5 The Real Output of the Stock Exchange

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A stock analyst, unhappy with his job, went to lunch with an officer of a competing pension fund. The analyst made his case carefully, explaining which of his material was being ignored, and what lesser material from others was guiding actual trading. The officer, who had no intention of hiring the analyst, picked up the check. Who paid for the lunch?

Over the last three decades, trading on stock exchanges has been growing at a growing rate. In 1960, 958 million shares of stock were traded on the New York Stock Exchange (NYSE). By 1970, this had roughly tripled to 3,124 million. By 1987, the volume had grown another 15-fold to 48,144 million shares, and the NYSE was planning for a potential billion-share day by the early 1990s. This pattern of accelerating growth is even stronger on the newer exchanges on which the shares of smaller firms are traded. The volume on NASDAQ grew from 1,390 million shares traded in 1975 to 37,890 million in 1987. The acceleration is even more marked if we consider the recent growth in stocklike instruments such as options.

A trade of a share of stock is not a constant unit. In figure 5.1, we show the growth in the deflated dollar value of trades on U.S. securities markets. The line labeled "stocks" is the total market value of trades on all the stock

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2. Stock splitting behavior tends to keep the nominal value of the average share traded roughly constant in the intermediate run.
Fig. 5.1 Dollar (millions) volume of trading (deflated to 1982 by Standard and Poor's 500 index)

exchanges registered with the Securities and Exchange Commission. The line labeled "stocks, etc." includes nonstock securities; warrants, rights, equity options (whether traded or exercised) and trades in nonequity options. The deflator for the figure is an extremely conservative one, the value of the Standard and Poor's 500 portfolio over time. Clearly, the figure shows a dramatic change in the rate of growth of trading, partly driven by the expansion in nonstock but equitylike securities. Overall, the rate of growth of trades in the figure is 8 percent per annum, but the later periods clearly show more rapid growth. If we were to use a less conservative deflator for the figure, such as the GNP deflator, it would show an even more dramatic acceleration.

The growth in trading was accompanied by rapid growth in inputs at stock exchange member firms. Figure 5.2 displays selected inputs into NYSE member firms for the period beginning in 1971. The solid line shows total expenditures in 1987 dollars, using the GNP deflator. The line with asterisks shows registered representatives, that is, broker personnel. (This series is not available for 1984). This period of rapid trading growth was also a period of rapid growth in the resources consumed by the sector. These resources primarily produce intermediate outputs; trading services, knowledge and analysis to support trading decisions, and sales efforts.

What is the real output of the stock exchange? Has it grown as dramatically as figure 5.1 suggests? These are the issues addressed in this paper. Our inquiry focuses on several related analytical issues arising in the nature of the changes in stock exchange activity in recent years.

Baumol (1965) lists five ways in which the operations of securities markets produce a social output. For our purposes, we classify these into three administrative and two informational outputs. The administrative outputs are access to capital, liquidity, and low administration costs. The existence of securities markets permits any particular enterprise to be owned by many small capitalists, each diversified. This permits the sharing of risk. Further, the capitalists can have a shorter time horizon than the enterprise; the existence of a price at which the individual can sell shares means that the investment is liquid. The additional liquidity may reduce risk as well as lower investor costs. Finally, when compared with other forms of financial intermediation, the securities exchanges can involve considerably less administrative effort for the transfer of funds.

The informational outputs of the exchange are twofold. The importance of each output depends on the belief that securities prices reflect fundamentals, that is, the expected future earnings stream of the enterprise. First, information about the firm's prospects could be useful to investors in their effort to evaluate the wisdom of management's plans for the firm. For the single inves-

Fig. 5.2 Select inputs to NYSE member firms (real expenses, registered representatives)
tor, whether individual or institution, that information is potentially useful in deciding whether (and at what level) to continue to invest in the firm. For a particular firm's investors taken as a group, it is useful in selecting, evaluating, and compensating managers. Second, because stock prices are informative, they offer guidance to business management—information on the current cost of capital which is so important in determining the level of investment which it is appropriate for the firm to undertake. Thus, the securities markets could usefully transfer information out of the firm to investors, or reflect information (presumably known by some investor) that management would not otherwise know.

The dramatic increase in trading volume on the stock exchanges might have represented an increased service along any or all of these five dimensions. The origins and form of the increase in trading suggest the importance of the two informational dimensions. The increase is happening worldwide—not just in the United States. In the United States, it is driven by very rapid technological change based on the use of telecommunications equipment and computers and by the 1975 deregulation of stock brokerage. The technological effects have been much the same outside the United States, but deregulation has played a much smaller role until recently.

The new technologies and deregulation have made trading cheaper. The technologies let individual traders in brokerage houses more closely monitor and react to events in and affecting the markets. Today, they have Quotron terminals and Unix workstations to follow many different sources of information and act on them. The deregulation and technology let investors outside brokerage houses trade more cheaply at the margin. The exchanges themselves have accommodated the traders' desire for rapid response with electronic market infrastructure. The NASDAQ small-order execution system and the NYSE direct order transmission system are examples that permit reasonably direct computerized trading. One effect of these lower costs is that more traders in more countries participate in globalized markets. This creates an opportunity to execute very large trades quickly and without much effect on price—increased liquidity in the short term.

These changes create opportunities for traders to get and use information about companies and about the market. When a trader can easily take and later liquidate a large position, there are opportunities to earn an expected profit on even a small information advantage. As a result, traders pursue ever smaller arbitrage opportunities, better analysis of public information, and (illegal as well as legal) private information.

One response to this increased liquidity is the systematic pursuit of arbitrage opportunities. Wall Street "quants" perform computer intensive research not unlike that of professors of finance. The quants' goals, however, are to find systematic departures from theory and then to trade on them. Increasing liquidity means that smaller and smaller systematic departures can be exploited. Competition among potential traders means that, over time, only smaller and smaller departures persist.

Similar opportunities exist on the fundamental side of securities research and trading. A trader who can anticipate the contents and implications of a public announcement about a company can usually make a profit. Increased liquidity and lowered transactions costs mean that it is increasingly valuable to expend resources on anticipation of public announcements. The analyst's research activity is the more valuable, the more correct it is and the more unique it is; something known to everyone is already reflected in the stock price. As a result, competition among research analysts and traders leads to the pursuit of a priori less and less promising fundamental analysis. The marginal fundamental research project always earns zero expected return on the costs of gathering and processing the information about the company. As with the quantitative/arbitrage research efforts, the competition among analysts and traders can take two forms. The analyst can attempt to get to a better answer than analysts at other trading houses. This typically takes either better-informed or smarter analysts; the former are expensive, the latter subject to rapidly diminishing returns. The other form of competition involves getting to the answer more rapidly and trading on it earlier. This form of competition is a very effective destroyer of rents. But it suggests a substantial increase in the speed with which information is impounded in security prices.

The nature of the changes in securities markets suggests two directions of increase in the real output of the exchange: The first is the direct effects of lowered trading costs on the administrative outputs of the exchanges. The second is the indirect effects of increased informativeness of the prices of securities. It appears unlikely that either effect represents a large increase in the real output of the securities exchanges. Almost all of our formal argument is concerned with the informativeness effects, but we will briefly review the administrative effects here.

Trading costs are not primarily costs of owning publicly traded companies or costs of the existence of publicly held companies. A buy-and-hold lifecycle investor, for example, gains only incrementally from the decline in trading costs over the last decade and a half. Thus enterprises can be owned by a broad range of well-diversified investors either before or after the trading cost decline. The administrative effects seem likely to be second order. The value of quicker incorporation of information in stock prices is a more

6. The increased liquidity of the exchanges does provide some benefits, such as opportunities to rebalance portfolios at lower cost. In an economy with identical stockholders, equilibrium portfolio balancing involves no trades. But in an economy with stockholders in diverse tax circumstances, the lowered trading costs may permit more effective use of the securities markets to engage in tax-lowering trades. These, depending on one's view of the tax code, either usefully broaden the base of capital taxation or destroy useful attempts to tax favor particular types of capital.
difficult question. We ultimately conclude that this, too, likely represents an unimportant improvement in the output of the stock exchanges. But to reach this conclusion we need a more careful treatment of the potential social gains to informative stock prices. If outside analysts research companies more, and if much of the information they discover is reflected in the price of the stock, who finds this information useful and how? We will provide models of both of the two information flows discussed above, that to investors and that to management.

The question of the value of information in stock prices is a difficult one in no small part because of the plausibility of the hypothesis that the stock market should have grown more informative over the last decade. Many firms in the United States, facing increased worldwide competition, have felt themselves to be in a more difficult environment. It is a cliche of the 1980s that firms need to refocus on decision making for the long term and on competitiveness. These are times in which it is quite plausible that improved mechanisms for aligning management and shareholder interests on the long run could be particularly valuable. It is also plausible that, in apparently unsettled times, the stock price could communicate more things to management that it does not know.7

In what follows, we provide separate but similar analyses of the two informational hypotheses: (1) more informative securities prices better align investor and management incentives; and (2) better information in securities prices inform management about investment prospects. In both cases, we assume that the stock grows more informative because of outsider traders. These are self-interested investors who gather information about companies and trade in their securities in the hopes of private gain.

We use a standard model of information gathering and trading in the stock market, that of Grossman and Stiglitz (1980). In their model, the incentive to gather information about companies arises because informed investors can trade on it. Because they do trade on the information, equilibrium price is correlated with the information; by this mechanism, the securities market can grow more informative. Rational expectations by other investors limit the size of their trading gains, however. Information that traders gather and trade on is reflected partially in stock prices, partially in expected profits to the informed trader. The more investors know something, or the larger position informed investors take, the more the information tends to be revealed by the stock price. In equilibrium, the number of traders who become informed is determined by the cost of gathering the information and return. At a market equilibrium, so many traders become informed that they drive the return to information (suitably adjusted for risk) down to the cost. This model provides us with a way to understand the part of the problem concerning information gathering by outsider traders.

There are a number of ways in which more rapid or more complete reflection of information about companies in stock prices could be a socially valuable output: (1) stock market prices are often used in compensation contracts for high company officials; better information might make this principal-agent problem go better; (2) the stock market serves to guide investment. Better information might guide it to better uses; and (3) takeovers, leveraged buy outs, and so on, might provide discipline in management that would be more effective with better public information. By building models of (1) and (2), we argue that any beneficial effects are likely be small. Our arguments will clearly not apply to takeovers.

Theories of corporate officers' compensation suggest that use of the stock price can align officers' and stockholders' interests. There may be substantial costs of waiting to compensate officers on the basis of how their decisions actually work out in the future. Instead, the argument goes, the forward-looking character of the stock price lets the compensation be done closer to the decision point. This leads to an interesting puzzle. Many managers appear to believe that compensating them with stock tends to focus them on the present, not the future. Rather than encouraging high-payoff investments in R&D or other long-lived assets, the stock market encourages managers to show immediate profits. Further, this tendency has been getting stronger over time. As the managers see it, the markets are systematically shortsighted. Their irrationality translates into an irrational compensation scheme.

The managers, it turns out, are very likely right about everything but the irrationality. In the next section, we present a simple model of managerial compensation, a model based on the price established in a fully rational stock market. In the compensation model, managers' and stockholders' goals are not necessarily identical. Shareholders care only about their return; managers care only about their compensation and the effort they expend to get it. The incentive contract offered the managers uses the stock price to compensate them. To the extent the stock price reflects the future value of the firm, this tends to make the gap between shareholder and manager interests smaller. Managerial attention might, for example, be directed either to R&D or to making the quarterly earnings report look right. The first activity is high payoff, difficult to evaluate, and uncertain; the second is the reverse. A good incentive contract rewards the first and ignore the second. Our model determines whether the self-interested information-gathering and trading behavior of stock-market participants, who might gather information about either managerial activity and trade on it, leads to such a contract.

For the purpose of compensating the managers, shareholders would like the stock price to reflect the R&D management activity more, the earnings report less. But investor research may have the reverse effect. The stock market equilibrium does not systematically tend to invest in information about the more

7. Of course, it is also a cliché of this period that the stock market does none of these things, but rather the reverse, by focusing companies on short-run returns. This is a point to which we shall return.
valuable activity. Although we show this result precisely below, it is easy to anticipate its intuition here. From the point of view of the compensation contract, one would like the stock price to reflect managers' value added. But that is not what traders care about; they want to know about the value of the firm. In both gathering information and trading on it, their incentives lead them to the wrong activity.

Our analysis of the way the stock market guides investment is similar. The role of information is different here. There is information about the firms' prospects not known to the firms' officers or directors. The market, by displaying a large $q$ (Tobin 1969; Hayashi 1982), can signal the need for an expansion of the firms' capital stock.

Our analysis of this situation closely parallels the previous one. Once again, we distinguish between two different pieces of information to gather and trade on. One of these concerns the value of the firms' existing projects; the other, the value of the incremental investment project. To guide investment correctly, the market would have to emphasize the latter information. Once again, the reverse is true; for the case of a small incremental project, stochastically independent of existing projects, the stock price reflects only the value of existing projects.

Once again, the intuition is clear. Traders care about the value of the firm, which may be determined overwhelmingly by existing projects. They are not necessarily interested in the value added of the incremental project.

### 5.1 Real-Side Decisions, Managerial Agency, and the Long-Run Value of the Firm

The first value-of-information issue can be addressed in a basic principal-agent model of relationships between the owners of a firm and its stockholders. The classic approach to this problem combined three elements. First, managers' and shareholders' incentives are not aligned a priori; managerial effort needs to be elicited by incentives under moral hazard. Second, the board of directors is sophisticated in setting the managerial compensation scheme but is limited in what it can observe; compensation is based on observable indicators of the effects of managers' actions, not on the actions themselves. Although the board cannot observe the managers' actions, it correctly anticipates the effect of incentives on managerial actions. Our model also has rational expectations in another sense. The stock price is equal to the present value of per-share earnings, adjusted for risk and deducting any managerial compensation. This equation is not an identity that managers take as given. Rather, it is an equilibrium condition.


The value of stock market information for managerial compensation can be addressed in this framework with two simple changes. First, we give the stock market itself an explicit informational role. We follow Grossman and Stiglitz (1980), Hellwig (1980), and Admati and Pfleiderer (1987) by introducing outside traders who can research the firm and trade on the results of their research. We use the standard model in which outside traders' information is partially revealed by the stock price. If it were fully revealed, there would be no incentive for research. To capture the long-run/short-run distinction of our introduction, we also model the outsiders as capable of researching any of several different aspects of the firm. This also leads immediately to our other novel feature. We let managers choose a vector of activities, not a single effort level. Thus, the model has a rich enough logical structure to permit statements like "outsiders research short-run earnings, not long-run prospects, so managers direct their efforts to the short run."

We make specific assumptions about functional forms and distributions, following the literature. In particular, both shareholders and managers have constant absolute risk aversion preferences about wealth, and managers' utility is separable in wealth and effort. The joint distribution of the future value of the firm and all signals observed by outside traders is normal.

Ultimately, the firm will have earnings

$$V = f(x) + \sum \Theta_i,$$

where $x$ is a vector of choice variables for management, and $\Theta$ is a random term outside anyone's control. These revenues are discounted to the present. For our application, it is natural to think of $f(x) + \Theta$ as being calculated from the sum of present earnings, $\gamma$, and the present value of future earnings, $\gamma^*$. Both $\gamma$ and $\gamma^*$ depend on $x$, perhaps differently, and the sum of their random components is $\Theta$. The manager/agent picks $x$, and bears some private effort costs, $c(x)$, in doing so. So far, we closely follow the usual agent-theoretical models of managerial compensation, except that $x$ is a vector. The problem for the directors/shareholders, then, is to be slightly more complex than usual. They need to elicit not only overall managerial effort, but the right mix of the different efforts, $x^*$. 9

We follow the literature by assuming that compensation cannot be based on $x$, which is fundamentally unobservable, or on $V$, which is observed too late. Instead, compensation is based on the current stock price, $P$. The intuition held by both economists and practitioners has been that $P$ reflects all publicly available information about $V$. Thus, under a fundamentals or efficient-markets theory of how $P$ is set, management's incentives are aligned with shareholders.

9. The effort variables, $x$, are naturally unobservant, and we have written both $f(x)$ and $c(x)$ as arbitrary functions. Clearly, there is an arbitrary normalization here. We could write $f(x*) = \sum_i x_i^*, c(x^*)$, without any loss of generality.
The net compensation of the manager is given by:

\[ T(P) - c(x), \]

where \( T(P) \) is a transfer or compensation function. We assume \( T \) is linear, \( T(P) = t_0 + t_1 P \). In this framework, \( x \) is subject to moral hazard. A self-interested manager will set \( x \) to maximize expected monetary income minus effort costs, adjusted for risk. In certainty-equivalent terms, this is

\[ U_n = \max_x t_0 + t_1 E[P | x] - c(x) - \frac{1}{2} a \sigma_e^2. \]

The last term is the risk premium in the manager's compensation. Because higher \( x \) generally leads to a higher mean price, (3) does represent an incentive contract. As long as the managers' coefficient of absolute risk aversion, \( a \), is positive, the solution \( t_1 = 1 \) and \( t_0 = -E[V] \) is not optimal, because it requires the managers to bear too much risk.

We assume that directors, in setting \( T(P) \), act in the long-run interests of all shareholders. They will pick the function \( T(.) \) to maximize the appropriately risk-adjusted terminal value of the firm. We will return to the details of this problem.

In the standard model with exogenous information, \( x \) is set by the managers according to (3). The stock price is set by

\[ P = E[V | x] - T(P) - \text{(shareholders' risk premium)}, \]

because constant shareholder risk aversion implies linearity in \( E[V] \) and rational expectations implies the value of the firm is calculated at the managers' equilibrium action. Finally, \( t_0 \) and \( t_1 \) are set by the board to maximize shareholder welfare subject to (3). Except in some special cases (certainty, risk-neutral manager), the equilibrium does not attain the first best. Perhaps better information from an active set of researcher/investors would help.

### 5.2 Investor Preferences and Stock-Market Equilibrium

We let the informativeness of \( P \) about \( V \) be endogenous. Individual or institutional investors can research different aspects of \( V \) and trade on that information. We assume that in performing these activities, investors are self-interested. They trade on their research information only to the extent it gives them a risk-adjusted return. They only do research that leads to profitable trades. We will follow Grossman and Stiglitz (1980) in modeling one effect of this activity. The more informed investors trade, the more \( P \) reflects their research efforts. If other investors have rational expectations, they use the information in \( P \). This limits the private value of research. In our treatment, the increased informativeness of \( P \) has a second spillout; the board of directors can use it in a compensation contract.

The research possibilities are about different aspects of \( V \). We assume that investors are grouped in types, \( i \), each of which can research a particular aspect. For clarity, we link each research aspect to a particular managerial effort level, \( x_i \). In particular, we assume an informed investor of type \( i \) observes,

\[ y_i = x_i + \Theta_i, \]

This is an imperfect signal of the effort \( x_i \) because it contains noise. It is also an incomplete signal of the ultimate value of the firm. Because

\[ V = f(x) + \sum_i \Theta_i, \]

any particular research project bears on only a particular aspect, such as the current or future earnings of the firm. Our assumption that there are multiple nontrivial signals and that any particular investor sees at most one of these means that each informed investor is still somewhat uncertain about \( V \). Thus no risk-averse investor takes infinitely large positions in the security. We will investigate two different problems: a short-run problem in which the amount of research being done is fixed and a long-run problem in which research is endogenous.

We assume that investors are risk averse and that they have constant absolute risk aversion. An investor's utility function over ex post wealth is \( U(W) = -\exp(-aW) \) where \( a \) is the coefficient of (absolute) risk aversion. This specific form of preferences is helpful because it, together with competitive rational expectations and normally distributed errors, implies a linear asset-demand equation. An investor who observes signal \( y_i \) demands stock according to

\[ q_i = \frac{E[V | y_i, P] - P - T(P)}{a \text{ var}(V | y_i, P)}. \]

The numerator in (7) is the investor's expected return on a share of stock. A positive signal leads informed investors to take a long position, a negative signal to short. The denominator is risk aversion times the variance of the

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10. This can be justified as corresponding to an optimal choice when the model is regarded as the reduced form of a more detailed, dynamic formulation. See Holmstrom and Milgrom (1987).
11. There are no investment bankers or raiders on boards forcing shortsightedness in our model.
12. This is an assumption of convenience. Models in which investors choose research projects, possibly pursuing several, have been investigated by Admati and Pfleiderer (1987). These models quickly become extremely technically complex. Price-taking investors who research multiple projects would add little to our treatment. Takeover investors who investigate everything and mount a raid are a different matter.
investor's risky return. Investors with better research (i.e., smaller variances around ultimate value) take larger positions.\footnote{Following Grossman and Stiglitz (1980), we write the problem as if the stock of the firm at hand were the only risky asset in the economy. Admati and Pfleiderer (1987) treat the case of an investor demanding a portfolio of different securities. Although the definition of the riskiness of a further investment in a particular firm is changed by the portfolio treatment, the fundamental parts do not seem to be altered.}

Why are both numerator and denominator in (7) written as depending on $P$ as well? In rational-expectations equilibrium, $P$ reveals some of the information about $y_i$. Suppose that the results of one particular kind of analysis, for example, $y_i$, suggests low future stock value. Researchers/investors who see $y_i$ dump the stock, and its price will therefore be lower. As a result, $P$ incorporates some of the information in the $y_i$. This dependence could be exploited by an uninformed investor who demands

$$
q_u = \frac{E[V | P] - T(P)}{\text{var}(V | P)}.
$$

The dependence between the price of the stock and researchers' information is also the reason the board can use $P$ as an input in managerial compensation, as we shall see.

To investigate the informativeness of the stock price as a signal of the research's contents, we now examine the equilibrium price equation. Each informed investor of type $i$ behaves according to (7); let there be $\lambda_i$ such investors. (For the moment, we assume $\lambda$ is exogenous.) Similarly, let there be $\lambda_u$ uninformed investors, and let the demand by noise traders be $z$. Normalize by $1 - \lambda_u = \Sigma_i \lambda_i$. Then price solves the zero net supply equation:

$$
0 = \lambda_u q_u + \Sigma_i \lambda_i q_i(P, y_i) + z.
$$

Because (9) is linear, $P$ is a linear function of the $y_i$ and $z$, and thus normal. The variance of $P$ and its covariance with the $y_i$ are determined by (7) - (9).

This relationship is simple to understand if we write out (7) and (8) explicitly. Let $\beta_{yi}^P$ be the coefficient of $P$ when $V$ is regressed on $P$ and $y_i$, and let $\beta_{y_i}$ be the coefficient of $y_i$. Write the manager's compensation $T(P)$ as $t_o + t_i P$.

Then,

$$
q_i = \frac{E[V] + \beta_{yi}^P P + \beta_{y_i}^{y_i} y_i - P - t_o - t_i P}{a \sigma^2(V | y_i, P)}.
$$

Because an informed investor of type $i$ can observe both $y_i$ and $P$, she can condition on both. Both are valuable information; $P$ contains information about other traders' information. The relation between signal $y_i$ and trading behavior depends on two things; $\beta_{yi}$, which measures $\delta E[V | \cdot]/\delta y_i$, and $\sigma^2(V | \cdot)$, which measures the risk borne by a type-$i$ trader.

Similarly,

$$
q_u = \frac{E[V] + \beta_{y_i}^P P - P - t_o - t_i P}{a \sigma^2(V | P)},
$$

where $\beta_{y_i}^P$ is the coefficient of $P$ in a regression for $V$ with no other regressors. Uninformed traders can condition only on the information revealed in $P$. They are always at greater risk than informed traders, because $\sigma^2(V | P)$ is necessarily larger than $\sigma^2(V | y_i, P)$.

The distribution of $P$ in equilibrium is then determined by

$$
P = \text{(constants)} + \left[ \sum_i \frac{\lambda_i \beta_{yi}^P y_i}{\sigma^2(V | y_i, P)} + z \right] \frac{1}{\Delta},
$$

where

$$
\Delta = \sum_i \frac{\lambda_i (\beta_{yi}^P - t_i - 1)}{a \sigma^2(V | y_i, P)} + \frac{\lambda_i (\beta_{y_i}^P - t_i - 1)}{a \sigma^2(V | P)}.
$$

5.3 The Alignment of Shareholder and Manager Interest

Knowing that research and investment leads to $\text{cov}(y_i, P) > 0$, and wanting to reward $x$, a value-maximizing board of directors will set managerial compensation to depend on $P$. They anticipate that managers will supply effort in order to earn stock-price-based income. The board's problem is to maximize shareholder well-being subject to (3) and subject to $U_m \geq U_o$, the manager's opportunity salary.

This problem takes the form

$$
\max_{\lambda_i V_i} \lambda_i V_i + \sum_i \lambda_i V_i
$$

s.t. (3) $U_m \geq U_o$.

That completes our statement of the model.

The ingredients of the model, then, are threefold. Managers are self-interested and need an incentive contract to align their interests with shareholders. The function $f(x) - c(x)$ need not be symmetric, so some activities can be more valuable than others. The management incentive contract should focus attention on those activities. The second ingredient is that investors are self-interested. They research those activities of the firm on which they can hope to make profits as informed outsider traders in informationally efficient markets. The third ingredient is the board, which maximizes shareholder welfare.

5.4 Exogenous Number of Informed Traders

The problem would become easier if the stock price came to incorporate more information about the more important managerial efforts, $x_i$. In (12), we see that $P$ is a linear function of the $y_i$, with coefficients depending on the
maximized at \( x_i = x^*_i \). Instead of putting weight, as the optimal linear compensation package would, on the least noisily signaled effort, in Paul's results the investors do the reverse.

At this juncture it should be clear that there is no systematic tendency for trading by those investors holding that information the board would like to see reflected in the price. If anything, rather the reverse seems to be true. Outside trading is guided by the logic of the stock market itself, not by the relationship between the stock market and the firm's decision problem.

### 5.5 Investor Research Decisions

Yet propositions 1 and 2 refer to an environment in which investors' research is exogenous. The informativeness of \( P \) is endogenous, but the information available to be reflected in \( P \) is not. Investors cannot pursue research opportunities focused on particularly valuable \( x_i \). Would a model with endogenous research effort have more favorable implications for the role of stock-market compensation in management decision making?

The simple answer is no. And the simple reason follows directly from the Grossman-Stiglitz equilibrium condition for endogenous research. Grossman and Stiglitz (1980) assume that traders invest in becoming informed in signal \( i \) until their utility gain from trading on \( y_i \) is just equal to the cost of the signal.

The cost of effort to the manager and the value to the firm appear nowhere in this calculation.

Let the research costs of aspect \( i \) be \( R_i \). Let the certainty equivalent of the return to knowing \( \Theta_i \) be \( V_i \). Let the certainty-equivalent return of an uninformed investor be \( V^*_i \). Then \( \lambda_i \), the mass of informed investors of type \( i \), rises until

\[
V_i = V^*_i + R_i.
\]

From Admati and Pfeiderer (1987), proposition 3.2, we know that \( V_i - V^*_i \) is equal to

\[
\frac{1}{2a} \log \left[ \frac{\sigma^2(\nu \mid P)}{\sigma^2(V \mid y_i, P)} \right].
\]

It is immediate from (18) and (12) that the return to purchasing signal \( i \) for the marginal investor is proportional to the tendency of type-\( i \) investors to trade on their information, other things equal. (The other things here include \( \beta^*_i \), so this may be overstrong. Yet \( \beta^*_i \) and \( \sigma^2(V \mid y_i, P) \) should move in opposite directions in the cross section of signals.) In particular, the return to the marginal investor is exactly proportional to the strength of a trader's response to a given forecast. (See Admati and Pfeiderer 1987, equation 3.4.) It therefore should not be surprising that the marginal investor's behavior will not be particularly directed toward the high-value investments.

The following result is immediate by symmetry:

### 5.6 The Value of Externally Generated Information in Managerial Decision Making

In the second theory of valuable information in the stock price, it is the firm's managers and board who learn from it. Part of this theory is similar to that of the last section. Outsiders research the firm and discover profitable new opportunities. To the extent that they trade on this research, they bid up the price of its shares. Yet part of this theory is different as well; in it, the firms' managers do not know about the profitable opportunities but instead learn about them from observing the share price.

This story is usually told in a slightly different way, in which it is the firm's cost of capital that is signaled to the managers and the board through its share price. Suppose outsider traders, basing their decisions on private research about fundamentals, drive up the share price. The resulting low cost of capital (rightly) means the firm should acquire additional capital and expand. Baumol (1965) points out that the informational story does not critically turn on the true marginal opportunity cost of capital to the firm. The new project could be financed out of retained earnings, so that there is no relation between the share price and marginal opportunity cost of capital. This does not affect the argument that the stock price might signal valuable opportunities to the managers and board. Indeed, the main point here is not about investment of new capital at all, but instead about the use of the stock price by insiders to gain useful information about the firm's prospects.

A similar role for the stock price is central to q-theory models of investment (Tobin 1969; Hayashi 1982). It is easy to see, however, that there is no relationship between the validity of the q-theory investment model and the valid-
ity of the valuable-information theory. In the q model, the origin of the information about new projects is unimportant. Management can research the profitable new opportunities and tell analysts about them. Alternatively, people outside the company can have done the research, and management can have inferred the opportunity from the high stock price. In either event, q > 1 and the firm should expand. The usefulness of q-theoretical models in econometric studies of investment, therefore, has nothing to do with the direction of information flow.

The value of increased stock-price informativeness, however, does turn critically on the direction of information flow. There is little informational value for managers in having the stock price quickly reflect things they have just told analysts. If outside analysts learn something about new projects that managers do not know and trade on it to the point it is reflected in the share price, then there is an informational gain. Managers, seeing opportunities reflected in the share price, can move to fund the projects.

This section has a very simple model of this potential information flow. The model suggests that the flow cannot be very important. The key assumption of the model is that the stock price reflects two kinds of outsider trading and research. The outsiders can research and trade on information about the firm’s incremental projects. But they can also research and trade on information about the firms’ existing projects. Securities prices confuse these two effects and thus provide a poor signal of the value of the incremental projects.

We can reuse much of the notation and many of the ideas of the previous section. We continue to assume that the ultimate value of the firm is determined as

\[ V = f(\mathbf{x}) + \Theta = \sum f(x_i) + \Theta, \]

where \( \mathbf{x} \) is a vector of choice variables for management, and \( \Theta \) is a random term outside anyone’s control. But for our purposes in this section, the interpretation of the variables changes somewhat. First, management and the board together pick \( \mathbf{x} \), and we assume here that they have no agency conflicts. All \( \mathbf{x} \) are already decided except \( x_r \), the new project. Further, we think of \( x_r \) as a single go/no-go decision; undertake the project or not.

The information structure is as follows: Management knows all of the \( f(x_i) \) except \( f(x_r) \). The value of the incremental project, \( f(x_r) + \Theta_r - c \), is a normal random variable. Management knows none of the \( \Theta_r \), nor can they be

14. Indeed, Hayashi’s formal model (1982) has no private information at all. All investors are equally informed, and the stock price reflects fundamentals. This is all that is needed for a q-theory model.

15. As far as we can detect, few managers claim to be the recipients of such signals, and few investors the senders. Yet they would not; managers do not lightly admit that outsiders know anything useful about their companies, and successful outsider traders earn more if they keep their own counsel. The exception is investors who have taken large positions in firms and who use takeover threats, seats on the board, and other large-scale mechanisms to compel policy changes. We shall return to this point.

16. We assume, for purposes of the discussion, that there are no tricky gaming issues between management and the outsider traders. Suppose, for example, that management will withdraw the project if the stock-market reaction is adequately adverse. Then the value of the security reflects this prospect, and (12) does not hold. Considerations such as this can only complicate management’s inference problem.
a mature firm or how capitalizing information into the stock price in minutes instead of days can add much value.\textsuperscript{17}

We can state the general point easily in Hayashi's language (1982). The board and the managers would like to know marginal $q$, the incremental value to the firm of doing the additional project. Outsider traders' profits depend on average $q$, not marginal $q$. Thus the signal-to-noise ratio in $P$ can be arbitrarily small, as in the case of an incremental project that is one $m$th of the firm and distributed independently of the inframarginal projects.

5.7 Conclusion

How rapidly has the real output of stock exchanges grown? Is it anything like as rapid as figure 5.1 suggests? Are the rapidly growing costs of having stock exchanges (fig. 5.2) merely the flow of resources into a sector making a booming social contribution? On balance, our analysis is not encouraging to a positive view on these issues. The gaps between social and private incentives to trade seem likely to be important in the modern era.

Neither of the two informational theories of the real output of the stock exchange suggests a large value for the increased activity of outsider traders. In both cases, the information that is valuable for making a real decision—compensating managers or deciding on a new project—bears no relation to the information impounded in prices by the activities of traders. The appropriate real decisions depend on value added—the value of the managers' decisions or of the new projects. The research and trading decisions of outsider traders are focused on the value of the firm, not on value added.

One of the best ways to become a cliché is to be a truth. Researching a firm's quarterly earnings report in the days after the end of the quarter but before the report is released may well be an excellent way to make a capital gain. At the same time, it could have no value in guiding management and could advance the date at which the board has a reasonable assessment of management performance by only a few days. Increased liquidity increases the resources devoted to this sort of rent seeking, without improving any real investment decisions.

Our analysis has not addressed takeovers, mergers, or the market for corporate control more generally. Traders in our analysis seek trading profits, not changes in control of the company. It is clear that a large trader seeking new management, a seat on the board, or other changes in the governance of the enterprise links real decisions and financial markets in a very direct way.\textsuperscript{18} It is an interesting and difficult question whether recent trends on the stock exchanges help or hinder this process. On the one hand, increased liquidity permits outsiders with valuable changes in corporate governance in mind to move more quickly. Yet such actors are typically held back by regulatory restrictions, which do not bind the arbitrageurs whose free riding is also enhanced by liquidity.

References
