Financial Disclosure and Regulation

A portfolio approach.

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Public firms in the U.S. are required to submit financial reports both quarterly and annually. While this is the common practice in Western countries at present, other reporting terms were once required, and different regulations still hold in various countries around the world. See, for example, De Ridder and Muller [1994] and Parker and Yamey [1994].

Should firms be required to disclose information, or should disclosure be discretionary? If disclosure should be required, what is the optimal amount of information that should be reported? In other words, how much detail should be provided to stockholders, or how often should reports be provided?

Most authors investigating these issues focus on a single firm, or on the effect of obtaining information about one firm from the financial reports of another related firm. We take a different approach—we investigate the question of disclosure in a portfolio theory context.

The socially optimal disclosure and the desirability of disclosure requirements have been widely studied in various aspects of theory. The economic literature reveals a variety of opinions regarding the need for disclosure and the optimal amount of information that firms should be required to disclose. Grossman [1981], Diamond [1985], and Fishman and Hagerty [1998] point out that in some cases disclosure regulation seems to be redundant, while other studies show that voluntary disclosure by firms is sometimes insufficient and thus disclosure regulation is needed.[1]

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Verrecchia [1990] notes that firms may voluntarily disclose positive information and avoid voluntary disclosure of negative information. We adopt Grossman's [1981] approach and assume that the firm cannot disclose only good information, because non-disclosure would be taken as bad news. Thus, we do not analyze the question of selective or biased disclosure but instead deal with the *level* of information. Hence, if the firm decides voluntarily to increase its disclosure, it will release more information, good and bad, in an unbiased fashion.

Easley and O' Hara [2004] discuss the effect of the mix of public and private information on firm values. We focus on the optimal level of public information and its implications for disclosure regulation in the multiple-firm case.

Dye [1990] and Admati and Pfleiderer [2000] look at the effect of learning about one firm from the disclosure of a different related firm. We approach the issue from a different angle, using a portfolio approach to analyze the value of financial disclosure to stockholders and the need for disclosure regulation. Our focus is the effect of firms' disclosure on the composition of investors' portfolios.

The interactions between firms in our model occur because a change in investors' estimates regarding one firm's parameters, say, its mean return, may affect the optimal investment proportions in all the other firms (as suggested by Markowitz [1952]). These interactions may be complex and non-trivial. Thus, in our model the effect of a firm's disclosure on its value and on the value of other firms is quite different from the effects discussed previously in the literature.[2]

We use the mean-variance framework. To derive the optimal mean-variance portfolio, one needs full and precise information regarding the values of the mean rate of returns vector and the variance-covariance matrix. In reality, this information is not known, and investors have to estimate values of the various parameters according to the information available. As the estimation process generally involves heterogeneous subjective beliefs, investors may err in their estimates, and thus may choose various inferior portfolios, which clearly implies a reduction in expected utility.[3]

We assume that disclosed information reduces estimation errors and clusters investor beliefs closer to the true parameters. Thus, stockholders are willing to pay to gather more information, which reduces the errors involved and improves their expected utility.

Our study rests on several assumptions:

- Reported information is truthful, unbiased, and costly.
- The firm's goal is to maximize its value, so it will disclose information voluntarily only if such disclosure increases its value.
- Investors select their optimal diversification by the mean-variance rule, and their estimates regarding the means and variance-covariance matrix are unbiased and based on the financial information available.
- The more precise the firms' financial disclosure, the more accurate the investors' estimates and therefore the smaller the investment errors. In the extreme case of full information disclosure, all investors know the true parameters. In this case, the model collapses to the classic homogeneous-belief capital asset pricing model, where all investors select efficient portfolios, i.e., linear combinations of the market portfolio and the riskless asset.

Assuming that managers' goal is to maximize the value of the firm's stock, and that stockholders' goal is to invest in a mean-variance-efficient portfolio, there may be a conflict of interest between the two parties. While it is obvious that (costless) financial disclosure improves stockholders' welfare, it is *a priori* not clear whether voluntary disclosure increases the firm's value.

To see this, note that when firms disclose incomplete information, equity portfolios selected by investors due to subjective beliefs generally differ from the optimal mean-variance tangency portfolio. This implies in turn that firms' equilibrium values may diverge from the predictions of the CAPM, which implicitly assumes all investors are fully informed.

Therefore, in an incomplete disclosure market, some firms may be overvalued in terms of their CAPM values, while other firms may be undervalued. Moreover, as investors' diversification depends on the information disclosed by all firms, this implies that each firm's value is affected not only by its own disclosure but also by other firms' disclosure. Thus, the effect of financial disclosure on a firm's value is not at all obvious.

Considering the disclosure cross-effect, what should be the optimal disclosure policy of the firm? Should disclosure be mandatory?

To address this issue, we analyze firms' equilibrium values in a market with incomplete disclosure, and compare them to the values as predicted by the CAPM. We show that in an incomplete disclosure market with an infinite number of assets and an infinite number of investors, firms' equilibrium values converge to their CAPM values. This result is based on our research in Levy, Levy, and Benita [2006]. Thus, the firm's value is independent of its disclosure policy and the disclosure policy of the other firms.

While we derive this result for infinite markets, numerical simulations demonstrate that the result also holds almost precisely in a finite market with reasonable numbers of assets and investors. Thus, considering the fact that disclosure is costly for firms, the implication is that firms do not have an incentive to disclose information voluntarily. As disclosure of information improves investors' welfare, in order to maximize social welfare the regulator has to force firms to disclose information.

DISCLOSURE AND FIRM VALUES IN A PORTFOLIO FRAMEWORK

We use the Sharpe [1964]-Lintner [1969] CAPM framework to analyze the effect of disclosure on firm values. One of the fundamental CAPM assumptions is that the mean rate of returns vector, μ, and the variance-covariance matrix, Σ, are known, and all investors agree on the values of these parameters. This assumption implies that firms provide stockholders full and precise information, and investors have homogeneous beliefs based on this information.

In our model, as in the Sharpe-Lintner CAPM, we assume that with full disclosure all investors have homogeneous beliefs. With only partial disclosure, however, the parameters are estimated subjectively by investors, so investors may have heterogeneous beliefs.[4] Thus, in an incomplete-disclosure market, portfolios selected by investors may be different from one investor to another, as well as different from the CAPM optimal portfolio. This in turn implies that firms' equilibrium values may generally diverge from the predictions of the CAPM.

To examine the effect of the lack of full information on firms' values, we first discuss the optimal mean-variance portfolio derivation and determination of firms' equilibrium values according to the classic CAPM, where full information is given and μ and Σ are known to all. We can then compare these values to firm values in a market with incomplete disclosure. Given the mean returns vector, μ, the variance-covariance matrix, Σ, and the riskless interest rate, r, the optimal investment proportion in the i-th firm, x_i, is given as follows:

$$x_i = \frac{\sum_{j=1}^{n} v_{ij}(\mu_j - r)}{\sum_{h=1}^{n}\sum_{j=1}^{n} v_{hj}\,\mu_j - r\sum_{h=1}^{n}\sum_{j=1}^{n} v_{hj}} \tag{1}$$

where the v_{ij} are the elements of the inverse matrix of Σ, and n is the number of assets (see Merton [1972, Equation (41)].

By the market clearing condition, the equilibrium value of the i-th firm, V_i, is given by:

$$V_i = x_i \sum_{k=1}^{K} T_k \tag{2}$$

where T_k is the k-th investor's wealth invested in equity, and K is the number of investors.

To analyze the equilibrium values in a market with incomplete disclosure, suppose that firms do not disclose complete information. Given the available partial information, the k-th investor estimates of μ and Σ are μ_k and Σ_k, which may generally differ from the true parameters.

One can incorporate the effect of the lack of financial information on investor beliefs quantitatively in two ways:

1. $\boldsymbol{\mu}_k = \boldsymbol{\mu}(1 + \boldsymbol{\varepsilon}_k)$ and $\Sigma_k = \Sigma E$, where $\boldsymbol{\varepsilon}_k$ is an error vector and E is an error matrix (or $\boldsymbol{\mu}_k = \boldsymbol{\mu} + \boldsymbol{\varepsilon}_k$ and $\Sigma_k = \Sigma + E$).
2. $\tilde{R}_{ik} = \tilde{R}_i + \tilde{\varepsilon}_{ik}$ where $\tilde{R}_i$ stands for the rate of return on the i-th firm, $\tilde{R}_{ik}$ is the k-th investor estimate of this distribution, and $\tilde{\varepsilon}_{ik}$ is an error term due to the lack of full disclosure.

Our model assumes that the error terms diminish with the amount of disclosed information, and at the limit when full information is available the error terms vanish (and $E \to I$, where I is the unit matrix, or $E \to 0$ in the additive case).

Approach (2) automatically implies that with partial disclosure, the investor will err both in μ and Σ because $\tilde{\varepsilon}_k \neq 0$ generally implies that both $\mu_k \neq \mu$ and $\Sigma_k \neq \Sigma$. Approach (1) lets us assume that the lack of reported information may induce $\mu_k \neq \mu$, or $\Sigma_k \neq \Sigma$, or both. Thus, approach (1) allows us to decompose the analysis into the investigation of errors regarding the mean returns and of errors regarding the covariances. Because of this advantage we use approach (1).

We focus on errors regarding only the expected returns, i.e., $\mu_k \neq \mu$ but $\Sigma_k = \Sigma$. A generalization of our analysis to both $\mu \neq \mu_k$ and $\Sigma \neq \Sigma_k$ is straightforward.[5]

As the estimation process involves subjective beliefs, it implies that μ_k differs from one investor to another, and has some distribution in the population. We want to isolate and analyze the effect of the lack of information on the firm's value, and we do not want to introduce systematic expectation biases, such as general overoptimism or pessimism. Thus, we choose a distribution of $\tilde{\mu}_{ik}$ so that it is unbiased, $E[\tilde{\mu}_{ik}] = \mu_i$, where μ_i is the true value of the i-th firm's expected return. We assume that the degree of the error in the investors' estimate of μ_i is proportional to the magnitude of μ_i. Thus, we take:

$$\tilde{\mu}_{ik} = \mu_i(1 + \tilde{\varepsilon}_{ik}) \tag{3}$$

where $\tilde{\varepsilon}_{ik}$ is an error factor regarding firm i that is distributed according to some probability density function $f_i(\tilde{\varepsilon}_{ik})$ with $E(\tilde{\varepsilon}_{ik}) = 0$. ($E(\tilde{\varepsilon}_{ik}) = 0$ ensures that $E[\tilde{\mu}_{ik}] = \mu_i$.) As the random variables $\tilde{\varepsilon}_{ik}$ represent the subjective idiosyncratic estimation errors, they are assumed to be independent across firms and across investors.

Our results do not actually hinge on any assumptions regarding the specific distribution of $\tilde{\varepsilon}_{ik}$. Thus, our model allows a different distribution of $\tilde{\varepsilon}_{ik}$ for different stocks, which implies that firms may disclose a differential amount of information.

Let us see how the lack of precise knowledge regarding μ_i affects the selected portfolios. When disclosure is incomplete, the investment proportion in the i-th firm generally varies across investors. The k-th investor's investment proportion in firm i, denoted by $\tilde{x}_{ik}$, is given by:[6]

$$\tilde{x}_{ik} = \frac{\sum_{j=1}^{n} v_{ij}(\tilde{\mu}_{jk} - r)}{\sum_{h=1}^{n}\sum_{j=1}^{n} v_{hj}\tilde{\mu}_{jk} - r\sum_{h=1}^{n}\sum_{j=1}^{n} v_{hj}} \tag{4}$$

where the tilde indicates that these values are stochastic (because the error term $\tilde{\varepsilon}$ is stochastic). By the market clearance condition we obtain:

$$V_i^* = \sum_{k=1}^{K} T_k \tilde{x}_{ik} \tag{5}$$

The asterisk denotes values corresponding to the market with incomplete disclosure; hence, V_i^* is the value of firm i in a market with partial disclosure. Note that unlike the CAPM clearance condition, here we use $\tilde{x}_{ik}$ rather than x_i, where $\tilde{x}_{ik}$ is some function of the k-th investor vector of ε realizations $\underline{\tilde{\varepsilon}}_k = (\tilde{\varepsilon}_{1k}, \tilde{\varepsilon}_{2k}, \ldots, \tilde{\varepsilon}_{nk})$ Hence V_i^* may generally be different from V_i in Equation (2).

Convergence to CAPM Firm Values

In large markets with many firms and investors, firms' equilibrium values converge to their CAPM values, i.e., $\mathbf{V}^* \to \mathbf{V}$. This result, which is based on Levy, Levy, and Benita [2006], implies that the firm has no incentive to disclose information voluntarily, as disclosure is costly and as the information disclosed does not increase the firm's value. The fact that $x_{ik} \neq x_i$ implies that investors hold mean-variance inferior portfolios, however, implying that the lack of disclosure reduces investors' expected utility. While with less disclosure the firms' values do not change, generally all investors lose in terms of expected utility, meaning disclosure regulation is clearly needed.

In Levy, Levy, and Benita [2006] we prove that in infinite markets ($K \to \infty$ and $n \to \infty$) with uncorrelated assets and incomplete disclosure, firms' equilibrium values converge to their CAPM values, i.e., to values with full disclosure, $\underline{V}^* \to \underline{V}$. The same result holds for correlated assets with equal correlations. When there are many but finite assets and investors, and under a general correlation matrix, we show in Levy, Levy, and Benita in numerical simulations that the same result holds almost precisely. Thus, the firm's value is not affected by the amount of its disclosure or by other firms' disclosure policy.

The reason behind this convergence result is rooted in the fact that as $n \to \infty$, the investor k's investment proportion in firm i, $\tilde{x}_{ik}$ becomes *linear* in $\tilde{\varepsilon}_{ik}$. This linearity, and the fact that expectations are unbiased ($E[\tilde{\varepsilon}_{ik}] = 0$), implies that $E[\tilde{x}_{ik}] = x_i$, which in turn implies the convergence of firm values to their CAPM values.

Numerical Simulations

While precise convergence holds only at the limit of infinite markets, numerical simulations demonstrate that firm values are almost identical in both the presence and the absence of disclosure in finite markets, and may be helpful in obtaining insight about the convergence result. We investigate equilibrium pricing in an incomplete disclosure market with a finite number of investors and stocks. We take the number of investors to be K = 10,000 and the number of stocks to be n = 20, which is rather

EXHIBIT 1
Stocks in the Numerical Simulation

Stock Number	Expected Return (%)	Standard Deviation (%)
1	12.71	22.33
2	16.73	19.73
3	13.42	26.02
4	14.36	22.81
5	20.11	25.03
6	11.18	19.86
7	13.49	29.86
8	15.44	33.10
9	19.60	33.87
10	14.35	33.20
11	10.21	16.35
12	13.39	30.33
13	12.02	24.09
14	14.24	22.03
15	17.69	21.75
16	15.73	30.23
17	19.87	29.09
18	15.77	28.09
19	15.36	32.92
20	16.56	29.95

conservative, as in actuality markets are much larger. For simplicity, we assume all investors have the same investment capital, i.e., $T_k = T$ for all investors; the results do not change significantly under different assumptions regarding the distribution of T_k.

We take the error factor, $\tilde{\varepsilon}_{ik}$, to be normally distributed with $\mu_\varepsilon = 0$ and $\sigma_\varepsilon = 0.3$ for all firms. To get a feeling for the meaning of $\sigma_\varepsilon = 0.3$, recall that if $\mu_i = 10\%$ this implies that there is about a 0.95 probability that investors' subjective estimates of μ_i will be in the range of 4% to 16%. Thus, σ_ε of 30% implies a relatively large amount of error in investor estimates.

We select stock expected returns, μ, and stock variances, σ^2 such that μ and σ^2 are correlated at about 40%, as found in , e.g., Douglas [1969] and Levy [1978]. Exhibit 1 illustrates the selected stocks' μ and σ in a mean-standard deviation space, and Exhibit 2 reports the correlation matrix assumed for these stocks.

Given the expected return vector, $\boldsymbol{\mu}$, the variance-covariance matrix, Σ, and the risk-free interest rate, which is taken as $r = 4\%$, the CAPM investment proportions' vector and the firms' values with full disclosure are first derived according to Equations (1) and (2). Next, we select for the k-th investor a vector of random error values ε_{ik} ($i = 1, 2, \ldots, n$). Given the simulation realizations vector of $\boldsymbol{\varepsilon}_k$, the subjective optimal diversification, $\tilde{\mathbf{x}}_k$, is derived for each investor ($K = 1, 2, \ldots, 10{,}000$) according to Equation (4). By aggregating across investors, we obtain the firms' values, $\underline{V}^*$, in the case of partial disclosure, as given by Equation (5).

Exhibit 3 illustrates the relation between V_i^* and V_i as obtained in a typical simulation (other simulations with different $\tilde{\varepsilon}$ realizations yield very similar results). We can see from the plot that in most cases $V_i^* \sim V_i$. Thus, while the result that firm values are unaffected by disclosure is proven mathematically for the case $K \to \infty$ and $n \to \infty$, it also holds approximately for a finite and relatively small market with $K = 10{,}000$ investors and $n = 20$, let alone for actual markets, which are much larger.

As disclosure of information is costly, this result implies that the firm has no incentive to disclose information. On the other hand, the k-th investor's investment proportions are different from the optimal proportions, $\mathbf{x}_k \neq \mathbf{x}$, so the investor's chosen portfolio is located below the capital market line, which implies reduced investor welfare in the absence of full financial disclosure.

Note that if a firm improves its disclosure, the investor's welfare will improve, but this will not enhance the firm's value, and all the benefit will go to the investors. Thus, there is a conflict of interest between investors and firms' managements regarding the need for disclosure; therefore disclosure regulation is necessary.

VALUE OF FINANCIAL DISCLOSURE TO STOCKHOLDERS

How much information should firms be required to disclose? To answer this question, we have to analyze the value of financial disclosure to stockholders, and compare this value with the disclosure costs. Analysis of the investor's welfare less due to lack of financial disclosure indicates the amount of disclosure that is socially optimal.

When firms disclose only partial information, investors generally select inferior portfolios, which clearly implies reduced expected utility. Therefore, investors are willing to pay for collecting more information, which reduces their estimation errors and improves their expected utility. We show that although firms do not have an incentive for financial disclosure, stockholders' expected utility improves with the amount of information disclosed by firms. Hence, this is a clear case for disclosure to be required.

Exhibit 4 illustrates the investor's loss due to the lack of financial disclosure in mean-standard deviation space.

Exhibit 2
Correlation Matrix of 20 Stocks

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1.00																			
2	0.25	1.00																		
3	0.24	0.22	1.00																	
4	0.21	0.23	0.16	1.00																
5	0.24	0.11	0.19	0.17	1.00															
6	0.23	0.14	0.19	0.18	0.22	1.00														
7	0.1	0.18	0.14	0.19	0.22	0.11	1.00													
8	0.22	0.16	0.18	0.2	0.18	0.15	0.24	1.00												
9	0.18	0.15	0.19	0.24	0.24	0.17	0.17	0.18	1.00											
10	0.11	0.12	0.21	0.14	0.12	0.21	0.22	0.23	0.17	1.00										
11	0.2	0.13	0.15	0.17	0.19	0.22	0.24	0.13	0.19	0.25	1.00									
12	0.11	0.16	0.2	0.15	0.17	0.13	0.16	0.22	0.2	0.17	0.11	1.00								
13	0.14	0.13	0.16	0.15	0.18	0.13	0.15	0.14	0.23	0.22	0.18	0.17	1.00							
14	0.16	0.25	0.11	0.13	0.12	0.13	0.14	0.23	0.18	0.21	0.24	0.14	0.24	1.00						
15	0.13	0.14	0.21	0.22	0.22	0.23	0.12	0.17	0.24	0.21	0.22	0.13	0.15	0.19	1.00					
16	0.19	0.23	0.13	0.2	0.19	0.17	0.25	0.13	0.2	0.19	0.22	0.17	0.14	0.17	0.17	1.00				
17	0.16	0.22	0.15	0.12	0.24	0.2	0.12	0.22	0.12	0.15	0.24	0.18	0.16	0.12	0.24	0.16	1.00			
18	0.21	0.12	0.18	0.25	0.23	0.25	0.13	0.13	0.23	0.16	0.13	0.22	0.24	0.11	0.18	0.14	0.14	1.00		
19	0.24	0.22	0.14	0.14	0.11	0.13	0.16	0.24	0.22	0.11	0.13	0.18	0.15	0.19	0.2	0.17	0.17	0.18	1.00	
20	0.13	0.22	0.19	0.17	0.24	0.19	0.14	0.14	0.22	0.11	0.22	0.18	0.13	0.23	0.22	0.18	0.22	0.14	0.23	1.00

Exhibit 3
V_i^* as Function of V_i—K = 10,000 Investors, n = 20 Stocks, and σ_ε = 30%

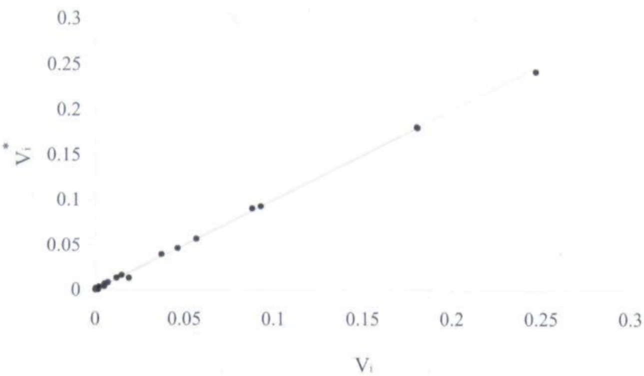
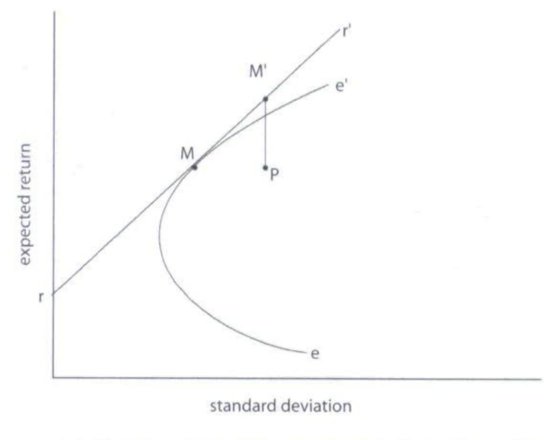


Exhibit 4
Investor Loss



Curve ee' and the line rr' denote the efficient frontier and the capital market line (CML), respectively. Suppose that due to optimization with μ_k and Σ_k, rather than μ and Σ, the k-th investor holds portfolio P. This investor's loss in terms of expected return due to inefficient diversification is defined as the vertical line denoted by PM′. This is the loss because with full disclosure the k-th investor could have selected an efficient portfolio with the same degree of risk (portfolio M′).[7]

Hence, the k-th investor's loss in terms of expected return, denoted by $\tilde{L}_k$, is given by:

$$\tilde{L}_k \equiv \mu_{M'} - \tilde{\mu}_{pk} = \left(r + \frac{\mu_M - r}{\sigma_M}\tilde{\sigma}_{pk}\right) - \tilde{\mu}_{pk} \tag{6}$$

where $\tilde{\mu}_{pk}$ and $\tilde{\sigma}_{pk}$ are the mean rate of return and the standard deviation of the k-th investor's portfolio, respectively, and μ_M and σ_M are the mean rate of return and the standard deviation of the optimal mean-variance portfolio (the market portfolio).

Note that L is given in percent. Therefore, the k-th investor's expected loss in dollar terms is given by the product of her percentage loss in terms of expected return, $\tilde{L}_k$, and her invested wealth, T_k. Thus, given the vectors **L** and **T**, one can aggregate over investors to derive the expected loss in the economy in dollar terms, denoted by I, as follows:

$$\tilde{I} = \sum_{k=1}^{K} \tilde{L}_k T_k \tag{7}$$

Under the assumption that $\tilde{L}_k$ is independent of T_k, the expected loss is given by:

$$E[\tilde{I}] = E[\tilde{L}_k] \sum_{k=1}^{K} T_k \tag{8}$$

From a social welfare standpoint, one should spend money on financial disclosure up to the point where the disclosure costs are equal to the benefits attributable to avoiding losses. The less information disclosed by firms, the higher the standard deviation of the error term, σ_ε, and hence the less efficient investors' portfolios.

To get an idea of the effect of the intensity of the error factor, σ_ε, on investors' loss, we carry out simulations for various levels of σ_ε, using empirical asset return distribution parameters. The assets are the 25 Fama-French portfolios sorted on size and book-to-market. This choice of assets has the advantage of employing data on a very large number of stocks, which are divided into a manageable number of portfolios. The means, variances, and covariances of these assets are estimated from the empirical annual returns over 1926–2001.[8]

We vary σ_ε from 1% to 6%. These are conservative values, implying small errors. Obviously, with higher errors, the loss to investors is even greater than the loss we report. We conduct one simulation for each σ_ε, and in each simulation we calculate the mean and the variance of each selected portfolio and also the mean and the variance of the optimal portfolio.

Then we calculate for each simulated portfolio the loss in terms of expected return according to Equation (6) (we have 10,000 random portfolios, as K = 10,000). Given the vector **L**, we calculate for each simulation the average percentage loss:

$$\sum_{k=1}^{10,000} L_k \,/\, 10{,}000 = \bar{L}$$

Exhibit 5 illustrates the location of the investors' portfolios in a mean-standard deviation space relative to the efficient frontier and relative to the CML (only 1,000 portfolios are graphed of the 10,000 portfolios). As can be seen from Exhibit 5, the higher σ_ε, the farther the investors' portfolios are from the CML. Thus, Exhibit 5 implies that, as expected, investors' portfolios become less efficient as σ_ε increases.

Exhibit 6 plots the average percentage loss, $\bar{L}$, as a function of the intensity of the error factor, σ_ε. We can see that a shift from an error factor of $\sigma_\varepsilon = 1\%$ to an error factor of $\sigma_\varepsilon = 6\%$ increases the average investor loss from 0.3% to about 9.6%. Thus, Exhibit 6 indicates that investor loss due to inefficient diversification is very sensitive to the level of σ_ε.

One can use our methodology to estimate the amount investors are willing to pay to gather more information in order to reduce the errors involved in their investment decision-making. To reduce σ_ε from 6% to 4%, for instance, investors are willing to pay 9.6% – 4.4% = 5.2% of the total market capitalization, which is no doubt a very large figure.

CONCLUDING REMARKS

The value of financial disclosure and the need for regulation are important and controversial questions. We take a portfolio approach to analyze these issues, focusing on the effect of lack of information regarding firms' mean returns vector on firm values and on the inefficiency of investor allocations.

We show that in large markets where investors' estimates are unbiased, the firm's value is not affected by its financial disclosure or by other firms' financial disclosure policy. Thus, considering the fact that disclosure of information is costly, our result implies that firms, whose goal is to maximize their market value, have no incentive to disclose information voluntarily. This may explain why firms generally report only the information required by regulators and do not volunteer more.

We also show that investor portfolios become more efficient with the amount of information disclosed by firms, which implies that investor welfare is diminished in the absence of financial disclosure. Thus, as improved disclosure enhances investor welfare but not the value of

EXHIBIT 5
Efficient Frontier, CML and Investors' Portfolios (1,000 representative portfolios)

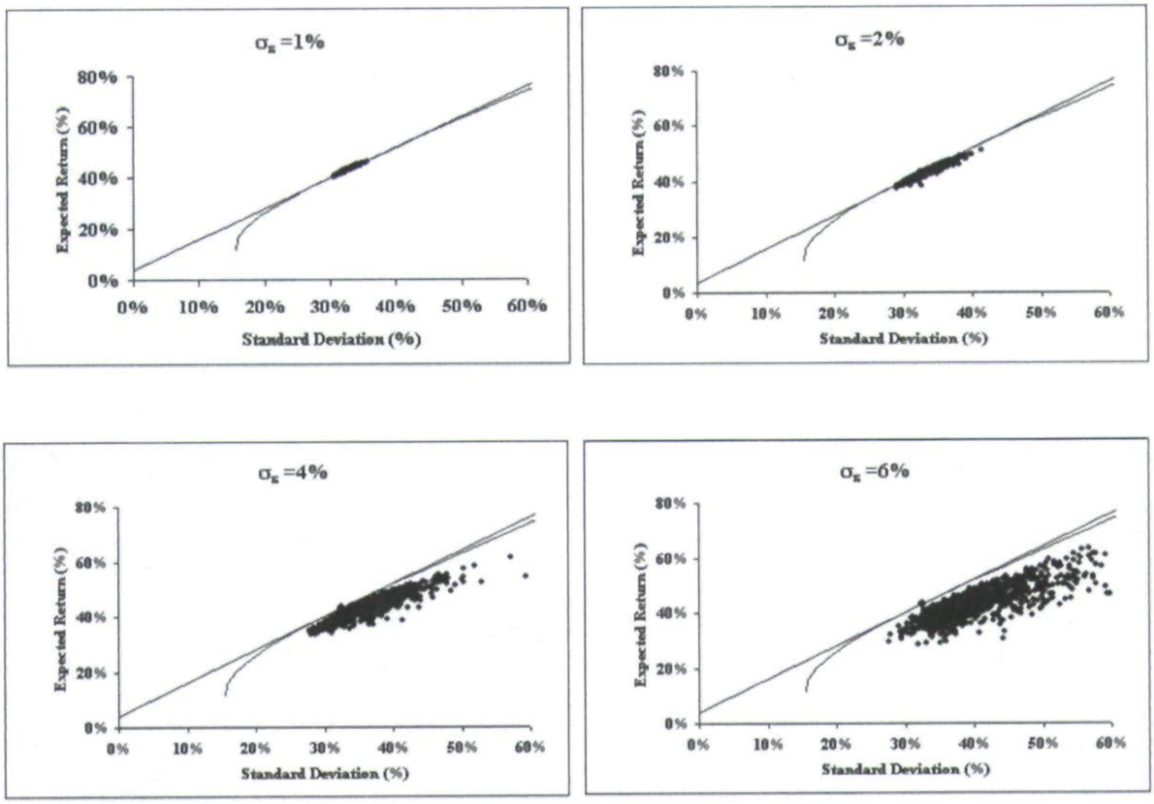
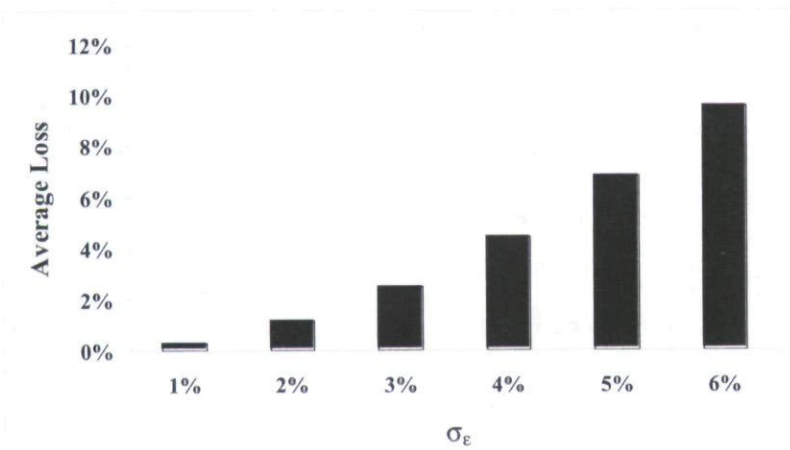


EXHIBIT 6
Average Loss in Portfolio Returns as Function of σ_ε



the firm, disclosure regulation is needed to maximize social welfare.

One can adopt the methodology suggested here to analyze investors' loss at various levels of disclosure precision. Preliminary results indicate that investors can lose quite a bit because of incomplete disclosure.

This is not to be taken to mean that the stricter disclosure regulations, the higher the social welfare, because disclosure of information is costly—and the cost rises with the precision and the frequency of the information disclosed. Regulators establishing mandatory disclosures have to take into consideration not only the investor loss induced by incomplete disclosure, but also the costs involved.

The optimal amount of information that firms should be required to disclose should be determined by minimizing both disclosure costs and investors' loss due to the absence of information.

ENDNOTES

The authors gratefully acknowledge financial support from the Zagagi Fund and from the Krueger Center of Finance.

[1]Admati and Pfleiderer [2000] show that in the case of multiple firms with correlated values investors can use information disclosed by one firm in valuing other related firms. In this case, disclosure regulation sometimes, but not always, improves welfare, while voluntary disclosure is often socially inefficient. See also Dye [1990].

[2]Easley and O' Hara [2004] also use a multiple-firm setting. In their framework, firms' returns are cross-sectionally uncorrelated, and investors have CARA preferences, so investor investments in one firm are independent of investor expectations regarding the other firms. The interaction among firms plays a central role in our analysis.

[3]Note that *any* deviation in the investor's estimate from the true values of the various parameters, whether it is optimistic or pessimistic, leads to selecting an inferior portfolio.

[4]The heterogeneous beliefs may also be due to private signals about the information that is not publicly disclosed. Note that under a certain set of assumptions prices may be fully revealing (see Admati [1985]). In general, though, prices will be at most only partially revealing (see Biais, Bossaerts, and Spatt [2003]), and beliefs will be heterogeneous.

[5]That is, we focus on the estimate of firms' expected profit. Suppose an investor (or a financial analyst) decides a given stock should be priced at a P/E multiple of, say, 15. Given the market price, the investor needs to estimate E, which is the expected earnings per share, to know whether to buy the stock. The more information available on profit, the better the estimate of μ.

[6]This is similar to Equation (1), but the subjective beliefs μ_k replace μ .

[7]Of course, with full information the investor will select some efficient portfolio corresponding to particular preferences, which does not necessarily coincide with portfolio M'. To avoid the introduction of hypothetical preferences, we choose to measure investors' loss due to an inefficient diversification in terms of expected return rather than in terms of expected utility.

[8]These data are available at the web site: http:// mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

REFERENCES

Admati, A. "A Noisy Rational Expectations Equilibrium for Multi-Asset Securities Markets." *Econometrica*, 53, 3 (1985), pp. 629-657.

Admati, A., and P. Pfleiderer. "Forcing Firms to Talk: Financial Disclosure Regulation and Externalities." *The Review of Financial Studies*, 13 (2000), pp. 479-517.

Biais, B., P. Bossaerts, and C. Spatt. "Equilibrium Asset Pricing Under Heterogeneous Information." Working paper, Carnegie Mellon University, 2003.

DeRidder, J., and H.R. Muller. "History of Accounting Theory." Working paper, University of Southern California, 1994.

Diamond, D.W. "Optimal Release of Information by Firms." *Journal of Finance*, 40 (1985), pp. 1071-1094.

Douglas, G.W. "Risk in the Equity Markets: An Empirical Appraisal of Market Efficiency." *Yale Economic Essays*, 9 (1969), pp. 3-45.

Dye, R. "Mandatory Versus Voluntary Disclosure: The Cases of Financial and Real Externalities." *The Accounting Review*, 65 (1990), pp. 1-24.

Easley, D., and M. O' Hara. "Information and the Cost of Capital." *Journal of Finance*, 59 (2004), pp. 1553-1583.

Fishman, M. J., and K.M. Hagerty. "Disclosure Decisions by Firms and the Competition for Price Efficiency." *Journal of Finance* 44 (1989), pp. 633-646.

Grossman, S. J. "The Informational Role of Warranties and Private Disclosure About Product Quality." *Journal of Law and Economics*, 24 (1981), pp. 461-483.

Levy, H. "Equilibrium in an imperfect market: a constraint on the number of securities in the portfolio." *American Economic Review* 68 (1978), pp. 643-658.

Levy, M., H. Levy, and G. Benita. "Capital Asset Prices with Heterogeneous Beliefs." *Journal of Business*, 2006, forthcoming.

Lintner, J. "Security Prices and Risk, and Maximal Gain from Diversification." *Journal of Finance*, 20 (1965), pp. 587-615.

Markowitz, H.M. "Portfolio Selection." *Journal of Finance*, 7 (1952), pp. 77-91.

Merton, R.C. "An Analytic Derivation of the Efficient Portfolio Frontier." *Journal of Financial and Quantitative Analysis*, 7 (1972), pp. 1851-1872.

Parker, R.H, and B.S. Yamey. *Accounting History: Some British Contributions*. Oxford: Oxford University Press, 1994.

Sharpe, W.F. "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk." *Journal of Finance*, 19 (1964), pp. 653-670.

Verrecchia, R.E. "Information Quality and Discretionary Disclosure." *Journal of Accounting and Economics*, 12 (1990), pp. 365-380.