"THE OPTION TO REPURCHASE STOCK"

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ABSTRACT

The signalling hypothesis is often used to explain the market reaction to the announcement of open market share repuchase programmes. Yet these programmes are not firm commitments. Although companies may announce their intention to reacquire shares, repurchase programmes done via the open market, by design, give managers the flexibility to forego repurchasing stock. As such, these programmes seemingly lack credibility as reliable information signals. We show that although these programmes may be poor signals, they contain valuable options. We model this as an exchange option. Empirical evidence from 892 announcements between 1980 and 1990 is consistent with the predictions of the model. Announcement returns are positively related to the magnitude of the repurchase and to the return volatility of the stock. The average maturity implied by the option is 22 months, a result strikingly similar to what is observed in practice. Perhaps most interestingly, we find that as predicted by the model, announcement returns are negatively related to a proxy for the correlation between the firm's traded price and its "true" price, the difference of which is most fundamental to giving value to the option.

Between 1980 to 1990 several thousand open market share repurchase programmes were announced by firms traded on the NYSE, ASE and NASD. The market reaction to such announcements is typically about 3.5 percent[1]. There has been no shortage of hypotheses offered to explain this market reaction. For example, traditional finance theory might argue that these programmes serve to optimally adjust capital structure. Alternatively, share repurchases have been argued to be a tax efficient alternative to paying cash dividends. Yet perhaps the most widely accepted explanation of the market's reaction to repurchase announcements is the signalling hypothesis: repurchases signal management's favourable information about the firm's future prospects (e.g. Dann (1981), Vermaelen (1981), Asquith and Mullins (1986), Ofer and Thakor (1987) and Constantinides and Grundy (1989)).

Despite wide acceptance of the signalling hypothesis, two troubling issues arise with this explanation. First, although fixed-price repurchases are rather definite commitments and are easy for the marketplace to monitor, no such commitment or monitoring opportunities exist to ensure performance with open market repuchases. When corporate boards authorise managers to reacquire shares on the open market, the programmes by design give managers discretion when to reacquire shares depending on "prevailing market conditions". Thus not all programmes are completed. In fact Netter and Mitchell (1989) find evidence that at least some programmes are not even initiated. They examine 530 NYSE, ASE and NASDAQ firms that announced a repurchase programme within two weeks of the Crash of 1987. At the end of March 1988, more than half of the NYSE and ASE firms making these announcements reported no decrease in shares outstanding. For NASDAQ programmes, two-thirds had failed to show any decrease. The ability of managers to effectively cancel these programmes with little notice raises troubling questions as to the costs of "false" signalling, a feature vital to traditional signalling models.

A second troubling issue concerns the magnitude of the market reaction. Several papers note that the average market response to the announcement of an open market share repurchase programme is 3.5% Such a small reaction raises concern on a more practical level. If the market is responding efficiently and 3.5% is total valuation impact associated

with the signal, it seems surprising that managers would have the ability to recognise such minor errors. For example, the magnitude of weekly price volatility for many stocks is greater than the price reaction to the announcement itself. If 3.5% is the full extent of mis-pricing in a firm's stock on average, the evidence would seem to indicate an unrealistic ability of managers to separate such pricing errors from noise.

In short, although the signalling story is widely accepted, the hypothesis is less appealing upon closer examination, at least with regard to open market repurchase programmes. In this paper we provide an alternative explanation. Similar to the signalling hypothesis, we also assume that managers may be better informed than outsiders. We also assume that insiders are interested in maximising the wealth of the long-term shareholders, perhaps because they too are long-term shareholders. Managers, acting in the best interest of long-term shareholders, will choose to buy back stock or in other words exercise the option imbedded in the programmes, when they believe the shares to trade at a discount from their "true" value. The degree to which market prices can diverge from "true" value and the ability of managers to exploit these valuation errors is what makes repurchase programmes valuable to long-term investors. If these investors set prices around the repurchase announcement, stock prices should increase to reflect the value of the option to take advantage of mispricing in the firm's shares. Thus, even though managers have no superior information at the time of the repurchase announcement, stock prices will increase when companies announce repurchase programmes.

We show that an open market repurchase programme is an option to exchange the market value of the stock for the true value of the stock. By applying Margrabe's model for exchange options (1978), we are able to make specific predictions about the value of the repurchase option. By further imposing the restriction that, around the announcement, managers do not have superior information, we derive a prediction for the stock market response "net of information signalling effects". We predict that this response is positively related to the volatility of the stock, the fraction of shares the company may repurchase and the potential for mis-pricing in the future.

Modelling a share repurchase programme as an option has several appealing advantages over the more common signalling device. First, unlike traditional signalling models, this approach does not require the specification of managerial signalling objectives nor does the model require signalling costs. Secondly, it explicitly accommodates the notion that not all programmes will be completed and that few programmes will be explicitly cancelled once authorised. Yet perhaps most importantly, the typical market reaction of 3.5%, which seems only mildly consistent with the signalling story, is strikingly consistent with the value obtained when modelling the repurchase as an exchange option.

We test the model using a sample of 892 open market repurchases announced between 1980 and 1990. For example, for highly volatile stocks and for stocks where the opportunities for departures from true value might be viewed as unusually high, the average announcement return to the repurchase announcement is 7.13 percent. On the opposite side of the spectrum, for low volatility stocks and for stocks where mis-pricing opportunities would seem to be low, the average announcement return is only 2.28 percent. We further examine the model's predictions by calculating the implied maturity of the option through maximum likelihood procedures. Here, the average implied maturity is 22 months, a rather reasonable estimate of the length of time needed for repurchase programmes.

The paper is organised as follows. In section I we provide the theory and employ Margrabe's (1978) model of exchange options to value the option to repurchase shares, assuming that, at the time of the announcement, the management has no inside information. In section II we present the data. Section III empirically examines various predictions of the model. Section IV summarises our conclusions.

I The Option to Repurchase Stock

A. Theory

We start with a simple example. Assume that at time t_0 a company with n_0 shares outstanding announces that it intends to buy back n_p shares before a specific date t_1 "depending on market conditions". Assume further that if no repurchase takes place, the true value per share at t_1 can take on two values : V_1^h and V_1^l with probability q and (1-q), respectively. Furthermore, let's assume that the repurchase does not create any real benefits. For example, there are no tax savings that might have a real impact on the firm's cash flow. And finally, let's also assume that the announcement to repurchase shares reveals no information about q or V_1^k (k = h,l) or in other words, open market share repuchase announcements have no signalling benefits.

Suppose that, at t_1, the company has to decide whether it will buy back the shares and that management knows the firm's true value per share V_1^k. To maximise the interest of the long-term shareholders, management will only repurchase shares if the true post-repurchase value per share, V_2^k, is higher than the value per share without the repurchase. Or, in other words, the repurchase will take place if

$$V_2^k = \frac{n_o V_1^k - n_p S_1}{n_o - n_p} \rangle V_1^k \qquad \text{or if} \tag{1}$$

$$\frac{n_p}{n_o - n_p}(V_1^k - S_1) \rangle 0 \tag{2}$$

where S_1 is the market price of the share at t_1. Note that we assume that this market price is not influenced by the repurchase decision. Furthermore, the repurchase takes place through a broker and the seller is generally unaware that he is selling to the corporation.

By announcing the (conditional) intention to repurchase stock, the company has created, per share outstanding, a fraction $n_p / (n_o - n_p)$ of a call option to buy the true value per share at the market price S_1. As S_1 is equal to the weighted average of V_1^h and V_1^l, this option will only be exercised if the true value per share is equal to V_1^h. Note that in this case wealth

is transferred from the selling shareholders to the long-term shareholders in the firm. This example illustrates the option nature of a repurchase programme; it is effectively an option to buy the true value of the share, better known by management, at prevailing market prices.

Alternatively, one can consider the repurchase option as an option to exchange the market value of the stock for the true value of the stock. Margrabe (1978) derives a closed form solution for an exchange option. Specifically, define V as the true value of the stock (known to management) and define S as the market price of the share. Assume that the rate of return on both values is given by

$$\frac{dS}{S} = \alpha_S dt + \sigma_S dz_S \tag{3}$$

and by

$$\frac{dV}{V} = \alpha_V dt + \alpha_V dz_V \tag{4}$$

where dz_i (i = V,S) is a Wiener process and σ_i is the standard deviation of rate of return on asset i. By employing the arbitrage argument that the position of an option buyer is similar to a dynamic trading strategy involving buying the true value of the share and shorting the stock traded in the market, Margrabe shows that the value of the option to exchange S for V is equal to

$$W(V,S,t) = VN(d_1) - SN(d_2) \tag{5}$$

$$d_1 = \frac{\ln\frac{V}{S} + \frac{1}{2}\sigma^2 t}{\sigma\sqrt{t}} \tag{6}$$

$$d_2 = d_1 - \sigma\sqrt{t} \tag{7}$$

N(.) is the cumulative standard normal density function and t is the maturity of the option. The return variance on a portfolio involving a long position in the true value and a short position in the market value of the stock , σ^2 is equal to:

$$\sigma^2 = \sigma_V^2 + \sigma_S^2 - 2\sigma_S\sigma_V\rho_{VS} \tag{8}$$

where ρ_{VS} is the correlation coefficient between the true rate of return and the observed market rate of return on the stock. Note that, the larger the correlation between the market rate of return and the true return, the lower the value of the option. This correlation can be considered as a measure of efficiency. If the stock is always priced correctly (i.e. S = V), the correlation between the true price and the market price will be one and the value of the option will be zero, as $\sigma_V = \sigma_S$.

B. The Market Response to Repurchase Announcements Without Signalling

The basic purpose of this paper is to predict market reaction to the announcement of an open market repurchase programme. In order to arrive at a market equilibrium, we make the following assumptions. First, we assume that at the time of the announcement, long-term investors exist and set prices. These are investors who plan to hold the stock until after the expiration of the option and who will benefit from any gain arising from reacquired shares. Because of the option value embedded in repurchase programmes, these investors will value the stock at more than the present value of the expected cash flows per share. This can easily be verified by going back to our simple example. Recall that when the true value per share outstanding prior to the repurchase is equal to V_1^h, the company will buy back stock. In this case, the "true" stock price per share outstanding after the repurchase, V_2^h, is greater than V_1^h, the true value per share if the repurchase does not take place. In the other case, when the true value of the share is V_1^l, the company will let the repurchase option expire (as V_2^l is smaller than V_1^l). Hence, as V_2^h is greater than V_1^h, an investor planning to hold the stock until after the repurchase decision will value the share at more than the present value of $qV_1^h + (1-q)V_1^l$.

Second, we also assume that there are enough liquidity traders and noise traders who are willing to sell shares prior to the expiration of the repurchase option, even when they know there is some probability they are trading with the corporation. Without this assumption, markets would break down as uninformed investors, anticipating future expropriation by insiders would either sell out immediately after a repurchase announcement, or hold on to the stock until after the expiration of the programme. Under either scenario, trading would be disrupted such that the repurchase would not be possible, thus making the repurchase option valueless. However, these scenarios seem unlikely. In practice, there is no evidence of a decline in trading volume following repurchase announcements. Furthermore, expressly choosing not to invest in firms repurchasing shares creates costs. Given the frequency with which repurchases are announced and the length of time they take to complete, investors choosing to avoid firms repurchasing shares would suffer from more poorly diversified portfolios than otherwise.

To predict the market's response to the announcement of an option market share repurchase programme, let us redefine V as the market value per share (assessed by long-term shareholders) after the repurchase announcement[3] and S as the market price before the repurchase announcement. Let us also redefine σ_S, σ_V and ρ_{SV} as the long-term shareholders' assessment of, respectively, the volatility of the stock return based on market prices, the true volatility of the stock return and the correlation between the true rate of return and the observed market rate of return on the stock. Note that σ_S could be different from σ_V. For example, if long-term investors believe that stock markets are characterised by excess volaility, then $\sigma_S > \sigma_V$. Hence, for the remainder of this paper, when we talk about, for example, the correlation between the "true" return and the market based return, we are actually talking about the long-term investor assessment of this correlation.

The announcement of a repurchase will according to (5) have two effects. First, prices may increase if the market believes that at the time of the announcement insiders may have superior information (i.e. if $V > S$). This is akin to the classic argument that repurchases "are information signals". Although it is possible that repurchases may have some signalling

properties, we ignore this potential and focus exclusively on the second effect. Namely, even if prices are fair at the announcement and V = S, the market reaction may still be positive as long as there exists some possibility that in the future, management will be able to recognise that market prices have diverged from the true value. We refer to this as the option value of open market share repurchase programmes.

If the market perceives prices to be fair at the time of an open market share repurchase announcement, what is the value of the option? The answer to this question can be obtained by setting V = S in (5). In this case, the option value simplifies to

$$W = S[2N(d_1) - 1] \tag{9}$$

$$\text{with } d_1 = \frac{1}{2}\sigma\sqrt{t} \tag{10}$$

Note that this is the value of the option arises from the ability to exchange the market price of one share for the true value of one share. As pointed out earlier, a repurchase programme to buy n_p shares out of n_o shares outstanding creates, per share outstanding a fraction $n_p / (n_o - n_p)$ of this option value. Hence, the return at the announcement of a share repurchase due only to the option effect of the exclusion of information signalling should be equal to:

$$x = \frac{n_p[2N(d_1) - 1]}{n_o - n_p} = \frac{F_p}{1 - F_p}[2N(d_1) - 1] \tag{11}$$

where F_p is equal to n_p/n_o. The return is positively related to the fraction of shares the company plans to repurchase, the maturity of the option, the volatility of the true return and the market return on the stock. It is negatively related to the correlation between the true return and the market return[4].

The conclusion that share repurchase programmes are beneficial to stockholders because they allow better informed managers to take advantage of uninformed selling shareholders is in marked contrast to the conclusions reached by Barclay and Smith (1988). They also start

from the assumption that managers are better informed and can take advantage of selling shareholders by repurchasing shares when they are undervalued. They conclude however, that "trading by better informed managers increases the bid ask spread, reduces the liquidity of the shares and thereby increases the firm's cost of capital and reduces its market value"[5]. These conclusions are obtained by extending Glosten and Milgrom's (1985) model of bid and ask prices with heterogeneously informed traders. However, this approach ignores that a share repurchase is essentially a zero-sum game: the losses of the uninformed go dollar for dollar to the long-term shareholders. Hence, the option to take advantage of selling shareholders should increase stock prices, if long-term shareholders are the marginal investor at the time of the repurchase annnouncement.

C. Simulated Values

Table 1 shows simulated announcement returns one would expect when modelling the repurchase programme as an exchange option. Here we parameterise the model with a series of assumptions regarding: the volatility of the (observed) stock return σ_S which we also assume is equal to σ_V, the true volatility; the fraction of shares the firm authorises for repurchase; the maturity of the option; and finally the correlation between the true return and the market return on the stock. Note that by assuming $\sigma_S = \sigma_V$, σ simplifies to $\sigma_S\sqrt{2(1-\rho_{SV})}$. In this table, we allow volatility to range from 20 to 60 percent. Although the percentage of shares firms announce for repurchase varies in practice, we assume two possible values: 10 percent and 15 percent. The maturity of the option to repurchase is rarely specified in advance. For a variety of reasons (including regulatory restrictions), these programmes sometimes take several years to complete. Hence, we simulate returns assuming option maturities of one and two years.

The final parameter required by the model is ρ_{SV}. Clearly, observability problems present a challenge here. For illustrative purposes, we assume correction values between the stock price and the true price of 0.20, 0.40 and 0.60. This range seems reasonable if we make a few simplifying assumptions. If (1) both true and market returns are generated by the

Market Model[6] (2) the true beta, β_V, is equal to the measured beta in the market, β_S,and (3) $\sigma_S = \sigma_V$. Under these conditions, it follows that the correlation between the true return and the market return is equal to

$$\rho_{SV} = \frac{\beta^2 \sigma_M^2}{\sigma_S^2} + \frac{\mathrm{cov}(e_V, e_S)}{\sigma_S^2} \tag{12}$$

where σ_M^2 is the variance of the rate of return on the market index, and cov(e_V, e_S) is the covariance between the true and market based residual return. Hence, one can decompose the correlation coefficient into systematic and idiosyncratic components. The systematic component is the fraction of the variance of the stock return explained by market wide information, or simply the R^2 from the market model. Roll (1988) finds an average value for R^2 of 17.9 employing a sample of NYSE and ASE traded companies. Moreover, he reports that more than 20 percent of the stocks in this sample have R^2's less than .05 yet nearly 10 percent had R^2's higher than .40. The second component of the correlation coefficient measures to what extent the stock market reflects company or industry-specific information. Roll reports that less than 40 percent of the monthly volatility in the typical stock can be explained by company or industry-specific news, suggesting that most of the volatility of stock prices is generated by "fads" rather than by information. Hence, assuming values for ρ_{VS} ranging from .20 to .60 seems reasonable.

Table 1 shows that, depending on how the model is parameterised, the implied market reaction arising only from the option value of a share repurchase programme varies between .79 percent and 9.71 percent. For example, if a company with high stock price volatility (σ = 0.6) and also where the opportunity for management to use its information advantages is relatively high (ρ_{SV} = 0.2) were to announce a two-year repurchase programme for 10 percent of their shares, stock prices should increase by 6.11 percent. Of course this might be a more extreme example. A more typical firm might be assumed to have an annual return volatility of 30 percent and ρ_{SV} = 0.40. Keeping all other features of the repurchase

programme the same, the price reaction inferred by the option model is 2.85 percent. This is strikingly similar to the returns reported in many empirical studies of about 3.5 percent. These simulated values arise while ignoring completely the potential signalling aspect of repurchase announcements. Thus, it would appear that the option value embedded in repurchase programmes may be able to explain a substantial portion, if not all, of the market reaction.

II Data

To test the predictions of the model, we obtained a sample of open market share repurchase announcements from Ikenberry, Lakonishok and Vermaelen (1994). Their sample was formed from announcements reported in the Wall Street Journal from 1980 through 1990 stating that an NYSE, ASE or NASDAQ firm intended to repurchase its common stock through open market transactions. To avoid excessive data clustering, we exclude announcements made in the fourth quarter of 1987. In the months immediately following the October 1987 crash, well over 800 firms announced share repurchases largely in response to low post-crash share prices. One last criterion we placed on the sample is that all repurchase programmes be for at least 2.5 percent of the shares outstanding. For very small repurchase programmes, the value of the exchange option is negligible and will be difficult to empirically separate from noise.

For each announcement, we obtain 36 monthly returns beginning 36 months prior to the repurchase announcement. These returns are used to compute the standard deviation of returns and the R^2 obtained from a market model regression of stock returns on the CRSP equal-weighted index of NYSE and ASE firms. The standard deviation of the firm's stock is, of course, an important input in our option model. R^2 is a proxy for ρ_{SV}, the correlation coefficient between the return to the "true" stock value of the firm versus the observed stock return. According to equation (12) this assumes that stock prices do not reflect company specific information. While this is obviously an extreme assumption, for empirical purposes, it is sufficient to assume that $\mathrm{cov}(e_V, e_S)$ is independent of R^2. In other words, the

likelihood that company-specific information is reflected in stock prices is independent of its correlation with general market movements.

Table 2 provides an overview of the percentage of shares involved in our sample, the market model R^2 the standard deviation (annualised) for our sample of 892 announcements. On average, companies in our sample announced repurchases for 8 percent of their shares (median: 6.15 percent). The average R^2's for our sample is 31.25 percent (median 31 percent), yet one-fourth of our sample has an R^2 greater than 43.00 percent. These values are greater than those reported by Roll (1988). Yet Roll also finds a significant relation between R^2 and firm size which would appear to explain, at least to some degree, our results. Our sample is drawn from repurchase announcements made in the Wall Street Journal where a bias favouring larger firms is clearly evident. Nearly one-third of our sample, when ranked concurrently with the announcement, is among the largest 20 percent of NYSE and ASE firms.

Only two trends are of any note in Table 2 . First, the percentage of shares involved in these repurchase programmes gradually increased between 1980 and 1990. In 1980, the mean programme was for 6.6% of the outstanding shares. By 1990, this had risen to 8.7%. The highest value occurred in 1989 where the mean programme was for 9.8% of the share base. A second trend evident in this table is the increase over time in the number of announcements made by firms where stock returns were relatively highly correlated with the overall market.

III The Evidence

A. Announcement returns and model predictions

We empirically evaluate the validity of viewing repurchase programmes as exchange options by examining the relationship between the market reaction to open market share repurchase

programmes and the theoretical determinants of the exchange option's value. To measure the average market reaction, we compute average risk adjusted cumulative abnormal returns from two days before to two days following publication of the announcement in the Wall Street Journal.. We begin the Table 3 by reporting the market reaction to repurchase programmes overall as well as by time period. We then turn our attention to measuring the market reaction with respect to the fraction of shares involved in the programme, the volatility of the stock, and R^2, a proxy we use to measure the correlation between the observed stock return and the return to the "true" value of the shares.

For all 892 repurchase programmes in our sample, the mean market reaction is 3.42 percent. However, it is clear from Table 3 that the average market reaction decreased during our sample period. During the early 1980s, the average market response was 4.57 percent. By the end of the decade, the average market response had fallen to 2.63 percent. This is consistent with the trend in R^2 we observed earlier whereby over time repurchase programmes were increasingly made by firms with relatively large R^2 values. These are programmes in which the option value is, ceteris paribus, less valuable than otherwise and thus provides us with our first piece of evidence consistent with viewing repurchase programmes as exchange options. Yet further evidence is also available in Table 3. Note that as the size of the repurchase programme increases from 2.5 - 4.5 percent to above 10 percent of share outstanding, the average market reaction increases from 2.63 percent to 4.40 percent. As the volatility of returns increases, so does the market reaction as predicted by the option model. And finally, note that as the R^2 increases, the market reaction generally declines. Each of these univariate properties is consistent with the options value embedded in open market repurchase programmes.

To further examine the impact of these variables, we report the results from various cross sectional regressions in Table 4 using abnormal announcement returns as the dependent variable. When each of the variables (the size of the programme, volatility of the stock and R^2 of the stock) is used individually in the regression, the sign of each coefficient is consistent with the option model and is significant at the one percent level in each case.

Furthermore, these variables would not appear to subsume one another for the coefficients change only slightly when the variables are included together in a single regression.

This initial evidence is remarkably consistent not only with the theoretical implications of the repurchase option, but also with the simulated values we examined earlier. To gain further insight into the robustness of evidence supporting the exchange option, we examine the market reaction to repurchase programmes using a two-way sorting procedure. This is done using the three variables in pair-wise combinations. For example, in panel A of Table 5, we report the average market reaction using a two-way sort on the fraction purchase and return volatility. We first sort firms into quartiles on the basis of the fraction of shares to be repurchased. Then *within* each of these quartiles, we further sort into four more quartiles on the basis of volatility. Average abnormal announcement returns are then computed for each of the 16 portfolios. Reported to the right of each row and the bottom of each column is the difference in the mean market reaction (and associated *t*-statistic) between extreme quartiles, holding the relative ranking of one variable constant. For example, looking at the first row of panel A, we see that even for relatively small programmes, the market reaction rises from 1.68 percent for low volatility stocks to 3.78 percent for high volatility stocks, a pattern consistent with the option model. Moving down panel A toward larger programmes, we see that the highest announcement returns are observed in those portfolios having the greatest volatility. In three of the four comparisons the difference is significant at least at the 5 percent level. To a large degree, the evidence in this panel is consistent with the implications of the exchange option model. For example, the second largest announcement return in panel A (5.69 percent) is experienced by the portfolio with the largest volatility and the largest repurchase size. At the same time, the second smallest announcement return (1.68 percent) is observed in firms with the smallest volatility announcing the smallest repurchase programmes.

In panel B, portfolios are formed by first ranking on the basis of the size of the repurchase programme and then on the basis of R^2. Holding the size of the programme constant, announcement returns decrease as the relative R^2 increases. Note that in this panel, the

highest abnormal return (5.89 percent) occurs in the portfolio containing firms with the lowest R^2, announcing the biggest repurchase programmes. Such a response is expected when viewing the repurchase programme as an exchange option.

The last panel in this table, reports the mean market reaction to portfolios formed first on the basis of volatility and then on the basis of R^2. Holding volatility constant, abnormal returns in the highest R^2 quartiles are consistently less than those in the smallest R^2 quartile. Holding R^2 constant, announcement returns tend to increase as price volatility increases. The exception to this generalisation occurs in those portfolios having the highest R^2. The option value in these programmes is theoretically at a low point. Given the noise in security returns, measurement error in these sub-portfolios may be affecting our results. Nevertheless, the largest market reaction reported in this panel 7.13 percent, occurs in the sub-sample having the highest volatility-and the lowest R^2. These are stocks where the option value embedded in repurchase programmes would seemingly be greatest. If managers are maximising the interests of long-term shareholders, one would also expect that these firms also announce larger than average programmes. This is indeed the case. The average programme for this sub-sample is for 9.6 percent of outstanding shares, about 20 percent larger than observed in our sample overall. Peering deeper, the average standard deviation (annualised) for this group is 62 percent while the average R^2 is 8.9 percent. Using these parameter values, a market reaction of 7.13 percent would be consistent with a repurchase programme requiring approximately two years to complete, a surprisingly reasonable assumption.

Summarising, the empirical evidence provides rather robust support for the hypothesis that the market reacts to a repurchase announcement in a manner consistent with an exchange option. The market reaction clearly favours those cases where the option is predicted to have its greatest value; in high volatile stocks and in stocks where the potential for mis-pricing is high (stocks with small R^2).

However, one might also view this evidence as consistent with signalling stories. For example, signalling models would also predict that information effects are more important in large repurchases programmes. However, signalling models typically depend on more formalised structures involving objective functions and which impose costs for false signalling. To a large degree, this is inconsistent with the fundamental characteristics of open market share repurchase programmes: they are not firm commitments. Here, it is not obvious how costs of false signalling are imposed. Furthermore, our approach leads to market reactions more consistent with the empirical evidence. Explaining the market reaction as a rational response to information signalling seemingly loses credibility if the implied valuation error is only on the magnitude of 3.5 percent.

B. Estimating the Implied Maturity of the Option.

The value of the option embedded repurchase programmes is not linear in the fraction purchased, volatility and R^2. Thus the regressions in table 4 are misspecified. A more correct test requires jointly estimating the model and one unknown parameter: the time to maturity of the option. As a simplifying first step, let's assume that the maturity of the option is constant across programmes. In this case, the time to maturity, t, can be estimated as a coefficient in the following cross-sectional regression

$$CAR_{i\,-2}^{+2} = \frac{F_{pi}}{1-F_{pi}}\left[2N(d_{1i})-1\right]+\varepsilon_i \tag{13}$$

$$\text{where } d_{1i} = \frac{1}{2}\sigma_i\sqrt{\hat{t}} \tag{14}$$

$$\text{and } \sigma_i = \sigma_{Si}\sqrt{\left(1-R_i^2\right)2} \tag{15}$$

where $CAR_{i\,-2}^{+2}$ is the cumulative abnormal return 2 days around the announcement for company i, and σ_{Si} is the standard deviation of the stock return[7]. The cumulative standard normal distribution function is estimated using the linear approximation proposed by Giddy (1983).

The regression is estimated using non-linear least squares and is equivalent to maximum likelihood estimation under the assumption of normally distributed errors. The resulting $\hat{t}$ and standard error are reported in the first row of Table 6. Using actual announcement returns, the implied maturity of repurchase option is approximately 22 months. This value is remarkably consistent with what is observed in practice. Furthermore, although it is uncommon for firms to explicitly provide a terminal date for their repurchase programmes, 22 months is consistent with the maturities companies state when they do choose to set a specific maturity.

On the other hand, it seems reasonable, for a variety of reasons, that the maturity of the programme is also a function of the number of shares the firm is choosing to repurchase. For example, SEC regulations limit the number of shares a company can repurchase per day to 25 percent of the average daily trading volume over the previous 40 days, thus requiring larger repurchases to take longer. Therefore we reestimate the model assuming that $\hat{t} = \gamma_0 - \gamma_1 F_p$. and expect γ_1 to be positive. Making these allowances, we see in the second row of Table 6 the intercept is now 19 months, only slightly lower than 22 months observed overall. Moreover, γ_1 is positive, suggesting that larger repurchase programmes do indeed have longer implied maturities. Unfortunately though, the coefficient is not statistically significant and in practical sense seems low. This lack of significance may result from the fact that although larger programmes do have longer maturities, these programmes may be driven by other considerations such as takovers or fundamental restructurings.

IV Summary and Conclusions

Open market share repurchase programmes are not firm commitments. They authorise the company to take advantage of market prices that, in management's opinion, may have deviated from "true" value. The discretion extended to managers as to when and if to purchase shares represents an exchange option whereby the market price per share is exchanged for the "true" value of the firm. To the extent that prices are always fair, such

options will be worthless. Yet if prices are not always fair and if management is able to detect valuation errors, open market share repurchase programmes may be valuable even if at the time of the announcement prices are fair and management has no superior information.

Using a sample of 892 open market share repurchases announced between 1980 and 1990, the market reaction is strikingly consistent with the theoretical predictions of the model. Announcement returns are positively correlated with the volatility of the stock and the fraction purchased. They are negatively related with the correlation coefficient of the stock and the market. Viewing this correlation as a proxy for the relationship between the true value versus the observed share price, firms announcing share repurchases with low correlations are cases where the option to repurchase shares is most valuable. Employing a maximum likelihood procedure, we find the implied maturity of the option is 22 months, a surprisingly realistic estimate of the time typically needed to execute these programmes.

Using reasonable assumptions about model parameters, the returns implied by the exchange model are strikingly similar to actual announcement returns. This is somewhat surprising for we explicitly model the option to be devoid of signalling properties. This presumption, of course, seems unlikely for, at the time of the repurchase announcement, managers frequently claim their shares are mis-priced and that undervaluation is a primary motive for undertaking the repurchase. Our evidence suggests that the "signal" emitted by these announcements appears to be largely discarded.

Similar findings are reported in a recent paper by Ikenberry, Lakonishok and Vermaelen (1994). They observe that the market reaction to open market repurchase announcements appears to largely ignore any signalling properties, even those announcement made by firms likely to be undervalued at the time of the announcement. Given that the costs to falsely signalling through a repurchase announcement are low, traditional signalling theory suggests that these announcements lack credibility. Yet even though the market appears to discredit any signals that managers might be explicitly or implicitly mentioning, the evidence suggests

that the market does not ignore the embedded exchange option extended in these programmes.

One might ask why is it that all companies simply do not continually announce open market share repurchase programmes if these programmes in fact represent valuable options? There are a variety of reasons for this. First, if the market efficiently prices the shares of at least some firms, the repurchase option in these firms will have little value and thus will not warrant the attention of the firm's management and board to authorise such programmes. Furthermore, the decision to exercise repurchase options requires company resources. In firms where resources are rationed, the firm's ability to exercise the options may be limited, thus reducing their value and making them unattractive to such firms. Share repurchase programmes will be appealing to firms with excess debt capacity, excess cash or cash flow, few growth opportunities and, as the exchange model suggests, where a potential for mis-pricing exists.

And finally, the option to repurchase shares is only valuable to the extent that managers can detect valuation errors. If managers lack the ability to correctly detect deviations between market prices and "true" value, then the options will again be of little value. In these cases, managers may be as likely to buy overvalued shares to the detriment of long-term shareholders as they are to buy undervalued shares to the benefit of long-term shareholders.

FOOTNOTES

1. See for example Comment and Jarrell (1991), Dann (1981), Ikenberry, Lakonishok and Vermaelen (1993) and Vermaelen (1981).

2. Note that the maturity of the repurchase option is not explicitly stated in many cases. When the maturity is stated, the company can extend it. For example, in May 1992, Philip Morris announced a $3 billion share repurchase programme, which was supposed to be terminated by December 1993. In January 1994, the company extended the programme to December 1994, as by December 1993 it had only repurchased for $1.8 billion.

3. Actually V is smaller than the stock price after the announcement because the stock price will reflect the value of the option to take advantage of undervaluation in the future. Note that we should also redefine σ_V, σ_S and ρ_{VS} as the market perceived value around the announcement.

4. Note that the formula values a European option, while the management actually has an American option. As the cash dividends received are independent of whether the stock is priced correctly or not, no argument can be made to exercise the option early because of dividend capture. There are however a number of other arguments for early or sequential exercise. An argument for early exercise can be made if there is some real benefit to the repurchase. For example, if buying back stock saves taxes, reduces agency costs or prevents a takeover, the company may want to exercise the option early. Sequential exercise is imposed by regulation: current SEC regulations restrict the number of securities a corporation can repurchase per day to 25% of the average daily trading volume during the last 40 days. Hence, the option to repurchase is essentially a portfolio of options with different maturities.

5. Barclay and Smith (1988) p 65.

6. i.e. $\frac{dS_t}{S_t} = \alpha_S + \beta_S \frac{dS_{Mt}}{S_{Mt}} + e_S$

   and

   $$\frac{dV_t}{V_t} = \alpha_V + \beta_V \frac{dS_{Mt}}{S_{Mt}} + e_V$$

7. Note that this specification assumes that $\rho_{SV} = R^2$.

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Table 1 : Theoretical values of abnormal returns as a result of the option effect (in percent)

t is the maturity of the option in years. $\rho_{S,V}$ measures the correlation between the true rate of return on the stock and the market rate of return. σ_S is the annual standard deviation of the return on the stock. Option values are shown as a percentage of the current stock price.

	Fraction purchased = 10%						Fraction purchased = 15%					
	t = 1 year			t = 2 years			t = 1 year			t = 2 years		
	ρ_{SV}			ρ_{SV}			ρ_{SV}			ρ_{SV}		
	0.2	0.4	0.6	0.2	0.4	0.6	0.2	0.4	0.6	0.2	0.4	0.6
σ_S												
0.2	1.11	0.96	0.79	2.21	1.92	1.57	1.77	1.52	1.25	3.51	3.05	2.49
0.3	1.66	1.44	1.18	3.27	2.85	2.34	2.65	2.30	1.88	5.20	4.53	3.72
0.4	2.22	1.92	1.57	4.28	3.75	3.09	3.62	3.05	2.49	6.81	5.96	4.91
0.5	2.74	2.39	1.96	5.42	4.61	3.83	4.36	3.79	3.11	8.32	7.32	6.07
0.6	3.27	2.85	2.34	6.11	5.41	4.51	5.20	4.53	3.72	9.71	8.61	7.18

Table 2 : Descriptive Statistics

The following table reports the total number of share repurchase plans announced in the Wall Street Journal for ASE, NYSE and NASDAQ firms. The distribution of announcements (quartiles) according to percentage of shares repurchased, the R^2 of a regression of the stock return and the equally weighted market index in the same time period, and the annual standard deviation of the rate of return on the stock, employing monthly data in the 36 months prior to the repurchase.

		Percent Repurchased Mean : 8%				R^2 Mean : 31.25%				Standard Deviation Mean : 37.14%			
Year	# of announcements	2.5 to 4.5%	4.5 to 6.25%	6.25 to 10%	Above 10%	0 to 20%	20 to 30%	30 to 43%	above 43%	< 27%	27 to 34%	34 to 45%	> 45%
1980	53	11	21	15	6	5	11	18	19	20	8	14	11
1981	59	21	8	17	13	8	17	14	20	9	14	12	24
1982	88	25	24	24	15	17	33	29	9	15	17	27	29
1983	29	12	9	5	3	16	5	7	1	11	3	7	8
1984	140	54	33	31	22	39	47	38	16	28	36	39	37
1985	87	17	23	24	23	42	18	20	7	25	25	21	16
1986	96	24	19	23	30	37	24	22	13	33	29	18	16
1987	74	13	16	20	25	18	20	20	16	23	25	8	18
1988	90	15	23	27	25	13	18	22	37	19	25	16	30
1989	95	16	24	23	32	14	14	13	54	16	21	37	21
1990	81	15	23	23	20	14	16	20	31	25	19	24	13
1980-1990	892	223	223	232	214	223	223	223	223	224	222	223	223

Table 3 : Announcement returns, study period, and determinants of option values

This table shows the relationship between the repurchase announcement abnormal returns, the time period and the determinants of the option value: the fraction of shares the company plans to repurchase, the standard deviation of the stock return and the R^2 of the market model regression.

Overall	1980-1990	Average abnormal announcement return (%)	number
		3.42	892
Time period	1980 to 1983	4.57	229
	1984 to 1986	3.21	397
	1987 to 1990	2.63	266
Fraction purchased	2.5% - 4/5%	2.63	223
	4.5% - 6.15%	3.35	223
	6.15% - 10%	3.36	232
	above 10%	4.40	214
Standard deviation (annual returns)	0 - 27	2.28	224
	27 - 34	2.99	222
	34 - 45	3.43	223
	above 45	4.86	223
R^2	0 - 20%	4.48	223
	20% - 30%	3.40	223
	30 - 43%	3.60	223
	above 43%	2.21	223

Table 4 : Cross-sectional regression of announcement returns

Reported values are regression coefficients from regressing the cumulative abnormal returns 2 days around the announcement against the percentage of shares the company wants to buy back (F_p), the monthly standard deviation of the stock return, σ_S, and the R^2 of a regression of the stock return against the market index. t-statistics in parenthesis.

$$CAR_{-2}^{+2} = \alpha + \beta_1 F_p + \beta_2 \sigma_S + \beta_3 R^2 + \varepsilon$$

		Independent variables		
	α	β_1	β_2	β_3
1	0.025 (6.33)	0.11 (2.82)		
2	0.01 (0.06)		0.31 (6.38)	
3	0.05 (10.49)			-0.05 (-3.79)
4	0.01 (1.06)	0.09 (2.42)	0.28 (5.80)	-0.04 (-3.00)

Table 5 : Announcement returns, fraction repurchased, volatility and R^2

This table reports mean cumulative abnormal returns 2 days around the announcement in percent for portfolios formed using two-way sorts. Panel A reports portfolios formed by first sorting into quartiles on the basis of fraction of shares announced for repurchase. Each of these quartiles is separately sorted into four more portfolios on the basis of monthly standard deviation measured in the 36 months prior to the announcement. Panel B is formed similarly only the second sort is done on the basis of R-square from a market model regression. Panel C forms portfolios first on the basis of monthly return standard deviation and secondly on the basis of R-square. T-statistics in parentheses test whether the mean of abnormal announcement returns in different quartiles are significantly different from each other.

	Quartile 1	Quartile 2	Quartile 3	Quartile 4	Difference $Q_1 - Q_4$ (t)
			Panel A : Standard Deviation		
Fraction repurchased					
Quartile 1	1.68	1.41	3.68	3.78	2.10 (3.79)
Quartile 2	2.38	2.17	2.96	5.88	3.50 (4.13)
Quartile 3	3.00	3.47	3.11	3.84	0.84 (1.31)
Quartile 4	3.76	4.02	4.12	5.69	1.93 (2.00)
Difference					
$Q_1 - Q_4$ (t)	2.08 (1.90)	2.61 (3.04)	0.44 (0.36)	1.91 (1.12)	
			Panel B : R^2		
Fraction repurchased					
Quartile 1	2.84	3.61	2.46	1.62	-1.23 (2.80)
Quartile 2	5.21	2.47	4.78	.95	-4.26 (6.03)
Quartile 3	4.01	3.21	3.70	2.50	-1.51 (2.44)
Quartile 4	5.89	5.10	3.71	3.21	-2.37 (2.71)
Difference					
$Q_1 - Q_4$ (t)	2.75 (1.92)	1.49 (1.03)	1.25 (1.07)	1.59 (1.72)	
			Panel C : R^2		
Standard deviation					
Quartile 1	2.40	2.56	1.89	2.28	-0.12 (0.28)
Quartile 2	3.94	2.67	2.94	2.95	-0.99 (1.51)
Quartile 3	4.46	3.93	3.42	1.88	-2.58 (3.98)
Quartile 4	7.13	4.63	5.60	2.10	-5.03 (5.06)
Difference					
$Q_1 - Q_4$ (t)	4.73 (3.32)	2.07 (1.28)	3.71 (2.95)	-0.18 (0.12)	

Table 6 : Non-linear estimation of the share repurchase option model

Maximum likelihood estimation of

$$CAR_{i\,-2}^{+2} = \frac{F_{pi}}{1-F_{pi}}\left[2N(d_{1i})-1\right]+\varepsilon_i$$

where $CAR_{i\,-2}^{+2}$ is the cumulative abnormal return 2 days around the repurchase announcement for stock i, F_{pi} is the fraction purchased and $N(d_{1i})$ if the value of the cumulative standard normal distribution at d_{1i}. d_{1i} is equal to $\frac{1}{2}\sigma_{im}\sqrt{2(1-R_i^2)\,\hat{t}}$, where σ_{im} is the standard deviation of the monthly stock return for company i in the 35 months prior to the repurchase and R_i^2 is the R^2 of a regression of the return on the stock against the market index in the same 35 month period. $\hat{t}$ is the variable to be estimated, the time to maturity of the repurchase option. In row 1 we assume $\hat{t}$ is constant across all firms. In row 2 we assume $\hat{t}_i = \gamma_0 + \gamma_1 F_{pi}$

1) $\hat{t}$ constant		
$\hat{t} = 21.86$	Standard error = 3.38	$\overline{R}^2 = 0.15$
2) $\hat{t} = \gamma_0 + \gamma_1 F_p$		
$\gamma_0 = 19.26$	Standard error = 3.32	$\overline{R}^2 = 0.15$
$\gamma_1 = 16.71$	Standard error = 55.1	