

Costless Versus Costly Signaling: Theory and Evidence from Share Repurchases*

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**COSTLESS VERSUS COSTLY SIGNALING:
THEORY AND EVIDENCE FROM SHARE REPURCHASES**

Abstract

A good firm can separate itself from a bad firm by giving a costly signal to capital markets; the bad firm will not mimic because the signal is costlier for the bad firm. A good firm can also separate itself by attracting scrutiny; the bad firm will not mimic because the bad firm will not want to be discovered.

The contribution of this paper is to develop a simple model to find out which signaling mechanism will be used under what circumstances in a capital market. We then test the predictions of the model – costless signaling is more likely to be used by undervalued firms that have more firm-specific risk, are more ignored, and are more undervalued – using a data set of open market share repurchases that contains firms that employ costless signals (announce share repurchases, but do not repurchase) as well as firms that employ costly signals (announce share repurchases, and repurchase.) The evidence in favor of the predictions of the model is surprisingly robust.

COSTLESS VERSUS COSTLY SIGNALING IN CAPITAL MARKETS:

THEORY AND EVIDENCE

A good firm can distinguish itself from a bad firm by sending a credible signal about its quality to capital markets. The signal will be credible only if the bad firm chooses not to mimic the good firm by sending the same signal.

Spence (1973) showed that if the cost of the signal is higher for the bad type than it is for the good type, the bad type may not find it worthwhile to mimic, and so the signal could be credible. Riley (1979) formalized the conditions under which such costly signaling equilibria exist. Numerous papers giving examples of such costly signaling in capital markets followed. An early paper was by Ross (1977), who showed how debt could be used as a costly signal to separate the good from the bad.

Crawford and Sobel (1982) showed that “cheap talk,” defined as a costless, non-binding, and unverifiable message, could also be a credible signal. They modeled a two-player non-cooperative information transmission game between a Sender and a Receiver. They demonstrated that the optimal response of the Receiver after a signal is received may affect the utility of the Sender in a way that it may be optimal for the Sender to tell the truth. In capital markets, an early paper was by Brennan and Hughes (1991), who modeled how good firms doing costless stock splits could motivate brokers to provide favorable reports about them.

The first contribution of this paper is to develop a simple model that gives the firm the choice between costless and costly signaling in a capital market. This allows us to make precise the circumstances under which either signaling mechanism will be used. In a recent paper, Austen-Smith and Banks (2000) have also allowed both costless and costly signaling. The main difference between their model and ours is that they view the two types of signals as complements in a general framework, whereas we model them as substitutes in the specific context of signaling to capital markets. This means that the focus in Austen-Smith and Banks (2000) is on how costly signals can improve cheap talk communication, whereas the focus in our

model is on when costly signals have to be used because cheap talk will not work.

Our theoretical model consists of an equal number of good firms and bad firms whose shares trade in a capital market. In the spirit of Grossman and Stiglitz (1980), the share prices of these firms are noisy and not perfectly revealing about the intrinsic value of the firm; thus, good (bad) firms may be undervalued (overvalued). This gives incentives to speculators to collect costly information about these firms, and trade profitably based on that information.

We analyze three mutually exclusive cases. In the first case, the utility gain from search if the firms are pooled or separated is positive. So speculators always collect costly information, and the firms are separated in equilibrium. Signals, costless or costly, are not needed. We categorize this case as the region of *natural separation*. In the second case, the utility gain from search if the firms are pooled or separated is non-positive, even if there is just one speculator. So speculators never collect any information, and the firms remain pooled unless the undervalued good firm separates by costly signaling. The overvalued bad firm does not mimic because the opportunity cost of burning money is higher for this firm. We categorize this second case as the region of *separation by costly signaling*. An interesting case arises when the utility gain from search if the firms are pooled is non-positive, but if the firms are separated, this is positive. In this third case, speculators have an incentive to investigate the firms that are separating themselves, but no incentive to investigate the firms if they are pooled together. This motivates the undervalued good firms to separate themselves by attracting scrutiny and get discovered, whereas overvalued bad firms are indifferent. If overvalued bad firms attract scrutiny, they will be discovered; if they keep quiet, as the good firms have separated, they will also be discovered. Assuming an epsilon fixed cost of attracting scrutiny, the overvalued bad firm will prefer to keep quiet. We categorize this third case as the region of *separation by costless signaling*.

It follows then that one necessary condition to obtain a costless signaling equilibrium in capital markets is the requirement that the utility gain from search if the firms are pooled is non-positive, but if the

firms are separated, this is positive. Contrast this with the costly signaling case. The only difference is that in the costly signaling case, the utility gain from searching the undervalued good firm that is signaling is non-positive, whereas in the costless signaling case, this is positive. This implies that, everything else held constant, there is less uncertainty about the value of the undervalued good firm that is using a costly signal to separate itself, than there is about the value of the undervalued good firm that is using a costless signal to separate itself. In other words, costless signals are more likely to be used by undervalued firms that have more risk. The intuition is that if there is more risk, there is more to discover by searching this particular firm, and, therefore, the likelihood of attracting the attention of speculators by cheap talk is higher.¹ By risk, we actually mean firm-specific risk, because speculators are likely to discover firm-specific factors and unlikely to discover systematic factors in their investigations.

Two more necessary conditions are needed for costless signaling to become viable. Note that the undervalued good firm has to attract speculators by drawing attention to itself, because it is the speculators who will discover its true value. Speculators would only get attracted if they can make profits from investigating. Everything else constant, the profits made by one speculator decreases as the number of competing speculators investigating the good firm doing the costless signaling increases, because they compete away speculative profits. Also, everything else constant, the profits made by one speculator decreases as the expected undervaluation of the good firm doing the costless signaling decreases, because there is less capital gain to be made by discovering and buying the undervalued shares. This implies that costless signaling is more likely to be used by more ignored firms and by more undervalued firms. Less ignored firms and less undervalued firms do not hold much appeal for speculators, because speculators cannot make much money from them. As a matter of fact, if the costs of search are high, speculators may never make money from investigating such firms. So less ignored firms and less undervalued cannot attract scrutiny and have to use costly signaling to separate.

¹ The same necessary condition drives the results of the Bhattacharya and Krishnan (1999) model of “suspicion” in capital markets.

Our model, therefore, has four testable implications. The first three are that the likelihood of undervalued firms choosing to use costless signals rather than costly signals to separate themselves in the capital markets is, one, positively correlated with their level of firm-specific risk; two, negatively correlated with their visibility; and three, positively correlated with their expected undervaluation. The fourth testable implication is that both costless and costly signals work, which implies that the information content of both kinds of signaling is the same.

The second contribution of our paper is to take these four testable implications of our model to the data. Our data set consists of a sample of firms that have done open market share repurchases. This data set offers a unique opportunity to test the predictions of our theoretical model, because we find that 25% of all firms that announce share repurchase programs *never purchase* a single share for up to four fiscal years after their announcement. It is plausible that this 25% of firms simply use the announcement, which is cheap talk, to attract scrutiny from speculators and have their true value discovered, whereas the rest of the firms repurchase their shares, which is costly, to signal their true value. The differences between these two sets of firms sheds some light as to which kinds of firms use cheap talk and which kinds of firms use costly signaling, enabling us to test the predictions of our model.

We test the predictions of the model using proxies for measuring the four variables of interest. Our proxy for measuring the firm-specific risk of the signaling firm is the ex-post standard deviation of cumulative abnormal returns around the announcement. Our measure of visibility is the number of analyst following. We use the book to market ratio as our primary measure of undervaluation. For our metric of the informational content of a signal, we follow the literature and use the mean of the cumulative abnormal return around the announcement.

This paper is not the first to examine stock repurchases as signals of firm value (see, for example, Asquith and Mullins (1986), Comment and Jarrell (1991), Dann, Masulis and Mayers (1991), Hertz and Jain (1991), Lee, Mikkelsen and Partch (1992), and Vermaelen (1981)). However, most of these

investigations assume that the repurchase is a costly signal, which may not be true in an open market stock repurchase program if the firm does not repurchase stock. Additionally, signaling firm value is not the only reason firms repurchase stock. Dittmar (2000) surveys all the hypotheses expounded in the literature to explain why firms repurchase shares and finds that three other motives are important at different times in the period 1977 to 1996. The three other motives are: one, share repurchases are an alternative means of distributing cash to shareholders (see, for example, Brennan and Thakor (1990), and Lucas and McDonald (1996)); two, share repurchases may be used to tilt leverage ratios towards a target leverage ratio (see, for example, Bagwell and Shoven (1988), and Havakimian, Opler and Titman (2001)); and three, share repurchases may be preferred to dividends when a firm has employee stock options outstanding because most stock options are not dividend-protected and share repurchases allow the firm to distribute cash without diluting the per-share value of the stock. This third motive is particularly important if managers hold a lot of stock options (see, for example, Jolls (1996), Kahle (2001), Fenn and Liang (2001), and Weisbenner (2001)).²

After controlling for the other motives for share repurchases, our empirical tests document that firms that announce share repurchases and do not carry them out, have a higher standard deviation of cumulative abnormal returns around the announcement, have fewer analysts following them, and have lower market to book ratios than firms which announce share repurchases and carry them out. These results indicate that firms that have more firm-specific risk, are more ignored, and are more undervalued are more likely to use a costless signal. Surprisingly, the mean cumulative abnormal returns documented during such cheap talk announcements is not statistically different than the mean cumulative abnormal returns documented during announcements that are followed through by actual repurchases. This indicates that both costless and costly signals “work.” These four pieces of evidence provide strong support for our theoretical model.

² Dittmar (2000) also finds that share repurchases deter takeovers by increasing share prices (see Bagwell (1991)). However, this method is most commonly linked to self tender offers, not open market repurchases. The latter is the subject of our paper.

Our theoretical and empirical analysis addresses two puzzles in this literature: one, why some firms announce open market share repurchases, but never repurchase any stock; and two, why stock prices increase at the announcement of an open market repurchase program, even though the announcement does not *commit* the firm to purchase any stock. Our hypotheses for these two puzzles, as formalized in our theoretical model and evidence provided in our empirical investigation are: in some special cases, the mere announcement of an open market share repurchase attracts scrutiny from speculators, who then discover the true value of the firm; and two, this causes stock prices to increase at the announcement of an open market repurchase program, even though the announcement does not commit the firm to purchase any stock.

Oded (2000), like us, also puzzles as to why the announcement of an open-market share repurchase program, which involves no commitment, is regarded as good news by the market. Ikenberry and Vermaelen (1996) argue that this may be because announcements are tantamount to creations of valuable options of buying undervalued shares in the future, but Oded (2000) argues that, if this were the reason, all types of firms would make such announcements. So, in equilibrium, such “cheap talk” cannot create value. He then goes on to develop a three-period signaling model that delivers positive announcement returns. In our paper, we contend that “cheap talk” can create value when it attracts the attention of speculators, who go on to discover the true value of the firm. We then put our hypothesis to the test.

The plan of the rest of the paper is as follows. We introduce the model in Section I. In Section II we analyze the choice between costless signaling and costly signaling. The testable implications are formalized in Section III. The data is discussed in Section IV. Section V is devoted to the empirical tests of the model. Section VI concludes.

I. Model

There are two types of projects, less risky projects and more risky projects. The less risky projects could have one of four payoffs with equal probability: $\mu+\delta$, $\mu-\delta$, $-\mu+\delta$ or $-\mu-\delta$. The more risky projects could have one of four payoffs with equal probability: $\mu+a\delta$, $\mu-a\delta$, $-\mu+a\delta$ or $-\mu-a\delta$. Here $a>1$.

There are two types of firms, good firms and bad firms, and each are equally likely. The good firms are equally likely to have less risky projects or more risky projects. The bad firms always have more risky projects.

Who knows what and when? This is given in Figure 1 below.

Insert Figure 1 about here

A. At time t

At time t , the world comes to know that both these types of firms will have access to a positive net present value project at time $t+4$. The NPV of this project is α . The investment required to start this project at time $t+4$ is I , which, with some loss of generality, we normalize to $-\mu - a\delta$. This ensures that, if the firm does not burn any money, the project can be funded from payoffs of the risky assets in all states for all types of firms.

B. At time $t+1$

At time $t+1$, nature picks a firm at random. The manager of the picked firm, which could be good or bad, knows the type of her firm. She may decide to keep quiet or to signal its value. Value could be signaled in one of two ways: attract scrutiny (costless signaling) or burn money m (costly signaling). The manager will take the action that maximizes the expected value of her firm. In other words, there are current shareholders who employ the manager to maximize the expected firm value, with agency problems, if any, resolved by the optimal contract between current shareholders and the manager.

C. At time $t+2$

At time $t+2$, there is a market for shares of these firms. The details of this market are inspired by

the extensive form introduced in Glosten and Milgrom (1985).³

There is a single risk-averse strategic trader who is endowed with some initial private information. This private information is a private signal he gets telling him whether $+\mu$ will occur (the mean payoff of the firm is positive – defined as the good news state) or whether $-\mu$ will occur (the mean payoff of the firm is negative – defined as the bad news state).

D. At time $t+3$

At time $t+3$, after receiving the private signal at time $t+2$, and after observing the action of the firm at time $t+1$ – which, recall, could be cheap talk or money burning or inaction – the risk-averse trader can acquire, at a cost c , additional private information about the firm. This additional private information is a costly private signal he gets telling him whether the firm has a very risky project or whether the firm has a less risky project. This information cost could be interpreted as the time and money spent doing further investigations by consulting an in-house expert or an outside expert. The information set of the trader will therefore consist of his free private signal, and the outcome of incremental costly information acquisition if he does any search.

E. At time $t+3.5$

At time $t+3.5$, nature picks one trader, out of the entire population of traders who would like to trade (potential traders consist of liquidity traders and the above strategic trader), to come to the trading window. The probability of the strategic trader to be picked is π . The parameter π is, therefore, a measure of the proportion of traders who base their trades on information. If the trader at the window is a strategic information trader, his order would be $+q$ if he has good news, and $-q$ if he has bad news. If the trader at the window is a liquidity trader, his order could be $+q$ or $-q$ with equal probability. The logic for liquidity noise is now standard (see, for example, Grossman and Stiglitz (1980)). Without it, the informed trader's order

³ We prefer to use the Glosten-Milgrom (1985) model over the Kyle (1985) model because the latter has execution risk, and in a model that has risk-averse speculators as ours has, a spurious risk premium is generated by Kyle (1985) models. Krishnan (1992) uses a binary framework to show the equivalence between Glosten-Milgrom (1985) and Kyle (1985), given identical parametric assumptions. So our conclusions do not depend critically on the particular details of the Glosten-Milgrom (1985) extensive form.

would fully reveal his private information, and thus there would be no incentive to collect costly information to trade.

Not only is the sign of the strategic trader's order flow, q , endogenous, but so also is its magnitude. The risk-averse strategic trader will choose the sign and magnitude of his order flow to maximize his utility, subject to his budget constraint. The strategic trader is a mean-variance optimizer. His problem is:

$$\begin{aligned} \text{Max}_{\{q\}} \quad & E(W_T | I) - \theta (Var(W_T | I)) \\ \text{s.t.} \quad & q P + B_T = B_0 \end{aligned} \tag{1}$$

where

θ is the coefficient of risk-aversion,

W_T is the random end-of-period wealth of the strategic trader at time $t+4$, which equals $qP_T + B_T$;

I is his information set at time $t+3.5$;

P_T is the random value of the firm at time $t+4$;

q is the size of his order flow at time $t+3.5$;

B_T is the size of his cash holdings at time $t+4$;

B_0 is the size of his cash holdings at time $t+3.5$, which we normalize to zero without loss of generality; and

P is the price offered by the market maker at time $t+3.5$, which is endogenous.

At the same time, market makers set the price at which they would be willing to sell q units and the price at which they would be willing to buy q units. Competition among risk-neutral market makers is assumed to give them zero expected profits conditional on all public information. This implies that the market maker sets the price equal to the conditional expected value of the share.

Shareholders in the world, like the strategic trader, are mean-variance optimizers. This means that the value assigned to a firm by a market is

$$\text{Conditional mean} - \theta \times \text{conditional variance} \quad (2),$$

where θ is the risk-aversion coefficient. The conditional mean and the conditional variance of shareholders will depend on their conjectures about the strategies being followed by the manager and the strategic trader, and will depend on the information they have at time $t+3.5$.

F. At time $t+4$

At $t+4$, since the $(-\mu-a\delta)$ funding required for the positive net present value project comes from the payoffs of the risky assets, and since the manager used up cash m for signaling (m equals zero for costless signaling or if the manager keeps quiet) at time $t+1$, the manager may have a shortfall of cash for the funding. This shortfall is

$$s = \text{Max} [(-\mu-a\delta) - (\text{Risky project payoff at time } t+4 - m), 0] \quad (3).$$

She will have to borrow this shortfall s ; otherwise, the positive NPV project will not be financed. External borrowing is costly. Let the cost of borrowing the shortfall s be denoted by $b(s)$. We shall assume that $b(0) = 0$, and that b is increasing in s .

The payoffs are revealed. Portfolios are consumed.

II. Equilibria

From the point of view of the manager of the good firm, it is apparent in our model that if she could, she would like to separate her firm by attracting scrutiny rather than incurring the deadweight cost of a costly signal. The reason this is true is because in the former case, the cost of separation is being borne by the strategic trader, who may find it in his interest to expend search costs and differentiate these firms, whereas in the latter case, the cost of separation is being borne entirely by the firm. It should be mentioned here that this unambiguous preference for costless signals over costly signals is an artifact of our model; in more general models, this result may not hold. The reason this result may not hold in more general models, as in the model of Austen-Smith and Banks (2000), is because the Receiver of the signal can pass off some or all of the costs of search to the Sender. As these search costs are passed entirely to the liquidity traders in our

model, this will not happen here. This allows us to claim that the manager of the good firm will always like to separate by attracting scrutiny, but if that is not possible, costly signaling is the last resort.

What are the special circumstances under which costless signaling is possible? We now explore this question.

A. Separating by costless signaling

We work backwards. Assume that we are at time $t+3.5$. What will the strategic trader do? The optimization problem of the strategic trader, given in (1), is a classic optimization problem in finance. The first order condition gives us the optimal order quantity of the strategic trader. This is

$$q^* = \frac{E(W_T | I) - P}{2 \theta \text{Var}(W_T | I)} \quad (4).$$

The second order condition reveals that it is a well-defined maximization problem. Substituting the optimal order from (4) into (1), we obtain the optimal utility achieved from trading:

$$U^* = \frac{[E(W_T | I) - P]^2}{4 \theta \text{Var}(W_T | I)} \quad (5).$$

Suppose the strategic trader has received good news. He will send in a positive order flow. The market maker, on seeing a positive order flow, would believe that it has come from the strategic trader with a probability π , and from a liquidity trader (who has observed nothing) with a probability $1-\pi$. Given that the market maker sets prices equal to the expected value, and the project with NPV of α is financed by all types in equilibrium, the price offered by the market maker, P , for positive order flows, is $\alpha + \pi\mu$. Therefore, from (5), the maximum expected utility of the trader who has seen good news and who trades is:

$$U^* = \frac{[\mu (1 - \Pi)]^2}{4 \theta \text{Var}(W_T | I)} \quad (6).$$

As (6) is positive, and as utility from not trading is zero – recall that his endowment was zero – the strategic trader will always trade. The analysis from the point of view of the strategic trader who has seen bad news is symmetric.

Let us now go to time $t+3$, where the strategic trader has to make a decision on whether to incur an additional cost c to find out whether the firm has a very risky project or a less risky project.

Note that the prices are being set by risk-neutral market makers. So these prices will not be conditioned on the perceived riskiness of the projects, which implies that these prices do not depend on whether the trader searches or does not search. This dramatically simplifies our analysis. It tells us that when we analyze whether a trader will search or not search, we can ignore the conjecture the market maker makes about the trader searching or not searching.

Suppose the two firms are pooled. This means that the universe of projects contains three-fourths of very risky projects (whose variance is $a^2 \delta^2$) and one-fourth of less risky projects (whose variance is δ^2). If the strategic trader does not search, his conditional variance is $0.75 a^2 \delta^2 + 0.25 \delta^2$. His maximum utility will then, according to (6), be

$$U^* = \frac{[\mu (1 - \Pi)]^2}{4 \theta (0.75 a^2 \delta^2 + 0.25 \delta^2)} \quad (7).$$

This is point D in Figure 2.

Insert Figure 2 here

If the strategic trader searches, he will discover very risky projects 75% of the time and less risky projects 25% of the time. He will then give an order, and his expected utility will then, according to (6), be

$$U^* = 0.75 \frac{[\mu (1 - \Pi)]^2}{4 \theta a^2 \delta^2} + 0.25 \frac{[\mu (1 - \Pi)]^2}{4 \theta \delta^2} \quad (8).$$

This is point C in Figure 2. This implies that the benefit of search is the distance CD if firms are pooled.

Suppose the two firms are separated. The strategic trader conjectures that it is the good firm that has separated by attracting scrutiny, and the bad firm has separated by keeping quiet. Given this conjecture, the universe of projects for the good firms contains half of very risky projects (whose variance is $a^2 \delta^2$) and half of less risky projects (whose variance is δ^2). If the strategic trader does not search the conjectured good firm, his conditional variance is $0.5 a^2 \delta^2 + 0.5 \delta^2$. His maximum utility will then, according to (6), be

$$U^* = \frac{[\mu (1 - \Pi)]^2}{4 \theta (0.5 a^2 \delta^2 + 0.5 \delta^2)} \quad (9).$$

This is point B in Figure 2. If the strategic trader searches the good firm, he will discover very risky projects 50% of the time and less risky projects 50% of the time. He will then give his order, and his expected utility will then, according to (6), be

$$U^* = 0.5 \frac{[\mu (1 - \Pi)]^2}{4 \theta a^2 \delta^2} + 0.5 \frac{[\mu (1 - \Pi)]^2}{4 \theta \delta^2} \quad (10).$$

This is point A in Figure 2. This implies that the benefit of searching the firm that has separated by attracting scrutiny, if the conjecture is that this is the good firm, is the distance AB. Note that given the conjecture that the firm which has kept quiet is a bad firm, there is no benefit of searching the firm that has kept quiet. Why? Because there is no uncertainty here; the bad firm has only very risky projects.

It is easy to analytically show that distance AB is greater than distance CD. This implies that if the

cost of search, c , lies within the following bounds, $AB \geq c \geq CD$, where

$$\begin{aligned}
 AB &= 0.5 \frac{[\mu (1 - \Pi)]^2}{4 \theta a^2 \delta^2} + 0.5 \frac{[\mu (1 - \Pi)]^2}{4 \theta \delta^2} - \frac{[\mu (1 - \Pi)]^2}{4 \theta [0.5 a^2 \delta^2 + 0.5 \delta^2]} \\
 CD &= 0.75 \frac{[\mu (1 - \Pi)]^2}{4 \theta a^2 \delta^2} + 0.25 \frac{[\mu (1 - \Pi)]^2}{4 \theta \delta^2} - \frac{[\mu (1 - \Pi)]^2}{4 \theta [0.75 a^2 \delta^2 + 0.25 \delta^2]}
 \end{aligned} \tag{11},$$

the strategic trader will search the firm that has separated by attracting scrutiny, will not search the firm that has separated by keeping quiet, and will not search any firm if the firms are pooled. These are the optimal responses of the strategic trader, given his conjectures on the signaling behavior of the managers.

We now have to show that, given these responses of the trader at time $t+3$, his conjectures on the signaling behavior of the managers at time $t+1$, will be upheld in equilibrium. Note from (4) that both the direction and the magnitude of the order flow have informational content. A positive (negative) order flow reveals good (bad) news. A small (large) order flow reveals whether the project is very risky (less risky). Specifically, the magnitude of the order if a very risky project is observed, will be, from (4),

$$|q^*| = \frac{\mu (1 - \pi)}{2 \theta (a^2 \delta^2)} \tag{12},$$

and the magnitude of the order if a less risky project is observed, will be, from (4),

$$|q^*| = \frac{\mu (1 - \pi)}{2 \theta (\delta^2)} \tag{13}.$$

This means, from (2), that the value assigned by the market at time $t+3.5$, given the conjecture that the good firm has separated itself by attracting scrutiny and the bad firm has kept quiet is : if they see a positive small

order flow, value assigned is $\alpha + \pi\mu - \theta a^2 \delta^2$; if they see a positive large order flow, value assigned is $\alpha + \pi\mu - \theta \delta^2$; if they see a negative small order flow, value assigned is $\alpha - \pi\mu - \theta a^2 \delta^2$; and if they see a negative large order flow, value assigned is $\alpha - \pi\mu - \theta \delta^2$. Note that we always have $+\alpha$ in the valuation because the positive NPV project will always be undertaken in equilibrium.

This means that at time $t+1$, if the good manager is expected to separate herself by attracting scrutiny and she does, risky projects will be detected 50% of the time at time $t+3.5$, and less risky projects will be detected 50% of the time at time $t+3.5$. Her expected value of the firm at $t+1$ will be $\alpha - 0.5 \theta \delta^2 (1+a^2)$. If she decides to keep quiet, her expected value of the firm at $t+1$ will be $\alpha - \theta \delta^2 a^2$, which is less than $\alpha - 0.5 \theta \delta^2 (1+a^2)$ because $a > 1$. So she will separate herself by attracting scrutiny. The bad manager, on the other hand, will keep quiet. If she attracts scrutiny at time $t+1$, given that firms that attract scrutiny are investigated, she will be discovered to be a bad firm at time $t+3.5$, because very risky projects will be discovered 100% of the time. If she keeps quiet, as the good firm has separated from it, she will still be regarded as a bad firm. Assuming an epsilon fixed cost of attracting scrutiny, the bad manager will prefer to keep quiet.

PROPOSITION 1: If $AB \geq c \geq CD$, and there is an epsilon fixed cost of attracting scrutiny, we have a unique costless signaling equilibrium. In this equilibrium, the good type will separate by attracting scrutiny, and will be discovered to be good. The bad type will keep quiet, and no one will investigate it. There will be no pooling in equilibrium.

If the cost of search is greater than AB , which is the highest possible benefit for search, there will not be any search. If there is no search, traders will not be able to induce separation. Under this situation, the good firm will have no recourse other than to resort to costly signaling to separate itself. We now consider this equilibrium.

B. Separating by costly signaling

If the cost of search is greater than AB , which is the highest possible benefit for search, we have

shown above that there will not be any search and, therefore, separation will not come about because of traders. This implies that the manager of the good firm may have to separate herself by costly signaling.

It is important to mention here that though the cost of search is high enough to dissuade the trader from searching, it does not dissuade him from trading. This is because his utility from trading, which is given in (5), is positive, whereas his utility from not trading is zero. So the trader will always trade; he will give a positive order flow if he has good news, and he will give a negative order flow if he has bad news. The magnitude of his order for a bad firm that has separated itself will be, from (4),

$$|q^*| = \frac{\mu(1-\pi)}{2\theta(a^2\delta^2)} \quad (14),$$

and the magnitude of his order for a good firm that has separated itself will be, from (4),

$$|q^*| = \frac{\mu(1-\pi)}{2\theta(0.5\delta^2 + 0.5a^2\delta^2)} \quad (15).$$

Our model on costly signaling follows the classic structure laid out by Spence (1973). The good firm separates itself by burning money m , whereas the bad firm does not do anything. Suppose this is the conjectured belief by the market. Assume that financing is needed only at the worst state, when the risky payoff is $-\mu - a\delta$. Later we will give the condition on exogenous parameter values that will guarantee this assumption.

If the bad firm stays true and is regarded as a bad firm, its value, is

$$\alpha - \theta\delta^2 a^2 \quad (16).$$

If the bad firm deviates by burning cash m and is perceived as a good firm, its value, is

$$\alpha - 0.5\theta\delta^2(a^2 + 1) - 0.5b(m) \quad (17).$$

If the good firm stays true, burns cash m , and is regarded as a good firm, its value, is

$$\alpha - 0.5\theta\delta^2(a^2 + 1) - 0.25b(m) \quad (18).$$

If the good firm deviates by not burning cash m and is perceived as a bad firm, its value, is

$$\alpha - \theta\delta^2 a^2 \quad (19).$$

Solve for m that makes (16) = (17). It will solve

$$b(m^*) = \theta \delta^2 (a^2 - 1) \quad (20).$$

It is easy to see that if m^* solves (20), (18) > (19). As the good type will not like to burn more money than is needed to separate, it will burn just m^* . The bad type will be indifferent. Finally, to ensure that financing is only needed for the worst state, our exogenous parameters have to satisfy the following condition: $(-\mu-\delta)-(-\mu-a\delta) > m^*$, i.e. $(a-1)\delta > m^*$.

PROPOSITION 2: *If $c > AB > CD$, we have a costly signaling equilibrium. In this equilibrium, the good type will separate by burning money m^* . The bad type will not burn any money. There will be no pooling in equilibrium.*

The proof as to why a pooling equilibrium may not exist is as follows. Suppose a pooling equilibrium does exist. We see a defection. What do we make of this out-of-equilibrium defection? If the defection is cash burning of m^* , it should be coming from the good type, because it is not in the interest of the bad type to burn m^* . So, according to the Banks and Sobel (1987) Universal Divinity refinement, we should believe that it is the good type that deviated. If that is the out-of-equilibrium belief, good types will deviate, and the pooling equilibrium will unravel.

Note that in the above model demonstrating costly signaling, in the interest of consistency, we retained one of the necessary conditions that drives the costless signaling result: good firms can have more risky or less risky projects, but bad firms only have more risky projects. This condition is not needed for our costly signaling result. The only critical condition needed for the costly signaling result is that good firms have a lower probability of a cash shortfall than bad firms. This ensures that if bad firms try to burn the same

amount of money as the good firm, they will have to undertake costly refinancing more often.⁴

C. Natural Separation

If the cost of search is less than the distance CD , which is the lowest possible benefit for search, there will always be search and, therefore, separation will come about because of traders. This implies that the manager of the good firm will not have to do anything.

Under natural separation, traders will give positive orders when they have good news and negative orders when they have bad news. The magnitude of the orders will distinguish the riskiness of the projects. Specifically, a small (large) order flow will reveal whether the project is very risky (less risky). These magnitudes are given in (12) and (13).

PROPOSITION 3: *If $AB > CD > c$, we have natural separation. In this equilibrium, traders will always search, and the market would be able to distinguish the good firm from the bad firm.*

III. Testable Implications

The first testable implication of our model comes from the critical assumption we needed to make costless signaling work for the undervalued good firm: their firm-specific risk should be high. If their firm-specific risk is not high, speculators have nothing much to discover, in which case it is difficult for the undervalued good firm to attract their attention, in which case the undervalued good firm has to resort to costly signaling to signal its true value. This implies that undervalued firms which have more firm-specific risk use costless signals to separate themselves from the pool, and undervalued firms which have less firm-specific risk use costly signals to separate themselves.

Recall that the benefit from searching the good firm when it is separated is AB , and the benefit of searching when all firms are pooled together is CD . The expressions for AB and CD were given in (11), and

⁴ In this paper, repurchasing stock is costly because this leads to a cash shortfall, which in turn leads to costly external financing. The extant literature has modeled this cost in different ways. In Brennan and Thakor (1990), for example, share repurchase are costly because they redistribute wealth from uninformed shareholders to informed shareholders. Our results depend on share repurchases being costly; they do not depend on why they are costly.

they were graphically depicted in Figure 2. It is easy to show that both AB and CD decrease as π increases. The intuition for this is as follows. As the size of informed trading increases, prices become more informative, and so the value of the additional information that can be obtained from costly search diminishes. In other words, more is the informed trading, less is the benefit from search. This is depicted in Figure 3.

Insert Figure 3 here

Figure 3 gives us the second testable implication of our model. Everything else equal, especially holding the cost of search equal, more is the mass of traders who trade because of informational reasons, more is the likelihood of a firm separating itself by a costly signal rather than a costless signal.⁵

The parameter a distinguishes the good firm from the bad firm. If a is 1, both firms are equivalent. As a increases, their difference increases, and, if the firms are pooled, the higher is the undervaluation of the good firm. It is easy to show that both AB and CD increase as a increases. This is depicted in Figure 4.

Insert Figure 4 here

Figure 4 gives us the third testable implication of our model. Everything else equal, especially holding the cost of search equal, more is the undervaluation of the good firm, more is the likelihood of the good firm separating itself by a costless signal rather than a costly signal.

The fourth testable implication of our model comes from our result that the good type can use both

⁵ The mass of informed traders, π , is exogenous in our model. It could be argued that the mass of informed traders is endogenous, and it should depend on the cost of search. We argue that this is not going to make any difference to the comparative statics. The reason is the following. If the only barrier to becoming a speculator is the cost of gathering information, the number of speculators in equilibrium will be such that if an additional speculator entered, he will lose money. Now suppose there is a shock in firm value which leads to a temporary disequilibrium. The additional speculator can now, perhaps, make short-term profits. He will make more short-term profits in the firm which had fewer speculators to begin with because there is less competition. Such firms will, therefore, attract the marginal speculator more.

costly as well as costless signaling to separate under different circumstances. This implies that the informational content of an announcement, whether it is cheap talk or costly signaling, is the same.

IV. Sample and Data

It is essential to the tests of the implications of our model that the firm has a choice of using a costless signal, which means that it has the freedom not to carry through an announced transaction. It is equally essential that some firms actually make this choice of not carrying through an announced transaction.

The announcement of open market stock repurchases meets both of these requirements. When the board of directors approves an open market stock repurchase program, the firm typically announces the program to the public. They do this because, if they do not, the repurchase may be a violation of the safe harbor provisions under the stock price manipulation provisions of the Securities and Exchange Commission. According to Stephens, Jagannathan and Weisbach (2000), there is little evidence of firms repurchasing stock without first announcing the program. However, once the firm announces the repurchase program, it is not obligated to repurchase stock. Further, as will be shown in Table I, 25% of firms announcing a stock repurchase never actually repurchase stock. This means that these firms signal with the announcement, but never incur the cost of the signal. Thus, open market stock repurchase announcements provide a unique opportunity to test the choice between costless and costly signals, and to investigate why some firms announce a share repurchase program and never repurchase any stock, whereas other firms announce and repurchase.

The initial sample consists of all firms announcing an open market stock repurchase between 1985 and 1995 as listed on Securities Data Corporation's Mergers and Acquisitions database. We exclude announcements in the last quarter of 1987. Netter and Mitchell (1989) show that twice as many repurchases were announced in this quarter than the prior three quarters of 1987. We exclude announcements made during this quarter because the magnitude of the number of announcements suggests that these announcements may differ from typical repurchase programs. We do not consider repurchase

announcements subsequent to 1995 because we wish to examine if the firm repurchases stock for four fiscal years following the announcement. We further require that the firms are listed on Compustat in the year of the announcement. This results in 6,604 announcements by 2,948 firms. Many of these firms have multiple announcements, which results in overlapping event windows when we consider the actual repurchases for the years following the repurchase. We therefore limit our analysis to the first repurchase announcement by each firm during the sample period.

To determine if a firm repurchases stock, we use the Compustat data item *Purchase of Stock*. As discussed in Stephens and Weisbach (1998), these data overstate stock repurchases because they include: 1) conversions of class A, class B, and special stock into common stock; 2) conversions of preferred stock into common stock; 3) purchases of treasury stock; 4) retirement or redemption of common stock; 5) retirement of preferred stock; and 6) retirement or redemption of redeemable preferred stock. In this paper, we are only interested in item 3, the purchase of treasury stock. We therefore adjust stock repurchases by reducing *Purchase of Stock* by any decrease in preferred stock that occurs. This removes items 2, 5, and 6. The resulting value may still be overstated by the amount of class A, class B, and special stock converted into common stock, and the amount of retired common stock. However, most firms have only a single class of stock and the retirement of stock is much less frequent than stock repurchases. Additionally, we measure if the firm repurchases stock, not the amount of the repurchase; thus, these errors have little impact on our results.

Data on the number of analysts following the stock are from IBES. The market capitalization and accounting data are from Compustat. The daily stock returns are from CRSP. All explanatory variables are measured as of the fiscal year end prior to the year of the repurchase announcement.

Panel A of Table I shows that of the 2,948 firms announcing repurchase programs in our sample period of 1985 through 1995, 1,849 (63%) repurchase stock within four fiscal years of the repurchase announcement and 740 (25%) firms do not repurchase stock in any of the four years following the

announcement. The other 359 (12%) firms are not listed on Compustat for the full four fiscal years, and they do not report repurchases in the years for which data is available. The majority (1,363 firms) of the 1,849 firms that repurchase stock make their first repurchases in less than one year, before the close of the first fiscal year end following the repurchase announcement. Another 264, 141, and 81 firms make their first repurchase before the close of the second, third or fourth fiscal year end following the repurchase announcement, respectively.

The previous statistics show that a significant 25% of the firms announcing a stock repurchase do not repurchase stock in the four fiscal years following the announcement. This percentage is surprising in light of the evidence in Stephens and Weisbach (1998). Stephens and Weisbach (1998) show that 10% of the firms announcing a repurchase program purchase less than 5% of their stock. Our results differ from Stephens and Weisbach (1998) for two reasons. First, Stephens and Weisbach (1998) look at Wall Street Journal Announcements; we use all announcements on Security Data Corporation, which relies on several news sources to track announcements. Second, our sample period is later than the sample period used in Stephens and Weisbach (1998), who look at the 1981 to 1990 period. Fewer announcing firms repurchase their stock in the later years of our sample. Panel B of Table II illustrates the percentage of firms repurchasing stock by the year of the announcement. In 1985 and 1986, only 10% to 11% of the firms did not repurchase stock in the four fiscal year after an announcement. However, in subsequent years, the number of non-repurchasers increased. In 1991 and 1994, for instance, the percentage of firms announcing but not repurchasing stock in the next four fiscal years peaked at 31%.

V. Empirical Tests

Our theoretical model predicts that a firm will chose a costless signal if the signal attracts scrutiny; otherwise, the firm must put its money where its mouth is and provide a costly signal. The first necessary condition needed for costless signaling to work is that the signaling firm should have more firm-specific risk, because speculators can then discover valuable information with costly search. If the proxy to measure firm-

specific risk is the ex-post standard deviation of cumulative abnormal returns around the announcement, our model predicts that this should be higher for the costless signals than it is for the costly signals. This is our first test.

The benefit to search is highest in the case of firms with few informed traders. This is because the value of private information is highest when few people are in the know. In this paper, we use the number of analysts following the firm as a measure of the level of informed trading. The second test of our theoretical model, therefore, is: firms with few analysts following them, where the benefits to search are high, will use a costless signal (announce share repurchases without actually repurchasing) for separating, whereas firms with large analyst following, where the benefits to search are low, will use a costly signal (announce share repurchases and actually repurchasing) for separating.

Vermaelen (1981), Dann (1981), Comment and Jarell (1991) and Grullon (2000) show that firms announcing stock repurchases are undervalued, and that the announcement is a signal of their undervaluation. Obviously, some firms are more undervalued than others. We have seen that the benefit to search is low if the signaling firm is not much undervalued. This is because the speculator will not obtain a significant capital gain in his share purchases of the undervalued firm. So our model has a third prediction: more undervalued firms use a costless signal (announce share repurchases without actually repurchasing) for separating, whereas less undervalued firms, where the benefits to search are low, will use a costly signal (announce share repurchases and actually repurchasing) for separating.

In this paper, we measure the degree of undervaluation of a firm by the firm's market to book ratio. This interpretation of the market to book ratio is used in several studies, and is based on the evidence of Ikenberry, Lakonishok and Vermaelen (1995). Ikenberry, Lakonishok and Vermaelen (1995) show that the positive stock price reaction at the announcement of a stock repurchase program may not be sufficient to correct the undervalued price since repurchasing firms, particularly low market to book firms, earn a positive abnormal return during the four years subsequent to the announcement. If you interpret this abnormal return

as an indication that repurchasing firms are undervalued even after the repurchase announcement, then low market to book firms are more undervalued relative to high market to book firms.

The third test of our theoretical model, therefore, is: firms with low market to book ratios, where the benefits to search are high, will use a costless signal (announce share repurchases without actually repurchasing) for separating, whereas firms with high market to book ratios, where the benefits to search are low, will use a costly signal (announce share repurchases and actually repurchasing) for separating.

Using the market to book ratio as a measure of undervaluation has its problems. One potential problem with this measure is that the market to book ratio could also measure a firm's investment opportunities. If firms use excess capital to repurchase stock, then firms with fewer investment opportunities would be more likely to repurchase stock because they would have more excess cash. Based on this interpretation, a negative relation exists between the probability of repurchasing shares and the market to book ratio. This prediction is the *opposite* of the relation predicted by our model. Thus, this alternative interpretation is simple to distinguish from the predictions of the model. Additionally, we use the ratio of research and development expenses to sales to further control for growth and investment opportunities.

In our model, both costless as well as costly signals are effective in different circumstances for separation; thus, both types of signals should have the same information content. The proxy for the information content of a signal is standard in the literature: it is the mean abnormal return at the announcement. So the fourth test of our theoretical model is: the mean abnormal return during an announcement of a stock repurchase does not depend on whether the announcement is carried out or not.

A. Summary Firm Characteristics of the Two Sub-Samples

We define a repurchaser as a firm that has announced an open market share repurchase and has repurchased in the four fiscal years following the announcement. A non-repurchaser is a firm which has announced an open market share repurchase, but has not repurchased any share in the four fiscal years following the announcement. Since the announcement may occur at anytime during the year, the choice of

four fiscal year-ends ensures that we allow at least three years to repurchase stock after the announcement. We repeat the analysis in this paper redefining a repurchaser as a firm that repurchases stock in the year of the announcement (i.e. within one year). We redefine a repurchaser in this way because our model investigates a firm's choice between costly and costless signals at the time of the announcement. At the time of announcement, the firm is likely to know whether it is going to repurchase or not repurchase in the next one year, but it may not know whether it is going to repurchase or not repurchase in the next four years. Thus, the one year horizon is used as a check for robustness.

Table II presents summary statistics and tests for differences between the repurchasing and non-repurchasing firms using t-tests for unequal, unpaired samples and Wilcoxon Rank-sum tests.⁶ The first row depicts the number of analysts of the repurchasing and non-repurchasing firms in the year prior to the repurchase announcement. Unfortunately, IBES only follows 1,548 of the 2,589 sample firms. So, we assume that any firm not covered by IBES has no analyst following. Though this assumption is not perfect, it is likely that firms not on IBES have significantly less analyst following. To check the impact of this assumption, we repeat all the analysis presented in this paper using only those firms that IBES covers. The results are unchanged. The mean (median) repurchasing firm has 5.57 (2) analysts following it in the year before the announcement. The mean (median) non-repurchasing firm has 3 (0) analysts following it in the year before the announcement. The difference between the repurchasing and non-repurchasing firms' mean and median number of analysts is statistically significant regardless of the definition of repurchases. These statistics support the implications of the theoretical model: firms that announce but do not repurchase are the ignored firms.

Table II also shows that repurchasing firms have significantly higher market to book ratios and are therefore less undervalued. We measure the market to book ratio as the market value of equity plus the book value of debt divided by the book value of assets at the fiscal year end prior to the announcement. The mean

⁶ Several of the variables investigated are not available for all sample firms.

(median) repurchasing firm has a market to book ratio of 1.48 (1.08), where as the mean (median) non-repurchasing firm has a market to book ratio of 1.14 (0.75). The difference between these two groups is significant regardless of the definition of repurchases. The firms that rely on a costless signal are more undervalued. This is in line with the prediction of our theoretical model.

Our theoretical model focuses only on the signaling motive. However, there are several other reasons why firms may repurchase stock. We control for these motives. First, Dittmar (2000) shows that large firms are the dominant repurchasers in the mid to late 1980s and 1990s. Our results in Table II are consistent with this finding since repurchasing firms have a significantly higher natural log of market capitalization. However, the firms' total assets do not differ significantly. Second, firms may repurchase stock to distribute excess cash if their investment opportunities are small. We measure the firm's cash flow as its operating income before depreciation divided by total assets in the fiscal year prior to the announcement, its cash balances as the amount of cash and marketable securities divide by assets in the fiscal year prior to the announcement, and its growth opportunities as the ratio of research and development expenses to sales in the fiscal year prior to the announcement. Research and development expense is assumed to be zero for any firm with missing data. Table II shows that repurchasing firms have significantly higher cash flow and significantly lower growth opportunities. But, cash balances are similar. Further, Table II shows that the average repurchasing firm has a higher dividend payout ratio (common dividends paid divided by operating income before depreciation), implying that the repurchase is a complement rather than a substitute for dividends. Third, since stock repurchases absorb equity and therefore alter the firm's leverage ratio, the firm may use a stock repurchase to achieve its target debt ratio (Bagwell and Shoven (1988) and Hovakimian, Opler and Titman (2001)). We measure the leverage ratio as total debt net of cash balances divided by assets in the fiscal year prior to the announcement. Table II shows that the leverage ratios of repurchasing and non-repurchasing firms are not significantly different. Fourth, since employee stock options are typically not dividend protected, firms with a high level of stock options outstanding may prefer repurchases to dividends

since repurchases do not dilute the per share value of the firm (Jolls (1996), Kahle (2001), Fenn and Liang (2001), and Weisbenner (2001)). Similar to Dittmar (2000), we measure the number of stock options outstanding as the percentage of common shares reserved for stock options in the fiscal year prior to the announcement as reported on Compustat. Table II shows that the mean percentage reserved is not significantly different across the two samples. Though the medians are significantly different, they are both zero, and so it is difficult to draw a conclusion from the summary statistics.

The last firm characteristic we examine is the percentage of shares sought in the repurchase. This item is from the repurchase announcement and is reported by Security Data Corporation, but it is not available for all firms. Not surprisingly, as we observe in Table II, repurchasing firms announce that they are planning to repurchase a greater percentage of stock than non-repurchasing firms.

B. Logit Analysis

To more formally test the implications of our theoretical model, we estimate a logit model in which the dependent variable is one if the firm repurchases stock in any of the four fiscal year ends following the repurchase announcement, and zero otherwise, conditional upon the firm announcing a stock repurchase. We investigate the impact that the number of informed traders (proxied by the number of analysts following) and undervaluation (proxied by market to book ratio) have on the probability of repurchasing, given that a firm announces a stock repurchase, while controlling for other motives to repurchase stock. Columns (1) through (6) in Table III present these results.

Column (7) presents results from a similar logit model where the dependent variable is one if the firm repurchases stock in the fiscal year of the repurchase announcement and zero if it does not repurchase in any of the four fiscal year ends following the announcement. This shorter repurchase horizon is used as a robustness check since it is possible that firms do not know at the announcement if they will repurchase four fiscal years later but they most likely know if they will repurchase that same year.

The results in Columns (1) through (7) in Table III strongly support the predictions of the theoretical

model. The coefficients on both the number of analysts and the market to book ratio are positive and significant, indicating that firms put their money where their mouth is and repurchase when there are more analysts following them, and when they are less undervalued. Our theoretical model suggests that this happens because under these circumstances it is difficult to attract scrutiny by just making an announcement. It is difficult to attract scrutiny because the benefit of search is small: these firms are well-known and there is not much mis-pricing.

To evaluate the economic significance of each variable in Table III, we calculate the derivative with respect to each independent variable, holding all variables constant at their mean. The coefficients of a logit model are not the partial derivatives of the probabilities with respect to the independent variable, and thus must be transformed to predict the effects of changes in one of the independent variables on the probability. We use the coefficients from column (6) to calculate the impact of each variable. We then multiply the derivatives by the standard deviation of the independent variable to determine the effect a one standard deviation change in the independent variable has on the probability. Column (8) in Table III shows that a one standard deviation increase in the market to book ratio results in a 10% increase in the probability of a stock repurchase; thus, if the firm becomes less undervalued by this amount, then the benefit to search is reduced, and the probability of a costly signal increases 10%. A one standard deviation increase in the number of analysts will increase the competition for profitable information and result in a 11% increase in the probability of a stock repurchase. These derivatives indicate that a change in the firm's mis-valuation or degree of informed trading will have a significant impact on the probability of a costly versus a costless signal.

The results presented in Table III are robust to controlling for all of the other reasons firm repurchase stock, reasons that were discussed in the summary statistics section. We find that cash flow, dividend payout, and the use of stock options significantly impact the probability of a repurchase given that a firm announces a repurchase program. Cash reserves, R&D expense, and the leverage ratio do not influence the

repurchase decision. Firm size as measured by market capitalization also does not influence the decision to repurchase, given that a firm announces a repurchase program. However, the coefficient on asset size is negative and significant.

The paper most similar to our empirical analysis is Stephens and Weisbach (1998). In this paper, the authors document the percentage of stock repurchased and investigate why some firms repurchase more stock than others. Our analysis differs from theirs in three ways. First, their question of interest differs from ours. Their question of interest is what determines the amount of stock a firm repurchases. We are interested in testing the dichotomous choice between costly and costless signaling. Second, because our question of interest differs, so does our testing methods. Stephens and Weisbach estimate a tobit model to investigate both the choice to repurchase and the percentage repurchased, whereas we use a logit model to focus on the difference in firms that announce and repurchase, and those that announce and never repurchase any stock. Third, we examine and control for several motives for repurchasing that are not relevant to their study. Thus, the results presented here cannot be inferred from their work.

C. Abnormal Returns

We now check the first and fourth predictions of our model. The first prediction is that costless signaling will work only if the signaling undervalued firms have more firm-specific risk. As explained before, this implies that the ex-post standard deviation of cumulative abnormal returns around the announcement should be higher for the costless signals. The fourth and last prediction of our theoretical model is that information content of both types of signals is the same. This implies that the ex-post mean of cumulative abnormal returns around the announcement should be the same for both these types of signals.

To test these predictions, we estimate the three-day abnormal return around the announcement of the repurchase program (days $t-1$ to $t+1$), using the CRSP value-weighted index and a comparison period from 200 days to 50 days before the announcement. Table IV presents the mean and the standard deviation of cumulative abnormal return. It uses both four and one fiscal year(s) to define a repurchaser. Consistent

with other studies, the mean abnormal return at the announcement of the repurchase is 3.6%, and it is significantly different from zero. The mean abnormal return for the firms that announce and then repurchase stock within the next four fiscal years is 3.6%, whereas the mean abnormal return for the firms that announce but do not repurchase stock within the next four fiscal years is 3.5%. The difference between these two means is not statistically significant. The standard deviation of abnormal return for the firms that announce and then repurchase stock within the next four fiscal years is 8.99%, whereas the standard deviation of abnormal return for the firms that announce but do not repurchase stock within the next four fiscal years is 9.77%. The difference between these two standard deviations is statistically significant at the 1% level. Thus, though the mean information content of the signals is the same, the standard deviation of the information content is higher for costless signals. As seen in the last two columns in Table IV, this conclusion holds whether we define a repurchaser as a firm who repurchases in the next four years after the announcement or as a firm which repurchases in the next one year after the announcement.

VI. Concluding Remarks

This paper focuses on the two signaling mechanisms that can be used by a good type to separate itself from the bad type: costless signaling and costly signaling. Under costless signaling, a good type can separate itself from a bad type by attracting scrutiny; the bad type will not mimic because the bad type will not risk attracting scrutiny and being discovered. Under costly signaling, a good type can separate itself from a bad type by giving a costly signal; the bad type will not mimic because the signal is costlier for the bad type.

We develop a simple model that gives the good type the choice of method. We set this model in the context of an undervalued firm signaling its value to the capital market. Costless signaling involves attracting scrutiny from speculators. Costly signaling involves burning money. We show that under this capital market environment, the undervalued firm will always prefer the costless signaling method to the costly signaling method. The intuition is that under the former method, the cost required for separating is borne by the speculator, whereas under the latter method, the cost required for separating is borne by the

undervalued firm.

Costless signaling is shown to work only under special circumstances. This is because the ability to attract scrutiny from speculators depends on whether there are enough incentives for these speculators to scrutinize the firm. In a capital market, the incentives of speculators to scrutinize a firm is the trading profits they obtain from discovering material non-public information about the firm. This means, and the model formally shows, that costless signaling will only work if the benefits to search are high. These benefits of search are high if there is more firm-specific risk about the value of the signaling firm. These benefits of search are also high if there is little public information available about the firm or if the firm is deeply undervalued, which increases the potential capital gain of the speculator.

We then take our testable implications to a sample of firms announcing share repurchases. This is a unique data set to test our theoretical model because 25% of firms that announce that they will repurchase their shares do not do it. Presuming that this 25% is the subset using costless signaling, we investigate the characteristics of this subset. Compared to the firms who actually repurchase, we find that this 25% has more firm-specific risk (as measured by standard deviation of abnormal returns), are more ignored (as measured by analyst following) and are more undervalued (as measured by market to book ratio). Surprisingly, costless signaling works as well as costly signaling; the mean abnormal return during the announcement for both are the same. These four pieces of evidence strongly support the predictions of our theoretical model.

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Table I
Percentage of firms repurchasing stock

Panel A

Firms first repurchasing stock in the first fiscal year after announcing	1363 (46%)
Firms first repurchasing stock in the second fiscal year after announcing	264 (9%)
Firms first repurchasing stock in the third fiscal year after announcing	141 (5%)
Firms first repurchasing stock in the fourth fiscal year after announcing	81 (3%)
Firms first repurchasing stock within four fiscal years after announcing	1849 (63%)
Firms not repurchasing stock within four fiscal years after announcing	740 (25%)
Firms dropping out of Compustat without repurchasing	359 (12%)
Firms in the sample	2948 (100%)

Panel B

Year	Total Firms	# firms repurchasing in four fiscal years after announcement	# firms not repurchasing in four fiscal years after announcement	% of firms repurchasing in four fiscal years after announcement	% of firms not repurchasing in four fiscal years after announcement	% of firms dropping off Compustat without repurchasing
1985	183	141	21	77%	11%	12%
1986	194	152	20	78%	10%	12%
1987	177	115	39	65%	22%	13%
1988	208	130	51	63%	25%	12%
1989	307	200	92	65%	30%	5%
1990	368	256	87	70%	23%	7%
1991	120	75	37	63%	31%	9%
1992	187	134	37	72%	20%	8%
1993	224	118	68	53%	30%	12%
1994	475	267	149	56%	31%	13%
1995	505	261	139	52%	28%	20%

Table II
Summary Statistics - Means and Medians

Note: Repurchasers are defined as firms which repurchase within four fiscal years after announcement (column 2) or within the fiscal year of the announcement (column 3); non-repurchasers are defined as firms which do not repurchase within four fiscal years after announcement (column 1). The market to book ratio is the market value of equity plus the book value of debt divided by the book value of the firm. Market capitalization is the market value of equity. Operating income is operating income before depreciation. The number of analysts is set equal to zero if the firm is not available on IBES. All explanatory variables are measured as of the year prior to the announcement. The means are on top, and the medians are below in parenthesis. The P-values are for t-tests for unequal, unpaired samples and Wilcoxon Rank-Sum tests.

	(1) Non-Repurchasers	(2) Repurchasers: within four fiscal year ends	(3) Repurchasers: within one fiscal year end	P-Value for (1) = (2)
Number of Analysts	3.00 (0.00)	5.57 (2.00)	6.02 (3.00)	0.00 (0.00)
Number of observations	740	1,849	1,363	
Market to Book	1.14 (0.75)	1.48 (1.08)	1.46 (1.08)	0.00 (0.00)
Number of observations	601	1,712	1,278	
ln Market Capitalization	4.37 (4.25)	4.98 (4.87)	5.06 (4.94)	0.00 (0.00)
Number of observations	625	1,731	1,290	
ln Total Assets	5.17 (5.16)	5.12 (4.95)	5.21 (4.99)	0.52 (0.49)
Number of observations	685	1,828	1,350	
Operating Income / Assets	0.01 (0.04)	0.14 (0.14)	0.15 (0.15)	0.00 (0.00)
Number of observations	648	1,775	1,305	
Cash / Assets	0.10 (0.04)	0.10 (0.04)	0.10 (0.04)	0.50 (0.07)
Number of observations	629	1,555	1,144	
R&D to Sales	0.31 (0.00)	0.08 (0.00)	0.09 (0.00)	0.00 (0.00)
Number of observations	651	1,813	1,342	
(Debt - Cash) / Assets	0.15 (0.11)	0.13 (0.12)	0.12 (0.11)	0.21 (0.18)
Number of observations	627	1,550	1,142	
% of Shares Reserved for Stock Options	0.05 (0.00)	0.06 (0.00)	0.06 (0.00)	0.30 (0.00)
Number of observations	675	1,818	1,344	
Common Dividend / Operating Income	0.06 (0.00)	0.11 (0.00)	0.12 (0.00)	0.04 (0.00)
Number of observations	647	1,773	1,307	
% of Shares Sought in Repurchase	0.06 (0.05)	0.08 (0.05)	0.08 (0.06)	0.00 (0.00)
Number of observations	631	1,543	1,143	

Table III
The Decision to Repurchase

Notes: Columns 1 through 6 present the coefficients from a logit model where the independent variable is a dummy variable equal to one if the firm repurchases stock within the 4 fiscal year ends following the announcement, and zero otherwise. Column 7 presents the coefficients of the logit model where the independent variable is a dummy variable equal to one if the firm repurchases stock within the fiscal year of the announcement, and zero if the firm does not repurchase within 4 years. Column 8 presents the change in the probability of a repurchase given a one standard deviation change in the independent variable using the coefficients from column 6. The market to book ratio is the market value of equity plus the book value of debt divided by the book value of the firm. Market capitalization is the market value of equity. Operating income is operating income before depreciation. The number of analysts is set equal to zero if the firm is not available on IBES. All explanatory variables are measured as of the year prior to the announcement. The intercept is included but not presented. The White corrected p-values are in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Repurchase within four fiscal years after announcement						Repurchase within one fiscal year after announcement	Effect of one σ movement in independent variable
Number of Analysts	0.06 (0.00)		0.05 (0.00)	0.03 (0.00)	0.06 (0.00)	0.04 (0.00)	0.03 (0.05)	11%
Market to Book		0.26 (0.00)	0.26 (0.00)	0.39 (0.00)	0.28 (0.00)	0.46 (0.00)	0.37 (0.04)	10%
ln Market Capitalization				-0.03 (0.51)		-0.02 (0.61)	-0.05 (0.49)	-7%
ln Total Assets					-0.20 (0.00)			-9%
Operating Income/Assets				6.29 (0.00)	6.09 (0.00)	6.94 (0.00)	12.11 (0.00)	24%
Cash /Assets				0.26 (0.70)	0.23 (0.72)	0.22 (0.76)	0.05 (0.97)	1%
R&D to Sales				0.04 (0.22)	0.04 (0.24)	0.03 (0.55)	-0.18 (0.54)	1%
(Debt - Cash)/Assets				0.05 (0.87)	0.25 (0.41)	0.14 (0.66)	-0.17 (0.12)	2%
% of Shares Reserved for Stock Options				4.01 (0.00)	3.48 (0.00)	4.21 (0.00)	2.65 (0.07)	7%
Common Dividend/ Operating Income				1.04 (0.00)	1.18 (0.00)	1.21 (0.00)	1.07 (0.12)	26%
% of Shares Sought in Repurchase						6.72 (0.00)	8.44 (0.00)	15%
Pseudo R ²	0.02	0.01	0.03	0.15	0.16	0.17	0.27	
Number of Observations	2,589	2,313	2,313	1,987	1,987	1,697	886	

Table IV
Abnormal Returns

Notes: The abnormal return is the three day (t-1 to t+1) abnormal return around the announcement of an open market stock repurchase using the CRSP value-weighted market return and a comparison period of –200 to –50 trading days. P-values from tests that determine if the mean abnormal returns are different than zero are in parentheses. The last row presents the p-value testing for difference between the samples using a t-test for unpaired and unequal samples to compare the means, and a F-test to compare the standard deviations.

	Mean of Abnormal Returns	Standard Deviation of Abnormal Returns	Mean of Abnormal Returns	Standard Deviation of Abnormal Returns
Repurchase within four fiscal years after announcement	0.036 (0.00) N=1,758	0.0899 N=1,758		
Repurchase within one fiscal year after announcement			0.037 (0.00) N=1,304	0.0911 N=1,304
No repurchase within four fiscal years after announcement	0.035 (0.00) N=647	0.0977 N=647	0.035 (0.00) N=647	0.0977 N=647
Repurchasers & Non Repurchasers	0.036 (0.00) N=2,405	0.0921 N=2,405	0.036 (0.00) N=1,951	0.0933 N=1,951
P-Value for difference between samples	0.83	0.01	0.65	0.04

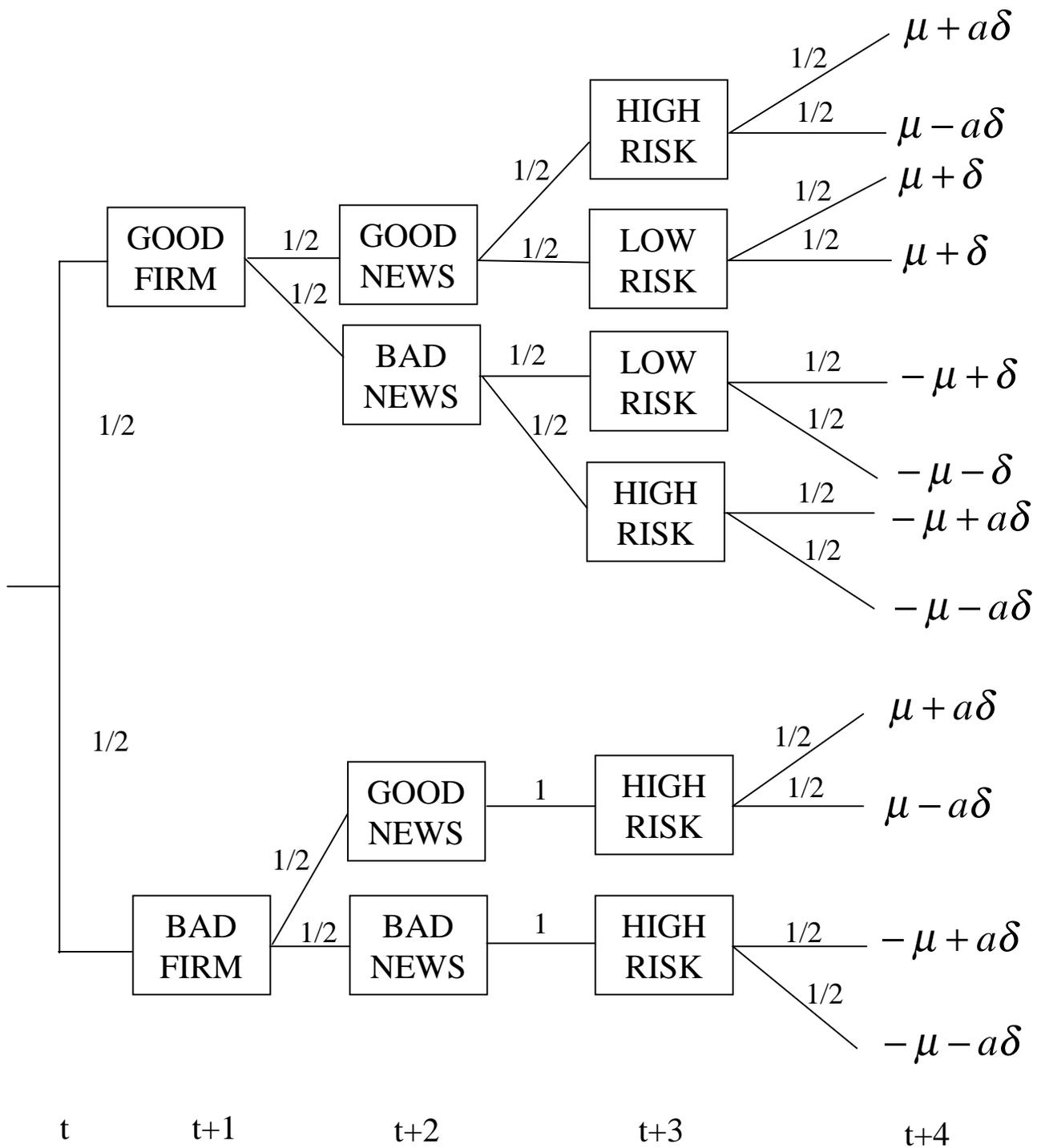


Figure 1. Resolution of uncertainty in the economy

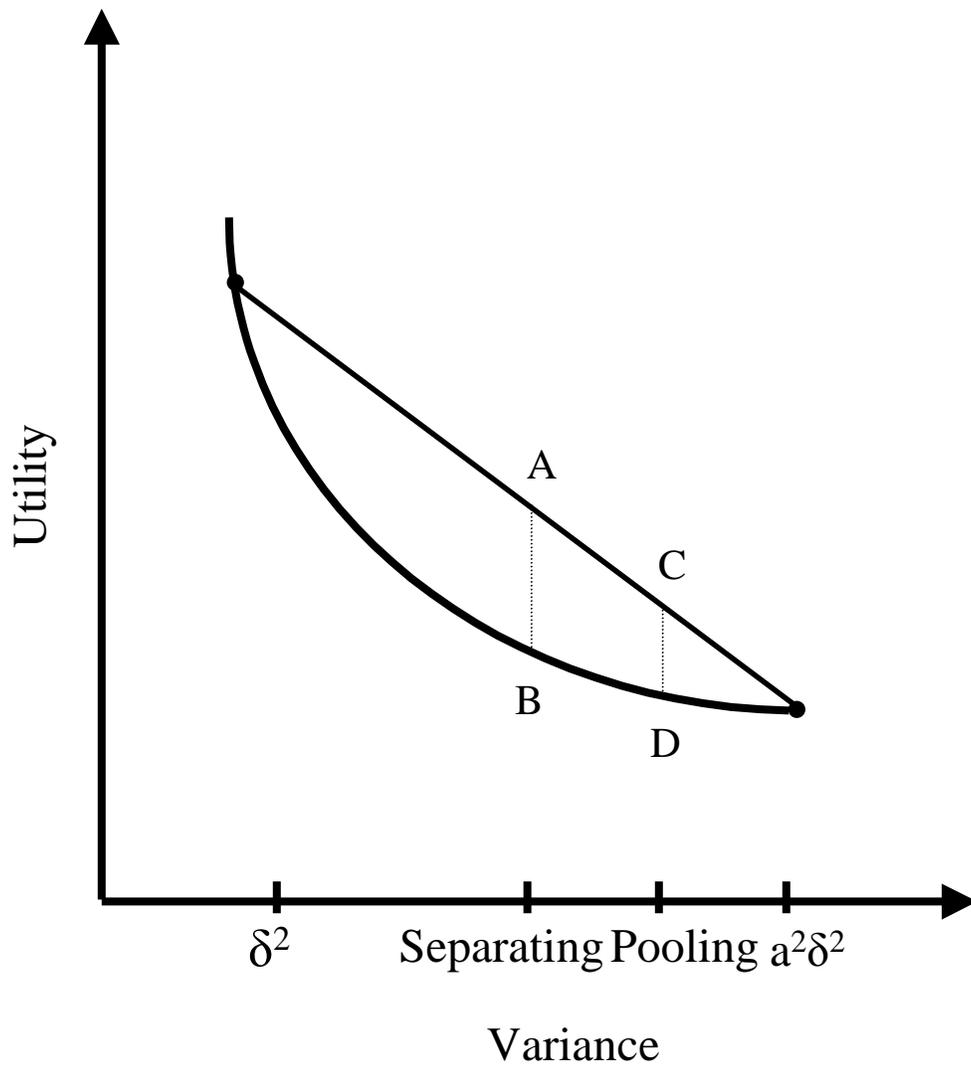


Figure 2. Utility gains to search

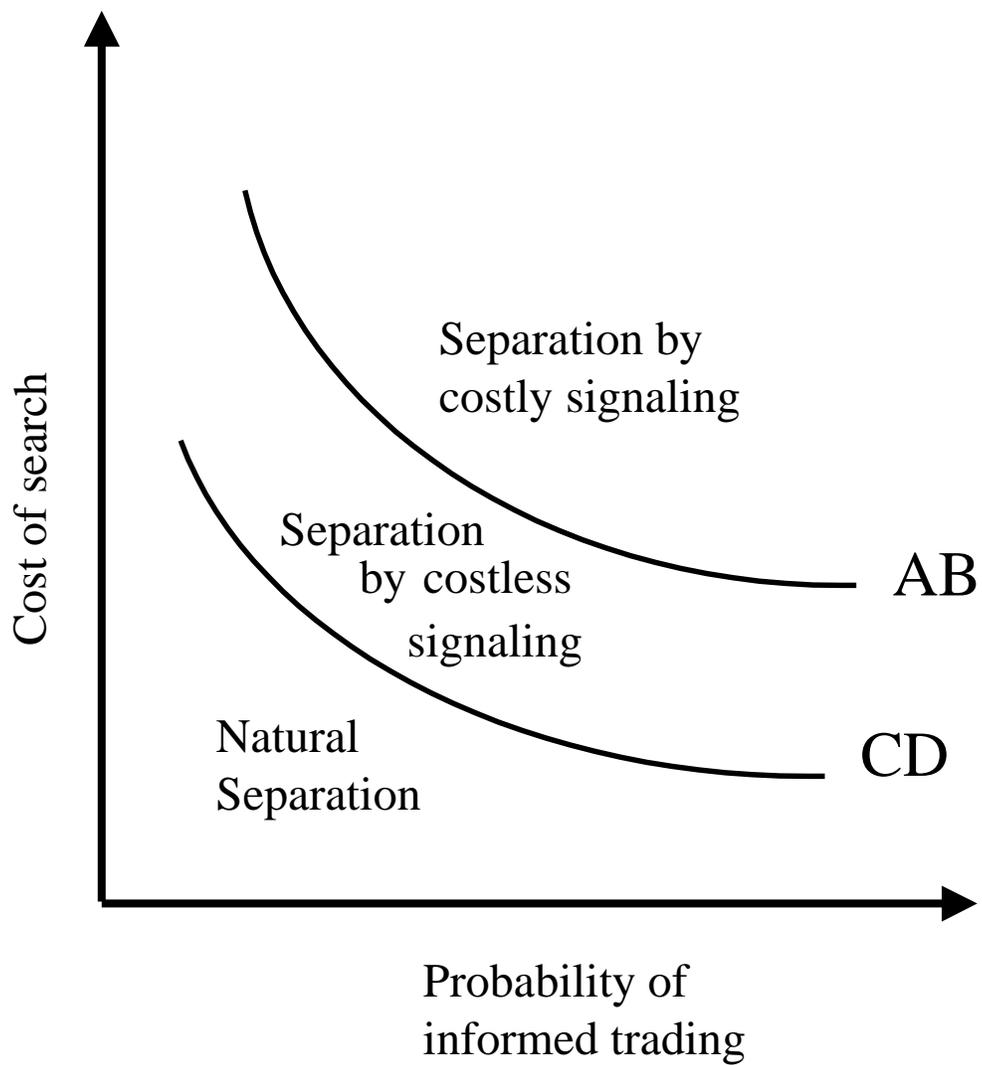


Figure 3. Separation zones keeping under-valuation of the good firm constant

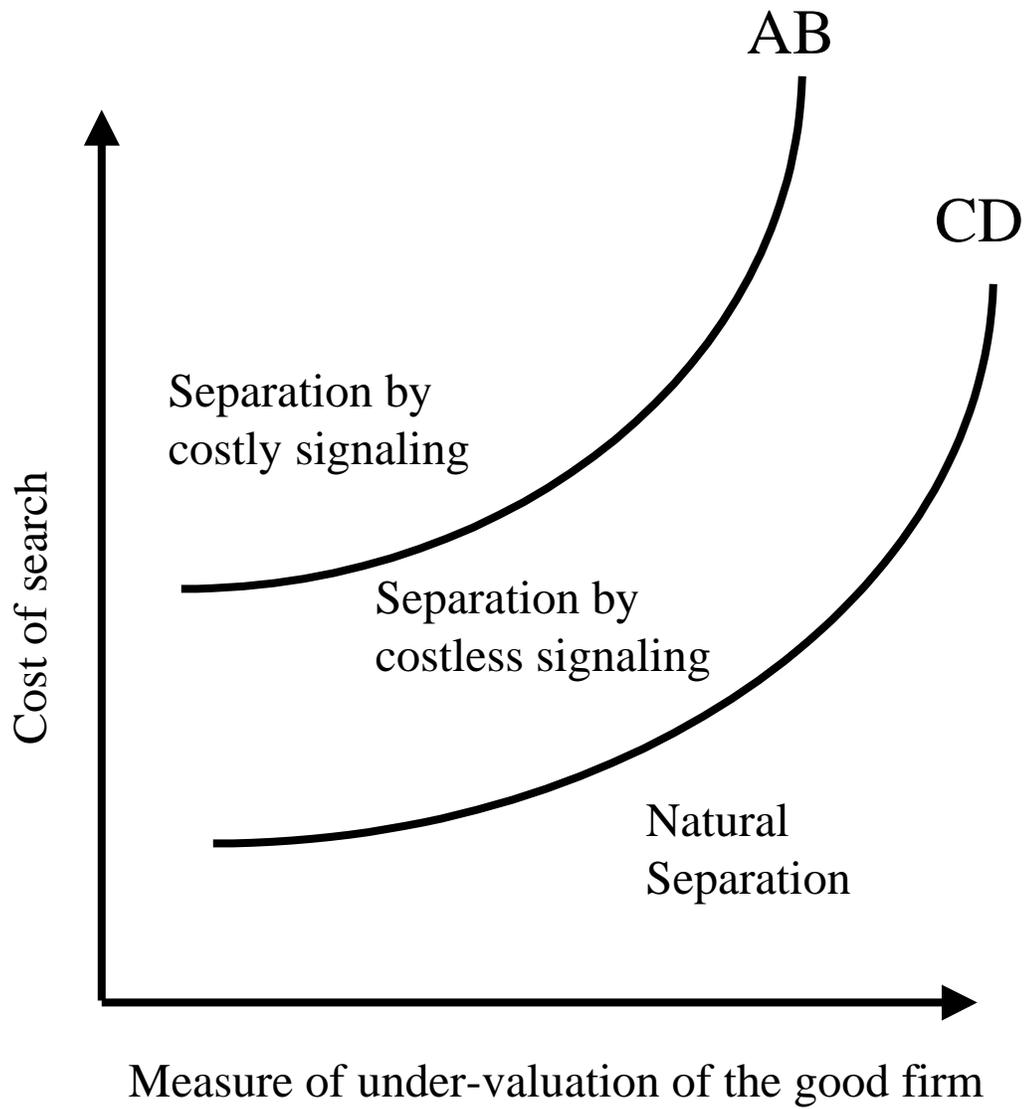


Figure 4. Separation zones keeping probability of informed trading constant