

# History of Value-at-Risk: 1922-1998

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## Purpose:

This working paper is being distributed to solicit comments, recollections and anecdotes from regulators and market participants who worked with VaR or related risk measures prior to 1993. Please forward any comments directly to the author.

Topics of particular interest are:

- early implementations of VaR or VaR-like measures in trading environments during the 1970's or 1980's;
- the extent to which industry practice (existing risk measures used in trading environments) influenced the SEC's Uniform Net Capital Rule, the SFA's 1992 capital rule and Europe's Capital Adequacy Directive;
- early use (especially during the 1980's) of names such as "value-at-risk", "capital-at-risk" and "dollars-at-risk"—which name arose first?
- papers published prior to 1993 that mention or describe VaR measures.

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*During the 1990's, Value-at-Risk (VaR) was widely adopted for measuring market risk in trading portfolios. Its origins can be traced back as far as 1922 to capital requirements the New York Stock Exchange imposed on member firms. VaR also has roots in portfolio theory and a crude VaR measure published in 1945. This paper traces this history to 1998, when banks started using proprietary VaR measures to calculate regulatory capital requirements.*

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We define VaR as a category of probabilistic measures of market risk. Consider a portfolio with fixed holdings. Its current market value is known. Its market value at some future time—say one day or one month in the future—is a random variable. As a random variable, we may ascribe it a probability distribution. A **VaR metric** is a function of:

1. that distribution and
2. the portfolio's current market value.

With this definition, variance of return, standard deviation of P&L and .95-quantile of loss are all VaR metrics. We define a **VaR measure** as any procedure that, given a VaR metric, assigns values for that metric to portfolios.

Early VaR measures developed along two parallel lines. One was portfolio theory, and the other was capital adequacy computations. Bernstein (1992) and Markowitz (1999) have documented the history of VaR measures in the context of portfolio theory. This paper reviews that material only briefly. It focuses primarily upon the development of VaR measures in the context of capital adequacy computations.

## **The Leavens VaR Measure**

The origins of portfolio theory can be traced to non-mathematical discussions of portfolio construction. Authors such as Hardy (1923) and Hicks (1935) discussed intuitively the merits of diversification. Leavens (1945) offered a quantitative example, which may be the first VaR measure ever published.

Leavens considered a portfolio of ten bonds over some horizon. Each bond would either mature at the end of the horizon for USD 1,000 or default and be worthless. Events of default were assumed independent. Measured in USD 1,000's, the portfolio's value at the end of the horizon had a binomial distribution.

Writing for a non-technical audience, Leavens did not explicitly identify a VaR metric, but he mentioned repeatedly the “spread between probable losses and gains.” He seems to have had the standard deviation of portfolio market value in mind. Based upon this metric, his portfolio had a VaR of USD 948.69.

## The Markowitz and Roy VaR Measures

Markowitz (1952) and, three months later, Roy (1952) independently published VaR measures that were surprisingly similar. Each was working to develop a means of selecting portfolios that would, in some sense, optimize reward for a given level of risk. For this purpose, each proposed VaR measures that incorporated covariances between risk factors in order to reflect hedging and diversification effects. While the two measures were mathematically similar, they support different VaR metrics. Markowitz used a variance of simple return metric. Roy used a metric of shortfall risk that represents an upper bound on the probability of the portfolio's gross return being less than some specified "catastrophic return."

Both Markowitz and Roy skirted the issue of how probabilistic assumptions might be specified. Roy's VaR measure required a mean vector and covariance matrix for risk factors. He observed that these must be "estimated from information about the past". Markowitz's VaR measure required only a covariance matrix for risk factors. He proposed that this be constructed using procedures that would be called "Bayesian" today:

These procedures, I believe, should combine statistical techniques and the judgment of practical men.

In a (1959) book, Markowitz elaborated, dedicating an entire chapter to the construction of subjective or "personal" probabilities, as developed by Savage (1954).

## Early Innovations

Markowitz and Roy intended their VaR measures for practical portfolio optimization work. Markowitz's (1959) book is a "how-to" guide to his optimization scheme, boldly describing for a non-technical audience computations that would remain infeasible until processing power became more available during the 1970's. Markowitz was aware of this problem and proposed a more tractable VaR measure that employed a diagonal covariance matrix. William Sharpe described this VaR measure in his Ph.D. thesis and a (1963) paper. The measure is different from, but helped motivate Sharpe's (1964) Capital Asset Pricing Model (CAPM).

Because of the limited availability of processing power, VaR measures from this period were largely theoretical, and were published primarily in the context of the emerging portfolio theory. This encompassed the work of Tobin (1958), Treynor (1961), Sharpe (1964), Lintner (1965) and Mossin (1966). The VaR measures they employed were best suited for equity portfolios. There were few alternative asset categories, and applying VaR to these would have raised a number of modeling issues. Real estate cannot be marked to market with any frequency, making VaR impractical. Applying VaR to either debt instruments or futures contracts entails modeling term structures. Also, debt instruments raise issues of credit spreads. Futures that were traded at the time were primarily for agricultural products, which raise seasonality issues. Schrock (1971) and

Dusak (1972) described simple VaR measures for futures portfolios, but neither addressed term structure or seasonality issues.

Lietaer (1971) described a practical VaR measure for foreign exchange risk. He wrote during the waning days of fixed exchange rates when risk manifested itself as currency devaluations. Since World War II, most currencies had devalued at some point; many had done so several times. Governments were secretive about planned devaluations, so corporations maintained ongoing hedges. Lietaer (1971) proposed a sophisticated procedure for optimizing such hedges. It incorporated a VaR measure with a variance of market value VaR metric. It assumed devaluations occurred randomly, with the conditional magnitude of a devaluation being normally distributed. Computations were simplified using a modification of Sharpe's (1963) model. Lietaer's work may be the first instance of the Monte Carlo method being employed in a VaR measure.

## **Twenty Years of Change**

The 1970s and 1980s wrought sweeping changes for markets and technology. For VaR, these had the combined effect of:

- expanding the universe of assets to which VaR might be applied;
- changing how organizations took risk; and
- providing the means to apply VaR in these new contexts.

When the Bretton Woods agreement collapsed in 1971, exchange rates were allowed to float, and an active foreign exchange forward market soon emerged. Today, this is the largest forward market in the world.

OPEC's dominance of world oil supplies led to two oil crises, which sent crude prices skyrocketed from USD 2 to USD 35 during the 1970s. Oil markets, which had been the province of a handful of global oil companies, were rapidly liberalized to counter the state pricing of OPEC.

Shortages of natural gas led the US Government to pass the 1978 Natural Gas Policy Act (NGPA). This started an eleven-year process of deregulation that transformed pipeline companies from distributors into transporters and opened the door for competition among independent marketing and distribution companies. Later, European natural gas markets and world electricity markets would experience similar liberalization.

Floating exchange rates, rampant inflation and monetarist experiments by the US Federal Reserve caused USD interest rates to gyrate. At the same time, archaic US regulations were incompatible with the high interest rates investors demanded, so the market for USD deposits migrated overseas. The US Federal Government embarked on a period of staggering budget deficits that lasted through the end of the century. This propelled a huge market for US Treasury securities. Disintermediation roiled the banking industry as borrowers sought financing directly from securities markets. New markets for US and Euro medium-term notes (MTNs) grew rapidly. Investment bank Drexel Burnham

popularized the use of high-yield bonds in corporate restructurings. The mortgage pass-through market grew dramatically and spawned markets for collateralized mortgage obligations (CMOs), strips and related instruments. First Boston introduced the first asset-backed security (ABS) in 1985, launching a vibrant market for securitized loans, leases and revolving debt.

The Chicago Mercantile Exchange (CME), which had long traded agricultural futures, introduced financial futures contracts. First came currency futures in 1972 and then US Treasury bill futures in 1975. Over time, futures contracts on bonds, deposits, indexes and currencies came to trade on exchanges around the world.

Currency and interest rate swaps were introduced in the early 1980s, starting with a currency swap arranged by Solomon Brothers in 1981 between the World Bank and IBM. Chase Manhattan Bank introduced the first commodity swap in 1986, and Bankers Trust introduced the first equity swap in 1989.

In 1973, Black and Scholes published their groundbreaking option-pricing model. That same year, the first registered options exchange, the Chicago Board Options Exchange (CBOE), opened for business.

Starting in the early 1980s, a market for over-the-counter (OTC) options gradually formed. Dealers experimented with new and “exotic” structures, including swaptions, caps, floors, Asian options, barrier options and lookback options. Initially, underliers were financial assets such as equities or currencies, but derivatives were soon introduced on oil and other commodities. By the close of the decade, volumes were mounting.

Perhaps the greatest consequence of the financial innovations of the 1970s and 1980s was the proliferation of leverage. Prior to 1970, avenues for compounding risk were limited. With the proliferation of new instruments, opportunities for leverage abounded. Not only new instruments, but new forms of transactions also offered leverage. Commodity leasing, securities lending, repos and short sales are leveraged transactions. All of these either did not exist or had limited use prior to 1970.

Within organizations, leveraging decisions became decentralized. Portfolio managers, traders, product managers and even salespeople acquired the tools of leverage. Transactions were implemented with a phone call. A single derivatives trader might leverage or deleverage his employer a hundred times a day.

As leverage proliferated, trading organizations sought new ways to manage risk taking. In turn, this motivated a need for new measures of risk. The traditional risk metrics of financial accounting were ineffective, especially when applied to derivatives. Exposure metrics such as duration, convexity, delta, gamma, and vega were widely adopted, but were primarily of tactical value. Trading organizations started to resemble a Tower of Babel, with each trading desk adopting risk metrics suitable for its own transactions. Even when two desks adopted similar metrics, there was no means of measuring their aggregate risks—you can’t aggregate a crude oil delta with a JPY delta. Organizations

increasingly needed a single risk metric that could be applied consistently across asset categories.

By 1990, a single processor could easily perform the most complex analyses proposed by Markowitz (1959). The age of the mainframe was waning. Personal computers were ascendant. Financial firms were embracing technology and were using it for such tasks as Monte Carlo pricing of complex derivatives.

Another important development was the rapid growth of a financial data industry. Reuters, Telerate, Bloomberg and more specialized firms started compiling databases of historical prices. These would provide the raw data needed to specify probabilistic assumptions used by VaR measures.

As the 1970s turned to the 1980s, markets were becoming more volatile. Firms were becoming more leveraged, and the need for financial risk measures, such as VaR, was growing. The resources to implement VaR were becoming available, but VaR remained primarily a theoretical tool of portfolio theory. Firms needed some way to measure market risk across disparate asset categories, but did not recognize how VaR might fill this need. US regulators were laying the groundwork for them to do so.

## **Origins of Regulatory Capital Requirements**

Prior to 1933, US securities markets were largely self-regulated. As early as 1922, the New York Stock Exchange (NYSE) imposed its own capital requirements on member firms.<sup>1</sup> Firms were required to hold capital equal to 10% of assets comprising proprietary positions and customer receivables.

By 1929, the NYSE capital requirement had developed into a requirement that firms hold capital equal to:

- 5% of customer debits;
- a minimum 10% on proprietary holdings in government of municipal bonds;
- 30% on proprietary holdings in other liquid securities; and
- 100% on proprietary holdings in all other securities.

This anticipated today's capital requirements for securities firms. As we shall see, it evolved into the VaR measures that firms use today.

During October 1929, the US stock market crashed, losing 20% of its value.<sup>2</sup> The carnage spilled into the US banking industry where banks lost heavily on proprietary stock investments. Fearing that banks would be unable to repay money in their accounts, depositors staged a "run" on banks. Thousands of US banks failed.

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<sup>1</sup> See Dale (1996), pp. 60-61.

<sup>2</sup> As measured by the Dow Jones Industrial average.

The Roaring '20s were over, and the Great Depression had begun. During this period, the US Congress passed legislation designed to prevent abuses of the securities markets and to restore investors' confidence.

The 1933 Banking Act combined a bill sponsored by Representative Steagall to establishing federal deposit insurance with a bill sponsored by Senator Glass to segregate the banking and securities industries. It distinguished between:

- **commercial banking**, which is the business of taking deposits and making loans, and
- **investment banking**, which is the business of underwriting and dealing in securities.

All banks were required to select one of the two roles and divest businesses relating to the other. Chase National Bank and the National City Bank both dissolved their securities businesses. Lehman Brothers dissolved its depository business. The First Bank of Boston split off its securities business to form First Boston. JP Morgan elected to be a commercial bank, but a number of managers departed to form the investment bank Morgan Stanley.

The 1933 Securities Act focused on primary markets, ensuring disclosure of pertinent information relating to publicly offered securities. The 1934 Securities Exchange Act focused on secondary markets, ensuring that parties who trade securities—exchanges, brokers and dealers—act in the best interests of investors. Certain securities—including US Treasury and municipal debt—were largely exempt from either act's provisions.

The Securities Exchange Act established the Securities and Exchange Commission (SEC) as the primary regulator of US securities markets. In this role, the SEC gained regulatory authority over **securities firms**,<sup>3,4</sup> which include investment banks as well as non-banks that broker and/or deal non-exempt securities.<sup>5</sup> The 1938 Maloney Act clarified this role, providing for self regulating organizations (SRO's) to provide direct oversight of securities firms under the supervision of the SEC. SRO's came to include the National Association of Securities Dealers (NASD) as well as national and regional exchanges.

The original Securities Exchange Act imposed a modest capital requirement on securities firms. It required firms to not incur aggregate indebtedness in excess of 2,000% of their net capital. This requirement limited credit available for stock market speculation, but its primary purpose was to ensure that securities firms had sufficient liquidity to meet obligations to clients. For this reason, the act excluded non-liquid fixed assets and exchange memberships from a firm's net capital.

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<sup>3</sup> US law refers to these as **broker-dealers**.

<sup>4</sup> This authority originally applied only to firms that were members of securities exchanges or who transacted business through an exchange member. In 1938, Congress amended the Securities Exchange Act, extending the SEC's authority over all securities firms transacting in non-exempt securities..

<sup>5</sup> Separate banking regulators oversaw commercial banks. US banks could be chartered by the Federal Government or by states. Federally-chartered banks were primarily regulated by the Office of the Comptroller of the Currency (OCC). State-chartered banks were primarily regulated by respective state regulatory agencies. In addition, most banks were required to be members of the Federal Deposit Insurance Corporation (FDIC) and most were members of the Federal Reserve System (the Fed).

In 1938, the Securities Exchange Act was modified to allow the SEC to impose its own capital requirements on securities firms, so the SEC started to develop a Net Capital Rule. In 1944, the SEC exempted from this capital rule any firm whose SRO imposed more comprehensive capital requirements. Capital requirements the NYSE imposed on member firms were deemed to meet this criteria.

In 1944, the SEC modified its Net Capital Rule to subtract from net capital 10% of the market value of most proprietary securities positions held by a firm. This **haircut** afforded a margin of safety against market losses that might arise during the time it would take to liquidate such positions. In 1965, the haircut for equity securities was increased to 30%.

## **The Paperwork Crisis**

Between 1967 and 1970, the NYSE experienced a dramatic increase in trading volumes. Securities firms were caught unprepared, lacking the technology and staff to handle the increased workload. Back offices were thrown into confusion trying to process trades and maintain client records. Errors multiplied, causing losses. For a while, this “paperwork crisis” was so severe that the NYSE reduced its trading hours and even closed one day a week. In 1969, the stock market fell just as firms were investing heavily in back office technology and staff. Trading volumes dropped, and the combined effects of high expenses, decreasing revenues and losses on securities inventories proved too much for many firms. Twelve firms failed, and another 70 were forced to merge with other firms. The NYSE trust fund, which had been established in 1964 to compensate clients of failed member firms, was exhausted.

In the aftermath of the paperwork crisis, Congress founded the Securities Investor Protection Corporation (SIPC) to insure client accounts at securities firms. It also amended the Securities Exchange Act to require the SEC to implement regulations to safeguard client accounts and establish minimum financial responsibility requirements for securities firms.

As a backdrop to these actions, it came to light that the NYSE had failed to enforce its own capital requirements against certain member firms at the height of the paperwork crisis. With its trust fund failing, it is understandable that the NYSE didn't want to push more firms into liquidation. This inaction would mark the end of SROs setting capital requirements for US securities firms.

## **The SEC's Uniform Net Capital Rule**

In 1975, the SEC updated its capital requirements, implementing a Uniform Net Capital Rule (UNCR) that would apply to all securities firms trading non-exempt securities. As with earlier capital requirements, the capital rule's primary purpose was to ensure that firms had sufficient liquid assets to meet client obligations. Firms were required to detail

their capital calculations in a quarterly Financial and Operational Combined Uniform Single (FOCUS) report.

As with the SEC's earlier capital requirement, haircuts were applied to proprietary securities positions as a safeguard against market losses that might arise during the time it would take to liquidate such positions. However, the system of haircuts was completely redesigned. Financial assets were divided into 12 categories such as government debt, corporate debt, convertible securities, preferred stock, etc. Some of these were further broken down into subcategories primarily according to maturity. To reflect hedging effects, long and short positions were netted within subcategories, but only limited netting was permitted within or across categories. An additional haircut was applied to any concentrated position in a single asset.

Haircut percentages ranged from 0% for short-term treasuries to, in some cases, 30% for equities. Even higher haircuts applied to illiquid securities. The percentages were apparently based upon the haircuts banks were applying to securities held as collateral.<sup>6</sup>

In 1980, extraordinary volatility in interest rates prompted the SEC to update the haircut percentages to reflect the increased risk. This time, the SEC based percentages on a statistical analysis of historical security returns. The goal was to establish haircuts sufficient to cover, with 95% confidence, the losses that might be incurred during the time it would take to liquidate a troubled securities firm—a period the SEC assumed to be 30 days.<sup>7</sup> Although it was presented in the archaic terminology of “haircuts”, the SEC's new system was a rudimentary VaR measure. In effect, the SEC was requiring securities firms to calculate one-month 95% VaR and hold extra capital equal to the indicated value.

US Securities firms became accustomed to preparing FOCUS reports, and started using them for internal risk assessments. Soon they were modifying the SEC's VaR measure for internal use. Because they were used for internal purposes, there is limited information on the measures customized by specific firms. One interesting document is a letter from Stephen C. Francis (1985) of Fischer, Francis, Trees & Watts to the Federal Reserve Bank of New York. He indicates that their VaR measure was based upon the SEC's but employed more asset categories, including 27 categories for cash market US Treasuries alone. He notes:

We find no difficulty utilizing on an essentially manual basis the larger number of categories, and indeed believe it necessary to capturing accurately our gross and net risk exposures.

Over time, securities firms found a variety of uses for these proprietary VaR measures. An obvious use was to provide a measure of a firm's overall market risk on an ongoing basis. Related applications were to calculate internal capital requirements and to support market risk limits.

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<sup>6</sup> See Dale (1996), p. 78.

<sup>7</sup> See Securities and Exchange Commission (1980) and Dale (1996), pp. 78, 80.

## Garbade's VaR Measures

During the 1980's, Kenneth Garbade worked in the Bankers Trust Cross Markets Research Group developing sophisticated modeling techniques for the US debt market. As part of the firm's marketing efforts, he prepared various research reports for distribution to institutional clients. Two of these, Garbade (1986, 1987), described sophisticated VaR measures for assessing internal capital requirements.<sup>8</sup> Garbade (1986) noted:

In view of the importance of risk assessment and capital adequacy to regulatory agencies and market participants, it is not surprising that many analysts have tried to devise procedures for computing risk and/or capital adequacy which are (a) comprehensive and (b) simple to implement. Without exception, however, those who make the effort quickly discover that the twin goals of breadth and simplicity are seemingly impossible to attain simultaneously. As a result, risk and capital adequacy formulas are either complex or of limited applicability, and are sometimes both.

Garbade's (1986) VaR measures modeled each bond based upon its price sensitivity to changes in yield—its “value of a basis point.” Portfolio market values were assumed normally distributed. Given a covariance matrix for yields at various maturities, the standard deviation of portfolio value was determined. With this characterization, VaR metrics—including standard deviation of loss and .99-quantile of loss—were calculated. Principal component analysis was used to reduce the dimensionality of the problem.

Garbade (1987) extended this work. He introduced a bucketing scheme that allowed him to remap a large portfolio of bonds as a smaller portfolio of representative bonds. He introduced a technique to disaggregate a portfolio's risk and allocate it among multiple profit centers.

Garbade's papers attracted little attention. They were circulated only to institutional clients of Bankers Trust. For prospective buy-side users of VaR, they were years ahead of their time. For Garbade, they were just an application of the theoretical research he was performing with other members of the Cross Markets Research Group. He did not include them in his (1996) edited collection of the papers he wrote while with the group.

## The 1988 Basle Accord

On June 26, 1974, German regulators forced the troubled Bank Herstatt into liquidation. That day, a number of banks had released payment of DEM to Herstatt in Frankfurt in exchange for USD that was to be delivered in New York. Because of time-zone differences, Herstatt ceased operations between the times of the respective payments. The counterparty banks did not receive their USD payments.

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<sup>8</sup> I am indebted to Craig Dibble, formerly of Bankers Trust, for bringing Garbade's 1986 paper to my attention.

Responding to the cross-jurisdictional implications of the Herstatt debacle, the G-10<sup>9</sup> countries formed a standing committee under the auspices of the Bank for International Settlements (BIS).<sup>10</sup> Called the Basle Committee on Banking Supervision, the committee comprises representatives from central banks and regulatory authorities. Over time, the focus of the committee has evolved, embracing initiatives designed to:

- define roles of regulators in cross-jurisdictional situations;
- ensure that international banks or bank holding companies do not escape comprehensive supervision by some “home” regulatory authority;
- promote uniform capital requirements so banks from different countries may compete with one another on a “level playing field.”

While the Basle Committee’s recommendations lack force of law, G-10 countries are implicitly bound to implement its recommendations as national laws.

In 1988, the Basle Committee published a set of minimal capital requirements for banks. These were adopted by the G-10 countries, and have come to be known as the 1988 Basle Accord. We have already discussed the SEC’s UNCR. The 1988 Basle Accord differed from this in two fundamental respects:

- It was international, whereas the UNCR applied only to US firms;
- It applied to banks whereas the UNCR applied to securities firms.

Historically, minimum capital requirements have served fundamentally different purposes for banks and securities firms.

Banks were primarily exposed to credit risk. They held illiquid portfolios of loans supported by deposits. Loans could be liquidated rapidly only at “fire sale” prices. This placed banks at risk of “runs.” If depositors feared a bank might fail, they would withdraw their deposits. Forced to liquidate its loan portfolio, the bank would succumb to staggering losses on those sales.

Deposit insurance and lender-of-last-resort provisions eliminated the risk of bank runs, but they introduced a new problem. Depositors no longer had an incentive to consider a bank’s financial viability before depositing funds. Without such marketplace discipline, regulators were forced to intervene. One solution was to impose minimum capital requirements on banks. Because of the high cost of liquidating a bank, such requirements were generally based upon the value of a bank as a going concern.

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<sup>9</sup> The G-10 is actually eleven countries: Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States. Luxembourg is also represented on the Basle Committee.

<sup>10</sup> The BIS is an international organization which fosters international monetary and financial cooperation and serves as a bank for central banks. It was originally formed by the Hague Agreements of 20 January 1930, which had a primary purpose of facilitating Germany’s payment of reparations following World War I. Today, the BIS is a focal point for research and cooperation in international banking regulation.

The primary purpose of capital requirements for securities firms was to protect clients who might have funds or securities on deposit with a firm. Securities firms were primarily exposed to market risk. They held liquid portfolios of marketable securities supported by secured financing such as repos. A troubled firm's portfolio could be unwound quickly at market prices. For this reason, capital requirements were based upon the liquidation value of a firm.

In a nutshell, banks entailed systemic risk. Securities firms did not. Regulators would strive to keep a troubled bank operating. They would gladly unwind a troubled securities firm. Banks needed long-term capital in the form of equity or long-term subordinated debt. Securities firms could operate with more transient capital, including short-term subordinated debt. The 1988 Basle accord focused upon a bank's viability as a going concern. It set minimum requirements for long-term capital based upon a formulaic assessment of a bank's credit risks. It did not specifically address market risk. The SEC's UNCR focused on a securities firm's liquid capital with haircuts for market risk.

Because banks and securities firms are so different, it is appropriate to apply separate minimum capital requirements to each. This was feasible in the United States and Japan, which both maintained a statutory separation of banking and securities activities.

## **The United Kingdom's "Big Bang"**

The United Kingdom enforced no statutory separation of banking and securities industries, but distinguished between them as a matter of custom. The Bank of England supervised banks. Securities markets were traditionally self-regulating, but the sweeping 1986 Financial Services Act—informally called the "Big Bang"—changed this. It established the Securities and Investment Board (SIB) to regulate securities markets. The SIB delegated much of its authority to SROs, granting responsibility for wholesale securities markets primarily to the Securities and Futures Authority (SFA). If a British firm engaged in both banking and securities activities, both the Bank of England and the SFA would provide oversight, with one playing the role of "lead regulator."

In 1992, the SFA adopted financial rules for securities firms, which included capital requirements for credit and market risks. These specified a crude VaR measure for determining market risk capital requirements for equity, fixed income, foreign exchange and commodities positions.

By the 1990's, concepts from portfolio theory were widely used by institutional equity investors. London had traditionally emphasized equity financing to a greater extent than other financial centers,<sup>11</sup> and this emphasis appears to have influenced the SFA in designing its VaR measure. While crude from a theorist's standpoint, the measure incorporated concepts from portfolio theory, including the CAPM distinction between systematic and specific risk. The measure did not employ covariances, but summing risks

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<sup>11</sup> See Scott-Quinn (1994).

under square root signs and applying various scaling factors seems to have accomplished an analogous purpose. Because of its pedigree, the SFA's VaR measure came to be called the "portfolio approach" to calculating capital requirement. As fate would have it, the SFA's initiative would soon be overtaken by events within the European Union.

## Europe's Capital Adequacy Directive

Germany had a tradition of **universal banking**, which made no distinction between banks and securities firms. Under German law, securities firms *were* banks, and a single regulatory authority oversaw banks. France and the Scandinavian countries had similar regimes. Accordingly, Europe supported two alternative models for financial regulation:

- the Continental, or German model of universal banking, and
- the Anglo-Saxon, or British model of generally separate banking and securities activities.

The European Union (EU) had a goal of implementing a common market by 1993. As the nations of Europe moved towards integrating their economies, the two models of financial regulation came into conflict. New EU laws needed either to choose between or somehow blend the two approaches.

The issue was settled by the 1989 Second Banking Coordination Directive and the 1993 Investment Services Directive. These granted European nations broad latitude in establishing their own legal and regulatory framework for financial services. Financial firms were granted a "single passport" to operate throughout the EU subject to the regulations of their home country. A bank domiciled in an EU country that permitted universal banking could conduct universal banking in another EU country that prohibited it. With France and Germany committed to universal banking, the single passport model effectively opened all of Europe to universal banking. It also permitted Britain to maintain a separate regulatory framework for its non-bank securities firms.

Since the securities operations of Germany's universal banks would be competing with Britain's non-bank securities firms, there was a desire to harmonize capital requirements for the two. The solution implemented with the 1993 Capital Adequacy Directive (CAD) was to regulate functions instead of institutions.

The CAD established uniform capital standards applicable to both universal banks' securities operations and non-bank securities firms. A universal bank would identify a portion of its balance sheet as comprising a "trading book". Capital for the trading book would be held in accordance with the CAD while capital for the remainder of the bank's balance sheet would be held in accordance with the 1988 Basle Accord, as implemented by Europe's 1989 Solvency Ratio Directive.<sup>12</sup> Bank capital was conservatively defined

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<sup>12</sup> The CAD and 1988 Basle Accord only set minimum requirements. National authorities were free to set higher requirements.

according to the 1989 Own Funds Directive, but local regulators had discretion to apply more liberal rules for capital supporting the trading book.

A bank's "trading book" would include equities and fixed income securities held for dealing or proprietary trading. It would also include equity and fixed income OTC derivatives, repos, certain forms of securities lending and exposures due to unsettled transactions. Foreign exchange exposures were not included in the trading book, but were addressed organization-wide under a separate provision of the CAD.

A minimum capital requirement for the market risk of a trading book was based upon a crude VaR measure intended to loosely reflect a 10-day 95% VaR metric.<sup>13</sup> This entailed separate "general risk" and "specific risk" computations, with the results summed. The measure has come to be known as the "building-block" approach.

General risk represented risk from broad market moves. Positions were divided into categories, one for equities and 13 for various maturities of fixed income instruments. Market values<sup>14</sup> were multiplied by category-specific risk weights—8% for equities and maturity-specific percentages for fixed income instruments. Weighted positions were netted within categories, and limited netting was permitted across fixed income categories. Results were summed.

Specific risk represented risk associated with individual instruments. Positions were divided into four categories, one for equities and three covering central government, "qualifying" and "other" fixed income instruments. Risk weights were:

- 2% for equities,
- 0% for central government instruments,
- 0.25%, 1% or 1.6% for qualifying instruments, depending upon maturity, and
- 8% for other instruments.

Results were summed without netting, either within or across categories.

By netting positions in its general risk calculation, the CAD recognized hedging effects to a greater extent than the SEC's UNCR. Like the UNCR, it recognizes no diversification benefits. In this regard, both the CAD and UNCR were less sophisticated than the SFA's portfolio approach.

## **Weakening of Glass-Steagall**

Across the Atlantic, the United States was embracing—albeit gradually—aspects of universal banking. The history of the Glass-Steagall act is one of incremental weakening of its separation between the banking and securities industries. Some of this stemmed

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<sup>13</sup> See Dale, p. 42.

<sup>14</sup> Derivatives were included in both the general and specific risk calculation based upon their delta-equivalent values.

from regulatory actions. Much of it stemmed from market developments not anticipated by the act.

The original Glass-Steagall Act permitted banks to deal in exempt securities. Banks were also permitted to engage in limited brokerage activities as a convenience to clients who used the bank's other services. Over time, that authorization was expanded.

Glass-Steagall did not prevent commercial banks from engaging in securities activities overseas. By the mid 1980s, US commercial banks such as Chase Manhattan, Citicorp and JP Morgan had thriving overseas securities operations. During the late 1980s, banks were also permitted to engage in limited domestic activities in non-exempt securities through so called "Section 20" subsidiaries.<sup>15</sup>

Currencies were not securities under the Glass-Steagall Act, but when exchange rates were allowed to float in the early 1970s, they entailed similar market risk. In 1933, futures markets were small and transacted primarily in agricultural products, so they were excluded from the act's definition of securities. Also, the Glass-Steagall Act did not anticipate the emergence of active OTC derivatives markets, so most derivatives did not fall under its definition of securities. By 1993, US commercial banks were taking significant market risks, actively trading foreign exchange, financial futures and OTC derivatives.

## **The Basle-IOSCO Initiative**

With banks increasingly taking market risk, in the early 1990s, the Basle Committee decided to update its 1988 accord to include bank capital requirements for market risk. This would have implications for non-bank securities firms.

As indicated earlier, capital requirements for banks and securities firms served different purposes. Bank capital requirements had existed to address systemic risks of banking. Securities capital requirements had originally existed to protect clients who left funds or securities on deposit with a securities firm. Regulations requiring segregation of investor assets as well as account insurance had largely addressed this risk. Increasingly, capital requirements for securities firms were being justified on two new grounds:

1. Although securities firms did not pose the same systemic risks as banks, it was argued that bank securities operations and non-bank securities firms should face the same capital requirements. Such "harmonization" would create a competitive "level playing field" between the two. This was the philosophy underlying Europe's CAD.

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<sup>15</sup> Section 20 of the Glass-Steagall Act forbade banks that are members of the Federal Reserve System from affiliating with any company engaged principally in underwriting or distributing non-exempt securities. In April 1987, the Fed interpreted this provision as permitting member banks to affiliate with companies engaged in limited securities activities. This interpretation was upheld by US courts, and commercial banks started forming "Section 20" affiliates.

2. Some securities firms were active in the OTC derivatives markets. Unlike traditional securities, many OTC derivatives were illiquid and posed significant credit risk for one or both counterparties. This was compounded by their high leverage that could inflict staggering market losses on unwary firms. Fears were mounting that the failure of one derivatives dealer could cause credit losses at other dealers. For the first time, non-bank securities firms were posing systemic risks.

Any capital requirements the Basle Committee adopted for banks' market risk would be incorporated into future updates of Europe's CAD and thereby apply to Britain's non-bank securities firms. If the same framework were extended to non-bank securities firms outside Europe, then market risk capital requirements for banks and securities firms would be harmonized globally. In 1991, the Basle Committee entered discussions with the International Organization of Securities Commissioners (IOSCO)<sup>16</sup> to jointly develop such a framework.

The two organizations formed a technical committee, and work commenced in January 1992. At that time, European regulators were completing work on the CAD, and many wanted the Basle-IOSCO initiative to adopt a similar building-block VaR measure. US regulators were hesitant to abandon the VaR measure of the UNCR, which has come to be called the "comprehensive" approach. The SFA's portfolio approach was a third alternative.<sup>17</sup>

Of the three VaR measures, the portfolio approach was theoretically most sophisticated, followed by the building-block approach and finally the comprehensive approach. The technical committee soon rejected the portfolio approach as too complicated. Led by European regulators, the committee gravitated towards the building-block measure, but US regulators resisted.<sup>18</sup>

Richard Breeden was chairman of the SEC and chairman of the technical committee. Ultimately, he balked at discarding the SEC's comprehensive approach. An analysis by the SEC indicated that the building block measure might reduce capital requirements for US securities firms by 70% or more. Permitting such a reduction, simply to harmonize banking and securities regulations, seemed imprudent. The Basle-IOSCO initiative had failed. In the United States, banking and securities capital requirements were to remain distinct.

## **Wilson's VaR Measure**

By 1993, a fair number of financial firms were employing proprietary VaR measures to assess market risk, allocate capital or monitor market risk limits. The measures took various forms. The most common approach generally followed Markowitz (1952, 1959). A portfolio's value would be modeled as a linear polynomial of certain risk factors. A

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<sup>16</sup> IOSCO was founded in 1974 to promote the development of Latin American securities markets. In 1983, its focus was expanded to encompass securities markets around the world.

<sup>17</sup> See Shirreff (1992) for a discussion of the competing issues faced by the technical committee.

<sup>18</sup> See Dimson and Marsh (1995) for a comparison of the three regulatory VaR measures.

covariance matrix would be constructed for the risk factors, and from this, the standard deviation of portfolio value would be calculated. If portfolio value were assumed normal, a quantile of loss could be calculated.

Thomas Wilson was working as a project manager for McKinsey & Co. He published (1993) a sophisticated VaR measure, noting:<sup>19</sup>

... This article aims to develop a method of incorporating stochastic covariance matrices into risk capital calculations using simple assumptions. In the most straightforward case, the adjustment to standard risk capital calculations is as simple as replacing the usual normal distribution with the standard t-distribution. The t-distribution has “fatter tails” than the normal distribution, reflecting the fact that the covariance matrix is also a random variable about which the risk manager has only limited prior information.

Wilson’s paper represents the first published attempt to reflect leptokurtosis and heteroskedasticity in the practical VaR measures used on trading floors. It is also the first detailed description of a VaR measure for use in a trading environment since Garbade’s (1987) paper. The author’s casual assumption that readers are familiar with the use of VaR measures on trading floors is indicative of how widespread such use had already become.

Without acknowledging his doing so, Wilson also touched on a philosophical issue of some practical importance. He suggested that the covariance matrix for risk factors actually exists, but that a user may have limited knowledge as to its values. This objective interpretation of the underlying probabilities runs counter to Markowitz’s (1952, 1959) subjective approach, which suggests that the covariance matrix does not actually exist, but is constructed by the user to reflect his own perceptions.

## **G-30 Report**

In 1990, risk management was novel. Many financial firms lacked an independent risk management function. This concept was practically unheard of in non-financial firms. As unease about derivatives and leverage spread, this started to change.

The term “risk management” was not new. It had long been used to describe techniques for addressing property and casualty contingencies. Doherty (2000) traces such usage to the 1960s and 1970s when organizations were exploring alternatives to insurance, including:

- risk reduction through safety, quality control and hazard education, and
- alternative risk financing, including self-insurance and captive insurance.

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<sup>19</sup> Wilson refers to Europe’s Exchange Rate Mechanism (ERM). In anticipation of unifying their currencies, European countries agreed to intervene in markets to maintain exchange rates between their respective currencies within certain trading “bands.”

Such techniques, together with traditional insurance, were collectively referred to as risk management.

More recently, derivative dealers were promoting “risk management” as the use of derivatives to hedge or customize market-risk exposures. For this reason, derivative instruments were sometimes called “risk management products.”

The new “risk management” that evolved during the 1990’s is different from either of the earlier forms. It tends to view derivatives as a problem as much as a solution. It focuses on reporting, oversight and segregation of duties within organizations. Such concepts have always been important. In the early 1990’s they took on a new urgency.

On January 30, 1992, Gerald Corrigan addressed the New York Bankers Association over lunch during their mid-Winter meeting at New York’s Waldorf Hotel. He had just flown from Geneva where, in his capacity as chairman of the Basle Committee, he had just launched the ill-fated Basle-IOSCO initiative. Now he was speaking in his other capacity as president of the New York Federal Reserve. His comments would set the tone for the new risk management:<sup>20</sup>

... the interest rate swap market now totals several trillion dollars. Given the sheer size of the market, I have to ask myself how it is possible that so many holders of fixed or variable rate obligations want to shift those obligations from one form to the other. Since I have a great deal of difficulty in answering that question, I then have to ask myself whether some of the specific purposes for which swaps are now being used may be quite at odds with an appropriately conservative view of the purpose of a swap, thereby introducing new elements of risk or distortion into the marketplace—including possible distortions to the balance sheets and income statements of financial and nonfinancial institutions alike.

I hope this sounds like a warning, because it is. Off-balance sheet activities have a role, but they must be managed and controlled carefully, and they must be understood by top management as well as by traders and rocket scientists.

That summer, Paul Volker, chairman of the Group of 30,<sup>21</sup> approached Dennis Weatherstone, chairman of JP Morgan, and asked him to lead a study of derivatives industry practices. Weatherstone formed an international steering committee and a working group of senior managers from derivatives dealers, end users and related legal, accounting and academic disciplines. They produced a 68-page report, which the Group of 30 published in July 1993. Entitled *Derivatives: Practices and Principles*, it has come to be known as the *G-30 Report*. It describes then-current derivatives use by dealers and

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<sup>20</sup> This incident is documented in Shirreff (1992). See Corrigan (1992) for a full text of the speech.

<sup>21</sup> Founded in 1978, the Group of 30 is a non-profit organization of senior executives, regulators and academics. Through meetings and publications, it seeks to deepen understanding of international economic and financial issues.

end-users. The heart of the study was a set of 20 recommendations to help dealers and end-users manage their derivatives activities. Topics included:

- the role of boards and senior management,
- the implementation of independent risk management functions,
- the various risks that derivatives transactions entail.

With regard to the market risk faced by derivatives dealers, the report recommended that portfolios be marked-to-market daily, and that risk be assessed with both VaR and stress testing. It recommended that end-users of derivatives adopt similar practices as appropriate for their own needs.

While the *G-30 Report* focused on derivatives, most of its recommendations were applicable to the risks associated with other traded instruments. For this reason, the report largely came to define the new risk management of the 1990's. The report is also interesting, as it may be the first published document to use the word "value-at-risk."

## **Organizational Mishaps**

By the 1990's, the dangerous affects of derivatives and leverage were taking a toll on corporations. In February 1993, Japan's Showa Shell Sekiyu oil company, reported a USD 1,050MM loss from speculating on exchange rates. In December of that same year, MG Refining and Marketing, a US subsidiary of Germany's Metallgesellschaft AG, reported a loss of USD 1,300MM from failed hedging of long-dated oil supply commitments.

The popular media noted these staggering losses, and soon focused attention on other organizational mishaps. In 1994, there was a litany of losses. China's state sponsored CITIC conglomerate and Chile's state-owned Codelco copper corporation lost USD 40MM and USD 207MM trading metals on the London Metals Exchange (LME). US companies Gibson Greetings, Mead, Proctor & Gamble and Air Products and Chemicals all reported losses from differential swaps transacted with Bankers Trust. Japan's Kashima Oil lost USD 1,500MM speculating on exchange rates. California's Orange County announced losses from repos and other transactions that would total USD 1,700MM. These are just a few of the losses publicized during 1994.

The litany continued into 1995. A notable example is Japan's Daiwa Bank. One of its US-based bond traders had secretly accumulated losses of USD 1,100MM over a 10 year period. What grabbed the world's attention, though, was the dramatic failure of Britain's Barings PLC in February 1995. Nick Leeson, a young trader based at its Singapore office, lost USD 1,400MM from unauthorized Nikki futures and options positions. Barings had been founded in 1762. It had financed Britain's participation in the Napoleonic wars. It had financed America's Louisiana purchase and construction of the Erie Canal. Following its collapse, Barings was sold to Dutch bank ING for the price of one British pound.

## RiskMetrics

During the late 1980's, JP Morgan developed a firm-wide VaR system.<sup>22</sup> This modeled several hundred risk factors. A covariance matrix was updated quarterly from historical data. Each day, trading units would report by e-mail their positions' deltas with respect to each of the risk factors. These were aggregated to express the combined portfolio's value as a linear polynomial of the risk factors. From this, the standard deviation of portfolio value was calculated. Various VaR metrics were employed. One of these was one-day 95% USD VaR, which was calculated using an assumption that the portfolio's value was normally distributed.

With this VaR measure, JP Morgan replaced a cumbersome system of notional market risk limits with a simple system of VaR limits. Starting in 1990, VaR numbers were combined with P&L's in a report for each day's 4:15 PM Treasury meeting in New York. Those reports, with comments from the Treasury group, were forwarded to Chairman Weatherstone.

One of the architects of the new VaR measure was Till Guldumann. His career with JP Morgan had positioned him to help develop and then promote the VaR measure within the firm. During the mid 1980's, he was responsible for the firm's asset/liability analysis. Working with other professionals, he developed concepts that would be used in the VaR measure. Later as chairman of the firm's market risk committee, he promoted the VaR measure internally. As fate would have it, Guldumann's next position placed him in a role to promote the VaR measure outside the firm.

In 1990 Guldumann took responsibility for Global Research, overseeing research activities to support marketing to institutional clients. In that capacity he managed an annual research conference for clients. In 1993, risk management was the conference theme. Guldumann gave the keynote address and arranged for a demonstration of JP Morgan's VaR system. The demonstration generated considerable interest. Clients asked if they might purchase or lease the system. Since JP Morgan was not a software vendor, they were disinclined to comply. Guldumann proposed an alternative. The firm would provide clients with the means to implement their own systems. JP Morgan would publish a methodology, distribute the necessary covariance matrix and encourage software vendors to develop compatible software.

Guldumann formed a small team to develop something for the next year's research conference. The service they developed was called **RiskMetrics**. It comprised a detailed technical document as well as a covariance matrix for several hundred key factors, which was updated daily. Both were distributed without charge over the Internet. The service was rolled out with considerable fanfare in October 1994. A public relations firm placed ads and articles in the financial press. Representatives of JP Morgan went on a multi-city tour to promote the service. Software vendors, who had received advance notice, started promoting compatible software. Launched at a time of global concerns about derivatives and leverage, the timing for RiskMetrics was perfect.

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<sup>22</sup> See Guldumann (2000).

RiskMetrics was not a technical breakthrough. While the *RiskMetrics Technical Document* contained original ideas, for the most part, it described practices that were already widely used. Its linear VaR measure was arguably less sophisticated than those of Garbade (1986) or Wilson (1993). The important contribution of RiskMetrics was that it publicized VaR to a wide audience.

## **Regulatory Approval of Proprietary VaR Measures**

In April 1993, following the failure of its joint initiative with IOSCO, the Basle committee released a package of proposed amendments to the 1988 accord. This included a document proposing minimum capital requirements for banks' market risk. The proposal generally conformed to Europe's CAD. Banks would be required to identify a trading book and hold capital for trading book market risks and organization-wide foreign exchange exposures. Capital charges for the trading book would be based upon a building-block VaR measure loosely consistent with a 10-day 95% VaR metric. Like the CAD measure, this partially recognized hedging effects but ignored diversification effects.

The committee received numerous comments on the proposal. Commentators perceived the building-block VaR measure as a step backwards. Many banks were already using proprietary VaR measures.<sup>23</sup> Most of these modeled diversification effects, and some recognized portfolio non-linearities. Commentators wondered if, by embracing a crude VaR measure, regulators might stifle innovation in risk measurement technology.

In April 1995, the committee released a revised proposal. This made a number of changes, including the extension of market risk capital requirements to cover organization-wide commodities exposures. An important provision allowed banks to use either a regulatory building-block VaR measure or their own proprietary VaR measure for computing capital requirements. Use of an proprietary measure required approval of regulators. A bank would have to have an independent risk management function and satisfy regulators that it was following acceptable risk management practices. Regulators would also need to be satisfied that the proprietary VaR measure was sound. Proprietary measures would need to support a 10-day 99% VaR metric and be able to address the non-linear exposures of options. Diversification effects could be recognized within broad asset categories—fixed income, equity, foreign exchange and commodities—but not across asset categories. Market risk capital requirements were set equal to the greater of:

- the previous day's VaR, or
- the average VaR over the previous six days, multiplied by 3.

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<sup>23</sup> A 1993 survey conducted for the Group of 30 (1994) by Price Waterhouse found that, among 80 responding derivatives dealers, 30% were using VaR to support market risk limits. Another 10% planned to do so.

The alternative building-block measure—which was now called the “standardized” measure—was changed modestly from the 1993 proposal. Risk weightings remained unchanged, so it may reasonably be interpreted as still reflecting a 10-day 95% VaR metric. Extra capital charges were added in an attempt to recognize non-linear exposures.

The Basle Committee’s new proposal was incorporated into an amendment to the 1988 accord, which was adopted in 1996. It went into effect in 1998.

## The Name “Value-at-Risk”

Origins of the name “value-at-risk” are murky. Several similar names were used during the 1990’s, including: “dollars-at-risk” (DaR), “capital-at-risk” (CaR), “income-at-risk” (IaR), “earnings-at-risk” (EaR) and “value-at-risk” (VaR). It seemed that users liked the “-at-risk” moniker, but were uncomfortable labeling exactly what was “at risk”. The “dollars” label of DaR was too provincial for use in many countries. The “capital” label of CaR seemed too application-specific. Some applications of VaR—such as VaR limits—were unrelated to capital. The “income” and “earnings” labels of IaR and EaR had accounting connotations unrelated to market risk. Software vendor Wall Street Systems went so far as to call its software “money-at-risk”. It is perhaps the vagueness of the label “value” that made “value-at-risk” attractive. Also, its use in the *RiskMetrics Technical Document* added to its appeal. By 1996, other names were falling out of use.

Guldimann (2000) suggests that the name “value-at-risk” originated within JP Morgan prior to 1985:

... we learned that “fully hedged” in a bank with fully matched funding can have two meanings. We could either invest the Bank’s net equity in long bonds and generate stable interest earnings, or we could invest it in Fed funds and keep the market value constant. We decided to focus on value and assume a target duration investors assigned to the bank’s equity. Thus value-at-risk was born.

It seems likely that the “DaR” and “CaR” names also arose during the 1980’s, since use of both was common by the early 1990’s. “DaR” appears<sup>24</sup> in the financial literature as early as June 1991—two years prior to the first known appearance of “VaR” in the July 1993 *G-30 Report*. “CaR” appears as early as September 1992.<sup>25</sup>

## The VaR Debate

Following the release of RiskMetrics and the widespread adoption of VaR measures, there was somewhat of a backlash against VaR. This has come to be called the “VaR debate”. Criticisms followed three themes:

1. that different VaR implementations produced inconsistent results;

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<sup>24</sup> Mark (1991).

<sup>25</sup> Wilson (1992).

2. that, as a measure of risk, VaR is conceptually flawed;
3. that widespread use of VaR entails systemic risks.

Critics in the first camp include Beder (1995) and Marshall and Siegel (1997). Beder performed an analysis using Monte Carlo and historical VaR measures to calculate sixteen different VaR measurements for each of three portfolios. The sixteen measurements for each portfolio tended to be inconsistent, leading Beder to describe VaR as “seductive but dangerous.” In retrospect, this indictment seems harsh. Beder’s analysis employed different VaR metrics,<sup>26</sup> different covariance matrices and historical VaR measures with very low sample sizes. It comes as no surprise that she obtained disparate VaR measurements! Despite its shortcomings, Beder’s paper is historically important as an early critique of VaR. It was cited frequently in the ensuing VaR debate.

Marshall and Siegel (1997) approached eleven software vendors that had all implemented the RiskMetrics linear VaR measure. They provided each with several portfolios and a covariance matrix and asked them to calculate the portfolios’ one-day 95% VaR. In this way, each vendor would be calculating VaR for the same portfolios using the same covariance matrix based upon the same VaR measure and the same VaR metric. The vendors should have obtained identical results, but they did not. Marshall and Siegel’s results are summarized in Table 1:

Portfolio	Standard Deviation of Vendors’ VaR Measurements
Foreign exchange forwards	1%
Money market deposits	9%
Forward rate agreements	10%
Bonds	17%
Interest rate swaps	21%

**Table 1:** Marshall and Siegel’s (1997) results are summarized with a standard deviation of vendors’ VaR measurements for each portfolio. Standard deviations are calculated as: standard deviation of VaR measurements divided by median of VaR measurements. Most vendors provided results for only certain portfolios, so standard deviations are each based on six to eight VaR measurements. A single outlier skewed the standard deviation for the money market portfolio.

The implementation issues that Marshall and Siegel highlighted were—and still are—an important concern. However, such issues arise with any quantitative software, and can be addressed with suitable validation and verification procedures.

Of more concern were criticisms suggesting that VaR measures were conceptually flawed. One such critic was Taleb (1997):

The condensation of complex factors naturally does not just affect the accuracy of the measure. Critics of VaR (including the author) argue that simplification could result in such distortions as to nullify the value of the measurement. Furthermore, it can lead to *charlatanism*: Lulling an innocent investor or business manager into

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<sup>26</sup> She employed one-day 95%, one-day 99%, two-week 95% and two-week 99% VaR metrics, applying each in one quarter of her VaR measurements. This was the largest contributor to the dispersion in her results.

a false sense of security could be a serious breach of faith. Operators are dealing with unstable parameters, unlike those of the physical sciences, and risk measurement should not just be understood to be a vague and imprecise estimate. This approach can easily lead to distortions. The most nefarious effect of the VaR is that it has allowed people who have never had any exposure to market risks to express their opinion on the matter.

Some criticism of VaR seems to have stemmed from traders resistant to independent oversight of their risk taking activities. Taleb's closing remark seems to play to that audience. As founder and head of risk management software vendor Algorithmics, Dembo (1998) speaks more to risk managers:

Value-at-risk, per se, is a good idea. But the way it's measured today, VaR is bad news because the calculation errors can be enormous. Often, the number that is computed is almost meaningless. In other words, the number has a large standard error ...

I also find a real problem with the idea that one can forecast a correlation matrix. If you try and forecast the correlation matrix, you've got a point estimate in the future. The errors that we've seen, resulting from correlation effects, dominate the errors in market movements at the time. So the correlation methodology for VaR is inherently flawed.

Such concerns have a practical tone, but underlying them are philosophical issues first identified by Markowitz (1952, 1959). If probabilities are subjective, it makes no sense to speak of the "accuracy" of a VaR measure or of a "forecast" of a correlation matrix. From a subjective perspective, a VaR measurement or a correlation matrix is merely an objective representation of a user's subjective perceptions.

The third line of criticism suggests that, if many market participants use VaR to allocate capital or maintain market risk limits, they will have a tendency to simultaneously liquidate positions during periods of market turmoil. Bob Litzenberger of Goldman Sachs comments:

Consider a situation when volatilities rise and there are some trading losses. VaR's would be higher and tolerances for risk would likely be lower. For an individual firm, it would appear reasonable to reduce trading positions; however, if everybody were to act similarly, it would put pressure on their common trading positions.<sup>27</sup>

This risk is similar to that of portfolio insurance, which contributed to the stock market crash of 1987, but there are differences. Stock positions tend mostly to be long because short selling comprises only a small fraction of equity transactions. Portfolio insurance programs in 1987 were designed to protect against a falling market, so they responded to the crash in lockstep. In other markets, positions may be long or short. In fixed income

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<sup>27</sup> Quoted in Dunbar (2000), p. 203.

markets, there are lenders and borrowers. In commodities markets, there are buyers and sellers. In foreign exchange markets, every forward position is long one currency but short another. If VaR measures compel speculators in these markets to reduce positions, this will affect both long and short positions, so liquidations will tend to offset.

## Conclusion

VaR has its origins in portfolio theory and capital requirements. The latter can be traced to NYSE capital requirements of the early 20<sup>th</sup> century. During the 1950's, portfolio theorists developed basic mathematics for VaR measures. During the 1970's, US regulators prompted securities firms to develop procedures for aggregating data to support capital calculations reported in their FOCUS reports.

By the 1980's, a need for institutions to develop more sophisticated VaR measures had arisen. Markets were becoming more volatile, and sources of market risk were proliferating. By that time, the resources necessary to calculate VaR were also becoming available. Processing power was inexpensive, and data vendors were starting to make large quantities of historical price data available. Financial institutions implemented sophisticated proprietary VaR measures during the 1980's, but these remained practical tools known primarily to professionals within those institutions.

During the early 1990's, concerns about the proliferation of derivative instruments and publicized losses spurred the field of financial risk management. JP Morgan publicized VaR to professionals at financial institutions and corporations with its *RiskMetrics* service. Ultimately, the value of proprietary VaR measures was recognized by the Basle Committee, which authorized their use by banks for performing regulatory capital calculations. An ensuing "VaR debate" raised issues related to the subjectivity of risk, which Markowitz had first identified in 1952. Time will tell if widespread use of VaR contributes to the risks VaR is intended to measure.

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Introduction to risk analysis History of Value-at-Risk VaR, relative VaR, marginal VaR, and incremental VaR Overview of risk methodologies Confidence level scaling factors Time scaling of volatility Components of market risk Basic dimensions of market risk Summary. Chapter 2. 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9. History of Value-at-Risk: 1922-1998. Working Paper July 25, 2002. During the 1990s, Value-at-Risk (VaR) was widely adopted for measuring market risk in trading portfolios. Its origins can be traced back as far as 1922 to capital requirements the New York Stock Exchange imposed on member firms. VaR also has roots in portfolio theory and a crude VaR measure published in 1945. This paper traces this history to 1998, when banks started using proprietary VaR measures to calculate regulatory capital requirements. We define VaR as a category of probabilistic measures of market risk. Consider a portfolio with fixed holdings. Its current market value is known. Its m