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Market Efficiency

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ABSTRACT: Efficient market research arose in response to allegations from the professional investment community and critics of financial accounting, and it preceded a formal, conceptual development of market efficiency. Several ambiguities exist with respect to previous definitions of market efficiency. Market efficiency is defined here in terms of the equality of security prices under two information configurations (*i.e.*, with and without universal access to the information system of interest). Casually, a securities market is efficient with respect to an information system if and only if security prices act *as if* everyone knows that information system. If this condition holds, prices are said to "fully reflect" the information system. Several attributes of this definition are advantageous, relative to those of earlier definitions.

EMPIRICAL research characterized as efficient market studies has been the subject of considerable attention in recent years.[1] Contentions regarding market efficiency originated in the professional investment community, particularly among those involved in security analysis whose goal was characterized as the identification of mispriced securities [Graham *et al.*, 1962]. Critics of financial accounting standards [Briloff, 1972] suggested that securities were mispriced because of accounting practices. The empirical research on market efficiency arose in response to those contentions and preceded a formal, conceptual development of market efficiency.

The purpose here is to discuss some important ambiguities associated with the concept of market efficiency and to offer a precise definition of the concept. Some of these issues have been discussed elsewhere, although mostly outside of the accounting literature, narrowly defined.

These ambiguities make the widely cited definitions of market efficiency conceptually incomplete and deficient in a fundamental sense. This can be somewhat discomforting, given the sizable empirical literature cited in favor of market efficiency. The problem is not simply that concepts are difficult to test empirically, a pervasive phenomenon not unique to the efficient market literature, rather, the problem is that, at a conceptual level, prior to empirical testing, it is unclear what is meant by the term *market efficiency*. Providing a precise definition is a prelude to a development of theories of market efficiency and to an interpretation of empirical research offered as tests of market efficiency.

A precise definition is essential to the development of a theory concerning the

[1] Reviews of the empirical work appear in Gonedes and Dopuch [1974] and Kaplan [1978].

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conditions under which market efficiency would or would not be expected to obtain. Potentially, theory can provide predictions regarding differences in market efficiency among different securities or differences in market efficiency with respect to different types of information systems. In other words, theory can serve as a guide to future empirical research and can complement the predominantly empirical tradition of efficient market research. One of the premises of our research culture is that the "generalizability" (*i.e.*, information content) of empirical evidence is enhanced by the presence of a conceptual, theoretical underpinning. Until recently, the research has existed with little or no formal foundation. The empirical findings have largely preceded a formal, conceptual development of market efficiency.

It is difficult to interpret empirical evidence as a test of market efficiency in the absence of a definition of what the concept means. A definition permits researchers who offer their research as evidence regarding market efficiency to show how their evidence is a test of market efficiency. In other words, there can be a link between the conceptual and the empirical levels, and the researchers can state precisely what additional assumptions are involved in making that transition.[2] The issues will be illustrated throughout by the research concerning changes in depreciation methods.

The analysis will consist of five sections: (I) discussion of equilibrium security prices, (II) definition of market efficiency, (III) attributes of the definition, (IV) theories of market efficiency, and (V) implications for empirical research.

I. Discussion of Equilibrium Security Prices

Market efficiency is viewed here as a property of an equilibrium mechanism or process by which security prices are formed. Investors come to the securities market with a diverse set of endowments of current and future consumption, preferences for current and future consumption, and beliefs about future states of the world. The security prices arise in a series of "spot" markets that periodically reopen (*e.g.*, daily). The reopening of these markets implies that these markets are incomplete at least in a nominal sense. Whether they permit the same allocation that would be attained in complete markets is another matter [Arrow, 1964]. In incomplete markets, expectations are formed about future prices, and equilibrium can be characterized as dependent on those expectations. One of the earliest discussions of the relationship between current prices and individuals' expectations appears in Muth's [1961] work on rational expectations.

Under uncertainty, capital market equilibrium can be characterized as a mapping from endowments, preferences, and beliefs into prices. Individuals' beliefs will be conditioned upon the information which each received. Hence, equilibrium prices at the time t will in part depend upon the signals received at time t by each individual.[3]

[2] This is not to say that a precise conceptual definition is a sufficient condition for an unambiguous interpretation of empirical work. Other aspects of the research design may introduce ambiguities.

[3] In general, individuals may not agree on the probability of future states, but typically equilibrium models assume agreement on the prices and other relevant attributes associated with each state [Radner, 1974]. Under information asymmetries among individuals, the partitioning of states over which there is conditional price agreement is a nontrivial issue. Presumably, the attributes that partition the states must be publicly observable in order to posit conditional price agreement [Radner, 1968, 1972; Demski, 1974]. Information asymmetries also raise nontrivial issues about the meaning, existence, nature, and stability of an equilibrium. For example, the concept of what is meant by equilibrium must be extended to incorporate the information asymmetry. These issues have been explored by Wilson [1977], Holmstrom [1977], Kobayashi [1977], Gjesdal

For convenience and precision, some minor notation is introduced. The information system of individual i at time t is denoted η_{it}. The configuration of information systems across individuals at time t is $\{\eta_{1t}, \ldots, \eta_{it}, \ldots, \eta_{It}\} \equiv \{\eta_{it}\}$, where I is the number of individuals. The signal received by individual i at time t from η_{it} is denoted y_{it}, and the configuration of signals at time t is $\{y_{1t}, \ldots, y_{1t}, \ldots, y_{1t}\} \equiv \{y_{1t}\}$. The beliefs of individual i at time t about future security prices that will prevail at time $t+k$ (for $k>0$) is denoted

$$f_{it}(P_{1t+k}, \ldots, P_{jt+k}, \ldots, P_{Jt+k} | \eta_{it}, y_{it}),$$

where J is the number of securities. The configuration of beliefs at time t is

$$\{f_{1t}(\cdot), \ldots, f_{it}(\cdot), \ldots, f_{It}(\cdot)\} \equiv \{f_{it}(\cdot)\}.$$

The price of security j at time t is P_{jt}, and the configuration of prices is $\{P_{1t}, \ldots, P_{jt}, \ldots, P_{Jt}\} \equiv \{P_{jt}\}$.[4] For ease of notation, y_{it} is treated as a scalar but could involve multiple signals. In particular, consider y_{it} as including a history of signals from prior time periods.

To say security prices depend upon individuals' diverse endowments, preferences, and beliefs may seem like an obvious statement, which would characterize the price formation process of many commodities.[5] Indeed, with respect to other commodities, the influence of endowments and preferences on prices and the subjective nature of the value of a commodity are readily acknowledged. Yet, security analysis [Graham *et al.*, 1962] has introduced the notion of the "intrinsic value" of a security. The role that endowments and preferences play in determining "intrinsic value" has not been well defined. The use of the term *intrinsic* appears to connote an objectivist concept, independent of subjective influences.[6] The departure of a security's price from its intrinsic value is one of the earliest definitions of market inefficiency. Even apart from the influence of endowments and preferences, prices are also a function of beliefs. If probabilistic assessments are treated from a subjectivist, personalistic viewpoint, the meaning of intrinsic value is ambiguous in a world of heterogeneous beliefs, even if individuals were identical with respect to endowments and preferences. Notwithstanding its ambiguity, notions of intrinsic value continue to play a role in discussions of the price formation process. For example, the Financial Accounting Standards Board's *Tentative Conclusions* [1976, p. 32] provides a discussion of intrinsic value, which, in turn, draws upon the definition provided by Lorie and Hamilton [1973, p. 114]:

> Intrinsic value is the value that the security *ought* to have and will have when other investors have the same insight and knowledge as the analyst.

This definition is presumably still personalistic because insight and knowledge will vary across individuals, and there are a number of interpretations of an individual's meaning when using the term *intrinsic value*. Although the notion of intrinsic value is unnecessary to the

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[1978], and Milgrom [1978]. These equilibrium considerations are still open issues. The discussion will casually refer to the resulting security prices as "equilibrium" prices. Production will not be explicitly considered, and the description in section I is to be viewed as a partial equilibrium characterization of the capital markets.

[4] Note that $f_{it}(\cdot)$ is defined only with respect to future prices, because this aspect of beliefs is of primary interest. In general, $f(\cdot)$ incorporates assessments of other relevant attributes (*e.g.*, dividends, earnings, commodity prices, interest rates, *etc.*) Also, η_{it} may be viewed as part of some generic η_i and describes the signals to be generated in t.

[5] Belief differences across individuals are characterized as if they arise solely because of informational differences. With information sufficiency broadly defined, this is not a restrictive assumption, and it facilitates the exposition.

[6] Consider Graham *et al.* [1962, p. 28]: A general definition of intrinsic value would be "that value justified by the facts, . . . "

development of a concept of market efficiency, it may be helpful to have an understanding of what might be meant by such a term, given that its use occurs with nontrivial frequency.

One interpretation is that the intrinsic value of a security to an individual is the price of the security that would prevail if everyone else possessed the *same* endowments, preferences, and beliefs as that individual. A somewhat more subtle form would permit the heterogeneity of endowments and preferences to affect price. In this context, an individual would assess the intrinsic value of a security as the price that would prevail if everyone else possessed the same beliefs as that individual but would retain their own endowments and preferences. Either version involves an assessment of what prices would prevail under those hypothetical conditions.[7]

If individuals define intrinsic value in either of the senses described above, individuals may perceive the market to be inefficient. When investors differ with respect to beliefs, an individual's assessment of intrinsic value may differ from price, even if investors were identical with respect of endowments and preferences. Heterogeneity with respect to endowments and preferences merely provides a further reason why an individual's perception of intrinsic value may differ from price.

This, of course, offers one avenue for defining market efficiency. In this context, the market is inefficient if some (*e.g.*, at least one) individuals perceive a discrepancy between assessed intrinsic value and price. However, I perceive that the empirical researchers have a different notion in mind. The market efficiency concept is viewed as logically distinct from the existence of such individuals.[8] The existence of such individuals could occur under at least three conditions:

1. Some individuals possess "superior" information. In this case, the market may be inefficient with respect to their superior information but not with respect to other information. Such a distinction would be lost in the above definition, because it defines market efficiency *per se*, rather than market efficiency with respect to a particular information item.[9]

2. An individual's information may be a proper subset of that information reflected in security prices (perhaps because it is too costly for that individual to extract the information from prices). Such an individual may "myopically" view prices differing from that individual's assessment of intrinsic value because prices reflect information not available to that individual. In a sense, the individual "erroneously" perceives the

[7] Alternatively, the belief component of the definition could be depersonalized by positing universal access to some fine information system, such as the union of everyone's information system or the finest information system conceivable. Clairvoyance is still another option. However, the definition must still address the endowment and preference component, and, in this sense, *intrinsic value* remains an "intrinsically" subjective concept.

[8] The point here is that market efficiency can be defined in a way logically distinct from the perceptions of these individuals. However, it is another matter to ask whether the existence of such individuals is conducive to or a deterrent to the attainment of market efficiency so defined. The answer will depend upon the equilibrium dynamics that are assumed. In this regard, Bernstein [1975] has argued that one of the "paradoxes" of efficient market is that such individuals are essential to the attainment of market efficiency. The dynamics were not well specified. However, it is also possible to imagine equilibrium processes where the existence of such individuals would be inconsistent with the attainment of market efficiency.

[9] Of course, it may be possible to repair this particular deficiency. The point here is that, as it stands, it implicitly defines market efficiency in a *strong* form sense [Fama, 1970]. If the market is any less than strong-form efficient, it is an inefficient market. The suggestion being made here is that this partitioning into "the market is efficient or "the market is inefficient" may be too coarse. A finer partitioning of the concept may be helpful, so that more precise statements are permitted, such as "the market is efficient (or inefficient) *with respect to some specific information.*"

market to be inefficient. Yet, by the above definition, the market would be said to be inefficient because of such individuals.

3. Moreover, heterogeneity of beliefs may prevail among individuals even if they possess identical information with respect to firm-specific and economy-wide data. For example, they may have purchased different education and may interpret signals in a different fashion because of different educational backgrounds. Efficient market research is typically concerned with only a subset of the total information in an economy. Educational differences are not of immediate concern. Again, it would seem helpful if the definition of market efficiency could admit to heterogeneous beliefs, which arise because of information differences beyond the scope of interest.

The purpose of this section has been to provide a brief characterization of security prices. In this setting, the role of heterogeneity was explored with the intention of providing a presumption that it might be helpful if the definition of market efficiency were able to accommodate such heterogeneity. The analysis now turns to the issue of defining market efficiency.

II. Definition of Market Efficiency

Subsequent notions of market efficiency did not rely explicitly on intrinsic value and are illustrated by the following definition, which appears in Fama [1970, p. 384].

> . . . in an efficient market prices "fully reflect" the information available . . . (1)

This definition has been extensively cited and criticized, by Fama [1970] among others, on the grounds that the terms *fully reflect* and *information available* are vague and nonoperational. In fact, definitions can be contrived that make the definition of market efficiency circular. For example, define *information available* as that which is fully reflected in prices. In this case, all securities markets are efficient by definition. However, the definition was intended more as an intuitive description of the concept rather than as a rigorous definition. Fama [1970] provided the more formal "fair game" model:

$$z_{j,t+1} = r_{j,t+1} - E(\tilde{r}_{j,t+1}|\Phi_t) \quad (2)$$

$E(\tilde{z}_{j,t+1}|\Phi_t) = 0$

$r_{j,t+1}$ = the realized return on security j in period $t+1$ (where return is defined as the percentage change in security price adjusted for dividends received),

$E(\tilde{r}_{j,t+1}|\Phi_t)$ = the expected return on security j in period $t+1$, conditional upon Φ_t,

Φ_t = the information set assumed to be fully reflected in prices in period t,

$z_{j,t+1}$ = abnormal return on security j in period $t+1$.

Expression (2) states that the abnormal return $z_{j,t+1}$ on security j in period $t+1$ is the actual, realized return $r_{j,t+1}$ *minus* the expected return $E(\tilde{r}_{j,t+1}|\Phi_t)$. $E(\tilde{r}_{j,t+1}|\Phi_t)$ is conditioned upon Φ_t, which is the information "set" assumed to be fully reflected in prices at time t. According to Fama, in an efficient market, the expected value of the abnormal return is zero.

There are several ambiguities associated with Expression (2). First, Le Roy [1976], among others, has criticized this model as being tautological in that it merely implies the expected deviation of a realization from its expected value is zero. The model is open to this interpretation

because it is not explicit about what information conditions the distribution of the $r_{j,t+1}$ term in Expression (2). Fama [1976] denies the tautology but admits that it is not empirically testable unless some equilibrium model of security returns is specified.[10] Second, Φ_t is not well-defined. Notwithstanding the ambiguity of the phrase *assumed to be fully reflected in prices*, the meaning of the term *information set* is unclear. It is unclear whether it reflects to *every* possible signal (*i.e.*, with respect to the entire information system) or merely to the signal that is empirically observed. Third, Expression (2) is belief-oriented, yet $E(\tilde{r}_{j,t+1}|\Phi_t)$ is not well specified under heterogeneous beliefs.

Subsequent attempts to repair the definitional problems have defined market efficiency as the equality of some aspect of equilibrium under two different information configurations. The three aspects selected have included equality of beliefs, equality of actions (*i.e.*, portfolio choice), or equality of prices. Examples appear in Le Roy [1976], Fama [1976], Rubinstein [1975], and Beja [1976]. The following subsection will offer a definition and section III will discuss its attributes.

A. Information System Efficiency and Signal Efficiency

As defined here, market efficiency with respect to an information item means that prices act *as if* everyone knows that information.[11] For example, market efficiency with respect to changes in the depreciation method for annual report purposes (see Comiskey [1971], Archibald [1972], Ball [1972], and Kaplan and Roll [1972], among others) means the market prices act *as if* there is universal knowledge of the change in accounting methods. Even though the universal knowledge condition may not hold literally, the market efficiency condition states that prices act *as if* it holds.

More precisely, a distinction will be made between information system efficiency (called η-efficiency) and signal efficiency (called y-efficiency) as follows:

y-efficiency

A securities market is efficient with respect to a signal y'_t if and only if the configuration of security prices $\{P_{jt}\}$ is the same as it would be in an otherwise identical economy (*i.e.*, with an identical configuration of preferences and endowments) except that every individual receives y'_t as well as y_{it}. (3)

η-efficiency

A securities market is efficient with respect to η'_t, if and only if y-efficiency holds for every signal (y'_t) from η'_t. (4)

Under Expression (3) (or (4)), prices will be said to *fully reflect* y'_t (or η'_t). The signal which includes both y'_t and y_{it} will be denoted y^*_{it}. The configuration of extended signals is $\{y^*_{it}\}$. The configuration of the extended information systems is $\{\eta^*_{it}\}$.

This distinction removes the ambiguity introduced by the use of the term *information set*. This ambiguity arises because the term was used to describe previous empirical studies. These studies deal only with observed signals. Presumably, such signals were viewed as sampling from a process, where information system effi-

[10] The "fair game" model as stated in Expression (2) has also been criticized for concentrating solely on the expected values of the return distribution and ignoring higher moments. However, Fama subsequently [1976] repaired this particular problem by defining market efficiency in terms of the entire return distribution.

[11] This definition originated with William Sharpe of Stanford University and is also referred to in Beja [1976]. It is similar to one offered by Rubinstein [1975].

ciency was of ultimate concern. However, the studies could be viewed more narrowly as merely tests of the signals observed. In the absence of a theory, it is difficult to know which interpretation to place on the results. Presumably, the theory would resolve whether η or y efficiency is being inferred. For example, costs of processing that are signal-dependent might lead to a prediction of y-efficiency but not η-efficiency.[12]

The distinction also addresses the issue of the generalizability of the results. If the researcher is offering the evidence as a test of y-efficiency, there is no implication that similar results would be inferred for as-yet-unobserved signals from η. However, if the researcher intends the evidence to be taken as a test of η-efficiency, market efficiency is being viewed as a property of the information system. Hence, by definition, it holds for every signal, and evidence on some of the signals can be generalized to the remaining (untested) signals. This is potentially important because η may be sufficiently rich that it would be impossible or extremely costly to examine empirically all of the signals.

Obviously, if η-efficiency is being claimed, care must be taken to define η, and to develop the theory that justifies this more ambitious interpretation of the empirical evidence. For example, in the context of firms that have changed depreciation methods, does the evidence pertain to other (unobserved) changes in depreciation methods (*e.g.*, changes that will take place in the future)? Alternatively, is the change in depreciation methods to be viewed as a sampling from a system that includes other types of accounting changes? If so, what are the characteristics of this class of signals? Presumably, a theory of market efficiency would address these issues.

III. Attributes of the Definition

There are several aspects of the definition worth noting:

1. Market efficiency is defined with respect to the price mechanism, rather than beliefs or portfolio choice. This definition is in the same spirit as the earlier "intrinsic value"-oriented definitions and the definition described in Expression (1), in the sense that both also refer to properties of security prices. Moreover, it is most descriptive of the efficient market empirical evidence, which deals directly with price behavior and at best indirectly with beliefs or portfolio choice.

2. It defines market efficiency in a world of heterogeneous beliefs and information. This is a critical distinction, because heterogeneous beliefs is a more general setting and a more realistic description of capital markets. For example, the evidence from the volume studies (Beaver [1968], among others) is consistent with heterogeneous beliefs with respect to earnings announcements. Also consider the range of experts' forecasts of inflation rates, growth in GNP, earnings and the like.

Expression (2) characterizes market efficiency in terms of beliefs with respect to $\tilde{P}_{t+1}$. This expression does not define how that composite belief function is being interpreted, since, in general, $f_{it}(\cdot)$ will vary across individuals. Of course, it is possible to assume homogeneous beliefs. However, to treat homogeneous beliefs as the sole interpretation is not only descriptively invalid, but needlessly restrictive. With heterogeneous beliefs, defining market efficiency in terms of identical beliefs under two information

[12] I am indebted to Joel Demski for first pointing out this distinction, which is discussed in greater length in Huber [1978].

configurations can be interpreted in several ways. One interpretation is that beliefs must be identical *for each individual* (*i.e.*, that the configuration of beliefs $\{f_{it}(\cdot)\}$ is the same for each i). Under Expression (3), $f_{it}(\cdot|\eta_{it}, y_{it}) = f_{it}(\cdot|\eta_{it}^*, y_{it}^*)$ for some specified $y_{it}^*(y_{it}$ and $y_t')$ for each i. Under Expression (4), this condition must hold for every signal y_{it}^*. In other words, under Expression (3), the beliefs of an individual observing the signal, y_{it}, must be that some as the beliefs that individual would hold if y_{it} and y_t' were observed. Moreover, this equality of beliefs must hold for each individual. Note that this condition does not impose an equality of beliefs *across individuals*. In other words, there is no requirement that $f_{it}(\cdot) = f_{ht}(\cdot)$ where i and h refer to two individuals. Under Expression (4), this equality of beliefs must hold for every signal y_t' from η_t'. Equality of beliefs for each individual is a severe condition in that inequality of even one individual would be sufficient to make the market inefficient. For the reasons offered earlier, it may be helpful to have a definition logically distinct from individuals' beliefs. Another interpretation is that only the composite (*e.g.*, some average or aggregation across individuals, as in Lintner [1969]) must be equal. However, if the composite is interpreted as consensus beliefs, as defined in Rubinstein (1975), then a belief-oriented definition is equivalent to a price-oriented definition.[13] In any event, a price-oriented definition permits heterogeneous beliefs but avoids the knotty issues raised here with respect to belief-oriented definitions.

Furthermore, it is important to distinguish between what is meant by a concept and how it is to be tested empirically for at least two reasons. (a) The methods used to test a hypothesis may vary over time as research technology changes, even though the concept of interest (*e.g.*, market efficiency) is unchanged. For example, the security returns are often viewed as having arisen from an equilibrium process characterized by the Capital Asset Pricing Model (*e.g.*, Fama [1970; 1976]). One of the sufficient conditions invoked in behalf of the CAPM is homogeneous beliefs. This is not to deny that empirical tests of market efficiency are joint tests of efficiency and other assumptions made in the research design, but market efficiency is a more general concept than the CAPM model.[14] Moreover, the CAPM is not the unique interpretation of the empirical evidence. For example, the security return observations could be viewed as realizations from a Lintner [1969]-type equilibrium process where heterogeneous beliefs prevail. Many of the earliest security price studies (*e.g.*, Fama *et al.* [1969] or Ball and Brown [1968]) make no explicit appeal to the CAPM. (b) The researcher may wish to develop analytical models of equilibrium processes where market efficiency is an issue but does not depend upon any particular equilibrium model such as the CAPM. Here, empirically testable hypotheses may not be of immediate interest.[15]

3. The definitions provided here deal only with one aspect of equilibrium behavior (the effect on security prices). Rubinstein [1975] has criticized price-oriented definitions of market efficiency for failing to incorporate effects on ac-

[13] Rubinstein [1975] defines *consensus* beliefs as those beliefs which if held by everyone, would produce the same set of prices.

[14] Recent critiques of the CAPM (Roll [1977; 1978] and Ross [1978], among others) underscore the potential desirability of distinguishing the concept of market efficiency from the CAPM. Also of special interest is the June–September, 1978 issue of the *Journal of Financial Economics*, devoted to market efficiency. In particular, Ball [1978] suggests that the CAPM may be misspecified.

[15] Rubinstein [1975], Kihlstrom and Mirman [1975], Grossman [1976], and Grossman and Stiglitz [1975] are examples of such analytical work.

tions (*i.e.*, portfolio choice). For example, the portfolio positions could differ under $\{\eta_{it}\}$ vs. $\{\eta_{it}^*\}$ even though prices are the same. As indicated earlier, the empirical research was responding to assertions by analysts, accountants, and others that *prices* did not fully reflect certain information. Hence, price-oriented empirical research and a price-oriented definition are most directly responsive to such allegations.

However, even if prices are one important consequence, this does not deny that there may also be other concerns which may require action-oriented definitions of market efficiency. For example, Beaver [1973] cites "improperly" diversified portfolios as one of the consequences or "costs" that may be incurred by an investor even in an efficient market. Consider the "myopic" individual of Section I. This is merely a particular illustration of a broader set of consequences that may not be reflected in price-oriented definitions. Investors may not be indifferent between two information settings (with and without universal access to η'). They may not choose the same portfolios, even though the prices are efficient with respect to η'. To address this issue fully requires a specification of the purpose or intent of studying market efficiency and more explicit assumptions about the equilibrium process. Definitions which focus on price effects have the property of being descriptive of a class of extant empirical research, which in turn focuses on one (albeit only one) aspect of the equilibrium.

Even where the policy maker is concerned with the effects of information on portfolio holdings, a price-oriented definition of market efficiency can still be of interest. For example, consider a policy decision to release some information publicly in an exchange setting (*i.e.*, financing and production decisions will not be altered). If the market is already efficient with respect to that information as defined in Expression (4), the policy maker can be assured that the release of such data will not alter security prices.

4. The definition defines market efficiency in a specific informational setting (*e.g.*, η_t'). As such, it permits as fine a partitioning of the market efficiency condition (*e.g.*, according to each conceivable η_t') as the researcher may wish. In this context, the distinction between strong, semi-strong, and weak form efficiency can be viewed as a coarse partitioning of information systems of interest. This three-fold distinction is convenient for many purposes such as the classification of previous empirical research as in Fama [1970]. However, in other cases, it may not be precise enough, if the market is efficient with respect to some η_t' within a given category, but not others. Expression (4) focuses upon equilibrium price conditions with and without universal access to η_t'. As such, it avoids severe definitions of market efficiency and the use of terms such as *the information available*, *the information the market uses*, or the *true probability distribution*, which have appeared in other definitions and whose meanings have not been well defined.

IV. Theories of Market Efficiency

It is one matter to define market efficiency, but it is another to construct an equilibrium model where market efficiency with respect to η_t' (or y_t') would obtain. A theory of market efficiency involves a specification of the process by which information becomes reflected in prices. Under what conditions would market efficiency with respect to η_t' be expected? Unless individuals are characterized as throwing away something of value, information in not used because it is costly (*e.g.*, costly to purchase η_t' or

costly to observe y_t'). Yet much of the empirical research has examined market efficiency with respect to publicly available information, such as changes in depreciation methods for annual report purposes. Why would one ever expect prices *not* to "fully reflect" publicly available information? Won't market efficiency hold trivially? The answer, of course, lies in the possibility that such data are not universally available at zero cost to all individuals.

Knowledge of the change may not be universal. Moreover, there may not be universal (costless) access to other information regarding the implications of the change. In other words, it may be costly to obtain the accounting training (*e.g.*, knowledge of depreciation methods, understanding a firm can have a different set of books for tax and for annual report purposes, *etc.*) and hence such knowledge is not universal. However, interpretation of the change goes beyond this and involves the assessment of managements' motivations for changing depreciation methods (*e.g.*, reflecting managements' expectations about future earnings, or plans for additional asset acquisitions). Such analysis (*i.e.*, information) is provided by the financial and accounting community, but perhaps not costlessly. Hence, market prices might not reflect this potentially costly information. This constitutes a simplified explanation of why a nonzero probability of market inefficiency with respect to "publicly available" information might be assessed. However, the cost of the information might be such that security prices act *as if* the information were costlessly available to all investors. This "as if" behavior is one interpretation of the empirical research on semi-strong form efficiency. From this perspective, the empirical studies of change in accounting methods are viewed as testing market efficiency with respect to more information than merely the knowledge that a change took place.

At an institutional level, some (*e.g.*, Bernstein [1975]) appear willing to give the analyst community credit for being the mechanism by which market efficiency is attained. Such information intermediaries have not yet been explicitly modeled. However, work by Kihlstrom and Mirman [1975], Grossman [1976], and Grossman and Stiglitz [1975] provide the beginnings of an analysis of the conditions under which market efficiency would or would not obtain. In these models, individuals "extract" information from prices. In the Grossman and Stiglitz model, individuals choose to become informed or uninformed, and at equilibrium each individual is indifferent, because either action (after deducting information costs) offers the same expected utility. In order for there to be incentives to purchase information, prices cannot "fully reflect" the information obtained. In the Grossman model, every individual is equally uninformed in that each receives a garbled signal, but prices act as an aggregation of everyone's information, such that the prices "reflect" information that is superior to that held by each and every individual. However, individuals extract this superior information from prices, and the prices "fully reflect" that superior information.

In a related vein, Verrecchia [1979] has constructed a model where price acts as an aggregator of beliefs (as distinct from an aggregator of information). As the number of individuals increases, prices behave *as if* everyone observed the ungarbled signal. The major difference is that there is no explicit learning from prices involved. Hence, while prices reflect the ungarbled signal, individual beliefs or portfolios may not reflect this

information. Neither Grossman nor Verrecchia requires the existence of a subset of "initially" more informed individuals (*e.g.*, superior analysts).

The models are partial equilibrium, where assumptions regarding the contracting opportunities permitted are central. For example, these analyses are essentially models of private information production. Had contracts which permitted collective production (or nonproduction) of information been considered, the information production incentives could have been dramatically altered. One such collective choice would be the centralized production of a signal, thereby avoiding the costs of redundant production. Many of the issues related to the institutional structure of information production are discussed in Gonedes [1976].

V. Implications for Empirical Research

The previous discussion has several potential implications for empirical research in market efficiency. A precise definition will facilitate theoretical development. As such, it can provide a specification of the conditions under which market efficiency would or would not obtain. For example, would differences be expected across securities or across information systems? The empirical evidence would follow in response to empirically testable implications of the theory rather than in response to allegations by analysts, critics, and regulators. In other words, the theory can serve as a guide to future empirical research.

An explicit adoption of this formal definition enables the researcher to be more precise in several respects:

1. It permits the researcher to specify precisely what is the information system under study. For example, is it only whether the firm has changed depreciation methods or, alternatively, is it a broader information system, as discussed earlier?

2. It permits the researcher to specify whether system efficiency or signal efficiency is being tested. If the former, what theory leads the researcher to assume generalizability to unobserved and untested signals from the system? If the latter, why is the more restricted view adopted? Is it merely because of a lack of justification for a broader view or because of some theoretical reason?

3. It permits the researcher to define the information system as broadly or narrowly, as desired. Again, presumably theoretical considerations could at least partially motivate the classifications of information systems.

4. It permits the researcher to distinguish the concept from the manner in which the concept is tested. The advantages of doing so were discussed earlier.

5. It permits the researcher to move rigorously from the conceptual level to the empirical level. The additional assumptions in such a movement can be specified, and the researcher can be more precise about the reasons why the empirical evidence constitutes an *indirect* test.[16]

Needless to say, the empirical studies do not directly test the conditions outlined in Expressions (3) or (4). The prices that would prevail in the hypothetical economy of universal possession of η_t' are not observed. Instead, the empirical studies infer the security price behavior that would be observed *if such a condition held.* A prominent example is the change in depreciation methods. In this case, the early studies held that if the market were

[16] These five implications for empirical research are not unique to the particular formal definition offered here. They presumably would flow from any formal definition which did not suffer from the ambiguities cited earlier.

efficient with respect to this information, the changes in equilibrium prices, *ceteris paribus*, would be zero. By way of residual analysis and other aspects of the research design, an approximation of the *ceteris paribus* condition was attempted. As Gonedes and Dopuch [1974] point out, in testing for market efficiency such studies have *assumed* the information effect would be zero in a market which fully reflected the information. A contextual argument (*i.e.*, no direct impact on cash flows) was typically offered to justify such an assumption.

Historically, there has been a considerable emphasis upon the ability to earn abnormal expected returns as a test of market efficiency. Its prominence is understandable, given the heritage of market efficiency. As indicated earlier, the origin of market efficiency is the professional investment community which sells services to clients on the basis that inefficiencies will lead to abnormal returns. From this perspective, a market inefficiency that cannot be converted into an abnormal return is "academic." As a result, it is natural that much of the research on weak form efficiency and the early work on semi-strong form efficiency adopted an abnormal return testing perspective. Under this perspective, a trading strategy is adopted based upon some publicly available signal.

Notwithstanding this tradition, Expressions (3) and (4) define market efficiency in terms of an equality of equilibrium prices under two information configurations. By contrast, they do not describe market efficiency in terms of the ability to earn abnormal expected returns (*i.e.*, as in the "fair game" model). The ability to earn abnormal returns is a potential *implication* of market efficiency but not a definition of it.[17]

A formal statement of "the ability to earn abnormal returns" is the "fair game" model, which suffers from several ambiguities, as discussed previously. Moreover, the ability to earn abnormal returns does not distinguish between information "fully reflected" in prices and information "never reflected" in prices.[18] Both situations can imply an inability to earn abnormal returns, yet it is potentially important to distinguish between them. For example, from a policy perspective, requiring public disclosure of such data for exchange purposes would have no effect on stock prices in the "fully reflect" case but would in general have price effects in the "never reflect" case. Moreover, critics such as Briloff [1972] contend that certain mispricing was "permanent" (*i.e.*, for an indeterminate length of time), and, if so, it would not be detected by an abnormal returns test. Finally, market efficiency studies have not been exclusively concerned with an ability to earn abnormal returns. Most prominently, consider the studies of the change in depreciation methods. The studies were concerned with the "announcement effect" of the earnings reported under the new depreciation method. In other words, did equilibrium prices change when depreciation methods were changed? Addressing the issue in this manner is consistent with

[17] The ability to earn abnormal returns rests in part upon what information is "fully reflected" in prices at *two* points in time (the beginning and end of the period over which the return is defined). Hence, it refers to a dynamic property of prices over time. It may be intuitively appealing to conjecture that market efficiency at both points in time (with respect to η') implies the inability to earn abnormal returns (from knowledge of η') over that interval. However, it is difficult to argue that the "ability to earn abnormal returns" is an implication of a definition without specifying the definition. A definition is a prerequisite to the derivation of implications.

[18] This feature underscores the fact that the ability to earn abnormal returns is an implication, not a definition of market efficiency. A definition is an *if and only if* statement, while an implication goes in one direction but the converse is not necessarily implied.

market efficiency as defined in Expressions (3) or (4), and is not testing the ability to earn abnormal returns from publicly available data.

A related question at this stage is: How, if at all, will the definitions provided here alter the behavior of researchers' testing for market efficiency? While such a question is an important one, it is somewhat premature and somewhat misdirected. The essential point here is that we are currently in possession of a sizable empirical literature testing an ill-defined concept. The analysis has attempted to highlight some important conceptual ambiguities associated with previous definitions and to provide a definition that is conceptually precise. Such a definition is a prelude to an interpretation of extant empirical evidence and to further development of a theory of market efficiency. This, indeed, may alter the nature of future empirical studies. However, at the present time, it is premature to speculate as to what it might be.

Closing Remarks

The analysis examines the concept of market efficiency in a world of heterogeneous individuals. In particular, a definition is offered which focuses upon the identity of equilibrium security prices under two information configurations. Loosely speaking, the securities market is said to be efficient with respect to some specific information if prices act *as if* everyone knows the information. Such a setting: (1) permits a definition of market efficiency in a world of individuals who are heterogeneous with respect to beliefs and information, (2) permits endowments and preferences to play a natural role in influencing prices, (3) permits individuals to perceive the market to be inefficient even if it is not, (4) gives the term *fully reflect* a well defined meaning, (5) distinguishes between information system efficiency and signal efficiency, (6) focuses upon prices as opposed to beliefs or actions, (7) relates directly to prior allegations of market inefficiency and to the set of empirical research that was directed at those allegations, (8) avoids issues of aggregation of diverse beliefs across individuals, and in doing so does not require homogeneous beliefs but permits them as a special case, (9) logically distinguishes the definition from any particular equilibrium model, (10) permits the concept to be as finely partitioned with respect to information as may be desired and avoids severe definitions of market efficiency, and (11) avoids the use of ill-defined terms, introduced in previous definitions.

Current research is beginning to provide models of equilibrium processes under which market efficiency would or would not be attained. A rationale is provided as to why tests of semi-strong form efficiency (*i.e.*, with respect to publicly available information) are nontrivial. The empirical research is briefly discussed, and the observation was made that the empirical tests are *indirect* tests of market efficiency because the prices where there is universal knowledge of (η_t') (or y_t') are never observed.

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