What Practioners Need to Know

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The Nobel Prize

On October 16, 1990, the Royal Swedish Academy of Sciences announced its selection for the Nobel Memorial Prize in Economic Science. For the first time since the prize for economics was established in 1968, the Royal Academy chose three individuals whose primary contributions are in finance and whose affiliations are not with arts and science schools, but rather with schools of business. Harry Markowitz was cited for his pioneering research in portfolio selection, while William Sharpe shared the award for developing an equilibrium theory of asset pricing. Merton Miller was a cowinner for his contributions in corporate finance, in which he showed, along with Franco Modigliani, that the value of a firm should be invariant to its capital structure and dividend policy.

The pioneering research of these individuals revolutionized finance and, of particular relevance for this column, motivated the application of quantitative methods to financial analysis. It is thus fitting that we devote this issue's column to the essential contributions of these Nobel laureates.

Portfolio Selection

In his classic article, "Portfolio Selection," Markowitz submitted that investors should not choose portfolios that maximize expected return, because this criterion by itself ignores the principle of diversification.[1] He proposed that investors should instead consider variances of return, along with expected returns, and choose portfolios that offer the highest expected return for a given level of variance. He called this rule the E-V maxim.

Markowitz showed that a portfolio's expected return is simply the weighted average of the expected returns of its component securities. A portfolio's variance is a more complicated concept, however. It depends on more than just the variances of the component securities.

The variance of an individual security is a measure of the dispersion of its returns. It is calculated by squaring the difference between each return in a series and the mean return for the series, then averaging these squared differences. (The square root of the variance, or the standard deviation, is often used in practice because it measures dispersion in the same units the underlying return is measured in.)

Variance provides a reasonable gauge of a security's risk, but the average of the variances of two securities will not necessarily give a good indication of the risk of a portfolio comprising these two securities. The portfolio's risk depends also on the extent to which the two securities move together—that is, the extent to which their prices react in like fashion to a particular event.

To quantify comovement among security returns, Markowitz introduced the statistical concept of covariance. The covariance between two securities equals the standard deviation of the first times the standard deviation of the second times the correlation coefficient between the two.

The correlation coefficient, in this context, measures the association between the returns of two securities. It ranges in value from 1 to −1. If one security's returns are higher than its average return when another security's returns are higher than its average return, for example, the correlation coefficient will be positive, somewhere between 0 and 1. Alternatively, if one security's returns are lower than its average return when another security's returns are higher than its average return, then the correlation coefficient will be negative.

The correlation coefficient, by itself, is an inadequate measure of covariance because it measures only the direction and degree of association between securities' returns. It does not account for the magnitude of variability in each security's returns. Covariance captures magnitude by multiplying the correlation coefficient by the standard deviations of the securities' returns.

Consider, for example, the covariance of a security with itself. Obviously, the correlation coefficient in this case equals 1. A security's covariance with itself thus equals the standard deviation of its returns squared (which, of course, is its variance).

Finally, portfolio variance depends also on the weightings of its constituent securities—the proportion of portfolio market value invested in each. The variance of a portfolio consisting of two securities equals the variance of the first security times its weighting squared plus the variance of the second security times its weighting squared plus twice the

1. Footnotes appear at end of article.

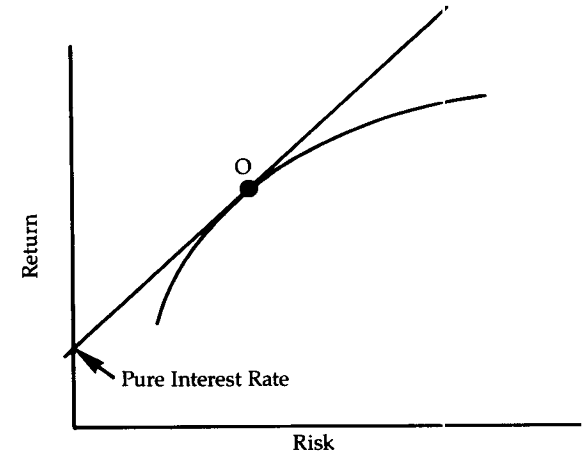
covariance between the securities times each security's weighting. The standard deviation of this portfolio equals the square root of the variance.

From this formulation of portfolio risk, Markowitz was able to offer two key insights. First, unless the securities in a portfolio are perfectly inversely correlated (i.e., have a correlation coefficient of -1), it is not possible to eliminate portfolio risk entirely through diversification. If we divide a portfolio equally among its component securities, for example, as the number of securities in the portfolio increases, the portfolio's risk will tend not toward zero but, rather, toward the average covariance of the component securities.

Second, unless all the securities in a portfolio are perfectly positively correlated with each other (a correlation coefficient of 1), a portfolio's standard deviation will always be less than the weighted average standard deviation of its component securities. Consider, for example, a portfolio consisting of two securities, both of which have expected returns of 10 per cent and standard deviations of 20 per cent and which are uncorrelated with each other. If we allocate portfolio assets equally between these two securities, the portfolio's expected return will equal 10 per cent, while its standard deviation will equal 14.14 per cent. The portfolio offers a reduction in risk of nearly 30 per cent relative to investment in either of the two securities separately. Moreover, this risk reduction is achieved without any sacrifice of expected return.

Markowitz also demonstrated that, for given levels of risk, we can identify particular combinations of securities that maximize expected return. He deemed these portfolios "efficient" and referred to a contin-

Figure A Efficient Frontier with Borrowing and Lending



tance. It was in part the challenge of this obstacle that motivated William Sharpe to develop a single index measure of a security's risk.

The Capital Asset Pricing Model

James Tobin, the 1981 winner of the Nobel Prize in economics, showed that the investment process can be separated into two distinct steps—(1) the construction of an efficient portfolio, as described by Markowitz, and (2) the decision to combine this efficient portfolio with a riskless investment. This two-step process is the famed Separation Theorem.[3]

Sharpe extended Markowitz's and Tobin's insights to develop a theory of market equilibrium under conditions of risk.[4] First, Sharpe showed that there is line emanating from the pure interest rate that is tangent to 0. The requisite assumptions are that (1) there exists a single pure interest rate at which investors can lend and borrow in unlimited amounts and (2) investors have homogeneous expectations regarding expected returns, variances and correlations. Under these assumptions, Sharpe showed that portfolio 0 is the market portfolio, which represents the maximum achievable diversification.

Within this paradigm, Sharpe proceeded to demonstrate that risk can be partitioned into two sources —that caused by changes in the value of the market portfolio, which cannot be diversified away, and that caused by non-market factors, which is diversified away in the market portfolio. He labeled the non-diversifiable risk "systematic risk" and the diversifiable risk "unsystematic risk."

Sharpe also showed that a security's systematic risk can be estimated by regressing its returns (less the pure interest rate) against the market portfolio's returns (less the pure interest rate). The slope from this regression equation, which Sharpe called beta, quantifies the security's systematic risk. The unexplained variation in the security's return (the residuals from the regression equation) represent the security's unsystematic risk. He then asserted that, in an efficient market, investors are only compensated for bearing systematic risk, because it cannot be diversified away, and that the expected return of a security is, through beta, linearly related to the market's expected return.

These insights posit a single source of systematic, or common, risk. (Stated differently, the residuals from the regression equation are uncorrelated with each other.) The important practical implication is that it is not necessary to estimate covariances between securities. Each security's contribution to portfolio risk is captured through its beta coefficient.[5]

Invariance Propositions

Between the publication of Markowitz's theory of portfolio selection and Sharpe's equilibrium theory of asset pricing, Franco Modigliani (the 1985 Nobel Prize winner in economics) and Merton Miller published two related articles in which they expounded their now famous invariance propositions. The first, "The Cost of Capital, Corporation Finance, and the Theory of Investment," appeared in 1958.[6] It challenged the then conventional wisdom that a firm's value depends on its capital structure (that is, its debt/equity mix).

In challenging this traditional view, Modigliani and corporate debt guarantees that firms in the same risk class will be valued the same, regardless of their respective capital structures. In essence, Modigliani and Miller argued in favor of the law of one price.

In a subsequent article, "Dividend Policy Growth, and the Valuation of Shares," Modigliani and Miller proposed that a firm's value is invariant, not only to its capital structure, but also to its dividend policy (assuming the firm's investment decision is set independently).[7] Again, they invoked the notion of substitutability, arguing that repurchasing shares has the same effect as paying dividends; thus issuing shares and paying dividends is a wash. Although the cash component of an investor's return may differ as a function of dividend policy, the investor's total return, including price change, should not change with dividend policy.

Modigliani and Miller's invariance propositions have inspired an enormous amount of debate and research. Much of the sometimes spirited debate has centered on the assumption of perfect capital markets. In the real world, where investors cannot borrow and lend at the riskless rate of interest, where both corporations and individuals pay taxes, and where investors do not share equal access with management to relevant information, there is only spotty evidence to support Modigliani and Miller's invariance propositions.

But the value of the contributions of these Nobel laureates does not depend on the degree to which their theories hold in an imperfect market environment. It depends, rather, on the degree to which they changed the financial community's understanding of the capital markets. Markowitz taught us how to evaluate investment opportunities probabilistically, while Sharpe provided us with an equilibrium theory of asset pricing, enabling us to distinguish between risk that is rewarded and risk that is not rewarded. Miller, in collaboration with Modigliani, demonstrated how the simple notion of arbitrage can be applied to determine value; as we all know, this has had a profound impact on subsequent financial analysis. As financial analysts, we owe a great debt to these Nobel laureates.

Footnotes

1. H. Markowitz, "Portfolio Selection," *Journal of Finance*, March 1952.
2. This same formula gives the sum of 1 + 2 + 3 + . . . + n. There is an amusing story about this formula and the famous mathematician, Gauss. According to legend, when Gauss was a child just

knew about the patent, but "It wasn't a big factor in his thinking."[9]

The SEC is trying to insure that investors get information on relevant insider transactions in a timely fashion. In January, the SEC modified the rules on filing, the first major revision of the 1934 Act.[10] The old rules required all vice presidents to file, which resulted in thousands of reports from industries such as financial services, where much of middle management has the title. (In 1989, there were more than 115,000 filings for over 200,000 transactions.) Now, the only officers who have to file are those who have significant policy-making duties, as spelled out in the proxy.

The reports are still due on the 10th day of the month following the transaction. In 1990, however, 22 per cent of the filings were late, and the delinquency rates have been as high as 55 per cent in recent years.[11] The SEC can levy fines under the new rules, and the "embarrassment factor" should spur executives to file promptly. Companies will also have to list on the cover of the proxy statement the names of officers and directors who did not file.

The combination of the SEC rule changes and the *Wall Street Journal* "Insider Trading Spotlight" should provide some very interesting reading for analysts, investors, SEC watchdogs and class-action lawyers.

Footnotes

1. S. Pratt and C. DeVere, "Relationship Between Insider Trading and Rates of Return for NYSE Common Stocks, 1960–66," in J. Lorie and R. Brealey, eds, *Modern Developments in Investment Management* (New York: Praeger Publishers, 1972).
2. J. F. Jaffee, "Special Information and Insider Trading," *Journal of Business*, July 1974.
3. H. N. Seyhun, "Insiders' Profits, Costs of Trading, and Market Efficiency," *Journal of Financial Economics* 1986, pp. 189–212.
4. M. Hulbert, "Insider Trading," *Forbes*, December 24, 1990.
5. A. Peers and G. Jasen, "Two Silk Greenhouse Officials Sold Stock For $2.6 Million Before Price Tumbled," *Wall Street Journal*, December 6, 1989.
6. J. S. Hirsch, "SEC Charges Ex-Philips Industries Head In Sale of Shares Before Buy-Out Failed," *Wall Street Journal*, February 28, 1990.
7. D. B. Henriques, "Insider Charge at Emerson Radio," *New York Times*, November 22, 1989
8. F. Norris, "The Limits of Audits," *New York Times*, September 7, 1989.
9. J. Sheban, "Texas Instruments Defends Handling of Patent News," *Wall Street Journal*, November 27, 1989.
10. "SEC Makes Rule Shift on Executives' Stock Reporting," *New York Times*, January 11, 1991.
11. K. G. Salwen, "SEC Seeks to Force Timely Reporting of Stock Trades by Company Executives," *Wall Street Journal*, January 11, 1991.

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described how he had begun by adding one plus two plus three but became bored and started adding backward from 100. He then noticed that one plus 100 equals 101, as did two plus 99 and three plus 98, and realized that if he multiplied 100 by 101 and divided by two (so as not to double-count), he would arrive at the answer.

3. J. Tobin, "Liquidity Preferences as Behavior Toward Risk," *Review of Economic Studies*, February 1958.
4. W. Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Uncertainty," *Journal of Finance*, September 1964.
5. The CAPM itself does not necessarily assume a single source of systematic risk. This is tantamount to allowing for some correlation among the residuals.
6. F. Modigliani and M. Miller, "The Cost of Capital, Corporation Finance, and the Theory of Investment," *American Economic Review*, June 1958.
7. M. Miller and F. Modigliani, "Dividend Policy, Growth, and the Valuation of Shares," *Journal of Business*, October 1961.