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THE ALLOCATION ROLE OF THE STOCK MARKET

Pareto Optimality and Competition

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I. Introduction

THERE IS A GENERAL consensus that U.S. financial markets are very competitive and efficient, with prices quickly reflecting the available information. There is also a widespread belief that these competitive and efficient markets enable the efficient allocation of scarce capital among alternative investment opportunities. This belief is not based on direct observation—it is virtually impossible to obtain the data concerning the joint probability distribution of returns to all possible projects which would be required for a direct assessment of the efficiency of the resource allocations to which the market gives rise. Rather, it is based on the well-known result that perfectly competitive markets generate Pareto efficient resource allocations.

The object of this paper is to question that conclusion, to show that even with apparently competitive and "efficient" markets, resource allocations may not be Pareto efficient.

II. The Concepts of Market Efficiency and Pareto Optimality

The vocabulary which has become popular within the financial literature has given rise to some confusion concerning the relationship between competitivity of markets and the efficiency of the economy. To an economist, "efficiency" of the market has a simple meaning: the allocation of resources generated by the market is said to be efficient (Pareto optimal) if there does not exist an alternative *feasible* resource allocation which can make some individual better off without making someone else worse off. There are some subtle problems in defining the set of feasible allocations; in particular, in the kinds of situations with which we shall be concerned here, where information is costly and markets may be incom-

* Princeton University. This paper surveys a large literature on the optimality of financial markets. Because of limitations of space, it is necessarily selective in coverage and in references. Since my objective, in part, is to bring to the attention of finance economists some recent results in the general theory of imperfect information and uncertainty, the ratio of such articles cited to articles more narrowly focused in the finance literature is higher than a more extended and balanced presentation would warrant. This is not intended as a slight to anyone. Fortunately, at least three extended surveys of related topics have appeared in recent years (Baron [1979], Ross [1978b], and Jensen [1972]), and the interested reader is referred to these for a more extended bibliography. My intellectual debt to Sandy Grossman should be obvious. I am also indebted to Nils Hakansson, Phil Dybvig, and Barry Nalebuff for helpful comments on an earlier draft. Research support from the National Science Foundation is gratefully acknowledged.

plete, an analysis of the efficiency of markets must take into account the costs associated with establishing markets and obtaining information.[1,2]

In the finance literature, the term "efficient markets" has come to take on some slightly different meanings. The two most widely employed refer to informational efficiency:

> "A market in which prices fully reflect available information is called 'efficient.'" (Fama (1970) p. 383.)

> "A market is efficient with respect to information set θ_t if it is impossible to make economic profits by trading on the basis of information set θ_t." (Jensen, [1978].)

and mean variance efficiency—prices in the market correspond to an equilibrium in which all individuals evaluate portfolios in terms of their means and variances, about which they all have identical beliefs.

Somewhat surprisingly, although interest in both concepts was undoubtedly motivated by a concern with the efficiency with which investment resources are allocated in a competitive economy, these concepts have not been directly related to the Pareto optimality of the economy. As we shall show, *efficiency in these senses is neither necessary nor sufficient for the Pareto optimality of the economy.*

There are three levels to the analysis of the efficiency of the market:

(a) *Exchange efficiency. Given* the set of assets which are available, and the information (beliefs) of the various participants, are the available assets traded in such a way that there is no rearrangement of ownership claims which would increase the expected utility of one individual without decreasing that of some other?[3]

(b) *Production efficiency.* In exchange efficiency, the set of assets (securities) which are available is assumed to be given. Here, the concern is with the determination of the supply of various assets, given the available technology, resources, and information. The analysis of production efficiency turns on three questions: (i) If firms maximize their market value, will the resource allocation be Pareto optimal? (ii) Would all shareholders wish firms to maximize their market value? If not, will there be unanimity in the actions they wish the firm to pursue? If there is unanimity, will the actions which are unanimously preferred be Pareto optimal? If not, what can we say about the equilibrium? (iii) Are there any

[1] It has become fashionable to refer to notions of optimality when the number of markets are given (and cannot be altered by government action) or when information is imperfect and costly, as constrained optima (or occasionally second best optima). But these costs are no less real than the costs of production. Simply because *economists* have ignored these costs in the past is no reason that we should treat these aspects of technology as "secondary" to those aspects of technology upon which economists have focused.

[2] Without a clear specification of the information/transactions technology, there is always a danger that any intervention in the economy designed, say, to alleviate problems arising from an absence of risk markets will either be infeasible or so costly to implement that it would not, in fact, constitute a Pareto improvement, for precisely the same reasons that the markets were absent in the first place. In the analysis below, these qualifications do not appear to have much force.

[3] The analysis does not, of course, require that individuals be expected utility maximizers; here, as elsewhere in this paper, we have not attempted to put the arguments in their most general form.

control mechanisms which ensure that the managers of firms will in fact pursue the policies which are in the interests of shareholders?

(c) *Information efficiency.* In the economists' conventional analysis of efficiency (as typified, say, by the Arrow-Debreu model), the beliefs about the probability distributions of various events (states) are given exogenously. Financial economists have rightly emphasized the importance of markets in conveying information. Information efficiency requires that: (i) the market must provide the correct incentives for gathering the right amount and kind of information; (ii) the market prices must reflect the information available to the various traders;[4] and (iii) firms must be able to convey efficiently information about their prospects to potential investors.

It is thus apparent that market efficiency, in the sense in which it has come to be used by finance economists, is only one part of overall market efficiency. But even more to the point, were the market to be informationally efficient in the sense of Fama and Jensen, investors would have no incentive to gather information. The only information that would be reflected in the market is costless information. Thus a market which was efficient in the Fama-Jensen sense would almost surely not be Pareto optimal.

Outline of the argument. In this paper we shall present several theoretical arguments which should make it apparent that there is no theoretical presumption simply because the financial markets appear to be competitive, or "pass" the standard finance literature tests concerning efficiency,[5] that they are efficient. The argument has three parts.

First, we establish that value maximization leads to (constrained) Pareto optimality only under restrictive conditions. Secondly, we show that there is a strong presumption *against* the informational efficiency of the economy, when that concept is appropriately defined in terms of the role the market plays in attaining the objective of a Pareto optimal resource allocation. Finally, we argue that there are strong theoretical reasons to believe that firms will not behave as if they were maximizing their market value (however that is defined). An analysis of firm behavior must take into account the fact that the interests of managers normally will differ from that of shareholders, but the limitations of control of managers by shareholders and inherent limitations in alternative control mechanisms (such as take-overs) leave managers a large element of discretion to pursue policies that are not consistent with value maximization. These information-incentive considerations do, however, provide the basis of a meaningful theory of the optimal financial structure of the firm, which we briefly sketch in Section 5. On the other hand, it can be shown that the equilibrium which emerges does not, in general, lead to Pareto optimal resource allocations.

Underlying all of our analysis is the observation that the presumption that competitive markets lead to Pareto optimal resource allocations is based on the

[4] We are, at this point, deliberately vague about what is entailed by "prices reflecting information." See below, Section IV.

[5] We shall, in fact, have little to say about these tests. For several recent studies questioning various aspects of market efficiency on empirical grounds, see the symposium in the *Journal of Financial Economics* edited by M. Jensen and Ross's survey of the Capital Asset Pricing Model [1978b].

Fundamental Theorem of Welfare Economics; but this theorem makes stringent, and unrealistic, assumptions concerning completeness of markets and the exogeneity of information (in particular, that individual beliefs about the characteristics of various securities or investments and about the likelihood of various events are given exogenously, and thus unaffected by any action of any participant in the market, by the prices which prevail in the market, or by any other information which an investor might acquire, either freely or by an expenditure of resources). These assumptions make the standard analysis particularly inappropriate for understanding the functioning of capital markets, where some of the main issues of concern center around the role of markets in conveying information.

III. Does Value Maximization Lead to (Constrained) Pareto Optimality?

With a complete set of risk markets, it is easy to establish that all shareholders would wish the firm to maximize their market value. Moreover, the existence of a complete set of markets provides firms with an easy way of calculating the effect on market value of any action which they might take; they simply evaluate the output of the firm at the state-contingent prices which are assumed to be invariant to the actions of the firm. Finally, the market allocation which is generated in this way, can be shown to be Pareto optimal. The assumption of a complete set of markets is clearly unrealistic. Thus attempts have been made to find weaker sets of sufficient conditions under which the market provides the requisite information which would enable firms to determine the effect of any action on market value,[6] and to assess, for these special cases, whether the market allocation is a (constrained) Pareto optimum.

3.1. *The Modigliani-Miller-Diamond Model and Its Extensions*

In the first set of models to be dicussed, there is only a single output. If each firm produces a single pattern of returns across the states of nature (i.e. the relative outputs in each state are fixed), and there are a large number of firms producing the same pattern, then there will be a competitive market for each of these "patterns." (Modigliani and Miller refer to these as risk classes.) Standard competitive analysis can be directly applied to these "composite" commodities: all shareholders will wish their firm to maximize the net market value (the value of output minus the value of inputs); and the market value of the firm is simply determined as the number of "units" of the pattern of returns times the price per unit, which, as in the earlier analysis, is assumed to be invariant to the action of the firm. It is also immediate that, given that the government is constrained in the same way that the market is (i.e. it is restricted to producing the same set of "composite commodities" and to distributing income to individuals by means of these composite securities), market allocations are efficient. (See Diamond [1967].)

[6] Without a complete set of risk markets, maximizing current market value and "long run" market value may require quite different policies. We ignore this distinction, focusing only on short run value maximization. But see Stiglitz [1972b].

The parallel with the analysis of conventional commodities should be clear: there could exist a competitive market for automobiles, even though there did not exist markets for steering wheels, fenders, etc. An automobile is a *composite* commodity, and so long as there are competitive markets for the composite commodity, the standard competitive analysis is directly applicable.

Again, from here, it is only a slight generalization to the observation that the pattern of returns of any one firm need not be identical to that of any other firm, so long as its (marginal) output can be written as a linear combination of the output of two or more other firms (provided short sales are allowed). The precise specification of the required "spanning" conditions has been the subject of an extensive literature (surveyed in Baron [1979]).

There are two basic objections to these models: first, the assumption of spanning, from a technological point of view, seems implausible. The output of most firms depends on events which are specific to that particular firm. Secondly, among the decisions which a firm must make are those relating to its financial structure. Although it is well known that these decisions have no general equilibrium consequences provided the firm does not go bankrupt in any state of nature (Stiglitz [1974a]), there is no reason to restrict firms to debt-equity ratios within the range which ensure a zero probability of bankruptcy (and in practice, there is considerable evidence that for many firms the market believes there is a finite probability of bankruptcy, reflected in the rates of interest on their bonds.) But then, Grossman and Stiglitz [1977, 1980a] have shown that if the spanning condition is to be satisfied for this set of decisions, there must, effectively, be a complete set of markets.

As we shall point out in Section 3.3, the first objection may not be particularly serious. We present there some further objections to the "spanning" model. More significantly, we establish in Sections 3.4–3.6 that even with spanning, markets will not be efficient if there is more than one commodity or if the set of "common market factors" is endogenously determined.

3.2. *Mean Variance Models*

There is another, slightly more persuasive approach, which looks for conditions (restrictions on technology, tastes) under which a full set of markets is not necessary; were a full set of markets available, some of the markets would be redundant (i.e. would have no trade).

Two categories of such models have been investigated. The first is the mean-variance model with homogenous expectations. Then, all individuals will buy the same portfolio of risky assets.[7] What is particularly attractive about this model is that it generates a simple formula for the valuation of risky assets

$$V_i = [\bar{X}_i - kE(X_i - \bar{X}_i)(M - \bar{M})]/r \tag{1}$$

[7] The sets of utility functions under which all individuals purchase the same risky portfolio (or linear combinations of a set of mutual funds) though more general than the quadratic, is still very restrictive. See Cass-Stiglitz [1970]. The set of restrictions on distributions has been studied by Ross [1978a].

where

V_i is the value of the ith firm,
X_i is the return to the firm, and $\bar{X}_i$ its mean,
M is the return to a portfolio consisting of the market; and
r is the rate of interest.

The value of the firm is proportional to mean output, reduced by an amount to take account of risk. The latter is simply equal to the correlation of the firms output with the market, times a risk discount factor k.

Equation (1) would, under the stipulated conditions, describe the values of different firms in the economy at any moment of time. If there are a large number of firms, it seems reasonable that firms would believe that were they to vary their production decisions slightly, their action would leave unaffected the market rate of interest and the risk discount factor. Stiglitz [1972a] and Jensen and Long [1972] established that if firms maximize their stock market value, given these beliefs, then the market allocation would not be Pareto optimal. The market seems, in such circumstances, to over evaluate own variance.

There were three criticisms of this analysis.[8] First, it was argued that firms would not take the risk discount factor as given. It is obvious that there is a particular variation in the risk discount factor which would support a Pareto optimum, but there is no persuasive reason why firms would hypothesize that particular value. Indeed, although the calculation of the risk discount factor is, in general, a complicated matter, for the special case where all individuals have constant absolute risk aversion utility functions, it can be shown to be related simply to individuals' risk aversion; hence, the change in investment decision by one firm would, in fact, leave the risk discount factor unaffected.

The difficulties encountered here in the analysis of the appropriate equilibrium concept are, in fact, no different from those encountered in standard competitive analysis. If there are a finite number of firms in a market, as there always are, the action of any one firm will have an effect on the price and/or actions of other firms; when there are a small number of firms, the strategic interactions of firms is an essential part of the analysis of markets. When there are a large (but still finite) number of firms, however, we ignore these interaction effects. We postulate that the firm acts as if it were a price taker, even though it may have a (barely perceptible) effect on price. This is to be viewed as a behavioral postulate, one which is, I think, plausible under the stipulated conditions. Our equilibrium analysis explores the implications of a similar behavioral postulate. I find the assumption in this context that firms take the risk discount factor as given a more plausible behavioral assumption than, say, the assumption that firms calculate the average value of the marginal rate of substitution between income in different states, or between mean and standard deviation and assume these "implicit prices" are constant.

The second criticism was that the analysis depended critically on there being a fixed number of firms. Under the circumstances, there would be a strong

[8] There are, of course, a number of more general criticisms of the capital asset pricing model; see, for instance, Ross [1978b], Jensen [1978] and the next subsection.

incentive to create additional firms, so long as the new firms were not perfectly correlated with the old firms. (See Merton and Subrahmanyam [1974].) If, however, there are fixed costs associated with establishing additional firms one can easily formulate a model in which the number of firms is endogenous, and sufficiently small that the risk discount factor is not zero. (See Stiglitz [1975b].)

The third response was the individuals would not wish firms to maximize their stock market value. This is in fact the case, but in those situations where shareholders do not wish the firm to maximize the market value, there will, in general, not be unanimity about what policy should be pursued. (See Grossman-Stiglitz [1980a].)

3.3. *Factor Models*

There is an alternative set of assumptions under which a complete set of risk markets is not required, which under suitable restrictions generates a Pareto optimal resource allocation in the single commodity world. This postulates that the output of any firm can be written as a linear function of certain common market factors μ_j and certain individualistic factors,

$$Y_i = \sum \beta_{ij}\mu_j + \epsilon_i. \tag{2}$$

It is then postulated that the individualistic factors are uncorrelated, and that there is a sufficiently large number of firms that individuals can diversify out of this "firm specific" risk. (The argument has been developed in more precise terms by Ross [1976].) Now there will be a "price," q_j, associated with each market factor, μ_j; again the value of the firm can be determined simply as the sum of the values of its components,

$$V_i = \sum q_j\mu_j. \tag{3}$$

Given the large number of securities in the market, and the ability to diversify which the market seems to afford, this would seem to be a plausible model. But a model should be evaluted in terms of all of its predictions; many of the predictions of a simple theory may in fact be borne out, but if there are other predictions which seem inconsistent with the facts, the theory should at least be questioned; and alternative theories, consistent with all the relevant facts, need to be constructed. There are at least three observations which seem inconsistent with the simple factor model. (These objections, it should be observed, appear to be equally applicable to the standard capital asset pricing model.)

First, an examination of individual portfolios suggests that a significant fraction of individuals are not sufficiently diversified that the firm specific risk can be ignored. Theoretical reasons (associated with imperfect information) for this are discussed in Section 4.

Secondly, if firms are valued as the factor model assumes *and* firms seek to maximize their market value, the *only* information which firms should seek in assessing any project would be the amount of each "factor" contained in the project. Typically this information is not reported, and indeed, information about risk (own variance) is commonly employed in project assessments which the factor model suggests should be irrelevant (indeed the very fact that such

information is collected is evidence against the model, if there is any cost to collecting this information.)[9]

Finally, the model has extremely strong and unrealistic implications when taxes are introduced. As investors and the IRS both know, the special provisions pertaining to long term capital gains mean that if the individual could buy and sell short the same security (a "wash sale") the individual could reduce his taxes at least to the point where the limitations on deductibility of short term losses are binding. (Since there are straightforward ways of converting interest income and ordinary income losses to short term capital gains, the loss off-set limitations may not be very binding.) It is precisely because of this that the IRS does not allow wash sales. But the factor model says that individuals can in effect engage in wash sales, not buying and selling the same securities, but buying and selling the same factors. Indeed, were there no restrictions on loss-offsets, no one would pay any taxes. In fact, individuals do pay taxes, and indeed for relatively few individuals are the loss-offset constraints binding. This may, of course, be because of transactions costs. This suggests that either the factor model does not provide a good description of the market, or that the transactions costs, constraints on short sales, etc. are of first-order importance in determining demands for securities, and any analysis which omits them may therefore be seriously misleading.

3.4. *Multi-commodity Models*

The only essential difference between the multi-commodity model and the single commodity model is that profits depend not only on the output of the firm in each state of nature, but also on the price at which it can sell that output. In a competitive market, it is reasonable to assume that the firm believes that the price in each state of nature is unaffected by its actions; thus, if each firm has "multiplicative uncertainty" (i.e. relative output in different states of nature is fixed), it believes that by doubling its scale of output, its market value will be doubled. But when all firms increase their scale, not only does the *level* of prices change, but, more importantly, prices change by different relative amounts in different states of nature. Thus, for the industry as a whole, there is not multiplicative uncertainty: changing the level of investment does change relative profits in different states. Changing the investment level changes the set of risk markets; firms will not take this into account but a social planner would. As a result, the market equilibrium is almost never a (constrained) Pareto optimum. Virtually the only cases in which it will be are those in which the stock market is irrelevant, e.g. when all individuals are identical or in which the demand functions have unitary elasticity, so profits are independent of output—there is no effective

[9] The objection that firms may have been speaking prose without knowing it—that they may have acted in accordance with the factor model without being able to articulate it—is not valid here; judgments about projects will inevitably be determined by the kind of information collected and reported. If information about own variance is obtained, but information concerning correlation with market factors is not, it seems implausible that the decisions will be made on the latter basis and not the former. Nor are the objections of the kind raised to the mark-up pricing model that firms use rules of thumb in the short run, but in the long run behave in accordance with the theory, plausible. The factor model provides a basis of *simplifying* the calculations; even if it were only approximately correct, there would be strong incentives for firms to adopt it as a "rule of thumb."

risk. (See Stiglitz [1975a, 1980a].) (As Hart [1975] pointed out, these inefficiencies can arise even in pure exchange economies.)

Note that the model we have just described is consistent with the factor model. A cross sectional study of various firms would show that the market value of each firm is described by an equation of the form (2). In this example, however, the market factors are, in effect, endogenous. To put it another way, the market may not be efficient in its choice of market factors.

The next two subsections provide further examples of this kind of inefficiency.

3.5. *Endogeneity of Markets*

It can be shown that opening new markets (which would appear to reduce the degree of market imperfection) may actually lower *everyone's* welfare. The opening of a market changes the price distribution. In the absence of a complete set of risk markets, prices serve both a risk function (since price and output are often negatively correlated) a well as the usual market clearing function. Their ability to perform this risk function may be seriously impaired by the opening of an additional market just as it was altered in the previous subsection by the level of investment. (See Newbery-Stiglitz [1979]); for examples involving exchange economies, see Hart [1975].)

3.6. *Complementarities in Risk Markets*

The "risk" associated with one firm's choice of a production plan clearly depends on the actions of other firms; if other firms' profits are negatively correlated with the profits generated by a particular production plan, then that production plan may not be viewed as risky. The question arises, is the equilibrium which emerges when each makes its production decisions independently necessarily efficient.[10] When there is an incomplete set of markets, it is known that the answer, in general, is negative: the demand for tea may depend on the availability of sugar, and conversely; if no sugar is produced, it may not pay to produce tea; and if no tea is produced it may not pay to produce sugar. The decisions to produce tea and sugar cannot be made in a decentralized manner. Similarly, Stiglitz [1972a] has constructed an example in which there are two groups of firms, each with two choices of techniques. It is shown that there are two equilibria: given that group 1 chooses, say, technique A, it pays group 2 to use technique C (because A and C are more negatively correlated than A and D); but given that group 1 chooses technique B, it pays group 2 to use technique D. Yet one of the equilibria Pareto dominates the other.

3.7. *Monopolistic Competition and the Capital Market*

Before completing our discussion of the consequences of incomplete markets, we should mention an important analogy which does have direct implications for the assessment of the optimality of the market. The theory of monopolistic competition is concerned with situations where, because of the fixed costs of

[10] The question does not arise in the Modigliani-Miller-Diamond model of Section 3.1, since there the only decision of the firm is the scale of production.

producing different commodities, not all commodities which could be are produced. Again, there is an incomplete set of markets. For any commodity, there may exist close, but imperfect, substitutes. An extensive recent literature (see Salop [1979]), Spence [1976], Dixit-Stiglitz [1977], and Lancaster [1979]) has not only established that, in general, the market allocations will not be (constrained) Pareto optima, but also identified the nature and source of the biases. There is a clear parallel between incomplete risk markets and incomplete commodity markets. (See Stiglitz [1975b], Dreze [1974].)

IV. Information and the Efficiency of Markets

One of the central functions of stock markets presumbly is to convey information from investors (about their attitudes to risk, beliefs about different projects, etc.) to firms. Yet the standard model has little to say about this information process: about the incentives it provides for the gathering of information (both about the likelihood of various events and about the characteristics of various securities), and the efficiency with which it transmits it. There is another equally important information transmission problem: since managers may be more informed about the investment opportunites available to the firm, they must somehow convey this information to potential investors. Capital markets in which it is costly to obtain and transmit information look substantially different from those in which information is assumed to be perfect, and they fail to possess the standard optimality properties.

4.1. *Prices and Information*

In financial markets, prices serve two roles; not only do they clear markets, they also convey and aggregate information. Thus prices perform a quite distinct role from that ascribed to them in traditional competitive analysis, and the optimality theorems which have been proved for that case do not directly apply here. Before turning to these welfare questions, however, we ask, do prices "fully reflect" all the information. If markets were perfectly efficient in transmitting information from the informed to the uninformed, informed individuals would obtain no return on their investment in information; thus, the only information which can, in equilibrium, be efficiently transmitted is costless information. With costly information, markets cannot be fully arbitraged. (See Grossman-Stiglitz [1976, 1980b].)

We noted earlier the ambiguity in the term "fully reflect" in the definition of informationally efficient markets. A natural interpretation is that by observing prices one can infer all the information of the participants in the market. Since the dimensionality of markets is smaller than the dimensionality of information, there would appear to be a strong presumption that markets could not be fully revealing (even of costless information). The question then arises, are there restrictions on preferences or distributions, such that the market is fully revealing of all information which is relevant to individual decision making. Although a variety of such conditions have been discussed in the literature (see, e.g. Grossman [1977]), they are very restrictive. For instance, even if all distributions are normal,

and all individuals have constant absolute risk aversion, for a futures market to be fully revealing requires that there be only demand *or* supply disturbances to the market. (See Bray [1979].)[11]

Although there has not yet been a thorough analysis of the welfare implications of these models, there appears to be a strong presumption that the incentives provided by the market for the acquisition and transmission of information do *not* generate optimal resource allocations (even taking into account the costs of acquiring and transmitting information). First, to the extent that information is quickly revealed by the market, individuals will not have an incentive to obtain it, even when it might be socially useful. There would appear to be a bias in favor of acquiring information which is individual-specific, i.e. is of value only to the individual acquiring the information. Secondly, as in our earlier discussion, although the action of any single individual in acquiring information may have no effect on the price distribution, the actions of all individuals do, and, when markets are incomplete, this change in the price distribution has welfare consequences which each individual ignores. Thus, if no one knows the state of nature, the price of a risky asset must be independent of the state of nature, while if a significant fraction of the population obtains some information about the state, the price will vary accordingly. This increase in the variability in the price of the asset imposes a risk on individuals, which, without a complete set of insurance markets, they may not be able to dispose of. Thirdly, as Hirshleifer [1971] emphasized, some of the gains of the informed are at the expense of the uninformed. The return to information is partly rent-acquisition; it is not a real social return.

4.2. *Screening Alternative Investments*

It is clear that some firms are better than others; one of the central problems of the investor is selecting out, or screening, the "good" investments from the bad ones. Screening equilibria have recently been the subject of extensive study (Spence [1973]; Stiglitz [1975c, 1981]; Rothschild-Stiglitz [1976]), and the ideas developed there have some immediate applications to capital markets.

There are two quite separate strands in the literature, one focusing on the behavior of firms (the users of the capital), and the other focusing on the behavior of banks (one of the primary sources of funds to the firm). A full understanding of market equilibrium requires that these two strands be brought together.

(i) Better firms have an incentive to have themselves identified as better firms; they are willing to pay for audits, advertising, etc. to persuade potential investors that they are, in fact, better, since if they are successful, their market value increases. Their gains are, of course, largely at the expense of the firms with which they otherwise would have been grouped, whose market value will decrease. Although there is a strong presumption that the screening equilibria will not be efficient, it is not obvious that there will be too much screening. The argument

[11] There are a number of interesting existence problems which arise in situations where prices convey information; see, e.g. Kreps [1977], Grossman and Stiglitz [1976], and Green [1977]. Under certain conditions, if there exists a complete set of markets, prices are fully revealing and equilibrium does not exist. (See Grossman [1977], and Grossman-Stiglitz [1980b].)

that there will be excessive investment in ability screening (Spence [1973]) was based on models in which there was no productive return to screening. Here, there is clearly a produtive return to allocating capital to managers who can obtain a high return from it.[12]

(ii) There are a variety of self-selection mechanisms by which information about firm characteristics can be conveyed to potential investors. For instance, if stock holdings of informed inside managers are observable, they may serve as a screening device. These managers (possibly the initial entrepreneur of the firm) pay a "price" in holding significant fractions of their wealth in the given firm in terms of the risks which they must bear. But they are more willing to do so if their estimate of the mean return to the firm is high (and the variance of the return is low). Note that this has an important implication: since managers will be incompletely diversified, they may not act in a risk neutral way in making investment decisions for the firm, even if other, "diversified" shareholders, would like them to do so. (See Stiglitz [1974b].)

Similarly, if there is a high cost of bankruptcy, managers of firms with low variances to their returns and high means will be willing to have higher debt-equity ratios. The financial structure of the firm thus conveys information. (See Leland and Pyle [1977] and Ross [1977].)

Two qualifications to these self-selection (or signalling) information equilibria need to be noted. First, in many instances the same information may be conveyed, more efficiently, in some other way; this is particularly true when tax considerations are taken into consideration. Thus, the same information conveyed by the firm's choice of a debt equity ratio might be conveyed by allowing the manager a choice among alternative compensation schemes. (See Stiglitz [1975d].) Secondly, there are important existence problems associated with competitive self-selection equilibria. (See Rothschild-Stiglitz [1976].)

(iii) The models described above were formulated *as if* the firm wished to "signal" to investors its characteristics; but the models could just as well have been formulated as if investors wished to screen potential investment opportunites; and indeed, several recent models of the lending markets have been formulated in precisely that way. Again, the various aspects of the firm's financial structure (in particular its debt-equity ratio) can serve as a screening device. (See Jaffee-Russell [1976], Stiglitz-Weiss [1980].) As in other screening models, equilibrium is characterized by non-linear "prices". As the amount individuals borrow increases, the interest rate they pay increases.

But, in addition, other aspects of the loan contract, e.g. the interest rate and collateral requirements, can serve as screening devices. What is of particular interest about these is that they generate equilibrium in which there is credit rationing (and possibly price dispersion). For instance, under not implausible conditions, riskier individuals (individuals who are more liable to default) are willing to borrow at higher interest rates. Thus, as the interest rate charged by the bank increases, the mix of applicants changes adversely. It may change sufficiently adversely that the net return to the bank is lowered. If, at this

[12] In the ability screening model, when there is a productive return to screening (as when individuals differ in their comparative advantage), then it can be shown that there may be too little screening in the market equilibrium. (See Stiglitz [1981].)

"optimum interest rate" demand exceeds supply, firms will ration credit. The usual mechanism by which supply is equated to demand is that, in the presence of excess demand, some unsatisfied customer offers a higher interest rate. Here, however, when he does so, the bank infers (and on average, its inferences are correct) that the individual is a sufficiently worse risk that he refuses to grant the loan.

Similar adverse selection arguments apply to other aspects of the loan contract; for instance, an increase in the collateral requirement may again decrease the return to the bank since those who have more collateral may be wealthier, and, with decreasing relative risk aversion, wealthier individuals are more willing to undertake risky projects.

(iv) The presence of differential information may seriously limit the effectiveness of competition between banks. The argument is a direct application of corresponding arguments for the used car market and labor markets developed by Akerlof [1970], Greenwald [1979], and Stiglitz [1981]. If the firm's present banker is more informed of the characteristics of the firm than other banks, any other bank which attempts to compete away a "good borrower" may find his bid matched, if the interest rate he offers is above that required for the banks to break even on the loan; but if the interest rate the competitor offers is below that required for the bank to break even on the loan, he will not attempt to match the offer. Thus the competitor bank will obtain only those customers to whom it has offered too "low" an interest rate. The argument applies with even more force to banking institutions than to labor markets: "used labor markets" perform a role in matching firms and workers (both in terms of tastes for non-pecuniary characteristics and abilities); these "matching" arguments for secondary markets are less persuasive for capital.

V. Incentives and Capital Markets[13]

The interests of the supplier of capital (the lender or investor) and the manager of capital (the borrower) will not, in general, coincide. For instance, in loan markets, the lender is concerned only with the probability that the firm defaults on its loan and with the value of the firm in those states of nature where it defaults; the borrower is concerned with the value of the firm in those states of nature where it does not default. As a result, the supplier of funds would, if information were costless, stipulate as finely as possible what actions the borrower could take. But information is not costless, and one of the reasons that the lender or investor turns control of his capital over to another is precisely because of these information costs. Still, the investor would like to design the terms at which capital is provided to the entrepreneur in such a way as to lead the firm to take actions which are in his interests. The supplier of capital faces, however, a quandry.

On the one hand, if he supplies funds in the form of a loan, since the entrepreneur would then be able to capture the full marginal returns to his actions, if there were zero probability of bankruptcy, the entrepreneur would

[13] Most of the arguments presented in this section are developed more formally in Stiglitz-Weiss [1980].

have "correct incentives." But the entrepreneur may not have sufficient capital to make the probability of default zero.

If the probability of default is not zero, then such contracts will not provide "correct incentives." Behavior of the borrower will then be affected by all the terms of the contract, including the rate of interest and the relationship between the availability of credit in the future and the interest rates charged in later periods, and present performance. The consequence is to strengthen the arguments made earlier for credit rationing; raising the rate of interest charged on a loan may lead the borrower to undertake riskier actions and the expected return to the bank may, as a result, actually be lower. (See also Keeton [1979].) Thus, even if there is excess demand for funds at the interest rate which maximizes the return to the bank, the bank may not raise the rate it charges. At this "optimal interest rate" firms will, in general, be making a positive profit; thus restricting the availability of loans in later periods to those who are successful in earlier periods provides an effective incentive for firms to undertake safe projects in earlier periods. More generally, equilibrium will be characterized by "contingency contracts." These contingency contracts have further implications for the ex post competitivity of the market: as in our earlier analysis of adverse selection, there are serious impediments to individuals shifting from one banker to another. (There is still ex ante competitivity: there is competition among banks in setting the terms of the contracts.)

Loan contracts not only provide incorrect incentives, they impose considerable risk on the entrepreneur, and if he is risk averse, he will want to share the risks with others in the economy.

On the other hand, if the investor supplies funds in the form of equity, the entrepreneur faces less risk, his behavior with respect to the choice of the probability distribution of outcomes is not distorted in the way it is with loan contracts, but he faces inadequate effort-incentives, since he captures only a fraction of the return to his activities.

Thus both polar forms of contractual arrangements (pure debt, pure equity) have their advantages and disadvantages. It is clearly not the case that the financial structure of the firm is irrelevant. With detailed assumptions concerning the supplier of capital and the "manager" (including the technological choices he faces), we can derive the equilibrium contract, the debt-equity ratio which represents a balancing of the various incentive (and adverse selection) considerations presented in this and the preceding section.

An important aspect of the "control" (incentives) problem is that, once the investor has turned over control of his capital, in the form of equity, to another individual, it may be very difficult for him to recover it or to regain control. (He can, of course, sell his shares to someone else, but this simply switches the problem to another individual.) The market provides only weak instruments for ensuring that inefficient managers ("controllers of capital") are replaced by efficient managers, particularly in widely held firms. For the usual reasons ("free rider" problems, costly information), voting mechanisms do not work. Grossman and Hart [1980] have shown how similar arguments can be used to explain why with rational expectations the take-over mechanism has only limited efficacy. Evolutionary processes are slow; they do not stop managers from squandering

their present capital; they only stop him from acquiring additional capital to waste.

In contrast, with loan contracts the lender can regain control of his capital in a more direct fashion. If these loans are short lived, they subject the firm to periodic review by outsiders. This periodic review may act as an effective incentive mechanism. (There are interesting questions concerning the optimal review period—length of loan, which we cannot pursue here.) This argument suggests that control over the managers of firms is not exercised so much by the shareholders, the suppliers of equity (although they nominally have "voting rights," these are not very effective), as by the lenders, who are in a position to withdraw their capital if the firm "misbehaves." But it is also clear that the policies which the bankers would like the firm to pursue are not, in general, consistent with firms maximizing their value.

In short, owners of capital have only limited control over those to whom they turn over use of their capital. They exercise control only indirectly (and then imperfectly) by the design of financial structures, incentive pay schemes, rules for take-overs, etc. (For a more extensive discussion of these issues, see Stiglitz [1980b].)

VI. Concluding Remarks

This paper has presented a variety of arguments which, though granting the seeming competitivity of the financial market, seriously question the presumption of the optimality of the resource allocations to which it gives rise. The objective of the analysis is not to advocate particular government interventions in the financial market. Rather, it is intended to counter the argument that because the market appears to be efficient and competitive, intervention would only lower welfare. The quantitative significance of these market failures, and whether selective intervention could or would result in an improved allocation of resources remain moot questions.

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