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Open-Market Repurchase Announcements, Actual Repurchases, and Stock Price Behavior in Inefficient Markets

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Abstract

In the efficient market framework, it seems difficult to explain why a firm would actually buy back its outstanding shares after the stock price goes up in response to an open-market repurchase announcement. We introduce the subject of market inefficiency in a way similar to the explanation of Shleifer and Vishny (1990, 1997) and reexamine corporate open-market repurchase strategy and stock price behavior. In contrast to previous studies dealing with open-market repurchase signaling, we establish a signaling equilibrium without the assumption that an announcement of open-market repurchase intention is a firm-commitment. In an inefficient market, the stock price of a firm may be undervalued when the market is subject to temporal pessimistic noise. Since the firm can earn capital gains by buying its outstanding shares at a bargain price, the firm has a strong incentive to execute stock repurchases even after it makes an announcement of repurchase intention. Empirically, our model predicts positive performance of long-run stock returns as well as positive announcement effects following open-market repurchase announcements.

Keywords: open-market stock repurchases, market inefficiency,
positive performance of long-run stock returns

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1. Introduction

Stock repurchases have become an important financial policy for listing firms over the last twenty years. As reported by Bagwell and Shoven (1989) and Grullon and Michaely (2000), open-market stock repurchasing has been the most popular method for firms to repurchase stock. Many empirical studies, such as those of Vermaelen (1981), Comment and Jarrell (1991), Netter and Mitchell (1989), Stephens and Weisbach (1998), and McNally (1999), report that stock prices rise in response to open-market repurchase announcements. That is, open-market repurchase announcements are good news for the stock market. This is known as the signaling hypothesis for open-market stock repurchases.[1]

In addition to the positive announcement effect, Ikenberry, Lakonishok, and Vermaelen (1995) find that stock prices further appreciate following announcements of open-market repurchases.[2] This phenomenon suggests that, for an announcing firm, purchase of its outstanding shares constitutes a profitable investment opportunity even after the stock price rises in response to the announcement of an open-market repurchase. In fact, although firms do not necessarily need to obey their announcements, Stephens and Weisbach (1998) report that most firms do follow through with such announcements.

As pointed out by Ikenberry, Lakonishok, and Vermaelen (1995), if the market

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[1] The signaling hypothesis could imply that a firm is undervalued because the future operating performance of the firm is going to improve. Alternatively, a firm could simply be inefficiently priced without implying any future improvement in operating performance. This paper deals with both cases.

[2] They report that, on average, announcing firms experience a significant positive stock price increase of about 12 percent over the subsequent four years.

evaluates the worth of the stock price of a firm based on the fundamentals, then outstanding shares will not be profitable immediately following the market reaction to the repurchase announcement. Thus, in the efficient market framework, it seems difficult to explain by the signaling hypothesis why a firm would actually buy back its outstanding shares after announcing its intention to repurchase shares. In this paper, we attempt to reexamine corporate open-market stock repurchase strategy and stock price behavior when there exist both informational asymmetry and market inefficiency.

We introduce the subject of market inefficiency in a way similar to the explanation of Shleifer and Vishny (1990, 1997). In our model, pessimistic noise causes market undervaluation of the stock price of a firm.[3] Smart money is costly, so the market misperception cannot be eliminated completely.[4] A firm can make use of this market undervaluation: by buying its outstanding shares at a bargain price and holding them until the noise disappears, the firm can earn capital gains. There is thus an obvious incentive for the firm to execute stock repurchases in the open market with pessimistic noise. From the viewpoint of market efficiency, the firm provides smart money via open-market stock repurchases. As the firm buys its own shares, demand increases and the stock price rises. In this process, the market mispricing is partially mitigated. The firm, however, never buys its shares to the extent that the market mispricing is

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[3] The assumption that the market contains noise can be supported by the empirical findings reported by Campbell and Kyle (1993), Redding (1996), and Morgan (1997). Recently, Daniel, Hirshleifer, and Subrahmanyam (1998) and Barberis, Shleifer and Vishny (1998) explored the mechanisms by which investor sentiment, based upon psychological theory, leads to market noise.

[4] Shleifer and Vishny (1990, 1997) and Shleifer (2000, Chapter 1) stress that smart money seems to be costly in the real world. Pontiff (1996) provides empirical findings that support the idea of costly smart money.

eliminated completely, because the firm cannot earn capital gains by doing so.

In contrast to previous papers dealing with open-market repurchase signaling, such as those of Ofer and Thakor (1987), Constantinides and Grundy (1989), and McNally (1999), we do not assume that a firm has to follow through on its announcement of an intention to repurchase its shares on the open market. Ikenberry and Vermaelen (1996) say that the irrevocability assumption of open-market repurchase announcements is not realistic. In practice, open market repurchase announcements provide firms with an option to buy back their outstanding shares but do not commit firms to do so.[5]

On the other hand, as pointed out by Stephens and Weisbach (1998) and Grullon and Michaely (2000), although firms are not required to announce their intention to repurchase shares on the open market, the announcement is interpreted as a safe harbor against stock price manipulation. We incorporate this idea into our model as follows. While an announcing firm can buy back any number of shares up to a relatively large proportion of its outstanding shares, the number of shares that a firm can buy back without making a repurchase announcement is restricted to a relatively small proportion of shares. We assume that if a firm repurchases a large proportion of its shares without making an announcement, the firm will be suspected of stock price manipulation or insider trading and a deadweight cost will be imposed on the firm.

The above setting establishes a signaling equilibrium in which a high-quality firm chooses to make an open-market repurchase announcement and a low-quality firm chooses not to announce. In the equilibrium, the high-quality firm makes an announcement in order to buy back a large number of shares at a bargain price caused

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[5] Ikenberry and Vermaelen (1996) insist that open-market repurchase programs are useful for firms because the programs expand the firms' investment opportunity sets by giving management an additional investment opportunity, that is, to purchase the firms' own shares.

by pessimistic noise. On the other hand, the low-quality firm does not announce its intention and buys back a small number of shares at a price lower than its fundamental value. By mimicking the low-quality firm, the high-quality firm can buy back its shares at a lower price than it can on the equilibrium path, because the market believes that a non-announcing firm is a low-quality firm. However, since the high-quality firm can buy back only a small number of shares without making a repurchase announcement, the capital gains the high-quality firm could earn is smaller than what it could earn on the equilibrium path. If the low-quality firm mimics the high-quality firm, then it loses the opportunity to earn capital gains, because the market believes that an announcing firm is a high-quality firm.

It should be stressed that the high quality firm has an intense incentive to actually buy back its outstanding shares following an announcement of repurchase intention even though the announcement is not a firm commitment. This is one contribution of our paper. As argued just above, an announcing firm can enjoy capital gains by repurchasing its shares at a bargain price if markets are not completely efficient.

Capital gains earned by the announcing firm results in the positive performance of long-run stock returns. Thus, our signaling model predicts both positive announcement effects and long-run positive performance of stock returns associated with open-market repurchase announcements. This type of prediction of positive long-run performance, which is consistent with the empirical finding of Ikenberry, Lakonishok, and Vermaelen (1995), has not been investigated theoretically. This is another contribution of our paper.

The central motivation considered in this paper is that actual repurchases may be inconsistent with the efficient market if the only reason for repurchasing shares is signaling. There are, however, some reasons for repurchasing shares that have nothing to do with signaling. One of the most cited reasons is the tax advantage of stock repurchases relative to cash dividends (e.g., Talmor and Titman, 1990; Bagwell and Shoven, 1991; Grullon and Michaely, 2000). Since we do not incorporate tax payment, there is no tax-related reason for the firm to buy back its shares in our model. The free cash flow hypothesis introduced by Jensen (1986) posits that the firm makes the decision to execute stock repurchases (or pay dividends) in order to avoid managerial overinvestment. There is no such problem in our model because we assume that the objective of the firm is to maximize the future stock price. We repeat that, in our model, the motivation for repurchase is the undervaluation of the stock price caused by pessimistic noise.

The remainder of this paper is organized as follows. In the next section, we present our model. In section 3, we analyze corporate open-market repurchase strategy and market behavior. In section 4, we examine stock price behavior and show some of the empirical implications of our model. In section 5, we address some remaining points of relevance to the model, and in section 6, we conclude the paper.

2. The Model

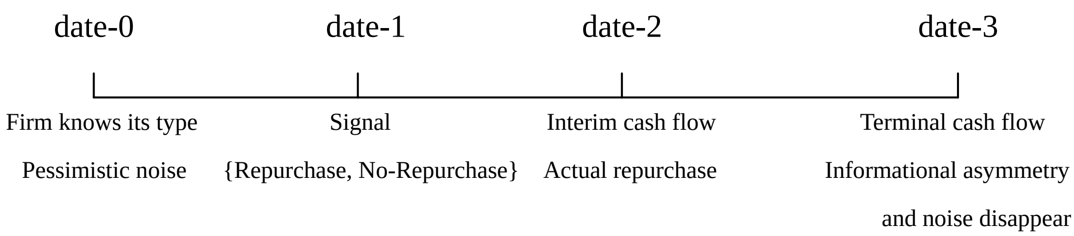

Figure 1. Time Line

Figure 1 summarizes the sequence of events and decisions over four dates. There are three types of participants in the model: a firm, noise traders, and smart traders. For simplicity, we assume that all participants are risk-neutral, and the interest rate is zero.

We consider the case of an all-equity firm whose objective is to maximize its stock price at the terminal date (date-3). For example, when a manager of the firm has an executive option expired at date-3, she cares about the date-3 stock price.[6] Initially, the firm has one outstanding share and no cash. The firm generates an interim cash flow, C>0, at date-2, which is its resources for stock repurchases. In addition, the firm generates a terminal cash flow, V^t>0, at date-3. The terminal cash flow depends on the quality of the firm, $t \in \{h, l\}$, where h means high quality and l means low quality. The terminal cash flow of the high-quality firm is larger than that of the low-quality firm, that is $V^h > V^l$. In this paper, we analyze the case of $V^h - V^l \le 2C$. The reverse case can be analyzed in a similar way.

There is an informational asymmetry regarding the quality (type) of the firm. At date-0, the firm knows its type but the market (noise traders and smart traders) does not. The market knows only the distribution over types; the probability of a firm being a high-quality type is θ ($0<\theta<1$) and that of it being a low-quality type is $1-\theta$. This informational asymmetry is resolved at date-3. All other parameters are equal between the two types.

The structure of the market is similar to that described by Shleifer and Vishny (1990, 1997). At date-0, noise traders experience a pessimistic shock, S>0, which will persist until date-3. As a reflection of the pessimistic noise, the date-0 demand schedule of noise traders is given by $[\theta V^h+(1-\theta)V^l+C-S]/P_0$, where P_0 is the market price at date-0. It can be interpreted that noise traders underestimate the firm value to the extent of the magnitude of the pessimistic shock, S. For the sake of simplicity, we assume that the magnitude of the pessimistic shock is smaller than the difference between the terminal cash flows of the two types. That is,

$$S \le V^h - V^l \le 2C.^{7} \qquad (1)$$

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[6] Jolls (1998) reports that executive options play an important role in explaining stock repurchase behavior.

[7] As will be shown later, $S \le V^h - V^l$ ensures that a low-quality firm does not buy back its

In this paper, we do not formally model the mechanism by which noise traders underestimate the firm value, but rather use the reduced demand schedule described above. Recent articles, such as those of Barberis, Shleifer, and Vishny (1998) and Daniel, Hirshleifer, and Subrahmanyam (1998), provide mechanisms by which investor sentiment, based upon psychological theory, leads to market misperception. For example, if traders have a representative heuristic or are overconfident, then they tend to underestimate the firm value just after observing a negative surprise. One can imagine a scenario in which the firm experiences an unexpected negative earning surprise prior to date-0, resulting in underestimation by the noise traders. This scenario seems to be consistent with the fact that firms tend to make open-market repurchase announcements after an abnormal stock price decline.[8, 9]

The total amount of cash that smart traders invest in the stock of the firm at date-0 is B_0, and the date-0 demand schedule of smart traders is given by B_0/P_0. Since the stock price is determined by the market clearing condition that the aggregate demand must be equal to the unit supply, the date-0 stock price of the firm is given by

$$P_0 = \theta V^h + (1-\theta)V^l + C - S + B_0 . \qquad (2)$$

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shares when the market believes that the firm is a high-quality firm. Also, $S \leq 2C$ ensures that the optimal amount of dollars the firm uses for repurchases is less than the interim cash flow, C.

[8] Under this scenario, many firms tend to announce an open-market repurchase program after systematic pessimistic shock appears. One example of systematic pessimistic shock may be the crash of 1987. It is well known that many firms announced open-market repurchase programs in the first few months after the crash.

[9] In the efficient market framework, Isagawa (2000) provides a signaling model in which a firm chooses to make an announcement of open-market repurchase after it experiences a stock price decline.

Note that the stock price of the firm is undervalued unless smart traders invest too much. Then, the firm has an incentive to repurchase its outstanding shares.

At date-1, knowing the pessimistic shock of noise traders, the firm decides whether or not it will announce an open-market stock repurchase at date-2. Let $j \in \{a, n\}$ represent a message sent by the firm, where *a* means an announcement and *n* means no announcement. It should be stressed that the firm does not need to follow through on its repurchase announcement. It is also possible that the firm buys back its shares without making an announcement. As described just below, however, the number of shares the firm can buy back without making an announcement is restricted to a small proportion of its outstanding shares.

Just after receiving a message $j \in \{a, n\}$, both noise traders and smart traders update their demand schedules. Let $V(j)$ denote the noise traders' assessment of the terminal cash flow of the firm conditional on a message *j*. The demand schedule of noise traders changes to $[V(j)+C-S]/P_1(j)$, and the demand schedule of smart traders changes to $B_1(j)/P_1(j)$, where $P_1(j)$ is the date-1 stock price of the firm conditional on a message *j*. It follows from the market clearing condition that the date-1 stock price is given by

$$P_1(j) = V(j) + C - S + B_1(j), \quad j \in \{a, n\}. \tag{3}$$

At date-2, an interim cash flow is realized and the firm decides on the amount of cash it will use to repurchase shares. Let $K(j;\, t) \geq 0$ denote the amount of cash used by type $t \in \{h, l\}$ following the date-1 message $j \in \{a, n\}$. Throughout the paper, the external financing problem is assumed away.[10] If the firm makes an announcement of repurchase intention, it can then invest any dollars up to the interim cash flow amount,

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[10] Vermaelen (1981) says that open-market repurchases are mainly financed with internal funds. Furthermore, in our model, the optimal amount of dollars that the firm uses for repurchasing following an announcement is less than the interim cash flow, *C*, under the condition of $S \leq 2C$. For more on this point, see section 3.

that is, $K(a;\ t)\leq C$. On the other hand, the amount of dollars that the firm can use for repurchasing without announcement is restricted to $D<C$, that is, $K(n;\ t)\leq D<C$. We assume that if the firm uses more than D dollars to buy back its shares without announcement, then it will be suspected of stock price manipulation or insider trading and a deadweight cost will be imposed on the manager of the firm. Without loss of generality, we assume that repurchased shares are redeemed.

The date-2 demand schedule of noise traders conditional on a message j is $[V(j)+C\text{-S}]/P_2(j)$, and that of smart traders is $B_2(j)/P_2(j)$. In addition, the firm of type t repurchases $K(j;\ t)/P_2(j)$ shares. Therefore, the date-2 stock price of the firm conditional on a message j is given by

$$P_2(j) = V(j) + C - S + B_2(j) + K(j;t)\,, \quad j\in\{a, n\},\ t\in\{h, l\}. \tag{4}$$

At date-3, the terminal cash flow of the firm is publicly realized, and both informational asymmetry and the pessimistic noise disappear. After realizing the true value of the firm, noise traders correct their assessment on the firm value so that the undervaluation disappears.[11] Since the number of outstanding shares is $1\text{-}K(j;\ t)/P_2(j)$ and the residual cash is $V^t\text{+}C\text{-}K(j;\ t)$, the date-3 stock price of the firm is given by

$$P_3(j;t) = \frac{V^t + C - K(j;t)}{1 - K(j;t)/P_2(j)} = \frac{P_2(j)[V^t + C - K(j;t)]}{V(j) + C - S + B_2(j)}\,, \quad j\in\{a, n\},\ t\in\{h, l\}. \tag{5}$$

The objective of the firm is to maximize the date-3 stock price, so the firm chooses a

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[11] Alternatively, we can consider the situation in which noise traders gradually correct their pessimistic assessment on the firm value. Daniel, Hirshleifer, and Subrahmanyam (1998) show that mispricing caused by overconfidence is partially corrected when public information arrives. In our model, public information arrives at date-1 (repurchase announcement) and date-2 (actual repurchases). Although it is necessary to assume $S_0>S_1>S_2$ under this scenario (S_t is the magnitude of date-t pessimistic shock), the results will not essentially change.

pair of {j, K} that maximizes (5). By plugging (4) into (5) and differentiating (5) with respect to $K(j;\, t)$, we obtain the following lemma.

Lemma 1. Let us define

$$f(j;t) = [V^t - V(j) + S - B_2(j)]/2 .$$

Suppose that $f(j;t) \geq 0$. Then, the date-3 stock price, $P_3(j;\, t)$, increases with $K(j;\, t)$ when $K(j;\, t) < f(j;\, t)$ and decreases with $K(j;\, t)$ when $K(j;\, t) > f(j;\, t)$.

Lemma 1 says that, for any $B_2(j)$, the optimal amount of dollars the firm invests in its shares is given by $f(j;\, t)$.

In order to incorporate the market inefficiency into the model, we assume that smart traders are competitive and incur a cost, $R>0$, to take per dollar position for one period (between two dates). As argued by Shleifer and Vishny (1990, 1997) and Shleifer (2000), most professional smart traders do not manage their own money in the real world. Since smart traders have to finance outside money, transaction costs caused by the imperfections in the money market are required. In addition, as shown by Shleifer and Vishny (1997), the agency relationship between smart traders (fund managers) and their fund providers may result in an agency cost on smart traders. It should be stressed that the misperception of noise traders is quickly and completely eliminated in the case of rational smart traders who can take any position without cost. In contrast to smart traders, the firm does not need to pay an additional cost for purchasing its shares because it uses only internal funds.[12]

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[12] The idea of costly smart money is the central argument of market inefficiency (Shleifer (2000, p.13)). This assumption also holds when the individual smart trader is risk-averse and there exists uncertainty with regard to the firm value (fundamental risk)

Under the above assumption of costly smart money, smart traders decide to take a non-zero position ($B \neq 0$) if and only if the gross return per dollar position exceeds R, or the rate of return exceeds R-1. The competition among smart traders ensures that the gross return for one period is equal to R or the rate of return is equal to R-1 whenever smart traders take a non-zero position. To ensure that the date-2 total demand of smart traders is strictly positive in the equilibrium, we assume that

$$1 < R < 1 + (V^h - V^l) / 2(V^l + C) . \qquad (6)$$

The second inequality requires that the cost of smart traders is not too large. When the cost is too large, smart traders will not take any position even if the stock price is mispriced. Since the third term is strictly larger than 1, there exists an R that satisfies (6).

3. Corporate Open-Market Repurchase Strategy

In this section, we consider signaling equilibria in which the high-quality firm chooses to make an announcement of repurchase intention and the low-quality firm chooses not to announce. In particular, we focus our attention on the equilibrium in which the noise traders' assessment of the terminal cash flow, $V(j)$, is correct, that is, $V(a)=V^h$ and $V(n)=V^l$.

First, let us consider the equilibrium path following a repurchase announcement ($j=a$). Here, we analyze the case in which the date-2 position of smart traders is strictly positive ($B_2(a)>0$).[13] In this case, we have two conditions to solve the equilibrium $B_2(a)$

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and noise process (noise trader risk). The assumption that the cost incurred on the firm is lower than the cost incurred on smart traders is also persuasive in such a risk-averse setting because the individual investor is likely to be more risk-averse than the firm.

[13] If $B_2(a)=0$, the following analysis is somewhat simplified, but the essence of the

and $K(a;\, h)$. One is the condition of smart traders, that is, smart traders have to earn R dollars per dollar investment. This condition is given by $P_3(a;\, h)=RP_2(a)$. The other condition requires that the high-quality firm maximizes its date-3 stock price. From lemma 1, this condition is given by $K(a;\, h)= f(a;\, h)$. By solving these two equations, we can obtain the following proposition.

Proposition 1. Suppose

$$2(R-1)(V^h + C)/(2R-1) < S \le V^h - V^l \,. \tag{7}$$

Then, in the equilibrium,

$$B_2(a) = S - 2(R-1)(V^h + C)/(2R-1) > 0\,, \tag{8}$$

$$K(a;h) = (R-1)(V^h + C)/(2R-1)\,. \tag{9}$$

Under (6), there exists an S that satisfies (7).

Proof: See Appendix.

In the proposed equilibrium, the high-quality firm has an intense incentive to buy back its shares on the market after it makes an announcement of repurchase intention, because the firm can earn capital gains by repurchasing its outstanding shares at a bargain price. To see this, by plugging (8) and (9) into (4) and (5) and rearranging, the date-2 and date-3 stock prices following an announcement are given by

$$P_2(a) = V^h + C - (R-1)(V^h + C)/(2R-1)\,, \tag{10}$$

$$P_3(a;h) = V^h + C + (R-1)^2 (V^h + C)/(2R-1) = RP_2(a)\,. \tag{11}$$

Equation (10) means that the date-2 stock price of the high-quality firm is lower than its fundamental value, V^h+C. Equation (11) means that the date-3 stock price is higher than V^h+C. The term of $(R\text{-}1)^2(V^h+C)/(2R\text{-}1)$ in (11) represents capital gains obtained by a stock repurchase at date-2. It can be easily shown that the date-3 stock

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results will not change.

price is equal to V^h+C if the high-quality firm does not buy back its shares. Note that $P_3(a)=RP_2(a)$ holds because of the condition of smart traders.

Since the demand of the high-quality firm for its shares is strictly positive ($K(a;h)>0$), the undervaluation caused by the pessimistic noise is partly mitigated at date-2. In this sense, it can be interpreted that an open-market stock repurchase is a supply of smart money. The firm does not provide sufficient money to bring the stock price to its fundamental value, however, because it loses the opportunity for capital gains by doing so.

Next, we consider the equilibrium path following no announcement. In this case, the total amount of dollars that the low-quality firm can use for repurchasing is restricted up to D. For analytical simplicity, we suppose that D is so small that the firm always uses D for repurchasing. Formally, we assume that

$$0 \le D \le (R-1)(V^l + C)/2R \equiv D^* . \qquad (12)$$

The following proposition characterizes the date-2 total demand of the low-quality firm and that of smart traders conditional on the absence of a repurchase announcement (j=n).

Proposition 2. Suppose (12) is satisfied. Then, in the equilibrium,

$$K(n;l) = D , \qquad (13)$$

$$B_2(n) = S - [(R-1)(V^l + C) + D]/R > 0 . \qquad (14)$$

Proof. See Appendix.

It follows from (13) and (14) that the date-2 and date-3 stock prices following no announcement are given by

$$P_2(n) = V^l + C - (R-1)(V^l + C - D)/R , \qquad (15)$$

$$P_3(n;l) = V^l + C + (R-1)D = RP_2(n) . \qquad (16)$$

Since the date-2 stock price is undervalued ($P_2(n)<V^l+C$), the low-quality firm also has an incentive to buy back its shares even though it does not make an announcement of repurchase intention. The term of $(R\text{-}1)D$ in the equation (16) represents capital gains generated from stock repurchasing.

In order to establish the proposed equilibrium, we have to show that both types of firms have no incentive to deviate from the equilibrium strategy. It is easy to show that the low-quality firm never chooses to make an announcement. To see this, note that

$$P_2(a) = V^h + C - S + B_2(a) > V^l + C .$$

The inequality follows from (1) and (8). Since the date-2 stock price following an announcement is larger than its fundamental value, repurchasing any shares results in a capital loss at date-3. Therefore, the low-quality firm never buys its shares if it makes an announcement. It should be stressed that an announcement of repurchase intention is not a firm commitment in our model. As a result,

$$P_3(a;l) = V^l + C < V^l + C + (R-1)D = P_3(n;l) . \quad (17)$$

Thus, the low-quality firm has no incentive to deviate from the equilibrium strategy.

By choosing not to make an announcement, the high-quality firm faces a tradeoff. That is, while the high-quality firm can buy back its shares at a lower price than it can on the equilibrium path, the amount of dollars it can use for repurchasing is restricted to *D*. If *D* is so small that the capital gains is smaller than the capital gains possible on the equilibrium path, then the high-quality firm does not deviate from the equilibrium strategy. In fact, we can obtain the following Lemma.

Lemma 2. Let us define

$$g(D) \equiv D[R(V^h + C - D)/(V^l + C - D) - 1], \quad 0 \le D < V^l + C. \quad (18)$$

Then, there exists $D^{**} \in (0, V^l+C)$ such that

$$g(D^{**}) = (R-1)^2 (V^h + C)/(2R-1) . \quad (19)$$

Suppose that

$$0 \le D \le \min\{D^*, D^{**}\}, \qquad (20)$$

where D^* is given by (12) and D^{**} is given by (19). Then,

$$P_3(a;h) \ge P_3(n;h). \qquad (21)$$

Proof. See Appendix.

As shown in the Appendix, $g(D)$ represents capital gains that the high-quality firm can earn by choosing no announcement. On the other hand, from equation (11), we know that $(R\text{-}1)^2(V^h+C)/(2R\text{-}1)$ represents capital gains that the firm can earn by making an announcement. Since $g(D)$ increases with D, the condition (20) ensures that the capital gains the high-quality firm can earn by choosing an announcement is larger than what the firm can earn by choosing no announcement. The high-quality firm then chooses to make an announcement under (20).

From the above arguments, under a set of parameters (V^h, V^l, C, S, R, D) that satisfies (1), (6), (7), and (20), the proposed signaling equilibrium exists.

Proposition 3. There exists a signaling equilibrium in which the high-quality firm makes an announcement of open-market repurchase intention and the low-quality firm does not make such an announcement.

In our model, the high-quality firm chooses to make an announcement of open-market repurchase intention in order to buy back a relatively large number of shares. On the other hand, the low-quality firm chooses not to announce an intention to repurchase shares because it cannot earn any capital gain following such an announcement.

4. Stock Price Behavior and Empirical Implications

In this section, we examine stock price behavior in the equilibrium and show some of the empirical implications of our analysis. The following proposition characterizes date-0 and date-1 stock prices.

Proposition 4. In the proposed equilibrium,

$$P_1(a) = P_2(a)/R = P_3(a,h)/R^2, \tag{22}$$

$$P_1(n) < P_0 < P_1(a). \tag{23}$$

Proof. See Appendix.

It follows from (23) that, in the proposed equilibrium, the stock price goes up in response to a repurchase announcement ($P_0<P_1(a)$). This is consistent with the typical empirical results of the immediate positive stock price reaction to open-market repurchase announcements.

In addition, the equation (22) shows that the date-2 stock price of the high-quality firm is larger than the date-1 stock price ($P_1(a)<P_2(a)$), and the date-3 stock price is larger than the date-2 price ($P_2(a)<P_3(a;\ h)$). That is, our model predicts that the stock price continues to go up gradually subsequent to an announcement of an open-market repurchase program. This prediction is consistent with the empirical findings reported by Ikenberry, Lakonishok, and Vermaelen (1995). Thus, our model can explain both the positive return at the announcement of a repurchase intention and the long-run positive return observed subsequent to the announcement.

In our model, the long-run stock return subsequent to an open-market repurchase announcement is given by

$$[P_3(a;h) - P_1(a)]/P_1(a) = R^2 - 1. \tag{24}$$

Note that the magnitude of the pessimistic noise does not directly affect the long-run return. This is the result from the condition of competition among smart traders.

The long-run return represented in (24) increases with a cost R of smart traders. Pontiff (1996) argues that costs of smart traders include both transaction costs such as brokerage fees, market impact costs, and bid-ask spreads, and holding costs such as borrowing costs, opportunity costs due to a margin requirement of short-sale proceeds, and risk exposure from imperfectly hedged positions. Our model then predicts that the magnitude of the long-run abnormal performance following open-market repurchase announcements has positive relationships with these costs.[14]

With regard to actual repurchases of an announcing firm, the equation (9) implies that the amount of dollars the firm uses for repurchasing increases with its interim cash flows. Stephens and Weisbach (1997) find that share repurchases of firms are positively related to their cash flows. This evidence is consistent with our prediction. The size of the repurchase program given by (9) also increases with R, as does the long-run return (see above). That is, given C and V^h, both the size of the repurchase program and the long-run return increase when R increases. In this sense, our model predicts a positive relationship between the repurchase size and the long-run performance.[15]

Finally, in contrast to previous studies, our model suggests that a non-announcing firm may buy back its outstanding shares on the market. It is difficult to examine whether or not firms actually buy back their shares on the open market without making a repurchase announcement. However, from the viewpoint of the institutions, firms are not required to announce their intention to make open-market stock repurchases.

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[14] In his empirical work, Pontiff (1996) uses the inverse of the stock price of a firm and market equity value as transaction cost proxies, and the short-term interest rate and dividend yield as holding cost proxies.

[15] Since we do not calculate P_0, we cannot show any relationship between the repurchase size and the announcement period return.

5. Discussions

There are several additional points worth discussing. First, in our model, an open-market stock repurchase is superior to cash dividends. Suppose that the firm chooses to distribute all the interim cash flow, C, as cash dividends in place of stock repurchases. By choosing cash dividends, the firm loses the opportunity to earn capital gains, because the firm cannot purchase its outstanding shares at a bargain price. In that case, the date-3 stock price following the distribution of cash dividends is lower than that following stock repurchases. There is an obvious incentive for the firm to substitute stock repurchases for cash dividends when its stock price is undervalued. Conversely, the firm tends to choose cash dividends when its stock price is overvalued. The firm incurs capital losses if it buys backs overpriced shares.

Next, the above results still hold when interim cash flow is uncertain or when pessimistic noise disappears before date-2 stochastically. Suppose that the firm generates an interim cash flow, $C>0$, with probability p ($0<p<1$), and generates no cash flow with probability $1-p$. In this case, the firm buys back its shares with only probability p. With positive probability $1-p$, the firm refrains from purchasing its shares even after it makes an announcement of repurchase intention.[16] In a situation where the pessimistic noise is random, the firm executes a repurchase only when the stock price is undervalued by the pessimistic noise. The firm has no incentive to buy back its outstanding shares unless the market is subject to pessimistic noise.

This argument shows the advantage of open-market repurchases over tender offers. In contrast to open-market repurchases, the firm must follow through after its tender

[16] Even if external funds are available for the firm, it has no incentive to raise external funds for repurchasing when the financing cost is equal to R.

offer announcement. Suppose that the firm incurs additional cost to raise external funds as smart traders do. Having made a tender offer, the firm has to incur the cost when neither interim cash flow nor pessimistic noise persists. On the other hand, the firm does not have to pay this cost under an open-market stock repurchase program. Thus, in the current model, an open-market repurchase is more desirable than a tender offer. This advantage of an open-market repurchase comes from its flexibility. Ikenberry and Vermaelen (1996) and Stephens and Weisbach (1998) stress the flexibility of open-market stock repurchases.

The results of the paper may hold when the firm considers the date-1 stock price in addition to the date-3 stock price. Suppose that the objective function of the firm is

$$\alpha P_1(j) + (1-\alpha) P_3(j;t), \qquad (25)$$

where α ($0<\alpha<1$) is the weight on the date-1 stock price. It immediately follows from $P_1(n)<P_1(a)$ and $P_3(n;h)<P_3(a;h)$ that

$$\alpha P_1(n) + (1-\alpha) P_3(n;h) < \alpha P_1(a) + (1-\alpha) P_3(a;h). \qquad (26)$$

Thus, the high-quality firm chooses to make an announcement.

In order to ensure that the low-quality firm chooses not to announce, we must place an additional restriction on α such that

$$\alpha P_1(a) + (1-\alpha) P_3(a;l) \le \alpha P_1(n) + (1-\alpha) P_3(n;l). \qquad (27)$$

In this way, it might be shown that the results still hold when the firm attends to the date-2 stock price in addition to the date-1 and date-3 stock prices.

Finally, the arguments developed in this paper may still hold when informational asymmetry exists with regard to interim cash flow rather than terminal cash flow. The low-quality firm, which has relatively small interim cash flow, has no incentive to announce an open-market repurchase intention since the firm has to repurchase its shares at a higher price at date-2. However, if the low-quality firm does not announce, it may still earn capital gains as a result of the pessimistic noise. The high-quality firm, which has relatively large interim cash flow, should continue to announce in order to earn capital gains from purchasing a relatively large number of shares. This argument implies that announcing firms have relatively higher cash flows than non-announcing firms.

6. Conclusion

In this paper, we reexamined open-market stock repurchases under the condition of both informational asymmetry and market inefficiency. The market is inefficient in the sense that smart traders are costly so that the mispricing caused by noise traders is not completely removed. The firm makes use of this market mispricing. In particular, when the market undervalues the stock of the firm, the firm can enjoy capital gains by repurchasing its outstanding shares at a bargain price. Thus, in our model, the firm has an intense incentive to actually buy back its shares following an announcement of repurchase intention even though the announcement is not a firm commitment.

Capital gains that the firm can earn through open-market repurchase activity cause the positive performance of long-run stock returns. Our model predicts that the stock price will continues to increase even after it rises in response to an announcement. These predictions are consistent with typical empirical findings.

Appendix

Proof of Proposition 1. We claim that $P_3(a;\, h) \geq P_2(a)$ and $0 \leq B_2(a) \leq S$ hold as follows. From (5), if $P_3(a;\, h) < P_2(a)$, then $K(a;\, h) + B_2(a) > S$ must hold. This means that at least one of $K(a;\, h)$ and $B_2(a)$ is strictly positive. However, the firm and smart traders never take long positions, because long positions result in a capital loss at date-3. Therefore, $P_3(a;\, h) \geq P_2(a)$, in which case taking short positions at date-2 does not generate capital gains at date-3. Therefore, $B_2(a) \geq 0$. Again, from (5), $P_3(a;\, h) \geq P_2(a)$ means $B_2(a) \leq S$.

It follows from (1) and Lemma 1 that

$$K(a;h) = [S - B_2(a)]/2 \le C. \tag{a. 1}$$

Since smart traders have to earn R dollars per dollar investment,

$$P_3(a;h) = RP_2(a) \Leftrightarrow V^h + C - K(a;h) = R[V^h + C - S + B_2(a)]. \tag{a. 2}$$

In the equilibrium, $K(a;\ h)$ and $B_2(a)$ must satisfy (a. 1) and (a. 2) simultaneously. By solving them, we can obtain (8) and (9). It is clear that $B_2(a)>0$ under (7).

The remaining point is to show that there exists an S that satisfies (7). Note that

$$(V^h - V^l) - 2(R-1)(V^h + C)/(2R-1) = [(V^h - V^l) - 2(R-1)(V^l + C)]/(2R-1) > 0.$$

The inequality follows from (6). Therefore, there exists an S that satisfies (7).

Proof of Proposition 2. By applying (a. 2) to this case, we obtain

$$B_2(n) = S - [(R-1)(V^l + C) + K(n;l)]/R \le S - (R-1)(V^l + C)/R. \tag{a. 3}$$

The inequality follows from $K(n;\ l)\geq 0$. Then,

$$[S - B_2(n)]/2 \ge (R-1)(V^l + C)/2R = D^*, \tag{a. 4}$$

It follows from Lemma 1, (12), and (a. 4) that

$$K(n;l) = \min\{D, [S - B_2(n)]/2\} = D. \tag{a. 5}$$

By plugging $K(n;\ l)=D$ into the first equation of (a. 3), we can obtain (14). Furthermore,

$$\begin{aligned} &2(R-1)(V^h + C)/(2R-1) - [(R-1)(V^l + C) + D]/R \\ &= [2R(R-1)(V^h - V^l) + (R-1)(V^l + C) - 2RD + D]/(2R-1)R > 0 \end{aligned} \tag{a. 6}$$

holds under (12). From (a. 6), (8), and (14), $B_2(n)>B_2(a)>0$.

Proof of Lemma 2. It follows from Lemma 1 and (14) that, under $D\leq D^*$, the amount of dollars that the high-quality firm uses for repurchasing is given by

$$K(n;h) = \min\{D, [V^h - V^l + S - B(n)]/2\} = D. \tag{a. 7}$$

Then, the date-3 stock price of the high-quality firm following no announcement is

$$P_3(n;h) = \frac{V^h + C - D}{1 - D/P_2(n)} = V^h + C + g(D), \tag{a. 8}$$

where

$$g(D) \equiv D[R(V^h + C - D)/(V^l + C - D) - 1]. \quad \text{(a. 9)}$$

Note that $g(D)$ is strictly increasing and is continuous with D for $0 \le D < V^l + C$. Since $g(0)=0$ and $g(D) \to \infty$ as $D \to V^l + C$, there exists a $D^{**} \in (0, V^l + C)$ that satisfies (19). From (11) and (a. 8), we see that the high-quality firm does not deviate from the equilibrium strategy if and only if

$$P_3(a;h) \ge P_3(n;h) \Leftrightarrow g(D^{**}) = (R-1)^2(V^h + C)/(2R-1) \ge g(D). \quad \text{(a. 10)}$$

Since $g(D)$ is strictly increasing with D, $g(D) \le g(D^{**})$ for $0 < D \le D^{**}$. Therefore, (a. 10) holds for D such that $0 \le D \le \min\{D^*, D^{**}\}$. There exists D such that $0 \le D \le \min\{D^*, D^{**}\}$ because $0 \le D^*$ and $0 < D^{**}$.

Proof of Proposition 4. First, we consider $P_1(a)$. If $B_1(a)<0$, then $P_1(a)<V^h+C-S<P_2(a)$. The second inequality follows from (7). This means that smart traders lose their money by taking a short position. If $B_1(a)=0$, then $P_1(a, B_1(a)=0)<RP_2(a)$. The inequality follows from (7). This means that smart traders can earn capital gains larger than R by taking a long position. Therefore, $B_1(a)>0$. In this case, $B_1(a)$ is determined by the condition of $P_1(a, B_1(a))=RP_2(a)$. By solving this equation, we can obtain

$$B_1(a) = S - 2(R-1)(V^h + C)/(2R-1) > 0.$$

The inequality follows from (7). Then, (22) holds in the equilibrium.

Next, we show that $P_1(n)<P_1(a)$. Suppose that $P_1(n) \ge P_1(a)$. In this case, $B_1(n)>S$ holds because

$$B_1(n) - S > B_1(n) - S - B_1(a) \ge B_1(n) - (V^h - V^l) - B_1(a) = P_1(n) - P_1(a) \ge 0.$$

Since $P_1(n, B_1(n)>S)>V^l+C>P_2(n)$, smart traders incur capital loss by taking such a large long position. Therefore, $P_1(n)<P_1(a)$.

Finally, consider the relationship between P_0 and $P_1(j)$. It follows from (2), (3), and $B_1(a)>0$ that $B_0>0$ has to hold when $P_1(a) \le P_0$. Since $P_1(n)<P_1(a) \le P_0$, smart traders incur

capital loss by taking such a long position at date-0. Therefore, $P_0<P_1(a)$. It also follows from (2), (3), and $B_1(n)\geq 0$ that $B_0<0$ has to hold when $P_0\leq P_1(n)$. Note that we can show $B_1(n)\geq 0$ by using an argument similar to that for $B_1(a)$. Since $P_0\leq P_1(n)<P_1(a)$, this date-0 short position brings capital loss to smart traders. Therefore, $P_1(n)<P_0$.

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