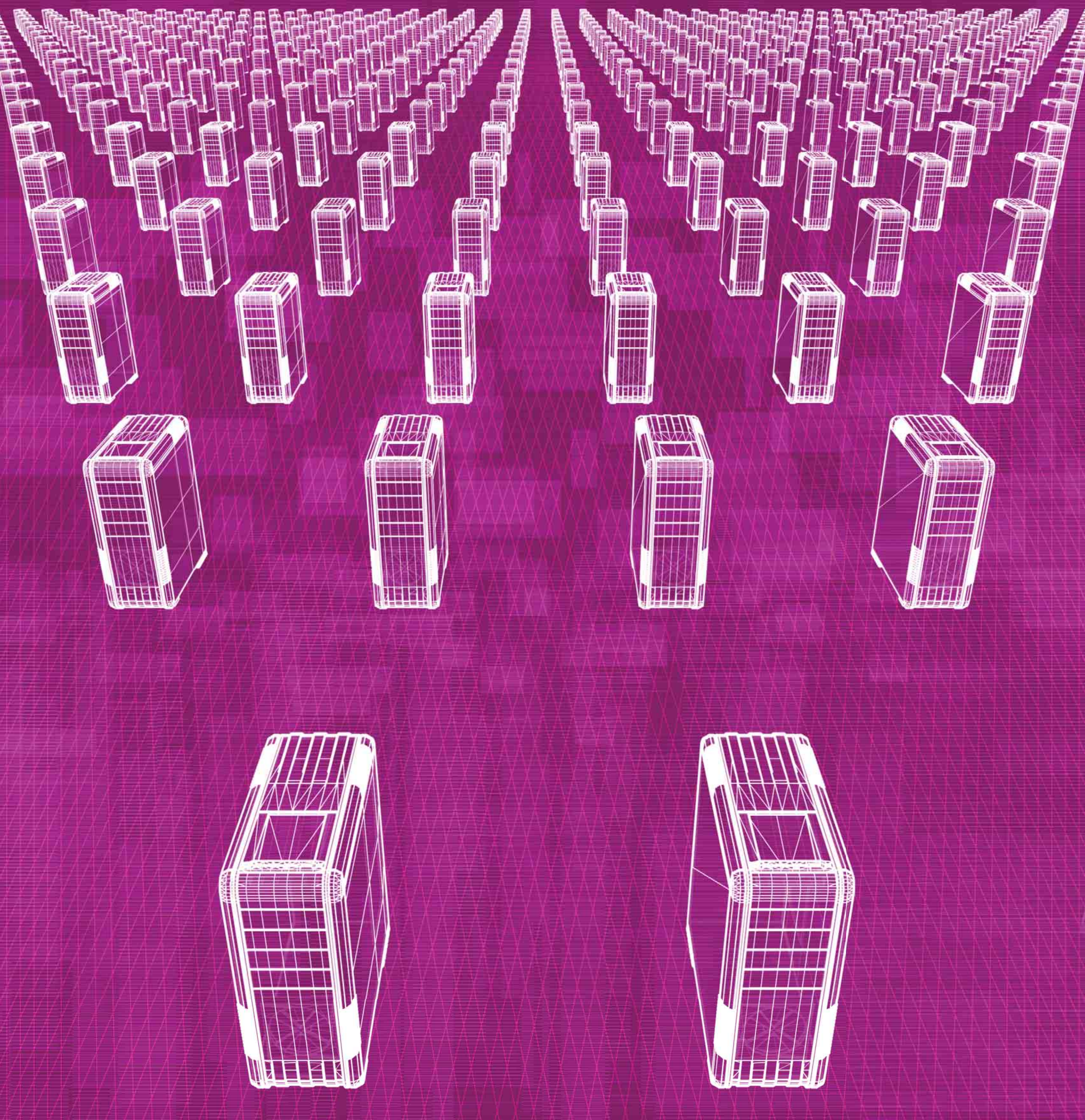
Anyone familiar with Moore's Law knows that it refers to a long-standing trend in the computer industry in which the number of transistors that can be placed on an integrated circuit doubles every two years. This trend, which has continued for more than half a century, tells us that future advances in processing power and capacity will not be linear, but exponential. For the financial services industry, this translates into nearly limitless opportunities to put this emerging wealth of computing power to work.

The leaders and visionaries of the financial services industry are already mobilizing and strategizing to redeploy their technical resources to reflect this changing technological environment. And it is clear that those companies that are able to capitalize on the capabilities and opportunities presented by this changing paradigm will enjoy a distinct competitive advantage.

Chapter I

TECHNOLOGY WITH A PURPOSE: THE NEXT GENERATION TODAY

by William Pryor



Technology with a Purpose: The Next Generation Today

by William Pryor

Technology has long been an essential behind-the-scenes partner in the financial services industry, providing the innovative incremental advances necessary for the industry to upgrade and expand its services. Improvements in storage capacity and processing speed, for example, have had a profound impact on data management and transactional capabilities, with accompanying reductions in cost. Yet despite these and other advances, the industry has struggled to fully leverage the power and promise of technology, with market participants eager for solutions that are not only faster and cheaper, but that also offer greater security and efficiency.

Relentless pressure on budgets has made cost containment and reduction an increasingly critical operating factor in the current environment. As firms struggle to compete, technology — often viewed as a driver of rising costs — is being pushed to overcome this fundamental challenge. At the same time, across the financial services industry, demand is growing for greater transparency, information and analytics; improvements to portfolio management and risk reduction; and new asset classes, products and services. All of this is being demanded as quickly as possible, although the reality is that developing new applications — at least currently — is a time-consuming endeavor that can take months or even years. Further complicating matters is the fact that the bar is constantly rising. Every shift in the business and regulatory environment heightens expectations in terms of the role technology should play in increasing security and reducing risk.

Another challenge facing financial services organizations is that they are supported by information technology functions that tend to mirror the compartmentalized organizations they serve, creating an indirect drag on efficiency. To support their broad data management tasks, these IT functions must often support divergent legacy accounting systems and platforms, as well as a profusion of add-on components that tie them all together. The end result is a diverse technology environment that is both costly to maintain and complex to retrofit.

On top of these pressures, market participants must continue to cope with an uncertain landscape marked by evolving regulatory issues, the hunt for investment returns and new client service demands, all of which further strain already overburdened IT systems and organizations. Taken together, these business dilemmas illustrate the need for fresh approaches to technology and underscore the increasingly critical role that lies ahead for third-party providers seeking solutions to meet these challenges head on.

Vision for the Future

Fortunately, the story of technology innovation within financial services does not end with these challenges. Several rapidly accelerating trends are laying the groundwork for the emergence of a new business and IT paradigm that promises to upend conventional thinking about the roles and capabilities of IT systems. First, information technology is increasingly viewed as an integral business function for financial services firms that must be oriented to achieve business results across the organization. Second, technology development is undergoing a transformation as the globalization of the workforce enables around-the-clock schedules, open source-based strategies gain acceptance and firms look to multiple procurement partners. Third, across the industry, data is increasingly being regarded as a profoundly valuable type of asset.

Although the origins of these trends pre-date the financial crisis, the market downturn has heightened the sense of urgency underlying them. Tough challenges invite bold solutions, and in response to that call, a visionary solution is taking shape.

While opinions differ as to the details and timing, the next generation of technology will draw on both clients' needs and the trends cited above to emphasize technology with a business purpose. At its core, an innovative new approach to technology would integrate and correlate information from a range of sources like never before, producing results that far exceed the sum of their parts. It would apply massive computer power to data (appropriately valued as an asset rather than a cost), allowing end users to experience a seamless flow of information through an expandable set of data management and processing tools across the full spectrum of risk and return management. Resting on a single multi-use platform, this highly integrated system would have the scale and flexibility to dramatically drive down data costs and would eventually evolve to offer predictive capabilities, among other highly useful functions. All of this would occur while enhancing the risk and compliance environment. In the end, this approach to technology envisions a means of fundamentally empowering the end user to accomplish business objectives rapidly and cost-effectively.

Such a solution opens the door to benefits that have long been viewed as essential goals for the future. Unleashing the full value of data, for instance, should incentivize market participants to optimize the use of the information that already resides in their IT systems but hasn't yet been fully leveraged. Such data could, for example, be used to create real-time awareness of any transaction's status globally, facilitating decision-making from a holistic perspective. And, as storage capacities rise dramatically, firms can use their vastly increased information resources to offer a wider range of services (drawing on data now optimally leveraged) at significantly lower costs.

For end users, the ultimate goal is to gain access to a dynamically complete investment picture that provides a look across the risk and return spectrum of capabilities, and plumbs the depths of asset classes in all their configurations. Solutions emerging today bring that goal ever closer.

The True Value of Data

As a key element of this vision, information technology no longer occupies its traditional place in the organization as a support function. Instead, it becomes a business function true to its essential mission: managing data as a genuine asset. Going forward, data will not simply represent inventory to passively store or warehouse, but rather dynamically interconnected information to correlate, integrate and use holistically. Indeed, the warehouse becomes the nerve center that adds value to stored legacy information, turning it into an actionable commodity.

In fact, at every step, information will acquire value just like any asset in a portfolio. A primary purpose of technology will become implementing strategies for enriching data to achieve larger business objectives across all functions. Such strategies will allow for enhanced reporting and analytical capabilities, including, for example, the use of data to test risk and investment assumptions, and to explore predictive scenarios built around various decision paths. Indeed, data management in the future will comprise only one element in an integrated series of operations that begins with transactional processing and includes work flow technology (to enable business automation), exceptions monitoring, data management and end-use data-rich dashboards (see page 9 for a discussion of dashboard capabilities).

This approach to information also recognizes that data needs differ among asset classes. While a single-tool approach tends to oversimplify this reality, the ideal solution will feature multiple tools seamlessly integrated into all functions and work processes, managing the data behind it and the business processes that support the data. More importantly, usability, business objectives and the search for value — all defined from the perspective of internal and external clients — will drive the design.

Platforms for Performance

Supporting these highly integrated operations will be “near turn-key” platforms that will only require human intervention for added-value tasks, such as the review of errors and exceptions. The vast bulk of processing functions will occur via high-speed automation, radically cutting work flow cycle times (particularly for hard-to-process asset classes such as over-the-counter derivatives). This approach not only reduces costs, but also makes data available far sooner — thereby further increasing its value.

At the same time, despite their versatility and powerful capabilities, reusability is key to making these platforms the centerpiece of technology strategies in financial services. Rather than be the cumbersome one-off end products of long development processes, they must result from short, modular development cycles that allow for ease of installation and ease of use. In addition, platforms cannot just be flexible; they need to be scalable, too. Economies of scale, alongside automation and innovative reusability, allow companies to shrink costs in ways that have long eluded IT organizations and the firms they support.

For providers, this idea carries huge implications for the future of the financial services industry. While it leverages best-of-breed technology capabilities, it also ratchets up the focus on quality of execution and service excellence. It is a solution that offers little room for over-promising and under-delivering.

Visions of what technology can accomplish are neither new nor rare. Unmet expectations are a universal source of management despair as project costs break budgets and promised deliverables fail to materialize. While this particular vision, based on all-too-real needs, may look attractive to clients and providers, how feasible is it? The answer lies, in part, in recognizing that the financial services industry stands at a critical juncture: the technology challenges it faces are tightly intertwined with its overall business challenges, a strong motivation to succeed. So how can it realize this idea?

Architecture

The solution that is emerging across the industry is not a technological abstraction, but rather consists of several key elements that already lie within, or close to, the realm of current capabilities. These include:

- The ability to store, process, use and re-use information of all types and from all sources quickly and to make it accessible anywhere from multiple devices
- Automated low-maintenance platforms that allow for easy replication
- The ability to dramatically drive down processing costs
- New approaches to developing tightly integrated systems based on best-of-class components
- Increased performance and risk analytics
- Proactive "what if" capabilities

Technology solutions have always represented a work in progress, as learning curves are mastered, new assumptions are tested and old ones discarded. Current trends in the industry are rapidly shifting views about what is feasible. At the same time, they are the product of insights gleaned from lessons learned.

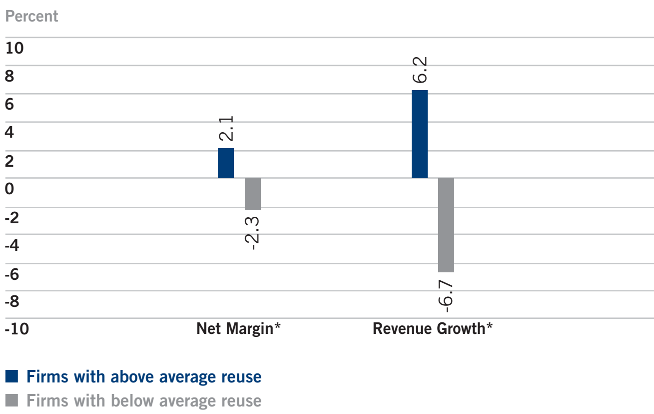
In considering how to move from vision to reality, a lesson in architecture is a good place to start. A defined reference architecture creates the framework that contains the key values, principles, assumptions and relationships that tie together processes, work flows and functions. It is the blueprint that sets out the rules for building and deploying systems and their enhancements. All too often, a system's architecture is inflexible, a barrier to change and a source of inefficiency resulting from a patchwork of subsequent fixes, add-on systems and course corrections.

A viable architecture to support solutions to today's business and technology challenges must embody several essential principles now entering mainstream thinking. Prime examples include emphasis on reuse of all information technology assets — software, data and processes — everywhere throughout the system. A second useful principle calls for component-based approaches to take precedence within all IT solutions and projects, in response to the "buy or build" dilemma, with customization reserved for standalone projects only. (This approach takes advantage of the gathering trend of commoditization occurring in the marketplace.) In addition, standardization — for example, with integration interfaces — should apply wherever possible. Thus, a standardized framework can provide for optimal flexibility and customization with remarkable efficiency, replacing a process of virtually continuous customization that represents an endless stream of "one-off" fixes.

Use and Reuse

Reuse, is a key architectural principle that is fast becoming a critically important emerging practice. A recent study conducted by the MIT Sloan School of Management's Center for Information Systems Research illustrates that firms that re-use their digital assets (their business processes, applications, data and technology) have higher growth and margins, and better meet business expectations, as shown in Figure 1.

Figure 1: Reuse Contributes to Firm Profitability and Growth



*Firm performance is FY 2008, industry adjusted. Median net margin is 4.3 percent and median revenue growth is 8.4 percent.
Source: Peter Weill, Stephanie Woerner and Mark McDonald, "Top Performing Firms Are Most Effective At Digital Reuse," MIT Sloan Center for Information Systems Research, Research Briefing Vol. X, No 10, October 2010.

While reuse offers a path to cut costs, perhaps more importantly it also offers a means to cut "time to market" — the development cycle that has too often turned into a graveyard for projects heavy on customization. Perhaps more important, it recognizes that IT assets have value that can be enhanced through reuse. This reality is especially true for data, which is frequently treated as if it were value-less. Reuse is also a useful example of how the industry can adopt practices considered standard elsewhere, such as among open source software developers.

Viewing data as an asset whose value can be repeatedly enhanced is the cornerstone of an effective data management solution. It drives the effort to add value to data faster, at diminishing costs, and with enriched content, available to support multiple cross-business requirements. It also makes security and encryption even more critical and underscores the need for identity-based access control, data entitlements based on role and data life-cycle policies.

Dashboards for Performance

An effective data management system will draw upon the reference architecture's fundamental principles to acquire, validate, secure, enrich and distribute data in a hub-and-spoke configuration. Thus:

- **Acquisition** will allow for multiple vendor sources, scheduled load balancing and timely updates, operations empowered to manage data flow through monitoring and exceptions, and integrity audits of incoming data
- **Validation** will store and review incoming data, monitor data for integrity, ensure that data can be compared, and establish rules for manual and exceptions work flow
- **Security** will ensure that data is protected and only accessed with appropriate authorization
- **Enrichment** enhances data from a variety of internal and external sources, and compiles new data fields as required
- **Distribution** employs standard data formats, integrates legacy data via flexible conversion, authorizes operations (as with acquisition) to manage data flow through monitoring and exceptions, and monitors data consumption

Similarly, transactional and data processing rely on minimal touch points, using high-speed automation to reduce time and cost. As such, flexible tolerance rules process straight through under a set of business-defined rules, while stopping the exceptions, subject to manual review. Moreover, providing access to the rules in plain text, distributed among the organization's internal clients, allows for more predictable results. In addition, tracing the provenance of data allows the history of each element of the work flow process to be audited. The centralized data model ensures that wherever the data sits, it is strictly controlled, along with access; any changes are strictly controlled and audited.

Dashboards and cloud computing are key ingredients to transforming tomorrow's vision into reality. And both technologies exist today. Although fundamentally different in mission and scale, they both share the goal of making vast amounts of information available in real time, as the result of a dramatic expansion in computing power.

Making data available to end users in a comprehensible format has always been a challenge for IT organizations, including providers. Historically, clients have reviewed data delivered in presentation-oriented reports. A conspicuous drawback to this method of information delivery has been the fact that the reports always have a backward-looking perspective. The advent of the dashboard represents a fundamental advance on solving this problem.

"Dashboard" has long been a common catchword to describe tools that centralize information and make it easily accessible in a highly visual manner. For the financial services industry, dashboards are a means to synthesize key data and apply holistic tools quickly to correlate, interpret and otherwise extract meaning (and therefore value) from it, all in one location, with daily frequency. For example, a dashboard can allow a pensions client to view its portfolio from every perspective (including risk), layer by layer, across all asset classes.

A dashboard is more, however, than a range of collocated data sets. It also works in conjunction with underlying tool sets to dial into specific asset-linked functions. Indeed, dashboards represent just the external face of a data-centric (as opposed to report-centric) environment that allows for interoperability with other systems, software and platforms. Visual by design, the dashboard allows the user to take increasingly granular looks at data however defined, using a data model that presents the business — rather than the technological — view. Indeed, it achieves granularity at the lowest possible level at the same time that it increases the frequency of data delivery to actionable real time.

As essential decision-making tools, dashboards promise to become central to end users' work processes. It is also foreseeable that they will acquire, in future iterations, predictive capabilities to assess multiple hypothetical scenarios. When combined with technological innovations in mobile devices, dashboards make their data available at the user's convenience.

The Power of Many

Behind the data-rich environment of the dashboard, and other elements of the integrated solution, lies the remarkable power of cloud computing. Definitions of cloud computing vary, but at its simplest, the cloud can be thought of as a low-cost parallel computer, comprising many linked commoditized processors working together to attain a common goal.[1]

Infinitely scalable and efficiently repeatable, the cloud can simultaneously provide infrastructure, platforms and software applications as services. Standardization represents the cornerstone of cloud computing, enabling substantial reductions in development and operating costs (also influenced by clouds' expandable and scalable storage capabilities). While lower costs are a definite advantage of pursuing a cloud-based strategy, speed trumps cost as cloud's strongest feature in the eyes of many experts. Not only can a cloud system be deployed rapidly, its speed also dramatically shortens calculation times. For example, pricing computations that typically consume hours overnight may take minutes. Another advantage of cloud computing can be data integrity. See the sidebar "Private Clouds: Data Security Delivered" on the next page.

[1] A working definition proposed by the National Institute of Standards and Technology has gained some traction in the industry. It defines cloud computing as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." See csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc.

Private Clouds: Data Security Delivered

Data security issues around cloud computing, including a perceived loss of control over sensitive, proprietary data, have been widely covered in the media. Such concerns underscore the importance of utilizing a "private cloud" environment. The best private cloud architectures outline standards for developers, limiting their access to the application's framework and providing a more automated security provision environment. By doing so, private cloud infrastructures can provide enhanced capacity capabilities, improved standardization and, most importantly, far greater data security.

Compared with the economics of traditional IT systems, cloud computing offers several notable advantages, as illustrated in Figure 2.

Figure 2: The Advantages of Cloud Computing

	Traditional IT	Cloud Computing
Cash Flow	Hardware / software purchased upfront	Costs incurred on pay-as-you-go basis
Risk	Entire risk taken upfront with uncertain return	Financial risk is taken incrementally and matched to return
Income Statement Impact	Maintenance and depreciated capital expense	Maintenance costs only
Balance Sheet Impact	Hardware / software carried as a long-term asset	Cost incurred on a pay-as-you-go basis / cost minimized

Note: Figure 2 reflects the perspective of a business unit comparing in-house infrastructure costs with the operation costs of using a public cloud to support processing with a clear choice between fixed cost and variable cost options.

As the "cloud" of applications developers expands, their output can be tapped for functions beyond processing and storage. API, or applications programming interface, allows developers to integrate data and software functions into new (or existing) applications. Thus, by leveraging a standardized data model, software development costs drop dramatically.

The Road Ahead

While our story began with the critical technology and related business challenges facing the financial services industry, a solution is at hand for those able to meet it. The idea of a seamlessly integrated approach to processing, managing, delivering and correlating data has the potential to change not only the technology landscape but, more importantly, the business landscape as well.

Tools available today, coupled with emerging new business approaches geared to address current organizational challenges, can shift this idea from a future possibility to an actual solution for today. Third-party providers, with their experience, expertise and deep resources, can help realize the vision now. At the same time, although the stakes are high for providers, the opportunities are enormous. Firms that excel at execution in achieving optimal computing power and that have the capability to leverage it will be best-positioned to reap the benefits. As technology innovation is increasingly viewed as a strategic imperative, rather than a support function, a game-changing chapter will begin to unfold across the financial services industry.

Chapter II

ADAPTING TO THE NEW REGULATORY ENVIRONMENT

by Clifford Lewis

Adapting to the New Regulatory Environment

by Clifford Lewis

Technology has dramatically advanced the trading of financial instruments over the past two decades. In that time, the practice of "open outcry" trading has been replaced by electronic trading platforms for equity, bond and currency markets, among other areas. This shift has fundamentally changed the way these markets behave and has led to higher trading volumes.

Regulatory changes have also played a role in the increasing use of computerized trading processes and electronic exchanges. Today, new regulations are poised to accelerate this trend, bringing even larger trading volumes and diminished costs to the huge derivatives market.

The proliferation of technology is certain, and as regulation forces more transactions onto electronic platforms, most financial market participants will need to change the way they operate. This reality poses both challenges and opportunities. To successfully navigate the new environment, market participants will need to adapt strategies and determine how to best leverage current technologies.

Growth of Electronic Trading

Upgrades in exchange technology, combined with the rising use of algorithmic trading, including high-frequency trading methods, have contributed to a significant increase in the percentage of trades that are placed electronically rather than verbally. See the sidebar "About Algorithmic Trading" below.

About Algorithmic Trading

Algorithmic trading involves the direct interface of computers with trading platforms to place orders. Using an algorithm, a computer analyzes market data and sends trading instructions to the exchange or platform without the need for human intervention. Because the computer can process information quickly, trades are placed rapidly. By contrast, high-frequency trades are a subset of algorithmic trading whose models profit by taking advantage of small incremental changes in the market. In doing so, they trade frequently, perhaps several times a second.

Computer algorithms, or formulas, are based on investors' proprietary requirements. Computers can process large amounts of information very quickly, analyze data patterns and place trades at high frequency. For example, an algorithm may seek arbitrage opportunities, looking for small differences in price or price movements.

Algorithms can be as different as the investors that generate them, and go beyond just placing a trade. While some institutions use them to gradually accumulate or dispose of a position in a single security, others are designed to determine everything from the timing of a trade to the price paid, the quantity and the way an order is routed. Some "smart order routers" will even select the best place to send the order. See Chapter 3 of this report for a discussion on the use of technology to generate algorithms.

In most markets, equity traders are early adopters of algorithmic trading. The US equity market was the first to embrace the use of algorithmic trading more than 15 years ago. Now, about two-thirds of the dollar amount traded in that market can be attributed to high-frequency traders.[2] In Europe, the amount is more difficult to gauge, but a 2009 study found that half of the liquidity on the Deutsche Börse was due to algorithmic trading.[3]

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[2] Hendershott, Terrence, Jones, Charles M. and Menkveld, Albert J., "Does Algorithmic Trading Improve Liquidity?" (August 30, 2010). *Journal of Finance*, Forthcoming; WFA 2008 Paper. Available at http://ssrn.com/abstract=1100635.

[3] Hendershott, Terrence and Riordan, Ryan, "Algorithmic Trading and Information," September 2009. NET Institute Working Paper No. 09-08. Available at SSRN: http://ssrn.com/abstract=1472050.

Asian stock and currency markets are just beginning to pick up the pace with electronic trading. Data centers designed to accommodate high-speed trading have experienced an increase in business throughout Asia. In early 2010, the Tokyo Stock Exchange introduced Arrowhead, a well-received order-matching program for cash products. Co-lo (co-located) systems are also coming into play in Asian markets to manage surging demand for high-frequency trading. For example, nearly a third of daily derivatives trades on the Singapore Exchange are attributed to high-frequency trading, up from less than half that two years ago.[54]

Over the past decade, electronic fixed income trading has come online in most markets. The foreign exchange market has also embraced the practice, and it is estimated that about half of trades in that market are also placed using computer algorithms.[55]

In the wake of the 2008-2009 financial crisis, the exponential increase in the use of electronic trading and its effects on the market has caught the attention of regulators.

New Rules Are Being Written

Regulators have taken a hard look at financial market trading and the implications for stability of the financial markets. In particular, trading practices in the $600 trillion over-the-counter (OTC) derivatives market have come under closer scrutiny than ever before.

However, now that transparency has become the new watchword, the wisdom of continuing to allow private, one-to-one derivatives swaps is being questioned. Concern has also mounted about the potential systemic risks involved in high-frequency trading following the May 2010 “flash crash” in the US equity markets. See the sidebar “A Closer Look at the Flash Crash” on page 18.

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[4] Diola, Rodney, “Here Comes High-Frequency Trading,” *The Asset*, August 31, 2010.

[5] Chaboud, A., B. Chiquoine, E. Hjalmarsson and C. Vega, “Rise of the Machines: Algorithmic Trading in the Foreign Exchange Market,” Board of Governors of the Federal Reserve System, International Finance Discussion Papers, 2009, No. 980. Table 2.

A Closer Look at the Flash Crash

On May 6, 2010, US equity trading was briefly halted when the Dow Jones Industrial Average suddenly plummeted 1,000 points before quickly recovering most of its losses to end the day down 348 points. This unusual market movement, the largest ever one-day drop on the Dow, rattled international markets and prompted immediate concern among regulators and the public.

The exact cause of the sudden drop is being investigated by the US Securities and Exchange Commission (SEC) and the Commodities Futures Trading Commission (CFTC) and it is now commonly accepted that the use of traditional non-high-frequency trading algorithms, which presumed a certain market structure that no longer exists, played a factor. Technology surely also played a role.

Circuit breakers, in place since the stock market crash of 1987, are designed to stop the trading of individual stocks when they fall too abruptly. However, since the number of exchanges has grown, shares can trade elsewhere when trading is halted on the bigger exchanges such as the New York Stock Exchange or the NASDAQ.

The general consensus is that technological improvements are a part of the solution. Shortly after the crash, NASDAQ CEO Bob Greifield echoed this sentiment, noting that improvements to current technology (i.e., circuit breakers) would be helpful.

In virtually every jurisdiction around the globe, new rules for financial transactions are being considered and written into law to eliminate certain investment risks. Thus far, proposed changes are focused on the trading of swaps, or derivatives, and the clearing of such trades in the United States and the European Union. Similar efforts are also under way to further regulate the operations of alternative asset managers, including the Alternative Investment Fund Managers Directive (AIFMD) in the EU. Among the most noteworthy regulatory reforms under way in the United States and the European Union are the Dodd-Frank Act and MiFID II.

Dodd-Frank Act

In 2010, in the wake of the 2008-2009 financial crisis, the US Congress passed the Dodd-Frank Wall Street Reform and Consumer Protection Act. Among its key goals was to improve the transparency of the OTC derivatives market and, as part of the Act, Congress approved the creation of new swap execution facilities (SEFs).

SEFs aim to push all swaps trades toward a similar market structure. Rules for the creation of these alternative venues, which could be used instead of exchanges for trading swaps, were still under construction at the time of publication and are expected to be finalized in mid-2011. However, the broad outlines are clear. SEFs are meant not only to improve price transparency in the market, but also to permit regulators to better monitor and respond to risks.

Effectively divided into two markets, swaps currently trade either bank-to-customer or in the inter-dealer (bank-to-bank) arena. SEFs are designed to cater to both types of transactions. The creation of SEFs is expected to open the swaps market to more players, diminishing the revenues of large dealers. Controversy has surrounded the proposal to create a centralized limit order book available to all participants, as well as to require a transparent request for quote system. Opponents to these measures worry that such requirements may alter the value of derivatives trades by allowing market participants to see what others are trading.

On the currency exchange side, many expect that these trades will continue to be exempt from clearing requirements for now. However, new rules under consideration may herald changes in coming years, completing the move to transparency across the market.

The new law will almost certainly force standardized derivatives transactions to go through central clearing facilities. Also known as clearinghouses, these facilities act as intermediaries between swaps buyers and sellers. The new rules, which are expected to be finalized in mid-2011, will likely mean that standardized OTC swaps will come to resemble listed futures contracts — another type of derivative that is exchange traded and standardized.

At the US Securities and Exchange Commission (SEC), work is under way on a system that would consolidate audit trade data trails across the equity and options markets. The system, which would be designed to improve the agency's oversight and regulation of the financial markets, may be built in part using existing technology. In addition to concerns about storing and processing the enormous amount of data such a system would generate — estimated at approximately 20 terabytes — the government will have to beef up staffing with expertise in data management and analysis. This situation highlights some of the inequities that currently exist between regulators and the traders they are trying to regulate.

As US regulators move closer to formulating final rules, the eyes of the world are watching. Among them, Europe is closest to determining its own next steps to regulate the derivatives market.

MiFID II

In the EU, a proposed overhaul of the 2007 Markets in Financial Instruments Directive (MiFID) has gained steam. The original law first permitted trading to take place away from stock exchanges, a move designed to increase alternative trading facilities and decrease trading costs.

In practice, however, it resulted in a profusion of trading data, which in turn has led to calls for a single, consolidated source of post-trade data. To address this issue, the EU has organized a review of the law with the aim of creating MiFID II, for which a consultation paper was published in December 2010.

MiFID II focuses on the effect of technological developments, including bank crossing networks and high-frequency trading. Perhaps its largest area of focus, however, is off-exchange trading venues that are not currently subject to MiFID's strict transparency rules.

The EU proposes moving so-called “dark pool” trades — OTC derivatives trades made on proprietary, private trade-matching systems — into venues where the same trading rules would apply as to other financial instruments. For example, a new type of organized trading facility could bring current in-house arrangements into the regulatory fold, publishing price quotes ahead of a trade and applying in-house trading limits. There is also talk of a consolidated tape for fixed income trades.

These proposals have raised alarm among some players in the OTC market. Many fear that business will simply go elsewhere if forced to endure the scrutiny that such regulations may bring. On the flip side, others worry the proposed rules are not tough enough, leaving too much wiggle room for those looking to maintain the status quo.

Whatever their final form, the new MiFID regulations will almost certainly shake up the business. Yet, together with changes under way in the US, the new regulatory environment in the EU is likely to encourage growth of electronic trading around the globe, ultimately helping spur economic growth.

Positive Effects of Regulation on Markets

Many academics believe that algorithmic trading helps improve liquidity and market function. That means the regulatory developments — which will serve to broaden the use of electronic trading — are good for the markets and the general investing public.

Since the crisis, volumes traded in derivatives have dropped. However, once the derivatives marketplace is open and available to all for trading and clearing is made easy (i.e., access to credit is opened), more speculators and high-frequency traders will enter the market.

This trend will create liquidity and further increase trading volumes. As trading transparency expands to include other asset classes — including spot currency — and those products come online, high-frequency traders will begin trading them for profit, further boosting market growth. To participate in this growth, all market participants must rethink their use of technology and how best to employ it in the new regulatory environment.

Rethinking Technology

Technology is the best tool for adapting to new regulatory conventions. To ensure compliance with new rules, derivatives market players will need to take a hard look at current technology platforms and retrofit them to the new market realities. The bar is much higher than it was before and demonstrating regulatory compliance will be challenging.

For buy-side participants, everything from valuations to risk management and central counterparty clearing must be considered, along with rising costs. Third-party providers can offer help by putting systems in place to handle a wide variety of tasks or retrofitting existing technology platforms to take on the additional volume of work. Outsourcing central clearing may also offer economies of scale. The bottom line is that service providers must help clients prepare for and navigate the regulatory changes.

Yet, the new legislation presents significant challenges for firms that currently dominate the OTC derivatives market. For these players, a leveled playing field will mean reduced revenues. However, in an age of significantly increased regulation and broader transparency, business models can be reinvented with new products and new ideas.

This reality will require a rethink of technology. Ways to offer the best price or the best execution will need to be explored. For example, firms may rebrand themselves by offering better access to new clearinghouses, new ways to properly allocate credit (such as cross-margining), and other technology-driven products and services.

As some firms work to reinvent themselves and bring technology up to speed, others are already well along the path to executing on business plans that capitalize on the pending regulatory changes. Among the first to benefit will be those in the business of building exchanges and clearinghouses. With existing operational trading and clearing technology, these firms can swiftly modify their technology platforms to permit trading and clearing of new types of products, such as credit default swaps (CDS).

Facing the Future

Regulatory reform is an expanding and changing variable around the world. Perhaps the biggest challenge is the uncertainty about the shape of future regulations. Yet, while no one knows exactly how far regulators will go, new rules stand to make the markets a better, safer place for everyone.

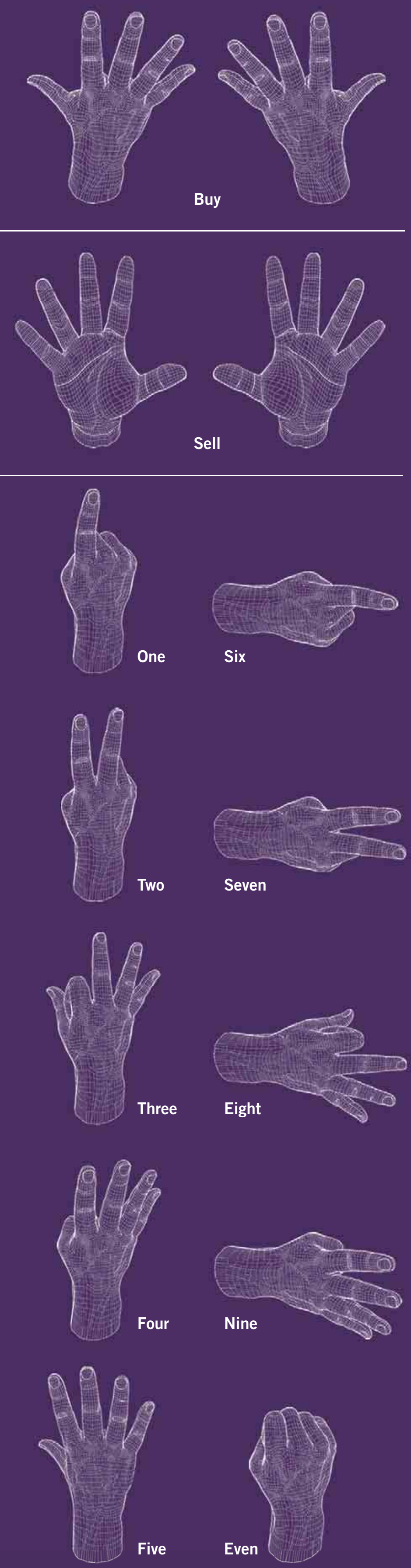
Technology is the only solution to effectively meet the challenges inherent in new trading regulations. It has already turbo-charged the process of switching from a relationship model to the tried-and-true Chicago market model — a model that has ensured the safety of customer risk positions and margin money over the past 100 years — which will democratize the markets and level the playing field for all. Further, success in eliminating credit risk hinges on the ability to harness technology to assess and analyze valuations and risks in real time. To do this, market transparency — through electronic execution platforms — is required.

Technology is the great equalizer. When equally distributed, it trends toward transparency and open competition. Advancing and improving upon technology protects the best interests of the world's economies and ultimately will help all market participants grow their businesses.

Chapter III

PORTFOLIO ALLOCATION AND MODELING – A TECHNOLOGICAL ARMS RACE?

by Jessica Donohue and Mark Hooker



Open Outcry

Investment professionals have historically relied on the use of shouting and hand signals — otherwise known as open outcry — as a method for communicating buy and sell orders on stock and futures exchanges. The system is used at financial exchanges such as the Chicago Mercantile Exchange and the American Stock Exchange (AMEX).

Using the system, traders typically make quick gestures across the trading floor to indicate a buy or sell order. A trader who holds his hands up with his palms facing in is gesturing that he would like to buy. When the trader's palms are facing out, it indicates a desire to sell.

The numbers one through five can be gestured on one hand with the fingers pointing directly upwards. For six through ten, the hand is held sideways, parallel to the ground. Counting starts from six when the hand is held in this way. To achieve blocks of ten, numbers are gestured from the forehead, while repeatedly touching the forehead with a closed fist indicates blocks of hundreds and thousands. Signals can also be used to indicate months, specific trade option combinations and additional market information.

Although rules vary significantly among exchanges, the purpose of the gestures remains the same.

Source: Chicago Mercantile Exchange, *An Introduction to Futures and Options*, 2006.

Portfolio Allocation and Modeling– A Technological Arms Race?

by Jessica Donohue and Mark Hooker

Ever since the advent of Modern Portfolio Theory, asset managers have used computation and mathematics to model portfolio risk and return. Being able to effectively quantify portfolios and markets has allowed managers to address the daily challenges of money management with objective information and analysis — both of which have steadily increased in volume, quality and granularity with the advance of computing power. While the application of technology to portfolio management and asset allocation has helped drive the greatest accumulation of investment assets in history, it has also had unintended consequences, effectively creating a kind of self-perpetuating technological arms race that has been blamed for exacerbating the financial crisis.

Although today's risk managers enjoy computational tools with unprecedented power at low costs, they must also navigate an ever-expanding investment universe as new emerging markets enter the investment mainstream and new types of securities are created. As a result, investors are confronting the challenges of comprehensively modeling portfolios and markets in the face of dramatic increases in the scope, detail and timeliness of financial data. Accommodating all of these inputs demands ever-increasing computational power, which in turn leads to the further proliferation of data, markets and security types. While computational capacity grows in line with Moore's Law, the billions of possible scenarios in the investment universe may expand at an even faster rate.

Perhaps even more important than advances in raw computing power are networks that increase productivity through the global linking of workstations and the interoperability of software, investment models and strategies. Thanks to the integration of capital markets and the increased international regulatory cooperation, trading practices and software, a risk assessment or alpha investment project that works in one market can rapidly be adapted and deployed in another. And with digital networks obliterating many traditional geographical barriers, teams can exchange lessons learned, adapt strategies, rewrite code and evolve models in a manner that was impossible only a few years ago.

This explosion of network-centric activity means that many asset owners and managers will forge ahead with investments in IT infrastructure that can accommodate this compounding complexity. An illustration of this challenge can be found in technology-driven solutions to some of the most important challenges of contemporary global asset management — market crowding, pricing inefficiencies, risk and rebalancing. The solutions to these problems are predicated on the notion that the effective application of computing power to risk modeling and operational efficiency can be almost as important to portfolio performance as the return characteristics of the underlying asset classes and investments themselves. Of course, the technology must be used by financial professionals who understand how best to apply it. The best tools in the wrong hands will not lead to optimal outcomes.

And so, the investment technology arms race moves steadily forward.

Investor Crowding and Order Flow Imbalances

One of the most disconcerting elements of the financial crisis for portfolio managers and asset allocators was the extraordinary correlation that they witnessed between assets that had been viewed as more independent. During the volatile months of asset decline in 2007 and 2008, and market recovery in 2009, equity markets saw extreme returns to factors such as valuation and momentum, and unusual combinations of factor returns as well. A principal cause of this behavior was the "crowding" of active investors into thematic long or short positions that would be quickly reversed as market volatility triggered portfolio losses and risk limits, engendering a vicious circle of market decline.

In the weeks and months prior to the financial crisis, investors accumulated steadily mounting position overlaps. This accumulation reduced the market inefficiencies they were relying on in pursuit of excess returns. Over time, these investment exposures delivered diminishing benefits. In response, many investors compensated by increasing leverage, thereby exacerbating crowding and further raising the risk of an eventual forced deleveraging. When the markets finally corrected and investors reduced their exposures en masse, a domino effect of position cuts and asset price devastation ensued.

One way of dealing with these concentrations of risk and portfolio vulnerability is to use computationally intensive models and conditioning overlays that calculate and model order flow imbalances (OFI), a technical measure of investment crowding.[6] To quantify OFI, investors must undertake a comprehensive analysis of intraday transaction level data, including trade and quote prices and quantities from the massive New York Stock Exchange Trades and Quotes (TAQ) database, which contains more than 20 terabytes of data for issues traded over the NYSE, the NASDAQ and regional exchanges from 2003 onward.

The OFI approach can be used to monitor the degree to which trading in stocks is buyer- or seller-driven. Abnormally imbalanced flows may indicate latent reversal risk when flows renormalize. Back-testing has revealed that in recent years, portfolios may have benefited from reduced exposure to overbought stocks across much of the alpha distribution. This testing concluded that a significant investment in IT infrastructure and domain expertise was critical to achieving these insights due to the computation-intensive nature of the program. Moreover, the technical and computational challenges of building and implementing the OFI investment model may create a kind of natural protection from those investors who might reduce its utility through mimicking strategies or arbitrage. See the sidebar "Defining a Back-test" below.

Defining a Back-test

In quantitative finance, back-testing refers to the use of historical data to simulate outcomes of a hypothetical investment strategy. For example, a researcher who wants to test the efficacy of a particular rebalancing rule could evaluate how it would have performed over any given time period and set of assets for which he or she has data. While the adage "past performance is no guarantee of future results" is especially applicable to back tests, they do provide insight into the relative merits of alternative strategies and are a key component of the quantitative research toolkit.

The modeling of entire markets in this way would not be possible without high-performance computers that can accommodate massive volumes of transaction and pricing data. As every new threshold of quantitative analysis is reached, investors raise the bar and develop expectations of market insight that is both broader, accommodating more investment scenarios, and deeper, with more precise factual information about investor behavior and its impact on securities prices. These expectations also extend to associated derivatives markets, in which data volumes are substantially larger and perhaps more indicative of investor sentiment and trends.

[6] Onayev, Zhan; Zdorovtsov, Vladimir and Thomas, Ric, "Order Flow Imbalance and Investor Crowding," *SSgA Capital Insights*, May 1, 2009

Hunting for Equity Market Inefficiencies in the Options Market

For years, financial scholars and practitioners have sought to predict future equity market performance using information gleaned from options markets. In many ways, quantitative assessment of options pricing is more challenging than for underlying securities, given the sheer scale of derivatives markets and the sophisticated calculations that investors must undertake to determine how options valuations might change with evolving conditions. As with order flow analysis, investors seeking to gain insight from investor behavior vis-à-vis these instruments must perform large-scale calculations that encompass multiple scenarios.

One potential source of a trading edge is the relationship between put and call option prices. Put options give the holder the right, but not the obligation, to sell the underlying security at a given price, while call options convey a similar right to buy the underlying security at a given price. Theoretically, put and call option prices contain the same information according to put-call parity, but market frictions like transactions costs and option pricing model deficiencies produce deviations from put-call parity in practice. See the sidebar "Put-Call Parity 101" below.

Put-Call Parity 101

Put-call parity states that the premium of a call option implies a certain fair price for the corresponding put option having the same strike price and expiration date, and vice versa. Those fair prices correspond to an arbitrage relationship, where (theoretically) riskless profits could be earned by trading on deviations from put-call parity.

Investors have long preferred to trade in the options market rather than in the underlying stock market when they have superior information, because options contracts embed significant leverage. The fact that options traders tend to be well-informed, and that options markets are not fully efficient, can be combined to generate stock-specific forecasts based on observed deviations from put-call parity. However, this kind of modeling is significantly more complex than it is for cash market instruments, requiring simultaneous treatment and consideration of a range of options with different strike prices, maturity dates, and open interest and trading volume that may change markedly across time for each stock.

Applying such analysis to a broad range of securities, say 1,400 US large cap stocks per month, with historical option contract data acquired from the Chicago Board Options Exchange (CBOE) option database over a back-test sample long enough to deliver conclusions robust to changes in market regimes, compounds that challenge but represents the standard for a leading active quantitative manager.

Were the approach to be applied to multiple global equity markets with vastly more securities in the sample, the mathematical and technological challenges of the model would expand several fold. Likewise, were a put-call parity strategy to be undertaken in fixed income or derivatives markets, the universe of securities to be considered — and the complexity of the model — might expand by an order of magnitude.

Investors who want to understand the critical signals that can be extracted from investor behavior must be prepared to keep pace with the growth of the markets. As markets expand in size and scope, by definition, market models and the calculations that drive them must expand correspondingly. Asset owners and managers who cannot keep pace with these accelerating computational demands may find themselves in the financial market equivalent of flying a high-performance aircraft through turbulence without any instrumentation.

Full-Scale Optimization

Portfolio optimization involves determining the allocation among available assets that maximizes an investor's utility. The specific characteristics of the utility function and of the asset returns often interact to yield a computationally challenging maximization problem.

Lack of computing power in 1952 made simplifying assumptions unavoidable in Nobel laureate Harry Markowitz's solution to this maximization problem — his now well-known mean variance optimization. Traditional asset allocation methodologies based on mean variance optimization are adequate if at least one of two conditions holds: either asset returns are distributed normally or investor utility is not affected by non-normalities (asymmetries and fat tails) in returns. The global financial crisis reminded us that, in fact, investors are much more sensitive to downside deviations than upside deviations and return distributions can be highly non-normal.

Fortunately, advances in computer processing have made the original maximization problem tractable, rendering Markowitz's simplifying (and often unrealistic) assumptions unnecessary. Investors can now use full-scale optimization to calculate portfolio utility for every period in a sample, considering as many asset mixes as necessary to identify allocations that yield the highest expected utility for their particular utility function. The computational challenge of this type of numerical search procedure is substantial, but modern computing capabilities permit comprehensive analysis of thousands of investments and millions — or even billions — of hypothetical investment scenarios.

While mean variance optimization only takes into account expected returns, volatilities and correlations, full-scale optimization implicitly takes into account all features of the return distributions, including skewness, fat tails and correlation asymmetries, thereby better reflecting the inherent risks. This approach may be particularly appropriate for investors with an aversion to losses below a specified threshold — for example, those facing reserve requirements, loan covenants, or the risk of insolvency or termination.

For these investors, a kinked utility function, rather than a quadratic utility function, best describes their concern for breaching a particular threshold. Their aversion to losses larger than that critical threshold is very high (hence the utility function is steep), while they are much less concerned about losses smaller than the threshold (so the utility function abruptly becomes much less steep). The management of this tail risk is critical as investors are deploying a larger proportion of assets to hedge funds, private equity and other alternative investments, which generate non-normal return distributions.

Optimal Rebalancing

Once optimal allocations have been determined, whether by traditional mean variance optimization or by full-scale optimization, those carefully chosen portfolio weights begin to drift almost immediately as asset prices change. Investors face a dilemma: as soon as they implement an optimal allocation, the portfolio's various components gain or lose value, rendering the portfolio suboptimal.[7]

In a perfect world without transaction costs, investors would simply set up a trading algorithm to continually rebalance the portfolio to the optimal weights. But trading costs are substantial and they vary in accordance with the type of security being traded, the size of the position, and the time and place of trade execution. At the other extreme, investors could save on transaction costs by never rebalancing the portfolio; that no one does this suggests that there is a cost — albeit an implicit one — associated with deviating from the optimal weights.[8]

Traditional portfolio rebalancing methodologies, such as calendar-based strategies that periodically rebalance to target allocations, and tolerance-band approaches, which trigger trades upon breach of predetermined thresholds, are relatively easy to implement and are certainly preferable to both no rebalancing and continual rebalancing. However, a new approach using dynamic programming allows an investor not only to explicitly weigh the tradeoff between suboptimality costs and transaction costs but also to account for the fact that a rebalancing decision made today affects the rebalancing decisions available at future times. This optimal rebalancing approach uses multi-period optimization technology to generate trading rules for a specified time horizon.[9]

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[7] Kritzman, Mark, Myrgren, Simon and Page, Sebastien, "Optimal Rebalancing: A Scalable Solution," *Journal of Investment Management*, Vol. 7, No. 1, 2009.

[8] Kritzman, Mark, Myrgren, Simon and Page, Sebastien, "Portfolio Rebalancing: A Test of the Markowitz-Van Dijk Heuristic," *MIT Sloan Research Paper No. 4641-07*, March 2007.

[9] Page, Sebastien, "The Right Mix: How and When to Rebalance," *Canadian Investment Review*, May 15, 2009.

Using massive parallel processing to drive dynamic programming, optimal rebalancing is based on an algorithm that creates a roadmap of rebalancing decisions. Any number of asset allocation scenarios may be considered, though the computational challenge rises sharply with the number of variables used in the model.

This computational challenge — involving the consideration of literally billions of portfolios — is called the curse of dimensionality. On a regular workstation, it would be impossible to undertake the number of calculations needed to map all of the possibilities for a portfolio of just a few assets.

Even using 28-processor grid computing and parallel processing to speed up complex computations does not supply enough power to determine an optimal rebalancing schedule for a portfolio with as few as 10 assets. Fortunately, Markowitz and quantitative investment manager Eric van Dijk created an algorithm that reduces the computational complexity of the problem and makes rebalancing solutions feasible for up to 100 assets.[10]

Dynamic programming (in conjunction with the Markowitz and van Dijk improvement) substantially reduces rebalancing costs compared to the simple heuristics typically employed by investors such as monthly, quarterly or semi-annually rebalancing and tolerance bands ranging from 1 to 5 percent.[11] For example, an investor with a $1 billion portfolio allocated among four assets could save roughly $600,000 in trading costs by employing dynamic programming to determine his rebalancing schedule as opposed to using calendar or range-based heuristics.

Resolving Investment Challenges with Enhanced Technology

Most market observers agree that in an era of uncertain macroeconomic fundamentals and continuing investor uncertainty, non-normal return distributions will remain a fact of life. Investor crowding, asymmetric demand for equity options and other behavior-based factors will continue to impact portfolios. The art and science of asset allocation will likely continue their evolution, moving whole-portfolio optimization to the center of asset management. Ironically, this is due in some measure to globally deployed IT systems and infrastructure that integrate markets and transmit trading information of ever-greater granularity in near real time.

As the global pool of investments under management continues to expand, and as the proportion of these assets that move across borders increases, asset owners and managers must cast an ever-wider net, incorporating into their strategies more markets, assets classes and securities types. It is a truism of risk management that investors cannot manage what they can't measure. And measurement of globally distributed portfolios demands ever-larger models composed of ever-more numerous and varied securities.

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[10] Kritzman, Mark, Myrgren, Simon and Page, Sebastien, "Optimal Rebalancing: A Scalable Solution," *Journal of Investment Management*, Vol. 7, No. 1, 2009.

[11] State Street Global Markets, Optimal Asset Allocation, Managing Institutional Portfolios, 2010.

While this challenge may be daunting, it cannot be ignored because all market participants — dealers, buyers and electronic markets — are similarly committing to the new technologies that define markets. Asset owners and managers have little choice but to continue investing in IT systems and raw computational power for building intelligent, networked models that seek to map risk and dynamically evolve both in service to alpha acquisition and to enhance risk management.

But technology alone cannot resolve critical investment challenges. A state-of-the-art operating room and arrays of diagnostic technology, by themselves, do not necessarily foretell a successful medical procedure any more than supercomputers, databases and networked workstations alone can manage a globally allocated investment portfolio. The human factor — experienced financial practitioners, expert in both the theory and application of financial practice — is an important determinant of successful financial outcomes. In the complex partnership between expertise and technology, the arms race of ever-more powerful systems engaging ever larger and more complex markets shows few signs of abating.

END NOTE

End Note

It appears the stage is set for an exciting era of innovation as increasingly powerful and sophisticated technology becomes inextricably intertwined in the DNA of the financial services industry. It is this continuing convergence of advanced business processes and technology that is steadily moving us closer to achieving the true, seamless integration of information, tools and front-office capabilities. This phenomenon has the potential for significant impact in the financial services industry. Not only will it help facilitate the full spectrum of risk and return management, but it promises to fundamentally change the way investment decisions are considered and made.

Indeed, we are nearing the day when this increasingly powerful technology, properly and efficiently deployed, will be able to provide institutional investors with an unprecedented level of awareness of their business environments, helping to better inform their decision-making processes and empower them to manage risks and optimize returns in ways simply not possible in the past.

The role of technology and innovation in the financial services industry is evolving more quickly, and with greater potential impact, than ever before. For service providers and the clients they serve, the potential benefits are numerous, and include the promises of more informed, holistic decision-making, more powerful predictive capabilities and enhanced risk and compliance frameworks in which to operate. As our industry continues to embrace and incorporate these amazing technological advances, we are able to extract more intelligence and potential value from raw data today than ever before. This trend is certain to continue going forward. And, in addition to helping market participants to grow their respective businesses and portfolios, this evolution of technology in the financial services industry will help lead to increased transparency and openness, protecting the best interests of the respective market players, their clients and the economies from which they operate.

While there are clearly some compelling business advantages associated with this enhanced role of technology and innovation in the financial services industry, there are also a number of obligations. Going forward, industry participants will need to respond to the numerous challenges presented by the rapidly changing regulatory environment we've witnessed since the global financial crisis. The regulatory landscape continues to evolve and the number of parties interacting with one another continues to increase. All the while, providers are expected to react more quickly, continue to create new functions and features, and seamlessly integrate those new features with the rest of their service offerings.

To ensure ongoing compliance with this new and constantly evolving set of rules, providers will need to be able to quickly and efficiently retrofit their technology platforms to suit these newly introduced regulatory conventions. Coping with the challenges associated with a regulatory landscape in a state of constant flux will be a key challenge facing the financial services industry going forward, but it, too, is a challenge that can be overcome through the strategic application of technology.

As for the institutional investors themselves, they continue to clamor for newer, more complex and more flexible ways to manipulate, enrich, adapt and view their business data. Portfolio managers who were once content to revisit risk models quarterly or monthly are now demanding access to information on a much more granular and timely basis. And now, the bar is being raised even higher, as institutions search for ways to use this data not only as a detailed reflection of the recent past, but also as a telltale window into the future. Realizing the benefits of private cloud computing will be critical going forward.

As we've seen, for the most part, the technology required to achieve these goals already exists. One of the primary challenges in implementing it, of course, is that many financial organizations are still reluctant to make the sizable and ongoing technology investments required to meet their increasingly complex business needs in this fast-changing business/technology paradigm.

Going forward, those organizations with the foresight to make wise, strategic investments in technology will lead the industry. Those organizations bold enough to embrace innovation and embed leading-edge technologies into every aspect of their operations will be well-positioned to thrive, while those that fail to capitalize on the opportunities presented by this new business/technology paradigm risk being left behind altogether.

Notes

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