THE THEORY OF SECURITY PRICING AND MARKET STRUCTURE

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with a Foreword by Paul A. Samuelson

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ABSTRACT

This manuscript reviews the evolving literature on the pricing of assets and the structure of financial markets. It begins with the development of early stock valuation models and proceeds to a description of the efficient-market hypothesis. The survey then examines recent empirical data that has led to a reevaluation of the assumptions underlying an efficient market and ends with a brief survey of the recent literature on market-making and how these models relate to studies of efficient markets.

FOREWARD

Paul A. Samuelson, MIT, February 1992

The economic theory of finance is one of the great success stories of our time. Now even Nobel Prizes are given to its innovators--a sign that economic theorists recognize the scientific worthiness of the finance models.

Flowers and medals are all very well but money talks loudest of all. Wall Street has beat a track to the door of those mathematically adept in the arcane arts of finance. Thus, a bright MIT student whose undergraduate thesis I supervised a decade ago recently made the headlines with his over-20-million-dollars earned annual bonus. (His thesis found a random-walk treasury bond market so efficient that no one could garner surplus capital gains, but apparently, subsequent to graduation, he learned how to refute his own findings.

When a new scientific theory triumphs, is that the end of the story as we allegedly live happily ever afterward? No. Economic statisticians and historians must monitor the speculative markets that are pronounced to be "efficient"--to test whether they stay that way. Marshall Blume and Jeremy Siegel, after reviewing old findings, present for us new evolutionary evidence. If stock prices move in an unfathomable random walk, how can it be that investors in small stocks do better than their conservative cousins? Can we really count on end-of-the-year killings in those small stocks? Once the secret is out, year after year? Rather than report on the off-the-cuff opinions of John Kenneth Galbraith, Milton Friedman, or Paul Samuelson, Blume and Siegel dig out the evolving facts on low capitalization markets. It is a never-ending project.

Market structures do differ. A hundred analysts study changes in IBM earnings and prospects. Few investors have even heard the name of a new over-the-counter company. Is it plausible that two such stocks will display the same statistical structure? Or compare the Tokyo market of the 1990s with that of earlier times when chewing gum and tacit pools held together Japanese stock prices. We need to know the latest wrinkles of evolving market structure. Better still we seek a good theory that will help us, before markets know how they are going to be reformed, guess where they will be evolving toward. I found valuable the authors' account of how market structure affects market inefficiencies.

Modern finance theory is fascinating precisely because it is still open-ended. The rigor of Euclid's geometry, which is the rigor of rigor mortis, is quite another thing. Thus, I continue to debunk chartism and technical trading methods. But experience makes me think that a few folk do have an intuitive flair for making money by sensing patterns of momentum. You can't learn to do it from a book, and they can't explain to their daughters how to do it. Neither to you nor to David Rockefeller will these Babe Ruths transfer cheaply the rents of their rare ability. So, for economic science, it is valid to regard speculative prices as effectively white noise. In the same way, experience has persuaded me that there are a few Warren Buffetts out there with high rent-earning ability because they are good at figuring out which fundamentals are fundamental and which new data are worth paying high costs to get. Such super-stars don't come cheap: by the time you spot them their fee has been bid sky high! Their possible existence does not refute the version of market efficiency that I deem scientifically realistic and useful. In my envisaged efficiency equilibrium, rents to ability to grapple with uncertainty are not zero but for the bulk of investors they do average out to be minuscule. Costs incurred to dig out relevant data are positive but competitors grind down the intra-marginal returns sought. The ex post stochastic variation of prices diverges from any person's ex ante expectations, and it is the heterogeneity of ex ante expectations that primarily generates the extensive real world transactions between buyers and sellers.

I state these heresies diffidently and in a low key--for the reason that any and all of my super stars could be merely lucky. There is no escaping chance in the science of finance. Even the beautiful Black-Scholes option formula depends on an ex ante parameter of variability whose value we can never "know" with precision. Just as a researcher in medicine pools the results of many studies of cholesterol and mortality in a final meta-analysis, so are my judgments the upshot of my meta-analysis of a lifetime of divergent experiences. Who is to say your different life path is not better than mine?

Reading the present work brings to my consciousness another secret conviction. I do believe in micro-efficiency of organized markets. Diversification does raise risk-corrected returns. Holding the broadest index of stocks in your portfolio does enable you to outperform on a risk-corrected basis most money managers. That is the micro-efficiency that myriad empirical observations do bear out. But is it the case that modern markets are macro-efficient in the sense that the average level of the Standard & Poor's Index or of more comprehensive aggregates is a "correct" appraisal of fundamental wealth and production prospects?

On that question I am agnostic. Markets can produce for themselves self-fulfilling syndromes of optimism and pessimism. If I believed in 1928 that Price/Earnings ratios were too high in Wall Street, I could lose my shirt arguing with the tape. (By contrast, if I perceive a micro-divergence between GM's pre-dividend and post-dividend price, it's a favorable calculated risk to bet against it. As I and other experienced cookies do this, we make excess profits from our acts and at the same time our acts work to iron out the aberration.) It is hard enough to define rationally what macro-efficiency of the aggregate level of stock prices means, much less believe in it! That is why I tend as a macro-agnostic to side with Robert Shiller of Yale rather than the newest Ph.D. from Cook County.

Much of what we know about finance we learned from Wharton School researchers. Marshall Blume and Jeremy Siegel carry forward that great tradition!

I. INTRODUCTION

A market in financial assets serves two major functions. The first is price determination--signaling investors and firms where the most profitable investments can be made and at what price. An increase in the price of a security is a signal to investors that the market values a particular productive activity more favorably, making it cheaper for the firm's owners to finance investment. Thus, prices of financial assets serve a function similar to prices in the standard economic models of supply and demand: allocating scarce resources to their best uses.[1]

The second function of the market in financial assets is to bring together buyers and sellers of existing securities and to enable firms to raise new capital by issuing new security. The structure of this market, defined by such factors as the number of separate market-makers, trading rules, dealer involvement, and the auction mechanism, determines the effectiveness of this second function of market-making.

Until recently, theoretical models assumed that the determination of price was independent of the specific market structure in which securities were traded. Prices were assumed to be functions of such variables as dividends, earnings, interest rates, and risk factors. The specific institutional structure of the market was assumed to have no effect on the price of a security. Recently a growing body of literature suggests that the institutional structure of the market itself may play an important role in how new information becomes incorporated in security prices. The implication of this new research is that price determination must be analyzed in conjunction with the market structure, with different structures leading to different prices.

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[1]One should be mindful that monopolies, foreign trade restrictions, and other restrictive practices can enhance the price of a security without increasing welfare. Similarly, an oil crisis may depress the price of existing shares while creating tremendous opportunities for new energy saving investment.

It is the purpose of this treatise to present an interconnected history of the evolving theory of the pricing of assets and the structure of the financial markets. The paper makes no attempt to provide a comprehensive list of references for every topic discussed, since we wish to concentrate on the major threads in intellectual development of this field. In keeping with the spirit of a history, the primary references will generally be the original papers even though there may have been more recent research presenting similar ideas in possibly more elegant ways.

Section II reviews the early theory of the pricing of risky assets known as fundamental analysis. It then reviews the early tests of technical analysis or charting techniques, which tried to find predictable dependencies in stock price changes. These early tests of technical analysis found that price movements of stocks and bonds are essentially random. This implied that charting techniques, which relied on nonrandom prices, were useless. The apparent random character of changes in stock prices led to the development of the efficient-market hypothesis, reviewed in Section III. This hypothesis claimed that if all known pricing factors, such as earnings or past price patterns, are included in the price of a security, then the market price must generally follow a process that has become known as a "random walk."

Further tests bore out the random character of changes in stock prices, which validated the efficient-market hypothesis. Few investors, even those who managed large investment pools such as mutual funds, outperformed the returns available from an investment in a random collection of securities. Coupled with the theory of efficient markets, these findings supported the case for investing in large diversified baskets of stocks that matched broad-based indices, since it was difficult, if not impossible, to try to "beat the market." At the same time that researchers were carrying out these empirical tests of market efficiency, major theoretical advances in the theory of asset pricing led to the development of the well-known capital asset pricing model (CAPM) used by both academics and practitioners.

Almost as soon as the evidence for an efficient market appeared to be overwhelming, a series of empirical results emerged that were inconsistent with the predictions of the efficient-market hypothesis as it was understood at that time. These studies, reviewed in Section IV, showed that over long periods, the returns of small firms significantly exceeded those of larger firms by more than could be explained by pricing theories developed under the efficient-market hypothesis. Many of these excess returns were perplexingly related to the calendar, mostly occurring early in the month of January. The further discovery of relations between price movements and the day of the week and even the time of the day provided further challenges to the efficient-market hypothesis.

There also emerged further evidence that was inconsistent with the efficient-market hypothesis. Some advisers appeared consistently to outperform the market and "insiders" earned significantly higher returns than predicted by the efficient-market hypothesis. Finally, studies of stock market returns over long periods suggested that future returns were predictable from past returns and that the stock market appeared excessively volatile relative to the predictions of the efficient-market theory. As a result, researchers tried to modify the existing asset pricing theory to explain these anomalies, but such attempts have, so far, proved unsuccessful.

The empirical evidence against the efficient-market hypothesis caused a reexamination of the basic theoretical model underlying the hypothesis (Section V). This reexamination found a logical inconsistency in the efficient-market hypothesis itself. If the prices in the market already reflected all the information about the security, as the efficient-market hypothesis claimed, there would never be any trading among individuals as a result of new information, since the prices of securities would adjust instantaneously to any such new information. Yet, if no trading took place, there would be no incentive to collect information on any security since there would be no opportunity to profit in the absence of trading. If no information is produced, it is impossible for prices to reflect all information, so the very concept of an efficient financial market collapses.

In short, the "paradox" of an efficient market is that a market can only be efficient if some people think it isn't and invest resources in obtaining information. Although this observation may be self-evident to those who operate in financial markets, it was a challenge to theoreticians who modeled the prices of financial securities.

The new models of market pricing that arose from these insights included not only informed traders who set prices in the early models of an efficient market, but also a second group of investors who traded for reasons unrelated to new information. The second group became known as "liquidity" traders and helped provide a solution to the logical inconsistencies inherent in the efficient-markets hypothesis. The "liquidity" traders provided added "noise" to the trading of informed investors so that the contraparty in a trade never knew with certainty whether the initiator of a trade had new information or not.

The introduction of noise traders also influences the volatility of asset prices. Some models have shown that noise traders could cause the prices of securities to deviate from "fundamental" or full information values for long periods of time. Furthermore, security prices could be a function of the information traders believe (but do not know for certain) other traders possess, a concept which harkened back to John Maynard Keynes's insights into speculative markets.

The introduction of liquidity traders also led to a reexamination of the nature of market-making itself, reviewed in Sections VI and VII. The institutional structure of a financial market interacts with the demands of both informed and liquidity traders to determine the bids, offers, and prices of securities. The efficiency of the market in discovering prices depends not only upon the costs and competition inherent in market-making, but also upon the types of information possessed by different traders.

New models showed that security prices are a function of the type of market and rules under which they are traded. The prices of securities traded in call markets, where orders are aggregated and transacted at a single point in time, might be different from the prices of the same securities traded in the more common continuous markets, characterizing most of the world's stock exchanges. The implication of this work is that the pricing function of the capital markets, which is of critical importance to the allocation of investment, could not be separated from the institutional structure of the market itself.

II. THE EARLY LITERATURE ON ASSET PRICING

A. Fundamental Analysis

Early writers on the subject of security analysis assumed that the essence of investing was to determine the "true," "intrinsic," or "fundamental" value of a security and that this value could differ from the current market price. At that time, there was no formal theory explaining why the market price and the intrinsic price of a security might differ. Graham and Dodd (1934) published *Security Analysis*, which became a classic in investment analysis. In that work they asserted:

> [a security analyst] is concerned with the intrinsic value of the security and more particularly with the discovery of discrepancies between the intrinsic value and the market price. We must recognize, however, that intrinsic value is an elusive concept. In general terms it is understood to be that value which is justified by the facts, e.g., the assets earnings, dividends, definite prospects, as distinct, let us say, from market quotations established by artificial manipulation or distorted by psychological excesses.[2]

According to their view, the intrinsic value of a security is a function of the future earnings, or "earning power" of a company, rather than "book value," a concept used by earlier

[2]Graham and Dodd (1934), p. 17.

analysts. Graham and Dodd maintained that, while the market price of a security can deviate on occasion from its intrinsic value, over time it will move back to this value.[3]

Implicit in their approach to the evaluation of securities are the assumptions that some investors have better information than others and those investors with better information can accumulate underpriced securities without a significant, and self-defeating, impact on the market price of the stock. Only as other investors learn the true value of the security will the price adjust to its intrinsic value. Graham and Dodd did not provide any explicit model of the mechanism by which a stock price will adjust to its intrinsic value; they merely assumed that such an adjustment would ultimately take place.

In the jargon of the current academic literature, Graham and Dodd implicitly assumed that investors have "heterogeneous expectations." Stated simply, all investors do not have the same opinions about the future prospects of the company and some may be better informed than others. This assumption turns out to be critical in understanding both the development of the efficient-market hypothesis and the recent literature on market-making mechanisms.

B. The Dividend Discount Model

It has long been recognized that the value of a financial asset is the discounted present value of the cash flows that investors receive. When interest rates and cash flows are known, application of the present value formula is simple. However, when cash flows and the rate at which they are discounted are uncertain, application of the present value formula becomes far more complex.

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[3]Williams (1938) also emphasized the "fundamental" and "intrinsic" valuation of securities.

Myron Gordon was the first to develop a formula which, over time, has become the benchmark for the valuation of equity.[4] For the purposes of valuing a firm, Gordon assumed that a stock has an expected per share dividend of size D one year from now and that this per-share dividend will grow in the future at a constant compound annual rate of growth, g. The fundamental or intrinsic price of the stock is the discounted value of this stream of expected future dividends. The discount rate, r, which Gordon described only in very general terms, is related to the market rate of interest and the stock's risk. Under these assumptions, the price of the stock, P, is given by the simple formula:

$$P = \frac{D}{r - g} .$$

This formula implies that the value of the stock increases if either the expected current level of dividends or the growth rate of dividends increases, and it declines if the discount rate increases. These results accord with the common intuition about how dividends, growth, and discount rates should influence security prices.[5] Wall Street often calls the Gordon model and its many variations the "dividend discount model."

A major limitation of this model is that it offers no insight into the source of the variation in the discount rate among different securities. Conceptually, the appropriate discount rate is the sum of an interest rate on some safe investment plus a risk premium that is positively related to the risk of the stock. However, in the 1950s and early 1960s, the concept of risk and the associated risk premium were not well developed. Further insights into the measurement of

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[4]This formula was first presented in Gordon and Shapiro (1956) and later expanded in Gordon (1962).

[5]One of the most popular uses of this model is to equate the expected return of a security with the discount rate. To do this, one rearranges the model by solving for r in terms of the current price. In this rearranged form, r is the sum of the dividend yield and the expected growth rate in dividends, both of which can be estimated.

risk and the associated risk premium came with the theoretical development of the Capital Asset Pricing Model (CAPM) in the 1960s, a model that relies heavily on the efficient-market hypothesis and is described in Section III.D. below.

The type of analysis espoused by Graham and Dodd as well as Gordon is generally termed "fundamental analysis." These models made explicit those variables, such as earnings and dividends, that need to be forecast. Therefore, determining the intrinsic value of a stock was an analytical exercise involving forecasts of firm-specific variables.

C. Technical Analysis

A second approach to choosing securities is termed technical analysis or "charting."[6] Chartists plot the history of past prices (and often volume) and try to discern some predictive pattern for future price movements.

Chartists give various reasons why there might be predictive patterns in past prices. Patterns might arise as investors with superior information about the future level of earnings of a company begin to accumulate its shares. This buying generates increased volume and an increase in price. Some chartists may be able to detect this pattern before others and start accumulating the security. This will ultimately drive the price to higher levels, resulting in profits both for the chartists and the original investor with superior information.

Chartists themselves never worry explicitly about whether the price of a security is correct in terms of the fundamentals of the company. However, if chartists react to the trading of informed investors, chartists may facilitate the adjustment of a stock price to its new

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[6]The original classic in the field was published by Edwards and Magee (1954). A recent summary of technical analysis is contained in Levine (1988).

equilibrium. As a result many chartists, who sometimes refer to themselves as "micro-market economists," believe that their techniques do rely implicitly on sound fundamental grounds.

III. THE EFFICIENT-MARKET HYPOTHESIS

A. Early Studies

Paralleling the development of the theory of valuation were empirical studies that examined the statistical properties of commodities and financial assets. Working (1934) published an examination of the statistical properties of wheat prices and found the changes to be essentially random. But the significant breakthrough came in London in 1953, when the Royal Statistical Society met to examine a paper by the statistician Maurice Kendall about the behavior of speculative prices.

Kendall (1953) exhaustively examined the weekly behavior of British stock prices and U.S. commodity prices.[7] He concluded that *changes* in stock and commodity prices conform to a chance process, as if determined by the turn of a roulette wheel. The *level* of stock and commodity prices are simply the summation of these changes in price.

Roberts (1959) explored this difference between price levels and price changes through an experiment. He simulated random price changes for 52 weeks and then summed these price changes to obtain the price levels.[8] Although the price changes themselves in Roberts's simulation are perfectly random, the sum of these price changes, or the price levels themselves, appear to form patterns like those that chartists follow, such as "head-and-shoulder" formations,

[7]What was particularly impressive about this work was the number of calculations that were undertaken without the benefit of modern computers.

[8]An extremely simple type of random process can be simulated by moving prices up or down equal amounts depending on the flip of a fair coin. More complicated random behaviors allow for unequal probabilities of moving up or down and the existence of a trend.

"flags," "pennants," "breakthroughs," and so on. However, because of their random construction, these patterns could not be used to predict future prices.[9] After these studies, the academic literature began to reject the usefulness of technical analysis which relied on these patterns to predict future prices.

Even before the empirical work cited above, theoretical literature had been published concerning the nature of random walk processes, that is the process by which the sum of random changes generates the price level of a particular security or asset.[10] In a most prescient work, a French student named Louis Bachelier presented a Ph.D. dissertation in 1900 before the Faculty of Sciences of the Academy of Paris entitled *The Theory of Speculation*.[11] Bachelier described the random motion of speculative prices and derived the foundations of option theory. In his dissertation he wrote, "From the consideration of true prices, one could say: *At a given instant, the market believes in neither a rise nor a fall of true prices*," and later, "Clearly the price considered most likely by the market is the current true price: if the market judges otherwise, it would quote not this price but another price higher or lower."[12] These sentences comprise the earliest known references to the workings of an efficient market. Bachelier was so ahead of his time that he recognized that the random walk process for security prices possessed some important mathematical properties that were to be rediscovered five years later by Albert Einstein in one of his early works on the Theory of Relativity.

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[9]At the same time, Osborne (1959) reached similar conclusions.

[10]It is believed that the term "random walk" originated in a note by Karl Pearson in a 1905 issue of *Nature* magazine and was used to described the path of a drunk left to wander on an open field.

[11]The work was originally published as Bachelier (1900) and is dedicated to Monsieur H. Poincaré. It is found in its translated edition in Cootner (1964).

[12]Cootner (1964), pp. 26 and 28.

Bachelier's thesis stood alone in the mathematical derivation of security prices for over 60 years until Samuelson (1965), Mandelbrot (1966), and Fama (1965) provided further theoretical frameworks that predicted the random walk behavior of stock prices.[13] The random properties of security returns were fundamental to the development of the efficient-market hypothesis.[14]

B. Definitions of an Efficient Capital Market

An "Efficient Capital Market" is a market in which the prices of all securities reflect all available information about the assets. This definition requires elaboration. First, in order for the price to reflect exactly all the information about the asset, nothing can impede the purchase and sale of securities, such as brokerage fees, taxes, and so on. To the extent that impediments exist to the trading of assets, the prices will only imperfectly reflect information of relevance to the valuation of the securities.

Second, the phrase "all available information" needs explanation. Does it mean *all* information about every security, whether possessed by insiders or not, or just publicly held information? These issues will be discussed in the next section.

Third, to say that "prices reflect" information implicitly assumes a specific pricing model of how information about risk and return should be incorporated into the prices of securities. One candidate for a pricing model is the dividend-discount model already discussed; another

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[13]Samuelson (1973) also emphasized that the random walk properties applied only to the prices on securities adjusted for dividends, and not to prices (or price indices) which exclude dividends or interest. In fact, over time the price of securities excluding the income return will follow a negative autocorrelated process which he called "red noise." These observations become important for investors examining long-term stock and bond indices which typically exclude reinvested dividends.

[14]Malkiel (1973) popularized this characteristic of stock prices with his book *A Random Walk Down Wall Street*.

candidate, discussed in Section D below, is the Capital Asset Pricing Model (CAPM), which takes explicit account of the riskiness of individual assets. Ultimately, tests of the efficient-market hypothesis are really joint tests of the validity of a specific pricing model and the correspondence of market prices to those implied by that pricing model.

In appreciating the more recent literature on market-making, it is important to note that this early literature on efficient capital markets assumed that the market prices incorporated new information instantaneously into stock prices. Casual observation suggests that it may take time for market prices to adjust to new information, but the assumption in this earlier literature is that this time is so short that there is no need to model the precise way in which this adjustment takes place. The more recent literature on market-making directly examines the processes by which new information is incorporated into stock prices. Specifically, the structure of a market itself--the technology and rules relating the activities of dealers and investors--may lead to different paths of prices. This new literature implies that the concept of an efficient market involves not only a pricing model but also the market structure itself, a concept that is elaborated in Sections VI and VII.

C. Levels of Market Efficiency

Since prices reflect all available information in an efficient market, the only reason for prices to change in such a market (excepting "fair" return consistent with holding the asset) is the arrival of *un*anticipated new information. Since such information is as likely to be favorable as unfavorable, the asset's price movement is as likely to be upward as downward.[15] Changes in the price of the security will therefore be unpredictable, and prices themselves will follow a "random walk." This is why the efficient-market hypothesis is so closely tied to the random walk theory of security prices.

In an unpublished paper presented to the Seminar on the Analysis of Security Prices at the University of Chicago, Roberts (1967) defined three levels of market efficiency.[16]

C.1. Weak Form Efficiency

A market is defined as "efficient in the weak sense" if the current and past prices (and perhaps volume of trading) do not provide meaningful forecasts of future changes in prices. This definition is usually shortened to: A market is *weakly efficient* if the current price reflects all past price and volume information.

If capital markets are efficient in the weak sense, there are no dependencies in past price changes that a chartist could use to predict future changes. An indirect proof follows: Assume there does exist a positive run in prices, which implies that the next price change is more likely to be positive than negative. If such runs exist, investors will try to buy as soon as they see any evidence of a positive run. As investors attempt to buy the stock, the buy orders of these investors will cause a jump in price, the run will stop, and these investors will gain no further advantage. According to the efficient-market hypothesis, this process takes place so quickly that it would be impossible to exploit the prior run in prices. The price of the security adjusts to a new level instantaneously and thereby eliminates all statistical price dependencies.

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[15]In a more general sense, it is possible that a large number of small favorable events could be counterbalanced with a smaller number of more unfavorable events. Prices of securities in these circumstances will follow a generalized version of a random walk called a "martingale."

[16]Fama (1970) made Roberts's arguments more rigorous.

As a result, forecasting future price changes from past price changes becomes impossible, and the level of the stock price follows a random walk.

Early statistical tests, such as those of Cowles and Jones (1937) and Working (1934), provided strong and consistent support for this hypothesis. Later Osborne (1959), Fama (1965), and others confirmed the random, or Brownian motion of stock prices.[17] Although they found some small positive short-run autocorrelation in prices, they considered it small enough that, given transactions costs, investors could not use these dependencies for profit. In the mid-1960s, Fama and Blume (1966) examined the profits from a trading strategy that relied on the theory of relative strength and trading trends. Their tests, and studies that followed, found that there were no abnormal returns from this type of trading.

C.2. Semi-Strong Efficiency

Weak form efficiency was widely accepted by the financial community. Since most analysts relied on fundamental research, they had little sympathy with chartists and others who disdained the use of earnings and dividends and used price patterns to forecast stock prices.

After examining whether past prices could be used to predict the future, it was a natural step to study whether other types of information are discounted in security prices. A market is defined as "efficient in the *semi-strong* sense" if the current price of a stock reflects all *publicly* available information. If this is so, such information has no value in forecasting future price changes, since it is already discounted in the price. It is not necessary that all investors have the

[17]Two major types of tests were used to estimate the degree of dependence among successive price changes and hence the random nature of security prices. One was correlation tests, and the other was runs tests. The runs tests counted the number of runs of positive changes, of zero price changes, and of negative price changes and compared these numbers to those expected under the random walk hypothesis.

same information, but only that prices reflect all publicly available information, even if the trading is confined only to a few astute traders.

Semi-strong efficiency can be tested in two ways. First, researchers evaluated whether market professionals, such as investment managers who run private accounts or mutual funds, are consistently able to outperform the market. Again, Cowles (1933) was a pioneer in this field; in his article "Can Stock Market Forecasters Forecast?" he concluded that

> A review of the various statistical tests, applied to the records for this period, of these 24 forecasters, indicates that the most successful records are little, if any, better than what might be expected to result from pure chance. (p. 323)

Later, a 1962 Wharton study of mutual funds concluded that the performance of equity mutual funds was on average no better than randomly selected groups of stocks.[18] Following this study was a number of other studies of mutual funds, all reaching similar conclusions.[19] These studies persuaded many academics that the market for equities was efficient in the *semi-strong* sense.

More recent studies have reached similar conclusions about the ability of money managers to realize superior returns. Henriksson (1984) finds average returns for mutual funds matched the market, but this was before fees were subtracted, while Brinson, Hood, and Beebower (1986) found that large corporate pensions plans underperformed the market by over 1 percent per year. Ippolito (1989) did find that mutual funds outperformed certain benchmarks from 1965 through 1984, but these results have recently been challenged by Elton, Gruber, Das, and Hklarka (1991). All these results imply that managers of mutual funds, with all their

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[18]Brown, Friend, Herman, and Vickers (1962).

[19]Jensen (1968); Sharpe (1966); and Friend, Blume, and Crockett (1970).

resources for analyzing individual companies, are unable on average to outperform randomly selected portfolios of stocks.

A second group of empirical tests of semi-strong efficient markets revolved around the speed of adjustment of market prices to new information. These tests examined whether the investors who hold stocks after the release of public information earn excess returns. The events studied included stock splits, merger announcements, secondary offerings, and many other actions that might revise expectations.[20] These findings confirmed that stock prices rapidly incorporated new information and that no extraordinary return could be earned by investors acting on publicly available information.[21]

Although convincing to many scholars, these academic studies of price dependencies, trading rules, and mutual funds had only a marginal impact on the practice of investing money in the 1960s. However, combined with the many performance studies of institutional money managers, these studies finally convinced many market practitioners that it is difficult to

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[20]Fama, Fisher, Jensen, and Roll (1969); Dodd (1981); and Scholes (1972).

[21]The majority of Justices on the Supreme Court recently has endorsed the use of the semi-strong definition of efficiency in legal cases by accepting the argument that the price of a stock reflects all relevant publicly available information, including any misleading information released by a company or an insider. Consequently, if there were such misleading information, an investor who purchased or sold such a stock could be damaged and hold the provider of the misleading information liable, even though the investor did not rely upon or even know about the misleading information. As long as some investors were aware of the information, the stock price would reflect this information, and any investor basing an investment decision on the market price would implicitly be relying on the misleading information. This theory of damages is termed "fraud on the market place" [Basic Incorporated vs Levinson, 99 L. Ed. 2d 194 (1988)].

outperform the market.[22] As a consequence, it is not surprising that institutional investors currently have over 10 percent of all domestic equities invested in index funds.[23]

The implications of a semi-strong efficient market upon investor behavior are profound. Since prices reflect all relevant publicly available information, investors should realize that all the different views of the prospects of a firm are already incorporated into the price, thereby eliminating any potential abnormal profits from investing in any particular security. An efficient market should discourage investors from security analysis, which merely provides information that other investors already have. Since market prices already incorporate this information, gaining access to it will be of no value. Thus, even if some investors learned information that was new to them, these investors should not change their view as to the correct price of any security or make any change to their portfolios.

In a semi-strong efficient market, an investor requires access to non-public or inside information to determine that a market price is wrong. Security analysis, traditionally defined, does not use inside information and hence would not benefit an investor.

C.3. Strong Form Efficiency

A market is efficient in the *strong* sense if the current price of a stock reflects *all* information, whether the information is publicly available or not. The additional feature of

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[22]A. G. Becker and Merrill Lynch were early providers of such studies. Many firms now undertake these studies, but SEI is now the dominant firm through its purchase of the performance evaluation business of both A. G. Becker and Merrill Lynch.

[23]*Pension and Investment Age* (July 24, 1989), p. 2. There may be additional equities that are managed in styles closely resembling index funds not included in the figure of 10 percent.

strong efficiency is the inclusion of "inside information" into the price of a stock, through either insider trading or the revelation of such information to other traders.[24]

Early studies of insider trading showed that inside information was valuable in pricing securities. Jaffe (1974) found that insiders earn about 6 percent more per year, before transaction costs, than investors without special information. Since insiders often trade for reasons not related to inside information, and since the data on insider trading do not distinguish between informationally motivated trading and other types of trading, the additional returns that insiders earn on informationally motivated trades are probably in excess of those reported in these studies.

This research opened the question of whether outsiders could use the insider trading reports that the SEC collects to make superior returns. Insiders are required to report their trading to the SEC within ten days of the end of the month in which they trade, producing significant delays between the actual insider trading and the reporting of these trades. With such delays, it would be surprising if these reports had any predictive value under a semi-strong version of the efficient market. Yet Jaffe (1974) found that, even with a lag, outsiders could mimic insider trading to make additional returns. Some recent research has questioned this result, since the magnitude of the excess return depends on the benchmark portfolio chosen.[25]

Studies of insider trading disproved market efficiency in the strong sense. However, these studies did not disturb some proponents of the efficient-market hypothesis. After all, the

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[24]Efficiency considerations alone might suggest the desirability of having the current market price of a stock reflect inside information. If the information were favorable, but not reflected in the price, a seller of the stock would be harmed. Similarly, if the information were unfavorable, but not reflected in the price, the buyer would be harmed. However, legal statutes, reflecting social policy in the United States as well as many other countries, dictate that it is unfair for insiders to profit from their inside information, and laws and regulations have been enacted to restrain insider trading. A case for insider trading is made by Leland (1992).

[25]See Seyhun (1986, 1988) and Rozeff and Zaman (1988).

strong form of the efficient market is an extreme concept, much like a perfect vacuum. Since the set of relevant information is theoretically infinite, it is unreasonable to expect that the market would literally incorporate all information into stock prices at every point in time.

D. Asset Pricing in an Efficient Market

One of the implications of an efficient market is that, under weak assumptions, the risky portion of the portfolio of every investor (without access to insider information) should be as diversified as possible.[26] This prescription for investing stems from the statistical property that total risk can be reduced, for a given expected return, by holding a large quantity of smaller risks. That diversification pays has often been summarized by the popular expression "Don't put all your eggs in one basket," which has strong theoretical and empirical support.[27]

Markowitz (1952) provided a formal model of diversification that identified efficient portfolios--portfolios that minimize risk at each level of expected return and maximize expected return at each level of risk. Markowitz argued that risk-averse investors would only hold these efficient portfolios. Markowitz's model showed that the demand for a risky asset depended not only upon the return characteristics of each security individually but also upon the interrelations among the return characteristics of all securities. This analysis gained Markowitz the 1990 Nobel Prize in Economics.

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[26]One set of assumptions needed to make this statement correct is that the distribution of returns is not too skewed and that the returns of any non-marketable asset, such as human capital, are uncorrelated with the returns on marketable assets. If returns of non-marketable assets are correlated with the returns of marketable assets, investors would hold not only the market portfolio but an additional portfolio to hedge the risk of the non-marketable assets. See Mayers (1972).

[27]See Markowitz (1959), Samuelson (1967), and Tobin (1958).

Markowitz demonstrated that securities with lower than average expected returns, and possibly even negative expected returns, would be included in a portfolio as long they provided sufficient diversification of risk. He also showed that risk that was uncorrelated with the market influenced the demand for the asset very little, especially if there were a large number of assets. His model was not totally at odds with traditional fundamental analysis, since asset demands were still a function of the analyst's estimates of expected returns even though the treatment of risk was far more sophisticated (and less intuitive) than had been previously believed.

It was not long before the fundamentals of portfolio selection developed by Markowitz were applied to concepts of an efficient market. Sharpe (1964), who was awarded the Nobel Prize along with Markowitz, and Lintner (1965a, 1965b) described the nature of portfolio selection under the assumption that all available information was already incorporated in prices.[28] Since in an efficient market security prices reflect such information, there is no reason to substitute one's own estimate of expected return and variance for that already implicit in the market. Sharpe demonstrated that if one accepted the market's judgment about the returns on each asset, then the best portfolio of risky assets to hold is one that is totally diversified and where each security is held in proportion to its value in the market. The surprise is that the above conclusions hold *no matter what the risk preferences of the investor*, as long as the investor is risk-averse and risk can be measured by the standard deviation of one-period returns. If an investor tilted his portfolio towards any particular risky asset, it would increase the investor's risk without any compensating increase in expected return.

The theory of portfolio selection combined with that of an efficient capital market was a powerful incentive for the development of fully diversified portfolios, or "index funds." These funds hold assets in proportion to their market value and are managed at low cost and without

[28]Mossin (1966) independently developed similar asset pricing relations.

regard to the fundamental factors influencing security prices, on the assumption that such information is already reflected in prices.

Total risk could be controlled by moving between such an index fund and "risk-free" assets, or short-term money market instruments. Investors with a high risk tolerance would hold a greater fraction of their wealth in the index fund (perhaps even borrowing funds) while more risk-averse individuals would hold a smaller fraction of wealth in such a fund. Under no circumstances would it be optimal for either type of investor to overweight his or her portfolio with high or low risk *individual* stocks. By changing the proportion of risky and risk-free assets, the investor can adjust the overall risk level of his portfolio.[29]

Sharpe (1964) exploited the concept of diversification to develop a formal model to explain the differences in risk premiums of individual stocks, which came to be known as the Capital Asset Pricing Model or CAPM. The risk premium is defined as the difference between the expected return on a risky asset and the return on a safe asset, such as a Treasury bill. Sharpe demonstrated that in an efficient market the risk premium on each stock would be proportional to the risk premium on the entire stock market (the expected return on the market minus the risk-free rate), where the constant of proportionality (called the *beta* coefficient of the stock) is related to the covariance of the individual stock's return with that of the market. Note that the beta coefficient, and hence the risk premium is only associated with the *co*variance of the asset's excess return with the market, not that part of the variability of its individual return which can be diversified away in a large portfolio.

For the first time, the CAPM gave investors an operational way to determine the risk premium on individual stocks. By regressing the historical returns of a stock on the returns of

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[29]This property became to be known as the "mutual fund separation theorem." The separation theorem was first analyzed by Tobin (1958).

the overall market, one could estimate the beta coefficient.[30] The premium on the entire market could also be obtained from historical studies of aggregate stock and bond returns. The popularity of beta as a means of measuring the risk of a portfolio rapidly spread to portfolio managers who themselves were increasingly in touch with academic research.

It was not long before researchers began to find some troubling discrepancies between the predictions of an efficient market and the empirical data. Low risk assets seemed to overperform relative to the predictions of the CAPM and high risk assets tended to underperform.[31] And, as Roll (1977) strongly maintained, there were theoretical difficulties in any empirical test of the CAPM. In theory, the market portfolio in the CAPM consists of all risky assets including real estate, bonds, and other non-equity assets. In practice, the empirical tests of the CAPM measured the return on the market portfolio of only a subset of risky assets--often proxying this market portfolio by a stock index such as the S&P 500. Roll showed that the use of an incomplete measure of the market portfolio resulted in mismeasuring the beta coefficients of individual assets and made tests of the CAPM meaningless. Despite these problems, by the end of the 1970s, the CAPM was the most sophisticated pricing mechanism available to portfolio managers and was widely used in investment analysis.

IV. EMPIRICAL CONTRADICTIONS TO THE EFFICIENT MARKET

Despite the large body of evidence in support of the early version of the efficient-market hypothesis, a growing number of studies raised questions about its validity.

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[30]Blume (1971) showed that beta coefficients of diversified portfolios of stocks were sufficiently stationary over time to make historically estimated beta coefficients a reliable predictor of future risk, suggesting that the CAPM may have some empirical content.

[31]Friend and Blume (1970); Blume and Friend (1973); Fama and MacBeth (1973); and Black, Jensen, and Scholes (1972).

A. Value Line

Black (1973) published an article entitled "Yes, Virginia, There is Hope: Tests of the Value Line Ranking System." This paper presented empirical evidence that the security recommendations of the *Value Line Investment Survey*, which reviews and ranks over 1,700 common stocks, had some value in forecasting future prices. Subsequent studies of the Value Line recommendations have reached similar conclusions.

The prediction record of Value Line is impressive. From April 16, 1965 through December 30, 1990, the stocks in their top-rated "Group 1" realized compound annual capital gains of 14.1 percent. In contrast, the value of the stocks in the lowest rated group (Group 5) realized compound annual capital losses of 0.6 percent.[32] Groups 2 through 4 experienced appropriately ranked intermediate returns.[33]

Since Value Line's recommendations are widely circulated to the investment community, these findings violated the semi-strong version of the efficient-market hypothesis and proponents of efficient markets found these results disturbing. Most of the evidence, at least through the 1970s, had supported efficient markets and overwhelming evidence showed that the typical mutual fund with all its resources could not outperform the market.

More recently, Stickel (1985) concludes that Value Line appears to have some private information that is not completely reflected in the market, particularly for small stocks.[34] The

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[32]These returns only measure capital gains and do not include the additional return due to cash dividends.

[33]These returns assume that the investor constructs five portfolios at the beginning of each year based upon the last set of recommendations in the prior year and holds these portfolios for one year. In fact, Value Line publishes recommendations weekly. If one adjusts the five portfolios within a year for these intermediate changes in recommendations, the results are even more impressive.

[34]See also the work by Huberman and Kandel (1987, 1990).

most recent literature suggests that the Value Line's superior performance is based on excess returns associated with recent rank changes, and most of these rank changes are, in turn, based on recent earnings surprises, especially for small stocks.[35] This finding is important since other research has noted that, especially for small stocks, stock prices still reacted for several days after a large earnings surprise, a phenomenon that has been termed "post-earnings-announcement drift."[36] Even as academicians were dissecting the causes of the superior Value Line performance, they were finding other evidence that was at odds with an efficient market.

B. Closed-End Investment Companies

A persistent puzzle for efficient-market advocates was the presence of funds whose only assets were traded securities and whose value differed markedly from the value of these underlying securities. These funds, referred to as closed-end investment companies, trade like stocks on organized exchanges and almost always sell at a discount to net asset value. Over the last thirty years the discount on the seven largest funds has averaged about 15 percent and, in the mid-1970s, has been as high as nearly 30 percent.

A fundamental question facing efficient-market advocates was why anyone would buy the underlying shares of such funds when such shares could be purchased at a discount by buying the fund itself. Alternatively, why would anyone buy such funds when they are first issued, since, although originally sold at full net asset value, they almost always sank quickly to a discount?[37]

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[35]Affleck-Graves and Mendenhall (1992).

[36]The first citation to this phenomenon appeared in Ball and Brown (1968). More recent evidence is found in Bernard and Thomas (1989, 1990).

[37]Indeed, these discounts point to a potentially profitable investment through the purchase of a closed-end fund at a discount and the simultaneous short sale of the underlying securities. Abstracting from transactions costs, the dividends received from the fund would exceed the dividends paid on the short position, yielding a riskless profit. However, shorting the underlying

The lack of answers to these elementary questions posed a dilemma to efficient-market advocates.[38]

Many possible explanations have been offered including potential tax liabilities, lack of liquidity of the underlying stocks, and management fees. Malkiel (1977) found that none of these explanations was sufficient to resolve the puzzle, while more recent studies have resorted to such abstract notions as "investor sentiment" to explain the discounts.[39]

C. The Calendar Anomaly Literature

Perhaps some of the most persuasive evidence against the efficient-market hypothesis comes from the "anomaly" literature, which has discovered unusual patterns in the price behavior of securities. Some of the most puzzling price anomalies are related to seasonal and calendar patterns in the movements of stock prices. Other anomalies relate to returns that are dependent upon the size of a firm and the dividend yield. Most surprisingly, many of these anomalies seem to occur in January, a phenomenon which became known as the "January Effect."

In the mid-1970s, Blume and Friend (1974) showed that there were substantial differences in the returns between large and small firms that could not be explained by the CAPM model. From 1928 through 1968, the returns on stocks of small firms far exceeded the returns on those of large firms, although the reverse occurred during some subperiods. Recent

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stocks requires margin and exposes the investor to a paper loss if the discount should widen. Another potential way to profit is to gain control of the fund and liquidate the underlying securities, eliminating the discount.

[38]A related phenomenon is the underperformance of initial public offerings after being opened to public trading. For an excellent analysis of this issue see Ritter (1991).

[39]See Lee, Shleifer, and Thaler (1991) for an up-to-date survey; this work indicates that investor sentiment, which is also linked to the small stock returns, strongly influences the discount on these funds.

articles have reached similar conclusions about the "size" effect,[40] and there is even evidence that this effect is present in foreign markets.[41]

The existence of a size effect in explaining stock market returns may not be that surprising. After all, it is possible that the accepted models of equilibrium had omitted some components of risk that were correlated with size. What is surprising, however, is that virtually all of the differences in the returns between large and small companies occurred in the month of January. Michael Rozeff and William Kinney (1976), using an equally-weighted index, noted that stock returns were significantly greater in January than in other months. This research followed up on the findings of R. Officer (1975) confirming a seasonal in Australian stock prices. Neither of these works recognized that the seasonal pattern arose because of the return behavior of small stocks. However, Keim (1986) classified New York and American Stock Exchange stocks by deciles of market value into ten portfolios and then calculated "abnormal" returns. Abnormal return is defined as the difference between the realized return on a stock over a period of time and a benchmark return over the same period. In Keim's work, the benchmark return is the return that an investor would have expected over that period on a stock of similar risk but without knowledge of the company's size.

Keim discovered that abnormal returns in January and the relative market value of the firm's equity are strongly correlated. From 1941 through 1981 the average January gain of the S&P 500 Index was 1.34 percent, while it was 8.06 percent for the smallest 20 percent of all stocks, and more recent work suggests the effect was present far earlier.[42] Moreover, further research revealed that most of the difference in the returns between small and large firms

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[40]See Banz (1981) and Basu (1977, 1983).

[41]See Keim (1986).

[42]See Lakonishok and Smidt (1988).

occurs in the first few days of January.[43] As yet, no one has given a satisfactory rationale for these results.[44]

Another peculiar pattern is the "day-of-the-week effect." Monday returns, measured from Friday close to Monday close, are on average negative, and virtually all of this negative return occurs from Friday close to Monday open.[45] The greatest daily returns occur on Fridays with the smallest companies realizing the greatest return. Other return irregularities have been reported during a trading day[46] and during a calendar month, with returns in the first half of each month exceeding those in the second half.[47]

Still another anomaly is the dividend yield effect. Blume (1980) reported a U-shaped relation between dividend yield and excess returns, with the greatest excess returns accruing to those stocks with either a zero yield or a high yield. Keim (1986) showed that virtually all of this relation is due to the returns in January.[48]

These anomalies are at odds with the predictions of the capital asset pricing model. However, in recent years some of these calendar anomalies may have been reduced or have

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[43]Keim (1983).

[44]Keim's data show that there is also some size effect in the remaining 11 months of the year. However, this apparent evidence of a size effect in these months is due to a statistical problem in measuring returns. When this problem is corrected, the size effect is negligible in these 11 months. See Blume and Stambaugh (1983). A good popularly-written review of the January effect is found in Haugen and Lakonishok (1988).

[45]Cross (1973); French (1980); Gibbons and Hess (1981); and Keim and Stambaugh (1984).

[46]Harris (1986) and Smirlock and Starks (1986).

[47]Ariel (1987).

[48]A recent paper by Christie (1990) suggests that the apparently greater excess return on stocks with zero yields is sample sensitive, and with a different sample, he finds that the excess returns on stock with zero yields are negative, not positive.

disappeared.[49] Whether this is the result of investors acting on the results of these studies or just a statistical happenstance is yet to be determined.[50]

D. Volatility Tests

A further setback to the efficient-market hypothesis consists of the growing body of research on the volatility of financial markets. While to the casual observer markets may often seem extremely volatile, proponents of the efficient-market hypothesis claim that rapid price movements are just a consequence of new information being rapidly incorporated into the valuation of securities.

The value of any asset is the present value of the future cash flows that it spins off. However, in an important article, Shiller (1981) found statistical evidence that financial markets, and particularly the stock market, are too volatile to be explained by the behavior of these cash flows.[51] Shiller studied the aggregate dividends and earnings of the S&P 500 index from 1871 through 1979. He used this information to calculate what the "intrinsic" value of the S&P 500 stocks should be, for a wide range of discount rates, if investors knew with certainty the future path of dividends. Shiller called this intrinsic value the "perfect foresight," or "*ex post* rational"

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[49]From 1982 through 1991 the average January return on the bottom quintile of stocks has been 5.32 percent while it has been 3.20 percent for the S&P 500 Index. During this period the excess return has been reduced by 70 percent over the average of the previous forty years. The excess return for small stocks was very large, however, in January 1992.

[50]It should be noted that actually matching the performance for small stocks indices has been very difficult due to high transactions costs. The DFA U.S. Small Stock Company Portfolio, which attempts to mimic the bottom quintile of stocks, has experienced a January gain over the last decade of 3.58 percent, versus the 5.32 percent theoretical for small stocks; see Fama (1991).

[51]Reprinted in Shiller (1989). LeRoy and Porter (1981) have published related work.

value of the S&P 500 index.[52] He found that the actual value of the S&P index fluctuated far more than could be explained by subsequent cash flows to investors and attributed this "excess volatility" of the stock market, as the phenomenon came to be known, to "irrational" behavior, such as investor over-reaction to short-run fluctuations in earnings or other variables.

There have been a number of criticisms of Shiller's methodology.[53] Some have questioned the use of standard statistical tests to analyze long-term series that tend to behave like random walks. Others have indicated that the rather arbitrary decision of firms to pay dividends or retain earnings can account for the apparent excessive smoothness of dividend series. Advocates of Shiller's results have produced a great number of articles demonstrating how speculators, feeding on "noise" or liquidity traders, can make the market excessively volatile, a phenomenon we describe in Section V. The outcome of this debate is not yet settled.

Concerns about excess volatility were heightened by the stock crash of October 1987. The record one-day drop of 22 percent in the Standard and Poor's 500 Stock Index on October 19, 1987 (and even greater drop in the index-related futures price) has still not been associated with any identifiable event.[54] Some recent research suggests that large movements in the overall market can occur even when no obvious events cause major changes in expected future dividends or discount rates.[55]

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[52]The concept of the perfect foresight price (or yield) was introduced earlier in a similar study of the British "consol" (or long-term bond) market over a two-hundred-year span. This study also showed excess reaction to short-term trends. See Shiller and Siegel (1977).

[53]See Kleidon (1986) and Marsh and Merton (1986).

[54]See Siegel (1992). Mitchell and Netter (1989) argue that restrictions on takeovers proposed by the House Ways and Means Committee caused the Crash. However, these actions occurred on October 14, 1987, not on October 19.

[55]See Cutler, Poterba, and Summers (1989) and Roll (1988).

E. Returns Predictability

An issue related to the excess volatility of the market was evidence that the returns to stock prices display "mean reversion"--periods of high returns followed by periods of low returns and vice versa. If stock prices actually followed a random walk, there would be no tendency for stock returns to revert to some statistical mean. However, a number of studies demonstrated that there was a tendency for stock returns to revert to some average value over long periods.[56]

Early evidence of mean reversion led to tests of the predictability of future returns based on past returns. Early studies did reveal some small, short-run positive correlations between daily stock price movements, correlations that were greater for portfolios than for individual stocks.[57] Lo and MacKinlay (1988) have confirmed in a recent study the presence of such short-run correlations and have shown them to be far more significant for small than for large stocks.[58]

The early evidence studies of short-run correlation did not bother advocates of efficient markets because such correlation explained only a very small fraction of the daily, weekly, or even quarterly variation in stock prices. Of far greater concern are the more recent findings that stock returns are far more predictable than originally thought over long horizons. Supplementing the evidence of positive short-run correlation of returns, recent research showed that long-run periods of high returns were followed by periods of low returns and vice versa. This negative long-run correlation applied to individual stocks as well as to the entire market. De Bondt and Thaler (1985, 1987) showed that stocks that were extreme winners or losers over

[56]See Poterba and Summers (1988) and Black (1990).

[57]See Fisher (1966).

[58]Also see Conrad and Kaul (1988).

the previous 3 to 5 year period reverse their behavior in subsequent years.[59] This "contrarian" view of stock investing, although frowned on by efficient-market supporters, has long had its advocates on Wall Street.

Not only did past returns influence future returns, but recent research has confirmed that both the price-earnings ratio and the dividend yield have strong explanatory power in long-run statistical tests. Fama and French (1988) found that between 25 percent and 40 percent of the returns to equities over long periods could be attributable to the dividend yield, while others found similar results for earnings.[60]

These findings focused the debate on whether return predictability represented movements of the market away from fundamental intrinsic values, as suggested by Shiller (1984) and Summers (1986), or whether it was related to long-term changes in expected returns, perhaps associated with changes in real economic conditions, as proposed by such efficient-market supporters as Fama and French (1989). That these long-term market movements appear correlated across assets and economies does little to resolve the debate.[61] Clearly more sophisticated models of asset pricing than the CAPM are needed to identify the determinants of the expected returns on financial assets.

F. Comments

It is important to note in interpreting the above anomalies that a capital market can only be shown "inefficient" relative to a particular asset pricing model. For example, the finding that the performance of small firms exceeds that predicted by CAPM or other models may mean

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[59]Lehmann (1990) has discussed these results.

[60]Also see Campbell and Shiller (1988).

[61]See Keim and Stambaugh (1986) and Ferson and Harvey (1991).

that these models do not adequately adjust for the risks inherent in such firms. Even the anomalous seasonal patterns of return may be related to seasonal shifts in risk or investor preference functions. Proving market inefficiency is particularly difficult when examining long-term return series, where evidence implies that the simple assumption of constant expected returns is not true.[62]

Most of the empirical work on asset pricing abstracts from the institutional structure in which assets are traded. One exception is the recent work of French and Roll (1986), who confirm that the variability of stock returns when the market is open for trading is far higher than between the previous day's close and the next day's open. This result is consistent with the hypothesis that traders attempt to extract information from the movement of prices, which motivates even further trading.[63] This may also indicate a relation between the structure of trading and the pricing of securities, the subject of much of the current literature on market-making.

G. Further Developments in Asset Pricing

In an attempt to explain the empirical anomalies found in security prices, theoretical work continued to generalize the capital asset pricing model. Black (1972) extended the CAPM to an economy that restricts short selling or does not possess a risk-free asset. The latter was important since uncertain inflation precludes the existence of an asset that is riskless in real terms. Brennan (1970) studied the effects of taxation, and Levy (1978) examined the impact of transactions costs on asset pricing. Although these refinements led to somewhat different

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[62]For an excellent review of this problem, and recent asset pricing literature, see Fama (1991).

[63]This finding is also consistent with the hypothesis that more news is released during trading hours.

allocations among assets, they did not change any substantive results of the capital asset pricing model.

The original development of the CAPM assumed that the distribution of future returns was known and did not change over time. An important extension to the CAPM was to allow the distribution of returns to change unpredictably over time. Merton (1973) was the first to introduce such changing opportunity sets by allowing the future risk-free rate to be random.[64] His model showed that the expected return of an asset depends not only upon the covariance of the asset's return with the market but also upon the covariance of the asset's return with *future* expected returns. This model was the first to suggest that the correlation with a single market index might be inadequate to describe asset returns.

In response to Roll's critique of the lack of a well-defined market portfolio, Breeden (1979) developed a consumption-based capital asset pricing model. In this model the betas are computed as the covariance of security returns with an individual investor's consumption, with no need to specify the "market" portfolio.[65] Although such a formulation has strong theoretical foundations, empirical tests of the model, especially against the standard CAPM, have proved to be quite disappointing.[66]

One interesting result that has come out of the consumption-based asset pricing models was the finding by Mehra and Prescott (1985) that historical returns on equity were too high (and real returns on fixed assets too low) to be explained by the prevailing models of investor behavior, except under conditions of extreme risk aversion. These findings, dubbed the "equity

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[64]More recently, see Campbell (1992).

[65]Lucas (1978) laid the theoretical foundation for this type of analysis.

[66]See Mankiw and Shapiro (1986) and Breeden, Gibbons, and Litzenberger (1989).

premium puzzle," have led to extensive research which ultimately may help explain excess volatility and other market anomalies.[67]

The empirical inadequacies of the traditional CAPM and later the difficulty in identifying *the* market portfolio led Ross (1976) to offer an alternative theory of asset pricing. Ross proposed that certain economic and financial factors that include production, interest rates, and inflation drive asset returns instead of some aggregate market measure, such as the S&P 500 Index. Ross suggested that these factors could be used to fashion low variance portfolios in a way that was more effective than the traditional CAPM.

This model, called Arbitrage Pricing Theory or APT, has been subject to wide debate. It can be shown to be equivalent to the CAPM model under certain assumptions. The underlying theory is that the factors against which investors wish to hedge are far too complicated to be summarized by some ill-defined market portfolio. Chen, Roll, and Ross (1986) found that the growth of industrial production, the default premium on long-term corporate bonds, and, secondarily, the interest rate and term structure premium were far more successful at explaining individual stock returns than the standard CAPM model. Although empirical tests of these multifactor models have been promising, this theory does not rest on as strong theoretical foundations as the single factor or consumption CAPM.

But the single factor CAPM was running into more empirical trouble. Recent research showed that the returns on individual stocks were better explained by various size-of-firm variables than by the betas estimated in the traditional CAPM models. This finding corroborated the anomaly literature in that small stocks significantly outperformed large stocks, particularly in January.

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[67]For an excellent review of this literature, see Abel (1991).

In fact, Fama and French (1991) found that the most important variable in explaining cross-section returns in the market was the book-to-market ratio of the individual firms (with high ratios outperforming small ratios) and that beta has absolutely no additional explanatory power when the book-to-market ratio is added to equations estimating security returns. One can say that recent results have thrown individual asset pricing models into disarray. But a fundamental insight of CAPM, that diversification pays and that portfolio managers' results must be measured against the risk-return tradeoffs available in the market, still hold. Richer and more institutionally based models may be needed to explain the pricing anomalies and expected returns on individual assets.

V. HETEROGENEOUS EXPECTATIONS AND FINANCIAL MARKETS

A. Early Work

The early development of the efficient-market hypothesis recognized that investors had different views about the future values of dividends, earnings and other factors, but these differences, in the end, were reconciled by the workings of the market. As investors attempted to profit from these different expectations, prices in the market would adjust immediately to incorporate all relevant information. Out of this process would emerge a consensus view of the returns and risks of each security.

In an important study of security pricing under heterogeneous expectations, Lintner (1969) showed that the equilibrium value of securities is a weighted average of each investor's expectations, with greater weight given to those investors with greater wealth and to those investors with a greater tolerance to risk. Risk tolerance matters because investors who are more tolerant of risk are willing to place more of their wealth in assets that they perceive to be mispriced.

Lintner showed that if the view of each investor is replaced by this weighted average, or *consensus*, the equilibrium level of stock prices is identical to the level reached when each investor has different expectations and interacts in an efficient market. Thus was born the artifice of a "representative investor" with consensus expectations. Instead of incorporating the different views of each investor into the determination of security prices, one could instead use the representative or consensus view and obtain the same set of equilibrium prices.[68]

B. Rational Expectations

The incorporation of differential information into the pricing structure of risky securities thus seemed to present no real conceptual difficulties. However, Grossman (1976) showed that earlier studies on heterogeneous expectations contained a critical flaw. In the process of analyzing market equilibrium, Grossman noted that stock prices could not reflect all information as required under the strong or semi-strong form of the efficient-market hypothesis.

The flaw in the earlier research was the failure to recognize that market prices themselves contain information. Since the aggregate supply and demand of stocks determine prices, and each investor's supply and demand reflect the specific information available to that investor, prices must contain information about the views of others. In an efficient market, individuals would deduce as much information as possible from the bids and offers of other investors, incorporate that information into the information that they may have obtained

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[68]Rubinstein (1975) showed in a very general context that there will always exist a consensus belief which, if held by all investors, would lead to the same set of equilibrium prices.

independently, and then recalculate their security demands accordingly. The resultant set of prices is termed a *rational expectations equilibrium*.[69]

If all participants in the market tried to infer the information of others from their bids and offers, the market price of each stock would ultimately embed all the relevant information about the security. In these circumstances, the market prices are said to be *fully revealing* in that the prices contain the special information and opinions of all investors. The market price of every security is said *to aggregate* all public and private information.

The concept of a fully revealing equilibrium is similar to the strong form of the efficient-market hypothesis. As noted earlier, a strongly efficient market reflects all information whether it is public or private. If the market is strongly efficient, the price of a security already incorporates all individuals' information relevant to determining the price of a security.

C. Auction Processes

C.1. Definitions

The price setting structure that underlies Grossman's rational expectations model is a "recontracting auction." In this type of auction, all investors negotiate back and forth, taking into account the reaction of all other participants, until every investor is satisfied with the final price. No offers are binding until everyone agrees with the final configuration of quantities and prices. Such an outcome is called a "Nash Equilibrium," insofar as each participant has reacted optimally given the reaction of every other participant.[70]

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[69]Lintner's model of equilibrium assumed that investors did not revise their expectations in light of the bids and offers of other investors, and thus was not a rational expectations equilibrium except in a one-period non-recontracting auction. Section C.1 below defines a recontracting auction.

[70]This common and often used strategic equilibrium was first described by Nash (1950).

This type of equilibrium contrasts with that found in standard economic models, which is termed a "Walrasian equilibrium" after the nineteenth century French economist Leon Walras. In this equilibrium, participants reveal a schedule of desired purchases or sales at a wide array of prices and then an auctioneer finds the price that clears the market. A financial market that comes close to a Walrasian market is the bidding for government securities in the periodic Treasury auctions. Participants submit a schedule of quantities and prices at which they wish to acquire certain securities and recontracting is not permitted.[71]

C.2. Example

The following example illustrates a "rational expectations" equilibrium under the auction process postulated by Grossman in which no offer is binding until there is full agreement by all parties.

> Suppose that the current market price of ABC Corp. is $20 a share and that you obtain some private or special information that indicates to you that the price should really be $22 a share.
>
> Being "rational," you look at the market price of $20 and conclude that others may have other information that tells them that the stock is not worth as much as your information would suggest.
>
> Nonetheless, you determine that, although ABC Corp. may not be worth $22 a share, it is worth more than $20, perhaps as high as $20 1/2. In trying to extract the maximum profit, you place an order to buy ABC Corp. at a price no higher than $20 1/8.
>
> But in a rational expectations equilibrium, a potential seller will go through the same thought process. He will ask, "Why is someone suddenly bidding up to $20 1/8 for ABC Corp.? Does he know something that I do not?" Thus, the potential seller is concerned that the potential buyer may have some private information that indicates a value for ABC Corp. of more than $20.

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[71]Often a single price does not clear this market (the "tail" of the distribution) as the government distributes securities along the demand curve. The public is able to participate by submitting noncompetitive bids, which are allocated at the average price.

In the first round of bidding, the seller will use the current price of the stock, his own information, and the information that you are willing to buy at $20 1/8 to raise his offer price to somewhere above $20. By doing so he will avoid selling to, or avoid being "picked off" by the knowledgeable investor.

Let's say the potential seller counters with a tentative offer to sell at $20 1/4. You will use your own information and the information that another is willing to sell at $20 1/4 to determine whether you should accept this offer.

If you still decide to accept the offer, the seller knows that the offering price is still too low and will revise it upwards again.

Ultimately the price will adjust to a new equilibrium level that reveals all of the special information that individual investors possess. In a rational expectations equilibrium, no investor will have the incentive to trade at the final price, since there will be no profit from a trade once the price reflects all the information.

D. Inconsistency of Rational Expectations Equilibria

Grossman noted that the theory has a serious flaw in this version of a rational expectations equilibrium. If there is any cost associated with obtaining private information, investors in this model have no incentive to collect and process this type of information. As a consequence, all investors will abandon the search for costly information and hence no new information will be produced. Under these circumstances, capital markets will no longer be efficient.[72]

Thus, the presence of costly information and a strongly efficient capital market are logically inconsistent. Since an investor derives no benefit from securing private information, no

[72]Fama's original development of the efficient-market hypothesis assumed that information was available to all and at no cost, so there is no logical inconsistency in the efficient-market hypothesis. See Jensen (1978) for a description of the tradeoff between the cost of obtaining information and market efficiency.

resources will be devoted to security analysis and prices would not, and could not, reflect all information.

A key result of the rational expectations equilibrium with informed traders is that the very process of making an offer to buy or sell reveals "too much" information to the other side of the potential trade. If a trade is to occur, an informed trader must be able to make an offer without fully revealing his private information; otherwise the price will rise to the point where the trade becomes unprofitable.

E. "Noise" Traders

Model builders had to find some device to add more "uncertainty" to the model to prevent the price from revealing all the information that informed traders possessed about a security. Initially, it was assumed that there was exogenous uncertainty in the supply of the security which prevented investors from knowing whether trades were informationally motivated or not.[73]

To enable informed traders to hide partially their information from other informed traders, later work introduced "noise" or "liquidity" traders who buy and sell for reasons other than the possession of special information.[74] If an informed trader is unable to determine with certainty whether a bid or offer is from another informed trader or a noise trader, that trader cannot know in fact whether special information motivates the bid or offer. Since there is a possibility that a bid or offer comes from a noise trader, an informed trader has the possibility of profiting from making a trade. Thus, the existence of non-informationally motivated traders

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[73]See Grossman and Stiglitz (1980).

[74]Among the reasons for "liquidity" trading are tax considerations, changes in wealth levels, changes in risk preferences, and the accumulation or decumulation of assets for consumption.

provides the incentive for spending resources on the acquisition of information about the value of securities and the opportunity to profit from this activity and permits the existence of a rational expectations equilibrium with costly information.

E.1. Early References

The first reference to liquidity trading was made in a 1971 article written under the pseudonym of Walter Bagehot.[75] Bagehot posited three types of investors: "one, transactors possessing special information; two, 'liquidity-motivated' transactors who have no special information but merely want to convert securities into cash or cash into securities; three, transactors acting on information that they believe has not yet been fully discounted in the market price, but which has."[76]

The third type of investor is not consistent with a rational expectations equilibrium. These investors by failing to make profits and suffering transactions costs should eventually learn that their information is already discounted into the price and stop trading.[77] Possibly, as a consequence, recent research omits this third type and uses only the "liquidity" investors to induce noise into the trading process.

Models that do not include this third group may be ignoring a large number of investors. The trading volume of many institutional traders, often exceeding 100 percent per

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[75]Bagehot (1971). The real author of this paper is Jack Treynor. Walter Bagehot himself lived from 1826 to 1877 and was a noted English banker and journalist. This article is extremely prophetic but was ignored until recently. Indeed, some recent work can be viewed as formalizing the essential insights of this article.

[76]Bagehot (1971), p.13. One might add to the third type those who believe the market has *in*correctly discounted known information.

[77]The assumption that traders eventually learn from their mistakes may not be true in a finite horizon, overlapping generation model, for as P.T. Barnum said, "There's a sucker born every minute."

year, is too large to be attributable to liquidity trading alone. This observation, coupled with their inability to outperform the market, is suggestive that there are large number of investors who believe, incorrectly, that they have some special information about the true value of a security.

E.2. Market Volatility

The presence of noise traders also has led to a growing literature concerning how they may influence the volatility of financial markets. Speculators who trade on signals that contain no information about the value of a security can move prices away from the fundamental or full information valuation. Friedman (1953) persuasively argued that destabilizing speculation could not be profitable, and such speculators, by losing wealth, would eventually be driven from the market. However, in a series of articles by De Long, Shleifer, Summers, and Waldmann, it is argued that noise traders can destabilize financial markets, causing excess volatility and other pricing anomalies.[78] Rational value investors may not wish to take opposing positions when prices are driven away from fundamental values since most investors maximize over finite horizons, and it may be that noise traders might make security prices even more mispriced in the future when the rational investor must sell his holdings. Hence noise traders may not be driven from the market and prices may not revert to their fundamental value. This behavior restricts arbitrage over time since assets may become even more mispriced when the rational investor liquidates his holdings.

Kraus and Smith (1990) have obtained a similar result that investors who trade for reasons that are not relevant to determining the asset price can influence the trading behavior of

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[78]See, for example, De Long, Shleifer, Summers, and Waldmann (1990). Shleifer and Summers (1990) review this approach.

informed investors. This will be true especially if some traders are uncertain whether other traders possess special information. Each trader may interpret the willingness of the other traders to hold positions as indicating some probability that the other traders may have received favorable private information, even though no one has actually received a favorable signal. As the authors note, it is sometimes impossible for a group of traders to know whether the demands of other traders are due to the possession of private information or to beliefs about the information of the first group.

This line of reasoning is reminiscent of Keynes's discussion of the behavior of capital markets in the *General Theory* more than fifty years earlier. Keynes wrote:

> This battle of wits to anticipate the basis of conventional valuation a few months hence, rather than the prospective yield of an investment over a long term of years, does not even require gulls amongst the public to feed the maws of the professional; -- it can be played by professionals amongst themselves. . . . We have reached [the point] where we devote our intelligences to anticipating what average opinion expects the average opinion to be.[79]

VI. MARKET-MAKING STRUCTURE

The introduction of noise or liquidity traders also began the process of interrelating the asset pricing literature with the market-making literature. The interaction of informed and non-informed traders not only changed the equilibrium in the markets but was critical in the developing models that describe the way prices are posted by dealers and other market participants. The separation of asset pricing and market-making, which had long been a hallmark of efficient-market literature, was breaking down.

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[79]Keynes (1936), pp. 155-56.

The last section showed that if the only reason individuals trade is that they possess (true) private information, then in an efficient market no one will trade or acquire costly information. If there were no trading, an efficient capital market would not exist. However, when investors trade for liquidity or other reasons not related to information, it pays some investors to acquire costly information and trading takes place. Recent literature raises the possibility that the rules and organizational structure of a market could make a substantial difference in how security prices are determined. This section describes different types of market structures for the purpose of understanding some of the more widely known models of price determination at the micro-market level.

A. Types of Market Structures

There are two basic types of markets for common stocks: continuous and batch markets. In a continuous market, buyers and sellers continually interact with each other or through an agent, called a dealer, and trades can take place at any point in time. In a batch market, orders are accumulated and executed together at specific points in time. The execution of a batch market can be through a dealer, auctioneer, or automated computer system. Real financial markets often involve combinations of these two types of markets.

B. Continuous Markets: Auctions and Dealers' Markets

There are two variations of a continuous market. One is an auction market and the other is a dealers' market. An auction market brings together all potential buyers and sellers at one physical location (or through a computer network). If the auction market takes place in a physical location, there is a limitation on the number of individuals that can gather together in what is termed the "crowd" or the collectivity of buyers and sellers. Where there are a large number of buyers and sellers, the market structure has to impose some restrictions on the crowd's access to the market, and in this case investors must use agents to act on their behalf. An example of an auction market in a physical location is the market for most commodity and financial futures where the auction takes place in what is called the trading pit.

In contrast to a market at a physical location where the number of traders is limited, advances in computer networking now make it possible to include a larger number of potential buyers and sellers and theoretically all potential buyers and sellers.[80] An example, though not a pure one, of an auction market using a computer network is Autranet, which institutional investors use to trade amongst themselves. Autranet is a billboard system in which institutions can advertise their desires to buy or sell individual securities. It is not a pure "auction" because the institutions typically indicate only the approximate size of their intentions, and the system itself only introduces a prospective buyer and seller. Once paired, the two institutions leave the system and negotiate the price and volume over the telephone.

A dealers' market consists of professionals who set prices at which they will buy or sell securities on their own account. Dealers post their bid and ask prices along with the number of shares available at each price for one or more stocks. A public investor (an investor who is not a dealer) can only execute a trade by notifying the dealer, who uses his own inventory to satisfy the order. In contrast to an "auction" market, public investors, or their agents, never trade among themselves. The National Association of Securities Dealers Automated Quote system

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[80]A practical problem in permitting wide access to a computer network is providing assurance to the participants that contraparties will honor their buy and sell commitments. Steven Wunsch has recently implemented a batch system in which institutions can enter their orders directly, and the orders are guaranteed by Banker's Trust.

(NASDAQ), part of the over-the-counter market, is for the most part a dealers' market.[81] Dealers use a computer system to display their quotes.[82] A public investor places a buy or sell order with an over-the-counter broker, who either acts as a dealer himself or, as an agent, executes the order with another dealer.[83]

C. Batch Markets: Sealed and Open

As with continuous markets, there are various types of batch markets. In one type of batch market, investors' bids and offers are kept secret, or "sealed" from the eyes of other investors. These bids can be either open market orders for a given number of shares or an entire schedule of quantities to be traded depending upon the actual price at which the market clears. As mentioned above, major investors in the new issue market for U.S. government securities submit entire schedules, and the closing price is then calculated.

If investors are able to view the orders of other investors before the auction takes place and to revise their orders before the actual auction, the market is termed open or "unsealed." The important difference between these two types of batch markets is that investors only know about their own demands in the sealed process, whereas in the unsealed process, investors learn about the demands of others. With different amounts of information available to investors, it is

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[81]At least one large institutional investor circumvents the dealer by having the dealer place a bid or ask into NASDAQ as if it were the dealer's quote, while in fact it is the quote of the investor. For this service, the dealer receives a commission.

[82]The quotes include the bid and ask prices and the number of shares available at these prices. In practice, the posted numbers of shares are nominal amounts and may understate the actual numbers of shares available at the quoted prices.

[83]An over-the-counter broker must be registered with the National Association of Securities Dealers or NASD.

highly possible that the clearing price in each type of market could differ, and recent work has confirmed this intuition.[84]

A distinguishing characteristic of a continuous market, in contrast to a batch market with sealed orders, is that buyers and sellers agree on a price and quantity before a trade takes place. A distinguishing characteristic of a batch market with sealed orders is that a trader does not know *both* the price and quantity before the auction. With unsealed orders, a trader may know both price and quantity just before the auction.

D. Actual Markets

Actual markets do not fall neatly into these highly stylized compartments and indeed are much more complex. As an example, the usual pattern of trading on the New York Stock Exchange (NYSE), the largest equity market in the U.S., is to begin or "open" trading with a batch market and then to change to a continuous market with characteristics of both a dealer market and a market where investors can trade directly with each other through floor traders. The Appendix provides more detail about the actual trading practices of the three major North American equity markets: the New York Stock Exchange, the Over-the-Counter Market, and the Toronto Stock Exchange.

VII. THE THEORY OF MARKET-MAKING

A. Inventory Models

In the spirit of the original versions of the efficient market, the early literature on market structure assumed a continuous dealer market, in which the dealer's sole role was to facilitate non-informationally motivated trades. The dealer played no role in the price-discovery

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[84]See Leach and Madhavan (1989).

process. The only purpose of the dealer was to provide transaction services to the public, with the "bid-ask spread" as compensation for these services. In short, the dealer maintained an inventory to facilitate the trading of public investors.

In a pioneering article, Demsetz (1968) viewed trading costs "as the costs of exchanging titles."[85] Demsetz then went on to explain that the bid-ask spread is "the markup that is paid for predictable immediacy of exchange in organized markets."[86] Immediacy is described as the service of providing an investor with an immediate execution of a buy or sell order. Thus, the bid-ask spread is very much like the inventory markup of a normal merchant, a markup charged to cover operating costs and the required return on working capital.

Since, in Demsetz's view, trading through the dealer is just like any other merchant trading activity, the principles of classical economics apply. The amount of competition that the dealer faces has a direct influence on the size of the bid-ask spread, just as it would in any market. Other markets for the stock or other market-makers provide competition to the specialist. In the spirit of a competitive model, Demsetz also argued that as the volume of "trading" increased, the bid-ask spread would decline. This conclusion is drawn from the analogy with physical goods, where rapid turnover of inventory is associated with smaller margins. Demsetz presented some empirical analysis in support of his model.

But the parallel of the trading of stocks to the usual trading of goods by a merchant is not perfect. In the case of trading goods, the merchant must finance inventory by borrowing money or selling assets and must receive compensation for the interest costs incurred or revenues forgone. In the case of securities, however, there is an offsetting revenue stream in that stocks themselves are productive assets and provide a return to the holder.

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[85]Demsetz (1968), p. 35.

[86]*Ibid.*, pp. 35-36.

In the spirit of a merchant trading model, Stoll (1978), and later Ho and Stoll (1981), proposed a rationale for a bid-ask spread that explicitly recognizes that an inventory of securities provides a revenue stream. Their model assumes a single monopolistic dealer who is risk-averse and has invested his wealth in three types of assets: inventory of stock for market-making, cash or short-term safe assets, and other risky assets. By standing ready to buy or sell individual stocks, the dealer's inventory will change over time in a random way. Sometimes, the dealer will own too much or too little of a given stock relative to the desired allocation of his wealth, or "optimal portfolio." As a result, the risk and return characteristics of his overall portfolio will often be driven to suboptimal levels because of randomly changing inventory positions. The bid-ask spread emerges in this model as the compensation necessary to induce the dealer to hold a non-optimal portfolio.

An implication of this model is that the bid-ask spread is a function of the dealer's risk-aversion and level of wealth. The bid-ask spreads of two equivalent stocks could differ if they were assigned to dealers with different risk tolerances and wealth levels.

A major contribution of these types of inventory models is that they provide insight into why there may exist a bid-ask spread even though a dealer in equities does not bear the usual carrying costs of inventory. The bid-ask spread arises as compensation to induce a dealer to hold a non-optimal portfolio of assets. However, it should be noted that these inventory models provide no insight into how new information or differences in investors' information affects the price of a stock.

B. Theory of Continuous Markets

B.1. Setting the Bid-Ask Spread

One of the first models incorporating informed traders was that of Glosten and Milgrom (1985).[87] They assumed a continuous dealer market with both informed and uninformed traders. The dealer is risk-neutral and behaves competitively. As a consequence, the objective of the dealer is to obtain an expected profit of zero. In the Glosten and Milgrom model, the dealer posts a bid and offer price that is binding for one trading unit. The traders arrive randomly, each with reservation prices for buying or selling. The informed trader uses both public information and his own private information in deriving his reservation price, whereas the uninformed trader uses only public information in deriving his reservation price.[88]

Importantly, the dealer does not know whether the next trader is informed or not. Since the dealer has no costs, competition forces the dealer to set the bid and offer prices so that the expected gain from each trade is zero. The following illustrates how the dealer sets the bid-ask spread in such a model.

> Let us assume that your best estimate of the true value of the stock is 20 1/8. You, the dealer, need to set your bid and offer prices around the true price in order to make zero profit from a trade. Assume that if the next trader buys the stock and is an informed trader then you believe the value of the stock is 20 3/8.
>
> The problem is that you do not know whether the next buyer will be informed or uninformed--you know only the probability of his being informed or uninformed. Let us assume that you believe that there is a fifty-fifty chance that the buyer will be informed. Since your goal is only to break even on average, you would set your ask price to the unconditional expected price given that the next trade is a buy. In this case, you would set the ask price at 20 1/4, gaining 1/8 if the buyer is uninformed and losing 1/8 if the buyer is informed.

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[87]Glosten and Milgrom build on an earlier model by Copeland and Galai (1983).

[88]Because of differences in time preferences for consumption, two investors with exactly the same information can have different reservation prices.

Similarly you would go through the same exercise on the assumption that the next trader decides to sell stock to you. Taking into account your expectation of the price given the trader was informed, your expectation of the price given that the trader was uninformed, and the probability of a seller being informed or uninformed, you set an offer price so as to obtain expected profit of zero.

Regardless of whether the next trader is informed or not, you will have already incorporated into your bid and ask price the loss if the trader happened to be informed.

In this example, the dealer does not know whether the offer is from a liquidity or informed trader. If the dealer knows that the buyer is a liquidity trader, he would sell at a lower price, so liquidity traders have an incentive to identify themselves as such. Moreover, informed traders have an interest in being mistaken for liquidity traders. For example, if the market believes that liquidity traders transact in smaller lots than informed traders, large and informed traders will split their orders into smaller orders in order to mimic liquidity traders. Informed traders also may try to hide their identity by using a number of brokers to execute a trade, as well as other techniques.[89] Therefore, both liquidity and informed traders face a number of strategic decisions in executing trades.[90]

Glosten and Milgrom go on to show that the market can fail in that no trades take place. Specifically, as the proportion of informed traders increases, the bid-ask spread will widen. At some point, the bid-ask spread may become so large that trading ceases.[91] In this case, the market fails since it does not reveal in any meaningful sense the true price of the security.

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[89]See Black (1991).

[90]It should be noted that Glosten and Milgrom's model is not rich enough to take into account this strategic behavior.

[91]If in the limit, all traders become informed, there will be no trading under the rational expectations equilibrium, as discussed previously.

B.2. Monopoly Dealers and Price Discovery

One of the reasons that the market may fail in the Glosten and Milgrom model is their assumption that the dealer behaves competitively by always choosing bid and ask prices that produce zero expected gain per transaction. They conjecture that a monopolistic dealer would in some circumstances keep the market open, while competitive dealers would let it close.[92] The argument is the following: A monopolistic dealer may decide to post a quotation, knowing he will lose to an informed trader, but since the quotation is only good for one trading unit, his losses will be limited. As a result of this experiment, the dealer will learn something about the true price of the security and be able to make profits from future liquidity traders.

In a competitive model, a dealer is unable to recoup earlier losses since other dealers also will have learned about the first dealer's experiment. Hence, under competition a dealer will not experiment by posting a quote to discover the correct price. Therefore, under some circumstances, the granting of a monopoly to a dealer may encourage the faster discovery of correct prices, which benefits society.

C. Sequential Batch Markets

For the purposes of analyzing strategic behavior, Kyle (1985) has analyzed a sequential batch market in which there are also three types of participants: liquidity traders, informed traders, which he calls "monopolistic news traders," and dealers, who take advantage of the information in the order flow and in the sequence of prices. Kyle extends the Glosten and Milgrom model by deriving the exact sequence of prices assuming both dealers and informed traders behave strategically. He shows that the price path is still a random walk although the informed trader may be accumulating shares over time.

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[92]Leach and Madhavan (1989) provide a formal proof of this conjecture.

Kyle rigorously derives the dynamic optimizing trading strategy of informed traders as these traders try to profit from their special or inside information. The problem facing the informed trader is how to minimize the effect of his trading on the price of the security and obtain the greatest gain as the market price adjusts to the new information. Kyle shows that the informed trader will prefer to trade small quantities in each batch using the transactions of liquidity traders to camouflage his trading. Not surprisingly, as the number of liquidity traders increases, the profits of the informed trader also will increase. Kyle also examines the profits of informed traders as the number of batch markets approaches infinity and becomes a continuous market and finds that informed traders prefer fewer batch markets to more.

Interestingly, in Kyle's model market prices are almost never equal to the true price except at the end of the series of auctions when all information is revealed. Even under these circumstances, he shows that the past history of market prices has no value for predicting future changes, just as in the earlier theory of efficient markets. Thus, the earlier evidence offered in support of the efficient-market hypothesis, namely, that historical changes in market price have no predictive value and that most investors are unable to outperform the market, is also consistent with the hypothesis that investors have heterogeneous expectations and that market prices can deviate from their true values.

Recent research by Admati and Pfleiderer (1988) has added a fourth class of investor to Kyle's model. These participants are liquidity traders who can anticipate their liquidity needs and be flexible in timing their participation in batch auctions. The term used for these traders is "discretionary liquidity traders."

The discretionary liquidity traders will find it in their interest to trade together by concentrating their orders in the same auction. With an increased presence of liquidity traders, a price change will be less sensitive to the size of the net order imbalance. Liquidity traders have an incentive, as in the case of continuous markets, to reveal their presence to a dealer. Because of the increased presence of liquidity traders, there will also be more informationally motivated volume. Order flow attracts order flow.

The empirical implication of this theory is provocative. On exchanges such as the NYSE, price changes should be less sensitive to net order imbalances at the opening, when a batch auction prevails, than during the day, when a continuous auction prevails. In the terminology of the Street, the market is "deeper" at the morning opening, when liquidity traders concentrate their orders.[93] Furthermore, those investors who have some discretion as to the timing of their purchases would find they receive better prices during this auction.[94]

A recent article by Madhavan (1989) extends the analysis of batch markets by analyzing the differences between the prices set in sealed and unsealed batch auctions. In a sealed auction, buyers and sellers place orders that are not subject to revision. In an unsealed auction, traders are able to revise their orders before the final price is determined. As noted in Section V. C., an unsealed auction is closer to the recontracting equilibrium that characterizes the literature on an efficient market.[95]

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[93]Of course trading on the opening is influenced by investors with different interpretations of the news events that have occurred since the previous close. Sometimes the morning price may be particularly volatile because of the greater uncertainty of the intrinsic value of the stock. As the demands are revealed throughout the day, volatility may decrease.

[94]Another reason for liquidity traders to concentrate their market orders at the opening of the NYSE is that the trading costs may be less. First, since all stocks trade at the same price at the open, a buyer of stock will sometimes be buying at essentially a bid price, an ask price, or within these two prices. Thus, on average, the trade price for a buy or sell will be between the bid and the ask price. Second, there is no floor brokerage on orders executed at the open.

[95]To the extent that specialists reveal the order imbalance and likely opening price before actually opening a stock, the opening procedure on the New York Stock Exchange where investors are able to change their bids and offers before the official opening resembles closely an unsealed batch auction.

In an unsealed batch auction, an informed trader can observe the orders of others and may learn something about the number of liquidity traders as well as special information from the informed traders. As a result, the informed trader also may revise his orders and hence influence the price set in the batch auction. In contrast, in a sealed batch auction, the submitted orders reflect only the original information available to each investor. Since the order flow in these two types of batch auctions is based upon different sets of information, the prices set in sealed and unsealed auctions can differ. Hence, the rules and procedures of a stock exchange may have significant impacts on the types of information that stock prices reveal.

Grossman and Miller (1988) contrasted batch markets with continuous markets and concluded that in some circumstances one type of market will dominate the other. Specifically, with normal news flow, liquidity traders will prefer a continuous market, since for small orders, a trader knows in advance the price and quantity that can be traded and receives immediate execution. However, in the presence of significant new information, a batch market, with its greater concentration of orders, may be the more efficient market. It is interesting to note that the trading process on the NYSE parallels these observations. A continuous market accommodates small trades, but in the presence of significant news, or a large order imbalance, trading may be halted and the market reopened with a batch auction.

D. Market Fragmentation

Markets are becoming increasingly fragmented as the growth of alternative ways of exchanging equities in any part of the world allows traders to bypass national exchanges, avoiding either taxes, uncompetitive commissions, or outright detection. Furthermore, some dealers have successfully attracted liquidity traders by "feeding off" the quotations published in central exchanges and attempting to avoid trading with informed traders. The literature on market fragmentation is limited, but growing.

Pagano (1989) has shown that, under certain conditions, there could emerge two or more separate markets: one for large orders and one for small orders. For instance, institutions may find it profitable to engage in a costly search for a trading partner rather than to place a large order on an exchange where it might have an adverse price impact. Small investors, however, avoid this high fixed cost of search by using an exchange. Thus, separate markets with different allocations between fixed and variable costs could arise as a natural outcome of the competitive process.

Pagano's thesis is consistent with the development in the United States of the so-called "upstairs market" where, in response to large institutional orders, brokers search out the contraparties. Grossman (1990), using somewhat different logic, provides a rationale for an "upstairs" market. Sometimes, a broker will know of a customer who is willing to sell or buy a particular security at the right price, but who has not submitted a formal order. For example, a broker might know of a large institution that wants to accumulate some industry group without being specific as to the actual names. If an institution wants to sell stock in that same industry, the upstairs market may provide an ideal arena in which to trade.

E. Comments

The literature on market-making has made substantial contributions to our understanding of how investors incorporate new information into security prices. But so far progress has only been made in the context of stylized partial equilibrium models. In contrast, some variants of the CAPM represent a general equilibrium for asset pricing.

Typically, the literature on market-making focuses upon the discovery of the true or intrinsic value of an individual asset in a single market. There are at least three major types of investors: informed investors who have superior information about the true value of the asset; liquidity investors who trade for random reasons not related to the true value of the asset; and the market-maker who is an uninformed investor who only knows the parameters of the distribution from which the true value is drawn, but not the specific drawing. Informed traders attempt to maximize their profits, while hiding behind the trading of liquidity traders. The trading of informed investors drives the price of the asset closer to its intrinsic value. To date, the literature has not addressed the question of relative pricing of different assets or the overall level of the market itself.

In contrast, the CAPM and its extensions can be viewed as general equilibrium models for the pricing of both risky and riskfree assets. In this general equilibrium framework, each potential asset can be viewed as a productive, usually stochastic technology that produces an output at a future date, and investors have homogeneous views as to the joint probability distribution of outputs from these assets. Within such a framework, these asset pricing models can be used to determine the level of savings and the portfolio choice of each investor, the price of the aggregate portfolio of risky assets,[96] and the relative prices of each asset within that portfolio.[97]

Future research on market-making needs to broaden the models to include consumption and investment decisions, the pricing of the aggregate portfolio of risky assets, and the relative pricing of each asset within that portfolio. It is almost certain that a general equilibrium under

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[96]See Friend and Blume (1975).

[97]See Lintner (1969).

heterogeneous expectations will differ from one under homogeneous expectations.[98] The essence of the market-making literature is the recognition that investors have heterogeneous expectations--a characteristic lacking in the traditional asset pricing models. As the market-making literature starts to address the effect of heterogeneous expectations upon the general equilibrium, it promises to supplant the early models of asset pricing and produce new insights into the pricing of risky assets.

VIII. CONCLUSION

Academic research on the pricing of securities has come nearly full circle from the days of Graham and Dodd. In those days, most researchers took it for granted that investors had different expectations about the future and that observed security prices could and often did differ from their true or intrinsic values. Although there may be times when there is a gap between the market price of a security and its intrinsic value, Graham and Dodd assumed, without explicitly modeling the adjustment process, that over time this gap will diminish.

Graham and Dodd viewed the intrinsic value of a security as a function of the future earning prospects of the firm, and later Gordon formalized this view in his well known dividend-discount model. What was missing in Gordon's model was a formal theory to determine the appropriate risk-adjusted discount rate. Indeed, the very concept of risk was not well defined at the time.

The theoretical development of portfolio theory was advanced in the 1960s by Harry Markowitz and William Sharpe. Markowitz's model allowed heterogeneous judgments about the distribution of future returns in that each investor could utilize his own judgment in this model

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[98] See, for example, Abel and Mailath (1990) and Myers and Majluf (1984).

to form efficient portfolios. By imposing the additional, theoretically crucial assumption that all investors had the same view of the future, Sharpe developed the Capital Asset Pricing Model, or CAPM. This model provided, for the first time, a formal theory for measuring the risk of an individual security. This risk was summarized by a "beta" coefficient which could be used to determine the discount rate appropriate to any security.

Empirical research found that publicly available information had little predictive value in forecasting security prices. This evidence, combined with research that showed that the typical professional investor turned in a lackluster performance, suggested that any differences in expectations would not play an important role in determining market prices. Thus was born the "Efficient-Market Hypothesis" which asserted that market prices properly reflected all the relevant information. For the purposes of obtaining tractable theories of security pricing, one might just as well assume a "representative investor" and attribute this investor's expectations to everyone. Hence the assumptions needed to derive the CAPM did not seem to be refuted by market data.

Despite the early empirical work supporting the efficient-market hypothesis, there emerged a large body of empirical literature that was inconsistent with this hypothesis as epitomized in the CAPM and its variations. Numerous studies found anomalies, particularly those connected to calendar time, that were difficult to reconcile with any reasonable variant of most researchers' views of an efficient market. Additionally, some researchers concluded that the stock market was too volatile relative to that implied by a dividend discount model in an efficient market with homogeneous expectations.

At the same time that empirical chinks appeared in the efficient market and representative investor models of security pricing, there reappeared theoretical literature, reminiscent of Graham and Dodd, that explicitly modeled investors with heterogenous expectations. Within this framework, recent literature explores the interrelation between market structure and the incorporation of new information into the observed price. It analyzes questions such as: What are optimal trading strategies for different investors? What are the characteristics of market prices as they adjust to the new information? How does the totality of knowledge about the true price become incorporated into the market price?

Unlike Graham and Dodd, who believed that there was a true value for a security and that this value was driven by the future earning prospects of a company, the current literature on market-micro structure is silent on what determines the true or intrinsic value of a security. It is assumed that the payoff value comes from some arbitrary distribution function.

The above simplifications may be adequate to analyze the reaction of the market to a single piece of new information. But it is clearly inadequate to understand market valuation in the face of real information flows. There is rarely a time when the "true" price is revealed in the market or when full information prevails. In the earlier literature on market efficiency, the assumption of homogeneous expectations gave meaning to the concept of a "true" price. When investors are heterogeneously informed and full information is never revealed, the very concept of a true price may not be defined.

To come full circle from the days of Graham and Dodd, researchers will need to model the way in which investors process new information about earnings, dividends, and underlying asset values of a firm. Perhaps new pricing models will be developed that will bring us back to some of the same fundamental variables that Graham and Dodd advocated while explicitly incorporating the market structure in which the firm's securities are traded. Newly available transaction data will then allow empirical researchers to discover both the strengths and weaknesses of existing and forthcoming models. In this ongoing evolution of theoretical and empirical work, the academic community will continually obtain better insights in the theory of security pricing and market structure.

APPENDIX

THE STRUCTURE OF WORLD EQUITY MARKETS

Actual security markets are much more complex than those assumed in the theoretical literature on market microstructure. To provide an overview of this complexity, this appendix contains a description of the three major North American security markets: the New York Stock Exchange, the Over-the-Counter Market organized under the NASD, and the Toronto Stock Exchange.[99]

New York Stock Exchange (NYSE)

The trading mechanisms and procedures of the New York Stock Exchange (NYSE) have evolved over almost 200 years and do not fall into any simple scheme of classification. At some times, trading takes place in a batch market; at other times, trading takes place in a dealer's market. Trading in each stock is controlled by an assigned dealer, called a specialist. In principle, the dealer in a particular stock is a monopolist, but he in fact does face competition from traders on the floor of the NYSE, dealers and traders in other markets, and even the general public.

At the opening, the NYSE operates as a batch market where buying and selling interests are matched at a common price. After the opening, the NYSE normally operates as a continuous market with features of both an auction market and a dealer market. On occasion, when there is impending news or a large order imbalance, the continuous market can be suspended or "halted" and then reopened in the same way as at the beginning of the day.

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[99]We express our gratitude to Deborah B. Sosebee of the New York Stock Exchange, Gene Finn of the NASD, John Carson for the Toronto Stock Exchange, and Eric Kirzner of the University of Toronto for their careful reading of this appendix to verify the accuracy of the institutional descriptions that it contains. Still any errors that remain are our responsibility.

Recently, the NYSE introduced "circuit breakers" to stop trading of all NYSE-listed stocks in response to major declines in the Dow-Jones Industrial Average.[100]

In return for being granted the position of a monopolistic dealer, the specialist has both "affirmative" and "negative" obligations that limit his trading activities. According to the NYSE, the principal affirmative obligations of the specialist are to smooth prices and facilitate the execution of public orders in the case of a temporary order imbalance, to act as a catalyst to bring buyers and sellers together, to serve as an auctioneer, and to manage the "book." Negative obligations require that the specialist refrain from trading with the trend or stepping in front of public orders.

Formerly, the book was a spiral ring notebook in which the specialist recorded both limit and stop orders[101] as well as more specialized orders.[102] Currently, a computer screen has replaced the physical book for limit and stop orders, although specialized orders are still recorded manually. On occasion, the NYSE specialist will reveal the contents of the book to floor traders. Indeed, some specialists position the screen of their electronic book in such a way that any person on the floor of the exchange can see it. An investor off the floor may be able to learn of the contents of the book by asking a floor trader for that information, but this is cumbersome.

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[100]The Circuit Breakers halt all trading on the NYSE for one hour if the DJIA falls 250 points during the day and an additional two hours if the DJIA falls another 150 points.

[101]There are two types of stop orders: One is an order that becomes a market sell order if the price of the security falls to a particular level. The other is an order that becomes a market buy order if the price of the security increases to a particular level. A market order is an order to buy or sell immediately at the prevailing market price. A limit buy order is an order to buy at or below a prespecified price. A limit sell order is an order to sell at or above a prespecified price.

[102]An example is a percentage order. Schwartz (1991) contains a description of this and other special types of orders.

The opening proceeds as follows: The specialist has the responsibility for setting an opening price at which all trades--be they buy or sell--will be executed. In setting this price, the specialist will take into account public market orders to buy or sell at the open, previously submitted limit, stop, and specialized orders, interest in the crowd, and finally his own inventory position. Until the stock is actually opened, investors can cancel or change their orders.[103] The specialist often provides (but is not obliged to provide) information about the volume of orders as well as a likely opening price to NYSE members on the floor of the Exchange. The members in turn have the option of relaying this information to their customers. Additionally, when faced with a significant order imbalance, the specialist has the option of publishing a pre-opening indication for external dissemination on electronic medium of the likely opening price in the hope of soliciting additional orders to close the order imbalance.

If the specialist can find a price not too far from the previous close, he may open the stock at that price and cover the order imbalance from his own inventory.[104] Otherwise, he may delay the opening to give time for other traders and investors to place orders. If the specialist plans to set the opening price substantially higher or lower than the previous close, the rules of the Exchange encourage, but do not require, the specialist to give an indication of the possible opening range on the tape and wait an appropriate interval of time before opening the

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[103]Previously, the specialist matched all the orders by hand to determine the order imbalance at each possible opening price. Nowadays, Opening Automated Report Service (OARS), an electronic system integrated with the electronic book, facilitates this matching process by calculating the imbalance of market-at-open-orders.

[104]If the specialist wants to open a stock with too large a price change from the prior close, the specialist must seek permission from a floor official. Specifically, approval is required if the price change is more than one dollar from a last sale of a stock under $20 a share or two dollars for a stock over $20.

stock. As a consequence, the opening on the NYSE has characteristics of both a sealed and an unsealed batch process.[105]

After the opening, the market for stocks on the NYSE is usually a continuous market. The specialist for a stock quotes a bid and an ask price as well as the depth of the market--that is, the number of shares available at each price. The offers to buy and sell are a combination of the limit orders on the specialist's book and the offers from the specialist himself.

Example

The Specialist's Book
Limit Orders

Buy		Sell	
Price	Shares	Price	Shares
		20 1/2	3000
		20 3/8	500
		20 1/4	10000
20	2500		
19 7/8	400		

The specialist might quote a bid price of 20 for 2500 shares and an ask price of 20 1/4 with 10000 shares. In this case, non-specialist limit orders represent both sides of the quote.

Alternatively, the specialist might quote a bid price of 20 for 2500 shares and an ask price of 20 1/8 for 2000 shares, with the ask price representing an offering by the specialist. The specialist also could participate at the bid by, for instance, quoting a bid price of 20 for 5000 shares, adding 2500 shares to the limit order on the book. The specialist is required to execute the limit order before he executes his own order.

[105]See Section VI. C.

With a minor exception,[106] the earliest entered orders at a given price are executed first, a procedure called "time-price priority." A specialist's offer to buy or sell is always executed after all other orders at the same price, even if the other orders are entered after the specialist's order. The time priority of limit orders allows an exchange member in the crowd or even a public investor to step ahead of a specialist's own orders.

Example (Continued)

> Assume the same book as above and that the quote is a bid of 20 for 2500 shares and an ask of 20 1/8 for 2000 shares. If a member in the crowd submits a limit order to sell 2000 shares at 20 1/8, that member has effectively supplanted the specialist. A public investor could also submit a limit order to sell 2000 shares at 20 1/8 and supplant the specialist.

The specialist is obligated to honor the quoted bid and ask prices and the number of shares available at each quote. Nonetheless, the quoted bid and ask prices and the available shares do not fully describe the market. For example, a specialist or anyone in the crowd may execute a market order within the bid and the ask price. Likewise, the specialist may decide to buy or sell more shares at the quoted bid or ask price than he has guaranteed in his quote. Furthermore, a specialist may hold or "stop" an incoming market order in order for the seller or buyer to obtain a price better than the posted bid or ask. In these circumstances, the specialist will guarantee that the buyer and seller will do no worse than the posted quote at the time the order is stopped.[107]

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[106]If the primary CME S&P 500 futures contracts fall by 12 points, the NYSE's computers will wait at least five minutes before sending the specialist electronically submitted market orders that are identified with program trading in the NYSE-listed components of the S&P 500. This procedure is called the "Sidecar."

[107]If a limit order represents the side of a quote for which a market order is stopped and if that stopped order is subsequently executed at a better price, the original limit order will not have been not executed. Thus, the improvement in price for a stopped order may occur at the

Example (Continued)

> Assume the quote is a bid of 20 for 2500 shares and an offer of 20 1/4 for 10,000 shares and the book is given as above, so that both the bid and offer represent public limit orders. An investor is considering placing a market order to buy 100 shares. The published quote indicates that the price of this purchase will be 20 1/4, but there is the possibility that the price will be 20 1/8 if someone in the crowd steps in or the specialist chooses to sell the stock at this price.

When an investor places a market order to buy or sell on the NYSE, there is always the possibility of an execution at a price or depth better than the published quotation, either with someone in the crowd or with the specialist. On occasion, the SEC and Congress have highlighted this possibility of price improvement as a desirable feature of an exchange. This possibility of price improvement means that the published quotes are not necessarily the best prices at which trades can actually take place. In effect, the NYSE rules permit unpublished bids and offers on the part of floor traders and specialists that are better than the published bids and offers.

There are two ways to transmit a small order to the specialist post. The first, and traditional way, is for the broker to call a clerk on the edge of the floor of the exchange who in turn gives the order to a floor trader. The floor trader walks the order to the specialist's post for that stock and acts as an agent to obtain the best price. The second, and now more common way for small to medium size orders, is for the broker to transmit the order electronically to the specialist's post. The specialist then acts as an agent to obtain the best possible price. The electronic system known as SuperDot expedites the transmission of the order to the specialist and the confirmation of the execution back to the broker.[108]

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expense of a previously entered limit order.

[108]Currently, a broker can use SuperDot to transmit market orders of up to 30,099 shares and limit orders of up to 99,999 shares.

SuperDot has facilitated program trading by allowing a trader to prepare in advance an entire program of market orders for execution at some later unspecified point and then to transmit this program to SuperDot in a matter of seconds.[109] This ability to transmit almost instantaneously an entire program of orders to the floor of the Exchange is a major tool in reducing the trading risk of a program trade. Some risk still remains in that during the delay between the transmission of a market order to the specialist and its actual execution, market prices might change.

SuperDot does not provide for the automatic execution of small trades, and indeed as long as there is a possibility of obtaining a better execution than at the published quotes, it would not be possible for SuperDot to provide such automatic execution.[110] As described below, other markets do provide for automatic execution of small trades.[111]

The execution of large orders frequently occurs in what has become known as the "upstairs" market. Since a large order to buy or sell could have a substantial impact on the price of the security, institutional investors try to hide the true extent of their planned trades. Institutional investors often use the upstairs market to discreetly match a large order with orders

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[109]The NYSE defines a program trade as a simultaneous trade of 15 or more stocks with a total market value of over one million dollars.

[110]A change to SuperDot that would allow automatic execution is the creation of an electronic file containing all unexposed bids and offers, and orders could only be executed against the exposed and unexposed bids and offers.

[111]The NYSE has on occasion experimented with automatic execution for small trades. The first experiment (1971) was the Automated Trading System (ATS) covering two or three stocks in which market orders of 199 shares or less were executed automatically against the published quote. The goal was to determine whether a specialist could monitor an automatic executing system and at the same time carry on his other responsibilities. The second experiment (1982) was the Registered Representative Rapid Response system (R4) in which a broker could confirm an order for 100 shares at the quoted price before sending it to the floor for execution. The SEC reluctantly gave permission for this experiment with the strong reservation that the system negated the possibility of price improvement.

from other investors, or against a broker's own account as a principal. Once matched, these orders are generally transmitted to the floor of a registered exchange where they are executed according to the rules of that exchange.[112] Under these circumstances, if the order were to hit any limit orders, these limit orders would first be satisfied from one side of the matched order. To date, no major market provides automatic computerized execution of large orders.

Rule 390 of the NYSE restricts the arenas in which members of the NYSE can execute trades on NYSE stocks. The interpretation of this rule (formerly Rule 394) has varied over time. Today, it requires that NYSE members execute all trades for their own account on a registered exchange when the NYSE is opened. The only exception are "Rule 19c-3 stocks," which are stocks first listed on the NYSE after April 26, 1979. The SEC instituted Rule 19c-3 as a modest experiment to enhance competition in the trading of listed equities.

The intention of Rule 390 is to keep member firms from making markets in their own back office in competition with the specialists on registered exchanges. It also prevents firms from internalizing customer orders--thereby bypassing competing dealers and markets. As some large brokerage firms have acquired specialists on both the regional exchanges and on the NYSE itself, Rule 390 is less effective at preventing the internalization of order flow and maintaining the separation of broker and dealer activities. In the case of Rule 19c-3 stocks, NYSE members are free to make markets in their own offices and, importantly, can bypass the specialist book.

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[112]The exception is Rule 19c-3 stocks as discussed below.

NASDAQ[113]

The trading mechanisms for Over-the-Counter (OTC) stocks have evolved over time from a loosely organized network of dealers to a highly sophisticated computerized network. Operated by the National Association of Security Dealers (NASD), this network offers a large range of support facilities.[114]

The OTC currently provides different trading mechanisms for stocks as a function of their size and volume. In the 1960s, the trading of stocks not listed on any registered exchange took place in a loosely organized telephone network of dealers, termed the "Over-the-Counter" market. Each morning a stack of "pink sheets" was published that listed many thousands of OTC stocks, the dealers who made a market in each stock, and representative bids and offers of these dealers as of 2:00 pm of the prior day. These "pink sheets" served two purposes: They allowed investors to price OTC stocks, and they provided a listing of the brokers who made markets in each OTC stock. To trade a particular issue, a broker was required to obtain and compare three different quotes if possible, before executing the order. This process required a minimum of three phone calls.

A major change occurred in the OTC market in 1971. In that year, the NASD developed NASDAQ, an automated quotation system, for the larger, more actively traded OTC stocks. NASDAQ is a network of computer terminals in which dealers in OTC stocks enter

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[113]NASDAQ is the acronym that is always used for this market. It stands for National Association of Security Dealers Automated Quote System.

[114]The NASD is also the self-regulatory body for the OTC market.

current quotations for dissemination through the network. NASDAQ provides the same function of displaying prices and dealers as the "pink sheets," but on a current basis.[115]

In addition to the bid and offer price, the quotation of each dealer contains a binding indication of the number of shares available at the bid and the offer price, which is termed the "depth" of the market. In practice, dealers have for the most part displayed only the minimum mandated number of shares (500 to 1,000 shares) rather than the actual depth of the market. Thus, the true depth of the market is often greater than displayed. To obtain a quote for an order larger than the nominal size still requires a telephone inquiry and perhaps some negotiation.[116]

It is of interest that dealers usually post only the minimal mandated depth even though the design of NASDAQ allows a larger depth to be published. Apparently, dealers do not wish to reveal their true intentions. This observation demonstrates that, while highly advanced computerized trading system may be technically feasible, a system will only succeed if it meets the needs of its participants.

The largest and most actively traded stocks on NASDAQ, which capture 95 percent of the dollar volume, have been designated National Market Stocks (NMS) and as such, are subject

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[115]There are two methods for trading the NASD stocks that are not part of NASDAQ. First, pink sheets for the least active NASD stocks are still published daily. Second, NASD has developed a computer bulletin board where brokers and dealers can advertise an interest in trading a specific stock where this interest can be binding or non-binding.

[116]In November 1990, the NASD introduced SelectNet, a computerized network that allows dealers and brokers to bypass the telephone and broadcast an order of any size to all the other dealers for instantaneous execution. According to the NASD, this system now executes several million shares a day.

to "last trade reporting."[117] The effect of this requirement is that both the price and volume of any trade in a NASDAQ/NMS stock must be reported within 90 seconds.[118]

In December 1984, NASD introduced the Small Order Execution System (SOES) that allowed the automatic execution against the best bid and offer of market orders of up to 1,000 shares for NASDAQ/NMS stocks and up to 500 shares for the other stocks quoted in NASDAQ.[119] In January 1989, SOES was expanded to include limit orders. Public orders are executed rotationally among those dealers with the best bid and ask prices. Importantly, this rotational assignment of orders gives no priority to those market-makers who were first with the best bid or offer nor to those who provided the greatest depth. A market-maker can jump into the rotational trading at any time and have virtually the same access to order flow as any other market-maker.

To provide guaranteed liquidity to SOES, any registered market-maker in a NASDAQ stock now must participate in this system. During the Crash of October 19, 1987, when participation in SOES was voluntary, many market-makers withdrew from SOES, drawing much criticism. As a result, the NASD adopted a rule that requires market-makers who withdraw

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[117]The NASD was the first to use the term NMS, but it now applies to any stock with last trade reporting requirements.

[118]Because of the number of dealers and 90 second delays, the ordering of some of the reported trades may not reflect the time sequence of actual executions, although most small trades are now automatically executed and reported within seconds of the actual time of execution.

[119]Additionally, there are several competing automated proprietary systems operated by broker/dealers that often provide greater depth.

from making a market in a specific stock to wait twenty days before they can resume making a market in that stock.[120]

The Toronto Stock Exchange

The Toronto Stock Exchange trades stocks in two different ways: on a trading floor and through the Computer Assisted Trading System (CATS). Trading in the more active stocks generally occurs through a melding of the traditional crowd on the floor of the exchange with an electronic system that allows brokers off the floor to enter orders. Each of these active stocks has a Designated Market Maker (DMM), who has responsibilities similar to those of the NYSE specialist. Importantly, members of the exchange have open access to the book of limit orders as well as the identity of the brokerage house submitting each limit order. Quote vendors supply the contents of the limit order book to subscribers as well, but without the identity of the brokerage houses. Although an investor can sometimes obtain knowledge of the content of the book on the NYSE, it is a very cumbersome procedure. In contrast, the open system of the Toronto Exchange allows an investor to examine readily any book without first having to contact the floor.

In integrating the floor traders with an electronic screen, Toronto delays the transmission of electronically submitted orders to the floor by 30 seconds.[121] One might conjecture that this delay gives some trading advantage to floor traders. Floor traders do not see these orders

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[120]Since NASD market-makers are under no affirmative obligation to maintain a tight spread, one must question the efficacy of this new regulation. After all, market-makers can effectively withdraw from SOES by increasing their published spreads by a sufficient amount to discourage any trading through SOES.

[121]At the time of this writing, the Toronto Stock Exchange is considering closing its floor. Such an action would eliminate floor traders. DMMs will still make markets but in their own offices using electronic screens.

during the delay, but the designated marker-maker is aware of these orders and has the right to cause an additional delay in order to enter a previously declared order or to improve an execution price.

Trading in the less active stocks generally takes place through the Computer Assisted Trading System (CATS), which provides access to the Market Order System of Trading (MOST) and to the Limit Order Trading System (LOTS).[122] A DMM is assigned to manage the trading of the more active stocks included in CATS with the obligation to preserve an orderly market. A market surveillance computer program monitors the trading activity of the very thinly traded stocks in CATS, and is programmed to stop trading in the event of unusual price movements. In 1990, stocks traded through CATS represented 23.1 percent of the total trades on the Toronto, 22.4 percent of total share volume, and 17.2 of market value volume.[123]

In entering a large order, a trader in CATS or in the electronic system that is integrated with floor trading has the option of not disclosing to other investors that part of the order in excess of 5,000 shares. However, Toronto gives priority at a given price to disclosed orders, so that any undisclosed orders are executed only after the disclosed orders have been executed.

Like the U.S. market, there is an upstairs market that matches large trades. The rules of the Exchange require that these matched trades be executed on the exchange.[124]

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[122]A few actively traded issues, such as Petro Canada and TIPS (Toronto Index Participation Shares) are included in CATS.

[123]The office of John Carson at the Toronto Stock Exchange supplied this information.

[124]When the spread between the bid and offer is greater than the minimum tick size, the price of a matched order can be adjusted through offsetting changes in commissions to insure execution within the bid and the offer. To the extent that a cross occurs at a bid or an offer, the book must first be cleared, as on the NYSE.

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