THE JOURNAL OF FINANCE · VOL. XXXI, NO. 1 · MARCH 1976

REPLY

EUGENE F. FAMA*

SINCE THE PUBLICATION of the "Efficient Markets" review paper [1], many readers have commented that they find the discussion of the theory misleading or at least difficult to follow. Such judgments can only be made by readers, and when they are made by knowledgeable scholars like Stephen F. LeRoy [4], the author is forced to agree. I do not agree, however, with LeRoy's statement that the discussion of the efficient markets theory in [1] is tautological. Since I place all tests of market efficiency within the proposed theoretical framework, if the theory is tautological, the tests must be incapable of rejecting the hypothesis that markets are efficient. The tests are not deficient in this sense.

Rather than defending the efficients markets theory as presented in [1], I shall present the model in a different way which hopefully is free of whatever is misleading or difficult to follow in the earlier approach. The analysis is a condensation of [2] and [3, chs. 7 and 8].

An Efficient Capital Market

Market efficiency requires that in setting the prices of securities at any time $t-1$, the market correctly uses all available information. For simplicity, assume that the prices of securities at $t-1$ depend only on the characteristics of the joint distribution of prices to be set at t. Market efficiency then requires that in setting prices at $t-1$, the market correctly uses all available information to assess the joint distribution of prices at t. Formally, in an efficient market,

$$f(P_t|\phi_{t-1}) = f_m(P_t|\phi^m_{t-1}), \tag{1}$$

where $P_t = (p_{1t}, \ldots, p_{nt})$ is the vector of prices of securities at time t, ϕ_{t-1} is the set of information available at $t-1$, ϕ^m_{t-1} is the set of information used by the market, $f_m(P_t|\phi^m_{t-1})$ is the market assessed density function for P_t, and $f(P_t|\phi_{t-1})$ is the true density function implied by ϕ_{t-1}.

The description of an efficient market given by (1) is too general to be testable. To test market efficiency, a specification of the link between $f_m(P_t|\phi^m_{t-1})$ and P_{t-1} is needed. We must specify how equilibrium or market-clearing prices at $t-1$ are related to the market assessed distribution of future prices. This is a common feature of tests of market efficiency. Tests must be based on a model of equilibrium, and any test is a joint test of efficiency and of the model of equilibrium.

The usual general assumption is that the conditions of market equilibrium can (somehow) be stated in terms of expected returns. The characteristics of the market assessed distribution $f_m(P_t|\phi^m_{t-1})$ determine the equilibrium expected returns on securities, and the market then sets the prices of securities at $t-1$ so that it perceives expected returns to be equal to their equilibrium values. Formally, the

* Theodore O. Yntema Professor of Finance, Graduate School of Business, University of Chicago.

market sets $p_{j,t-1}$, the price of security j at $t-1$, so that

$$p_{j,t-1}=\frac{E_m(\tilde{p}_{jt}\,|\,\phi_{t-1}^m)}{1+E_m\left(\tilde{R}_{jt}\,|\,\phi_{t-1}^m\right)}, \tag{2}$$

where $E_m(\tilde{R}_{jt}\,|\,\phi_{t-1}^m)$ is the equilibrium expected return on security j implied by $f_m(P_t\,|\,\phi_{t-1}^m)$ and $E_m(\tilde{p}_{jt}\,|\,\phi_{t-1}^m)$ is the market assessed expected value of the price of security j at time t.

The price $\tilde{p}_{jt}$ will, however, be generated by nature, that is, it will be drawn from the true distribution of prices $f(P_t\,|\,\phi_{t-1})$. Let $E(\tilde{p}_{jt}\,|\,\phi_{t-1})$ be the true expected price of security j implied by $f(P_t\,|\,\phi_{t-1})$ and let $E(\tilde{R}_{jt}\,|\,\phi_{t-1})$ be the true expected return implied by $E(\tilde{p}_{jt}\,|\,\phi_{t-1})$ and $p_{j,t-1}$. If the market is efficient, that is, if (1) holds, we have

$$E(\tilde{p}_{jt}\,|\,\phi_{t-1})=E_m(\tilde{p}_{jt}\,|\,\phi_{t-1}^m) \tag{3}$$

and

$$E\left(\tilde{R}_{jt}\,|\,\phi_{t-1}\right)=E_m\left(\tilde{R}_{jt}\,|\,\phi_{t-1}^m\right). \tag{4}$$

Thus in an efficient market the true expected return on any security is equal to its equilibrium expected value, which is, of course, also the market's assessment of its expected value. In an inefficient market, on the other hand, true expected returns and equilibrium expected returns are not necessarily identical. In setting prices at $t-1$, the market may overlook some of the information in ϕ_{t-1}, or it may use the information incorrectly in assessing the distribution of future prices.

Market efficiency says nothing specific about how the characteristics of $f_m(P_t\,|\,\phi_{t-1}^m)$ determine the equilibrium expected return $E_m(\tilde{R}_{jt}\,|\,\phi_{t-1}^m)$. This is the province of the model of market equilibrium. Some model of market equilibrium, that is, some specific statement about how $E_m(\tilde{R}_{jt}\,|\,\phi_{t-1}^m)$ is related to characteristics of $f_m(P_t\,|\,\phi_{t-1}^m)$ is needed to test the market efficiency condition of (4), but the choice of a model of equilibrium is not restricted by the market efficiency condition. Thus I have some difficulty with LeRoy's [4] definition of an efficient market, given in his equation (7), which requires that equilibrium expected returns depend only on time t and not on the details of the information set ϕ_{t-1}^m.

Testable Implications of Market Efficiency

There are two common approaches to testing the market efficiency proposition of (4). One is based on the implication of (4) that in an efficient market, trading rules with abnormal expected returns do not exist. Consider any trading rule, based on the information ϕ_{t-1}, which specifies proportions $\alpha_j(\phi_{t-1})$, $j=1,\ldots,n$, of investment funds to be put into individual securities at time $t-1$. If the market is efficient, then from (4),

$$\sum_{j=1}^{n}\alpha_j(\phi_{t-1})E\left(\tilde{R}_j\,|\,\phi_{t-1}\right)=\sum_{j=1}^{n}\alpha_j(\phi_{t-1})E_m\left(\tilde{R}_{jt}\,|\,\phi_{t-1}^m\right);$$

that is, the expected return for any such trading rule is just the implied linear conbination of the equilibrium expected returns. Given some specification of the values of equilibrium expected returns, if we can find trading rules for which this statement does not hold, then (4) does not hold and the market is inefficient. It seems, then, that (4) is a testable proposition about an efficient market.

The second approach to tests of efficiency is based on the implication of (4) that there is no way to use the information ϕ_{t-1} available at $t-1$ as the basis of a correct assessment of the expected return on security j which is other than its equilibrium expected value. In general terms, the usual test is to take some specific element of information (past returns, an earnings report, announcement of a merger, etc.) available at $t-1$ and try to use it to identify deviations of the true expected return from its assumed equilibrium expected value. Again it seems that (4) is a testable proposition about an efficient market.

REFERENCES

1. Eugene F. Fama. "Efficient Capital Markets: A Review of Theory and Empirical Work," *Journal of Finance* XXV (2) (May 1970), 383–417.
2. ———. "Short-Term Interest Rates as Predictors of Inflation," *American Economic Review* LXV (2) (June 1975).
3. ———. *Foundations of Finance*, New York: Basic Books, 1976.
4. Stephen F. LeRoy. "Efficient Capital Markets: A Comment," *Journal of Finance*, this issue.