The Role of Information in Financial and Capital Markets

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1. Introduction

Financial systems are crucial for the allocation of resources in a modern economy. They channel household savings to the corporate sector and allocate investment funds among firms. They allow intertemporal smoothing of consumption by households and expenditures by firms. They allow both firms and households to share risks. Comparing financial systems across countries there is a great variety of financial systems. Most countries have both financial markets and banks but the relative importance of these differs. At one extreme, countries like the U.S. have “market-based” financial systems where financial markets play an important role and banks are less significant. At the other extreme, countries like Germany have “bank-based” systems where banks dominate credit allocation and financial markets are not very important. In many parts of the world there is a conscious effort to try and move towards market-based systems. There appears to be a widespread belief that these are superior to bank-based systems. Allen and Gale (1999) argue that there should be no such presumption. Both systems have advantages and disadvantages and a comparison of the two involves complex trade-offs.

A crucial issue in the operation of financial systems is the way in which information is generated, distributed and used. How do different financial systems ensure that information is used in such a way that resources are allocated effectively? Chapter 7 of Allen and Gale (1999) compares the financial systems of different countries and considers these issues at length. This paper summarizes the basic arguments.

Countries differ significantly in the way in which financial assets are held and it is helpful to start by considering this. Table 1 shows the distribution of financial assets ultimately owned by the household sector in the U.S., U.K., Japan, France and Germany. It can be seen that Japan has the highest proportion directly held by households while the U.K. has the lowest. Table 2 shows the portfolio allocation of total financial assets ultimately owned by the household sector. In the U.S. and U.K. domestic equity is the most important asset category. It is in this sense that their financial systems are market-based. In France, Germany and particularly Japan cash and cash equivalents which mainly consists of bank accounts of various sorts are the most important. Holdings of equity and bonds are relatively unimportant. It is in this sense that they are bank-based.

The way in which information is generated and used to allocate resources has received considerable attention in the context of financial markets. In contrast, relatively little work has been done analyzing how information is generated and resources allocated when banks and insurance companies are the predominant providers of finance. At first sight, it might seem that economies with liquid stock markets and many publicly quoted companies would be more effective at allocating resources than economies with a few large intermediaries and a small number of publicly quoted companies. Public companies have to provide more information about their operations than private companies do and the prices of those companies are themselves informative. So it might seem that the more markets there are, the better. It is argued below that this is not necessarily the case.
There are three different ways of thinking about the role of financial market prices in allocating resources.

1. Prices as indicators of value and scarcity.

2. The statistical use of prices to analyze risk.

3. Prices as aggregators of information.

Prices are traditionally thought of as indicators of value and scarcity. This view, which is summarized in Section 2, asserts that prices provide sufficient information for the efficient allocation of resources. Prices can also be used as data to estimate asset-pricing relationships, such as the Capital Asset Pricing Model (CAPM), which are used by firms for decision making. Asset markets readily provide such data, but it is argued in Section 3 that the information may also be generated in other types of financial system. The third role of prices is to reveal agents' private information. Under certain conditions, this information is aggregated in prices and becomes publicly available for resource allocation. It is shown in Section 4, that under certain conditions, private information can be completely revealed through a loan market as well as through an equity market. Thus, bank-based and market-based systems can be equally efficient. Nonetheless, there do exist conditions under which intermediation can suppress information, but the way in which this occurs is subtle and requires careful analysis. It is shown, by means of a simple example, that intermediation can prevent the exploitation of private information to achieve an efficient allocation of resources, but this result depends on the distribution of information among agents, that is, on who has the information to begin with. Finally, Section 5 contains concluding remarks.

2. Prices and Decentralization

The first role of prices as indicators of scarcity and value is the standard neoclassical view of prices which originated with Adam Smith's notion of the "invisible hand". The modern version of this theory is captured in the Arrow-Debreu (AD) model and the fundamental theorems of welfare economics. If markets are complete and various other restrictions are satisfied, markets allow a Pareto efficient allocation of resources. When firms maximize their value and individuals maximize their utility, resources are not wasted. Nobody can be made better off without making somebody else worse off.

The neoclassical theory of resource allocation, which culminated in the AD theory, was initially developed under the assumption of perfect certainty. In this case complete markets involves there being a market for every good at every date. Under these conditions, decision-making is relatively simple. Every agent knows the future values of the relevant prices and interest rates, so maximizing the value of the firm is a purely technical exercise. Debt finance and equity finance are equivalent. The main informational role of financial markets is to provide the term structure of interest rates.
Stock markets are informationally redundant since the value of the firm can easily be calculated from the prices of inputs, outputs and interest rates.

The practical implementation of these ideas in terms of how firms should make investment decisions to maximize their value is the subject of *capital budgeting*. Over the years, it has become a mainstay of the curriculum in most business schools. It has been expounded in numerous textbooks for many years. Current examples which are in wide use are Brealey and Myers (1996) and Ross, Westerfield and Jaffe (1996). According to the methodology outlined in these books, managers first need to derive the stream of cash flows, \( C_t \) for \( t = 0, 1, \ldots T \), where \( C_0 \) is the initial cost of the investment. This is done using various types of information. Projections based on accounting data generated within the firm usually play an important part. Once the cash flows have been calculated, they are discounted at the opportunity cost of capital for each period. For simplicity, let this be \( r \) each period. The calculation gives the ‘net present value’ (NPV) of the investment.

\[
NPV = C_0 + \frac{C_1}{1 + r} + \frac{C_2}{(1 + r)^2} + \ldots + \frac{C_T}{(1 + r)^T}
\]

NPV is obviously maximized by accepting positive NPV projects and rejecting negative NPV projects. There are a number of other capital budgeting methods such as internal rate of return (IRR) and profitability index (PI) which are widely used and are equivalent to NPV if correctly applied. The focus will be on NPV below.

The discount rate \( r \) that should be used can be found from the bond market. Since there is no uncertainty, markets are complete as long as every agent can borrow and lend at this rate. Then there is unanimous agreement among the shareholders about the optimal policy for the firm. Shareholders should simply tell the managers to follow the NPV rule (or an equivalent). If all managers follow this rule, the allocation of resources within the economy will be Pareto efficient. Furthermore, the actual mechanics of decentralizing decisions from shareholders to managers are particularly simple. The information that shareholders need to convey to managers is minimal. The shareholders do not need to tell the managers anything except ‘Maximize NPV’. In particular, they do not need to tell the managers their preferences or the discount rate that should be used. The managers can observe the interest rate themselves.

NPV is not only a useful way for shareholders to decentralize decision making to managers. It is also an excellent way to decentralize within the firm. Managers at head office do not need to convey huge amounts of information to subsidiaries. They too can simply ask their subordinates to ‘Maximize NPV’. If all divisions of a firm do this then the overall value of the firm is maximized. The move by many firms in recent years to decentralize by having ‘profit centers’ is essentially based on this type of logic. The popularity of internal management systems using Economic Value Added or EVA® which is based on these types of ideas, indicates their practical importance (see, for example, Stern, Stewart and Chew (1995) and Glassman (1997)).
All this ignores the agency problems between managers and shareholders. In particular it assumes that it is easy to ensure that managers do maximize NPV. This abstraction from agency problems will be maintained throughout. However, it is perhaps worth noting in passing that even with regard to solving the agency problem, this type of decentralization is advantageous. The methods to be followed are fairly straightforward and it can be relatively easily checked ex post whether or not the correct procedures were in fact implemented by managers.

The neoclassical model of resource allocation with certainty thus provides a practical framework for implementing decentralization from shareholders to management and within the firm. Moreover, it can be justified as being desirable both for shareholders and society as a whole. Since the only external financial data required are contained in the term structure of interest rates, the method can be applied in any institutional context where there are financial markets or intermediaries. However, the case of uncertainty requires more stringent assumptions.

If markets are complete, then the theory developed for the neoclassical model under the assumption of certainty carries over to the case of uncertainty more or less unchanged. When there is uncertainty, complete markets require that there is a market for every good at every date in every possible state of the world. Given this, decentralization from shareholders to management and within the firm can again be straightforwardly achieved. Maximization of value is a technical exercise provided the equilibrium prices of all inputs and outputs are known. Again, stock markets are informationally redundant, since the value of the firm can easily be calculated from the prices of the (contingent) inputs and outputs. These are all known for sure at the initial date when all decisions are made but before any uncertainty is resolved.

However, the unrealistic nature of the complete-markets assumption limits the usefulness of the theory as a model for the decentralization of investment decisions. It can be shown that under certain conditions, value maximization is sufficient for constrained Pareto efficiency when markets are incomplete. However, the value of the firm depends in a complex and non-linear way on the choice of the firm's production plan and the marginal valuations of the shareholders. How does the firm gain the knowledge necessary to make these investment decisions? In very special cases, such as the Diamond (1967) model with multiplicative uncertainty, the relationship between the value of the firm and investment is linear, so it is enough to know the stock price in order to maximize the value of the firm. In general, things are more complicated.

In contrast, corporate finance textbook expositions of capital budgeting techniques offer a much simpler method of calculating the effect of an investment decision on the value of the firm. It simply replaces the stream of cash flows above with a stream of expected cash flows, $E[C_t]$ and calculates the present value using a discount rate from an asset pricing model estimated from historical price data. The asset pricing model used is usually the CAPM. The conditions under which this is an appropriate method are reviewed in the next section.
3. Risk, Decentralization and Institutions

A significant part of the literature on financial economics has been devoted to a particular model, the CAPM. The great advantages of the CAPM are that it is conceptually simple, has some empirical plausibility and is relatively easy to use in practice for capital budgeting. Fama and Miller (1972) and Fama (1976) provide an excellent account of the traditional justification of this type of approach. Suppose the statistical distribution of stock prices is represented by a normal distribution. (The tails of the distributions which are actually observed are "fatter" than the normal so this is an approximation.) Given normality, von Neumann-Morgenstern expected utility can be expressed as a function of the mean and variance of an investor's portfolio. By making a variety of other assumptions it is possible to derive the simple relationship

\[ E_{r_j} = r_F + \beta_j (E_{r_M} - r_F) \]

where \( E_{r_j} \) is the expected return on a stock, \( r_F \) is the risk free rate, \( \beta_j \) is the covariance between the return on the stock and the return on the market (which is a portfolio consisting of all the stocks available weighted by value) divided by the variance of the market and \( E_{r_M} \) is the expected return on the market.

Initially, empirical studies such as Fama and MacBeth (1973) provided some support for the validity of the CAPM. This, combined with its practical simplicity, has led to the widespread use of the CAPM. More recent and more sophisticated tests have been less favorable (see Ferson (1995) for a survey). Despite this, the CAPM has continued to be widely used, particularly as a means of finding discount rates for capital budgeting.

Although there is a vast theoretical literature on the CAPM (see Ingersoll (1987) for a good account), most of it assumes a fixed quantity of stock and a fixed amount of investment. CAPM-type models with endogenous investment in a general equilibrium framework are rare. One example is Geanakoplos and Shubik (1990), who investigate the efficiency of resource allocation when the CAPM is embedded in a general equilibrium model with uncertainty (see also Magill and Quinzii (1996)). Geanakoplos and Shubik show that the conditions required for the CAPM to hold are quite special and the conditions for efficiency under the CAPM are more special still. It is sufficient for Pareto efficiency that, among other things, there be only one consumption good in each state of nature and that investors' have quadratic utility functions. If either of these assumptions is relaxed then efficiency is no longer guaranteed. Hence, even if the CAPM holds because, say, stock returns are normally distributed, an efficient allocation of resources is not necessarily obtained.

The deficiencies of assuming quadratic utility are well known. In particular, the range of wealth for which investors have a positive marginal utility of consumption is limited and within this range an increase in wealth leads to a reduction in the amount held in risky assets. The assumption of a single good is also problematic. However, Geanakoplos and Shubik are able to show that if redistributions of income do not affect
relative commodity prices very much the allocation with decentralized investment decisions is constrained Pareto efficient.

Although the theoretical underpinnings are based on special assumptions and the empirical support for the CAPM is questionable, the popularity of the CAPM is not surprising. The methodology provides a practical way for firms to decentralize their investment decisions from shareholders to managers and from head office to divisions. Our main interest in this section is to see how the CAPM can be used in different institutional frameworks. Two different scenarios are considered.

1. A stock-market economy

2. An intermediated economy

The stock-market economy can be thought of as corresponding to the U.S. In recent times, at least, some firms in practically every industry are listed. The intermediated economy can be thought of as being like the U.S. in the nineteenth century or some European economies in the twentieth century or with some qualifications, Japan today. In this case, finance is provided by intermediaries such as banks and insurance companies. There is a stock exchange, but only the intermediaries are listed. They make loans to firms and have equity investments in them. To the extent individuals in Japan primarily invest through banks and insurance companies this model is a representation of the Japanese economy.

The version of the CAPM that will be implicit in the discussion below assumes the existence of a risk free asset and quadratic utility as the justification for mean-variance analysis. The standard result that all investors have some combination of the risk free asset and the market portfolio holds (the mutual fund theorem). Also it can be shown that the CAPM equilibrium is Pareto-efficient.

A stock market economy

The CAPM is perhaps most easily interpreted in terms of a stock-market economy. In this case all stocks are quoted on the stock exchange. There is also a market for bonds. Bonds take the role of the risk-free asset and the interest rate on bonds determines the risk-free return. In this case, there is a considerable amount of information publicly available in the form of prices and interest rates. This information can be used in a number of ways.

The current stock prices of firms allow us to calculate discount rates for evaluating projects. Consider a two-date CAPM world with costs for a type j firm at date 0 of y_{0j} and expected revenues at date 1 of E_y_{1j}. The value of the firm before the expenditure of y_{0j} is y_{0j} + MV_j where MV_j is
\[ MV_j = \frac{EY_{ij}}{1 + ER_j} \]

If the stock is sold net of the initial input \( y_0 \) then the stock price is simply \( MV_j \). Given an estimate of \( EY_{ij} \) and the stock price \( MV_j \), it is easy to calculate the implied value of \( ER_j \). The accuracy of this process depends critically on the accuracy of the estimate of \( EY_{ij} \) and since predicting the future is never easy this may not be a robust way of obtaining an estimate of \( ER_j \).

An alternative procedure, which avoids the need to estimate \( EY_{ij} \), is to make use of the history of stock prices to estimate the CAPM. Formal derivations of the CAPM model usually have two dates. However, if we assume that the history of the stock market consists of repeated trials of the model and that the process is stationary, the data generated by the stock market can be used to estimate the CAPM. There are, of course, many statistical issues involved in any practical attempt to use historical data to estimate the CAPM (see, for example, Fama (1976)). However, in principle it is possible to estimate the model and to find \( \beta \)'s for particular firms and industries. These can be used, together with an estimate of \( ERM \) based on historic data and a value of \( r_F \) from the bond market, to calculate \( ER_j \).

**Proposition 1**: The manager of a type-\( j \) firm can maximize the welfare of shareholders by choosing investments to

\[
\text{max } \text{NPV} = C_0 + \frac{EC_1}{1 + ER_j}
\]

where \( C_0 \) is the cost of the investment, \( EC_1 \) is the expected cash flow and \( ER_j \) is the expected return on stocks of type \( j \) in the market and is given by the CAPM

\[
ER_j = r_F + \beta_j (ER_M - r_F).
\]

In this economy, the financial markets play an important role in providing the historical information that managers need to make efficient investment decisions in the following sense. They give \( r_F \) directly and provide the data from which \( \beta_j \) and hence \( ER_j \) can be estimated. Of course, in making the capital budgeting decision the managers must estimate the expected cash flow \( EC_1 \) from the investment. This is usually a difficult problem and cannot be avoided. However, by using historical stock market data to estimate the CAPM and find a discount rate, the problem of estimating firms' expected future cash flows to back out a discount rate from the current stock price has been eliminated. The CAPM methodology is also preferable to simply looking at historical rates of returns on stocks because the current risk free rate may be different from the rate in the past.
The shareholders do not need to provide explicit instructions to the managers other than to ‘Maximize NPV’. They do not need to convey their degree of risk aversion or anything else about their preferences or anything about the discount rate the managers should use in evaluating projects. It follows from the results mentioned above that in the setting described the allocation of resources will be Pareto-efficient.

Decentralization within the firm

Many large corporations have tens of thousands of employees. Some of the largest, such as General Motors and NTT, have turnovers which are equivalent to the GDP’s of reasonably sized countries. Managing these large organizations is an extraordinarily difficult task. One possibility is to have a hierarchical centrally managed organization. In this case large amounts of information must be transferred from head office to the divisions and vice-versa. This includes but is not limited to the information senior managers at head office would need to make ongoing decisions. They would then send out detailed instructions to the divisions on how to proceed. An alternative to this type of centralized command and control organization is decentralization into autonomous divisions. How can such decentralized divisions be coordinated? One alternative is to simply let them operate on their own with little oversight. At best managers of divisions will decide on what they think is desirable for the organization as a whole. At worst they will pursue the interests of their own division.

Another alternative is to decentralize and tell the division managers to ‘Maximize NPV’. As discussed in the case of certainty above, this provides a ready benchmark that can be understood throughout the organization. It avoids the need for large amounts of information to be transferred between head office and the divisions. Perhaps the greatest advantage of the CAPM framework and this type of capital budgeting methodology is that it provides a practical way to delegate decisions.

Implicit in the preceding discussion is the assumption that each firm operates in a single industry. However, the theory can readily be extended to conglomerates that have divisions in multiple industries provided there are no technological externalities between the divisions. Given enough independence between divisions, the financial markets provide the information that allows firms to decentralize investment decisions to divisions. All that is necessary to calculate the $\beta$ for each division of the conglomerate is that in each industry there are some firms that are listed on the stock exchange. Knowledge of their prices provides the necessary information to estimate $\beta$’s.

Proposition 2: In the CAPM framework, firms with autonomous divisions can maximize their shareholders' welfare by instructing the managers of each division to maximize NPV.

In technical terms what is required for divisions to be autonomous is that technologies be additively separable. What this means is that each division operates as a separate firm. For example, this assumption would not be satisfied in a corporation where services such as advertising, financial accounting, information technology, and so
forth are provided to divisions from the head office. Without such an assumption, there is no simple decentralization theory.

Furthermore, even if the conglomerate is effectively a collection of separate firms, the fact that most divisions are not listed and publicly traded as separate firms may have an effect on the quality of the information available. For example, in empirical studies, financial economists often use pooled data sets, that is, they assume that all the firms in an industry have the same value of \( \beta \) and pool the data on all these firms to calculate an estimate of \( \beta \) from the time series of prices. They do this because, assuming their assumption is correct, more data gives a more precise estimate. Clearly, having fewer firms listed in the industry (because some are divisions of multi-industry conglomerates) will reduce the precision of the estimate of \( \beta \). While it may be possible in principle to implement the CAPM when only a few firms in an industry are quoted, in practice it may be very difficult because of the quality and quantity of the data available.

An intermediated economy

The use of the CAPM for capital budgeting is usually assumed to take place in a stock market economy, because the availability of historical stock price series makes it easy to estimate the CAPM. However, it may be possible to implement it in economies with different institutional structures. The CAPM requires everyone to hold some combination of the risk-free asset and the market portfolio, but there are many institutional frameworks that allow this to be done. Also, since the structure of the optimal portfolio is so simple, the information needed to make optimal decisions is also limited. This allows the capital budgeting methodology to be extended to different institutional frameworks.

Suppose, for example, that

- Finance is provided to firms through intermediaries, such as banks or insurance companies.

- The intermediaries are the only entities that are listed on the stock exchange.

- In addition to this limited stock market, there is also assumed to be a market for risk-free bonds.

A financial system satisfying these properties is referred to as an intermediated economy. Examples of intermediated economies include a number of countries, such as the U.S., in the nineteenth century, some European economies in the twentieth century and a number of emerging economies today. This model also has some relevance for less extreme financial systems, such as Germany and France, where the number and value of companies listed is significantly smaller than in the U.S. and U.K. Given that in Japan most individuals invest through banks and insurance companies it is also relevant there.
The capital budgeting methodology can be applied to an intermediated economy, as long as the limited amount of information required by the CAPM is available.

**Proposition 3:** Provided firms' managers (i) have enough information to find the discount rate corresponding to the CAPM discount rate $E_{r_f}$ and (ii) maximize NPV using this discount rate, the allocation of resources will be the same as with a stock market where every firm is listed as in Proposition 1.

To see why this result holds, first consider the simplest case where the intermediaries are essentially like mutual funds that finance their investments by issuing equity and then use the funds to make equity investments in firms. There are constant returns to scale up to a maximum size. There is free entry and this maximum size is such that there are many intermediaries and the market is competitive. At date 0, the intermediaries issue equity to investors. They use the funds obtained to purchase the firms from entrepreneurs initially and to provide the funds for investment after the managers have made an investment decision.

If the discount rates used by the managers are the same as in Proposition 1, the production decisions will be the same. By holding the stocks of the intermediaries, investors are able to hold the market portfolio. Given the CAPM framework assumed, this is optimal for them. This follows from the mutual fund theorem, which shows that in a CAPM framework it is optimal to hold some combination of the market portfolio and the risk-free asset. The investors' portfolio holdings will be identical to the stock market economy where all firms are listed separately.

Having seen how resources are allocated in the case where the intermediaries are mutual funds, it is straightforward to extend the result. Changing the form of the intermediary will not alter the result provided the financing of the intermediaries and firms does not alter risk sharing opportunities. For example, if the intermediaries are banks and issue risk-free deposits as well as equity to finance themselves, then a Modigliani-Miller type argument ensures that the allocation of resources is the same as in the stock-market economy. If there is a risk-free asset, investors will simply substitute deposits for the risk-free asset or vice-versa. Similarly, if an insurance company issues an equity-based asset, there will be no change in the allocation. Since everybody's overall portfolio is some combination of the risk-free asset and the market portfolio this equity-based asset will simply be held by everybody in the right ratio so that it constitutes part of the market portfolio. A similar result will also hold if the firms finance themselves by debt and equity, rather than using only equity.

The crucial issue raised by Proposition 3 is how managers have enough information to find the discount rate $E_{r_f}$ appropriate to their industry. In a stock-market economy, the necessary information is provided by the market in a readily accessible form. The risk-free rate $r_F$ can be found from the bond market. Historical data can be used to estimate $E_{r_M} - r_F$ and $\beta$. In an intermediated economy, $r_F$ can again be found from the bond market. The information concerning $E_{r_M} - r_F$ and $\text{Var}(r_M)$ can be obtained from the stock prices of the intermediaries. Since the intermediaries are effectively like
mutual funds and together hold the market portfolio, it is possible to use historical data on
their returns to estimate $E_{rM}$ and $Var(r_M)$. This can be done in just the same way as in the
full stock-market economy, except that the number of stocks will be much fewer. It is
interesting to note that in a study of U.S. stock prices from 1802-1987, Schwert (1990)
found that the mean and standard deviation of returns were remarkably stable through
time despite the fact that the number of stocks increased from 12 bank stocks at the start
to over 1500, representing a broad range of industries, by the end of the period.

The most difficult task is to calculate $Cov(r_M, r_j)$ which together with $Var(r_M)$ can be
used to find $\beta_j$. A historical series of $r_M$ can be found from the stock market. The
main problem is to find a series of $r_j$ if no appropriate listed stock can be found. When
there is no stock market data available for the industry, internally generated data must be
used instead. The managers should use accounting data to calculate the amount
generated for owners, i.e. the free cash flow, in each period and work out the return $r_j$ this
 corresponds to. This data series can then be used for the stock market returns $r_j$ and
hence $\beta_j$ and the appropriate discount rate $E_{r_j}$ can be found. It is an empirical issue how
good the estimates of the $\beta$'s obtained in this way are compared to those obtained from
stock market data. However, at least in theory both a stock market economy and an
intermediated economy can do equally well.

Discussion

This section has considered the decentralization of investment decisions in the
context of a CAPM framework and compared different institutional structures. As far as
the decentralization of decisions from shareholders to managers are concerned the results
are similar in the two cases considered. Shareholders only need to instruct managers to
maximize NPV. They do not need to convey information about their preferences or their
discount rates. Managers can obtain the historical information they need to estimate the
CAPM and find appropriate discount rates from financial markets or internally. It is a
practical issue as to which provides the best estimates for decision making. As far as
decentralization within the firm is concerned, in both the stock-market and intermediated
economies, it is possible to decentralize without having information flows between the
head office and the divisions. The necessary information can be obtained from markets
or within the division.

The asset pricing model that has been focused on here is the CAPM. There are of
course many other asset pricing models such as Ross' (1976) APT and more recently
Fama and French's (1993) three-factor model. Although these pricing models may have
advantages empirically, they are not as attractive theoretically. The CAPM provides a
theory of decentralization where, at least in the form assumed above, it is optimal for
shareholders to tell managers to maximize NPV. In other asset-pricing contexts it is not
clear that this is a sensible strategy for shareholders to follow.

Finally, the restrictiveness of the CAPM model cannot be overemphasized. One
reason why it is possible to implement the capital budgeting methodology in various
institutional settings is because the information called for by the CAPM is relatively
limited. But this follows from the restrictive assumptions of the CAPM itself, not least the assumption that everyone agrees about the true distribution for each random variable. With diversity of opinion, informational problems can be much more complex, however, and this may be the reason why different institutional structures matter.

4. Informational Efficiency, Investment and Risk Sharing

The third important role of prices is as aggregators of information. One of the questions that received considerable attention in the 1960's and 1970's is the extent to which stock markets are informationally efficient and reflect the available information. The notion implicit in much of this research is that if stock prices are informationally efficient, they provide a good mechanism for allocating investment resources. This view is well expounded by Fama (1976, p.133) who wrote:

An efficient capital market is an important component of a capitalist system. In such a system, the ideal is a market where prices are accurate signals for capital allocation. That is, when firms issue securities to finance their activities they can expect to get ‘fair’ prices, and when investors choose among the securities that represent ownership of firms' activities, they can do so under the assumption they are paying ‘fair’ prices. In short, if the capital market is to function smoothly in allocating resources, prices of securities must be good indicators of value.

Extensive evidence was provided during the 1960's and 1970's that markets are efficient in the sense that investors pay ‘fair’ prices and it is not possible to make excess returns above the reward for bearing risk using information that is publicly available. This is termed semi-strong form efficiency. There was some evidence that even using information that is apparently private it is not possible to make excess returns. This is termed strong-form efficiency. More recently studies have been less supportive. For surveys of the empirical literature on efficient markets see Fama (1970; 1991) and Hawawini and Keim (1995).

Grossman (1976) developed a theoretical model to show how private signals obtained by investors could become incorporated in prices so that apparently private information became public. If an investor has favorable information, he will buy the security and bid up its price while if he has unfavorable information he will sell it and bid down the price. Grossman was able to show that under certain conditions, prices aggregate all the economically relevant private information. This result provides a theoretical underpinning for the notion of prices as aggregators of information and led to a large literature on information revelation, including Grossman and Stiglitz (1980), Hellwig (1980) and Diamond and Verrecchia (1981).

The large number of publicly listed firms in the U.S., together with extensive disclosure requirements and the large amount of information produced by credit rating agencies, means that a great deal of information about firms’ activities is released. In addition to this publicly available information, there are many analysts working for
mutual funds, pension funds and other intermediaries who gather private information. The empirical evidence on efficient markets suggests that much of this information is reflected in stock prices. Taken together, this can be interpreted as evidence that U.S. stock markets do an effective job of allocating resources efficiently.

On the other hand, in some countries, such as Germany and other continental European countries, relatively few companies are listed and accounting disclosure requirements are limited, so very little information is publicly available. In addition, the number of analysts that follow stocks is small, so only limited private information is incorporated in prices. In Japan there is also less information available. The implication would appear to be that the financial systems in these countries do a poor job of allocating resources compared to the U.S.

The first point here is that there may be substitutes for the information revealed by prices, in which case the mere existence of more price data in the U.S. may not be a decisive point in favor of a market-based system. For example, credit allocation in Japan is mainly determined by banks and insurance companies. These institutions usually have direct ties to the firms they invest in and access to considerable amounts of information. Allocative efficiency may be achieved without the release of information either directly or indirectly.

More importantly, though, there is a cost to having stocks publicly quoted. There is considerable evidence that U.S. stock prices are very volatile. The traditional explanation for this volatility is the arrival of new information about payoff streams and discount rates (see Fama (1970) and Merton (1987)), although it may also result from the uninformative activity of "noise" traders, that is, traders who are irrational or who are motivated by liquidity motives. The volatility of stock prices can cause considerable variability in the consumption of investors who liquidate stocks to finance their consumption. If investors are risk averse, noisy consumption is clearly undesirable. Informational efficiency and Pareto efficiency are not the same concept. If price volatility makes investors worse off there can be informational efficiency without Pareto efficiency as will be shown below.

In a well-known paper, Hirshleifer (1971) pointed out that the release of information could destroy valuable risk sharing opportunities. Allen (1983) and Laffont (1985) investigated this in the context of security markets and showed that more information could make people worse off because the added price volatility increases consumption variability. Jacklin and Bhattacharya (1988) showed that bank deposits can be more desirable than equity mutual funds for similar reasons.

In this section, the trade-off between the value of information as a guide to resource allocation and its harmful effects on risk sharing is investigated. In financial systems like Germany's, few companies are publicly quoted and little information is revealed by the companies that are. This lack of information, which may be bad from the point of view of efficient decision-making, may be a good thing from the point of view of risk sharing.
Suppose that there is a continuum of entrepreneurs in the economy. Each one has an identical endowment at date 0. They can either consume this or invest $k$ in a production process that at date 1 produces output

$$y = \theta f(k)$$

where $\theta$ is the aggregate state of nature and $f(k)$ is a standard neoclassical production function with $f'(k) > 0$ and $f''(k) < 0$. The entrepreneur can consume the output at date 1. Clearly, the higher is $\theta$ the higher is each entrepreneur's output. Each entrepreneur gets a private signal on the aggregate state of nature before he makes his investment decision at date 0 but the signal is noisy. Entrepreneur $i$ receives the signal

$$\theta_i = \theta + \varepsilon_i$$

where $\varepsilon_i$ is an independently and identically distributed random variable with $E\varepsilon_i = 0$ and $\text{Var} \varepsilon_i > 0$.

As a benchmark, first consider the case where there is no stock market. Entrepreneurs self-finance and make investment decisions simultaneously without observing one another’s actions, so each entrepreneur’s decision is only based on his private signal $\theta_i$. The allocation is better than would be the case if everybody ignored their private signal but clearly it is not as good as if they knew the true value of $\theta$.

Now suppose that there exists a stock market. Entrepreneurs can invest part of their endowment in the market and raise funds for their productive activity from the market. At first sight it might seem that such a market would be redundant since every entrepreneur can self-finance. In fact this is not the case. The market plays an important role because the market's equilibrium return on equity aggregates the entrepreneurs' information so they can all make better investment decisions. The equilibrium is just a standard Rational Expectations Equilibrium (REE) where the aggregate information $\bar{\theta}$ is perfectly revealed by stock prices as in Grossman (1976). As a result all agents are able to make better investment decisions and the allocation with a stock market is Pareto superior to the allocation without a stock market where entrepreneurs invest on their own. The allocation is in fact efficient since the entrepreneurs are ex ante identical and the REE eliminates the asymmetric information associated with private signals.

Note that the optimal risk sharing studied here could be implemented by a variety of institutional arrangements. The way in which an economy with a capital market achieves optimal risk sharing has been discussed explicitly, but the same could be done by a competitive banking system. If banks took deposits from producers and re-lent them to producers at the same interest rate, the demand for loans and supply of deposits would determine the equilibrium return which would also reveal the true state of the world. In this case, the intermediaries are merely performing the role of markets in a different guise.
Proposition 4: The REE equilibrium in a stock market or in a bank loan market implements the first best allocation. There is full allocative efficiency and risk sharing is optimal since there is only one type of agent.

Suppose next that there are two types of agents, investors and producers. Investors have an endowment of the good in the first period and none in the second. They maximize the expected utility of consumption over both periods. The producers have no endowment, but can raise capital on the market to invest in production as before. For simplicity, it is assumed that they only consume in the second period. There is again a REE in the stock market where the value of \( \theta \) is fully revealed. However, the welfare properties of this REE are quite different from those of the REE with a single representative agent. Although information revelation still leads to an ex post optimal allocation of investment, the uncertainty generated by the revelation of \( \theta \) imposes risk on both agents that may not be optimal ex ante. In fact the following can be shown.

Proposition 5: If (i) the production technology is linear in the amount of capital used, i.e. \( f(k) = k \), (ii) as the rate of return earned by the investor goes up the amount saved goes down and (iii) the producers are risk neutral, the REE equilibrium is Pareto inferior to the equilibrium with no information.

In general, this result suggests that the uninformative equilibrium is likely to be better from a welfare economics perspective if:

- the producer is not gaining from the information revealed in the REE (because his profits are low) and
- the investor is not gaining from the information revealed in the REE (because his allocation depends on \( \theta \) in a way that provides negative insurance) and
- the allocation of risk is close to optimal in the uninformative equilibrium (because the less risk averse party is bearing most of the risk).

The proposition starkly demonstrates that there is no presumption that more information leads to a better outcome, even if that information is useful for productive efficiency. This has important implications for financial systems. It suggests countries such as Japan, Germany and France, where accounting information about companies is not freely available and there are few analysts following companies, are not necessarily at a disadvantage compared to countries such as the U.S. and U.K., where the reverse is true. Allocative efficiency is offset by the fact that investors bear a lot of risk.

Stock markets and banks have so far not been distinguished. As before they are essentially equivalent. The model is next extended in order to gain some insight into how stock markets and banks aggregate information differently.

The case where producers have private information about a common productivity shock has so far been assumed. In other words it has been assumed there is only one
industry. Now consider the case where there are a number of different industries and each industry has a different productivity shock. Ex ante it is unknown which are going to be the more productive industries and which are going to be less productive. This imposes risk and the issue is how to deal with it. As before, agents are either producers or investors and production decisions are made by producers after information is revealed. In this case the following proposition can be demonstrated (see Chapter 7 of Allen and Gale (1999)).

**Proposition 6:** With many industries, each with a different productivity shock, the equivalence of a stock-market and intermediated economy depends on who has the information. If producers have the information the two are equivalent. If investors have the information, it will be revealed by a stock market but not by a banking system.

While in much of this paper, stock-market and intermediated economies have theoretically been equivalent this is not the case here. The homogeneity of deposits in terms of them all paying the same rate of interest means that investors' information cannot be conveyed by a banking system while it can be conveyed by a stock market.

An important assumption of the analysis above is that the information is about a common shock. To the extent that information is firm specific and hence independent it is helpful if it is revealed. Thus for example if credit rating agencies produce information about a firm then that will help allocate resources efficiently to that firm. By holding a portfolio of such firms the independent risk can be eliminated. Here there is only a productive efficiency advantage and no risk sharing disadvantage. A similar argument holds for the revelation of firm specific accounting information and other types of information.

There has been a large literature on the welfare properties of models where there is some form of "noise" or "liquidity" trading and prices are partially revealing. Much of this literature is concerned with the desirability of allowing insider trading. One view is that insider trading involves the informed benefiting at the expense of the uninformed. This may lead the uninformed to limit their participation and in extreme cases can cause market breakdown. Another view is that insider trading is desirable because it leads to prices being more informative which improves the allocation of investment. For a variety of positions and analyses of insider trading see Manove (1989), Ausubel (1990), Fishman and Hagerty (1992), Leland (1992) and Bernhardt, Hollifield and Hughson (1995).

Another strand of the literature considers the role of prices in inducing efficient investment in the context of financial systems. Jacklin and Bhattacharya (1988) compare the role of equity markets and bank deposit contracts in ensuring efficiency. They show that the desirability of each depends on the attributes of the underlying investments and the information available. Boot and Thakor (1997a,b) compare various aspects of different financial systems. The important characteristic of financial markets in their models is that stock prices reveal information and this is what differentiates them from banks. Their first paper analyzes the development of financial systems and shows banks will predominate early in their history while the informational advantages of markets may
allow them to emerge subsequently. The second shows that financial innovation occurs more with separated commercial and investment banking than with universal banking. Subrahmanyam and Titman (1999) are interested in the development of financial systems and also characterize stock markets by the information revelation of prices. They show that there can be interesting interactions between information that is acquired fortuitously by investors and information that is paid for. Similarly to Pagano (1993), it is shown that with a fixed cost for investors to participate in primary equity markets a high participation equilibrium with many new issues and a low participation equilibrium with few new issues can both exist.

Finally, a number of papers consider the feedback role of stock prices in providing incentives when there is an agency problem between shareholders and managers. Holmstrom and Tirole (1993) consider how compensation contracts can be conditioned on stock prices to give effort incentives. Dow and Gorton (1997) consider how good investment incentives can be provided to managers when stock prices contain information managers do not have.

5. Concluding Remarks

The role of information in financial markets is a rich and varied one. Two aspects of information in financial systems have been focused on. The first is that stock markets make a great deal of information available which allows the decentralization of decisions both between shareholders and managers and between head office and divisions. However, bank-based financial systems may permit the same kind of information to be obtained internally and may do as well in allocating resources.

The second is that informational efficiency and Pareto efficiency are not the same. An economy with informational efficiency may allocate resources well but may have price volatility and impose too much risk on holders of financial assets. There is a trade-off between these two factors. It is thus not immediate that good accounting disclosure standards, effective credit rating agencies and other aspects of the U.S. financial system are always desirable. They may be if imposing risk on investors is not very costly. However, if investors view bearing risk as highly undesirable, the kind of system that has traditionally existed in Japan where information is much more sparsely available may be superior. This will be especially true if the financial system can attain allocative efficiency without public disclosure.

One final point is that the analysis in Sections 3 and 4 assumes that before any information is revealed everybody agrees on the distribution of returns. In some cases such as the financing of new technologies this is not an appropriate assumption. Chapter 13 of Allen and Gale (1999) considers whether financial markets or intermediaries such as banks are better at providing finance for projects of this type where there is a lack of previous experience and opinion can be diverse. The diversity of opinion considered arises from differences in priors rather than differences in information. The advantage of financial markets is that they allow people with similar views to join together to finance projects. This will be optimal provided the costs necessary for each investor to form an
opinion before investment decisions are made are sufficiently low. Finance can be
provided by the market even when there is great diversity of opinion among investors.
Intermediated finance involves delegating the financing decision to a manager who
expends the cost necessary to form an opinion. This type of delegation turns out to be
optimal when the costs of forming an opinion are high and there is likely to be
considerable agreement in any case. The analysis suggests that market-based systems
may lead to more innovation than bank-based systems.
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