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ABSTRACT

The notion of asset market efficiency -- that market prices "fully reflect" all available information -- requires the operation of mechanisms that rapidly incorporate new information into asset prices. Particularly problematic -- both theoretically and empirically -- has been the case where new information is not widely shared, so-called "strong-form" efficiency. This paper examines the relevance of a mechanism for attaining strong-form efficiency based on knowledgeable investors being willing to take large positions in order to eliminate unexploited profit opportunities. We examine theoretically and empirically, the latter using daily stock market data, the impact of a number of factors on the efficacy of this mechanism: the portfolio size and degree of risk aversion of potential investors, the ability to borrow, and the hedging opportunities provided by the stock market.

ON RISK, RATIONAL EXPECTATIONS, AND EFFICIENT ASSET MARKETS

Guy V.G. Stevens and Dara Akbarian[1]

I. Introduction

The notion of asset market efficiency -- that market prices "fully reflect" all available information (Fama 1970) -- requires the operation of mechanisms that rapidly incorporate new information into asset prices.[2] Most empirical evidence is consistent with the hypothesis that markets such as the U.S. stock market possess what is called "weak form" and "semi-strong form" efficiency: that both data on past returns and other publicly available information cannot improve forecasts of returns [Fama (1970), Abel and Mishkin (1983), Uri and Jones (1990)].[3] However, when we get to "strong form" efficiency -- the efficient incorporation of information that initially, at least, is not public knowledge -- there is little empirical or theoretical support for rapid convergence to the rational expectations or efficient markets price. It is the contention of this paper that, in assessing the realism of mechanisms that either promote or prevent strong-form efficiency, a key and often underappreciated factor is the effect of *risk.*

The empirical evidence regarding strong-form efficiency is sparse and, generally, unfavorable [Niederhoffer and Osborne (1966), Fama (1970), Baesel and Stein (1979), and Givoly and Palmon (1985)]. Theoretical support is similarly weak. Almost two decades of research on learning mechanisms, usually under the assumption of homogeneous information, has given only partial support to the attainment of a rational expectations equilibrium, and that as a long-run

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[2] In this paper, following Mishkin (1983), Shiller (1984), and Summers (1986), we will use the terms "rationality" and "efficiency" interchangeably, as well as the terms "efficient markets price" and "rational expectations price."

[3] However, as argued persuasively by Shiller (1984) and, especially, Summers (1986), the same data are also consistent with significant deviations from rationality.

limit.[4] Where problems of heterogeneity of information or differences in investors' abilities to process it are involved, the theoretical results are typically even less favorable for stock market efficiency.[5] Models developed by Figlewski (1978), Shiller (1984), Haltiwanger and Waldman (1985), and De Long, Shleifer, Summers, and Waldman (1990) all possess solutions where the class of less-informed or less-rational investors prevents the market from realizing the full information, rational expectations price.

Proponents of rational expectations and strong-form efficiency have long recognized that the simple paradigms originally used for support, based on costless and universally available information and a homogeneous class of rational investors, are oversimplified and unrealistic [e.g., Fama (1970), p. 387]. However, at least since Fama (1970), supporters have suggested, if not developed rigorously, a more realistic alternative model based on the speculative activity of the class of well-informed or rational investors. A clear statement of the nature of this model or mechanism can be found in Mishkin (1983):

> "Second, this [rational expectations equilibrium] condition should be a useful approximation even if not all market participants have expectations that are rational. Indeed, even if most market participants were irrational, we would still expect the market to be rational *as long as some market participants stand ready to eliminate unexploited profit opportunities."* (p. 11, italics and expression in brackets added).

An examination of the empirical relevance of this mechanism is the main goal of this paper.[6]

The Fama-Mishkin approach implies that a few or, for that matter, even one informed and rational investor, by taking large positions in an under or over-valued asset, can do exactly what would be done if all investors possessed the same information. It can be argued, further, that any *leakage* of the new information by virtue of other market participants observing these large positions is just a bonus in terms of promoting movement to the new efficient-markets equilibrium.[7]

One requirement for the action of such a mechanism is that the investor has the *ability* to

[4] See Bray (1983) for a comprehensive discussion of the results. Friedman (1979) and Bray (1983) develop learning models where there is convergence to the classic rational expectations equilibrium. For cases of non-convergence or convergence to an equilibrium other than the classic one, see Cyert and DeGroot (1974), DeCanio (1979), and Fourgeaud, Gourieroux, and Pradel (1986).

[5] See Radner (1983) for a general discussion of problems posed by heterogeneity of information for convergence to a rational expectations equilibrium.

[6] Because we are interested here in *short run* convergence to the efficient markets or rational expectations price, we ignore the long run argument that well-informed, rational investors will make higher profits and accumulate wealth faster than other investors, eventually causing the latter to make up an insignificant part of the market [Friedman (1953, pp. 157 ff.), Cootner (1967, p. 80)]. See Figlewski (1978) and DeLong, Shleifer, Summers, and Waldman (1990) for models that contradict long run convergence based on the above wealth argument.

[7] For a discussion of leakage problems, see Hirshleifer and Riley (1992); see also footnote 10, below.

take large positions -- through sufficient initial wealth and/or the opportunity to borrow and lend. Another is that the informed investor is essentially *risk neutral or not "too" risk averse, or that the market provides ample opportunity to hedge the risks inherent in large unbalanced portfolios.* As will be discussed below in detail, it thus becomes an *empirical question* whether unexploited profit opportunities can thus be eliminated -- the answer dependent, in particular, on the degree of risk aversion, the wealth of the investor, the size of the profit opportunity, and the existence of market opportunities to hedge or diversify away the rapidly increasing risk associated with large positions in a single asset.

Many of the same factors are also relevant for the realism of the models, noted above, where the class of less-informed or irrational investors causes the market price to diverge from the efficient or rational expectations solution. Virtually all of these models require the class of informed or rational investors to be risk averse.[8] Risk aversion allows this class to reach equilibrium even when "excess" expected returns persist; and the degree of risk aversion of this class along with the level of (undiversifiable) risk in the system are directly related to the discrepancy, in equilibrium, between the existing price and the rational expectations price.

The goal of this paper, then, is to investigate the theoretical and, especially, the empirical relevance of conditions that, under risk aversion, would still allow large shifts in portfolios in response to the appearance of unexploited profit opportunities. Section II is devoted to theoretical issues, in particular the key individual and market factors that are necessary and/or sufficient for large changes in the holdings of a single stock. In section III, we investigate empirically the short-term variance-covariance structure of the U.S. equities market and, using these results, calculate the extent to which investors of varying risk preferences and wealth can, single-handedly, move selected stock prices to their new rational expectations equilibria.

II. Theoretical Considerations

A. The Impact of New Information on the Rational Expectations Price

We assume initially a stock market made up of a set of risk averse investors, each of whom

[8] One exception is the model of Haltiwanger and Waldman (1985), where "congestion effects" (costs) and "synergistic effects" substitute for risk aversion.

maximizes an expected utility function of the mean and variance of one-period return.[9] Initially, all investors share identical expectations, the market equilibrium is fully rational and, therefore, all assets will be priced according to the capital asset pricing model. Accordingly, the expected return per dollar , $\bar{r}_i$, and share price, P_i, of any given stock i will be related to the market portfolio and the risk-free interest rate as follows:

$$\bar{r}_i = \bar{Y}_i/P_i = r_f + [\bar{r}_m - r_f](\sigma_{im}/\sigma_m^2), \tag{1}$$

where: $\bar{Y}_i$ is expected nominal income per share for stock i (expected dividends plus capital gains); r_f, the rate of return on the risk-free asset (1 + the riskless rate of interest, R_f); $\bar{r}_m$, the expected rate of return on the market portfolio; σ_{im}, the covariance between the returns on the market portfolio and the ith stock, and σ_m^2, the variance of the return on the market portfolio. (See, e.g., Copeland (1983) chpt. 7, Elton and Gruber (1987) chpt. 11.)

In this section and subsequent sections we will examine the ability of an investor, upon obtaining new and, for the short-run, private information, to single-handedly move market prices to the rational expectations equilibrium that incorporates this information. Let us consider a very specific example, so that one can calculate easily what the final rational expectations equilibrium would be. Assume that our investor is the only person that learns that a government subsidy, amounting to S dollars per share, will be awarded to a given firm -- a subsidy that will be announced publicly in a short period of time. In the meantime -- to avoid the complications of "leakage" problems -- we will assume further that the investor will be able to purchase, up until the announcement date, as many shares of the stock as desired at today's price.[10] Since the subsidy will be paid in every state of nature, the only change in the probability distribution of the firm's returns (per share) will be a shift in the mean by S, to $\bar{Y} + S$; it is easily shown that none of

[9] Since the utility function we rely on the most in the empirical section is an exponential function, $U(W) = -e^{-aW}$, exhibiting constant absolute risk aversion (CARA), it is necessary to assume that all risky returns follow a normal distribution. (See Ingersoll (1987), p.98.)

[10] For a consideration of the many problems that arise when, either naturally or as a result of the investor's actions, his information leaks to other speculators, see, e.g. Hirshleifer and Riley (1992). All leakage problems break the rules of the original Mishkin formulation, because leakage implies the spread of the information, however imperfectly, to part or all of the rest of the market. By postulating that the investor can purchase as many shares as desired at the *existing* market price, we are weighting the example in favor of Mishkin's conclusion: if, on the other hand, in attempting to purchase a large block of shares, the investor causes the price to rise because of monopsony considerations, he will tend to stop his purchases prematurely because of his rising marginal cost.

the other moments of the distribution change -- its variance or covariances with other security returns. Thus, because nothing on the right hand side of equation (1) changes, the expected rate of return per dollar of stock i, $\bar{r}_i$, must remain constant; as a result the final rational expectations equilibrium price of share i, P^*_i , must jump to leave the ratio $(\bar{Y}_i + S)/P^*_i$ equal to the unchanged $\bar{r}_i$.[11] Solving that relation for P_i^*, we find that the price must jump by $S/\bar{r}_i$:

$$P^*_i = P_i + S/\bar{r}_i. \tag{2}$$

As we will calculate in the next section, even small changes in price, when realized in the short run, lead to enormous rates of return -- dwarfing the contribution of the firm's dividends.

A more topical example, but similar in structure to the above, would be information of a new takeover bid at a given premium over the current market price; if the takeover price were certain, then, once again, the new information would lead to an increase in the knowledgeable investor's expected rate of return, with no change in his assessment of the firm's variance or covariances.

B. Individual Equilibrium

To find the investor's optimal holdings of all risky and riskless assets before and after the receipt of the new information, we will assume, as is customary, that the investor maximizes the expected utility of his or her income, E[u(Y)]. That income, Y, can be expressed alternatively as the sum of returns on holdings of riskless bonds (B) and risky stocks (the Z_is, below, with $\tilde{r}_i$ the risky return), or as total wealth (W) times the riskless rate of return plus the sum of "excess" returns on stock holdings:

$$Y = r_f B + \sum_{i=1}^{N} Z_i \tilde{r}_i = r_f W + \sum_{i=1}^{N} Z_i(\tilde{r}_i - r_f) \tag{3}$$

Given that total wealth, W, is a predetermined constant at the time of decision, by putting no restrictions on the sign or size of either B or the Z_is, we are implicitly assuming that the investor can borrow or lend any amount at a constant riskless rate of interest (r_f).[12]

[11] We are assuming here that the increase in the expected return as a result of the subsidy has a negligible effect on the expected return on the *market* portfolio, $\bar{r}_m$.

[12] Once again, we are weighting the assumptions in favor of large portfolio shifts; investors will not be hindered or stopped in the attempts to purchase large blocks of shares by an increasing borrowing rate.

Maximization of expected utility by the investor leads to the well-known set of first order conditions:

$$E[u'(Y)(\tilde{r}_i - r_f)] = 0, \quad i = 1, N. \qquad (4)$$

After making the required assumptions about the type of utility function and the probability distribution of returns, one could work directly with this set of first order conditions (e.g. Mossin (1973), pp. 50 ff.). Given, however, that all the examples studied below will depend only on the first two moments of the probability distributions of interest, we will instead use an equivalent approach which relies on the somewhat more transparent first order conditions for the risk-return efficiency frontier.[13] As will be done for specific examples below, the investor's optimal portfolio can also be determined by maximizing expected utility subject to the efficiency frontier.

C. The Risk-Return Efficiency Frontier

The risk-return efficiency frontier is defined as the locus of points minimizing variance conditional on a given expected rate of return. As noted above, with the option of unlimited lending and borrowing in the riskless asset, the investor's expected return, E(Y), is defined as:

$$E(Y) = \bar{Y} = r_f W + \sum_{i=1}^{N} Z_i (\bar{r}_i - r_f) = r_f W + \mathbf{z}'\bar{\mathbf{m}} \qquad (5)$$

On the right hand side, $\bar{\mathbf{m}}$ and $\mathbf{z}$ are both N by 1 column vectors of excess expected returns and nominal security holdings, respectively. The variance of the overall portfolio return, V(Y), is equal to:

$$V(Y) = \sum_{i=1}^{N} \sum_{j=1}^{N} Z_i Z_j \sigma_{ij} = \mathbf{z}'\mathbf{C}\mathbf{z}, \qquad (6)$$

where σ_{ij} is the covariance of return between assets i and j, and **C** is the N by N matrix of variances and covariances $[\sigma_{ij}]$. Minimizing V(Y) subject to a given expected return, E(Y), leads to the first order conditions:

$$2\mathbf{C}\mathbf{z} - \lambda\bar{\mathbf{m}} = 0, \qquad (7)$$

where λ is the Lagrange multiplier for the constraint, (5) above. Solving this system of equations for **z** leads to the following expression for the vector of optimal holdings of risky assets along the efficiency frontier:

[13] See, e.g., Elton and Gruber (1987), chapter 4, or Mossin (1973), p. 55.

$$\mathbf{z} = \lambda/2\mathbf{C}^{-1}\bar{\mathbf{m}}. \tag{8}$$

Although the level of vector **z** depends on the unknown λ -- and, therefore, generally on the investor's utility function and the required expected return -- equation (8) does fix the *ratios* of various risky assets held along the efficiency frontier in any optimal portfolio: the famous portfolio separation theorem discovered by Tobin (1958). Thus, irrespective of the investor's wealth or utility function, the ratio of holdings of any two assets i and j, will be constant at all points along the risk-return efficiency frontier. This optimal ratio will depend only on the investor's estimates of expected excess returns, variances, and covariances:

$$Z_i / Z_j = \sum_k c^{-1}_{ik} (\bar{r}_k - r_f) / \sum_k c^{-1}_{jk} (\bar{r}_k - r_f). \tag{9}$$

The numerator of (9) shows that holding of any asset, Z_i, is proportional to the product of the elements of the ith row of the inverse of the covariance matrix, the elements c^{-1}_{ik}, times the vector of excess expected returns.

By substituting the optimal **z** from the first order conditions (8) back into the expressions for the variance [**z'Cz**] and expected return [$r_f W + \bar{\mathbf{m}}'\mathbf{z}$], one derives the well-known efficiency frontier that turns out to be *linear* in the excess expected return and standard deviation. Eliminating the Lagrange multiplier, the frontier becomes:

$$\sigma_Y = \sqrt{V(Y)} = (\bar{\mathbf{m}}'\mathbf{C}^{-1}\bar{\mathbf{m}})^{-1/2} [E(Y) - rW]. \tag{10}$$

D. Conditions for Large Shifts in Portfolio Holdings

So far these equations and relationships do not illuminate the most important question for this paper: What are the conditions under which an investor can or cannot accumulate a large position in an asset for which he has received or derived valuable new information? And what are the conditions under which he can hedge the potential rapid buildup of overall portfolio risk by appropriately changing his holdings of other assets?

The theoretical conditions for the buildup of portfolio risk are most easily illuminated by an adaptation of the approach developed by Anderson and Danthine (1981). They partition the equilibrium conditions similar to (7) in an illuminating way and, although not strictly necessary, facilitate the linking of the theoretical terms in (7) to empirical data.

Let us denote the stock for which the private information is forthcoming as asset number 1, with expected return, $\bar{r}_1$, variance, σ_{11}, and holdings Z_1. There would, therefore, be N-1 other risky assets. Following Anderson and Danthine, partition the first order conditions for the risk-return frontier (7) into the equation for the first asset and an N-1 equation block for the remaining risky assets:

$$\sigma_{11}Z_1 + \sum_{j=1}^{N-1} \sigma_{1j}Z_j = \lambda\backslash 2\bar{m}_1 \tag{11}$$

$$\mathbf{c}^{\mathbf{1}}Z_1 + \mathbf{C}_{N-1}\mathbf{z}_{N-1} = \lambda\backslash 2\bar{\mathbf{m}}_{N-1}$$

The symbols in the first equation have been defined above. In the lower block, $\mathbf{c}^{\mathbf{1}}$ is a N-1 column vector comprising all but the first element of the first column of the original **C** matrix; $\mathbf{C}_{N-1}$ is the N-1 square submatrix of the variance-covariance matrix **C** formed by eliminating the first row and column; similarly $\mathbf{z}_{N-1}$ and $\bar{\mathbf{m}}_{N-1}$ are the N-1 column vectors comprising all but the first element of the old **z** and $\bar{\mathbf{m}}$ vectors, respectively.

This partition becomes particularly meaningful when we substitute actual data for the theoretical variances, covariances and expected returns in equations (11). For the expected return on the ith asset, $\bar{r}_i$, one typically takes the average of observed returns over some sample period. Thus, for example, for a sample of size T, the empirical estimate, $\hat{\bar{r}}_i$, of the subjective expected return, $\bar{r}_i$, equals $1/T \sum_{k=1}^{T} r_{ik}$. For an estimate of an element of the vector of expected *excess* returns, $\bar{m}_i$, we subtract the riskless rate of interest, yielding: $\hat{\bar{m}}_i = 1/T \sum_{k=1}^{T} (r_{ik} - r_{fk})$. Similarly, an element of the variance-covariance matrix, **C**, turns out to be: $\hat{\sigma}_{ij} = 1/T \sum_{k=1}^{T} (r_{ik} - \bar{r}_i)(r_{jk} - \bar{r}_j)$. Let $\mathbf{r}^{\mathbf{i}}$ be the column vector of the T observations on the return on asset i around its mean; and let **R** be the T by N-1 matrix with columns $\mathbf{r}^{\mathbf{j}}$ for assets 2, N. Then the empirical estimate for the matrix $\mathbf{C}_{N-1}$ in equation (11), above, would be **R'R**/T (where **R'** is the transpose of **R**).

We are now ready to rewrite the partitioned equation set (11), substituting the empirical estimates defined above for the theoretical means, variances and covariances appearing in (11):

$$\mathbf{r}^{\mathbf{1}\prime}\mathbf{r}^{\mathbf{1}}Z_1 + \mathbf{r}^{\mathbf{1}\prime}\mathbf{R}\mathbf{z}_{N-1} = (\lambda T/2)\hat{\bar{m}}_1 \qquad (12)$$
$$\mathbf{R}'\mathbf{r}^{\mathbf{1}}Z_1 + \mathbf{R}'\mathbf{R}\mathbf{z}_{N-1} = (\lambda T/2)\hat{\bar{\mathbf{m}}}_{N-1},$$

where the expression $\mathbf{r}^{\mathbf{1}\prime}\mathbf{r}^{\mathbf{1}}$ is the estimate of the variance of return on variable 1, $\hat{\sigma}_{11}$, times the number of observations, T; all factors T can be moved to the right hand side of (12) for convenience.

Let us now solve the bottom block of N equations for the N-1 by 1 column vector $\mathbf{z}_{N-1}$. Assuming that the various inverses exist,

$$\mathbf{z}_{N-1} = \lambda T/2\,(\mathbf{R}'\mathbf{R})^{-1}\hat{\bar{\mathbf{m}}}_{N-1} - (\mathbf{R}'\mathbf{R})^{-1}\mathbf{R}'\mathbf{r}^{\mathbf{1}}Z_1. \qquad (13)$$

This expression makes the holdings, Z_j, for each of the *other* N-1 assets, a function of the excess returns on *all* these other assets ($\hat{\bar{\mathbf{m}}}_{N-1}$) and the holding for asset 1, Z_1. Note particularly the set of coefficients multiplying Z_1: $-(\mathbf{R}'\mathbf{R})^{-1}\mathbf{R}'\mathbf{r}^{\mathbf{1}}$. This is (minus) the N-1 by 1 vector of estimated *least squares regression coefficients,* $\hat{\beta}$, when the time series of returns for asset 1, $\mathbf{r}^{\mathbf{1}}$, is regressed on the returns for all the other N-1 assets. Thus, insofar as the return on a particular asset r_j has a "high" positive coefficient in the regression for r_1, the holding of asset j will be correspondingly low.

Let us now substitute this expression for $\mathbf{z}_{N-1}$ into the first equation in system (12). We then get:

$$\mathbf{r}^{\mathbf{1}\prime}\mathbf{r}^{\mathbf{1}}Z_1 - \mathbf{r}^{\mathbf{1}\prime}\mathbf{R}(\mathbf{R}'\mathbf{R})^{-1}\mathbf{R}'\mathbf{r}^{\mathbf{1}}Z_1 = \lambda T/2\hat{\bar{m}}_1 - \lambda T/2\,\mathbf{r}^{\mathbf{1}\prime}\mathbf{R}(\mathbf{R}'\mathbf{R})^{-1}\hat{\bar{\mathbf{m}}}_{N-1} \qquad (14)$$

As noted above, the first term, $\mathbf{r}^{\mathbf{1}\prime}\mathbf{r}^{\mathbf{1}}$ is an estimate of $T\hat{\sigma}_{11}$. Moreover, the coefficient of the second entry for Z_1, $-\mathbf{r}^{\mathbf{1}\prime}\mathbf{R}(\mathbf{R}'\mathbf{R})^{-1}\mathbf{R}'\mathbf{r}^{\mathbf{1}}$, can be shown to be equal to $-T\hat{\sigma}_{11}R_1^2$, where the latter is *the multiple correlation coefficient for the regression of the first asset's return (r_1) on the returns for the other N-1 assets*.[14] We thus have a final equation for the holdings of asset 1 along the risk-return ef-

[14] Given the definition of the vector of regression coefficients, $\hat{\beta}$, the expression $\mathbf{r}^{\mathbf{1}\prime}\mathbf{R}(\mathbf{R}'\mathbf{R})^{-1}\mathbf{R}'\mathbf{r}^{\mathbf{1}}$ is easily shown to be equal to $\mathbf{r}^{\mathbf{1}\prime}\mathbf{R}\hat{\beta}$. But this term can be shown to be equal to $\mathbf{r}^{\mathbf{1}\prime}\mathbf{r}^{\mathbf{1}}R_1^2$, which in turn equals $T\hat{\sigma}_{11}R_1^2$

(Footnote continues on next page)

ficiency frontier:

$$Z_1 = \{\lambda/[2\hat{\sigma}_{11}(1-R_1^2)]\}\{(\bar{r}_1 - r_f) - \sum_{j=2}^{N} \hat{\beta}_j(\bar{r}_j - r_f)\} \qquad (15)$$

As derived, equation (15) shows that the optimal holding of asset 1 in any minimum variance portfolio is related crucially to the multiple correlation coefficient, R_1^2; given the levels of the expected excess returns and other variables in the equation, as the return of asset 1 is more highly correlated with any linear combination of the returns of other stocks, the holdings, Z_1, will be higher.

Under certain circumstances, the equilibrium condition (15) can be used to determine the *change* in asset holdings as expected returns and other factors change. For small changes in the own expected excess return, $\bar{r}_1 - r_f$, where λ changes only marginally, the equation shows that the change in Z_1 is proportional to the factor $\lambda/[2\hat{\sigma}_{11}(1-R_1^2)]$. More important, equation (15) with λ equal to a constant also holds *for changes of any size* when the investor has a CARA utility function.[15]

As R_1^2 approaches 1, the response to a unit change in $\bar{r}_1 - r_f$ approaches ∞, a case with a result identical to that which underlies the Fama-Mishkin mechanism. In this limiting case the result is the same as the case of risk neutrality, because a perfect hedge exists for the risk of asset 1: as the investor increases his holding of asset 1 to capture the higher return that only later will be revealed to the market, he goes short in an optimal combination of other assets, thereby leaving his overall portfolio risk *unchanged.* However, for anything less than an R_1^2 of 1, the increase in the holdings of asset 1 will be limited. Thus, the extent to which the investor can act alone to assure the ef-

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(Johnston (1972), p. 131). As explained above, the number of observations, T, can be absorbed into the right hand side of the equation.

[15] It turns out, in fact, that this is an exact result for a CARA utility function. This can be seen from the equation for the shares in the risky portfolio, **w**, and the fact that for this utility function, the total value of risky holdings is a constant. The equation for **w** is $\alpha\mathbf{C}^{-1}\mathbf{m}$, where α is a parameter of the CARA utility function. Since total risky holdings equals some constant, say K, then the equation for the dollar value of the holding of asset 1, Z_1, would be $K\mathbf{w}_1$ -- a constant as long as the determinants of **w** do not change. But in equation (15), above, we write Z_1 as a function of λ; thus, for the two expressions to be equal, λ must be a constant for a CARA utility function. See Ingersoll (1987), p. 98, for the derivation of the equation for the asset shares in a CARA utility function.

ficiency of the market, "to stand ready to eliminate unexploited profit opportunities," is an empirical question. The answer depends on the many variables in equation (15), but primarily on the size of R_1^2, the size of the own variance, $\hat{\sigma}_{11}$, and the size of the change in the expected return of the asset in question.

For special cases, equation (15) can be simplified even further. Where λ continues to be assumed constant and the only cause of a change in the holdings of a given asset, ΔZ_i, is *a change in its own expected return*, $\Delta\bar{r}_i$, one can take the first difference of equation (15) as follows:

$$\Delta Z_i = \{\lambda/[2\hat{\sigma}_{ii}(1-R_i^2)]\}\ \Delta\bar{r}_i. \tag{16}$$

Besides confirming the dependence of the size of changes on the product of the multiple correlation coefficient and the own variance, equation (16) also shows that, assuming the constancy of λ, $\hat{\sigma}_{11}$, and R^2, changes of *any* magnitude can be generated by suitably large changes in the expected return. Thus, it is clear once again, that how much risk aversion limits an investor's ability to eliminate unexploited profit opportunities is an empirical question.

A corollary to (16), again for small changes or special cases like the CARA utility function, is a particularly simple and illuminating version of the portfolio separation theorem noted above in equation (9). Where the changes in the expected own rates of return are equal -- i.e., $\Delta\bar{r}_i = \Delta\bar{r}_j$ -- the *ratio* of the change in holdings depends only on the ratio of the stocks' adjusted risk factors:

$$\Delta Z_i/\Delta Z_j = \hat{\sigma}_{jj}(1-R_j^2)\ /\ \hat{\sigma}_{ii}(1-R_i^2) \tag{17}$$

III. Experiments With New Information Using U.S. Stock Market Data

As summarized in equations (16) and (17), we have identified three *empirical* factors that are crucial in determining the magnitude of the response of a given investor to cases of new information of the type we are studying. These are the stock's "hedge-adjusted" variance ($\hat{\sigma}_{ii}(1-R_i^2)$), the characteristics of the investor (wealth and attitude toward risk, all embodied in λ), and the effect of the new information on the investor's assessment of the firm's expected return ($\Delta\bar{r}_i$).

The goal of this section is to investigate the empirical relevance of these factors in helping or hindering a given investor to eliminate the unexploited profit opportunities emphasized by Fama and Mishkin. We attack this question through a number of experiments or simulations, estimating the impact of new information concerning the expected return of specific stocks on the portfolio holdings of various representative investors. These simulations are based on empirical estimates of the expected return and variance-covariance structure of a large part of the U.S. stock market, and on a variety of alternative specifications of the investor's level of wealth and degree of risk aversion. The criterion we shall use to assess whether it is possible for a given investor to eliminate the profit opportunity or price differential is the size of the *change* in the investor's holdings as a percentage of the outstanding equity of the firm in question. This criterion is, of course, at best a necessary condition for strong-form efficiency: if an injection of valuable private information does not lead to a significant change in the investor's holdings, then we conclude, in this case, that the stock's price could not move to the rational expectations price and that strong-form efficiency could not be achieved. Should this negative result occur, an analysis of the results can determine whether the combination of the investor's risk aversion and the buildup of portfolio risk was the major cause. If, on the other hand, the new information causes the investor to demand a large percentage of the outstanding equity of the firm, then we can say that it is at least possible, despite his risk aversion, that the investor's actions alone are capable of driving the market price to the new rational expectations equilibrium. Without specific market demand and supply equations, one cannot, of course, be more specific.

A. Choice of Sample and Time Period

In choosing a sample, we want to include a selection of stocks large enough to provide a reasonably complete picture of an investor's actual opportunity set for hedging the risks associated with heavy purchases of one stock. It bears reiterating that, unlike the well-known result where little more than 20 different stocks are sufficient to statistically explain the variation in the market portfolio, it may take many more stocks -- if it can be done at all -- to explain with a high R^2 the variation in the return of a *particular* stock. Because the market portfolio is *the* quintessential highly diversified portfolio, its overall variance is affected only marginally by the idiosyncratic risks of individual stocks. On the other hand, for a portfolio constructed to hedge the risk of a particular stock, the importance of idiosyncratic factors is crucial; only if the variance of this particular stock is largely caused by factors common to the returns of other stocks -- hence ruling out the importance of idiosyncratic factors by definition -- will it be possible to construct a good hedge portfolio.

In principle, one could use all stocks, listed or otherwise, to form a hedge portfolio for the stock of the firm for which our investor has received or derived his private information.[16] Limits in the number of observations, even for daily data, makes this maximal approach impossible for now. As a compromise, we have constructed our portfolios from a large number of stocks that are also quantitatively very important: all of the consistently reported stocks -- 245 in number -- in the top decile, by value of outstanding equity, of listed securities on the New York Stock Exchange at the end of 1991; 199 of these stocks are in the S&P 500 index, accounting at the end of 1991 for 83.7% of the total value of the shares in that index. The other 46 firms in the top decile are large foreign firms, traded on the Exchange but not in the S&P 500, which equal over 45% of the total equity value of the decile. The sample and its construction is discussed at more length in the Appendix.

The data for this study are from the stock file maintained by the University of Chicago's Center for Research in Security Prices (CRSP); data are available on a monthly or daily basis.[17] For this study, the use of daily returns seems preferable; most new information is likely to become public in a short period of time, so the risks the investor faces seem more realistically to be those captured in daily variances and covariances.

The sample period chosen for this investigation runs from the beginning of 1988 through the end of 1991. A start after the crash of 1987 seemed appropriate and, at the time of the beginning of this empirical work (summer of 1993), the end of 1991 was the latest possible termination

[16] We do not treat here the possibility of using derivatives for the purpose of hedging the risks of the large unbalanced portfolios that are generated in the experiments discussed below. Partly this is because of our view that most of the conclusions below would be unaffected by their incorporation into the study. It also seems to be the case that, by postulating the existence of non-redundant derivatives, we just push the analysis of the increasing risk of holding large unbalanced portfolios back one stage -- to the provider of the derivatives; presumably, the cost of the appropriate derivative would be an increasing function of the quantity issued, because of the increasing risk exposure of its issuer.

[17] See, for details, Center for Research in Security Prices (1991).

point. Such a sample contains 1,010 observations, allowing as many as 765 degrees of freedom for any regression one might want to run.

Chart 1 is a histogram of the annualized average rate of return over the sample period for each included firm.[18] The mean of these annualized returns was 24.7%, fairly high by historical standards; however, it should be recalled that rates of return were quite high as the market recovered from the crash of 1987. In fact, for the same period, the annualized daily *price change* for the S&P 500 was 15.5% -- before adding in the effect of dividends on the rate of return.

B. Hedge Portfolios

As shown in the previous section, one of the key factors determining how private information will be translated into stock purchases is the percentage of the variance of a stock's return that can be explained by a linear combination of the returns of other stocks (its R_i^2).[19] Chart 2 shows the distribution of these multiple correlation coefficients for the 245 stocks in our sample. For those accustomed to dealing only with the market or other well-diversified portfolios, where the overall return can be largely explained statistically by just a few factors or stocks, it sometimes comes as a shock to discover how *little* of a typical stock's return, on average, can be explained by the returns of other stocks. With a mean R_i^2 for the sample of only 0.58, it is clear that a large part of the variance for the stocks of the most important firms in the economy consists of *idiosyncratic risk.*

C. Specific Examples of Optimal Purchases Resulting from the Receipt of Private Information

In this section, we report on a number of experiments to assess the impact of the various factors discussed above on a solitary investor's ability, by making "large" purchases, to single-handedly move the market from one rational expectations equilibrium to another. As noted above, our criterion for measuring the investor's ability to move the market will be the size of the purchases induced by the new information -- size as measured by the change in dollar holdings, but more importantly by the change in the percentage of the firm's outstanding equity held by the in-

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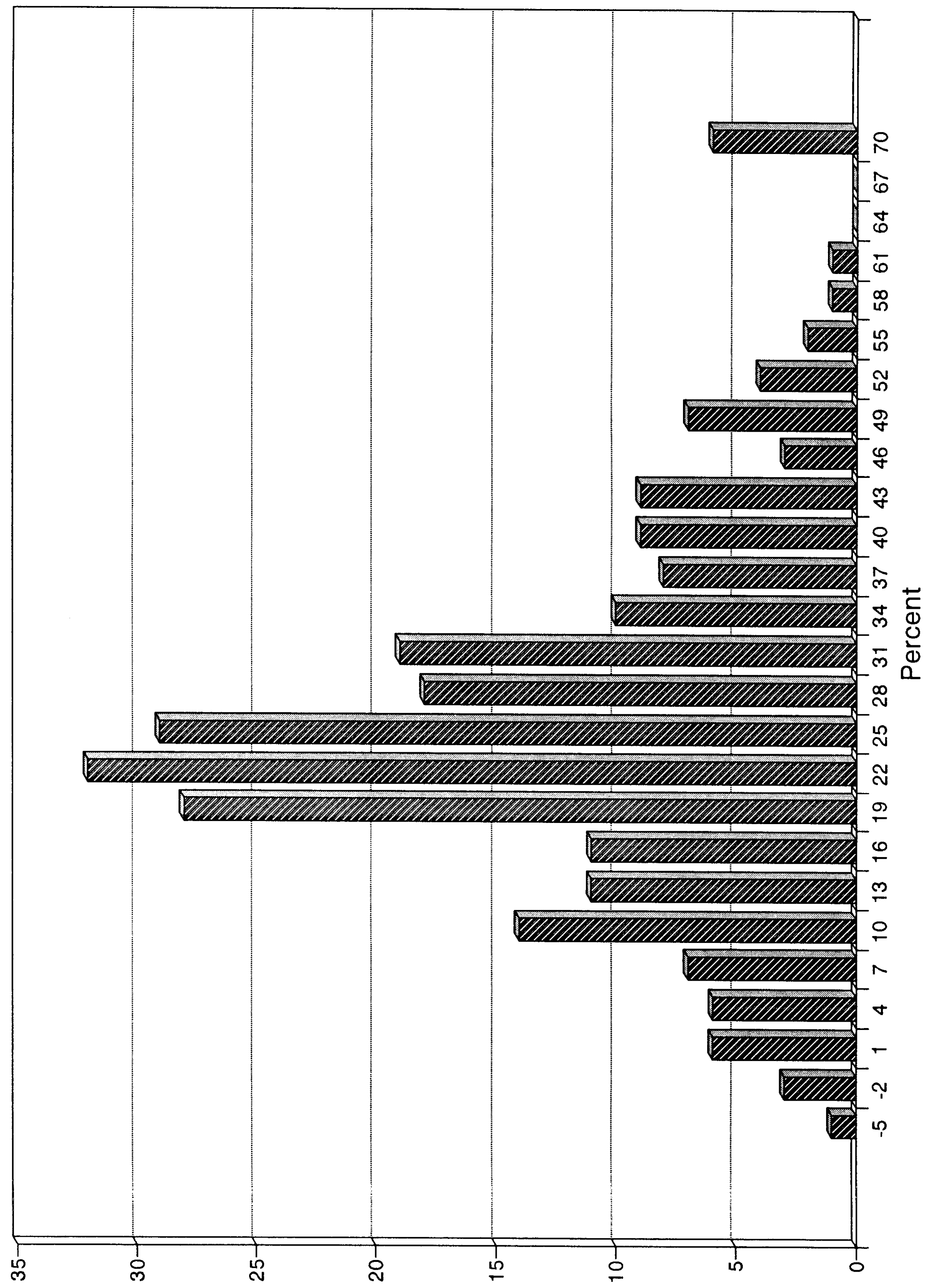
[18] The annualized (*ex post*) rate of return was estimated by first calculating the average daily return, $\bar{r}_i$, for a given firm i, and then raising $1+\bar{r}_i$ to the 252.5 power (the latter being the average number of annual trading days for the sample period).

[19] Note also the importance of the factor $\sigma_{ii}(1-R_i^2)$ in equations (16) and (17) -- the percent of a firm's variance that cannot be diversified away.

Chart 1: Distribution of Annualized
Mean Returns for 245 Stocks



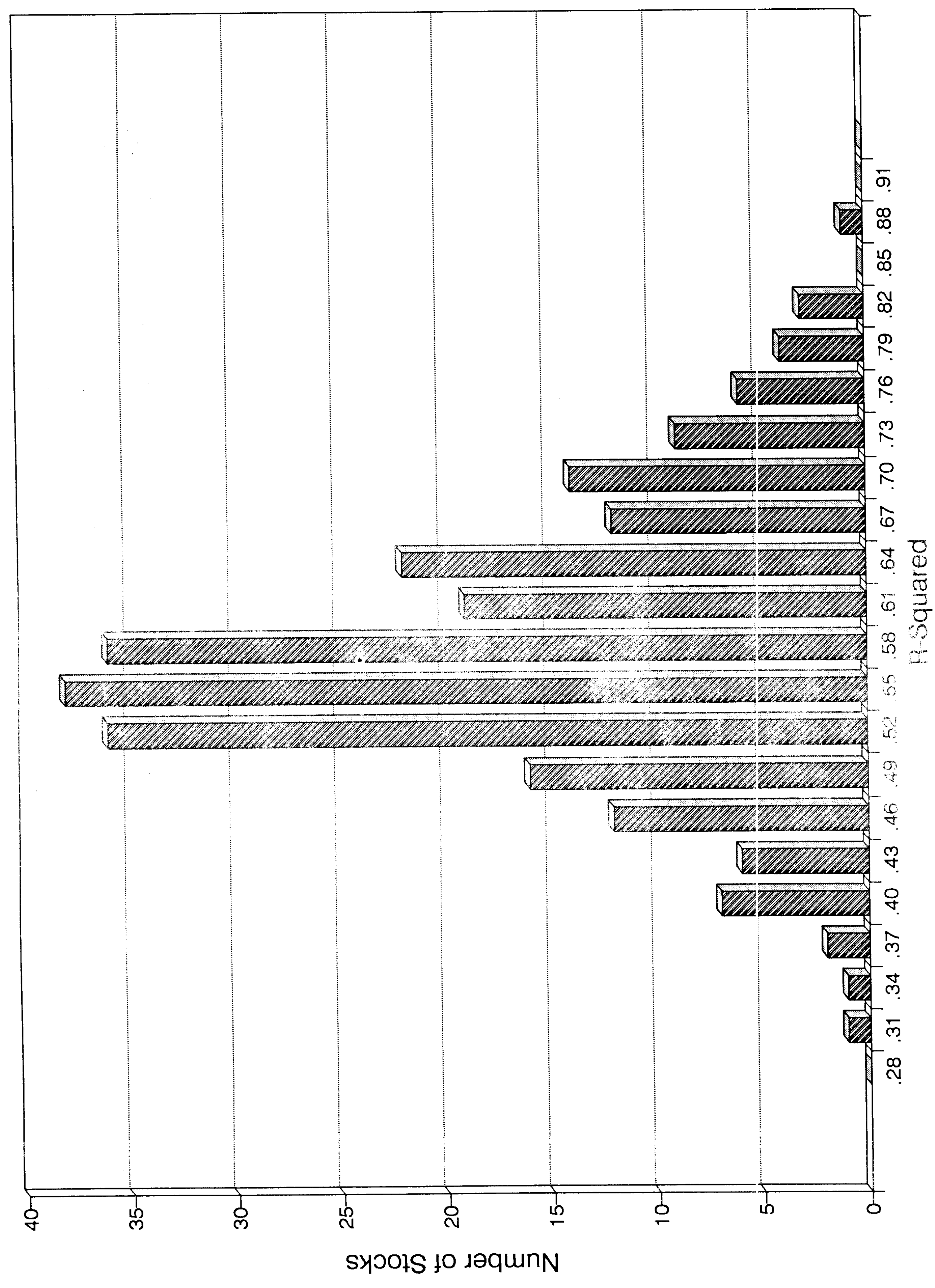


Chart 2. Distribution of R-Squareds

vestor.

In the experiments that follow, we have attempted to vary, within reasonable limits, the relevant parameters or factors that might affect the size of the investor's purchases in the light of his newly arrived information. These include, in particular, the investor's net worth and degree of risk aversion, the level of the risk-free rate, and the characteristics of the stock in question -- most importantly, the degree to which its variance can be diversified away. Where parameters are not easily varied, we have tried to err in the direction of encouraging large purchases; thus, we allow infinite borrowings at the riskless rate of interest and no limitations on short selling.

Of the alternative, but equivalent, approaches noted above for calculating the investor's optimal portfolio, we will choose the maximization of the investor's expected utility subject to the calculated risk-return frontier. Initially, two alternative utility functions were used for comparative purposes: a quadratic and an exponential -- the latter, as discussed above, exhibiting constant absolute risk aversion (CARA). However, because of the quadratic's property of increasing absolute risk aversion, it became immediately clear that, for our purposes, the results for the CARA utility function were all that was needed.[20]

C.1 The Baseline Optimum. Each experiment below compares two optimal portfolios, the first calculated for a common baseline case and the second for the case where the investor adds new information for a single stock to that already incorporated in the baseline. Below and in the Appendix, alternative baselines are calculated depending on the level of the investor's wealth, the level of the riskless rate of interest, and the vector of expected returns for the risky stocks. The one factor that remains constant in all the experiments is the variance-covariance structure, estimated as described above for the set of 245 securities in our sample.

In Tables 1 and 2 below, results are reported for two combinations of initial wealth and risk preferences. The first represents a moderately small investor with $1 million in net wealth and moderately conservative risk preferences; with respect to the latter, given the expected rates of

[20] Typically, we would calibrate the two utility functions so that both would result in an identical portfolio for the initial or baseline case (before the investor received or discovered his private information). However, because of the quadratic function's increasing absolute risk aversion, in every case after the receipt of information, the portfolio chosen with the quadratic had a lower total of risky stock holdings than that chosen with the CARA utility function. Because of the separation theorem, this implied that the change in the holding of the stock for which positive new information was obtained would always be smaller for the quadratic case.

return and covariances assumed for the baseline, the investor puts 50% of his wealth in risky assets.[21] The second case is one corresponding to a very large investor, with the size and risk preferences of a large contemporary hedge fund: command of $5 billion in net resources and risk preferences such that 90% of net wealth is invested in risky assets under the baseline assumptions.[22]

Alternative baselines for different riskless rates of interest are reported in the Appendix; since reasonable variations make no difference, the results reported below set the riskless rate of interest at the mean value for Treasury Bills for the 1988-91 period, 6.97% at an annual rate.

As derived in equation (10) above, the efficiency frontier is a straight line in the standard deviation and excess expected return of the optimal portfolio; the slope of the frontier is $(\bar{\mathbf{m}}'\mathbf{C}^{-1}\bar{\mathbf{m}})^{1/2}$, where, as reported above, $\bar{\mathbf{m}}$ is the column vector of expected excess daily returns and $\mathbf{C}^{-1}$ is the inverse of the variance-covariance matrix of daily returns. The same $\mathbf{C}$ matrix, calculated over the 1988-91 period, was used for all the experiments. On the other hand, two quite different alternatives were calculated for the baseline $\bar{\mathbf{m}}$ vector. The obvious candidate would be the vector of average returns observed for the sample period. One set of experiments was run using this choice, the results reported in the Appendix. The only problem with this alternative was that the optimal portfolio chosen for the baseline case was far different from the "market" portfolio; in particular almost half the stocks were held in short positions. As discussed in more detail in the Appendix, the choice of baseline did not, however, change the qualitative nature of the results reported in Tables 1 and 2.

In order to have a baseline portfolio in line with the characteristics of the market portfolio, we adjusted the vector of expected returns, leaving the variance-covariance matrix unchanged. The new $\bar{\mathbf{m}}$ vector was chosen to force a baseline portfolio that approximated the market: all stocks

[21] Assuming a CARA utility function as specified above, an exponent a equal to 1/1,000,000 achieves the desired result.

[22] Recent newspaper stories indicate that George Soros's Quantum Fund had almost $10 billion under management in early 1994 (Reuters, March 7,1994); approximately half that much was, at that time, managed by Steinhardt and Co. (The Wall Street Journal, April 1, 1994, p.C1). A hedge fund like the Quantum or Steinhardt funds clearly invests far more than the 50 percent of its "wealth" in risky assets assumed for the first case. The proper way to look at such a high percentage holding of risky assets is not that the investors in the fund would be particularly risk oriented with respect to their total wealth, but that they put into the fund only that part of their portfolios that are to be invested in the riskiest assets.

held in positive quantities, with weights equal to those in the market portfolio. The average of these adjusted expected returns was 8.9%, significantly lower than the average return of 24.7% for the sample period. The experiments reported in the main body of this paper start from this second baseline.

The major characteristics of the baseline portfolios calculated for the new $\bar{\mathbf{m}}$ vector and the two alternative cases of initial wealth and risk preferences are reported in the first two columns and rows of Table 1. Holdings of key stocks in the baseline, to be discussed below, are reported in the first two columns. Important characteristics of the optimal portfolios are reported in the first two rows: the dollar holdings in riskless and risky assets (columns 8 & 9); the amounts of long and short holdings of risky assets (columns 10 & 11); the overall expected value and standard deviation of the portfolio and the slope of the risk-return locus at this optimum (columns 12-14). The overall expected return and standard deviation were 7.9% and 6.9%, respectively, for the smaller baseline portfolio (W = $1 million), and 8.8% and 12.4% for the larger (W = $5 billion). By construction, no short positions are held in the baseline and the investor holds each stock in proportion to its percentage weight in the market. In the case of the smaller investor, the portfolio contains 0.001 percent of the share value of each firm; for the larger portfolio the share jumps to 1.6 percent.

C.2 Alternative Examples of the Impact of New Information. Tables 1 and 2 summarize the results of 12 experiments: 3 alternative scenarios for the receipt of private information with respect to each of four different firms. The firms differ according to their sizes and their low, high, or average hedging possibilities (as measured by their R^2 with the other 244 stocks in the sample). On the low side, both in size and R^2, is Courtaulds PLC, whose return had one of the lowest coefficients of variation with the sample -- only 0.29 -- and whose size, in terms of the value of its equity at the end of 1991, at $3.7 billion, was the lowest of the four firms. Two intermediate cases in terms of R^2 are Boeing Corporation (0.57) and British Gas PLC (0.56) whose multiple correlation coefficients were very close to the sample mean (0.58); two such firms were chosen because of their disparate sizes, Boeing at $13.6 billion and British Gas at $186 billion. Finally, Shell Transport and Trading Co. had one of the highest R^2s in the sample at 0.82, and also one of the

Table 1
Baseline Portfolios and Optimal Portfolios Generated by 1% Increase in Expected Return on Specified Stocks*

		-Baseline Holdings-**							---------Summary Characteristics of the Portfolio---------						
		W=$1 mil	W=$5 bn	Final Holdings	% of Firm Equity	Change from Baseline	Change From No Diversification	$(1-R)^2\sigma$	$ Riskless	$ Risky	$ Long	$ Short	Annual E(R)	Annual STD(R)	CML Slope at Optimum
Baseline	W=$1 mil								.5	.5	.5	0	.079	.069	.0086
	W=$5 bn								500	4500	4500	0	.088	.124	.0086
Courtaulds Plc	W=$1 mil	.00042		.058	.0016	.057	.041	.000342	.474	.526	.755	.229	.08	.071	.0089
	W=$5 bn		3.75	518	14	514	368	.000342	269	4731	6795	2064	.09	.127	.0089
Boeing	W=$1 mil	.0015		.15	.0011	.149	.065	.000132	.477	.523	1.083	.56	.081	.074	.0093
	W=$5 bn		13.8	1352	9.9	1338	582	.000132	292	4708	9750	5043	.091	.133	.0093
British Gas	W=$1 mil	.021		.202	.0011	.181	.079	.000108	.493	.507	1.04	.532	.082	.076	.0096
	W=$5 bn		188.9	1814	.96	1625	713	.000108	438	4562	9354	4791	.092	.137	.0096
Shell Transport	W=$1 mil	.019		.841	.0050	.823	.152	.0000237	.404	.596	2.56	1.97	.089	.095	.0119
	W=$5 bn		177.7	7576	4.5	7405	1364	.0000237	-364	5364	23057	17694	.105	.171	.0119

* All dollar holdings (columns 1-3,5-6,8-11) are in millions of dollars.

** Holdings in baseline portfolios for four named stocks are shown in columns 1 and 2; summary characteristics of baseline portfolios appear in row 1.

larger sizes with equity valued at $169 billion.[23] In the first two columns of Table 1, one can find the holdings of each of these four stocks for the two baseline portfolios. As noted above, although the dollar value of holdings in the large fund is as much as $189 million for British Gas, in percentage terms these holdings are only 1.6 percent of the outstanding equity of each company.

C.3 An Increase in an Expected Return by 1 Percentage Point. The first experiment, the impact of new information indicating a small increase of 1% in the expected return of a given stock, is intended primarily to examine the properties of the system as embodied in equations (15) to (17) above. Eight related cases are presented in Table 1: results for the smaller and larger wealth levels for the common 1% change in expected return applied successively to each of the four stocks. As expected, the presence of investor risk aversion limits the change in the holdings of the affected stock for each case. Although the changes in holdings shown in Table 1 are sometimes large (all expressed in millions of dollars), in no case is this change large enough to *assure* that the investor could single-handedly move the firm's stock price to its new equilibrium value. For the smaller investor, with 50% of his $1 million in wealth invested in stocks for the baseline portfolio, the largest final dollar holding for the four experiments is $841 *thousand* for the 1% increase in the expected return for Shell Transport -- far less than 1% of the total market value of Shell's equity (columns 3 and 4 of row 9). In none of the experiments for the smaller wealth level does the investor end up holding more than .005% of the firm.

For the case where the investor controls $5 billion in wealth, investing 90% in risky assets in the baseline portfolio, the results are somewhat less clearcut. For the larger firms, British Gas and Shell, the increased expected return results in large final holdings -- over $7 billion in the case of Shell -- but these never reach as much as 5% of the firm's equity (column 4). For the cases of Courtaulds and Boeing, the final holdings reach 9.9 % and 14%, respectively. Although not high enough to clearly imply that this single investor's action will force the firm's market price to its new rational expectations equilibrium, these percentage changes are in a range where, depending on assumptions about the behavior of other investors, a significant impact on the market price would be possible.

[23] This high R^2 is something of a fluke, caused by the presence in the sample of the related company, *Royal Dutch Petroleum Company*. However, it is presumably possible to go long in one of these securities and short in the other.

The *ratio* of the dollar changes in the holdings (shown in column 5) are closely approximated by the ratio of the hedging factors, $(1-R_i^2)\sigma_{ii}$ -- a result derived for small changes in equation (17), above, and true for all changes for the CARA utility function, as shown in footnote 14.[24] Thus, for a common change in the expected return, such as the 1% underlying Table 1, the *change* in the dollar value of holdings in Shell Transport will always be the largest -- approximately 4.56 times the *change* the holdings of British Gas, 5.57 times the change in the holdings of Boeing, and 14.4 times the change in the holdings of Courtaulds.

As we have discussed above, the net change in the investor's holdings depends, in addition to the size of the perceived change in the expected return, on two other major factors: (1) the investor's preferred trade-off between risk and expected return (usually a function of wealth and other variables, but in the case of a CARA utility function, representable by the exponent of the utility function alone); and (2), the opportunities provided by the stock market for hedging or diversifying away the potentially large increase in portfolio risk resulting from a huge position in a given stock. The differences between the final holdings in the two cases listed in Table 1, the lines labeled $1 million and $5 billion for a given stock, illustrate the impact of the first of these factors. The size of the final holdings for the two cases listed in the table differ by a factor of 9000. If we were comparing positions with a utility function exhibiting constant *relative*, rather than absolute risk aversion, the different wealth levels alone would lead to portfolios differing by a factor of 5000.

How much of the increase in holdings over the baseline can be attributed to the second factor: the investor's ability to use the various risk diversification possibilities available in the market? A look at the composition of the investor's optimal portfolio after the adjustment to the new information shows that the stock market is used extensively in what appears to be an attempt to minimize overall portfolio risk (columns 8 through 11). In this frictionless world with no limitations on borrowing or short positions, the optimal portfolio often has significant short positions -- varying from $0.229 million to almost $17.7 *billion*; thus, the British Gas experiment for the $5 billion wealth level shows aggregate short positions of $4.791 billion balanced by long

[24] Equations (16) and (17) assume, it should be remembered, that the Lagrange multiplier, λ, does not change. The hedging factors are reported in column 7 of Table 1.

positions of \$9.354 billion, leading to a figure in column 9 of \$4.562 billion for the net holdings of risky assets. A further telling example is the fact that, for both Shell Transport cases, the long positions in Shell Transport stock of \$0.84 million and \$7.6 billion are balanced by short positions in the highly correlated Royal Dutch Petroleum stock of \$0.58 million and \$5.2 billion (not shown in the table).

One way to attempt a measure of the reduction in risk offered by market opportunities for diversification is to determine what would have happened if no such opportunities were available at all. In column 6 of Table 1 one finds the results for the same 1% experiments *under the assumption that the investor is limited to purchasing only the stock for which the new information is obtained.* Thus, no other stocks are available, either in long or short positions, to reduce the build-up of risk as the investor purchases shares in the stock for which the new information has arrived. In this counterfactual, the capital market line would have a slope defined by the characteristics of only this one stock: $(\bar{r}_i - r_f)/\sqrt{\sigma_{ii}}$. Using this line to calculate the holdings of the stock in question for both the baseline portfolio and the new portfolio based on the change in the investor's information, one arrives at the changes in the holdings listed in column 6 of the table. The changes in this column are from 18 to 71 percent of those in column 5. Thus, using the changes in column 6 as a rough guide, had the large investor not availed himself of the opportunities for risk reduction through diversification, he would have increased his holdings of Courtaulds to only 10 percent of the firm's equity and his holdings of Boeing to only 4.4 percent. Particularly striking is the case of Shell: because of the extensive risk reduction opportunities available for a firm whose R^2 with the rest of the market is as high 0.82, the change in column 6, at \$1.4 billion, is only 18% of the optimal change of \$7.4 billion in column 5.

D. More Realistic Changes in Expected Returns

The experiments reported in Table 2 explore the impact of higher and, we will argue, more realistic changes in expected returns. For the upper panel, the investor generates information that causes him to *double* his estimate of the firm's expected return (without changing his assessment of the firm's variance and covariances). For the lower panel, the expected return is changed to be consistent with information that causes the firm's equilibrium price to increase 10 percent.

Table 2
Optimal Portfolio Generated by:

Doubling Expected (Gross) Returns for Specified Stock*

		Final Holdings	% of Firm Equity	Change from Baseline	Change From No Diversification	$ Riskless	$ Risky	$ Long	$ Short	Annual E(R)	Annual STD(R)	CML Slope at Optimum
						---------Summary Characteristics of the Portfolio---------						
Courtaulds Plc	W=$1 mil	.4	.0011	.4	.312	.31	.69	3.36	2.67	.116	.146	.018
	W=$5 bn	3932	> 100	3932	2811	-1263	6263	30271	24008	.155	.263	.018
Boeing	W=$1 mil	1.33	.001	1.33	.582	.293	.707	6.97	6.26	.22	.25	.032
	W=$5 bn	12008	86	11994	5242	-1361	6361	62720	56360	.35	.46	.032
British Gas	W=$1 mil	1.56	.0008	1.54	.675	.441	.559	6.98	6.42	.23	.27	.034
	W=$5 bn	14039	7.3	13850	6070	30.4	5030	62778	57748	.38	.48	.034
Shell Transport	W=$1 mil	6.86	.004	6.84	1.26	-.3	1.3	19.5	18.2	.91	.54	.068
	W=$5 bn	61753	36.5	61575	11346	-6685	11685	175179	163495	2.02	.97	.068

Expected 10% Change in Stock Price Within 2 Weeks*

Courtaulds Plc	W=$1 mil	14.3	.39	14.3	10.2	-5.92	6.92	102.7	95	2.1E+14	4.2	.531
	W=$5 bn	128646	> 100	128642	92245	-57241	62241	914874	852633	6.7 E24	7.6	.531
Boeing	W=$1 mil	37.2	.27	37.2	15.7	-5.37	6.37	188	-182	1.0 E34	6.8	.857
	W=$5 bn	334856	> 100	334842	141597	-51450	56450	1.69 E6	1.64 E6	4.3 E55	12.3	.857
British Gas	W=$1 mil	45.2	.024	45.2	19.3	-1.23	2.23	199	197	1.9 E40	7.5	.945
	W=$5 bn	406819	> 100	406630	173269	-15073	20073	1.79 E6	1.77 E6	4.5 E64	13.5	.945
Shell Transport	W=$1 mil	205.9	.12	205.9	36.9	-23.5	24.5	579	554	3.1 E121	16	2.02
	W=$5 bn	1853323	> 100	1853152	331477	-215703	220703	5.21 E6	4.99 E6	4.8 E168	28.8	2.02

* All dollar holdings (columns 1,3-8) are in millions of dollars.

D.1 A Doubling of the Expected Return. Since the expected returns for the four firms varied from 7.9% to 9.2% in the baseline, a doubling of a firm's expected return added at a minimum almost 8% to the firm's annualized *excess* return -- a much larger shock than in Table 1.

Column 2 of the upper panel of Table 2 makes explicit what was implicit or suggested by the same column of Table 1: when the information implying this larger change in the expected return comes to the large, more risk-seeking investor, for firms such as Courtaulds or Boeing, the investor's optimal holding at the old price is *close to or even greater than the total value of the firm's equity.* Such changes in optimal holdings are certainly large enough to affect the firm's share price and, if the price the investor must pay is a rising function of his purchases, large enough possibly to force the market price to the new rational expectations equilibrium price prior to the general availability of the information. Thus, for the larger investor, the optimal holdings of Courtaulds, at $3.9 billion ($3932 million in the table), actually exceeds the total value of the firm's outstanding equity. For Boeing the percentage reaches 86 percent. Shell and British Gas are intermediate cases, at 36.5 and 7.3 percent, respectively, primarily because of the extraordinarily large value of their outstanding equity. It is also the case, as in Table 1, that the smaller investor, with his lower wealth and greater degree of risk aversion, never comes close to controlling a significant share of the firm's equity.

Thus, even though, as expected, the risk aversion of the larger investor limits the size of his holdings, this risk aversion alone does not prevent him from purchasing very large percentages of these rather large firms. As discussed above, this result is obviously also dependent on the empirical assumptions concerning the variance-covariance structure of the market and the investor's ability to borrow and sell short without restrictions. Of these latter factors, it may well be that the most important assumption is *not* the variance-covariance structure of the market, but rather the limitless ability to borrow and to sell short; column 4 of the the table shows that when the investor is again denied the benefits of diversification, although the new equilibrium change in the portfolio is always less than the primary case, the desired changes in the holdings are still large enough to give the investor a commanding percentage of the shares of the firm.

Although market opportunities for diversification are not always necessary to allow the large investor to purchase a commanding share of a given firm, the optimal portfolios are highly diversified. The last row of the panel shows that for Shell, the stock with the best diversification possibilities, an unconstrained optimum leads to a portfolio with long positions of $175 billion ($61.7 billion of which is for shares of Shell), borrowing of $6.7 billion, and short positions totaling $163 billion ($44 billion of which are short positions in Royal Dutch Petroleum). Such positions seem clearly impossible in today's world, but since they are consistent with the realistic sizes of large funds and the observed variance-covariance structure of the market, their impossibility probably is a result either of institutional and legal limitations on borrowing and short-selling or the fact that new information rarely comes in such a precise (certain) form.

D.2 A Subsidy Adding 10% to the Firm's Market Price. The dramatically different results in Tables 1 and 2 for the $5 billion wealth holder are wholly the result of differences in expected returns. That there exists some finite change in a stock's expected return that will induce an investor at some point to hold a large percentage of the equity of a firm, irrespective of the increasing risk of these holdings, is a direct implication of equation (16). Given the proportionality demonstrated in that equation between the change in the holdings of a given stock and the change in its expected return, the major question becomes the determination of the range of changes in expected returns that can be considered empirically reasonable. Only a little reflection suggests that, where new information implies even a modest increase or decrease in a stock's price in the near future, the change in the expected return over the short run, in annual percentage terms, can be very large indeed -- considerably larger than the doubling of the daily return posited for the upper panel of Table 2.

Let us consider the change in the daily and annual expected returns implied by information leading to the certainty of a government subsidy or a friendly takeover -- either to occur in the near future.[25] As for the size of the ultimate effect on price once the subsidy or takeover is announced, a 10% change seems well within the range of possibility. The translation of the above price change into a rate of return depends on *when* it is projected (or known) to occur. In our

[25] The only problem with a takeover as an empirical example is that, in the real world, takeovers are rarely certain and frequently lead to protracted battles; thus, it is usually not the case that the variance-covariance structure for the firm remains unchanged. We do not address the question of changes to the market's variance-covariance structure in this paper.

world, based on daily returns and correlations, and the implicit assumption that portfolios can be changed quickly with the arrival of new information, a 10% change in *one day's time* translates into an annual rate of return of approximately 2,829,130,600,000 percent.[26] Knowing precisely when the takeover or subsidy would be announced is obviously crucial for the investor to be able to realize such Gargantuan rates of return, and might be objected to as overly unrealistic; however, much less precise knowledge still leads to the same general conclusion. Suppose, for example, that the timing of the takeover and the 10% increase in share price is less precisely known: the event known only to be occurring sometime in the next two weeks. At a minimum, assuming that the event occurs only on the last day of the period, this information leads to an increase in the annualized rate of return of 1,092 percent.[27]

The results in the bottom panel of Table 2 assume a change in the daily expected return which, when annualized, equals 1,092 percent. We consider this an underestimate of the daily rate of return that would be expected given conclusive knowledge of a takeover to be announced in the near future. The positions that are shown in the panel are thus lower bounds for the positions that would be expected to result in such an institutional setting.[28]

The results for this experiment confirm and underline those for the previous experiment. For the $5 billion wealth holder, the desired positions in the stocks for which the new information becomes available are more than the total value of the firm's equity in all cases. As adumbrated in the previous case, the investor takes enormous short positions to minimize the overall risk of holding such a long position. However, the expected return has increased so much that, even with no opportunities for diversification, the investor would increase his holdings of the stock enough to control almost 100% of the shares in all the companies; this is shown in column 4. Thus, for the larger investor, the risk reduction opportunities provided by the market are not essential for our

[26] For this calculation we ignore dividends and assume the average number of trading days for the 1989-91 period: 252.5. Thus $(1.1)^{252.5}-1 = 28{,}291{,}306{,}000$.

[27] Assuming compounding over 26 two week periods, the annualized rate of return would be $(1.1)^{26}-1 = 10.918$. Assuming 10 trading days in a two-week period, the daily rate of return leading to a 10% change in two weeks would be $(1.1)^{0.1}-1 = 0.00958$. (A daily return leading to a compounded 10% return over a year is 0.000376.)

[28] Clearly, in a strict theoretical sense, a portfolio model based on a *daily* horizon is only applicable to a longer-term problem as an approximation -- in this case, we would argue, as a lower bound. Intuitively, and only roughly so, one might think of a model where the investor has information of an event that will occur two weeks hence, but which requires the investor to act immediately.

conclusion.

In contrast to the implications of the results for the large wealth level, despite these much higher changes in expected return, the holdings of the smaller investor never come close to 1% of the firm's outstanding equity. Thus, there seems little prospect that this investor's actions will affect the firm's market price prior to the general release of the information -- at which point we would expect the stock price to jump to the new rational expectations equilibrium.

This conclusion for the smaller wealth holder is robust for even much larger changes in the expected rate of return. Even in the case where the information is precise enough to specify the day of the takeover, and thus lead, as discussed above, to an expected change of 10% in the firm's price in one day, the optimal holdings for the smaller investor would not increase to more than 4.1% of any of the four firms. It would take an expected return of more than *100% in a given day* for this investor to desire as much as 40% of any of these stocks.

IV. Conclusions

The major goal of this paper was to investigate whether a realistic degree of risk aversion would prevent a single, but well-endowed market participant in the U.S. stock market from "eliminating unexploited profit opportunities" and moving the price of a stock to its new rational expectations equilibrium. If so, one could argue that the mechanism sketched by Fama (1970) and Mishkin (1983) could not possibly lead to a rational expectations equilibrium and strong-form efficiency. This is a question that cannot be answered *a priori*, so a major part of the study involved using data on daily returns to estimate the variance-covariance matrix for a representative sample of 245 firms and to use it to examine how optimal portfolios change as a function of new information, risk preferences, and wealth.

As predicted by our equations (15) and (16), an investor obtaining valuable new information was frequently found in the simulations to accumulate large positions in the affected stock, leading to a very unbalanced portfolio -- but one of determinate size because of the buildup of portfolio risk. However, the characteristics of the investor turned out to be crucial for determining whether the *size* of this unbalanced position in the affected stock would be large enough to assure that the stock price would move significantly towards, or to, its new efficient markets equilibrium value. A moderate sized investor with about $1 million in net wealth turned out to be too small, almost irrespective of his attitude toward risk, to single-handedly move the market price. On the other hand, a large investor with wealth of $5 billion and risk preferences such that 90% of his net worth was invested in risky assets (a rough approximation to a large contemporary hedge or mutual fund), sometimes would, in our world, accumulate a position in the affected stock large enough to purchase all the outstanding equity of most firms. Thus, for the case reported in the bottom panel of Table 2, with its very large, but, we argue, realistic increase in short-run expected return, *risk aversion alone* did not prevent the Fama-Mishkin mechanism from operating. In fact, even when we prevented the investor from hedging the risk of his unbalanced portfolio, in some cases the large investor still sought to buy up the whole of the outstanding equity of the firm in question. For this latter reason, the unrealism of the enormous short positions found in some of the optimal portfolios may not be important.

Our results imply, therefore, that risk aversion alone cannot categorically refute the possibility that new information need *not* be widely held to be incorporated efficiently into market prices. In this sense, the model we dubbed the Fama-Mishkin mechanism could serve to justify strong-form efficiency. Despite the drag of risk aversion, profit opportunities were potentially exploitable because of a combination of three factors: the size of the investor (taken in conjunction with the intesity of his aversion to risk); the opportunities for hedging (some of) the risk accumulating in large unbalanced portfolios; and the ability for unlimited borrowing at the riskless rate of interest. These last two factors led to results -- the size of short positions and borrowing -- that seemed far outside the bounds of realism; of the two, we argued that probably only the latter, the avaiability of unrestricted borrowing at the riskless rate, was crucial to the results. Although the caveats are many, the importance of the first factor points to a potentially positive social role for investors with the size and risk preferences of large contemporary mutual and hedge funds. Given the size of the larger firms in the U.S. and world economy, only investors such as these seem capable of taking large enough positions to eliminate directly the unexploited profit opportunities provided by new information.

Although our results indicate that the presence of risk aversion cannot necessarily refute the efficacy of the Fama-Mishkin mechanism, they cannot, of course, prove that the market will move effortlessly from one rational expectations equilibrium to another. Given the assumption of risk aversion, and the high levels of undiversifiable risk that from our calculations are necessarily associated with large unbalanced positions, the world of this paper is potentially quite consistent with the models of noise traders and irrational investors studied by Figlewski (1978), Shiller (1984), and DeLong, et. al. (1990). Viewed in this light, one might profitably distinguish between the potential *efficacy* of the Fama-Mishkin mechanism and its contribution to *strong-form efficiency*. We have shown that this mechanism may sometimes be capable of incorporating information that is not widely shared into market prices *as efficiently as public information* is incorporated. However, if the original equilibrium was distorted by a class of irrational or inefficient investors, then, even if the Fama-Mishkin mechanism produced the same results as the public information case, the final equilibrium would still remain distorted.

APPENDIX

In this appendix we consider in more detail than was possible in the text the following subjects: the choice of and composition of the sample; the calculations for representative hedge portfolios; the construction of the baseline portfolio used in the text and the alternative baseline calculated using as the expected return vector, the observed average returns for the sample period 1988-91.

I. The Sample

The data for the model were obtained from the University of Chicago's Center for Research in Security Prices (CRSP); for more details see, Center for Research in Security Prices (1991). As described in the text, above, our sample consisted of the top decile of New York Stock Exchange traded stocks -- as measured by the annual capitalization value. Stocks with an incomplete daily trading history over the sample period January 1, 1988 to December 30, 1991 were eliminated from the sample. A total of 245 stocks remain in the sample. The 199 firms in the sample that were also listed in the S&P 500 accounted for over 83% of the value of the S&P 500 index at the end of 1991; moreover, the 46 firms in our sample *not* listed in the S&P 500 -- mostly large foreign-based multinationals -- accounted for approximately 45% of the equity value of the decile.

The 245 members of the sample are listed in Table A1. In addition to the company name, included in the table are each stock's CUSIP number, the annual capitalization or equity value as of December 1991, the ratio of the firm's equity to the total for the sample, its beta (December 1991), the R-squared for the firm's hedge regression (discussed in the text and in the next section below).

II. Hedge Portfolios

Throughout the paper we emphasized the potential importance of the multiple correlation coefficient from the regression of a given stock return on all the other returns in the sample, i.e. the proportion of the variance of a given return that can be explained by the set of all other returns. For concreteness we reproduce in Table A2 the coefficients and *t* ratios from the hedge regressions for the four stocks that are emphasized in our study: Boeing, British Gas, Courtaulds PLC, and Shell Transport. Given the more than 700 degrees of freedom for each regression, coefficients with t statistics over 1.95 are significantly different from zero at the 5% level; significant coefficients are boxed in the table.

III. Baseline Portfolios

As noted in the text, the net purchase of a given stock as a result of the receipt or discovery of new information was calculated by finding the change in the investor's final holding of the affected stock from the holding in a baseline portfolio. Two methods for calculating the baseline were noted in the paper. An obvious candidate was to use only sample information for the baseline calculation, essentially assuming that the *sample* means, variances, and covariances could be used as reasonable proxies for an investor's subjective expectations for future periods. A problem that developed with this approach was that the baseline portfolio calculated using only the sample information looked very different from the market portfolio. Many stocks were held in short positions, and the ratio of a given stock's holding in the baseline portfolio to the total outstanding value of its equity was often far different from the corresponding ratio in the market portfolio.

Although we later determined that the difference in baselines had no effect on the conclusions of this study (see Table A3 below), this unusual looking baseline prompted us to modify, in the body of the paper, the procedure used for its calculation. In the paper we modified the vector of expected returns (but not the covariance matrix) to derive a new baseline portfolio that was identical to the market portfolio: each stock was held in proportion to the ratio of the total value of the equity of the firm to the total value of equity (annual capitalization) for the whole sample of 245 stocks. (See column 5 of Table A1, below, for these ratios.) This modification was achieved by using equation (8) in the text: $\mathbf{z} = \lambda/2\mathbf{C}^{-1}\bar{\mathbf{m}}$. Normally, sample estimates of the covariance matrix $\mathbf{C}$, a value for λ, and the vector of expected excess returns $\bar{\mathbf{m}}$ would be used with equation (8) to solve for $\mathbf{z}$, the vector of stock holdings. To get optimal holdings that mimic the market portfolio, one can define $\mathbf{z}$ as the series of *ratios* equal to those for the market portfolio and then solve (8) for the vector of expected excess returns, $\bar{\mathbf{m}}$, that are consistent with the chosen vector of ratios. Tobin's separation theorem establishes that, given this latter vector of expected excess returns, any optimal vector of risky asset holdings will be proportional to the market portfolio.

Table A3 presents the results of two experiments with the alternative baseline, using the observed sample values for excess expected returns. In the upper panel, we reproduce the experiment for the larger wealth level ($5 billion) and a 10% change in the price of a given stock within two weeks -- first run in Table 2 using the constructed or "synthetic" baseline. As can be seen by comparing these results to those in Table 2, there is no change in the conclusion: for each firm, the investor seeks to buy up all the outstanding equity of the firm.

In the lower panel, we gauge the impact of a change in the riskless rate of interest on the results of the previous experiment; the riskless rate of interest is raised to 8% from 6.97%. The higher riskless rate of interest changes the quantitative results only a little, and the qualitative results not at all. In fact, the *changes* from the baseline of both panels in Table A3 are identical. This result is predicted above by equation (16).

Table A1
Sample Members and Characteristics

Stock #	CRSP CUSIP	Stock	Annual Capitalization (Billions)	Relative Size	Beta	R-Squared
1	00176510	A M R CORP DEL	5.088	0.0011	1.4	0.70
2	00192010	A R C O CHEMICAL CO	4.196	0.0009	1.3	0.36
3	00282410	ABBOTT LABS	25.422	0.0057	0.9	0.66
4	00814010	AETNA LIFE & CAS CO	5.119	0.0012	1.0	0.61
5	00915810	AIR PRODUCTS & CHEMICALS INC	5.297	0.0012	1.4	0.54
6	01310410	ALBERTSONS INC	6.677	0.0015	0.8	0.54
7	01371610	ALCAN ALUMINUM LTD	4.120	0.0009	1.1	0.69
8	01951210	ALLIED SIGNAL INC	8.569	0.0019	1.0	0.51
9	02003910	ALLTEL CORP	4.216	0.0009	0.9	0.38
10	02224910	ALUMINUM COMPANY AMER	6.137	0.0014	1.2	0.71
11	02261510	ALZA CORP	3.515	0.0008	1.8	0.49
12	02355110	AMERADA HESS CORP	4.259	0.0010	0.8	0.57
13	02451E10	AMERICAN BARRICK RES CORP	4.386	0.0010	0.8	0.55
14	02470310	AMERICAN BRANDS INC	8.210	0.0018	1.1	0.50
15	02532110	AMERICAN CYANAMID CO	5.195	0.0012	1.2	0.57
16	02553710	AMERICAN ELECTRIC POWER INC	6.113	0.0014	0.5	0.65
17	02581610	AMERICAN EXPRESS CO	11.891	0.0027	1.3	0.60
18	02635110	AMERICAN GENERAL CORP	6.159	0.0014	1.1	0.43
19	02660910	AMERICAN HOME PRODS CORP	21.048	0.0047	0.8	0.60
20	02687410	AMERICAN INTERNATIONAL GROUP INC	24.541	0.0055	1.1	0.71
21	03017710	AMERICAN TELEPHONE & TELEG CO	68.116	0.0153	0.7	0.60
22	03095410	AMERITECH CORP	19.178	0.0043	0.6	0.77
23	03189710	AMP INC	6.095	0.0014	1.3	0.59
24	03190510	AMOCO CORP	24.191	0.0054	0.5	0.68
25	03522910	ANHEUSER BUSCH COS INC	16.189	0.0036	1.1	0.57
26	03948310	ARCHER DANIELS MIDLAND CO	8.652	0.0019	1.0	0.50
27	04882510	ATLANTIC RICHFIELD CO	18.223	0.0041	0.6	0.69
28	05301510	AUTOMATIC DATA PROCESSING INC	7.470	0.0017	1.0	0.50
29	05430310	AVON PRODUCTS INC	3.975	0.0009	1.4	0.39
30	05527020	B A T INDUSTRIES LTD	21.785	0.0049	1.1	0.53
31	05534B10	B C E INC	10.085	0.0023	0.4	0.46
32	05538H20	B E T PUBLIC LIMITED COMPANY	4.390	0.0010	0.7	0.39
33	05943810	BANC ONE CORP	12.296	0.0028	1.2	0.48
34	06605010	BANKAMERICA CORP	16.149	0.0036	1.2	0.57
35	06636510	BANKERS TRUST NY CORP	5.687	0.0013	1.3	0.61
36	06738E20	BARCLAYS PLC	37.181	0.0084	0.9	0.54
37	07170710	BAUSCH & LOMB INC	3.202	0.0007	1.1	0.53
38	07181310	BAXTER INTERNATIONAL INC	9.021	0.0020	1.0	0.52
39	07785310	BELL ATLANTIC CORP	22.187	0.0050	0.6	0.77
40	07986010	BELLSOUTH CORP	25.360	0.0057	0.6	0.77
41	09367110	BLOCK H & R INC	4.211	0.0009	0.9	0.51
42	09702310	BOEING CO	13.616	0.0031	1.1	0.56

Table A1
Sample Members and Characteristics

Stock #	CRSP CUSIP	Stock	Annual Capitalization (Billions)	Relative Size	Beta	R-Squared
43	09959910	BORDEN INC	4.026	0.0009	1.0	0.52
44	11012210	BRISTOL MYERS SQUIBB CO	34.968	0.0079	0.8	0.71
45	11041930	BRITISH AIRWAYS PLC	33.831	0.0076	1.1	0.56
46	11088940	BRITISH PETROLEUM PLC	246.727	0.0555	0.6	0.68
47	11090140	BRITISH GAS PLC	186.455	0.0420	0.9	0.56
48	11102140	BRITISH TELECOMMUNICATIONS PLC	378.061	0.0851	0.5	0.57
49	11216960	BROKEN HILL PROPRIETARY CO LTD	58.278	0.0131	0.7	0.39
50	11588510	BROWNING FERRIS INDS INC	4.398	0.0010	1.4	0.54
51	12189710	BURLINGTON NORTHERN INC	3.825	0.0009	0.8	0.50
52	12550910	C I G N A CORP	4.206	0.0009	1.0	0.61
53	12611710	C N A FINANCIAL CORP	6.056	0.0014	0.8	0.65
54	12614910	C P C INTERNATIONAL INC	7.645	0.0017	1.1	0.61
55	13442910	CAMPBELL SOUP CO	10.581	0.0024	1.0	0.49
56	13644030	CANADIAN PACIFIC LTD	4.027	0.0009	1.1	0.52
57	13985910	CAPITAL CITIES ABC INC	8.349	0.0019	0.9	0.49
58	14414110	CAROLINA POWER & LIGHT CO	4.460	0.0010	0.4	0.56
59	14912310	CATERPILLAR INC DE	5.413	0.0012	1.0	0.53
60	15235710	CENTRAL & SOUTH WEST CORP	5.486	0.0012	0.3	0.63
61	16381210	CHEMICAL WASTE MGMT INC	4.174	0.0009	1.0	0.49
62	16675110	CHEVRON CORP	23.693	0.0053	0.7	0.69
63	17119610	CHRYSLER CORP	9.371	0.0021	1.6	0.49
64	17123210	CHUBB CORP	7.772	0.0017	0.7	0.61
65	17303410	CITICORP	8.134	0.0018	1.2	0.60
66	19121610	COCA COLA CO	54.852	0.0123	0.9	0.76
67	19416210	COLGATE PALMOLIVE CO	8.901	0.0020	1.0	0.64
68	20279510	COMMONWEALTH EDISON CO	4.953	0.0011	0.4	0.48
69	20588710	CONAGRA INC	8.136	0.0018	1.1	0.57
70	20911110	CONSOLIDATED EDISON CO NY INC	7.632	0.0017	0.3	0.62
71	20961510	CONSOLIDATED NATURAL GAS CO	4.204	0.0009	0.5	0.56
72	21666910	COOPER INDUSTRIES INC	5.370	0.0012	1.3	0.55
73	21935010	CORNING INC	7.298	0.0016	1.0	0.57
74	22268740	COURTAULDS PLC	3.702	0.0008	1.1	0.28
75	23975310	DAYTON HUDSON CORP	5.400	0.0012	1.5	0.56
76	24419910	DEERE & CO	3.339	0.0008	0.9	0.54
77	24736110	DELTA AIR LINES INC DE	2.528	0.0006	1.3	0.65
78	24801910	DELUXE CORP	3.922	0.0009	0.9	0.52
79	25084710	DETROIT EDISON CO	4.814	0.0011	0.3	0.49
80	25384910	DIGITAL EQUIPTMENT CORP	4.314	0.0010	1.4	0.54
81	25406310	DILLARD DEPARTMENT STORES INC	5.149	0.0012	1.2	0.55
82	25468710	DISNEY WALT CO	22.541	0.0051	1.4	0.58
83	25747010	DOMINION RESOURCES INC VA	6.440	0.0014	0.3	0.61
84	25786710	DONNELLEY R R & SONS CO	5.092	0.0011	1.2	0.55

Table A1
Sample Members and Characteristics

Stock #	CRSP CUSIP	Stock	Annual Capitalization (Billions)	Relative Size	Beta	R-Squared
85	26054310	DOW CHEMICAL CO	15.624	0.0035	1.2	0.61
86	26353410	DU PONT E I DE NEMOURS & CO	31.785	0.0072	1.1	0.69
87	26439910	DUKE POWER CO	7.401	0.0017	0.3	0.60
88	26483010	DUN & BRADSTREET CORP	10.289	0.0023	0.9	0.46
89	27746110	EASTMAN KODAK CO	13.171	0.0030	0.8	0.51
90	29101110	EMERSON ELECTRIC CO	12.335	0.0028	1.2	0.60
91	29356110	ENRON CORP	5.371	0.0012	0.7	0.42
92	29364F10	ENTERGY CORP	5.780	0.0013	0.7	0.40
93	29765910	ETHYL CORP	3.388	0.0008	1.4	0.49
94	30229010	EXXON CORP	75.884	0.0171	0.6	0.73
95	30257110	F P L GROUP INC	6.586	0.0015	0.4	0.56
96	31358610	FEDERAL NATIONAL MORTGAGE ASSN	20.850	0.0047	1.4	0.61
97	34386110	FLUOR CORP	3.404	0.0008	1.5	0.53
98	34537010	FORD MOTOR CO DE	20.928	0.0047	1.2	0.67
99	36232010	G T E CORP	32.226	0.0073	0.7	0.60
100	36473010	GANNETT INC	7.316	0.0016	1.2	0.56
101	36476010	GAP INC	4.748	0.0011	1.7	0.54
102	36960410	GENERAL ELECTRIC CO	73.020	0.0164	1.2	0.75
103	37033410	GENERAL MILLS INC	11.224	0.0025	0.9	0.63
104	37044210	GENERAL MOTORS CORP	22.743	0.0051	1.0	0.65
105	37044240	GENERAL MOTORS CORP (GME)	6.779	0.0015	1.1	0.45
106	37055010	GENERAL PUBLIC UTILS CORP	3.061	0.0007	0.5	0.41
107	37056310	GENERAL RE CORP	9.790	0.0022	0.7	0.57
108	37246010	GENUINE PARTS CO	3.893	0.0009	0.9	0.53
109	37329810	GEORGIA PACIFIC CORP	5.500	0.0012	1.4	0.57
110	37576610	GILLETTE CO	12.498	0.0028	1.3	0.55
111	37732730	GLAXO HOLDINGS PLC	71.493	0.0161	1.2	0.62
112	38255010	GOODYEAR TIRE & RUBR CO	4.899	0.0011	1.1	0.40
113	38388310	GRACE W R & CO	3.605	0.0008	1.3	0.50
114	39056810	GREAT LAKES CHEM CORP	4.937	0.0011	1.3	0.46
115	40621610	HALLIBURTON COMPANY	3.080	0.0007	1.2	0.67
116	41135230	HANSON PLC	87.736	0.0198	0.9	0.65
117	42307410	HEINZ H J CO	11.159	0.0025	0.9	0.58
118	42786610	HERSHEY FOODS CORP	3.521	0.0008	1.0	0.55
119	42823610	HEWLETT PACKARD CO	17.588	0.0040	1.5	0.57
120	43357850	HITACHI LIMITED	196.165	0.0442	0.4	0.79
121	43707610	HOME DEPOT INC	22.337	0.0050	1.4	0.58
122	43812830	HONDA MOTOR LTD	20.183	0.0045	0.6	0.64
123	43850610	HONEYWELL INC	4.572	0.0010	1.1	0.49
124	44216110	HOUSTON INDUSTRIES INC	5.941	0.0013	0.4	0.59
125	44485910	HUMANA INC	3.249	0.0007	0.7	0.46
126	45067910	I T T CORP	8.590	0.0019	1.1	0.63

Table A1
Sample Members and Characteristics

Stock #	CRSP CUSIP	Stock	Annual Capitalization (Billions)	Relative Size	Beta	R-Squared
127	45230810	ILLINOIS TOOL WKS INC	3.649	0.0008	1.2	0.54
128	45245410	IMCERA GROUP INC	2.568	0.0006	1.2	0.46
129	45270450	IMPERIAL CHEMICAL INDS PLC	46.567	0.0105	1.2	0.61
130	45303840	IMPERIAL OIL LTD	6.154	0.0014	0.5	0.39
131	45325840	INCO LTD	2.440	0.0005	1.1	0.54
132	45920010	INTERNATIONAL BUSINESS MACHS	28.770	0.0065	0.7	0.66
133	45950610	INTERNATIONAL FLAVORS & FRAG	4.188	0.0009	1.2	0.53
134	46014610	INTERNATIONAL PAPER CO	8.154	0.0018	1.3	0.64
135	47816010	JOHNSON & JOHNSON	33.063	0.0074	1.0	0.70
136	48258410	K MART CORP	9.945	0.0022	1.5	0.55
137	48783610	KELLOGG COMPANY	15.950	0.0036	0.7	0.59
138	49436810	KIMBERLY CLARK CORP	9.469	0.0021	0.9	0.48
139	50155620	KYOCERA CORP	12.996	0.0029	0.5	0.68
140	53245710	LILLY ELI & CO	17.777	0.0040	1.1	0.61
141	53271610	LIMITED INC	9.782	0.0022	1.9	0.56
142	54042410	LOEWS CORP	7.820	0.0018	0.9	0.57
143	56979010	MARION MERRELL DOW INC	7.142	0.0016	1.0	0.35
144	57174810	MARSH & MCLENNAN COS INC	6.653	0.0015	0.8	0.51
145	57459910	MASCO CORP	4.507	0.0010	1.3	0.52
146	57687920	MATSUSHITA ELECTRIC INDL LTD	194.686	0.0438	0.5	0.80
147	57777810	MAY DEPARTMENT STORES CO	8.737	0.0020	1.4	0.57
148	58013510	MCDONALDS CORP	17.740	0.0040	1.0	0.57
149	58505510	MEDTRONIC INC	5.673	0.0013	1.0	0.50
150	58574510	MELVILLE CORP	5.554	0.0013	1.3	0.52
151	58933110	MERCK & CO INC	49.751	0.0112	0.8	0.73
152	59018810	MERRILL LYNCH & CO INC	6.115	0.0014	1.7	0.61
153	60405910	MINNESOTA MINING & MFG CO	22.049	0.0050	0.9	0.68
154	60705910	MOBIL CORP	25.166	0.0057	0.8	0.73
155	61166210	MONSANTO COMPANY	7.062	0.0016	1.1	0.53
156	61688010	MORGAN J P & CO INC	12.554	0.0028	1.1	0.62
157	61744610	MORGAN STANLEY GROUP INC	4.240	0.0010	1.4	0.49
158	62007610	MOTOROLA INC	13.990	0.0031	1.5	0.55
159	62890010	N B D BANCORP INC	5.219	0.0012	1.1	0.50
160	63853940	NATIONAL WESTMINSTER BK PLC	59.932	0.0135	0.9	0.54
161	63858510	NATIONSBANK CORP	12.536	0.0028	1.4	0.54
162	65163710	NEWMONT GOLD CO	3.395	0.0008	0.3	0.53
163	65248770	NEWS CORP LTD	17.331	0.0039	2.1	0.51
164	65584410	NORFOLK SOUTHERN CORP	8.616	0.0019	1.1	0.60
165	65653160	NORSK HYDRO A S	4.519	0.0010	1.0	0.47
166	66581510	NORTHERN TELECOM LTD	10.662	0.0024	1.0	0.60
167	66938010	NORWEST CORP	6.040	0.0014	1.2	0.52
168	67076810	NYNEX CORP	17.295	0.0039	0.6	0.68

Table A1
Sample Members and Characteristics

Stock #	CRSP CUSIP	Stock	Annual Capitalization (Billions)	Relative Size	Beta	R-Squared
169	67459910	OCCIDENTAL PETROLEUM CORP	5.144	0.0012	0.8	0.41
170	67734710	OHIO EDISON CO	3.528	0.0008	0.5	0.51
171	69347510	P N C FINANCIAL CORP	6.574	0.0015	1.0	0.51
172	69350610	P P G INDUSTRIES INC	6.990	0.0016	1.2	0.49
173	69430810	PACIFIC GAS & ELEC CO	14.122	0.0032	0.4	0.53
174	69489010	PACIFIC TELESIS GROUP	17.831	0.0040	0.6	0.72
175	69511410	PACIFICORP	5.322	0.0012	0.3	0.52
176	69921610	PARAMOUNT COMMUNICATIONS INC	5.325	0.0012	0.8	0.42
177	70816010	PENNEY J C INC	9.107	0.0021	1.2	0.55
178	70905110	PENNSYLVANIA POWER & LIGHT CO	4.133	0.0009	0.4	0.49
179	71344810	PEPSICO INC	33.048	0.0074	1.0	0.72
180	71708110	PFIZER INC	23.901	0.0054	1.2	0.58
181	71753710	PHILADELPHIA ELECTRIC CO	5.757	0.0013	0.4	0.50
182	71815410	PHILIP MORRIS COS INC	69.294	0.0156	1.0	0.68
183	71833750	PHILIPS N V	3.295	0.0007	0.9	0.48
184	71850710	PHILLIPS PETROLEUM CO	6.538	0.0015	1.0	0.53
185	72447910	PITNEY BOWES INC	6.260	0.0014	1.3	0.50
186	74158910	PRIMERICA CORP NEW	5.313	0.0012	1.6	0.54
187	74271810	PROCTER & GAMBLE CO	36.449	0.0082	0.9	0.67
188	74457310	PUBLIC SERVICE ENTERPRISE GROUP	7.236	0.0016	0.4	0.62
189	74740210	QUAKER OATS CO	4.687	0.0011	0.6	0.52
190	75511110	RAYTHEON COMPANY	6.909	0.0016	0.6	0.46
191	75811010	REEBOK INTERNATIONAL LTD	3.056	0.0007	1.6	0.45
192	76176310	REYNOLDS METALS CO	3.173	0.0007	1.2	0.65
193	76242T10	RHONE POULENC RORER INC	6.442	0.0015	1.2	0.33
194	77434710	ROCKWELL INTERNATIONAL CORP	6.416	0.0014	0.9	0.54
195	78025770	ROYAL DUTCH PETE CO	43.422	0.0098	0.6	0.65
196	78108810	RUBBERMAID INC	5.087	0.0011	1.3	0.57
197	79549B10	SALOMON INC	4.407	0.0010	1.3	0.44
198	80311110	SARA LEE CORP	14.392	0.0032	1.1	0.61
199	80660510	SCHERING PLOUGH CORP	12.664	0.0029	0.9	0.65
200	80685710	SCHLUMBERGER LTD	13.841	0.0031	1.0	0.67
201	81185010	SEAGRAM LTD	9.523	0.0021	1.1	[illegible]
202	81238710	SEARS ROEBUCK & CO	15.711	0.0035	1.2	0.55
203	82270360	SHELL TRANSPORT & TRADING CO PLC	159.454	0.0361	0.7	0.62
204	83569930	SONY CORP	12.731	0.0029	0.5	0.75
205	84258710	SOUTHERN COMPANY	12.184	0.0027	0.4	0.59
206	84533310	SOUTHWESTERN BELL CORP	22.174	0.0050	0.7	0.71
207	85206110	SPRINT CORP	5.612	0.0013	0.7	0.43
208	86387150	STUDENT LOAN MARKETING ASSN	6.233	0.0014	0.9	0.56
209	86676210	SUN INC	2.976	0.0007	1.0	0.45
210	86791410	SUNTRUST BANKS INC	5.476	0.0012	1.0	0.50

Table A1
Sample Members and Characteristics

Stock #	CRSP CUSIP	Stock	Annual Capitalization (Billions)	Relative Size	Beta	R-Squared
211	87161610	SYNTEX CORP	5.191	0.0012	1.4	0.53
212	87182910	SYSCO CORP	4.942	0.0011	1.1	0.53
213	87235140	T D K CORP	3.797	0.0009	0.3	0.63
214	87938220	TELEFONICA DE ESPANA S A	27.345	0.0062	0.8	0.55
215	88037010	TENNECO INC	5.088	0.0011	0.8	0.45
216	88169410	TEXACO INC	15.458	0.0035	0.6	0.51
217	88284810	TEXAS UTILITIES CO	9.236	0.0021	0.4	0.50
218	88320310	TEXTRON INC	3.886	0.0009	1.0	0.46
219	88731510	TIME WARNER INC	10.867	0.0024	1.3	0.41
220	88736010	TIMES MIRROR CO	4.018	0.0009	1.3	0.57
221	89233510	TOYS R US	11.681	0.0026	1.3	0.58
222	89348510	TRANSAMERICA CORP	3.764	0.0008	1.1	0.53
223	90254910	U A L CORP	3.057	0.0007	1.4	0.46
224	90290582	U S X MARATHON GROUP INC	4.938	0.0011	1.1	0.49
225	90291110	U S T INC	6.665	0.0015	1.0	0.52
226	90476760	UNILEVER PLC	54.468	0.0123	0.9	0.68
227	90478450	UNILEVER N V	16.684	0.0038	0.8	0.80
228	90553010	UNION CAMP CORP	3.211	0.0007	1.1	0.55
229	90654810	UNION ELECTRIC CO	3.817	0.0009	0.3	0.47
230	90781810	UNION PACIFIC CORP	11.894	0.0027	1.1	0.59
231	91270710	UNITED STATES SURGICAL CORP	3.816	0.0009	0.7	0.44
232	91288910	UNITED STATES WEST INC	15.864	0.0036	0.7	0.69
233	91301710	UNITED TECHNOLOGIES CORP	5.953	0.0013	1.3	0.53
234	91528910	UNOCAL CORP	6.131	0.0014	0.9	0.58
235	91530210	UPJOHN CO	5.648	0.0013	1.2	0.46
236	92977110	WACHOVIA CORP	5.832	0.0013	0.8	0.49
237	93114210	WAL MART STORES INC	73.560	0.0166	1.2	0.72
238	93142210	WALGREEN COMPANY	5.369	0.0012	1.3	0.49
239	93448810	WARNER LAMBERT CO	9.320	0.0021	1.0	0.62
240	94974010	WELLS FARGO & CO NEW	4.142	0.0009	1.3	0.62
241	96040210	WESTINGHOUSE ELECTRIC CORP	4.604	0.0010	1.2	0.50
242	96216610	WEYERHAEUSER COMPANY	7.519	0.0017	1.5	0.56
243	98088310	WOOLWORTH CORP	4.147	0.0009	1.3	0.52
244	98252510	WRIGLEY WILLIAM JR CO	3.817	0.0009	1.1	0.61
245	98412110	XEROX CORP	7.521	0.0017	1.2	0.52

Table A2
Hedge Regressions for 4 Key Stocks*

	Boeing (#42)		British Gas (#47)		Courtaulds PLC (#74)		Shell Transport (#203)	
Stock #	Parameter Estimate	t Statistic	Parameter Estimate	t Statistic	Parameter Estimate	t Statistic	Parameter Estimate	t Statistic
1	(0.0150)	[illegible]	0.0245	[illegible]	[illegible]	0.65	(0.0010)	(0.07)
2	0.0200	[illegible]	(0.0168)	(0.62)	(0.0094)	(0.20)	(0.0171)	(1.35)
3	(0.0076)	[illegible]	(0.0379)	(0.88)	(0.1032)	(1.35)	0.0202	1.00
4	0.0272	0.65	0.0185	0.49	(0.0250)	(0.37)	0.0107	0.61
5	(0.0101)	(0.25)	$\boxed{(0.1138)}$	$\boxed{(3.14)}$	0.1018	1.57	0.0095	0.56
6	(0.0086)	(0.25)	(0.0275)	(0.88)	(0.0063)	(0.11)	(0.0094)	(0.64)
7	0.0820	1.78	0.0177	0.42	0.1102	1.48	0.0068	0.35
8	(0.0320)	(0.94)	0.0188	0.61	0.0190	0.35	(0.0220)	(1.52)
9	(0.0289)	(0.76)	(0.0087)	(0.25)	0.0320	0.52	0.0151	0.93
10	(0.0017)	(0.04)	(0.0439)	(1.01)	(0.0864)	(1.12)	0.0116	0.57
11	0.0004	0.02	0.0272	1.10	0.0489	1.11	0.0167	1.44
12	0.0160	0.41	(0.0344)	(0.96)	(0.0048)	(0.08)	(0.0027)	(0.16)
13	(0.0162)	(0.56)	0.0078	0.30	(0.0048)	(0.11)	(0.0179)	(1.47)
14	(0.0064)	(0.17)	0.0257	0.77	0.0014	0.02	(0.0173)	(1.10)
15	(0.0241)	(0.64)	(0.0254)	(0.75)	(0.0128)	(0.21)	(0.0186)	(1.16)
16	(0.0510)	(0.68)	0.0028	0.04	(0.1509)	(1.25)	(0.0535)	(1.68)
17	0.0534	1.77	0.0191	0.70	0.0329	0.68	(0.0032)	(0.25)
18	0.0447	1.52	0.0053	0.20	(0.0088)	(0.19)	$\boxed{(0.0323)}$	$\boxed{(2.59)}$
19	0.0119	0.23	0.0151	0.33	(0.0792)	(0.97)	(0.0181)	(0.84)
20	(0.0162)	(0.32)	0.0089	0.20	0.0901	1.11	0.0013	0.06
21	(0.0189)	(0.44)	0.0230	0.59	0.1303	1.87	(0.0276)	(1.50)
22	(0.1258)	(1.76)	$\boxed{0.1418}$	$\boxed{2.19}$	0.1216	1.05	(0.0189)	(0.62)
23	$\boxed{(0.1166)}$	$\boxed{(3.00)}$	0.0200	0.56	(0.0805)	(1.28)	(0.0194)	(1.17)
24	$\boxed{(0.1384)}$	$\boxed{(2.59)}$	0.0228	0.47	(0.0577)	(0.67)	(0.0016)	(0.07)
25	0.0085	0.21	0.0021	0.06	(0.0417)	(0.63)	0.0122	0.70
26	0.0545	1.71	(0.0212)	(0.73)	0.0174	0.34	0.0121	0.90
27	(0.0090)	(0.14)	0.0306	0.54	0.0564	0.55	0.0052	0.19
28	(0.0192)	(0.52)	(0.0158)	(0.47)	(0.0611)	(1.03)	(0.0085)	(0.54)
29	(0.0350)	(1.49)	0.0073	0.34	(0.0109)	(0.29)	0.0074	0.75
30	(0.0286)	(0.92)	(0.0395)	(1.40)	0.0267	0.53	0.0134	1.01
31	[illegible]	(1.13)	(0.0064)	(0.09)	0.1269	1.03	(0.0334)	(1.02)
32	0.0084	0.32	0.0132	0.56	$\boxed{0.0909}$	$\boxed{2.15}$	0.0095	0.85
33	(0.0035)	(0.11)	0.0350	[illegible]	(0.0673)	(1.41)	0.0166	1.32
34	(0.0133)	(0.48)	$\boxed{(0.0568)}$	$\boxed{(1.29)}$	0.0565	1.25	(0.0147)	(1.26)
35	(0.0470)	[illegible]	(0.0252)	(0.77)	(0.0684)	(1.52)	$\boxed{0.0385}$	$\boxed{2.52}$
36	0.0249	0.69	0.0359	1.10	$\boxed{0.1157}$	$\boxed{1.99}$	0.0219	1.43
37	0.0248	0.63	(0.0105)	(0.30)	0.0733	1.16	(0.0058)	(0.35)
38	(0.0285)	(0.83)	0.0152	0.49	(0.0017)	(0.03)	0.0152	1.04

* Numbers in parentheses are negative values.

Table A2
Hedge Regressions for 4 Key Stocks*

Stock #	Boeing (#42) Parameter Estimate	Boeing (#42) *t* Statistic	British Gas (#47) Parameter Estimate	British Gas (#47) *t* Statistic	Courtaulds PLC (#74) Parameter Estimate	Courtaulds PLC (#74) *t* Statistic	Shell Transport (#203) Parameter Estimate	Shell Transport (#203) *t* Statistic
39	(0.0457)	(0.74)	(0.0712)	(1.28)	0.0226	0.23	$\boxed{0.0642}$	$\boxed{2.47}$
40	0.0769	1.12	0.0053	0.09	(0.0376)	(0.34)	0.0133	0.45
41	0.0286	0.83	(0.0026)	(0.08)	$\boxed{0.1099}$	$\boxed{1.99}$	(0.0240)	(1.65)
42	NA	NA	(0.0065)	(0.20)	(0.0179)	(0.31)	(0.0264)	(1.72)
43	(0.0569)	(1.50)	0.0045	0.13	(0.0776)	(1.27)	$\boxed{(0.0447)}$	$\boxed{(2.79)}$
44	0.0497	0.90	(0.0209)	(0.42)	(0.0410)	(0.46)	(0.0086)	(0.36)
45	0.0373	1.12	0.0236	0.78	0.0526	0.98	(0.0053)	(0.37)
46	0.0309	0.52	$\boxed{0.2693}$	$\boxed{5.05}$	0.0249	0.26	$\boxed{0.1986}$	$\boxed{8.15}$
47	(0.0079)	(0.20)	NA	NA	0.0379	0.59	0.0221	1.31
48	$\boxed{0.1034}$	$\boxed{2.30}$	$\boxed{0.2673}$	$\boxed{6.71}$	(0.0008)	(0.01)	$\boxed{0.0505}$	$\boxed{2.64}$
49	(0.0005)	(0.01)	(0.0200)	(0.59)	0.0082	0.14	(0.0157)	(0.99)
50	0.0130	0.45	0.0333	1.28	(0.0157)	(0.34)	0.0083	0.68
51	0.0154	0.50	$\boxed{0.0550}$	$\boxed{1.96}$	(0.0192)	(0.38)	(0.0090)	(0.68)
52	(0.0203)	(0.46)	0.0051	0.13	0.0189	0.27	(0.0047)	(0.25)
53	(0.0659)	(1.70)	$\boxed{(0.0740)}$	$\boxed{(2.10)}$	0.0130	0.21	(0.0205)	(1.24)
54	0.0435	0.93	0.0803	1.89	(0.0372)	(0.49)	0.0062	0.31
55	0.0341	1.15	0.0060	0.22	(0.0099)	(0.21)	0.0045	0.36
56	(0.0110)	(0.26)	(0.0571)	(1.50)	0.0020	0.03	0.0296	1.66
57	(0.0343)	(0.82)	0.0213	0.56	(0.0536)	(0.79)	(0.0254)	(1.42)
58	(0.0855)	(1.17)	(0.0297)	(0.45)	0.0201	0.17	0.0469	1.51
59	(0.0128)	(0.34)	(0.0364)	(1.06)	(0.0324)	(0.53)	(0.0042)	(0.26)
60	(0.0015)	(0.02)	0.0452	0.71	0.1894	1.67	(0.0508)	(1.70)
61	(0.0468)	(1.73)	(0.0102)	(0.41)	(0.0627)	(1.43)	(0.0178)	(1.54)
62	0.0503	0.95	0.0015	0.03	$\boxed{(0.1711)}$	$\boxed{(2.00)}$	0.0311	1.38
63	0.0187	0.77	(0.0303)	(1.37)	(0.0529)	(1.34)	0.0098	0.95
64	(0.0244)	(0.52)	(0.0050)	(0.12)	0.0271	0.36	0.0074	0.38
65	0.0143	0.51	(0.0290)	(1.14)	0.0287	0.64	(0.0149)	(1.25)
66	(0.0438)	(0.83)	0.0645	1.34	$\boxed{(0.2115)}$	$\boxed{(2.48)}$	0.0021	0.09
67	0.0715	1.61	(0.0282)	(0.70)	(0.0527)	(0.74)	$\boxed{0.0438}$	$\boxed{2.33}$
68	(0.0930)	(1.89)	(0.0269)	(0.60)	(0.0418)	(0.53)	0.0174	0.83
69	(0.0199)	(0.58)	0.0309	0.99	0.0216	0.39	0.0015	0.10
70	0.0628	0.96	(0.0961)	(1.63)	(0.0451)	(0.43)	(0.0057)	(0.21)
71	(0.0682)	(1.52)	$\boxed{0.1117}$	$\boxed{2.74}$	(0.0122)	(0.17)	(0.0173)	(0.91)
72	0.0123	0.32	(0.0002)	(0.01)	(0.0231)	(0.38)	(0.0036)	(0.22)
73	0.0465	1.29	(0.0325)	(1.00)	0.0087	0.15	(0.0098)	(0.64)
74	(0.0069)	(0.31)	0.0120	0.59	NA	NA	0.0096	1.01
75	0.0636	1.68	0.0528	1.54	(0.0337)	(0.55)	0.0156	0.97
76	0.0206	0.59	(0.0129)	(0.41)	0.0295	0.53	(0.0029)	(0.20)

* Numbers in parentheses are negative values.

Table A2
Hedge Regressions for 4 Key Stocks*

Stock #	Boeing (#42) Parameter Estimate	Boeing (#42) t Statistic	British Gas (#47) Parameter Estimate	British Gas (#47) t Statistic	Courtaulds PLC (#74) Parameter Estimate	Courtaulds PLC (#74) t Statistic	Shell Transport (#203) Parameter Estimate	Shell Transport (#203) t Statistic
77	0.0112	0.27	(0.0106)	(0.29)	(0.0750)	(1.14)	(0.0205)	(1.18)
78	(0.0476)	(1.35)	0.0280	0.87	(0.0187)	(0.33)	0.0032	0.21
79	0.0708	1.36	0.0035	0.07	(0.0604)	(0.72)	0.0374	1.69
80	0.0199	0.65	0.0080	0.29	(0.0041)	(0.08)	(0.0125)	(0.96)
81	0.0202	0.60	(0.0066)	(0.22)	(0.0084)	(0.16)	0.0204	1.43
82	0.0437	1.09	0.0175	0.48	0.0415	0.64	0.0188	1.10
83	(0.0722)	(0.86)	(0.0840)	(1.10)	(0.0558)	(0.41)	(0.0251)	(0.70)
84	0.0500	1.18	0.0254	0.66	(0.0349)	(0.51)	(0.0129)	(0.71)
85	0.0718	1.75	0.0269	0.72	(0.0341)	(0.52)	0.0130	0.74
86	(0.0073)	(0.15)	(0.0219)	(0.49)	0.1440	1.81	(0.0054)	(0.26)
87	(0.0030)	(0.05)	(0.0088)	(0.15)	0.0970	0.90	0.0078	0.27
88	0.0144	0.38	(0.0649)	(1.86)	(0.0065)	(0.11)	0.0015	0.09
89	(0.0161)	(0.46)	0.0508	1.61	(0.0196)	(0.35)	(0.0184)	(1.24)
90	(0.0061)	(0.15)	0.0444	1.17	(0.0473)	(0.70)	(0.0131)	(0.73)
91	(0.0550)	(1.45)	(0.0179)	(0.52)	0.0126	0.21	0.0035	0.21
92	(0.0113)	(0.29)	(0.0123)	(0.35)	0.0172	0.28	0.0018	0.11
93	(0.0232)	(0.79)	0.0156	0.59	0.0252	0.54	(0.0206)	(1.67)
94	(0.0318)	(0.52)	(0.0157)	(0.28)	(0.0527)	(0.53)	(0.0194)	(0.74)
95	(0.0465)	(0.67)	(0.0429)	(0.68)	(0.0981)	(0.87)	(0.0088)	(0.30)
96	0.0205	0.66	0.0480	1.71	(0.0057)	(0.11)	(0.0046)	(0.35)
97	0.0172	0.64	0.0446	1.82	0.0370	0.85	(0.0242)	(2.11)
98	0.0569	1.34	0.0696	1.81	0.0135	0.20	0.0059	0.32
99	0.0571	1.24	0.0339	0.81	(0.0080)	(0.11)	(0.0148)	(0.76)
100	0.0199	0.54	(0.0954)	(2.85)	0.1105	1.85	(0.0178)	(1.13)
101	(0.0003)	(0.01)	(0.0102)	(0.45)	(0.0111)	(0.28)	0.0010	0.09
102	0.0165	0.29	(0.0522)	(1.03)	(0.0008)	(0.01)	(0.0153)	(0.64)
103	0.0109	0.23	(0.0069)	(0.16)	0.0391	0.52	(0.0087)	(0.44)
104	(0.0366)	(0.90)	(0.0103)	(0.28)	0.0676	1.03	(0.0158)	(0.91)
105	0.0741	2.08	(0.0082)	(0.25)	0.0521	0.91	0.0344	2.28
106	(0.0762)	(1.21)	0.0529	0.92	(0.1466)	(1.44)	(0.0191)	(0.71)
107	(0.0103)	(0.22)	0.0353	0.84	(0.0376)	(0.50)	0.0091	0.46
108	0.0129	0.30	(0.0873)	(2.27)	0.0168	0.24	0.0290	1.61
109	0.0561	1.59	0.0302	0.94	(0.0117)	(0.20)	(0.0259)	(1.73)
110	(0.0024)	(0.07)	(0.0257)	(0.88)	(0.0860)	(1.65)	0.0018	0.13
111	0.0217	0.57	0.0078	0.23	0.0539	0.88	0.0048	0.30
112	0.0024	0.09	(0.0079)	(0.33)	(0.0240)	(0.56)	0.0012	0.11
113	0.0072	0.25	0.0060	0.23	0.0366	0.78	0.0000	0.00
114	(0.0475)	(1.42)	0.0121	0.40	0.0693	1.28	(0.0095)	(0.67)

* Numbers in parentheses are negative values.

Table A2
Hedge Regressions for 4 Key Stocks*

Stock #	Boeing (#42) Parameter Estimate	Boeing (#42) t Statistic	British Gas (#47) Parameter Estimate	British Gas (#47) t Statistic	Courtaulds PLC (#74) Parameter Estimate	Courtaulds PLC (#74) t Statistic	Shell Transport (#203) Parameter Estimate	Shell Transport (#203) t Statistic
115	(0.0251)	(0.69)	0.0140	0.43	(0.0617)	(1.05)	0.0113	0.73
116	0.0270	0.63	0.0582	1.50	(0.0813)	(1.17)	0.0480	2.64
117	0.0673	1.71	0.0019	0.05	0.0311	0.49	0.0066	0.40
118	(0.0228)	(0.59)	0.0122	0.35	(0.0259)	(0.42)	(0.0426)	(2.62)
119	0.0173	0.60	0.0170	0.65	(0.0453)	(0.97)	0.0159	1.30
120	(0.0160)	(0.33)	(0.0072)	(0.16)	0.1084	1.39	(0.0238)	(1.15)
121	0.0046	0.15	0.0055	0.20	(0.0571)	(1.18)	(0.0104)	(0.81)
122	0.0494	1.31	(0.0014)	(0.04)	0.0772	1.27	0.0035	0.22
123	(0.0022)	(0.06)	(0.0944)	(2.83)	0.1563	2.64	(0.0037)	(0.23)
124	0.0341	0.51	0.1447	2.40	(0.0610)	(0.57)	(0.0262)	(0.92)
125	(0.0477)	(1.55)	0.0021	0.07	0.0305	0.61	0.0092	0.70
126	(0.0150)	(0.30)	0.0058	0.13	0.0255	0.32	(0.0001)	(0.00)
127	0.0705	2.00	(0.0619)	(1.93)	0.0306	0.54	0.0021	0.14
128	(0.0957)	(2.86)	(0.0276)	(0.90)	(0.0319)	(0.59)	(0.0015)	(0.10)
129	(0.0044)	(0.08)	0.0900	1.91	(0.0615)	(0.73)	0.0214	0.97
130	0.0166	0.32	(0.0293)	(0.63)	0.1286	1.56	0.0048	0.22
131	(0.0348)	(1.05)	(0.0088)	(0.29)	(0.0647)	(1.21)	(0.0206)	(1.47)
132	0.0051	0.09	(0.0123)	(0.25)	0.2028	2.32	0.0001	0.01
133	0.0368	0.87	(0.0562)	(1.46)	(0.0196)	(0.29)	(0.0298)	(1.65)
134	(0.0253)	(0.57)	0.0215	0.54	(0.0686)	(0.96)	(0.0078)	(0.41)
135	(0.0516)	(0.99)	0.0502	1.06	(0.0400)	(0.48)	0.0157	0.71
136	0.0090	0.25	0.0422	1.31	0.0416	0.72	0.0011	0.07
137	(0.0510)	(1.11)	0.0094	0.23	(0.0893)	(1.21)	(0.0062)	(0.32)
138	(0.0011)	(0.03)	0.0652	1.77	0.1003	1.53	(0.0270)	(1.56)
139	0.0373	0.92	(0.0250)	(0.68)	0.1394	2.14	0.0030	0.18
140	0.0070	0.15	0.0314	0.77	(0.0370)	(0.51)	0.0119	0.62
141	0.0474	1.97	(0.0131)	(0.60)	(0.0558)	(1.44)	0.0242	2.37
142	(0.0073)	(0.15)	0.0077	0.18	(0.0138)	(0.18)	0.0133	0.65
143	0.0141	0.62	(0.0213)	(1.03)	0.0226	0.61	0.0105	1.07
144	0.0280	0.64	(0.0028)	(0.07)	(0.0449)	(0.64)	(0.0235)	(1.27)
145	(0.0493)	(1.51)	(0.0182)	(0.61)	(0.1023)	(1.95)	0.0237	1.71
146	(0.0236)	(0.43)	0.0072	0.14	(0.2154)	(2.45)	(0.0054)	(0.23)
147	(0.0407)	(1.12)	(0.0094)	(0.28)	0.0420	0.71	(0.0507)	(3.28)
148	0.0816	2.06	(0.0429)	(1.19)	0.1232	1.93	(0.0130)	(0.77)
149	0.0181	0.49	0.0019	0.06	0.1353	2.29	(0.0185)	(1.19)
150	0.0427	1.09	(0.0311)	(0.88)	(0.0385)	(0.61)	(0.0073)	(0.44)
151	0.0415	0.71	(0.0420)	(0.80)	0.0521	0.55	0.0178	0.72
152	(0.0213)	(0.67)	0.0331	1.14	(0.0612)	(1.19)	(0.0084)	(0.62)

* Numbers in parentheses are negative values.

Table A2
Hedge Regressions for 4 Key Stocks*

Stock #	Boeing (#42) Parameter Estimate	Boeing (#42) *t* Statistic	British Gas (#47) Parameter Estimate	British Gas (#47) *t* Statistic	Courtaulds PLC (#74) Parameter Estimate	Courtaulds PLC (#74) *t* Statistic	Shell Transport (#203) Parameter Estimate	Shell Transport (#203) *t* Statistic
153	0.0513	0.90	(0.0397)	(0.76)	(0.1667)	(1.81)	0.0178	0.73
154	0.1148	1.85	0.0063	0.11	0.1140	1.14	0.0124	0.47
155	(0.0821)	(2.08)	(0.0032)	(0.09)	(0.0970)	(1.52)	(0.0154)	(0.91)
156	0.1026	2.64	0.0272	0.77	0.0916	1.46	(0.0046)	(0.28)
157	0.0010	0.03	(0.0537)	(1.68)	0.0679	1.20	0.0221	1.48
158	(0.0118)	(0.40)	(0.0056)	(0.21)	(0.0151)	(0.31)	0.0186	1.47
159	(0.0219)	(0.58)	(0.0058)	(0.17)	0.0948	1.55	(0.0029)	(0.18)
160	(0.0343)	(0.94)	0.0802	2.41	(0.0474)	(0.80)	(0.0199)	(1.27)
161	(0.0292)	(1.02)	(0.0018)	(0.07)	0.0160	0.35	0.0168	1.38
162	(0.0299)	(1.04)	0.0143	0.55	(0.0009)	(0.02)	0.0091	0.75
163	(0.0261)	(1.34)	0.0205	1.16	0.0286	0.91	0.0008	0.09
164	0.0544	1.27	(0.0111)	(0.29)	0.0134	0.19	(0.0094)	(0.52)
165	0.0480	1.48	0.0289	0.98	0.0897	1.71	0.0044	0.32
166	0.0602	1.53	0.0139	0.39	0.0239	0.38	0.0007	0.04
167	0.0295	0.93	(0.0223)	(0.77)	(0.0262)	(0.51)	0.0042	0.31
168	(0.0432)	(0.62)	0.0551	0.88	(0.0494)	(0.44)	0.0144	0.49
169	0.0405	1.28	(0.0130)	(0.45)	0.0323	0.63	(0.0014)	(0.11)
170	0.0382	0.76	(0.0196)	(0.43)	(0.0712)	(0.88)	0.0253	1.19
171	0.0124	0.40	(0.0019)	(0.07)	(0.0324)	(0.65)	(0.0037)	(0.28)
172	0.0615	1.76	0.0288	0.91	0.0547	0.97	0.0102	0.69
173	0.0321	0.59	(0.0619)	(1.26)	0.0973	1.11	0.0370	1.61
174	0.1853	3.40	0.0023	0.05	0.0158	0.18	(0.0067)	(0.29)
175	0.0831	1.54	(0.0234)	(0.48)	(0.0284)	(0.33)	(0.0175)	(0.76)
176	0.0373	1.18	0.0523	1.82	(0.0888)	(1.74)	0.0255	1.89
177	0.0207	0.54	(0.0078)	(0.22)	(0.0074)	(0.12)	(0.0060)	(0.37)
178	0.0280	0.34	0.0592	0.79	0.0801	0.60	(0.0113)	(0.33)
179	0.0233	0.55	(0.0380)	(0.98)	0.0416	0.60	(0.0003)	(0.01)
180	0.0663	1.64	(0.0285)	(0.77)	0.0163	0.25	(0.0142)	(0.82)
181	0.1338	2.86	0.0269	0.63	0.0471	0.62	0.0049	0.25
182	(0.0514)	(1.02)	(0.1021)	(2.25)	0.0424	0.52	(0.0144)	(0.67)
183	(0.0351)	(1.18)	(0.0208)	(0.77)	0.0118	0.25	(0.0056)	(0.45)
184	0.0189	0.61	(0.0061)	(0.22)	(0.0454)	(0.91)	0.0191	1.46
185	(0.0309)	(0.91)	0.0292	0.95	0.0782	1.43	(0.0128)	(0.89)
186	0.0514	1.74	(0.0425)	(1.59)	0.0044	0.09	0.0091	0.72
187	0.0067	0.13	(0.0008)	(0.02)	(0.0002)	(0.00)	(0.0464)	(2.03)
188	0.1002	1.64	0.0720	1.30	(0.0157)	(0.16)	0.0051	0.20
189	(0.0647)	(1.61)	(0.0667)	(1.83)	0.0527	0.81	(0.0007)	(0.04)
190	(0.0014)	(0.03)	(0.0228)	(0.53)	(0.1126)	(1.49)	(0.0215)	(1.08)

* Numbers in parentheses are negative values.

Table A2
Hedge Regressions for 4 Key Stocks*

Stock #	Boeing (#42) Parameter Estimate	Boeing (#42) *t* Statistic	British Gas (#47) Parameter Estimate	British Gas (#47) *t* Statistic	Courtaulds PLC (#74) Parameter Estimate	Courtaulds PLC (#74) *t* Statistic	Shell Transport (#203) Parameter Estimate	Shell Transport (#203) *t* Statistic
191	0.0114	0.58	(0.0016)	(0.09)	0.0057	0.18	(0.0062)	(0.73)
192	(0.0302)	(0.72)	0.0001	0.00	(0.0016)	(0.02)	0.0191	1.07
193	0.0152	0.61	0.0284	1.26	(0.0036)	(0.09)	(0.0028)	(0.26)
194	0.0311	0.99	(0.0086)	(0.30)	(0.0403)	(0.79)	(0.0042)	(0.31)
195	(0.0723)	(0.69)	0.1505	1.58	0.0749	0.44	0.7077	19.27
196	0.0032	0.09	(0.0519)	(1.55)	(0.0098)	(0.16)	0.0236	1.51
197	(0.0358)	(1.38)	0.0324	1.38	0.0117	0.28	0.0005	0.05
198	0.0511	1.25	(0.0773)	(2.08)	0.0268	0.41	0.0269	1.54
199	(0.0396)	(0.92)	0.0054	0.14	0.0056	0.08	(0.0179)	(0.98)
200	0.0761	1.86	(0.0053)	(0.14)	0.0279	0.42	0.0195	1.12
201	(0.0429)	(0.64)	0.0097	0.16	0.0124	0.12	(0.0010)	(0.04)
202	0.0048	0.13	(0.0007)	(0.02)	(0.0461)	(0.78)	0.0160	1.03
203	(0.1463)	(1.72)	0.1008	1.31	0.1381	1.01	NA	NA
204	0.0015	0.03	(0.0109)	(0.26)	(0.0105)	(0.14)	0.0011	0.05
205	(0.0658)	(1.14)	0.0161	0.31	0.0887	0.95	(0.0178)	(0.72)
206	(0.0861)	(1.48)	(0.0922)	(1.74)	(0.1149)	(1.22)	0.0150	0.60
207	0.0754	2.73	(0.0184)	(0.73)	(0.0588)	(1.32)	(0.0013)	(0.11)
208	0.0017	0.05	0.0309	0.95	0.1116	1.92	0.0014	0.09
209	0.0051	0.15	(0.0010)	(0.03)	(0.0126)	(0.22)	0.0138	0.93
210	0.0068	0.20	(0.0035)	(0.12)	0.0446	0.83	(0.0090)	(0.63)
211	0.0208	0.66	0.0000	0.00	0.0042	0.08	(0.0185)	(1.39)
212	(0.0297)	(0.84)	(0.0548)	(1.70)	0.0542	0.95	(0.0109)	(0.72)
213	0.0259	0.71	0.0063	0.19	(0.0467)	(0.79)	0.0390	2.53
214	0.0464	1.04	0.0283	0.70	(0.0787)	(1.10)	(0.0364)	(1.92)
215	(0.0009)	(0.03)	0.0460	1.55	(0.0210)	(0.40)	(0.0091)	(0.66)
216	(0.0326)	(0.73)	(0.0408)	(1.01)	(0.0005)	(0.01)	(0.0174)	(0.92)
217	(0.1242)	(2.00)	(0.0488)	(0.87)	(0.0267)	(0.27)	(0.0313)	(1.18)
218	(0.0001)	(0.01)	0.0340	1.23	0.0186	0.38	(0.0111)	(0.85)
219	0.0005	0.02	0.0008	0.03	0.0492	1.21	0.0194	1.82
220	(0.0156)	(0.48)	0.0576	1.95	(0.0087)	(0.16)	(0.0157)	(1.13)
221	0.0024	0.08	(0.0370)	(1.34)	0.0091	0.19	0.0088	0.68
222	(0.0340)	(0.86)	0.0514	1.44	0.0232	0.36	0.0069	0.41
223	0.0383	1.70	(0.0068)	(0.33)	0.0215	0.59	0.0211	2.20
224	0.0296	0.92	(0.0102)	(0.35)	(0.0644)	(1.24)	0.0330	2.42
225	0.0057	0.16	0.0218	0.67	(0.0697)	(1.20)	(0.0008)	(0.05)
226	0.0098	0.17	0.0490	0.95	0.2020	2.21	0.0297	1.23
227	(0.0735)	(1.04)	0.0533	0.83	(0.1350)	(1.19)	0.0203	0.68
228	0.0598	1.49	(0.0284)	(0.78)	0.0005	0.01	0.0277	1.62

* Numbers in parentheses are negative values.

Table A2
Hedge Regressions for 4 Key Stocks*

Stock #	Boeing (#42) Parameter Estimate	Boeing (#42) *t* Statistic	British Gas (#47) Parameter Estimate	British Gas (#47) *t* Statistic	Courtaulds PLC (#74) Parameter Estimate	Courtaulds PLC (#74) *t* Statistic	Shell Transport (#203) Parameter Estimate	Shell Transport (#203) *t* Statistic
229	0.0169	0.27	0.0151	0.27	(0.0873)	(0.87)	0.0008	0.03
230	(0.0266)	(0.58)	0.0130	0.31	0.0261	0.35	(0.0007)	(0.04)
231	0.0168	0.60	(0.0200)	(0.78)	0.0200	0.44	0.0039	0.33
232	0.0683	1.13	(0.0140)	(0.25)	0.0574	0.59	(0.0339)	(1.32)
233	$\boxed{0.1178}$	$\boxed{3.01}$	0.0219	0.61	$\boxed{0.1298}$	$\boxed{2.05}$	0.0098	0.59
234	0.0367	1.08	(0.0484)	(1.57)	(0.0681)	(1.24)	0.0031	0.22
235	0.0269	0.96	0.0318	1.25	0.0080	0.18	0.0060	0.51
236	0.0071	0.15	0.0382	0.88	(0.0279)	(0.36)	(0.0296)	(1.46)
237	0.0244	0.56	0.0359	0.91	(0.0723)	(1.04)	0.0198	1.08
238	0.0432	1.23	0.0333	1.04	0.0371	0.65	0.0243	1.63
239	0.0564	1.32	0.0091	0.23	0.0077	0.11	0.0032	0.18
240	0.0537	1.61	0.0221	0.73	(0.0330)	(0.61)	0.0273	1.92
241	(0.0198)	(0.60)	0.0087	0.29	(0.0421)	(0.79)	0.0134	0.96
242	(0.0152)	(0.45)	(0.0497)	(1.62)	(0.0283)	(0.52)	(0.0191)	(1.33)
243	(0.0355)	(1.16)	0.0096	0.34	$\boxed{0.0993}$	$\boxed{2.01}$	0.0093	0.71
244	(0.0686)	(1.77)	0.0419	1.19	0.0224	0.36	(0.0022)	(0.13)
245	(0.0285)	(0.74)	0.0288	0.82	(0.1068)	(1.72)	(0.0065)	(0.40)

* Numbers in parentheses are negative values.

Table A3
Optimal Portfolio Generated With Alternative Baseline

Expected 10% Change in Stock Price Within 2 Weeks*

				---------Summary Characteristics of the Portfolio---------						
	Final Holdings	% of Firm Equity	Change from Baseline	$ Riskless	$ Risky	$ Long	$ Short	Annual E(R)	Annual STD(R)	CML Slope at Optimum
Courtaulds Plc W=$5 bn	130815	> 100	128642	-99220	104220	1.65 E12	1.54 E12	2.45 E41	10.21	.509
Boeing W=$5 bn	344188	> 100	334842	-93430	98430	2.14 E12	2.04 E12	1.03 E70	14.25	.993
British Gas W=$5 bn	425939	> 100	406630	-57053	62053	2.41 E12	2.35 E12	1.05 E80	15.62	1.19
Shell Transport W=$5 bn	1867813	> 100	1853152	-257682	262682	5.59 E12	5.32 E12	3.05 E174	29.81	4.34

Expected 10% Change in Stock Price With Increase of Risk-Free Rate to 8%*

Courtaulds Plc W=$5 bn	130593	> 100	128642	-82937	87937	1.64 E12	1.55 E12	1.92 E41	10.19	.508
Boeing W=$5 bn	343988	> 100	334842	-77146	82146	2.13 E12	2.05 E12	8.63 E69	14.24	.991
British Gas W=$5 bn	425879	> 100	406630	-40769	45769	2.40 E12	2.36 E12	9.51 E79	15.62	1.19
Shell Transport W=$5 bn	1866980	> 100	1853152	-241399	246399	5.57 E12	5.33 E12	2.51 E174	29.79	4.34

*All dollar holdings (columns 1,3-7) are in millions of dollars.

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