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The Individual Investor in the Market: Forming a Belief Regarding Market Efficiency

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Do the actions of investors drive the market toward efficiency or do investors utilize fads and other information unrelated to the true value of the security to drive the market away from efficiency? Investors have been forced to examine a multitude of challenges to the efficient markets hypothesis in recent years. One of the most formidable of the challenges is the "excessive market price volatility" argument. We examine this argument, as presented in the "variance bounds" literature, and conclude that, although markets may be inefficient, the "variance bounds" literature has not proved the case conclusively.

I. INTRODUCTION

For investors who want to "beat the market," there is a shortage neither of data nor of advice. Readily available are such primary data as annual reports, 10Ks, and 10Qs. Secondary data sources include the financial press (e.g., *The Wall Street Journal* and *Investors Daily*); investor's services such as *The Value Line Investment Survey*, *Standard & Poor's*, and *Moody's*; and computer data bases that can be obtained on floppy disks. For advice investors can turn to *Wall Street Week* or any number of newsletters published by advisors who claim to know what stock to buy and/or when to buy it. Can investors reasonably expect to "beat the market" by superior application of this information?

Many, if not most, financial economists in academia believe that individuals should simply purchase a diversified portfolio of securities (or, perhaps, a well-managed, diversified mutual fund). They insist that efforts to "beat the market"

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are destined to failure. Their argument proceeds from the "Efficient Markets Hypothesis" (EMH).

According to the EMH, the prices of securities, at any given moment, reflect all of the information available to investors. Suppose that information about a common stock were available which would justify paying a higher (or lower) price than the market price. What would happen? Investors, eager to profit from the pricing error, would immediately purchase (sell) the mispriced security, thus driving its price up (down) to the price justified by the information available.

Numerous attempts over the past 25 years to test the EMH have led to refinements. The EMH now comes in three different forms: the weak form, the semi-strong form, and the strong form. It is important for investors to distinguish between these three forms.

The weak form of the EMH holds that the current price of any security is independent of the security's price history. That is, knowing all of the prices at which a security has traded for every trade in the security's history cannot help investors to predict any future price. If the weak form of the EMH is correct, then technical analysis can be of no value to investors.

The semi-strong form of the EMH incorporates the assumptions of the weak form but adds more. It holds that *all public information* (including the series of prices at which a security has sold) is impounded in the market price. If so, reading annual reports, 10Ks, 10Qs, etc., is a nonproductive activity; security analysis can be of no value to investors.

The strong form goes one step further; it holds that *all information* (including insider information) is impounded in the prices of securities. Under the strong form investors cannot obtain excessive profits even if they know about a buy-out before it is announced.

A belief regarding the efficient markets hypothesis dictates investment practices. Accepting the concept implies that investors should (1) form diversified portfolios of securities meeting their risk and income objectives and (2) trade securities only when objectives change, when excess funds are available, or when funds are needed. Investors who reject the EMH might reasonably attempt to (1) identify and purchase underpriced securities, (2) identify and sell overpriced issues, and (3) trade securities to benefit from market timing.

It has long been held that security prices change only in response to *new* information. New information occurs randomly since any trend or prior knowledge would make the information predictable; therefore, it would not be new information. Price changes therefore must be random. However, early tests implying a random walk in stock price changes (Fama, 1965) have been modified by evidence of potential long-term price reversion (Fama & French, 1988) and short-term correlations (Lo & MacKinlay, 1988).

Investors and security analysts gathering and using information in an attempt to "beat the market" would appear to drive markets toward efficiency. However, market efficiency anomalies, such as the P/E Ratio effect, January effect, etc., focus on specific "pockets" of potential inefficiency and provide evidence that markets may not be driven all the way to efficiency. In general, empirical tests are inconclusive and, in some degree, contradictory.[1]

A basic premise in asset valuation is that an asset is worth the present value of its future cash flows. We refer to this as the true value of the asset. If the market price of a security is not consistent with its true value, investors must be responding to something other than pertinent information concerning the asset. Fads (Shiller, 1989), overreaction (DeBondt & Thaler, 1985), or speculative bubbles (West, 1988) may explain security prices. If so, markets cannot be efficient. A test which proves that market prices are not consistent with the present value of their future cash flows would prove that the EMH is false and end the market efficiency question once and for all. The "variance bounds" test is promoted as such a test. Some scholars (e.g., Shiller, 1989) performing the test find that the volatility of market prices is too great for the value of a security to equal its true value and conclude that markets are inefficient.

Do investors utilize "irrelevant" information to drive markets away from efficiency? We offer no answer to this question and draw no conclusion about the efficiency of financial markets. However, an examination of the foundation of the variance bounds test will prove useful to investors who are concerned about the issue. This paper focuses on the theory which asserts that the volatility of market prices is too great to be consistent with the efficient markets hypothesis. We briefly review the theory and examine its theoretical underpinnings. Our objective is to expose weaknesses in the excessive volatility argument and to show that the variance bounds tests are not valid when risk is considered. We conclude that the individual should look with skepticism upon the excessive volatility argument when forming a belief concerning market efficiency.

In Section II we explain the traditional variance bounds theory. Section III examines the theory and uncovers three flaws in the original argument. Our summary and conclusions are presented in Section IV.

II. VARIANCE BOUNDS THEORY

LeRoy (1989) explains that very low market prices in the mid-1970s stimulated researchers to reexamine the theory of asset pricing.[2] They argue that asset prices should have low volatility relative to the volatility of dividends; and, further, that these volatility implications apply directly to market efficiency theory. LeRoy and Porter (1981), Shiller (1979, 1981a, 1981b, 1989), and Singleton (1980) lay the foundation for what is now known as variance bounds testing. Their finding, that the variance of market prices exceeds that of a proxy for fundamental value,[3] introduces a new challenge to market efficiency.

The Formal Argument

Shiller (1979, 1981a, 1981b), LeRoy and Porter (1981), and Singleton (1980) introduce the rationale that the fundamental value of a security is equal to the security's market price plus a random error. This implies that the fundamental value of security i at time t, π_{it}, may be linearly decomposed into an expected component (i.e., market price), p_{it}, and an unexpected component, x_{it}.

$$\pi_{it} = p_{it} + x_{it} \tag{1}$$

Equation (1) implies that the fundamental value is predicted by market price and disturbances. It necessarily follows that

$$\sigma_\pi^2 = \sigma_p^2 + \sigma_x^2 + 2\sigma_{p,x} \tag{2}$$

The market price must be uncorrelated with the random component as a condition of market efficiency. Hence the variance of the time-series of fundamental values must be equal to the sum of the variances of the price series and the series of random errors:

$$\sigma_\pi^2 = \sigma_p^2 + \sigma_x^2 \tag{3}$$

Since variances are non-negative, the variance of the fundamental value series sets an upper bound on the variance of the price series.

$$\sigma_\pi^2 \geq \sigma_p^2 \tag{4}$$

Inequality (4) is the cornerstone of first generation variance bounds tests. LeRoy and Porter (1981) and Shiller (1979, 1981a, and 1981b) find that the variance of market prices exceeds that of the fundamental value series, thus leading them to question the validity of the efficient markets hypothesis.[4] Many subsequent tests have been performed and, although many of the problems of the first-generation variance bounds tests have been overcome, primarily by improved econometric methods, the underlying theory has not been changed. It is this theoretical foundation that is examined here.

III. THREE FLAWS IN THE TRADITIONAL VARIANCE BOUND ARGUMENT

The First Flaw

First, the variance bounds specification in (4) is less restrictive than it seems. Zero correlation between p_{it} and x_{it} clearly implies the relationship expressed in (3). Equation (4) follows from (3), but the converse is not necessarily true. Equation (4) does not guarantee zero correlation between p_{it} and x_{it}. In fact, the relation expressed in (4) implies a range of correlation between p_{it} and x_{it}. Consider (2) and note that the variance bounds specified in (4) imply that

$$\frac{\sigma_\pi^2}{\sigma_p^2} \geq 1 \tag{5}$$

and, therefore, that

$$\frac{\sigma_x^2}{\sigma_p^2} + 2\rho_{p,x}\frac{\sigma_x}{\sigma_p} \geq 0 \tag{6}$$

where $\rho_{p,x}$ is the correlation coefficient between p_{it} and x_{it}. From (6) it follows that (4) actually identifies a range of values of correlation between p_{it} and x_{it}

$$-\frac{1}{2}\frac{\sigma_x}{\sigma_p} \leq \rho_{p,x} \leq 1 \tag{7}$$

that is, the variance of market price exceeds the variance of fundamental value if and only if

$$\rho_{p,x} < -\frac{1}{2}\frac{\sigma_x}{\sigma_p}. \tag{8}$$

(8) states the actual rejection region for market efficiency under the traditional variance bounds test.[5]

The Second Flaw

The second flaw is that traditional variance bounds testing is strongly influenced by the empirical relationship between π_{it} and p_{it}. Scott (1985, (2), (4), and (5)) and Easton (1985, (7)) generalize (1) as

$$\pi_{it} = a + bp_{it} + u_{it} \tag{9}$$

in performing regression-based variance bounds tests. Utilizing (9), the ratio of variances is,

$$\frac{\sigma_\pi^2}{\sigma_p^2} = \frac{b^2}{R^2} \tag{10}$$

where R^2 is the coefficient of determination from the regression of (9). Applying the traditional variance bounds criteria for market efficiency from (5) implies that

$$R^2 \leq b^2 \tag{11}$$

This has the unsettling implication that the proportion of fundamental value explained by market price must be *smaller* than some specific limit, otherwise we reject market efficiency. For example, if $b^2 = 0.5$ markets are tested to be efficient if market price explains 10% of the variation in fundamental value and are tested to be inefficient if market price explains 90% of the variation in fundamental value. This is contrary to the intuitive concept that market price and fundamental value should be closely linked in an efficient market. Equation (11) presents no problem if $b \geq 1$; however, Scott (1985, Table 1, p. 602) finds that b is significantly less than one; indeed, he finds b not significantly different from zero. Easton (1985) finds that b varies with the level of the discount rate used in calculating the proxy for fundamental value. The estimate of b is less than unity for the lower range of discount rates. Scott's and Easton's results cast serious doubt upon the validity of the linear assumption in (1).[6]

The Third Flaw

The third flaw in the traditional variance bounds argument is that (1) is an inequality for any state other than risk neutrality. To examine this claim, we reconstruct the relationship.

The relationship between the market price of a security and its fundamental value begins with the decomposition of the actual cash distributions, ACF_{it}, into their components: the expected dividends, ECF_{it}, and unexpected dividends, UCF_{it}.

$$ACF_{it} = ECF_{it} + UCF_{it} \tag{12}$$

The fundamental value, π_{it}, can then be expressed as

$$\pi_{it} = \sum_{j=1}^{\infty} \left(\frac{CPI_t}{CPI_{t+j}}\right)\left(\frac{1}{1+rr}\right)^j ACF_{i,t+j} \tag{13}$$

where CPI is the Consumer Price Index at the time of the distribution (t+j) and the beginning of the time period (t) and rr is the real rate of return which is assumed to be the constant (e.g., 3%) part of the time varying realized return. Equation (13) presents the price that a rational investor would pay for a security with (1) full knowledge of all future cash (or equivalent) distributions, (2) perfect information concerning future inflation as accounted for by the CPI, and (3) a desire to achieve a realized real rate of return of rr. Note that the certain cash flow is discounted using a rate having no risk premium. Since it involves an infinite stream of distributions, we use the term "fundamental value." We combine the inflation and real return factors into a time varying realized return, r_{t+j}, which includes no risk premium.

$$r_{t+j} = \left(\frac{CPI_{t+j}}{CPI_t} \right)^{\frac{1}{j}} (1 + rr) - 1 \tag{14}$$

Equations (12), (13), and (14) can be combined if and only if the assumption of risk neutrality is imposed. Assuming a risk neutral world we have

$$\sum_{j=1}^{\infty} \frac{ACF_{i,t+j}}{(1 + r_{t+j})^j} = \sum_{j=1}^{\infty} \frac{ECF_{i,t+j}}{(1 + r_{t+j})^j} + \sum_{j=1}^{\infty} \frac{UCF_{i,t+j}}{(1 + r_{t+j})^j} \tag{15}$$

The left hand side (LHS) variable, ACF, is a certain cash flow and must be discounted with no risk premium. The right hand side (RHS) variables, ECF and UCF, are uncertain cash flows and can be discounted with no risk premium only under the risk neutrality assumption. However, the risk neutrality assumption is not attractive. The first term on the RHS is the discounted expected dividend stream, the market price. It is contrary to basic concepts of stock valuation to assume that there is no risk premium associated with this term. The relationship is a decomposition and both sides must be discounted by the same factor to maintain equality (Shleifer & Summers, 1990). If we discount the RHS by a factor containing a risk premium, the LHS, the certain cash flow, must also be discounted using a risk premium. This practice is used in variance bounds theory and the pseudo value is called the "*ex post* rational" price. But, this is *not* theoretically correct and there is no assurance that an equality is established by applying some arbitrary risk premium to the LHS.

For clarity let us examine the conditions under which (15) reduces to (1). Investors price risky equities by discounting expected, but uncertain, cash distributions by a discount factor, k_i. Thus, the current market price is

$$p_{it} = \sum_{j=1}^{\infty} \frac{ECF_{i,t+j}}{(1 + k_{i,t+j})^j} \tag{16}$$

The discount rate, k_{it}, includes a risk premium and varies from firm to firm and over time as implied by the subscripts. Under the assumption of risk neutrality, $k_{i,t+j} = r_{t+j}$ and

$$x_{it} = \sum_{j=1}^{\infty} \frac{UCF_{i,t+j}}{(1 + r_{t+j})^j}. \tag{17}$$

Then (15) reduces to (1), which implies that the fundamental value is a linear combination of the expected information effects, p_{it}, and the unexpected effects,

x_{it} in a risk neutral world. But, there is no reason to believe that the same relationship holds in a risk averse world.

A theoretically correct relationship under risk aversion can be established utilizing assumptions normally accepted in security valuation. Without loss of generality, we treat both actual and expected dividend growth rates, (g_{Ai}) and (g_{Ei}), respectively, as constants over the period $t = 1,...,\infty$. Thus,

$$ECF_{i,t+j} = D_{it}(1 + g_{Ei})^j \tag{18}$$

and

$$ACF_{i,t+j} = D_{it}(1 + g_{Ai})^j \tag{19}$$

Similarly, $k_{i,t+j}$ and r_{t+j} are treated as their effective geometric average values over time and designated henceforth as k_i and r_f, respectively.

The sum of the infinite series created by substituting (18) into (16) converges (see Gordon (1962)) to:

$$p_{it} = \frac{D_{it}(1 + g_{Ei})}{k_i - g_{Ei}} \tag{20}$$

where $(k_i - g_{Ei})$is strictly positive for any finite market price. In a similar manner, substituting (19) into (13) (or the equivalent LHS of (15)) yields the theoretical true (or fundamental) price

$$\pi_{it} = \frac{D_{it}(1 + g_{Ai})}{r_f - g_{Ai}} \tag{21}$$

where $(r_f - g_{Ai})$ is strictly positive for any finite fundamental price.[7] Solving for D_{it}, in (20) and substituting into (21) yields the relationship

$$\pi_{it} = p_{it}\left[\frac{(1 + g_{Ai})(k_i - g_{Ei})}{(1 + g_{Ei})(r_f - g_{Ai})}\right] \tag{22}$$

The ratio in brackets is a certainty equivalent factor between the fundamental value (the discounted value of a stream of certain real cash distributions) and the market price (the discounted value of a stream of expected but uncertain cash distributions). In a risk averse world the relationship is nonlinear as shown by (22). It is obvious that this relationship does not produce the variance boundary that is produced by (1). We argue that (1) is an inequality in a risk averse world; thus, the variances that are derived from the relationship cannot be interpreted as valid bounds.

IV. Summary and Conclusions

This study shows that the theory underlying the excessive price volatility challenge to market efficiency is flawed. We have not shown that markets are efficient; but we have given investors reason to doubt the argument for market inefficiency based on the evidence for excessive price volatility. Our conclusion is consistent with a statement by Fama (1990), "As always, then, the answer to the basic market-rationality question must be left to the reader."

Notes

1. Fama (1991) provides an excellent review.
2. The Dow Jones Industrial Average reached a modern period low in 1974.
3. Researchers applying *ex ante* discount rates to realized prices and dividends refer to this proxy for the security's fundamental value as the "*ex post* rational price." See Kleidon (1986a) for a discussion of this term.
4. Critics (Flavin (1983), Kleidon (1986a,b), and Marsh and Merton (1986)) quickly find problems with the early analyses. New tests intended to correct these problems are developed by Mankiw, Romer, and Shapiro (1985), Scott (1985), Campbell and Shiller (1988a,b), and LeRoy and Parke (1990). These second-generation tests are criticized by Shea (1989). Articles by LeRoy (1989), West (1988), and Gilles and LeRoy (1990) present excellent reviews of the variance bounds literature.
5. LeRoy and Porter (1981, p. 561) apparently recognize that their variance bound specification implies some range of correlation between p and x, but they do not elaborate. Their orthogonality test implicitly assumes a correlation of zero. Froot (1987), in an unpublished paper, spells out the correlation range more clearly. Frankel and Stock (1987), comparing tests of efficiency of foreign exchange markets, make a similar point. Our results are derived independently and presented in a different form.
6. We abstain from lengthy review of second generation tests because (a) that task is accomplished admirably by Gilles and LeRoy (1990) and (b) those tests are not pertinent to our examination of the model.
7. Economic rationality is lost if market price or fundamental price is allowed to assume an infinite value.

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