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Information Production, Market Signalling, and the Theory of Financial Intermediation

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I. Introduction

CURRENT THEORIES OF FINANCIAL markets have been unable to successfully deal with the existence of financial intermediaries. In fact, there is very little theory which attempts to explain the purpose which intermediaries serve in capital markets. There is a relatively large literature dealing with portfolio choice of intermediaries, particularly commercial banks.[1] But all of this literature lacks a convincing analysis of the underlying rationale for the operation of the intermediary. The basic problem is that, in a perfect market environment, intermediaries could perform no unique financial service that investors would be unable to reproduce as easily. And, while it has long been understood that intermediation must develop as a response to costly market imperfections, few theories have been offered which provide a concrete explanation of the intermediary function.

A recent effort using an imperfect markets approach which relied on transactions costs to motivate financial intermediation was made by Benston and Smith [2]. Another reason for the intermediary function, proposed by Campbell [4], is to maintain the confidentiality of information about the firm's investment projects possessed by manager-insiders but valued by competing firms. As suggested by Leland and Pyle [15], however, there may be an even more powerful explanation which follows from the existence of informational asymmetries in capital markets. The specific hypotheses proposed by Leland and Pyle is that there is something intrinsic in intermediation which solves the problems of moral hazard and appropriability which inhibit the production of information. It is useful to think of their hypothesis as maintaining that information production is a sufficient condition for the emergence of intermediaries in an otherwise perfect capital

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[1] See Pyle [15] for survey of this literature.

market. The purpose of this paper is to develop a rigorous inquiry into the merits of the hypothesis posed by Leland and Pyle.

It is important to keep in mind, as the hypothesis of this paper is laid out, that there is a potentially powerful null hypothesis regarding the existence of financial intermediaries.[2] That hypothesis is that financial intermediaries are merely portfolio managers which would, in an unregulated competitive market, earn a competitive management fee. It follows that the unique kind of financial intermediation industry observed in the United States is a product of the regulatory environment. This view tends to minimize the significance for capital markets of information asymmetries. In general, this view hypothesizes that problems surrounding information are not critical in explaining intermediaries as we know them.

The ultimate explanation of the emergence of intermediaries to which this paper leads is eclectic. That is, the view taken in this paper is that none of the explanations which have appeared in the literature; i.e., to achieve economies in transactions costs, to protect confidentiality, or to produce information; stand alone as satisfactory explanations of intermediaries as we know them. Rather they are complementary explanations of intermediation. This paper concentrates on the information production role of intermediation and demonstrates that, contrary to the supposition of Leland and Pyle, intermediation, per se, is not sufficient to resolve the moral hazard and appropriability problems intrinsic in the market for information. But this does not imply that an important function of intermediaries is not the production of information. Our hypothesis is that intermediaries emerge as information producers because the production of information, the protection of confidentiality, the provision of transactions services, as well as other intermediary services, are naturally complimentary activities.

In addition to offering some insight into the role of financial intermediaries, this paper presents an important conclusion about the resolution of the moral hazard problem in financial markets which arises when there is imperfect information. It is demonstrated that initial wealth endowments resolve the moral hazard problem in that they function as a guarantee of the reliability of information. That is, the market will believe the signals of those who have a sufficient stake in the market that they have no incentive to misrepresent their information. This result leads to the important and general conclusion that initial wealth endowments act as a barrier to entry in the market for information and as a general constraint on reliability.

The general procedure adopted in this paper is to search for a Rational Expectations equilibrium in a capital market with imperfect information about the value of firms.[3] The concept of equilibrium employed here is somewhat broader than that which has been used in recent treatments of incentive signalling problems. The equilibrium sought is one where both the values of firms are accurately identified and this is accomplished in the most efficient manner. The

[2] See Fama [7] for a treatment of "banks" (defined in a broad sense) which is consistent with this null hypothesis.

[3] An anonymous referee deserves credit for the suggestion that the results be organized around a formally stated Rational Expectations equilibrium. This suggestion proved exceptionally helpful.

efficient Rational Expectations equilibrium defined here, in effect, requires equilibrium in both the capital market and the market for information.

The search for an equilibrium proceeds through a sequence of market regimes which are increasingly complicated but which provide increased avenues for resolution of the problems created by imperfect information. The treatment of this sequence of market regimes is organized into two sections. In each section investors know only the average value of firms in the market but may invest in costly information about the true value of firms. The distinguishing characteristic of Section II is that investors decisions on the profitability of information production depend solely on the returns they receive from the securities they purchase. The next section extends the results of Section II to include the possibility that owners of projects may offer investors side payments to either invest or not invest in information opportunities. This section demonstrates that investors acquire no advantage in the resolution of the moral hazard problem by organizing themselves as intermediaries.

In Section IV the final result of Section III is directly contrasted to the hypothesis posited by Leland and Pyle. This section is concluded with the argument that intermediaries evolve as important information producers if they jointly produce information about the value of firms as well as other services valued in the marketplace. This suggests that an important function of intermediation is the production of information about the value of investments, but that information production alone is not a satisfactory explanation of the intermediary's function. A brief final section points out the generality of the results.

II. IMPERFECT INFORMATION AND THE VALUES OF FIRMS: THE CASE OF NO SIDE-PAYMENTS

Introduction and Definition of Equilibrium

In this section we introduce the basic set of assumptions which will be used, with some crucial modifications, throughout the paper. We then consider a simple model of the market value of firms where investors have imperfect but symmetric information about the values of individual firms. This model is nearly identical to the basic model which has served as the starting point of other authors who have written on this and related topics, e.g., Akerlof and Ross. We then consider an extension of the basic model which allows asymmetric access to information by investors.

Each of the market regimes considered in this section and the next is analyzed to determine whether there exists a Rational Expectations equilibrium and whether the equilibrium is what will be labeled "efficient." A market regime will be said to have a Rational Expectations equilibrium if these conditions are met: (1) individual agents maximize their own wealth, taking prices of assets as given; (2) asset prices adjust in a tattonement process so that the asset market clears; (3) ex ante expectations of market participants are fulfilled. This Rational Expectations equilibrium will be said to be efficient if there are no opportunities for profitable production of information which are forgone in equilibrium.

The conditions for equilibrium are essentially the same as the equilibrium conditions employed in incentive signalling models, as for example in Spence [20], Ross [18] and Bhattacharya [3]. The equilibrium essentially says that the market provides some mechanism whereby the assets in the market become properly valued. But an efficient Rational Expectations equilibrium involves an additional and stronger condition.[4] This condition requires that the market must provide some mechanism for investments in information to take place which are profitable for investor-information producers acting as price-takers. Specifically, the market must provide a mechanism which allows investors to undertake any opportunity to identify the value of firms which is profitable when viewed as a price-taker. Therefore, an efficient Rational Expectations equilibrium requires not only that the information asymmetry is resolved but that it is resolved efficiently.

Assumptions Of The Analysis

There are two assumptions, one mentioned explicitly below and one only implicitly, which drive the analysis in this and the subsequent sections. The first is that there are no opportunities for costly signals of value by firms to the market which provide the basis for a successful incentive signalling scheme. Ross [18] has suggested that penalties incurred by managers in the event of bankruptcy may be just such a cost which allows capital structure to be a signal. In another context Leland and Pyle [15] have employed such a signal for owner-managers. Whatever the merits of these arguments (and these positions are not immune to criticism, see Chen and Kim [6] and Bhattacharya [3]) we assume that such perfect signals do not exist. Indeed, if they did there would be no room for the present analysis and no room for intermediaries as information producers.

The second assumption is that investors with informational advantages cannot privately use their information for profit. In fact, the assumption employed below of a tatonnement process for price determination assumes that private information immediately becomes a public good. While this may, at first glance, seem to be an unfortunate assumption, it is, in fact, chosen by design. When portfolios held by investors with information advantages are small relative to the market, they can invest their own funds based on their information with little impact on the market. If they seek to increase their profits beyond that obtainable from their own funds, they must persuade the market of the quality of their information. Their only other alternative is to wait for trading on their superior information to gradually increase their wealth.[5] But it is precisely the attempt to attract new funds based on superior information which is the subject of this

[4] In most incentive signalling models the distinction between these conditions is not particularly meaningful in that a signalling equilibrium satisfies both conditions. The additional element introduced here which makes the two conditions meaningful is the opportunity for investors to invest in information about the value of assets. This introduces profit opportunities which create a meaningful distinction between the existence and efficiency of equilibrium. In effect, most existing analyses of signalling problems do not consider equilibrium with respect to both the valuation of firms and the production of information, whereas both are considered here.

[5] See Figlewski [8] for an analysis of market efficiency with this type of wealth redistribution.

analysis. The assumption that information, once acquired, becomes public through its use, focuses our analysis on the market where investors with information advantages are not an inconsequential part of the market.

This assumption creates the same difficulties encountered by Grossman [11]. If the return to information is to come from trading profits some noise must remain in market prices. On the other hand, it is not only possible, but enlightening to permit the firms whose value is being determined in the market to directly compensate investors for producing information.[6] This is the path down which the analysis of this section leads, though this section stops short of the formal introduction of side payments. Side payments form the basis for the analysis of Section III.

The specific assumptions underlying the model in this section are as follows.

(i) All firms in the market consist of profitable investment projects with one of two unique return distributions, either type A or type B.

(ii) The number of A assets or firms is N_A, and the number of B assets is N_B, $N = N_A + N_B$.

(iii) Investors are identical in all respects including the values they attach to particular return distributions, except that they have distinct wealth endowments, W_i.

(iv) Investors place values V_A and V_B on firms of type A and B where $V_A > V_B$.

(v) All investors have the same information about the identities of individual assets and their values. Specifically, investors know $\bar{V}$, the average or cross-sectional values of assets but not the identity of each individual firm.

(vi) The number of assets required to achieve the full benefits of diversification in an investors portfolio of accurately valued firms is equal to either N_A or N_B assets, whichever is lower. This means investors will lose nothing by limiting the size of their portfolio to N_A or N_B assets, if they believe all firms are properly valued.

(vii) Equilibrium prices are formed as in a tatonnement process where prices bid by investors are instantaneously known by all others.

(viii) Owners of firms are distinct from investors with capital. They undertake their investment projects and therefore receive value from their assets only by selling title to their projects to investors.

A Model of Market Value With Symmetric Information Among Investors, But No Opportunities For Information Production

Under these assumptions investors will value all N firms at $\bar{V}$. Even though investors know there are assets in the market worth more or less than $\bar{V}$ they have no way of reliably identifying undervalued or overvalued assets. Moreover, no investment strategy could consistently outperform that of purchasing equal

[6] It should be noted that Bhattacharya [3] points out that there is a problem in Ross' analysis in that the implications of side payments from the owners of overvalued firms are not fully developed.

fractions of all assets valued at $\bar{V}$.[7] While it is possible to derive excess returns, ex post, from randomly identifying a disproportionate number of undervalued assets, it is equally probable that equivalent losses may be the result. The expected value of a random selection of $n < N$ assets is still $n\bar{V}$; but a risk averse investor would require a premium to invest in those assets since a random portfolio also introduces additional portfolio risk resulting in the value of the portfolio being less than $n\bar{V}$.

If there are no better alternatives (as assumption (vii) implies) owners of A firms will be willing to accept this result. But since at $\bar{V}$, type A assets are undervalued by $V_A - \bar{V}$, individually, and $N_A(V_A - \bar{V})$ in total, it would be to the advantage of the owners of type A assets to communicate their identities, even at a cost, to the market. If information provided by firms regarding their true values were considered reliable by investors, competition among investors for undervalued assets would establish V_A and V_B as prevailing prices of A and B assets in equilibrium.[8] However, owners of overvalued firms have an equal incentive to maintain the status quo.

In order to see whether all firms will remain valued at $\bar{V}$ suppose that owners of undervalued projects advertised themselves to the market as owners of type A assets hoping that competition would restore the prices of their assets to V_A. They could even incur costs of distributing this information of $V_A - \bar{V}$ per asset and still be as well off as when the market price reflected average values. Owners of overvalued assets, however, should be willing to pay up to $\bar{V} - V_B$ to somehow maintain the market price at $\bar{V}$. To accomplish this they might pay up to $\bar{V} - V_B$ per asset to misrepresent themselves as owners of undervalued assets. Since owners of undervalued assets have no more incentive to establish the true qualities of assets than the owners of overvalued assets have to frustrate this result, the market would be unable to discern the true values of individual assets. Investors could not rely on any information imparted to the market by owners of projects. The moral hazard involved in the transfer of reliable information implies that the price of all firms will be $\bar{V}$.[9] The information asymmetry means that there will not be a Rational Expectations equilibrium.

[7] Actually, in the absence of information about the true identities of assets, the optimal investment strategy would be to purchase an equal portion of each asset, where the value invested in each asset is a function of the investor's relative market wealth, or,

$$V_{ik} = \frac{W_i}{N} \quad \text{and} \quad \sum_i W_i = \bar{V}N \forall\, i, k$$

V_{ik} = value of kth asset purchased by ith investor, and W_i = wealth invested in the market by the ith investor. In this fashion the most risk-return efficient investment is made which guarantees the investor returns worth, W_i, with no unnecessary portfolio risk.

[8] Wealth would be redistributed from owners of overvalued assets to the owners of undervalued assets in the amount $N_B(\bar{V} - V_B) = N_A(V_A - \bar{V})$.

[9] Leland and Pyle [14] suggest that another result is possible; that is, the market may fail due to the withdrawal of undervalued firms. This is an example of the problem discussed by Akerlof [1]. This requires either that there are a large number of unprofitable firms in the market so that, on average, firms are unprofitable, or that profitable firms withdraw to get a higher value elsewhere. The first possibility requires that there is no method by which firms with unprofitable projects can be

Market Value and the Incentive for Information Production

The conclusion that all firms in the market will trade at a value $\bar{V}$ is due to the fact that investors are precluded from gathering information about the true value of assets. Suppose, instead, that investors can obtain information, at a cost, that allows them to perfectly identify type A and B assets. Assumption (v) can be amended to include this possibility. The modified assumption is: (v) Each investor has costless access to the cross-sectional average value of firms, $\bar{V}$. In addition each investor has the ability to acquire information about the true value of all firms at a cost. For the ith investor the cost is C_i.[10]

One motivation for investors to undertake the investment in information might be to attempt to extract excess profits from the purchase of undervalued assets at $\bar{V}$. With this motive in mind, the investor would decide whether to invest in information by comparing the excess profits from investing his wealth in type A firms with the cost of acquiring information, i.e., he will invest if

$$\frac{W_i(V_A - \bar{V})}{\bar{V}} > C_i \tag{1}$$

where

W_i = wealth of the ith investor

$\frac{(V_A - \bar{V})}{\bar{V}}$ = the excess rate of return from investing in type A firms at $\bar{V}$.

C_i = cost of information for the ith investor.

Note that assumption (vi) insures that he loses nothing by restricting his portfolio to $N_A < N$ securities, once he has discovered the true identities of firms.

It would be profitable for investors to behave this way only if the information acquired were to remain private. This will generally not be the case when investors in the market are few and large enough that others are aware of their opportunities and actions. In markets where prices are efficient market signals of available information, the incentives for collecting information are significantly affected. Grossman [11] and Grossman and Stiglitz [12] have shown that in markets where asymmetries in information about the quality of assets exist, the market price may instantaneously and efficiently aggregate and summarize all available information about the quality of the asset. Under these conditions, information may be characterized as a public good (the value or usefulness of

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discouraged from entering the market. For if firms are perceived to be profitable, on average, the market will still operate. This is considered explicitly in Campbell [5] and it seems unlikely that this problem will be significant. The possible existence of firms with unprofitable projects is not considered here. The other possibility is that undervalued firms withdraw because they believe they can receive a higher value in another place or at another time and the market will still function but only with low quality firms. Such possibilities are also excluded here by assumption (viii).

[10] There are a number of alternative possible specifications for information costs. This specification implicitly assumes economies in information production which makes it inefficient for any single investor to produce information about only part of the firms in the market and another investor produce information about another group of firms. Campbell [5] employs a specification which does not employ this assumption and a more general analysis of the implications of alternative specifications is presented in Kracaw [13].

information is undiminished as it becomes available to other investors) which cannot be protected so as to extract excess profits from the market.

To see the implication of this problem more clearly, imagine an investor with information production opportunities who undertakes the opportunity at cost, C_i, and successfully identifies each asset in the market. Due to the opportunity to extract excess profits from the market, the investor no longer purchases an equal fraction of each asset but chooses only type A assets (causing prices to rise by increasing competition for those assets). The effect of these actions is to signal other investors the true identities of the undervalued assets. In a tatonnement market the remaining investors react to new knowledge of the assets in the market by bidding up the prices of type A assets to V_A and bidding down type B assets to V_B. Because trades do not take place out of equilibrium, the information producer is unable to extract any excess returns by purchasing undervalued assets.[11] If such a strategy is attempted, the investor must incur the cost of information, C_i. The information producer, therefore, receives only market value for his investment, but incurs a cost, C_i.[12] Again, there is no Rational Expectations equilibrium.

III. THE MARKET VALUE OF FIRMS WITH SIDE PAYMENTS

Introduction

The preceding section showed that investors have no apparent incentives to acquire information that might identify the true values of firms, particularly if that information is costly. In the absence of investor supplied information, market prices reflect the average value of firms, $\bar{V}$, and a redistribution of wealth takes place from owners of undervalued firms to owners of overvalued firms. Our analysis thus far has neglected to deal with the incentive of undervalued firms to induce the production and use of that information. This section will describe a sequence of market regimes where owners of firms are free to offer side payments to the producers of information to either invest or not invest in information.

Monopolistic Access to Information

The analysis begins, as before, with a market for N assets where a number of investors have the ability to produce information at a cost. To simplify the analysis, we first assume that only one investor, investor i, has such an opportunity, at cost $C_i < N_A(V_A - \bar{V})$. Investor i is, therefore, a monopolist. This is

[11] The prospect of giving false signals as to identities of undervalued assets may seem to offer opportunities for excess profits by initially purchasing overvalued assets. However, the nature of the tatonnement process precludes success of these "false signals" in that all prices must be known to all in equilibrium. A false signal may initially bid up prices of overvalued assets, but eventual investment in undervalued assets serves as an opposite signal.

[12] Even if $C_i = 0$, no motivation exists for production of information since investment in only type A firms still leaves the producer of information exactly as well off as holding a fraction of all assets valued at $\bar{V}$. It is also impossible for information producers to extract gains by trading interests in assets since that action may be a signal as efficient as the market price.

formalized by adding the following sentence to assumption (v): "All investors except i have costs of information which exceed the total amount of under or overvaluation." At a market price, $\bar{V}$, the owners of undervalued firms stand to lose $N_A(V_A - \bar{V})$, the amount by which their firms are undervalued, to the owners of overvalued firms. Recovery of some or all of these potential losses is an incentive to firm A owners to induce the production and use of information.

If the owners of undervalued firms are aware of each other and are able to collude in their activities, then they may offer a side payment, S_A, to induce investor i to produce information and determine the true values of firms. The amount of the side payment is bounded above and below such that

$$C_i < S_A < N_A(V_A - \bar{V}). \tag{2}$$

As in Section II, since investors cannot improve their own positions by producing information, the minimum side payment which might induce that production would be C_i, enough to just cover the costs of production. On the other hand, the maximum side payment owners of A firms would be willing to make is $N_A(V_A - \bar{V})$. Anything more would leave them worse off than if they accepted $\bar{V}$. Thus, if $C_i < N_A(V_A - \bar{V})$ there will be incentives to produce information offered by owners of A firms in the form of side payments. The maximum net gain to investor i for producing information is $N_A(V_A - \bar{V}) - C_i$.

It should be obvious, however, that there will be incentives offered by owners of overvalued firms to forego information production, as well. Again, assuming the owners of overvalued firms have an equal opportunity to collude,[13] their maximum side payment should be no more than $N_B(\bar{V} - V_B)$. And, since the act of not producing information involves no cost on the part of the investor, the minimum feasible offer would be zero. The range of possible side payments from B firm owners to not produce information is,

$$0 < S_B < N_B(\bar{V} - V_B) \tag{3}$$

where S_B is the side payment offered by owners of B firms.

When there are positive costs of information acquisition, $C_i > 0$, a comparative advantage lies with owners of overvalued firms. Since by definition, the total amount of undervaluation equals the total amount of overvaluation (i.e., $N_A(V_A - \bar{V}) = N_B(\bar{V} - V_B)$), the maximum gross side payments affordable by both groups or owners is the same. But the maximum net gain to investor i is greater if he accepts side payments not to produce information because he avoids incurring the cost of information. When $C_i = 0$, there is no comparative advantage

[13] It is interesting to note that in the case where collusive opportunities are assumed to be restricted, some different results follow. For instance, suppose the cost of colluding between any 2 firms is Z, then the cost of colluding on the part of overvalued firms is ZN_B and that of undervalued firms is ZN_A. The maximum side payments (assuming that $Z < (\bar{V} - V_B)$ and $Z < (V_A - \bar{V})$) made by firms is

$$S_A = [(V_A - \bar{V}) - Z]N_A$$

$$S_B = [(\bar{V} - V_B) - Z]N_B$$

and relative power of persuasion rests with the group of fewer numbers.

to producing or not producing information and the impact of side payments on market equilibrium is, at best, indeterminate.[14, 15] Again, no well defined motives exist which induce investors to undertake production of information and this market regime fails to satisfy the conditions for existence of a Rational Expectations equilibrium.

Competition and Production of Reliable Information

In the remainder of this section, a market regime is described where competition exists for the side payments offered to produce information. It is demonstrated that a competitive information market performs quite differently from one that is monopolistic. We proceed by first examining a market where all information is reliable and define the incentives for its production. This is formalized by adding an additional assumption for this subsection: (IX) Investors are pathologically honest. In the following subsection this assumption is dropped and a market regime is described where unreliable information is produced if it is deemed profitable to do so. Mechanisms for resolving the moral hazard problem in the information market are then considered.

Suppose we complicate the analysis slightly by assuming that more than one investor in the market has the capability to produce profitably the same information. It is advantageous to simplify the analysis by assuming that only two investors (i and j) are able to produce the information at distinct costs, C_i and C_j. Also, we assume that $C_i < C_j$. Hence, the market here is different only by the inclusion of an additional, slightly less efficient, producer of information. This means assumption (v) now stipulates: Two investors i and j, have costs of information which are less than the total under or over-valuation and $C_i < C_j$.

When two investors are able to reveal the true values of firms, the owners of overvalued firms must induce both to forego information opportunities or lose the excess value they wish to retain. On the other hand, the owners of undervalued firms need only induce one or the other to invest in information in order to regain the value they otherwise might lose. More specifically, the owners of undervalued firms are able to offer a gross side payment of $N_A(V_A - \bar{V})$ to either information producer. If owners of overvalued firms offer side payments to both producers of information they must divide their resources, $N_B(\bar{V} - V_B)$, somehow. If, for

[14] Actually this result can be reached in either of two ways. Either the actual cost of obtaining information may be negligible, or the investor may interpret the side payment to collect information as a reliable signal of the identities of undervalued firms. This signal serves as an equally efficient means of determining the identities of firms as does undertaking the production of information, but at no cost. The important point, however, is that even if the side payment offers reveal the identities of firms to investor i, he is indifferent about passing that information on to the market due to the equality of gross side payments. Yet another possibility arises if the bidding itself is assumed to be public. In this instance overvalued firms could publicly mimic undervalued firms but with no intention of paying off if actually identified as overvalued. But they could then contract with an agent to bid against the undervalued firms. Ignoring any costs of the agency relationship this would lead to the same disequilibrium result.

[15] Stalemates of this sort will, in fact, work to the advantage of B firms since they benefit most from the status quo. Also, because the cost of inaction is unambiguously zero, the advantage would swing the incentive to not producing information, whenever C_i was anything but certain.

instance, they divide their resources evenly, the maximum side payments offered would be $\frac{1}{2} N_B(\bar{V} - V_B)$. And if, as in the case of offers to investor i,

$$N_A(V_A - \bar{V}) - C_i > \tfrac{1}{2} N_B(\bar{V} - V_B) \tag{4}$$

information production would be profitable. A similar condition exists for offers made to investor j. Only if investor j's cost of information were greater than $\frac{1}{2} N_B(\bar{V} - V_B)$ would the inequality above not be met and information not produced. Thus, if overvalued firms engage in a bidding contest with undervalued firms to influence producers of information they are no longer able to maintain the status quo.

In addition, the most efficient producer of information should emerge as the recipient of the side payment from A firms. This results from the fact that $C_i < C_j$. Investors i and j effectively bid for the side payment of A firms until,

$$C_j = S_A \tag{5}$$

where investor j can no longer profit by investing in information. At that point, investor i emerges as the most efficient producer of information receiving $S_A = C_j$ as payment for information. The profit generated by investor i in the process is

$$S_A - C_i = C_j - C_i \tag{6}$$

and firms are accurately and efficiently revalued in the market.

A general solution of equilibrium in a competitive information market where the owners of overvalued firms are assumed to attempt to simultaneously influence both producers of information, no longer favors the owners of overvalued firms. Even if those owners were allowed to concentrate their resources in one side payment to whichever investor A firms dealt with and cause the resolution of market equilibrium to be game-theoretic in nature, it still appears that owners of A firms will prevail. This is because it will always be to the advantage of one information producer, or the other, to contract with A firm owners because B firm owners can never successfully bribe both simultaneously. This conclusion will be insured if the owners of A firms can instigate side payment contracts conditional on investors not contracting with others.[16] Therefore, if there are competitive, information producers who are pathologically honest there will be an efficient Rational Expectations equilibrium because the low cost information producer will win a bidding contest to identify undervalued firms.

[16] Again, as in the monopolistic case, it appears possible that the mere action of offering side payments may serve as an adequate signal of the identities of the alternative groups. In that case information producers need not incur the cost of actually producing information but merely infer their identities from the side payment offers they receive. The result of this would be to reduce the gross side payments undervalued firms would have to make to reveal their identities. The overvalued firms could follow a strategy which would compel the undervalued firms to pay for information production. The strategy, would be to publicly mimic the true undervalued firms but with no intention of paying off, and employ an agent to bid against the undervalued firms but protect their identity. It is problematical whether undervalued firms might discover some incentive which would induce them to carry out such a strategy.

Moral Hazard and the Production of Unreliable Information

In the preceding section the Rational Expectations equilibrium depended on the existence of competitive and honest information producers. Under these conditions contracting for production of information was a simple process involving only the determination of the price at which information will be produced. One way to view the impact of the pathological honesty assumption is that it leads to a world of costless contracts. As long as information producers will behave honestly, regardless of the incentives to cheat, then potentially costly contract provisions which limit such incentives will be dispensible. However, when market participants act dishonestly if such behavior is profitable, as assumed in this subsection, more complex contracts may be necessary to ensure reliable performance. The costs of such contracts, and the incentives they create to induce reliable behavior are as important as the price of production.

There are basically two ways to structure contracts to deal with the problem of dishonesty. One way is to include provisions in the contract which permit the monitoring of the information producer to insure the honest production of information. But the costs of such monitoring activities are likely to be rather high and the problems of monitoring have been well developed, although in a somewhat different context (see Jensen and Meckling [13]). The other alternative, which is pursued here, is to devise contract provisions which offset the incentive to behave dishonestly. The particular incentive clause which is considered here as a contractive option is a requirement on investment by the information producer in the firms he claims are undervalued.

Suppose, that in the bidding situation described above, investor j realizes that he is able to extract profits from the market if he contracts dishonestly with the owners of firms. The way he can do this is to underbid investor i despite his own higher cost of producing information, but with no intention of actually producing that information. Investor j could randomly identify N_A firms and claim they were the true N_A firms. He could win the bidding with the more efficient investor i by bidding an amount, S_A, which is just under investor i's cost of producing information, C_i. This side payment of S_A could still be secured from firms since it is to the advantage of any firm to pay S_A/N_A to be revalued to V_A.

Of course, investor i will not be ignorant of the opportunities to misrepresent the identities of firms. He knows that investor j will underbid him with a dishonest bid once j's own cost of production has been reached. In effect, he knows that honesty is a losing strategy and will therefore have to withdraw from the market or follow j's lead. The question then becomes: What will be the outcome of the bidding process if both are dishonest when it is profitable to do so?

To evaluate the net gain from dishonest behavior it is necessary to consider the portfolio positions taken in the market by each investor-information producer. Each investor can certify his honesty, *up to a point*, by the position he takes in the market. To see this, consider the portfolio losses to which investors i and j will be subject if they commit their entire wealth endowment to the assets they claim are overvalued.[17] Pursuing the case of investor i, if he constructs a portfolio

[17] Given assumption (*Vi*), the market will assume that investors can hold such portfolios at no cost in terms of forgone diversification if they have actually identified the true undervalued firms.

of the N_A firms he had identified as undervalued, the expected value of this random selection of firms is $\bar{V}$. By paying V_A for these firms, or more appropriately a portion of each at a pro-rata value of V_A,[18] investor i's expected portfolio losses are

$$W_i\left[\frac{\bar{V} - V_A}{V_A}\right]. \tag{7}$$

At any prevailing side payment, S_A, offered in the market the incentive for any investor i, to produce unreliable information is given by

$$S_A - W_i\left[\frac{V_A - \bar{V}}{V_A}\right]. \tag{8}$$

Conversely, the corresponding incentive to produce reliable information is

$$S_A - C_i. \tag{9}$$

Therefore, there is a greater incentive for i to produce reliable information when

$$C_i < W_i\left[\frac{V_A - \bar{V}}{V_A}\right], \tag{10}$$

or when the costs of producing information are less than anticipated portfolio losses.

The problem facing the market is to determine the incentives of information producers to misrepresent the identities of firms. The ability of the market to accomplish this depends on its knowledge of characteristics of information producers. Suppose, temporarily, that the market already knew each potential information producers cost of production. In this case the bidding process would be needed to determine the most efficient information producer. The problem would be simply to insure that the low cost information producer did not have an incentive to cheat. One way to accomplish this is to require that the information producer have enough wealth committed to the undervalued firms that the inequality in (10) is satisfied. But suppose that the wealth endowment of the most efficient producer is insufficient to satisfy (10). In order to get reliable information, firms will have to contract with a less efficient producer who has sufficient wealth to be perceived as reliable, if one exists.

If knowledge of the relative costs of various producers is not known to the markets, as is assumed to be the case, then the bidding process will have to be used to establish the most efficient reliable information producer. By using the bidding process the market can still arrive at the same contract with the same producer as it would if knowledge of relative costs were initially available.[19] This

[18] More realistically, we mean investors will purchase an equal portion of each firm at a pro-rata value of V_A.

[19] Actually it is unlikely that the market will have an equilibrium which is totally free of cheating. For example the investor (i) that wins the bidding can secretly approach any one firm and threaten to identify it as a B firm unless it pays a bribe just short of $V_A - V_B$ which is sufficient to cover any losses incurred by the investor on his own investment in the firm. If the information producer does this to enough firms it will benefit them to pay another investor with a large portfolio to invest in information and reveal their true identity. But there is then the possibility that these investors may collude and share the original bribe. However, there is a greater incentive to blackmail true A firms than to seek bribes from B firms because the portfolio losses for the investor will be lower. This will tend to limit the number of incorrectly valued firms in the market.

is accomplished when the owners of undervalued firms accept the lowest bid (S_A) where it is clear that there is no incentive to misrepresent the identity of firms, i.e., the lowest value of S_A offered by any producer, say producer i, where

$$S_A < W_i\left[\frac{V_A - \bar{V}}{V_A}\right]. \tag{11}$$

When this condition holds for any producer i, he will expect to incur a net loss if he cheats. And, therefore, producer i can produce information profitably only if he does so reliably.

As long as there is at least one information producer who bids an amount S_A which satisfies (11) the moral hazard problem in the market for information will be solved. But, the Rational Expectations equilibrium which results will not be efficient. The emergence of a signal of reliability in the production of information enables the market to identify the true values of firms. However, it is because this signal is necessary to establish the reliability of information that the information itself may be produced inefficiently. This is because it is possible that the most efficient producers of information have insufficient endowments to signal reliability. Therefore, the efficiency of the Rational Expectations equilibrium depends on the distribution of wealth endowments and information costs across potential producers of information. What is necessary is that the most efficient information producer has sufficient wealth to signal reliability. Short of this, the efficiency condition will not be satisfied. It is interesting to note that while the emergence of a signal of reliability ensures that firms are identified. It also imposes a barrier to entry for information producers which may preclude entry to the most efficient producers.

Intermediation and the Moral Hazard Problem

If information producers are to successfully eliminate information asymmetries regarding the qualities of assets, it is clear that the information they produce must be perceived by the rest of the market as reliable. The establishment of reliability in the marketplace is concurrent with the resolution of any moral hazards which inhibit the production of information or diminish its integrity. Some authors have suggested that efficient information producers in the form of intermediaries may emerge to resolve these problems. Let us consider how information producers might organize themsleves as intermediaries and how this form of organization affects the resolution of the moral hazard problem. In order to clearly specify the way the intermediary is organized, we begin with the simple case where information producers are pathologically honest. This will help us concentrate, momentarily, on explaining the ownership structure of the intermediary. Later, the moral hazard problem will be presented again as we relax the assumption of honest behavior.

Consider the ownership structure and mode of operation of an intermediary organized by information producer i. Suppose producer i forms an intermediary to collect sufficient funds from other investors to purchase all N_A undervalued firms at a price $N_A V_A - S_A$. If producer i is the most efficient producer of

information bidding for the undervalued firms, then S_A is the competitive price of information which just underprices the next most efficient producer. Therefore the owners of undervalued firms receive full value for their assets, less the competitive price required to establish that value.

In return for their capital, investors in the intermediary receive a fraction of the assets of the intermediary worth $N_A V_A - S_A$. Given that the intermediaries assets are worth $N_A V_A$, their fraction of ownership, X, is,

$$X = \frac{N_A V_A - S_A}{N_A V_A} \tag{12}$$

(therefore, the value of the claims held by those investors is $X(N_A V_A)$, or $N_A V_A - S_A$). As compensation for producing information which identifies the undervalued firms, producer i receives the competitive value of that information, S_A. He does so by receiving a fractional share of the assets of the intermediary of

$$1 - X = \frac{S_A}{N_A V_A} \tag{13}$$

(the value of the claims of producer i against the intermediary is $(1 - X)$ $(N_A V_A)$, or S_A).

When information producers are pathologically honest, the outcome of competitive bidding among intermediaries for undervalued assets is the same as it was among non-intermediary information producers. More efficient information producers are able to offer higher prices for undervalued assets since their costs of producing that information are lower. In the case of two producers i and j, if $C_i < C_j$, as was assumed before, then the intermediary formed by i is able to offer a higher price for the undervalued firms than can the intermediary formed by j. That is, i will offer $N_A V_A - S_A$ where $S_A = C_j$ and just price producer j out of the market. As a result, the investors in the intermediary formed by i receive market value for their investment, the owners of undervalued firms receive the fair market value of their assets (less information costs), and information producer i receives the competitive value of producing information about those assets and accrues profits of $S_A - C_i$.

Now suppose that information producers are no longer pathologically honest. As was the case above, information producers who organize intermediaries act essentially as investment brokers who invest the funds of their investors in supposed undervalued firms. In return they receive a fraction of the value of the assets they purchase. When information producers are not pathologically honest, this arrangement allows the information producer to profit by misrepresenting the value of his information. This results because the production of unreliable information is costless but by organizing an intermediary an information producer accrues a share of the assets he purchases, even though they may not be worth $N_A V_A$. For instance, producer j could organize an intermediary at no cost by selecting N_A firms randomly and financing that selection by issuing claims against supposed A firms. The value of a randomly chosen portfolio of N_A firms, and of the intermediary in this case, would $N_A \bar{V}$. The value of the share of the intermediary accruing to producer j is $(1 - X)N_A \bar{V}$, or substituting from (13), is $S_A(\bar{V}/$

V_A). So, as information producers engage in bidding for undervalued firms, when the price of producing information is bid down to $S_A = C_j$, investor j can continue to bid, in the expectation of making a profit by not incurring the cost of identifying the true undervalued firms. Investor i will recognize the incentive for j to behave dishonestly and will perceive that he will have to behave dishonestly in order to continue to bid against j. Without further constraints on reliability the bidding process will degenerate and no Rational Expectations equilibrium will be reached.

If investors in intermediaries were able to observe the competitive price of producing information as well as each intermediary's actual cost of production then the moral hazard problem is easily resolved. Investors could then compare the incentive to produce reliable information with that to produce unreliable information. Where, for producer i,

$$S_A - C_i > S_A(\bar{V}/V_A) \tag{14}$$

it is more profitable for producer i to produce accurate information than not. If, however, the cost of information production is not observable or if information production cannot be easily monitored then, as in the case of non intermediary information producers, it will not be feasible to directly make this comparison.

In markets where information costs are not observable, the resolution of the moral hazard problem lies, as in the previous section, in assuming that at least some information producers invest enough of their own wealth in the intermediary to establish their reliability. For instance, if producer i were to invest W_i in the assets of the intermediary he would receive returns from two sources. As before, producer i would receive a fraction of the assets of the intermediary of S_A/N_AV_A in return for identifying undervalued firms. And producer i would receive the fair value of his own investment of W_i, or a fraction of the value of the intermediary of W_i/N_AV_A. The fraction of the intermediary accruing to other investors now is $(N_AV_A - W_i - S_A)/N_AV_A$ (since producer i furnishes some capital of his own, he need raise only $N_AV_A - W_i - S_a$ from outside sources).

In the event that producer i produces information reliably, at S_A, the change in the wealth of producer i is

$$S_A - C_i.$$

If, at the same price, he feigns the production of information, the change in wealth becomes,

$$S_A(\bar{V}/V_A) - W_i\left[\frac{(V_A - \bar{V})}{V_A}\right]$$

where the first term is the incentive to produce unreliable information and the second is the portfolio losses sustained in the process (i.e., the second term equals the fraction of the intermediary which the information producer has acquired with his own funds W_i/N_AV_A times the total overvaluation of the intermediary, $(V_A - \bar{V})N_A$). When investors are able to observe the wealth invested by information producers then they can be assured that any information producer can be regarded as reliable when his losses on his own investment exceed the gain

from cheating. Or, the reliability of any intermediary is established when W_i is large enough such that,

$$W_i\left[\frac{(V_A - \bar{V})}{V_A}\right] > S_A(\bar{V}V_A)$$

Investors will only invest in intermediaries which have large enough endowments to verify their reliability. Hence, some more efficient intermediaries may be precluded from the market by a market-imposed wealth constraint. In that case the Rational Expectations equilibrium is not efficient and owners of firms bear the costs of resolving moral hazards in the market as higher equilibrium prices for information are obtained.

IV. INFORMATION PRODUCTION AND THE ROLE OF INTERMEDIARIES

In the previous sections it has been demonstrated that a competitive market in information about the value of firms, where information producers have a sufficiently large stake in the value of their information, will function, but will not have an efficient Rational Expectations equilibrium. By this it is meant that the market for information will not fail and firms will not be valued according to the market average. But the avoidance of the moral hazard problem pertaining to the reliability of information is not accomplished costlessly. Specifically, the requirement that the portfolio of the investor-information producer be large enough to establish the reliability of his information creates a barrier to entry in the market for information. Highly efficient information producers with small portfolios will be unable to compete with less efficient producers who have sufficient wealth to establish their reliability. As a result, it is likely that information will be produced less efficiently than it otherwise might and the opportunities for collusion among information producers will be enhanced.

The analysis in the previous sections also demonstrates that intermediation does not in itself serve to resolve the problem of failure in the market for information. The moral hazard problem is resolved by the information producer having a large enough position in the market so as to be reliable. This can be accomplished either by investors observing the market portfolio of the large investor who, in the context of our model, wins the bidding; or by the winner accepting funds from other investors and acting as an intermediary. In the context of our model either solution works just as well because the crucial factors necessary for equilibrium are competition in the production of information and a sufficient stake in the market on the part of information producers that the quality of information is reliable.

It is fruitful to compare this conclusion with the suggestion made by Leland and Pyle [14] that intermediation resolves the problems encountered in the market for information. Leland and Pyle suggest that intermediaries resolve two problems which plague the market for information. The first is the public good nature of information which limits the saleability of information to investors. The second is the moral hazard problem of unreliable information.

Leland and Pyle argue that intermediation solves the first problem if it is presumed that investors cannot infer the intermediary's information by observing its portfolio. Throughout our analysis we have assumed the opposite. We have assumed that investors can observe the portfolios of other investors and that they presume that no investor values a firm at other than $\bar{V}$ without information which identifies the firm or an inducement from the firm to so indicate. Because Leland and Pyle ignore the possibility that firms rather than investors can profitably fund the production of reliable information by nonintermediaries, they are led to the conclusion that intermediation, per se, contributes to the avoidance of market failure. However, if there is some additional reason for undervalued firms to desire revaluation but without public knowledge of that revaluation, then intermediaries will be the preferred form of information producer. Leland and Pyle, however, offer no motivation for assuming that information cannot be inferred by observing portfolios.

The problem of the reliability of information is solved by intermediaries, according to Leland and Pyle, because, like entrepreneurs, they will communicate value to the market as a function of the size of the stake the information producer takes in the intermediary. It is important to note that Leland and Pyle's analysis assumes the existence of an incentive signalling equilibrium where there is a continuous valuation function which is positively dependent on the percentage of the firm or intermediary retained by the entrepreneur or information producer. Two comments on this approach are necessary. First, if there exists a signalling equilibrium, firms will be properly valued without the aid of intermediaries or other information producers (see the introduction to Section II). Second, where there does not exist an equilibrium incentive signalling scheme for firms, the moral hazard problem of the information market is resolved by the stake in the market held by the investor-information-producer. That is, it is not necessary to assume, a priori, the existence of an incentive signalling equilibrium for firms to resolve the moral hazard problem. But again there is nothing about intermediation, per se, which insures reliability.

Our analysis suggests that there must be some reason other than the difficulties created by asymmetric and costly information for intermediaries to emerge as an important type of information producer. The answer would seem to be that intermediaries can profitably emerge where they can jointly produce information as well as other products or services valued by investors. The obvious candidates for this joint production arrangement are the provision of liquidity or transactions services and the sale of insurance contracts. In addition, in the spirit of the assumptions made by Leland and Pyle, some firms may desire confidentiality and hence seek revaluation by the production of information through intermediaries rather than other types of market makers (see Campbell [4] for a more complete treatment of the confidentiality motive).

The hypothesis that intermediaries emerge through the joint production of information and other services desired by investors has the advantage that it encompasses other hypotheses which have been proposed. The explanations of intermediation available in the literature, e.g. Benston and Smith's [2] transactions cost argument and Leland and Pyle's asymmetric information argument,

each have merit but do not seem, to us at least, to be independently persuasive. The alternative view that intermediaries prosper when they simultaneously produce information and provide other services seems to be a more promising explanation of intermediaries as we know them. A complete model of the joint-production approach to intermediation awaits a separate treatment.

V. Conclusions

The principal focus of this paper has been the theory of financial intermediation. But the results presented here have a broader applicability. The general conclusion of the paper deals with any market with asymmetric information where there is no signalling equilibrium with regard to the direct signals of the owners of assets but where there are opportunities for the purchasers of assets to produce information about their value. The conclusion is that there will generally not be a Rational Expectations equilibrium for the asset market and the market for information.

The problem is not that the market is unable to produce information which leads to the identification of the true value of assets. Rather, it is that this production of information will not be done efficiently or at least cost. The underlying reason for this is that efficient information producers may not have a sufficient stake in the market to persuade the market of their reliability. Each investor-information producer's initial wealth endowment acts as a constraint on reliability and as a barrier to entry in the information production industry. It remains to examine the implications for market structure of this conclusion.

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