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FACULTY WORKING
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Asymmetric Information and Financial Intermediation

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May 1988

Asymmetric Information and Financial Intermediation

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ASYMMETRIC INFORMATION AND FINANCIAL INTERMEDIATION

ABSTRACT

This paper analyzes the evolutionary process of the bank as an asset transformer. First, the bank must have a cost advantage in acquiring information about the assets to be invested. If investors do not trust information produced by the bank, it would be in the best interest of the bank to engage in asset transformation, though probably a second best choice due to a credibility constraint. If the bank is less risk averse than investors, asset transformation could be a first best choice of the bank and the most efficient form of banking in terms of social welfare.

INTRODUCTION

The objective of this paper is to model the evolutionary process of financial intermediaries (hereafter, banks) as asset transformers. WHY do banks exist? This existence question has long been a vital issue to the understanding of the objectives and activities of banks in capital markets.[1] An analysis of the existence of banks provides an economic justification for the specific form of various activities conducted by banks. One important banking activity is asset transformation, the process of issuing liabilities and then using the proceeds to invest in other assets.

In order to explain the role of banks as asset transformers, researchers have focused upon the ability (or motivation) of banks to (i) hold diversified portfolios and (ii) produce information about assets held. Klein (1973) and Benston and Smith (1976), among others, suggest that depositors, on their own, hold suboptimal portfolios because of large denomination constraints (Klein) or substantial transaction cost constraints (Benston and Smith), and, therefore, banks evolve to exploit these constraints.

Leland and Pyle (1977) suggest that the role of banks would be to resolve problems associated with information asymmetry between borrowers and lenders. Chan (1983) shows that if the capital market collapses to the "lemons" market due to information asymmetry between managers and investors, banks could evolve as informed agents, contributing to resource allocation and social welfare.

A critique of Leland and Pyle is provided by Campbell and Kracaw (1980). If the market is not allowed to scrutinize assets held by banks, because investors can mimic the investment decisions of honest banks, it would be in the best interest of banks with low quality assets to produce false information. Diamond (1984) shows that portfolio diversification is a mechanism to reduce the agency problem of banks.[2]

The current study is improved upon the earlier works, and can be contrasted with in at least three different ways. First, we view asset transformation as a simple process of issuing risk-free debts (deposits) and investing the proceeds in a single class of risky assets; portfolio diversification itself is not required in the process of asset transformation.

Second, in order to address the moral hazard problem of banks, we explicitly distinguish between the broker bank and the asset transforming bank. The former sells information only; and the latter, utilizing its information, engages in the asset transformation. Because investors can observe the assets held by asset tranforming banks in our model (i.e., a single type of risky assets), the distinction between these two different banking modes allows us to create a situation in which it would be in the best interest of banks to invest in "high quality" risky assets.

Third, our capital market avoids the lemons market even though investors (lenders) cannot observe managers' (borrowers') investment decisions. As will be shown later, the capital market under such information asymmetry can establish a mixture of the conventional competitive equilibrium and the Akerlof (1970)-type lemons market equilibrium. We shall call such an equilibrium the mixed quality equilibrium; and introduce banks after the mixed quality equilibrium is established.

In brief, our main results, which reinforce those of earlier studies, are as follows. First, the bank must have a cost advantage in acquiring information about the assets to be invested. Second, when investors do not trust information produced by the bank, it would be in the best interest of the bank to engage in asset transformation, probably as a second best choice due to a credibility constraint. Third, when the bank is less risk averse than investors, asset transformation can be a first best choice of the bank and the most efficient form of banking in terms of social welfare.

We organize the remainder of this paper as follows: In Section I, we present a two-period rational expectations equilibrium model for the capital market without banks. We will show how the capital market establishes the mixed quality equilibrium. In Section II, we discuss the role of banks as information producers and asset transformers. We provide a summary of the paper in the last section.

I. CAPITAL MARKET WITHOUT BANKS

A. Assumptions

There are two periods; the beginning of the first period is denoted by t = 0, the end of the first period by t = 1, and the end of the second period by t = 2. There are potentially many risk adverse investors and N (a fixed number) risk neutral managers.[3] At t = 0, each manager develops one unit of an investment project.[4] There are two types of projects, H-type and L-type, differentiated by initial development (sunk) costs spent by managers, C_H and C_L, where $C_H > C_L$. H-type project will be shown to be of a higher quality than L-type. Investors cannot observe managers' development costs (i.e., project quality).

At the end of each period, the investment project yields a random return R which takes on one of two values, R_H and R_L, where $R_H > R_L$. The realized return is public information so that there is no *ex post* informational asymmetry about the realized return between managers and investors.[5] The probability distribution of R, conditional on the initial development cost, is

$$\Pr(R_i|C_j) = \begin{cases} y & \text{for } i = j \\ 1-y & \text{for } i \neq j \end{cases} \tag{1}$$

where i, j = H, L and $1/2 \leq y \leq 1$.[6] The probability distribution itself is common knowledge.

Even though investors cannot observe project quality at t = 0, they can, using the probabilistic relation (1), infer it to some degree by observing the realized return at t = 1. By Blackwell's sufficiency theorem, the random return R becomes more informative as y increases.[7] If y = 1/2, R does not carry any useful information; if y = 1, R is perfectly informative; and if $1/2 < y < 1$, R is partially informative.

Given the probabilistic relation in equation (1), the conditional means and variances of R are

$$E(R|C_H) = yR_H + (1-y)R_L \tag{2-a}$$

$$E(R|C_L) = (1-y)R_H + yR_L \tag{2-b}$$

$$\sigma^2(R|C_H) = \sigma^2(R|C_L) = y(1-y)(R_H-R_L)^2 \equiv V. \tag{2-c}$$

Because both projects bear the same amount of risk, we will call the former the high quality project, and the latter the low quality project.

In order to focus on the quality choice, we assume that each investor purchases one unit of the project. It is costly for investors to locate a manager with a project available. This transaction cost, h, is an increasing function of the market size, N. When investors enter the capital market at $t = 0$, investors have a homogeneous prior belief that the chance of purchasing the high quality project is z ($0 \leq z \leq 1$). In the self-fullfilling rational expectations equilibrium, the prior belief z must be equal to the proportion of high quality projects. We will use z interchangeably for the prior belief of investors and the equilibrium proportion of high quality projects since we are concerned only with the equilibrium behavior.

Given the investors' prior belief z, a manager and a matched investor reach an equilibrium wage contract for managerial services in the following way. Investors pay W at $t = 0$ for the first period's managerial service when all projects are indistinguishable to investors, and W_i ($i = H, L$) at $t = 1$ for the second period's managerial service paid at $t = 1$ in accordance with the first period's realized return R_i. These wages are endogenously determined; and, in particular, W_H is not a priori expected to be higher than W_L.

Given this wage contractual arrangement and the probabilistic relation in equation (1), managers' net present value (NPV) of the high and low quality projects, NPV_H and NPV_L, are

$$NPV_H = -C_H + W + \rho\{yW_H + (1-y)W_L\} \tag{3a}$$

$$NPV_L = -C_L + W + \rho\{(1-y)W_H + yW_L\} \tag{3b}$$

where $0 < \rho < 1$ is the risk-free discount factor.

Investors' one-period net expected utility (or certainty equivalent return) is described as[8]

$$U(E(R),V,P) = \rho(E(R) - \theta V) - P - h(N) \tag{4}$$

where $E(R)$ is the expected return, V is the variance of R, $\theta > 0$ is the measure of the investors' risk aversion, P is the payment to the manager, N (the number of managers) is the market size, and h is the transaction cost.[9] Because of competition among potentially many investors, they are willing to invest as long as they earn the reservation expected utility, which is assumed to be zero without loss of generality.

In order to focus on how the lemons market can be avoided in equilibrium, we assume that $0 < z < 1$.[10] Given z (and y), the probability that an investor receives R_H at $t = 1$, v, is

$$v(z) = yz + (1-y)(1-z). \tag{5}$$

Since $0 < z < 1$, it follows that $0 < v(z) < 1$.

When observing the realized return at $t = 1$, investors assess posterior probabilities about the project quality. Let $r(z)$ be the probability that the project yields R_H at $t = 2$ given that its realized return at $t = 1$ is R_H; and $s(z)$ be the probability that the project yields R_L at $t = 2$ given that its realized return at $t = 1$ is R_L. Using Bayes' rule, we have

$$r(z) = \frac{yz}{v(z)} \tag{6-a}$$

$$s(z) = \frac{y(1-z)}{1-v(z)} . \tag{6-b}$$

Both r and s increase, given z, when y increases.

Given that realized returns at $t = 1$ are R_H and R_L, investors' conditional expected utilities for the second period are U_H and U_L, respectively:

$$U_H = \rho\{rE(R|C_H) + (1-r)E(R|C_L) - \theta V\} - W_H \tag{7-a}$$

$$U_L = \rho\{(1-s)E(R|C_H) + sE(R|C_L) - \theta V\} - W_L . \tag{7-b}$$

The expected utility from the ownership of the project over two periods, U_P, is

$$U_P = \rho\{zE(R|C_H) + (1-z)E(R|C_L) - \theta V\} - W - h(N) + \rho\{vU_H+(1-v)U_L\}. \tag{8}$$

B. The Mixed Quality Equilibrium

In order for both high quality and low quality projects to exist in equilibrium, two conditions must be satisfied. First, managers must be indifferent as to whether they develop the high or low quality project; $NPV_H = NPV_L$. Using equations (3-a) and (3-b), we have

$$\Delta W = \frac{\Delta C/\rho}{2y-1} \quad \text{for } y > 1/2. \tag{9}$$

where ΔW ($\equiv W_H - W_L$) is the wage differential at $t = 1$, and ΔC ($\equiv C_H - C_L$) is the manager's development cost differential at $t = 0$ (its future value at $t = 1$ is $\Delta C/\rho$). Equation (9) shows the wage differential, adjusted for imperfect posterior information, required by managers to undertake the high quality project.

Second, given the equilibrium wage contract, investors anticipate their conditional expected utilities U_H and U_L at $t = 1$ are the same. Using equations (7-a) and (7-b), we have

$$\Delta W = \rho(r+s-1)\Delta E(R)^{11} \tag{10}$$

where $\Delta E(R) \equiv E(R|C_H) - E(R|C_L)$. Equation (10) shows the wage premium investors are willing to pay for the project that yields R_H, based on their posterior belief about project quality.

Combining equations (9) and (10) determines the mixed quality equilibrium, equation (11):

$$\rho(r+s-1)\Delta E(R) = \frac{\Delta C/\rho}{2y-1} \tag{11}$$

where the equilibrium proportion of high quality projects (if it exists), z, can be solved.

Figure I shows the graphical solutions of z (assuming their existence) when $y < 1$. The existence of the mixed quality equilibrium requires the maximum of the left hand side of equation (11), $\rho(2y-1)^2(R_H-R_L)$, must not be less than the right hand side;

$$y \geq \{(1/2) + (1/2)(\Delta C/(\rho^2 \Delta R))^{1/3}\} \equiv y_{min} \ (> 1/2)$$

where $\Delta R \equiv R_H - R_L$. That is, in order to avoid the lemons market, the informational content in R should exceed a certain minimum level.

Assuming that $y > y_{min}$, there are two possible solutions, z_A and z_B. We take z_A as the equilibrium solution in that z_B is not stable; if $z < (>)\ z_B$, the premium investors are willing to pay is greater (less) than the required wage differential (i.e., managers have an incentive to develop the high (low) quality project), and thus the proportion of high (low) quality projects will further increase.

We determine the equilibrium wages from the zero expected utility conditions; that is, $U_p = U_H = U_L = 0$ leads to

$$W = \rho\{zE(R|C_H) + (1-z)E(R|C_L) - \theta V\} - h(N) \qquad (12\text{-a})$$

$$W_H = \rho\{rE(R|C_H) + (1-r)E(R|C_L) - \theta V\} \qquad (12\text{-b})$$

$$W_L = \rho\{(1-s)E(R|C_H) + sE(R|C_L) - \theta V\}. \qquad (12\text{-c})$$

We assume that these equilibrium wages yield a non-negative NPV to managers.

II. MODELING BANKS

Given that the capital market is in the mixed quality equilibrium $(0 < z < 1)$, we now introduce banks at $t = 0$ as perfectly informed agents in the sense that they are able to locate and identify high quality project managers. We assume that perfectly informed agents can purchase the project before uninformed investors (i.e., perfect information includes the location of high quality managers). Therefore, the size of the capital market without banks shrinks by the number of perfectly informed agents. Since the mixed quality equilibrium is not affected by the market size (i.e., $\partial z/\partial N = 0$),[12] the presence of perfectly informed investors does not affect the equilibrium proportion of high quality projects held by uninformed investors.

A. Value of Perfect Prior Information

Before we discuss the conditions for the evolution of banks, it is useful to consider a situation where investors have direct access to perfect prior information at some fixed cost F while no banks yet exist. To determine the equilibrium number of perfectly informed investors, suppose that n investors decide to be perfectly informed in order to purchase the high quality project (we will see later that perfectly informed investors do not buy the low quality project), and N - n remaining managers sell their projects to uninformed investors. The perfectly informed investor behaves in the Nash way; that is, he assumes that others do not change their investment strategies. Also, he does not have to confess the possession of perfect information to the manager.

The investors' expected utility from the high quality project with perfect prior information becomes $\rho(1+\rho)\{E(R|C_H)-\theta V\} - W - \rho\{yW_H+(1-y)W_L\}$. By substituting equilibrium wages in equations (12-a), (12-b) and (12-c) (note that the transaction cost, h(N), is replaced by h(N-n) in equation 12-a) into the expected utility from the high quality project, the gain from perfect prior information, m(n), is computed as[13]

$$m(n) = (1-z)\{\rho(1+\rho)\Delta E(R) - \Delta C\} + h(N-n) > 0^{14} \qquad (13)$$

where the first term in the right hand side is the net expected gain from the high quality project relative to random investment, and the second term is transaction cost saving.

In Figure II, we draw $m(n)$ and F assuming that $m(0) > F$. The equilibrium number of perfectly informed investors, n^*, is determined where $m(n^*) = F$. For example, if $n < n^*$, the gain from perfect information exceeds the information acquisition cost, so that more investors purchase perfect information. Assuming that $n^* \leq N$, it is necessary and sufficient that in order for some investors to be perfectly informed, $m(0)$ must be greater than F, or N must be greater than some critical level that depends on the degree of informational imperfection and the magnitude of transaction cost. It can be shown that $\partial m/\partial y < 0$;[15] the gain from perfect prior information decreases as the accuracy of posterior information increases. Therefore, $\partial n^*/\partial y < 0$.

The availability of perfect information reduces the transaction cost to uninformed investors from $h(N)$ to $h(N-n^*)$, resulting in an increase in W (see equation 12-a) and, thus, managers' NPV. Since investors' expected utility remains the same regardless of whether they are perfectly informed or uninformed, the availability of perfect information increases social welfare[16] by increasing managers' NPV.

Finally, investors have no incentive to purchase perfect information to invest in the low quality project. The gain from the low quality project with perfect information can be shown as $m(n) - \{\rho(1+\rho)\Delta E(R) - \Delta C\}$ which is less than $m(n)$ for all n.

B. The Monopolistic Bank: Brokerage

Are banks still likely to evolve even when investors can be perfectly informed at some cost? We first consider a broker monopolistic bank that sells perfect prior information at some fee.[17] We assume that the broker bank is honest for our benchmark analysis.

Suppose that the bank serves n (< N) pairs of investors and managers so that there remain N - n managers who sell their projects to uninformed investors. The bank can charge m, as defined in equation (13), for its brokerage service because at such fee investors are indifferent as to whether they purchase the project through the bank or directly from a manager. Therefore, m(n) is the demand price for the information service provided by the bank. This information fee must not exceed the information acquisition cost, F.

Assume that the broker bank spends the same amount F to be perfectly informed (e.g., an irrevocable entry fee into the business of financial brokerage) and bears the variable cost of handling the customers, D_B (a strictly increasing and convex function of the number of clients, n). The broker bank's profit, U_B, is

$$U_B(n) = n\, m(n) - D_B(n) - F \tag{14}$$

where the adjustment for risk is not required because the broker bank does not assume any risk.

In Figure III, we draw the demand (m), marginal revenue (MR) and marginal cost (MC) curves. The marginal revenue curve is discontinuous at n* which is the equilibrium number of perfectly informed investors when no banks exist. Unless the broker bank has such a high cost condition that the marginal cost curve intersects the horizontal or discontinuous part of the marginal revenue curve, the optimal number of the broker bank's customers, n_B, would be greater than n^* at the fee of m_B which is less than F.

More specifically, the condition for the existence of the broker bank ($n_B > n^*$) can be expressed in terms of exogenous cost functions. Because $\partial U_B/\partial n \gtrless 0$ for $n \lessgtr n_B$,

$$n_B > n^* \text{ if } \left.\frac{\partial U_B}{\partial n}\right|_{n=n^*} > 0.$$

Since $m'(n^*) = -h'(N-n^*)$ and $m(n^*) = F$, the above inequality condition yields $n_B > n^*$ if

$$F - n^*h'(N-n^*) > D_B(n^*). \qquad (15)$$

The left hand side of inequality (15) is the marginal benefit of perfect information produced by the broker bank, while the right hand side is the marginal cost for the introduction of such bank. If inequality (15) is met, the number of uninformed investors (and, thus, their transaction costs) will be further reduced compared to the case where investors purchase perfect information individually. As a result, social welfare will further increase. In sum, the bank as an information producer must have a cost advantage in acquiring perfect information.

The overall proportion of high quality projects (q) increases in the presense of the bank. That is,

$$q = \frac{n+z(N-n)}{N} = \lambda(1-z) + z > z \tag{16}$$

where $\lambda = n/N$.

The welfare implications of the broker bank are provided by the following comparative static results on n_B (assuming that inequality (15) is met):

(i) $\partial n_B/\partial y < 0$: As R becomes more informative, the bank's contribution to social welfare decreases.

(ii) $\partial n_B/\partial N > 0$: As the potential size of the capital market without banks increases, the bank's contribution to social welfare increases.

(iii) $\partial n_B/\partial h > 0$ (assuming that h is a linear function): As the unit transaction cost to uninformed investors increases, the number of the bank's customers increases. This result might parallel the suggestion of Benston and Smith (1977) that the role of banks is to minimize the transaction cost.

C. The Monopolistic Bank: Asset Transformation

We now turn to a monopolistic asset transforming bank that issues risk-free bonds[18] and invests the proceeds in high quality projects. As was discussed before, an agent with perfect information has no incentive to invest in the low quality project. Hence, we do not need to consider dishonesty of banks when the bank performs the asset transformation function.

Investors buy either the risk-free bond from the bank or the risky investment project from a manager. The risk-free bond is sold for

P_f at $t = 0$ and pays R_f at the end of each period such that $P_f = \rho(1+\rho)R_f$. For clear exposition, we assume that the bank issues one share of the bond against one unit of the high quality investment project; the bank matches the number of bonds (i.e., customers) with that of risky assets.

The present value of risk adjusted profit of the bank when engaging in asset transformation, U_I, is

$$U_I(n) = n\{\rho(1+\rho)[E(R|C_H) - \theta_I V] - W - \rho[yW_H + (1-y)W_L]\} - D_I(n) - F$$

$$= n\{m(n) + \rho(1+\rho)(\theta-\theta_I)V\} - D_I(n) - F \qquad (17)$$

where n is the number of customers, θ_I is the risk aversion measure of the asset transforming bank, and $D_I(n)$ is its variable cost.

Let $\nu \equiv \rho(1+\rho)(\theta-\theta_I)V$ and $D_I(n) \equiv D_B(n) + k(n)$; where k represents extra costs incurred in the process of asset transformation such as the FDIC insurance premium (assuming $k(0) = 0$, $k' > 0$ and $k'' \geq 0$). U_I can be expressed as

$$U_I(n) = U_B(n) + n\nu - k(n). \qquad (18)$$

The last two terms in equation (18), the net benefit of asset transformation over brokerage, yield the cost conditions which justify asset transformation. Let n_I and n_B as the optimal numbers of customers of the asset transforming bank and the broker bank, respectively. There are four conditions to be considered.

First, if $n_I\nu - k(n_I) < 0$, it follows that $U_I(n_I) < U_B(n_I) < U_B(n_B)$. In this situation, the bank would stay as a broker if investors trust its information. In other words, when investors do not trust the bank, asset transformation is a suboptimal choice of the bank due to a credibility constraint. This result is consistent with Diamond's finding that portfolio diversification reduces the incentive costs of banks.

Second, if $n_I \nu - k(n_I) > 0$, it follows that $U_I(n_I) > U_B(n_I)$. In this situation, the bank might have a motivation to be engaged in asset transformation (though not a sufficient condition yet). For this inequality to hold, θ must not be smaller than θ_I. Hence, a necessary condition for asset transformation is that the bank is less risk averse than investors.

Third, if $n_B \nu - k(n_B) > 0$, it follows that $U_I(n_I) > U_B(n_I) > U_B(n_B)$; that is, asset transformation becomes a first best choice of the bank.

Fourth, if $n_B \nu - k(n_B) > 0$ and $\nu > k'(n_I)$, it follows that $n_I > n_B$. Social welfare in the presence of the asset transforming bank is definitely larger than that in the presence of the broker bank; i.e., the most efficient form of banking, in terms of social welfare, would be asset transformation. For the proof, since $U_I(n_I) > U_B(n_B)$, we need to show that $n_I > n_B$ (i.e., managers' NPV further increases) if $\nu > k'(n_I)$. The first derivative of equation (18) yields

$$U_I'(n_I) = U_B'(n_I) + \nu - k'(n_I) \equiv 0. \tag{19}$$

For $n_I > n_B$, $U_B'(n_I) < 0$ which is held if $\nu - k'(n_I) > 0$.

Finally, the additional comparative static results on n_I would be that $\partial n_I/\partial(\theta-\theta_I) > 0$ and $\partial n_I/\partial V > 0$; as investors become relatively more risk averse or the investment project becomes riskier, the asset transformation function of the bank increases.

D. Competitive Banks: Brokerage[19]

Suppose that there are x identical banks, and each handles n_C customers. Therefore, the total number of investors served by competitive banks is $xn_C = n$. Let m_C be the brokerage service fee of banks. The profit of a bank, U_C, is

$$U_C = n_C m_C - D_B(n_C) - F. \tag{20}$$

We assume that competitive banks earn zero profit. In Figures IV-a and IV-b, we draw competitive individual and market equilibria, respectively. In Figure IV-b, ΣMC represents the horizontal sum of individual marginal cost curves. The service fee and the total number of investors served by competitive banks are determined at the intersection of the m(n) and ΣMC curves. With the presence of competitive banks, more investors purchase the high quality project at a lower information fee, and, as a result, the NPV of managers increases. Although social welfare is obviously higher with competitive banks than without banks, the welfare comparison between competitive banks and a monopolistic bank is not clear because total spending on information acquisition (xF) may be too excessive.

III. SUMMARY

This paper examines the evolutionary process of banks as asset transformers in a mixed quality capital market equilibrium under asymmetric information. For the bank to be an information producer, it must have a cost advantage in acquiring information relative to investors. If the bank is not trusted, it might engage in asset transformation, a second best choice. If the bank is less risk averse than investors, asset transformation could be a first best choice of the bank and potentially be the most efficient form of banking in terms of social welfare.

FOOTNOTES

[1] For literature survey, see Baltensperger (1980) and Santomero (1984), among others.

[2] Ramakrishnan and Thakor (1984) suggest that coalition of banks reduces their incentive costs. However, Boyd and Prescott (1983) argue that the dishonesty issue might be overemphasized because criminal charges make the cost of such dishonesty extremely risky.

[3] Though risk aversion of managers is an important factor in determining optimal contracts in the principal-agent relation (see, for example, Shavell (1979)), the primary concern of our model is to show how the lemons market can be avoided in the presence of asymmetric information. The existence of the mixed quality equilibrium, from which the banks start evolving, is invariant with respect to risk aversion or neutrality of managers and/or investors.

[4] We exclude the uninteresting possibility of managers' self-owning projects.

[5] This assumption is required to avoid the moral hazard problem of managers who may attempt to fool investors by a false report.

[6] Note that y is not less than 1/2 so that the higher (lower) realized return is more closely related to the higher (lower) development cost. That is, $E(R|C_H) > E(R|C_L)$ if and only if $y > 1/2$.

[7] See DeGroot (1970) for the sufficiency theorem.

[8] This type of utility function is very convenient when one is primarily concerned with the quality choice (see, for example, Wiggins and Lane (1983)).

[9] We assume that the cost of locating a manager is entirely borne by investors. Because each manager offers one unit of the project, if more than one investors visit a manager, the investors except one should visit other managers. Given potentially many investors, as the number of managers increases, so does the average number of "costly" visits an investor has to make before being able to buy one project. Under the equilibrium wage contract described above that yields zero reservation expected utility in each period (i.e., once the equilibrium is reached at $t = 0$), no investor will visit another manager at $t = 1$. Therefore, the transaction cost incurs only at $t = 0$. Also, note that this transaction cost should be distinguished from the acquisition cost for perfect information which will be discussed in the next section.

[10] See Dokko and Kim (1987) for the cases where $z = 0$ and $z = 1$ and the details of the mixed quality equilibrium.

[11] Some properties of $(r+s-1)$, which are useful in our later analysis, are as follows: (i) $(r+s-1) = \{(2y-1)z(1-z)\}/\{v(1-v)\}$; (ii) $(r+s-1) > 0$ iff $y > 1/2$; (iii) given y, $\partial(r+s-1)/\partial z \gtrless 0$ iff $z \gtrless 1/2$; (iv) the maximum of $(r+s-1)$ is $2y-1$ when $z = 1/2$; (v) given z, $\partial(r+s-1)/\partial y > 0$; and (vi) $(r+s-1)$ is symmetric around $z = 1/2$.

[12] N does not appear in the equilibrium condition, equation (11).

[13] $m = \rho(1+\rho)\{E(R|C_H) - \theta V\} - W - \rho\{yW_H + (1-y)W_L\}$

$= (1-z)\rho\Delta E(R) + \rho^2\{(1-y)y + s(1-y)\}\Delta E(R) + h(N-n).$

From equations (5) and (6), $(1-r)y + s(1-r) = \{y(1-y)(1-z)/(v(1-v))\}$

$= (1-z)\{[y(1-y)/(v(1-v)] - 1 + 1\}$. From equation (11),

$\rho^2\{[y(1-y)/(v(1-v)] - 1\}\Delta E(R) = -\Delta C.$

[14] From the mixed quality equilibrium condition, equation (11), $\rho(2y-1)\Delta E(R) \geq (\Delta C/\rho)/(2y-1)$ because $(r+s-1) \leq (2y-1)$. Therefore,

$\rho^2\Delta E(R) > \rho^2(2y-1)^2\Delta E(R) \geq \Delta C$ for $y < 1$. Therefore, m is always positive.

[15] $\partial m/\partial y = -(\partial z/\partial y)[\rho(1+\rho)\Delta E(R)-\Delta C] + 2(1-z)(1+\rho)\Delta R$. A tedius calculation yields $(\partial z/\partial y)(2y-1) > 4(1-z)$, which leads to the desired result, $\partial m/\partial y < 0$.

[16] Social welfare is defined as the sum of total NPV's and consumer surpluses. When banks are introduced below (Section II), social welfare includes net profits (risk adjusted) of banks.

[17] With perfect prior information, the gain from the high quality project is greater than that from the low quality project. Hence, the bank confirms high quality projects only.

[18] We assume that the ability of the bank to issue risk-free bonds is exogenously given by FDIC deposit insurance.

[19] We consider only the case of competitive broker banks. The case of asset transforming banks can be similarly analyzed.

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FIGURE I

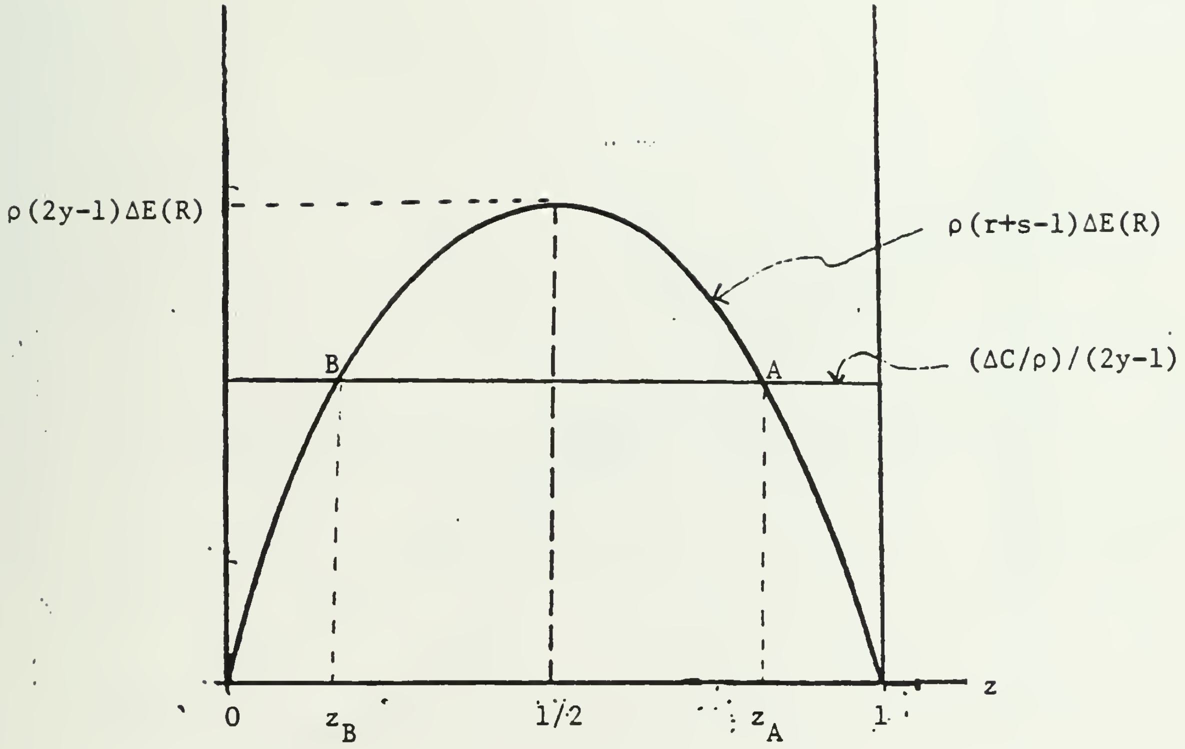

ρ(2y-1)ΔE(R)
ρ(r+s-1)ΔE(R)
(ΔC/ρ)/(2y-1)
B
A
0
z_B
1/2
z_A
1
z

FIGURE II

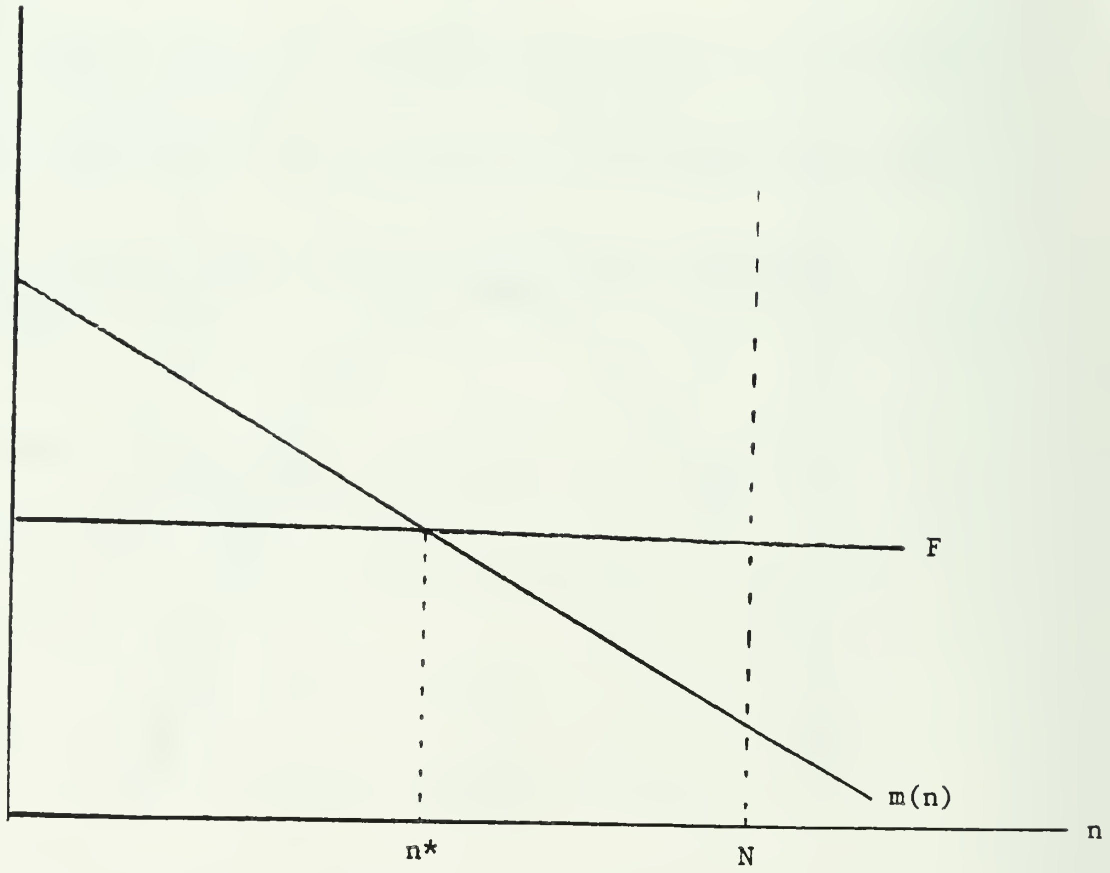


FIGURE III

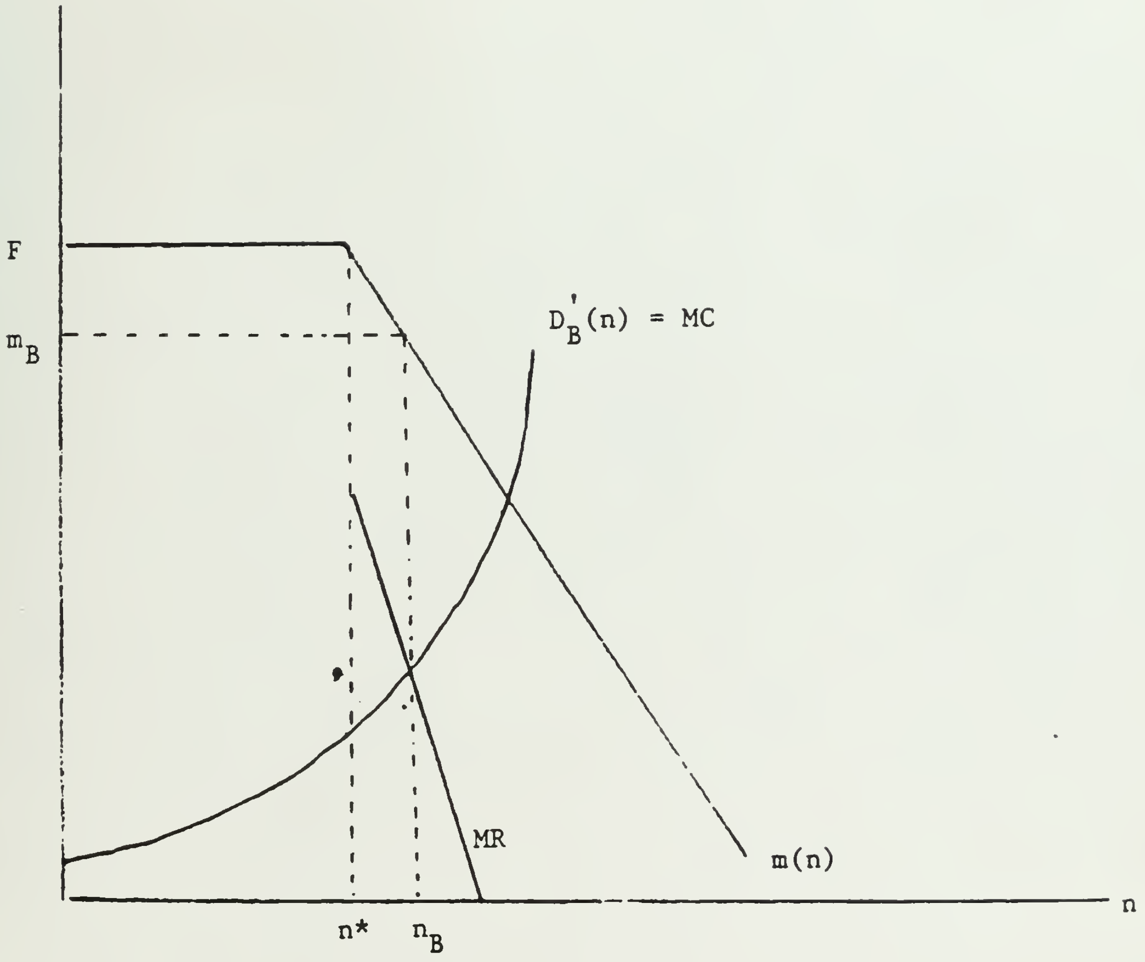


FIGURE IV-a

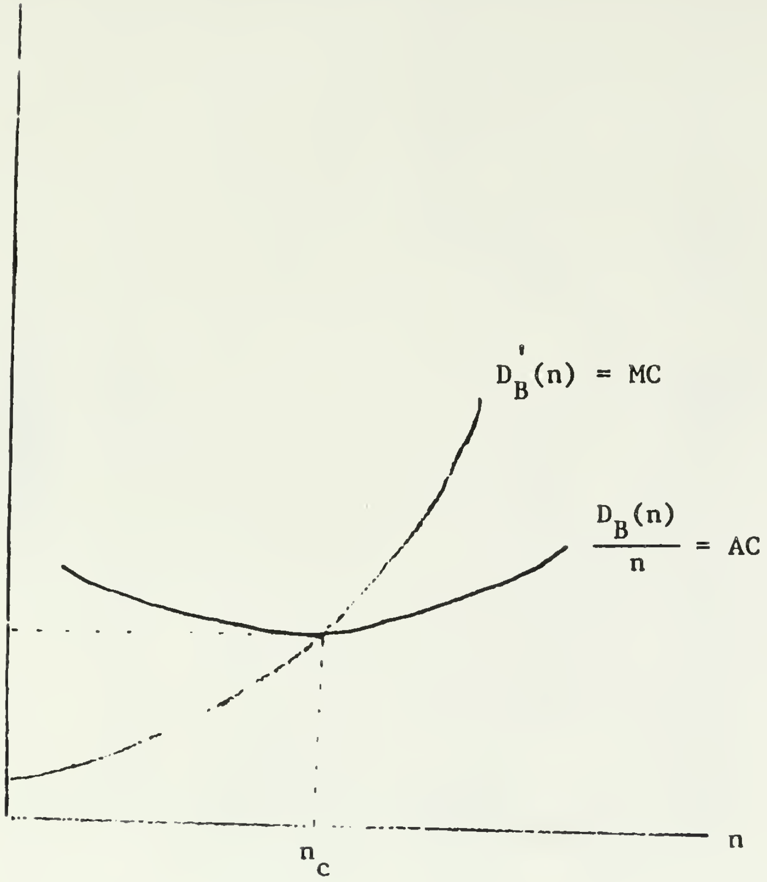
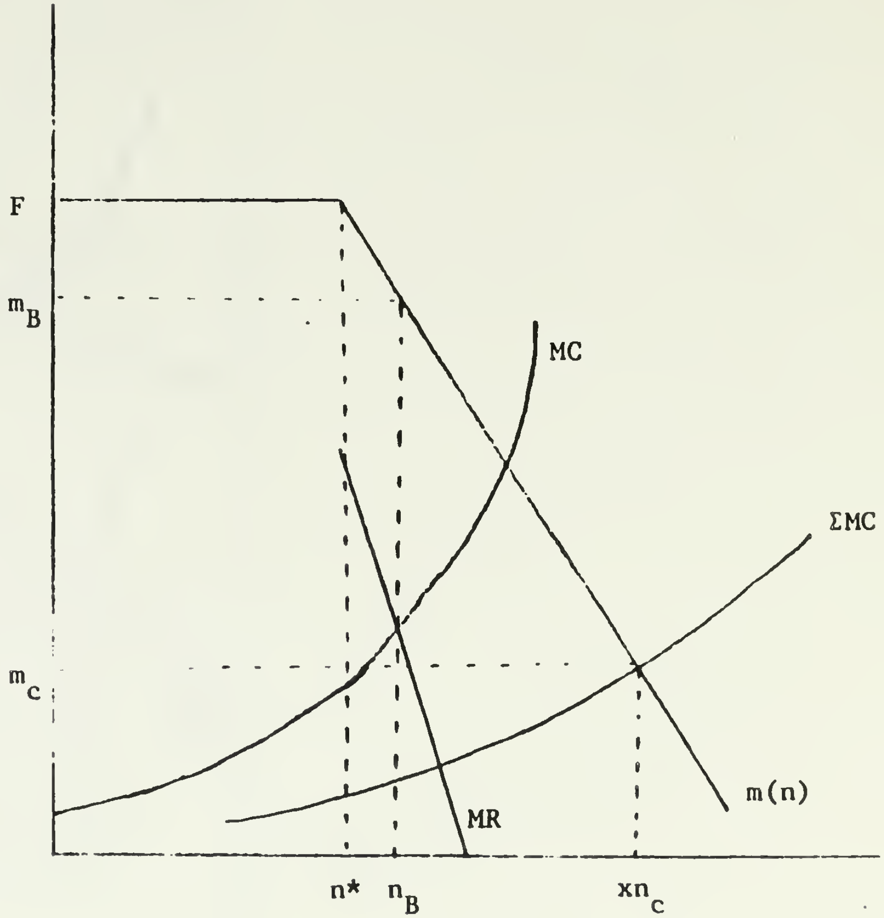


FIGURE IV-b



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