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## *I. Introduction*

The once-venerable "efficient capital market hypothesis" (ECMH) crashed along with world capital markets in October 1987, but its resilience has nearly matched the resilience of those markets. Despite another market break in 1989, for example, the ECMH has continued to be reflexively heralded by numerous corporate and securities law scholars as an accurate account of public capital market behavior. Together with overwhelming evidence of excessive market volatility, however, these catastrophic market breaks revealed instinct infirmities in the ECMH that could hardly be shrugged off as mere anomalies.

In response to the ECMH's eroding descriptive and prescriptive power, capital market theorists found in noise theory an auxiliary explanation for these otherwise inexplicable catastrophes. Noise theory introduced a behavioral and psychological component to the stoical account of capital market behavior that the ECMH offered. Noise theorists attribute market breaks and excess volatility to irrational investors who overreact to the flow of information. By introducing this human dimension to capital market theory, noise theory marks a refreshing and important step toward a more realistic understanding of public capital market behavior. Yet noise theory ultimately constitutes only incremental tinkering with a model of capital market behavior that is fundamentally flawed. The ECMH, as modified by noise theory, is a reductive model—based on linear mathematics and reasoning—that attempts to oversimplify complex dynamics.

Chaos theory has of late assumed an original and pivotal role in the discussion and analysis of capital market behavior. By understanding

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markets as nonlinear systems, chaos theory introduces an entirely fresh perspective on capital market behavior, one which the linear perspectives of the ECMH and noise theory deeply obscure. This new perspective is important because while capital market ideas rooted in the ECMH and noise theory tell only part of the story of capital market behavior, they nevertheless have dominated academic discourse on state corporate and federal securities law, particularly in the perennial debate over the system of mandatory disclosure under the Securities Exchange Act of 1934 (1934 Act).

The disclosure debate centers on the broad and important question of whether the benefits of the disclosure system justify its costs. Although it has been notably inconclusive, the disclosure debate is particularly interesting in the way that its terms have been shaped by the methodology underlying the ECMH. That methodology relies on investigating the impact of discrete bits of firm-oriented information on securities prices through linear regression analyses. Both opponents and supporters of the 1934 Act's disclosure system have seemed content to fix the terms of the debate in this way, which implies that the central question is the swiftness and accuracy with which information covered by the mandatory disclosure system is reflected in stock prices. Thus, discussion at this level elevates the role of firm-oriented information in capital market price formation to nearly exclusive importance. Such a discussion obscures the importance of information in the microstructure of capital markets—market transparency and price discovery—that chaos theory subjects to close scrutiny.

This Article builds on the premise that the ECMH's linear methodology is primitive and advances the following thesis: Obsession with the ECMH, even by its detractors, has left overlooked a key connection between the process of price discovery and the role of the mandatory disclosure system. To this end, Part II first reviews a series of recent events, including the 1987 and 1989 market breaks and the emergence of noise theory, that have revealed the ECMH to be an inadequate account of public capital market behavior. This review also shows that the use of the ECMH in debate concerning mandatory disclosure ignores the importance of other determinants of price in public capital markets. Part II also argues that the use of event studies to assess the merits of alleged disclosure violations is misguided because such studies rely upon the ECMH and ignore the complexities of the price discovery process. Finally, Part II demonstrates that the noise theory critique of the ECMH points in the

direction of these greater complexities, but has not been taken to its logical conclusion.

Part III introduces chaos theory. By confirming that capital markets are nonlinear systems, chaos theory's nonlinear perspective departs from the prevailing efficiency/noise frame of reference. Part III shows that chaos theory's perspective tends to support the existing mandatory disclosure system. More importantly, Part III suggests that information concerning price discovery is equally critical. Part IV, therefore, looks beyond the role of fundamental firm-oriented information covered by the mandatory disclosure system and toward information in the market microstructure. That investigation confirms the implausibility of the ECMH and calls for rejecting evaluations of the mandatory disclosure system based on the ECMH's simplified reductive techniques. Part V argues that greater linkage is necessary between price discovery and our understanding of the 1934 Act's mandatory disclosure system and the methods of policing violations of the Act. To develop an understanding of this overlooked connection requires further research into chaos theory, which this Article urges the Securities and Exchange Commission (SEC) to initiate.

## *II. Efficiency and Mandatory Disclosure*

The proper scope of the mandatory disclosure rules has been debated almost continually since the enactment of the 1934 Act.[1] While the express purpose of the Act is to prevent fraud against investors in financial assets,[2] this purpose has been subjected to substantial academic criticism. The criticism intensified as legal theorists began to recognize the implications of the ECMH, which was understood to provide nearly all the protection that investors needed.[3] The evidence supporting the ECMH was particularly attractive to many economists, who developed a fairly simple reductive

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1. *See* 1 LOUIS LOSS & JOEL SELIGMAN, SECURITIES REGULATION 171-73 (3d ed. 1989). *See generally* HOMER KRIPKE, THE SEC AND CORPORATE DISCLOSURE (1979); Steve Thel, *The Original Conception of Section 10(b) of the Securities Exchange Act*, 42 STAN. L. REV. 385 (1990).

2. *See* Randall v. Loftsgaarden, 478 U.S. 647, 664 (1986) ("Congress' aim in enacting the 1934 Act was not confined solely to compensating defrauded investors. Congress [also] intended to deter fraud and manipulative practices in the securities markets . . . .").

3. *See generally* Frank H. Easterbrook & Daniel R. Fischel, *Mandatory Disclosure and the Protection of Investors*, 70 VA. L. REV. 669 (1984).

theory as to why public capital markets are efficient. The evidence showed changes in stock price to be uncorrelated over time. The ECMH explained this evidence by finding that information—which was assumed to be produced randomly—was rapidly and accurately impounded into stock prices.[4]

Many legal theorists understood this view of capital market behavior to refute the proposition that the federal mandatory disclosure system could be bottomed on the goal of investor protection. If the public capital markets are efficient in a strong or even semi-strong sense, these proponents argued, then compulsory disclosure is unnecessary. Under this view, private incentives should be adequate to encourage the production or discovery and dissemination of information important to investors. Given these incentives, the process of information discovery and efficient price incorporation would provide adequate investor protection and would eliminate the need for any regulatory regime.[5]

Justifications for the mandatory disclosure system also used the ECMH as a baseline. The public goods rationale of that system, for example, views information as a public good, the production of which will benefit free riders. As a result, under a voluntary system of disclosure or under a state-by-state system, information will not be produced in optimal amounts.[6] Despite the desire to protect investors, this public goods rationale for the federal system of mandatory disclosure is largely utilitarian. A variation on this theme contends that it is unnecessary to identify third-party effects in order to defend federal mandatory disclosure rules because even without third-party effects, registrants cannot be expected to produce optimal amounts of information for investors.[7] Each version of this theme rests on the implicit premise that the information mandatorily disclosed would be swiftly and accurately reflected in stock prices.

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4. For the intellectual history of the random walk model, the ECMH, and related capital market theories, see Lawrence A. Cunningham, *From Random Walks to Chaotic Crashes: The Linear Genealogy of the Efficient Capital Market Hypothesis*, 62 GEO. WASH. L. REV. 546 (1994).

5. For a summary of these arguments, see ROBERTA ROMANO, THE GENIUS OF AMERICAN CORPORATE LAW 91-96 (1993).

6. *See* FRANK H. EASTERBROOK & DANIEL R. FISCHEL, THE ECONOMIC STRUCTURE OF CORPORATE LAW 290-91 (1991).

7. *See generally* John C. Coffee, Jr., *Market Failure and the Economic Case for a Mandatory Disclosure System*, 70 VA. L. REV. 717 (1984).

While many legal theorists have invested tremendous confidence and intellectual capital in the ECMH (though with varying degrees of enthusiasm), a recent series of confounding events has frustrated its usefulness as a tool of public and legal policy-making: World capital markets crashed in 1987 and broke in 1989, but the ECMH could not explain why;[8] noise theory emerged to offer more plausible accounts of such breaks and other market phenomena that the ECMH could not explain, such as excess volatility;[9] and the invocation of the ECMH in deregulatory reforms proved to be more rhetorical than real.[10] In addition, when the ECMH finally succeeded in influencing the United States Supreme Court in *Basic Inc. v. Levinson*,[11] ECMH devotees responded with as much discontent as satisfaction.[12]

Legal theorists devoted to the ECMH have had great difficulty in responding to these complications. Indeed, thus far it has been impossible to offer an adequate response to the phenomena of market breaks and excess volatility,[13] and there has been no showing that the use of the ECMH in practice has been much more than a rhetorical one.[14] To date,

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8. *See* Daniel R. Fischel, *Efficient Capital Markets, the Crash, and the Fraud on the Market Theory*, 74 CORNELL L. REV. 907, 915 (1989) ("To date, no convincing explanations of [the 1987 crash] exist.")

9. *See* Andrei Shleifer & Lawrence H. Summers, *The Noise Trader Approach to Finance*, J. ECON. PERSP., Spring 1990, at 19, 29-30. *See generally* ROBERT J. SCHILLER, MARKET VOLATILITY (1989).

10. *See* Donald C. Langevoort, *Theories, Assumptions, and Securities Regulation: Market Efficiency Revisited*, 140 U. PA. L. REV. 851, 876-89 (1992).

11. 485 U.S. 224 (1988).

12. *See generally* Jonathan R. Macey et al., *Lessons from Financial Economics: Materiality, Reliance, and Extending the Reach of* Basic v. Levinson, 77 VA. L. REV. 1017 (1991).

13. Many have attempted to "reconcile" the 1987 crash with the ECMH. *See* Cunningham, *supra* note 4, at 593 & n.243 (citing sources); *see also* Mark L. Mitchell & Jeffry M. Netter, *The Role of Financial Economics in Securities Fraud Cases: Applications at the Securities and Exchange Commission*, 49 BUS. LAW. 545, 557 n.87 (1994) (citing Charles J. Jacklin et al., *Underestimation of Portfolio Insurance and the Crash of October 1987*, 5 REV. FIN. STUD. 35 (1992); Mark L. Mitchell & Jeffry M. Netter, *Triggering the 1987 Stock Market Crash: Antitakeover Provisions in the Proposed House Ways and Means Tax Bill?*, 24 J. FIN. ECON. 37 (1989)).

14. Although no formal response has been made to the claim—most cogently elaborated by Donald Langevoort, *supra* note 10—that the ECMH has been used only rhetorically,

the responses that have been offered to the other two complications—*Basic* and noise theory—have succeeded less in reviving the validity of the ECMH as a useful policy tool than in revealing additional difficulties in invoking the prevailing capital market theory for policy analysis. Moreover, while these confounding events suggest the need for an entirely new approach to understanding capital market behavior, responses to date have continued to focus on the role of firm-by-firm mandatory disclosure obligations under the 1934 Act and the overriding importance of the information that the Act has traditionally covered.

### *A. Event Studies*

In *Basic Inc. v. Levinson*, the Supreme Court decided that the primary insight of the semi-strong form of the ECMH—"that the market price of shares traded on well-developed markets reflects all publicly available information"[15]—could serve as the basis for presuming that traders in a particular security satisfy the reliance requirement in a fraud action with respect to that security.[16] Theorists who support the ECMH as a policy tool responded to *Basic* by urging the use of event studies in lawsuits alleging violations of the 1934 Act's mandatory disclosure rules.[17]

This recommendation followed from two oddly coupled premises. First, ECMH supporters responded to *Basic* by taking the position that it was unworkable to have the existence of an efficient market serve as a basis for satisfying the reliance requirement in securities fraud cases.[18] This argument rested largely on the claim that demonstrating market efficiency

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some scholars, such as Mark Mitchell and Jeffry Netter, have shown how the SEC has used the ECMH in event studies. *See* Mitchell & Netter, *supra* note 13, at 572-84.

15. Basic Inc. v. Levinson, 485 U.S. 224, 246 (1988).

16. *Id.* at 247.

17. Advocates of the ECMH also urge its usefulness in other contexts arising under the 1934 Act's mandatory disclosure regime, such as insider trading rules. *See generally* JONATHAN R. MACEY, INSIDER TRADING: ECONOMICS, POLITICS, AND POLICY (1991).

18. *See generally* William J. Carney, *The Limits of the Fraud on the Market Doctrine*, 44 BUS. LAW. 1259 (1989); Macey et al., *supra* note 12; Jonathan R. Macey & Geoffrey P. Miller, *The Fraud-on-the-Market Theory Revisited*, 77 VA. L. REV. 1001 (1991) [hereinafter Macey & Miller, *Revisited*]; Jonathan R. Macey & Geoffrey P. Miller, *Good Finance, Bad Economics: An Analysis of the Fraud-on-the-Market Theory*, 42 STAN. L. REV. 1059 (1990).

was too difficult.[19] Second, the same efficiency theory was nevertheless used to advocate the "truth in the market" defense. This defense neutralizes the presumption of reliance on the market by demonstrating that truthful information supplied from outside the firm negated the price effect of the fraud.[20]

Following these two premises, the use of event studies has been formalized as a way to sort out which information dominated market price—the fraud or the truth—and has been expressly advocated as a method of determining whether a misstatement or omission was material.[21] In other words, it is argued, event studies can be used to evaluate whether alleged violations of the mandatory disclosure rules are well-founded.

Event studies are complex models that seek to test how particular information affects prices.[22] Legal theorists have attempted to present these models in the following simplified way.[23] To conduct the test, the researcher identifies the fraudulent statement or omission in question (the "event"), defines the time period over which that statement was made or the omission occurred (the "event window"), and then compares the actual price change in that period with the price change that the researcher believes would have occurred in the absence of the event.[24]

While event studies may be important tools for many applications, their use in securities fraud actions—or indeed in any context evaluating legal rules—poses important risks that should be recognized, but often are not.

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19. *See* Macey et al., *supra* note 12, at 1021.

20. The truth in the market approach was developed in Daniel R. Fischel, *Use of Modern Finance Theory in Securities Fraud Cases Involving Actively Traded Securities*, 38 BUS. LAW. 1 (1982).

21. *See* Macey et al., *supra* note 12, at 1021 & n.14.

22. Eugene Fama and his colleagues pioneered event studies. *See generally* Eugene F. Fama et al., *The Adjustment of Stock Prices to New Information*, 10 INT'L ECON. REV. 1 (1969). For the current state of event study methodology, including evaluation of its scientific usefulness and identification of its complexities and weaknesses, see Eugene F. Fama, *Efficient Capital Markets: II*, 46 J. FIN. 1575, 1599-1602 (1991).

23. For a discussion of event study methodology, see Macey et al., *supra* note 12, at 1028-42. Mark Mitchell and Jeffry Netter have presented a more expanded discussion of event study methodology and its potential use in securities fraud actions. *See* Mitchell & Netter, *supra* note 13, at 556-84.

24. The researcher determines the price change that would have occurred in the absence of the event by using a linear pricing model such as the capital asset pricing model (CAPM) or the market model.

First, consider the joint hypothesis problem, which frequently arises in tests investigating the weak form of the ECMH. The problem arises because these tests simultaneously investigate market efficiency and a linear pricing model, such as the capital asset pricing model (CAPM). While it is widely recognized that linear pricing models are of uncertain validity, legal scholars who support the ECMH nevertheless contend that weaknesses in tests of linear pricing models do not impair the usefulness of event studies.[25]

This claim must be carefully considered. First, these empiricists claim that event studies *mitigate* the joint-hypothesis problem because the studies use daily stock returns.[26] That approach by no means removes the problem entirely, however. Indeed, event study methodology uses long-term stock price histories to forecast the performance that would have occurred absent a particular event whose impact on the stock price is being investigated.[27] The approach relies precisely on some linear pricing model.[28]

Second, the robustness of event studies depends on precision in defining and dating the event.[29] In the context of alleged disclosure violations, this requires both identifying the particular misstatement or omission and specifying the time period over which it could have had a market impact. While in many cases identifying the event in this context will be unproblematic, specifying the event window almost always will be problematic. For example, in establishing the opening and closing dates of

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25. *See* ROBERTA ROMANO, FOUNDATIONS OF CORPORATE LAW 62 (1993) ("The criticism of [tests for weak-form efficiency or pricing model tests] is inapposite to event studies because use of daily return data permits precise measurement of stock price responses and mitigates the joint-hypothesis problem.").

26. *See id.*

27. Roberta Romano notes:

> We begin with a model of how stock prices are normally generated, such as the CAPM. This enables us to determine whether a piece of information (an "event"), such as the announcement of a stock split, affects the stock price, for we can ask whether stock returns in the event period are different from what our pricing model predicted.

*Id.* at 60.

28. *See id.* ("Because . . . the CAPM is a linear model, the statistical technique employed is linear regression analysis, which fits the best line to the data.").

29. *See id.* at 62 ("When an information event can be dated precisely and the stock price effect is large, statistical inferences are robust across asset-pricing models.").

an event window in which to measure the effect of a discrete bit of information, there is a trade-off between choosing a window long enough to ensure the inclusion of all dates on which the bit may have been received by investors and short enough to avoid the infection of the study by other bits of information. Event study methodology calls such an infection a "confounding event."[30]

If market participants and market processes incorporate information into prices in the linear manner assumed by the model, the problem of confounding events might be ameliorated (it can never be eliminated). In fact, however, the behavior of the market and its participants is nonlinear rather than linear—information is not promptly and proportionally reflected in prices, but is absorbed intermittently over time in indeterminate ways.[31] As a result, it is virtually impossible to construct an event window that will not suffer from one or more confounding events.[32]

Third, event study methodology depends on the validity of the semi-strong form of the ECMH. The methodology assumes that choosing an event window closing date is "straightforward . . . [b]ecause the market absorbs and processes information rapidly."[33] Because this is, of course, the classical definition of the semi-strong form of the ECMH, a peculiar problem appears. According to some of its defenders, the use of event study methodology is necessary in securities fraud actions like *Basic* because proving market efficiency is unwieldy. Yet one must assume an efficient market to conduct the event study.[34] Consequently, a substantial leap of faith in the ECMH seems necessary.

In particular, faith in event studies requires reliance on the statistical models underlying the ECMH and its companion pricing models, such as the CAPM and the market model. All of these models are based on linear assumptions and calculations conducted with computer technology

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30. Macey et al., *supra* note 12, at 1030.

31. *See infra* notes 42-57 and accompanying text (discussing chaos theory and mandatory disclosure). *See generally* Cunningham, *supra* note 4.

32. *See* Mitchell & Netter, *supra* note 13, at 558-59 (giving "advice" on how to minimize confounding events).

33. Macey et al., *supra* note 12, at 1031.

34. Professors Macey, Miller, Mitchell, and Netter attempt to distinguish between market efficiency and the impact of particular statements on stock prices as revealed by event studies. *Id.* at 1021. Despite the effort, the reliability of the latter depends on the validity of the former.

introduced in the 1960s and 1970s. Current computer technology, which began to develop in the late 1980s, employs far more sophisticated, nonlinear mathematics and shows that the older studies are both obsolete and unreliable.[35] One obvious consequence of this discovery is to undermine event study methodology's assumption that stock returns are random variables that follow the normal distribution. This assumption is critical to using the methodology. Yet all agree that the assumption is not necessarily true, but is only a rough approximation.[36] Worse, this recent evidence even shows that the assumption is far less of an accurate "approximation" than previously believed.[37]

In short, the simple event study methodology usually presented by legal theorists as a way to evaluate alleged violations of federal mandatory disclosure rules masks difficulties that limit the technique's usefulness for legal analysis. But as important as are all of these technical limits to event study methodology—including the assumption of market efficiency—the approach assumes that the only information that matters to price formation is that information usually understood to be covered by the 1934 Act's mandatory disclosure system. In other words, the new emphasis on event studies in response to *Basic* rests on the implicit view that the only relevant information is that regarding companies and industries (and perhaps economies and world events as well). This view ignores, or implicitly assumes away as unimportant, information concerning the manner in which prices are discovered in capital markets.[38]

### *B. Noise Theory*

Beyond the tensions implied by the advocacy of event studies in response to *Basic*, in recent years legal theorists who support the ECMH have also been constrained to confront noise theory. Economists and others trying to understand market volatility and the 1987 and 1989 world market breaks recognized that the ECMH was inadequate and looked to noise

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35. *See generally* Cunningham, *supra* note 4.

36. *See* Mitchell & Netter, *supra* note 13, at 563.

37. *See generally* EDGAR E. PETERS, FRACTAL MARKET ANALYSIS (1994); EDGAR E. PETERS, CHAOS AND ORDER IN THE CAPITAL MARKETS (1991); Cunningham, *supra* note 4.

38. *See infra* notes 42-57 and accompanying text (discussing chaos theory and mandatory disclosure).

theory as an auxiliary account of public capital market behavior. Noise theory holds that public capital markets are plagued by substantial irrational trading that is based on psychological and emotional impulses unrelated to fundamental values. Hence, even though such markets may process information quickly ("informational efficiency"), they do not process information solely about fundamental values ("fundamental efficiency").

While legal theorists who support the ECMH cautioned that the Supreme Court's ruling in *Basic* was unworkable because efficiency is too hard to prove, they also warned that rejecting the ECMH could have "staggering implications."[39] The validity of the fundamental/informational distinction presented by noise theory, for example, would explode federal securities laws. If the distinction is valid, then no rationale can support mandatory disclosure rules because there can be no assurance that information—of any kind—will be meaningful to investors.[40] In other words, whereas strong efficiency claims suggest that mandatory disclosure rules are unnecessary, strong market noise claims suggest that such rules would be unhelpful or irrelevant.[41]

The implications of noise theory's insights extend far beyond the theory's fundamental/informational distinction, however. Noise theory does not imply only that irrational trading pervades public capital markets with the result that prices of capital assets are driven by information unrelated to fundamental values. Indeed, if this were the theory's most important insight, then its contribution to capital market theory might be seen merely as marginal. For example, under this view, the ECMH and noise theory would simply represent two points on a continuum defined by relative efficiency and relative rationality. The ECMH assumes rationality and insists on the presence of at least substantial fundamental efficiency, whereas noise theory assumes irrationality and alleges that informational efficiency dominates fundamental efficiency. In this sense, therefore, noise theory is simply a variation on the theme of the semi-strong form of the ECMH. As Part III will demonstrate, however, the more important

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39. Macey & Miller, *Revisited*, *supra* note 18, at 1013.

40. *See id.* at 1014.

41. *See* Langevoort, *supra* note 10, at 881; *see also* JAMES D. COX ET AL., SECURITIES REGULATION: CASES AND MATERIALS 686 (1991) ("One may simultaneously accept the noisiness of prices and still believe that formalized disclosure (e.g., delivery of a full prospectus) to the broad community of investors is not cost-justified with respect to larger companies about whom a large body of information is always accessible to investors.").

implication of noise theory is that it reveals markets to be nonlinear systems, to which the linear mathematics and reasoning that underlie the ECMH are inapposite.

## *III. Chaos Theory and Mandatory Disclosure*

Chaos theory is one of the most widely discussed new paradigms in American thought. Chaos theory originated in the study of physics to describe complex systems that have the appearance of irregularity and randomness, but that upon careful inspection reveal order and pattern. Consequently, the term is a misnomer. A chaotic system is one that seems random on the surface (as when investigated using linear techniques), but that turns out to be nonrandom upon more critical inspection (as when investigated using sophisticated techniques applying nonlinear mathematics).

### *A. Linearity and Capital Market Theory*[42]

The ECMH is based on linear mathematics and reasoning. In this context, linearity simply means proportionality—a change in one variable will produce a proportionate change in another specified variable. There are two senses in which the ECMH is a linear notion. First, the statistical models underlying the ECMH are simple linear regression analyses calculating correlation coefficients, which are statements about how variables are related on a straight-line basis over time. In other words, a time series of stock price data is tested for correlation by fitting a straight line to the data and then calculating the correlation coefficient.

Second, the chief insight underlying the ECMH is linear in the sense that the ECMH defines a proportional relationship between information changes and price changes. In particular, the semi-strong form posits that information is swiftly incorporated into prices without bias. In effect, the ECMH abstracts above the processes by which price formation actually occurs and holds that the market acts as if only fundamental information counts—information is digested rapidly and without bias and is rendered useless once traded upon. Under this model, market prices equal fundamental values precisely because of the proportional relationship between information changes about underlying real asset values and the

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42. For a discussion of the effect of linearity and capital market theory on the mandatory disclosure debate, see generally Cunningham, *supra* note 4.

resulting price changes in the financial asset that represents those real assets.[43]

Noise theory agrees that information is digested rapidly and rendered useless once traded upon, but noise theory identifies some imperfections in the nature of the information so digested that lead to pricing biases. As a result of this fundamental/informational distinction, prices depart from fundamental values. But noise theory and its fundamental/informational distinction also reveal public capital markets to be nonlinear systems, which constitute a feedback system in which individuals alone and in the aggregate may overreact to information or may withhold action until some additional information has been produced. Feedback processes such as these are hallmarks of a nonlinear system because they indicate a nonproportional relationship between a cause and its effect (for example, between news and price changes).[44] Whereas noise theory attributes this nonlinearity to irrational behavior, chaos theory takes a broader view that incorporates this insight and extends beyond it.

Adopting a nonlinear perspective, chaos theory rejects the linear ECMH claim that public security prices behave randomly and holds instead that there is a pattern to the seeming randomness of public security price behavior. In practical terms, chaos theory agrees with both the ECMH and noise theory that information is digested rapidly. Chaos theory also agrees with noise theory that neither the process nor the result is directed purely by fundamental information. However, it disagrees with both the ECMH and noise theory in their belief that information is rendered immediately useless once traded upon. Empirical studies applying the nonlinear

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43. Note the circularity of the ECMH's foundations: The hypothesis is a linear one, and the tests of the hypothesis are also linear.

44. Nonlinearity means the absence of proportionality—changes in one variable produce a change in another variable, but not necessarily a proportional change. Noise theory teaches and explains that in the context of the ECMH, the market may react slowly or may overreact to particular information changes about a given security. More importantly, statistical models showing evidence of nonlinear dependence are possible precisely because of a lack of proportionality between information changes and price changes. The distinction between nonlinear and linear is important because observing linear autocorrelation coefficients that are not significantly different from zero—which is the fundamental basis of the empirical support for the ECMH—does not prove that the time series data under investigation are not dependent. Rather, nonlinear dynamics could be present and, if present, the series will be dependent. That implies that the system is not random, as the ECMH claims.

techniques of chaos theory show that information is not immediately absorbed by market prices, as the ECMH and noise theory both predict; rather, such information remains useful for periods of up to four years.[45]

Chaos theory thus reconceptualizes what noise theory has identified as informational efficiency. Chaos theory holds that the operative information that justifies the distinction between informational and fundamental efficiency renders that distinction precisely antithetical to the existence of fundamental efficiency. Because all information (fundamental or otherwise) is digested by market participants, but is not rapidly impounded into market prices, it ineluctably follows that such information is of critical importance. Building upon the earlier insights derived from the ECMH and noise theory, chaos theory also presents dramatic improvements in those models. First, as noted, chaos theory shows that information has continuing value even after being first traded upon, with the result that even the weak form of the ECMH is subverted.[46] Second, this continuing value in turn implies the strong possibility that there are underlying macroeconomic, structural, and technical forces that operate in systematic ways on security market behavior and prices and that would undoubtedly include the mechanisms of market price discovery.[47]

### *B. Implications for Mandatory Disclosure Debate*

Recall that while strong claims of market efficiency sometimes suggest that securities regulation is unnecessary, strong claims of market noise suggest that such regulation is sometimes unhelpful and irrelevant. Thus, the ECMH has been invoked to deny any justification for mandatory disclosure rules,[48] and noise theory can be read to hold that information

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45. *See* Cunningham, *supra* note 4, at 573-76, 589-90 (discussing Edgar Peters's rescaled range analysis studies and Lyaponov Exponent studies that show that public capital markets have average cycle length of approximately four years).

46. *See infra* notes 58-125 and accompanying text (discussing price discovery in market microstructure).

47. Those macroeconomic, structural, and technical forces also include such factors as market sensitivity to investor time horizons. *See generally* Cunningham, *supra* note 4. Such factors are neither directly related to fundamental values nor tied to irrational behavior.

48. *See* ROMANO, *supra* note 5, at 91-96; Jonathan R. Macey, *Administrative Agency Obsolescence and Interest Group Formation: A Case Study of the SEC at Sixty*, 15 CARDOZO L. REV. 909, 927-37 (1994).

so disclosed is unhelpful to investors because of the prevalence of irrational trading.[49] As a result, both the ECMH and noise theory have difficulty in defending the existing mandatory disclosure system. However, because they are founded on the fragile reference points of relative efficiency and relative rationality from which chaos theory breaks away, their prescriptive force should be discounted.

Chaos theory holds that public capital market phenomena that seem random (efficient) are in fact nonrandom and internally dependent.[50] Chaos theory also suggests that behavior or action that may appear to be irrational (noisy) may well be rational because it occurs in a system that is inherently nonlinear.[51] According to this view, fundamental information of a firm-oriented nature is still critical to investors. However, the effect of the creation and release of new fundamental information is not discrete or linear. Rather, bits of information in effect react to one another; therefore, each bit is only a contribution—though an indispensable one—to a more complex systemic process. In other words, the market's treatment of a discrete bit of information simultaneously takes into account the systemic changes that that information implies.[52]

The impact of discrete bits of information on markets therefore should not be evaluated by simplified techniques constrained by a linear frame of reference. Although measuring the market's treatment of an incremental bit of information on its own discrete terms may be theoretically possible, such an account is necessarily incomplete because the market is simultaneously treating (or deciding not to treat) other information. Accordingly, by isolating discrete bits of information from other informational variables—whether fundamental, macroeconomic, technical, noisy, or structural—the impact of a discrete bit of information measured by simple linear equations used in event studies necessarily will be distorted.

Chaos theory's insight that public capital markets are nonlinear systems also gives context to the long-recognized fact that firm-oriented information is the least important kind of information that affects public securities

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49. *See* Langevoort, *supra* note 10, at 881.

50. *See* Cunningham, *supra* note 4, at 582.

51. *See id.*

52. Moreover, trades are often made without regard to current changes in information. *See* Robert A. Schwartz, *Competition and Efficiency, in* MODERNIZING U.S. SECURITIES REGULATION (Kenneth Lehn & Robert W. Kamphuis, Jr. eds.) 383, 388 (1992) ("[P]rice changes are not caused by informational change alone.").

prices.[53] Far more important is information concerning the industry in which a firm operates, the structure of the market in which the security is traded, and macroeconomic conditions.[54] Further, as noted, all of this information has value even after market participants first act upon it.[55]

Several existing disclosure rules reflect the intuition that factors other than firm-oriented fundamental information bear strongly on public securities prices. These factors include disclosure concerning the absence of a trading market for the securities, the kinds of listing arrangements (if any) that have been made for the securities, and the extent to which the registrant or any security holder of the registrant holds shares available for future sale. None of this information reflects or relates to fundamental information concerning a registrant's business or financial condition. Each of them, however, clearly affects the probable performance of the security's price.

Even these modest disclosure rules may not be defensible within an ECMH or noise theory framework. As noted, however, chaos theory calls into serious doubt the basis for rejecting mandatory disclosure rules under the ECMH and noise theory. First, chaos theory's nonlinear perspective shows that the linear perspectives underlying the ECMH and the CAPM are inadequate bases to test the responsiveness of price to information flows. Second, chaos theory also suggests that noise theory is a somewhat crude account of more subtle and complex systemic processes. With respect to both the ECMH and noise theory, information should not be understood as being accurately or swiftly impounded into prices. Rather, there are both biases and lags.

This critique does not imply that chaos theory answers the critical question of whether the federal mandatory disclosure system can survive a cost-benefit analysis. Indeed, neither the ECMH, noise theory, nor chaos theory alone can answer that question because none can answer the prior question of whether registrants would produce optimal amounts of information voluntarily. However, the most widely (though not universally) accepted view is that firms are not likely to disclose voluntarily, whether because of third-party effects or otherwise.[56]

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53. *See* KRIPKE, *supra* note 1, at 24 (citing 1966 study).

54. *See id.*

55. *See supra* note 45 and accompanying text (noting four-year cycle of usefulness of information).

56. *See* Coffee, *supra* note 7, at 737-47; Easterbrook & Fischel, *supra* note 3, at 685-87.

Even if one accepts this proposition, however, the question of whether the federal mandatory disclosure system is defensible on cost-benefit grounds remains unanswered.[57] The ECMH and noise theory still may imply that the system is unlikely to survive a cost-benefit analysis, at least for large, widely followed companies. In contrast, however, the complexities revealed by chaos theory render the answer far more uncertain. The information lags and biases revealed by the nonlinear structure of public capital markets suggest that information is important and has great value over time. This revelation demands some investigation before any conclusions can be drawn about the cost-benefit question. Although the ECMH and noise theory give us no reason to concern ourselves with the process of price formation in the market microstructure, these insights from chaos theory mandate studying it closely. As Part IV shows, the price discovery process in the market microstructure demonstrates that the ECMH is false, even in its weak form, and that insights from chaos theory promise a superior explanation of public capital market behavior.

### *IV. Price Discovery in the Market Microstructure*

The ECMH assures us that securities have intrinsic value in the sense that the market price of a security defines what the security is worth. If this were true, it would be possible to calculate the value of a security in the abstract, without regard to the interests of potential buyers and sellers of that security. In fact, the prices of public securities are not determined by such abstract analyses, but are instead determined solely as the result of traders' orders meeting in the market.[58] The process by which market traders interact constitutes *price discovery*. Only through this process may it be possible for the market to generate prices that equal fundamental values. Due in part to widespread belief in the ECMH, the importance and complexity of accurate price discovery is often overlooked, although it is critical.[59]

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57. Indeed, it is perhaps an unanswerable question.

58. *See* Schwartz, *supra* note 52, at 386-87.

59. Robert Schwartz notes:

> [O]ur markets are not maximally efficient. Unfortunately, the prevailing academic opinion is that markets are efficient. However, with intraday price, quotation, and volume data becoming increasingly available to both practitioners and academic researchers, statistical evidence is beginning to emerge that prices are excessively volatile in short time intervals, that price discovery is imperfect,

Accuracy of price discovery depends in large part on *market transparency*, the extent to which traders make order flows publicly known and disclose orders, quotes, and trades.[60] In continuous markets like the National Association of Securities Dealers Automated Quotations (NASDAQ) and the New York Stock Exchange (NYSE), market transparency is limited, and limited market transparency interferes with accurate price discovery.[61] Market transparency is further obscured by *market fragmentation*, which occurs primarily as a result of the channeling of order flows through numerous markets. Market fragmentation is further compounded by the *immediacy* of markets, which enables trades to be made continuously throughout the trading day.[62]

Price discovery mechanisms in the market microstructure—and the subsidiary issues of transparency, fragmentation, and immediacy—influence trader actions to at least as great a degree as information flows influence investor actions.[63] As a result, inquiries concerning the justifiable scope of the mandatory disclosure system, as well as evaluating the merits of alleged violations of mandatory disclosure rules, must acknowledge and account for the importance of price determination in the market microstructure.

There is vigorous debate among financial economists and others as to whether it is necessary, possible, or desirable to minimize the existence

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and that trading costs are unduly high.

*Id.* at 384.

60. *See id.* at 386; *see also* Corinne M. Bronfman, *If It Ain't Broke, Don't Regulate It, in* MODERNIZING U.S. SECURITIES REGULATION, *supra* note 52, at 407, 409.

61. *See* Schwartz, *supra* note 52, at 385. Price discovery in continuous markets is obscured because (a) in quote-driven markets like NASDAQ, public participants do not place priced orders (instead, dealers post quotes at which the public may trade), and (b) in order-driven markets like the NYSE in which public participants commonly use limit orders to establish the price at which their transactions will be executed, those limit orders are then used to establish the price at which other public participants may trade. *Id.*

62. *See id.* at 384; *see also* Hans R. Stoll, *Organization of the Stock Market: Competition or Fragmentation?, in* MODERNIZING U.S. SECURITIES REGULATION, *supra* note 52, at 399, 402-03. Moreover, the immediacy of trading offered in continuous markets often contributes to market imperfections through higher trading costs, including the costs of the bid-ask spread, the market impact costs of particular trades, and the costs of commissions. Schwartz, *supra* note 52, at 389.

63. *See* Schwartz, *supra* note 52, at 388-89.

or consequences of market opaqueness, fragmentation, and immediacy.[64] The debate is vigorous in part because a number of competing goals are at stake, including not only market efficiency, but also market fairness, competitiveness, and linkage. Pursuing these goals by altering the nature of the market microstructure involves some trade-offs. For example, increased transparency might improve efficiency but simultaneously impair fairness. Additionally, minimizing fragmentation may improve linkage between markets but simultaneously impair competitiveness.

This Article does not pretend to resolve this vigorous debate or any aspect of it. Instead, it embraces two more modest goals. First, the following analysis of price discovery, a central part of this debate, is intended to illustrate the importance of the market microstructure in determining the price of public securities. This Article demonstrates that the process of price discovery contradicts the ECMH's prediction that prices are random and shows instead that the process supports chaos theory's prediction—and accompanying empirical evidence—that prices exhibit nonlinear dependence. Second, the succeeding discussion relates this result back to the discussion of the federal mandatory disclosure system and the limitations of noise theory, event studies, and the ECMH in evaluating that system.

### *A. Property Rights and Evolving Markets*

A threshold issue in the debate concerning the mechanisms of price discovery in the market microstructure is: Whose information is it? Is information concerning price discovery—quotes, trades, and prices—the property of the exchanges or other markets through which it is generated, or is the information more properly characterized as public property? Early disputes over this question concluded that the exchanges themselves had property rights in the information.[65] More recently, however, this

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64. *See id.* at 385-92. Professor Schwartz has suggested that market opaqueness, fragmentation, and immediacy could be addressed by alternative market structures, such as call-market trading. *See id.* at 386, 389-91.

65. *See* Corinne Bronfman & James A. Overdahl, *Would the Invisible Hand Produce Transparent Markets?*, 19 J. CORP. L. (forthcoming 1994) (manuscript at 7, on file with author) (citing Board of Trade v. Christie Grain & Stock Co., 198 U.S. 236 (1905)). Corinne Bronfman and James Overdahl offer amusing anecdotes that demonstrate the lengths to which the exchanges have gone to protect information regarding price discovery and to which nonmember brokers have gone to uncover such information. One example is the

property right in information has been weakened, primarily by the establishment of the National Market System (NMS) in 1975.[66]

### *1. The National Market System*

The SEC established the NMS under a congressional mandate and in the name of efficiency, fairness, and market linkage.[67] Establishment of the NMS was prompted by growing opaqueness and fragmentation of the capital market structure, "in which multiple markets offering limited access traded the same securities without publicly disseminating quote and trade information."[68] In part through a system of comprehensive disclosure showing where and how to obtain the best execution for orders, the NMS sought to establish a market that would generate the best prices.[69] In establishing the NMS, the SEC abolished fixed commission rates, established a consolidated quotation system and transaction tape, and enhanced market linkage—all of which contributed to reducing transaction costs and increasing market transparency.[70] As noted, establishment of the NMS also weakened the exchanges' property rights in the information of price discovery.[71]

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Baker Blackout, during which the exchanges soaped their windows and nonmember brokers removed bricks from the exchange wall to observe trading action. *See id.* at 6-7 & n.9.

66. *See* Securities Acts Amendments of 1975, Pub. L. No. 94-29, § 7, 89 Stat. 97, 111-17.

67. *See* Market 2000: An Examination of Current Equity Market Developments, [Current Transfer Binder] Fed. Sec. L. Rep. (CCH) ¶ 85,311, at 85,030 (Jan. 27, 1994) [hereinafter Market 2000 Study].

68. *Id.* Establishment of the NMS was also motivated in substantial part by political pressure to address a number of anticompetitive practices—including fixed commission rates—that emerged as the result of substantial self-regulation of stock exchanges. *See* COX ET AL., *supra* note 41, at 1284-85.

69. Market 2000 Study, *supra* note 67, at 85,030 (discussing establishment of NMS in Securities Acts Amendments of 1975).

70. *See* Bronfman & Overdahl, *supra* note 65, at 7; Roberta S. Karmel, *The Market 2000 Study*, N.Y. L.J., Oct. 15, 1992, at 3, 3.

71. *See supra* text accompanying note 66. Viewing public securities markets within a public goods framework has often been criticized. *See* J. Harold Mulherin, *Market Transparency: Pros, Cons, and Property Rights, in* MODERNIZING U.S. SECURITIES REGULATION, *supra* note 52, at 375, 379-80.

Great controversy has surrounded both the establishment and the implementation of the NMS. Many have criticized the SEC (and Congress) for failing to state clearly the precise mission to be accomplished by the creation of the NMS and for failing to explain how particular regulations were designed to further any such mission. The fundamental policy question that the SEC has not expressly answered is whether erecting and maintaining a single, regulated market is more desirable than permitting competition to flourish.[72] Instead, the SEC has taken a middle position by adopting an "evolutionary" approach to the subject of the structure of the U.S. equity markets.[73]

The SEC's middle ground is reflected in its pragmatic approach to defining property rights in market information. The SEC has taken the position that information concerning price discovery is public information, but has done so in the name of market competition.[74] Under the NMS, for example, the SEC promulgated its "firm quotation rule," which requires the National Association of Securities Dealers (NASD) "to make available

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72. *See* COX ET AL., *supra* note 41, at 1286-89 (citing, among other criticisms, Jonathan R. Macey & David D. Haddock, *Shirking at the SEC: The Failure of the National Market System*, 1985 U. ILL. L. REV. 315, 337-41; Norman S. Poser, *Restructuring the Stock Markets: A Critical Look at the SEC's National Market System*, 56 N.Y.U. L. REV. 883 (1981); Joel Seligman, *The Future of the National Market System*, 10 J. CORP. L. 79, 130-33 (1984); Walter Werner, *The SEC as a Market Regulator*, 70 VA. L. REV. 755 (1984)).

73. *See generally* Development of a National Market System, Exchange Act Release No. 14,416, [1978 Transfer Binder] Fed. Sec. L. Rep. (CCH) ¶ 81,502 (Jan. 26, 1978). The SEC has often been criticized for lacking any vision and has been viewed as vacillating in response to external pressure. *See* John C. Coffee, Jr., *The SEC and the Institutional Investor: A Half-Time Report*, 15 CARDOZO L. REV. 837, 876-92 (1994).

74. Participants in the debate over the NMS also argue the relative merits of the many different kinds of capital market structures in the United States. In the late 1970s, two visions prevailed, both of which were to be order-driven continuous-auction models: a stronger NYSE primary market in which all trades would interact or an electronic system in which all trades would be executed automatically at the best price. *See* Karmel, *supra* note 70, at 3. More recently, the quote-driven dealer model of the NASDAQ has been heralded by some as the optimal market structure. *See id.* In addition, some have argued that the call-auction model used by the Arizona Stock Exchange and other proprietary trading systems would best serve the interests of investors. *See* Schwartz, *supra* note 52, at 386 & n.5. As Roberta Karmel has observed, Congress has offered little guidance on the direction to be taken, and the SEC is unlikely to be able to move markets in any one of these directions. *See* Karmel, *supra* note 70, at 3. At best, the SEC can only tinker with the price discovery mechanisms in these evolving markets.

to information vendors full quotation information on those [over-the-counter] securities designated as NMS securities."[75] The SEC ruled in 1984 that in selling information to vendors, the NASD could collect fees for that information, but those fees could only be based on the NASD's costs of collecting and providing the information, not on the basis of the information's value to the vendors.[76] In short, the SEC's ruling, which followed a congressional mandate, "decreed that the prices produced by an exchange, once produced, were part of the public domain."[77] That position, in turn, was intended to encourage competition "among providers of trade-execution services to investors."[78] In effect, the SEC's position treats the information as private property affected with a public interest.[79]

### 2. *Continuing Evolution of the Equity Markets*

Since the establishment of the NMS, U.S. equity markets have changed substantially. Demographically, the number of individual investor trading accounts doubled between 1975 and 1990 (from twenty-five million to fifty-one million), although much of this individual participation is conducted through institutional intermediaries, such as pension and mutual funds.[80] Perhaps the change most widely noted by legal scholars has been the

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75. Bronfman & Overdahl, *supra* note 65, at 8 (citing S. REP. No. 75, 94th Cong., 1st Sess. (1975), *reprinted in* 1975 U.S.C.C.A.N. 179); *see* 17 C.F.R. § 240.11Ac1-1 (1993).

76. *See* Bronfman & Overdahl, *supra* note 65, at 8-9 (citing Exchange Act Release No. 20,874, 49 Fed. Reg. 17,640, 17,643 (Apr. 24, 1984)); *see also* National Ass'n of Sec. Dealers, Inc. v. SEC, 801 F.2d 1415, 1422 (D.C. Cir. 1986) (affirming SEC's administrative order that fees be cost-based).

77. Bronfman & Overdahl, *supra* note 65, at 9. By placing exchange-produced prices in the public domain, this approach, or at least the SEC's ruling, has been criticized on the ground that it views the NASD only as the "exclusive information processor" and ignores its status as "*the discoverer of market prices*." *Id.* Bronfman and Overdahl also report that the opposite is true for futures markets regulated by the Commodity Futures Trading Commission—information there is treated as private property. *See id.*

78. *Id.* at 10. The emergence of screen-based trading systems like Instinet and Portfolio Systems for Institutional Trading results from increased competition among providers of trade-execution services and results in lower costs of trading. *See id.* at 10-11.

79. In the separate-but-related context of municipal bonds, the SEC recently has proposed rules that would require the disclosure of bids, prices, markups, and related information regarded by many as proprietary.

80. Market 2000 Study, *supra* note 67, at 85,031.

institutionalization of the markets, in which institutions in 1992 owned slightly more than fifty percent of U.S. equities, up from thirty percent in 1975.[81] Perhaps the change least noted by legal scholars is the equally important increase in technological innovation. Technology in account handling and automation has matured rapidly in recent years. Innovations have affected the entire process of price discovery, and the most revolutionary innovations have come about through the automation of order entry, routing, execution, and reporting.[82]

Structurally, there has been a pronounced increase in trading on alternative markets that compete with the NYSE, the NASD, and the American Stock Exchange (ASE). Nevertheless, the NYSE and the ASE continue to serve as the primary forum of price discovery for listed securities in U.S. equity markets, and NASDAQ serves the same role for unlisted securities.[83] The five regional stock exchanges[84] compete with the NYSE and the ASE for order flow pursuant to grants of unlisted trading privileges.[85] Proprietary tradings systems—automated electronic trading networks called PTSs—also compete for the trade of stocks listed on the NYSE, the ASE, and the regional exchanges.[86] The competition for order

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81. *Id.*; *cf.* Coffee, *supra* note 73, at 837 & n.3.

82. The SEC's Division of Market Regulation notes:

> For example, a customer's order to buy 100 shares of a stock at the market price in 1975 could have taken up to an hour to travel from the branch office to the firm's trading desk, to the firm's broker on the floor of the exchange, to the specialist post, and back through the firm to the customer. Today the entire process—from the entry of the order to notification of the execution—can take less than a minute and is often completed while the customer is still on the telephone.

Market 2000 Study, *supra* note 67, at 85,031-32.

83. *Id.* at 85,032, 85,034. The NYSE still serves as the primary forum for price discovery for listed securities despite the decline in trading volume on the NYSE from 86% of all trades in 1981 to 67% in 1991. *See* Karmel, *supra* note 70, at 4.

84. The regional stock exchanges are the Boston, Chicago, Cincinnati, Pacific, and Philadelphia Stock Exchanges. Market 2000 Study, *supra* note 67, at 85,033.

85. *Id.* Orders are typically routed over the SEC-created Intermarket Trading System (ITS), through which they are exposed to other markets for trading interest. If no other market expresses an interest, then the order is executed at the highest quotation in the ITS. *Id.*

86. Professor Karmel notes:

> Proprietary trading systems collect indications of trading interest and rebroadcast them through one or more designated broker-dealers. Procedures for executing

flow is keen and reflects the substantial value of that order flow.[87] Competition for order flow for all stocks also comes from substantial trading through other means, including "fax trading" (the trading of U.S. equity securities on foreign markets).[88] The resulting market fragmentation has substantial implications for the price discovery process because it reduces market transparency and enables nonexchange markets to use exchange-produced market information at relatively low cost.[89]

### *B. Existing Levels of Transparency and Reform*

The SEC's Division of Market Regulation (the Division) recently released its study of the effect of changes in U.S. equity markets on the existing level of market transparency.[90] The study revisited the same questions originally posed by the establishment and implementation of the NMS and considered a number of prescriptions for regulatory reform, ranging from the strong interventionist approach of creating a "single market" to the deregulatory approach of substantially dismantling the SEC's oversight role.[91] As in the original establishment and implementation of

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> or settling transactions at volume and price levels are agreed upon, but the systems do not provide a guarantee or expectation of liquidity or embrace the traditional exchange notion of membership.

Karmel, *supra* note 70, at 4.

87. *See* Market 2000 Study, *supra* note 67, at 85,033.

88. *See id.* at 85,034.

89. In addition to the effects of market fragmentation on the price discovery process, trades in the burgeoning stock index futures market have also come to play an important role in price discovery. *See id.*

90. Market 2000 Study, *supra* note 67. The study was prompted by criticism from the General Accounting Office, which excoriated the SEC for failing to conduct a comprehensive review of the U.S. equity markets for over a decade. *See* Karmel, *supra* note 70, at 4 (citing U.S. GEN. ACCOUNTING OFFICE, SECURITIES TRADING: SEC ACTION NEEDED TO ADDRESS NATIONAL MARKET SYSTEM ISSUES 21, 33 (1990)). According to Professor Karmel: "The SEC's frustrations in trying to implement the 1975 Securities Acts Amendments have made the agency shy of market structure initiatives." *Id.* at 3-4. That "shyness" may explain why the connection between the mandatory disclosure system and the process of price discovery has not been seriously confronted, which is why Part V of this Article recommends that the SEC begin to study this overlooked relationship. *See infra* notes 126-28 and accompanying text.

91. *See* Market 2000 Study, *supra* note 67, at 85,036-37.

the NMS, the study rejected these polar positions and opted instead for a series of modulated reform proposals.[92]

In rejecting the strong interventionist position, the Division concluded that "the U.S. equity markets are not fragmented to the point that price discovery and liquidity have been adversely affected."[93] However, the Division also rejected an aggressive deregulatory program on the grounds that the existing regime represents a "carefully maintained equilibrium" that balances competitive forces on the one hand with the preservation of market integrity and the "needs of market users" on the other hand.[94]

In maintaining the current regime, the Division recommended a series of incremental reforms, including—most importantly—increased market transparency.[95] As noted above, market transparency denotes the "real-time dissemination of information about prices, volume, and trades."[96] The Division noted its belief "that transparency plays a fundamental role in the fairness and efficiency of the secondary markets. Transparency ensures that stock prices fully reflect information."[97] Transparency is critical to the existence of "an efficient price discovery mechanism."[98]

The Division's study emphasizes the crucial roles of market transparency and the price discovery mechanism in achieving market efficiency, the goal that the ECMH assures us has already been met. In particular, market opaqueness contradicts even the weak form of the ECMH, which holds that current market prices reflect all past prices, and implies precisely the opposite, for the requisite information is simply not as widely available as the ECMH necessarily assumes.

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92. *See supra* note 73 and accompanying text (explaining that SEC has taken "evolutionary" approach to reform).

93. Market 2000 Study, *supra* note 67, at 85,037.

94. *Id.*

95. In addition to transparency, the other prongs of the Division's recommendations focused on "fair treatment of investors, fair market competition, and market access." *Id.* at 85,038.

96. *Id.* at 85,039; *see* Mulherin, *supra* note 71, at 375 ("A perfectly transparent market would be an environment in which all relevant information including transaction prices, trading volume, quotes, order flow, and trader identification is instantaneously available to all potential investors. In many respects, therefore, a perfectly transparent market resembles the economist's notion of a perfectly competitive market.").

97. Market 2000 Study, *supra* note 67, at 85,039.

98. *Id.*

In short, the study's recommended changes (even if modest)[99] are a clear indication of skepticism about market efficiency. The need for these changes shows not only that the process of price discovery in U.S. equity markets is complex, but more importantly that the process cannot be relied upon to produce prices equal to fundamental values, despite the ECMH's predictions to the contrary. Furthermore, there can be no assurance that the proposed changes (or any other regulatory reforms or competitive forces) will advance the cause that the ECMH claims has already been achieved. Consequently, the proposed changes reinforce the need to understand the market microstructure when evaluating and enforcing mandatory disclosure rules. Consideration of a few principal issues that the study addressed demonstrates some of the ways in which existing price discovery processes do not assure the production of prices equal to fundamental values—in other words, that the ECMH is false.

*Display of Customer Orders.* Limit orders represent one of the primary means by which public customers instruct brokers to make stock trades. They are orders to buy or sell a security at a specific price.[100] At present, the exchanges (self-regulatory organizations or SROs) and NASDAQ do not disclose information with respect to limit orders, although the PTSs do.[101] The failure to display limit orders that are priced better than the best available quotes can "present an inaccurate representation of trading interest to other markets, thus contributing to fragmentation."[102] Moreover, because trades are usually made at the bid or ask price, the concealment of limit orders obscures the real price spread and therefore impairs accurate price discovery.[103] Of course, customers placing limit orders may prefer that they not be disclosed,[104] but it should be recog-

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99. *See* Karmel, *supra* note 70, at 4.

100. DIVISION OF MKT. REGULATION, U.S. SEC. & EXCH. COMM'N, SPECIAL REP. NO. 1271, THE OCTOBER 1987 MARKET BREAK 4-1 (1988). By contrast, market orders are orders to buy or sell a security at the best current market price. *Id.*

101. Market 2000 Study, *supra* note 67, at 85,039.

102. *Id.*

103. *See id.* Obscuring the real spread also creates the risk of enriching market makers at the expense of public customers. *Id.*

104. Many investors prefer nondisclosure of their orders and trades, in part to minimize the market impact of their trades. *See* Mulherin, *supra* note 71, at 378 ("This desire for anonymity is not peculiar to securities markets and also appears in settings as diverse as

nized that respecting that desire impairs accurate price discovery. The Division recommended balancing these interests by urging the SROs and NASDAQ to consider ways to increase the display of such orders.[105]

*Display of SelectNet Orders.* Related to the current narrow disclosure of limit orders is the narrow disclosure of orders through the SelectNet system. SelectNet is a screen-based trading system used by NASD members trading securities through automated systems.[106] Information transmitted via SelectNet is selectively displayed to only some market makers. The Division expressed concern about the "limited availability of information regarding SelectNet orders."[107] Like its recommendations to enhance disclosure of limit orders, the Division recommended broader dissemination of information conveyed through SelectNet, on the grounds that limited availability impairs transparency and therefore "frustrates competitive pricing."[108]

*Display of Nontraditional Trading.* The Division also called for greater transparency in connection with after-hours trading and trades in U.S. equity securities nominally executed abroad.[109] After-hours and off-shore trading have grown substantially in recent years, but existing reporting mechanisms do not accurately reflect such trading.[110] "Because full and accurate reporting of trades contributes to market efficiency and

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artwork and oil tankers."). Mandatory disclosure of limit orders could impair liquidity by making such investors reluctant to trade. *See id.*

105. *See* Market 2000 Study, *supra* note 67, at 85,039.

106. *Id.* at 85,040.

107. *Id.*

108. *Id.*

109. *See id.* at 85,041. Nontraditional, off-exchange trading has heightened the debate over transparency because as traditional exchanges become more transparent compared to other venues such as off-shore markets, more orders may flow to those other markets. This flow would increase fragmentation and ultimately impair overall transparency. *See* Mulherin, *supra* note 71, at 378-79. Transparency has also been the subject of vigorous debate among European exchanges. *See* Karmel, *supra* note 70, at 4.

110. *See* Market 2000 Study, *supra* note 67, at 85,041 ("In the first six months of 1993, approximately 17 million shares per day in NYSE and NASDAQ/NMS securities were executed after regular trading hours (half of which were faxed to off-shore trading desks for execution).").

fairness," the Division recommended developing a reporting system to reflect all such after-hours and off-shore trading.[111]

*Order Exposure Rule.* In addition to its recommendations directed toward greater market transparency, the Division also raised anew the desirability of an order exposure rule. Such a rule would require a market maker to guarantee the execution of a customer order at a proposed price and either bid publicly or offer the order at a better price before executing it.[112] The rule would increase the visibility of orders, although at some cost to market participants.[113] The NYSE has been considering an order exposure rule for over a decade, and the Division recommended further consideration of such a rule once its other recommendations concerning market transparency have been adopted.[114]

*Disclosure of Payment for Order Flow.* Dealers and specialists seek retail order flow from brokers by paying cash or offering other inducements to brokers, who in return direct orders to the dealers and specialists for execution.[115] Such payments or inducements may lead brokers to breach the fiduciary duty that they owe to their customers because the payments or inducements may impair best price execution for such orders.[116] The Division noted its belief that payment for order flow arises because competition for order flow on the basis of price quotations alone is inadequate.[117] The Division concluded that adoption of the transparency reforms discussed above would promote competition on the basis of quotations and thus would eliminate or minimize the need for direct intervention with respect to the practice of payment for order flow.[118] In addition, however, the Division recommended that disclosure of the practice

111. *Id.*; *see* Mulherin, *supra* note 71, at 379 ("One possible response in this current gap is to record the off-exchange trades on a run-off tape that would be consolidated with currently recorded transactions.").

112. Market 2000 Study, *supra* note 67, at 85,041.

113. *Id.* at 85,041-42.

114. *See id.*

115. *Id.* at 85,042.

116. *See id.*

117. *See id.*

118. *See id.*

of payment for order flow and the particular arrangements used to handle the orders appear on the customer confirmation and annual account statements.[119]

*Best Price Execution Generally.* The Division also generally emphasized the continuing obligation of brokers and dealers to achieve best price execution for customers.[120] To that extent, the Division recommended that brokers and dealers using automated trading procedures nevertheless continually monitor the quality of their execution methods to ensure that they are obtaining best execution of trades not only with respect to price, but also with respect to speed of execution.[121] Similarly, the Division recommended that markets and market makers offer price improvement devices on various markets.[122]

The foregoing issues highlight a number of imperfections in the market microstructure that impede price discovery and therefore interfere with any identity between the resulting market price and fundamental values. These imperfections not only reflect market disobedience to the ECMH, but also confirm the conclusion that neither the ECMH nor event studies should be

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119. *See id.* at 85,042-43 (citing Payment for Order Flow, Exchange Act Release No. 33,026, 58 Fed. Reg. 52,934 (Oct. 13, 1993)). Brokers often provide research and other services to investment advisors in exchange for brokerage commissions arising from trades in particular securities. These "soft dollar" arrangements relate primarily to institutional transactions rather than to retail trades. As with payment for order flow, soft dollar arrangements can also impair best execution of investor trade orders. *See id.* at 85,043. Consequently, the Division recommended full disclosure of such arrangements to affected customers. *See id.*

120. *See id.*

121. *Id.*

122. The Division stated:

> Auction principles dictate that trades in exchange-listed securities will be effected so that the orders will be exposed to other public orders or interest in a trading crowd, with the possibility that the order may receive a price that is better than existing quotations. Automated, quote-based executions for listed securities discard the possibility of price improvement for speedier executions. Some regional exchanges and third market dealers have incorporated order exposure and price improvement features into their small order execution systems to address this concern.

*Id.* at 85,043-44.

given a prominent place in the discussion or the enforcement of the mandatory disclosure system.

One final issue concerning market pricing systems leaves no doubt about this conclusion. NYSE stocks are currently quoted and traded in prices broken down to one-eighth of a dollar.[123] How can one argue that market prices accurately reflect fundamental values when prices are broken down in increments of only 12.5 cents per share? Although the average price of stocks traded on the NYSE may be sufficiently high so that 12.5 cents is not a material percentage of the price, disputes concerning the valuation of NYSE companies often are fought—at great expense—down to the last penny.[124] While one should not make too much of this point, it does indicate—when taken together with the other issues raised by the Division's study—that a strong agnostic stance toward the ECMH and event studies is warranted, particularly in mandatory disclosure discussions.

Whether the Division's reform proposals, which are modest and largely precatory, will succeed in promoting competition, fairness, and efficiency remains to be seen. The implied balance of regulatory reform and competitive forces may be the proper approach to the questions of price discovery, fragmentation, and market transparency. That important issue, however, is beyond the scope of this Article.[125] The existing structure—or, for that matter, any structure that emerges through regulatory reform or competitive forces—is not likely to make the process of price discovery materially more pure than it is. As a result, exposure of the underlying issues addressed by the Division's study illustrates a broader

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123. The Division recommended the elimination of the prevailing one-eighth pricing system in order to enhance intramarket transparency. *See id.* at 85,039-40. The Division also noted its belief that a decimal pricing system is "preferable and may be inevitable." *Id.* at 85,040. According to the Division, the existing system poses problems for accurate price discovery because its "minimum variation can cause artificially wide spreads and hinder quote competition by preventing offers to buy or sell at prices inside the prevailing quote." *Id.* at 85,039.

124. On the ASE, prices are reported in increments of one-sixteenth; on NASDAQ, prices are reported in increments of one-thirty-second for stocks bid at less than $10. *Id.* at 85,039 n.43. Following the release of the study, the NASD changed its pricing increment to one-sixty-fourth, much to the dismay of many traders. *See* William Power, *Informal Poll Shows Nasdaq Policy Upsets More Than 32/64 of Traders*, WALL ST. J., Apr. 8, 1994, at B1.

125. For an introduction to the terms of that debate and a framework within which it may be analyzed, see generally Bronfman & Overdahl, *supra* note 65.

point: that discussion and analysis of the mandatory disclosure system should be linked to an understanding of the complexities and imperfections of the price discovery process.

## V. *Linking Mandatory Disclosure and Price Discovery*

Apart from the issue of whether competition, regulation, or a balanced mixture of both will best serve the public interest, the importance and complexity of price discovery underscores the problem that one confronts in evaluating the 1934 Act's mandatory disclosure rules by reference to the ECMH and without reference to the market microstructure. The Division's study and its reform proposals, as well as the vigorous debate on the subjects discussed above, emphasize the importance of the market microstructure to accurate price discovery. While the ECMH and noise theory seem oblivious to the importance of this factor, chaos theory mandates taking it into account. Thus, it is worthwhile to consider the state of research on chaos theory and to postulate a program through which chaos theory might equip market scholars and practitioners with an improved understanding of capital market behavior.

### A. *State of Research*

Research on chaos and capital markets is in its infancy and has perhaps raised more questions than it has answered, but that fact should not preclude continued exploration. Indeed, the questions that the research on chaos and capital markets raises cannot be answered by the ECMH or noise theory, and the complexities that the research reveals are not even considered by those theories. Despite its infancy, the research and its accompanying technology are developing fairly rapidly. For example, evidence revealed by rescaled range analysis shows that the Standard and Poor's 500 Index (S&P Index) exhibits a pattern: an average life cycle of approximately four years.[126] This evidence indicates that there is a strong persistent element in the S&P Index, rather than the pure randomness that the ECMH would predict. In fact, the market does not begin to lose memory of events until after four years have passed.

Many market participants have recognized the insights that chaos theory and nonlinear dynamics offer and have designed elaborate trading

126. *See supra* note 45 and accompanying text (noting four-year cycle of usefulness of information).

techniques to exploit those insights.[127] Those participants regard the techniques as highly proprietary and have neither the incentive nor the inclination to make the techniques public. That information, however, could go a long way toward improving our understanding of public capital market behavior and could assist in the protection of investors. This Article does not suggest that market participants who rely on insights from chaos theory and nonlinear dynamics should be forced to disclose their information. On the contrary, their entrepreneurial energy should be respected, and they should be permitted to profit from their industry. This Article does suggest, however, that the SEC should recognize the value and importance of this information and consider ways of harnessing this information for the broader benefit of both investors and the public.

### *B. Proposal for a Research Project*

There are several possible ways to generate research on chaos technologies that would advance both the economic goal of protecting investors and the broader—but inseparable—social goal of enriching our understanding of public capital market behavior. The SEC itself could undertake a research project concerning the relevance of chaos theory to public capital markets. Such an effort could be conducted along the lines of the Division's study or along the lines of previous efforts that have been aimed at developing forward-looking information, Management's Discussion and Analysis (MD&A) practice, and disclosure practice generally. However, this project is likely to be more sophisticated than those and is likely to require resources not readily at the SEC's disposal. Accordingly, a more appropriate approach may be to limit the SEC's direct role in the initial project to that of coordinator and to allow private institutions to be the driving force behind the project.

In this sense, the project could more nearly resemble the SEC's Electronic Data Gathering, Analysis, and Retrieval project, rather than its MD&A-related projects. Investors, market makers, and registrants could be asked to participate voluntarily in the project. Market participants who have been developing the advanced trading techniques should be encouraged to participate. The goal would be the production and public dissemination

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127. *See generally* David Berreby, *Chaos Hits Wall Street*, DISCOVER, Mar. 1993, at 76; Matt Ridley, *Frontiers of Finance: On the Edge*, THE ECONOMIST, Oct. 9, 1993, at Survey 3; Gary Weiss, *Chaos Hits Wall Street—The Theory, That Is*, BUS. WK., Nov. 2, 1992, at 138.

of general information on chaos theory and public capital markets. If that project were to enhance our understanding of the behavior of particular securities in the light of broader market forces, then consideration could be given to dedicating a single page in SEC filings to a summary of the processes affecting a registrant's particular securities.

At least initially, an absolute safe harbor could be provided that would fully insulate the registrant from liability for the informational statements made on that page of the SEC filing. Moreover, in addition to the conventional cautionary language included in difficult disclosure contexts, a broad disclaimer of responsibility for the statements could be included, along with a clear statement that no party will be liable for anything that the party says. To avoid the temptation to use such a page to include fraudulent statements, any such disclosure could be subject to the direct review of the SEC, which would have the absolute right to permit or reject the disclosure.

The overall goal of the project would be to identify and to attempt to quantify the price impact of non-firm-oriented information, including information in the market microstructure. The results likely would assist our understanding of public capital market behavior and the role of firm-oriented and market information within the market. Those results would enable better evaluation of the appropriate degree of mandatory disclosure and would indicate how to evaluate the merits of alleged violations. Those lessons could lead to a range of prescriptions, from abolishing mandatory disclosure completely (including firm-oriented information) to calling for substantially broader mandatory disclosure at the level of registrants and firm-oriented information and in the context of the market microstructure. The contours of any prescription to broaden mandatory disclosure for registrants would likely include substantial use of safe harbor provisions, particularly with respect to information that, according to chaos theory's predictions, will have a particular impact on specified securities.[128]

## *VI. Conclusion*

While the existing state of chaos theory research raises more questions than it answers, one thing is clear: Price discovery in capital markets is

128. The use of safe harbor provisions for registrants simply recognizes the likelihood that any such information is bound to rest on theoretical premises that are not necessarily susceptible to proof or verification and may in fact turn out to be wrong—just as the ECMH has turned out to be wrong.

imperfect. Market opaqueness and fragmentation necessarily entail pricing imperfections, which produce prices that do not equal fundamental values and which undermine claims of market efficiency.[129] An understanding of the market microstructure becomes critical to evaluating both the mandatory disclosure system under the 1934 Act and methods such as event studies that attempt to assess the merits of alleged disclosure rules violations. In short, how much confidence can there be in the relationship between the disclosure of information by registrants and the resulting price effect when the market microstructure and price discovery mechanisms are rough and unsteady at best?

At a minimum, we should not look exclusively to market price histories to determine whether or to what extent disclosure violations occur. Instead, we should see market price effects discerned from event studies as only one factor among others when issues of materiality or other legal questions arise under the mandatory disclosure system. Other measures should also be used. Once the fact that market prices are not the best measure of security holders' damages is accepted, we should turn to fundamental valuation baselines.

These valuation techniques necessarily involve substantial exercise of judgment in evaluating the merits of alleged disclosure violations. Some advocates of event studies promote them precisely on the ground that they make engaging in such exercises of judgment unnecessary.[130] However, as is well known but not always acknowledged, event studies themselves demand substantial exercises of judgment, as the difficulties in defining an event window attest. Once we recognize the substantial role that judgment plays in conducting event studies and the narrow piece of the puzzle that substantial judgment enables us to see, then exercising judgment regains its appropriate place. The result of exercising that judgment is that we are provided a more complete basis for assessing the mandatory disclosure system and evaluating the merits of alleged violations of disclosure rules.

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129. *See* Mulherin, *supra* note 71, at 377 ("Conceptually, if securities prices were perfectly transparent, then investors would know, at any time, the fundamental value of any public issue. While an apparently laudable goal, this perfect transparency sets up a paradox—as securities prices become perfectly known, there is less individual return to discovering new information.").

130. *Cf.* ROMANO, *supra* note 25, at 60 ("The event study's importance is in measuring; by providing an anchor for determining value, it eliminates reliance on ad hoc judgments about the impact of specific information ('events') on stock prices.").

It has been said that one is perhaps better off not knowing how laws or sausages are made. ECMH devotees often seem to adopt this advice by refusing to recognize how prices are made. Chaos theory and nonlinear dynamics suggest that we should not refuse to look. We should not see the mandatory disclosure system as a closed set; rather, we should see the system as situated in a broader, more complex context that includes the process of price discovery in the market microstructure. While debate on the respective merits of promoting market transparency or minimizing market fragmentation is vigorous and far from settled, the terms of the debate illustrate the need to link an understanding of the market microstructure with the methods of assessing the mandatory disclosure system and evaluating the merits of alleged violations of mandatory disclosure rules.