ELSEVIER

Journal of Financial Economics 52 (1999) 225–256

JOURNAL OF Financial ECONOMICS

Does stock price elasticity affect corporate financial decisions?☆

Laurie Simon Hodrick*

Graduate School of Business, Columbia University, New York, NY 10027, USA

Received 12 September 1996; received in revised form 23 March 1998; accepted 1 January 1999

Abstract

This paper considers whether stock price elasticity affects corporate financial decisions. Basic economic principles and the existing theoretical literature predict that firms choosing the Dutch auction instead of the fixed price tender offer should be those firms expecting to face greater stock price elasticity. Econometric analysis suggests that firms choosing the Dutch auction instead of the fixed price tender offer between 1984 and 1989 are indeed those firms expecting to face greater stock elasticity, even though the average realized elasticities of the firms conducting the various tender offers fail to be significantly different. The expected elasticity remains an important determinant of the tender offer choice even when allowing for firm characteristics associated with the choice of repurchase method. Firms facing greater elasticity are also characterized. The findings suggest that expected stock price elasticity may be an important determinant of

* Corresponding author. Tel.: 212-854-8755.

E-mail address: laurie.hodrick@columbia.edu (L.S. Hodrick)

☆I am grateful for comments from Doug Bernheim, Dave Brown, Tim Bollerslev, Bob Comment, Harry DeAngelo, Margie Forster, Charlie Himmelberg, Bob Hodrick, Bo Honoré, Ken Judd, Bob Korajczyk, Rick Ruback, Bill Schwert (the editor), René Stulz, Chris Udry, an anonymous referee, and seminar participants at Arizona State University, Cornell University, Michigan State University, New York University, Stanford University, and the Universities of California, Berkeley, Southern California, and Wisconsin and the Western Finance Association Meetings. I acknowledge the generosity of the Lynde and Harry Bradley Foundation, the Hoover Institution, and the National Science Foundation through the Presidential Young Investigator Award, and the research assistance of Matthew Clayton, Cornelia Kullmann, and Elizabeth Odders-White.

0304-405X/99/$ - see front matter
PII: S0304-405X(99)00009-4

corporate the financial decisions that affect the supply of, or demand for, stock.

JEL classification: G35

Keywords: Repurchases; Dutch auctions; Fixed price tender offers; Elasticity; Quasi-maximum likelihood estimation

---

Since the 1980s, the United States has witnessed dramatic changes in the cash distributions paid to shareholders. Not only has the use of share repurchases increased explosively, as documented in Bagwell and Shoven (1989), but the financial innovation of the Dutch auction repurchase has supplanted the fixed price tender offer as the most common tender offer method.

Concurrently, research has explored the significance of deviations from the paradigm of perfect stock price elasticity. The empirical evidence in Bagwell (1992) demonstrates that firms do not face perfect price elasticity when they repurchase their shares. Moreover, an examination of previous studies reveals that a common set of characteristics describe the firms that choose particular self-tender repurchase methods as well as a firms' observed stock price elasticity.

This paper examines firms conducting self-tender offers between 1984 and 1989 to address two questions. First, what determines the firm's choice between the Dutch auction and fixed price tender offer repurchase mechanisms? Is expected stock price elasticity an important determinant of this corporate financial decision? Second, what characterizes firms expecting to face greater price elasticity when they repurchase their stock, by either self-tender method?

Econometric analysis suggests that firms choosing the Dutch auction instead of the fixed price tender offer between 1984 and 1989 are those firms expecting to face greater stock elasticity, even though the average realized elasticities of firms conducting the particular offers fail to be significantly different. The expected elasticity remains an important determinant of the tender offer choice even when allowing for firm characteristics associated with the choice of repurchase method. Firms choosing the Dutch auction systematically have the following characteristics: larger market capitalization, smaller insider holdings, larger institutional holdings, lower trading volume, and listing on the New York Stock Exchange (NYSE). They also seek to repurchase a smaller fraction of shares, and they tend to announce their repurchases later in the sample period. Firms facing greater elasticity systematically have the following characteristics: smaller market capitalizations, smaller insider holdings, larger institutional holdings, larger trading volume, smaller return variance, and inclusion in the Standard and Poor's (S&P) 500 Index. The empirical results are largely consistent with theoretical predictions.

The organization of the paper is as follows. Section 1 develops the hypothesis that the choice of self-tender repurchase method may be determined in part by a firm's expected stock price elasticity. Readers willing to accept this premise may proceed directly to Section 2, which discusses the explanatory variables used in the econometric analysis. Section 3 presents the data. Section 4 develops a structural econometric model of the choice of repurchase method and the determinants of stock price elasticity, discusses the estimation procedures, and presents the empirical results. Section 5 concludes. A technical discussion of the Quasi-Maximum Likelihood Estimation (QMLE) procedure is found in the Appendix.

1. The hypothesis

This paper considers the hypothesis that a firm's expected stock price elasticity may be a determinant of the choice of self-tender repurchase method. After defining stock price elasticity and introducing the fixed price and Dutch auction self-tenders, this section presents theoretical arguments motivating why firms expecting greater elasticity may favor the Dutch auction.

Stock price elasticity, defined as the percentage change in quantity associated with a percentage change in price, has conventionally been argued to be close to infinite. For example, Brealey and Myers (1996) p. 346 state that 'there seems to be widespread agreement with the general point that you can sell large quantities of stock at close to the market price as long as other investors do not deduce that you have some private information'. Without informational effects, therefore, firms should be able to repurchase their shares near the prevailing market price. Evidence in Bagwell (1992) suggests instead that stock price elasticity may be far from infinite when firms buy back their shares in a Dutch auction. Corroborative evidence has been detected in fixed price tender offers (Brown and Ryngaert, 1992), interfirm tender offers (Bradley et al., 1988), and large block transactions (Holthausen et al., 1990).

The econometric analysis that follows employs proxies for each firm's inverse elasticity, the reciprocal of elasticity. Inverse elasticity of demand is negative if the demand curve is downward sloping, while inverse elasticity of supply is positive if the supply curve is upward sloping. Inverse elasticity measures, also employed in Loderer et al. (1991), capture the positive relation between the repurchase premium and the willingness of shareholders to sell their shares in the repurchase. The paradigm of infinite elasticity implies an inverse elasticity near zero. In discussing the hypothesis, however, it is less cumbersome to continue to speak of greater or smaller elasticity, rather than, respectively, smaller or greater inverse elasticity.

The other salient issue is the choice of self-tender repurchase method.[1] Prior to 1981, all tender offers were executed using a fixed price tender offer. This offer specifies in advance a single purchase price, the number of shares sought, and the duration of the offer. Shareholders decide whether or not to participate, and if so, the number of shares to tender at that price.

The Dutch auction repurchase, introduced in 1981, specifies a price range within which the shares will ultimately be purchased, rather than a single purchase price. Shareholders are invited to tender their stock, if they desire, at any price or prices within the stated range. The firm then compiles these responses, creating a supply curve for the stock. The purchase price is the lowest price sufficient to buy the number of shares sought, and the firm pays that price to all investors who tendered at or below that price.[2] Since its advent, the number of Dutch auctions has increased dramatically, totaling more than half of all self tenders in each of the years 1988 and 1989.

In developing a hypothesis that links the choice of self-tender repurchase method to a firm's expected stock price elasticity, it is important to observe that the elasticity must be uncertain. If the elasticity is known with certainty, then the number of shares that would be tendered in response to any offer can be anticipated exactly. Since the purchase price in a fixed price tender offer could be set at the same price that would result in a Dutch auction offer for a given number of shares, there would be no link between the choice of repurchase method and the expected elasticity. When the elasticity is uncertain, basic economic principles and the existing theoretical literature predict that expected elasticity may be a determinant of the repurchase decision.

The first argument is that firms expecting greater stock price elasticity may choose the Dutch auction method if they desire to avoid oversubscription. This argument stems from three observations: that the avoidance of oversubscription may be desirable, that the risk of oversubscription is greater in the fixed price tender offer than in the Dutch auction, and that this advantage of the Dutch auction is increasing in the firms expected elasticity.

---

[1] This paper does not consider the decision to repurchase stock in the open market, since all existing theory and evidence suggests that open market repurchases are a dramatically different corporate financial decision. Open market repurchases outnumber self-tender offers 1031 to 166 during the period being studied (Comment and Jarrell, 1991).

[2] With both types of offers, if the aggregate number of shares tendered exceeds the number sought, SEC Schedule 13E-4 compels the company to purchase less than all shares tendered at or below the purchase price on a pro rata basis to all who tendered at or below the purchase price, that is, in proportion to the total number of shares tendered. If too few shares are tendered, then the firm either cancels the offer, provided it had been made conditional on a minimum acceptance, or it buys back all tendered shares.

The avoidance of oversubscription, while guaranteeing sufficient participation, may be desirable for a firm seeking to buy back only from the lowest valuation shareholders. In repurchases motivated by takeover deterrence, as in Bagwell (1991), the repurchase skews the distribution of the remaining shareholders towards a more expensive pool, making a potential takeover more costly. In repurchases motivated by distributional efficiency, as in Bagwell and Shoven (1989) and Brennan and Thakor (1990), the repurchase attracts specifically both those who have invested the least in information acquisition and those who have the smallest CAP gains tax liabilities.

The risk of oversubscription is greater for fixed price tender offers. Specifying the purchase price in advance, the fixed price tender offer is oversubscribed whenever its price exceeds the minimum price sufficient to purchase the amount of shares sought. In contrast, the Dutch auction purchase price is set in response to shareholder tendering. Hence, oversubscription can be minimized by setting a sufficiently low minimum price. Tendering only at discrete price increments can result in some oversubscription, but in practice this effect is of limited importance.

The sample evidence provides prima facia support for the idea that the Dutch auction method reduces the risk and amount of oversubscription. For the 76 firms conducting fixed price tender offers, the mean fraction of tendered shares repurchased is 73%. In the 42 oversubscribed offers, 51% of the tendered shares are purchased on average. For the 65 firms conducting Dutch auctions, the mean fraction of tendered shares repurchased is far greater, at 93%. Oversubscription is both less common, occurring only in 18 offers, and less sizeable, with 78% of the tendered shares purchased on average. In the 4 oversubscribed offers where the firm repurchased at the lowest range price, 53% of the tendered shares are purchased on average, while in the 14 oversubscribed offers where the firm repurchased above the lowest range price, 86% of the tendered shares are purchased on average.

Persons (1994) develops a model in which the oversubscription benefit of the Dutch auction as a takeover deterrent increases with the expected elasticity. While Persons' analysis does not rule out that the Dutch auction is always the preferred method, it can be demonstrated that, under specific parameters in his model, the Dutch auction is optimally chosen when greater elasticity is expected, while the fixed price tender offer is chosen when less elasticity is expected. Hence, the first argument linking the choice of self-tender repurchase method to the firm's expected elasticity is that firms expecting greater elasticity may be more likely to choose the Dutch auction method if they desire to avoid oversubscription.

Given that all firms do not choose the Dutch auction with the maximum price set at what would be the tender offer price, there must also be benefits associated with the fixed price tender offer. The second argument is that firms expecting less elasticity may be more likely to choose the fixed price repurchase method to

signal undervaluation of their stock. This argument stems from three observations: that the signaling effect of a repurchase may be desirable, that the credibility of the repurchase as a signal may be greater for the fixed price tender offer than for the Dutch auction, and that the credibility of the signal is decreasing in the expected elasticity.

The idea that corporate financial decisions can signal information to the market is pervasive. Since Dann (1981) and Vermaelen (1981), it has been commonly argued that firms repurchase stock in tender offers to signal their undervaluation. If a firm's true value is known to its managers but not to the market, then the firm's willingness to buy back stock at a premium may convince the market of the firm's undervaluation. This action is credible if the cost of false signaling for less undervalued firms is sufficient to preclude them from mimicking this behavior. These costs may include that the post-repurchase price of the stock falls once the truth is revealed, hurting managers who frequently commit not to tender shares in the repurchase.

Empirical evidence has been interpreted as consistent with the conjecture that the Dutch auction may be the less credible and less informative signal of undervaluation.[3] The average stock price reaction at the announcement of a Dutch auction is smaller than for a fixed price tender offer (8% versus 11%), and, on average, a smaller price premium is ultimately paid in a Dutch auction (13% versus 20%). Comment and Jarrell (1991) conclude that the Dutch auction is the less effective signal because it exposes the personal wealth of managers to less risk.

Persons (1994) contends that the relative signaling advantage of the fixed price tender offer declines as the expected elasticity increases. While the ratio of the cost of false signaling relative to the cost of truthful signaling is always higher for fixed price tender offers in his model, the signaling advantage of the fixed price tender offer vanishes as the price becomes increasingly elastic. Hence, the second argument linking the choice of self-tender repurchase method to the firms expected stock price elasticity is that firms expecting less elasticity may be more likely to choose the fixed price tender offer method if they desire to signal undervaluation of their stock.

In choosing between self-tender repurchase methods in practice, complex and potentially confounding considerations must be integrated into an ultimate decision. This section has developed two arguments to address this resolution. Since the relative importance of the oversubscription effect should be greatest

[3] While Persons (1994) contends that the fixed price tender offer is always the optimal signal of undervaluation, this conjecture is not universally accepted. Hausch and Seward (1993) argue instead that either of the self-tender methods may provide the stronger signal, depending on the firm's unobservable production technology.

Table 1
Predicted univariate coefficient signs

Summary of the predicted univariate coefficient signs on the independent variables used in the analysis of firms conducting Dutch auction and fixed price tender offer repurchases from 1984 to 1989, and in the analysis of expected stock price inverse elasticity. Takeover is a dummy variable which equals one if the firm is a target of activity, and is zero otherwise. Sought is the fraction of shares sought in the offer. Officers/directors is the fraction of shares held by officers and directors at the time of the offer. Equity is the market value of the equity, in tens of billions of dollars. Institutions is the fraction of shares held by institutional investors at the time of the offer. S&P is a dummy variable which equals one if the stock is included in the Standard and Poor's 500 Index, and is zero otherwise. NYSE is a dummy variable which equals one if the stock is traded on the NYSE, and is zero otherwise. Volume is the average number of shares that are traded per day for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, in millions of shares. Variance is the variance of the 25 daily returns for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, multiplied by one hundred. Year is a dummy variable which equals one if the repurchase was announced 1984–1986, and is zero otherwise.

Variables	Repurchase method (Dutch auction = 1)	Expected inverse elasticity
Takeover	Positive	
Sought		
Officers/directors	Negative	Positive
Equity	Ambiguous	Ambiguous
Institutions	Positive	Negative
S&P	Positive	Negative
NYSE	Positive	Negative
Volume	Ambiguous	Ambiguous
Variance	Negative	Positive
Year		

for firms expecting to face greater stock price elasticity, these firms may be more likely to opt for the Dutch auction. In contrast, firms expecting to face less elasticity may instead prefer the signaling advantages associated with the fixed price tender offer. In no way do these arguments exhaust the possible reasons for choosing a particular method of self-tender repurchase. Rather, they motivate the hypothesis that firms expecting greater stock price elasticity tend to choose the Dutch auction repurchase method.

2. The explanatory variables

Both theoretical arguments and prior empirical findings motivate the inclusion of numerous firm characteristics as explanatory variables for either the choice of self-tender repurchase method or the expected stock price inverse elasticity. The theoretical predictions are summarized in Table 1. One

explanation of the choice of self-tender method is that the Dutch auction may be the more effective takeover deterrent. This hypothesis generates interest in the presence of takeover threats.

A second explanation of the choice of self-tender repurchase method argues that the Dutch auction may be the more efficient means of distributing cash to shareholders who have invested less in information acquisition or have smaller capital gains tax liabilities. The cost of acquiring information should be related to the extent of asymmetric information and to the difficulties in obtaining information about the firm. Insider holdings may serve as a proxy for asymmetry of information, if insiders are more likely to possess valuable information. The level of daily trading volume, the exchange on which the stock trades, institutional holdings, and firm size may all serve as proxies for the extent of costly investor scrutiny. Inclusion of a stock in the S&P 500 Index may increase the extent to which the firm is studied by analysts. The cost of information acquisition may be greater for firms with higher daily return variance, if information volatility leads to greater stock return variability.

Capital gains tax liabilities should be related both to the extent of unrealized capital gains and to tax rates. Many institutions either transact tax-free or have basis values close to the market price as the result of active management, and hence hold little unrealized capital gains. Many insiders are long-term holders of the stock who tend to hold large unrealized gains generally subject to high marginal tax rates. Unrealized capital gains may also be smaller for firms with higher daily trading volume, if more of the basis values are closer to the prevailing market price.

A third explanation of the choice of self-tender repurchase method is that the credibility of the repurchase as a signal of undervaluation may be greater for the fixed price tender offer than for the Dutch auction. This hypothesis suggests a relation between the extent of asymmetric information and the choice of repurchase method, validating the information acquisition proxies discussed above.

A fourth explanation of the choice of self-tender repurchase method is that firms with greater uncertainty about their expected elasticity are more likely to choose the fixed price tender offer, as argued in Persons (1994). It could instead be argued that these firms are actually more likely to choose the Dutch auction to limit oversubscription risk. Persons suggests that the firm's market capitalization provides a negative proxy for the extent of uncertainty, since larger numbers of shareholders may reduce the uncertainty about the expected elasticity.

Descriptively, Comment and Jarrell (1991) and Kamma et al. (1992) characterize firms conducting Dutch auctions to be those having larger market capitalizations, smaller insider holdings, larger institutional holdings, listing on the NYSE, and those seeking to repurchase fewer shares than the firms conducting fixed price tender offers. Dutch auctions are more common later in the

sample period. Though theory predicts a relation between the presence of takeover threats and the repurchase method, this relation has not emerged in previous examinations of the data.

Both theoretical arguments and empirical findings also motivate the inclusion of numerous firm characteristics as explanatory variables for the expected inverse elasticity. Stulz (1988) and Bagwell (1991) argue that price inelasticity may be induced by capital gains taxation. Heterogeneous basis values or tax rates in the presence of capital gains taxation induce owners with greater unrealized gains to be more reluctant to sell. Proxies for the extent of taxation-induced inelasticity should be the same as the proxies for capital gains tax liability.

Mayshar (1979,1981) and Varian (1985) argue that price inelasticity may also be induced by asymmetric information or divergence of opinion. Proxies for the extent of asymmetric information-induced inelasticity should be the same as those for costly information acquisition.

Amihud and Mendelson (1986) argue that price inelasticity may also be induced by trading illiquidity. Traders facing incomplete information may be unwilling to take positions in illiquid assets unless compensated through expected return. Liquidity may vary across exchanges, as in Marsh and Rock (1986). Daily trading volume may serve as a proxy for the extent of liquidity, as may inclusion in the S&P 500 Index. Shleifer (1986), for example, argues that inclusion of a stock in the Index increases the stock's trading volume by raising institutional demand. Empirically, the positive price reaction when firms are added to the S&P 500 Index is related to changes in institutional demand (Pruitt and Wei, 1989). Harris and Gurel (1986) find permanent increases in trading volume for firms added to the Index.

Risk aversion provides a fourth reason for price inelasticity. Loderer et al. (1991) argue that price inelasticity should be larger for bigger firms with higher daily return variance and smaller trading volume, since risk averse investors demand greater compensation to increase holdings in firms that are larger, more volatile, and less liquid.

Descriptively, Bagwell (1992), Brown and Ryngaert (1992), and Loderer et al. (1991) characterize firms with less price inelasticity observed around corporate financial events as tending to have smaller market capitalizations, smaller insider holdings, and larger institutional holdings. Such firms are also typically included in the S&P 500 Index, have relatively high daily trading volume, and have smaller daily return variance.

Hence, possible explanatory variables for the self-tender repurchase method or the expected inverse elasticity include the following: market capitalization, the fraction of shares held by officers and directors, the fraction of shares held by institutions, whether the firm is included in the S&P 500 Index, whether the firm is listed on the NYSE, daily trading volume, and daily return variance. Whether the firm has been the recent target of takeover activity and the fraction of shares

sought in the repurchase might also explain the repurchase choice, though there is no obvious economic rationale for the inclusion of either variable to explain the expected inverse elasticity.

One issue is whether the fraction of shares sought is determined jointly with the choice of repurchase method, or whether the fraction of shares sought is effectively predetermined. Anecdotal evidence suggests that the fraction sought may be chosen prior to the choice of repurchase method, as was the case for Todd Shipyards in 1981. The firm's management planned to buy back 10% of its shares in a fixed price tender offer, and then was convinced by Bear, Stearns to instead use a Dutch auction (Wall Street Journal, September 23, 1981, p. 19). For TRW in 1985, the choice of repurchase method was again chosen after the size of the repurchase had been set. When the firm could not agree on a fair valuation for 22% of its stock, they adopted the Dutch auction method to 'let the marketplace determine the price … for the number of shares we wished to buy' (Business Week, October 7, 1985, p. 37).

The question, econometrically, is whether an endogeneity problem exists, such that firms with certain characteristics, which are not captured in the model, will be more likely to choose a particular size repurchase and a particular method of repurchase. If so, this endogeneity problem biases the estimate of the coefficient on the fraction sought. However, supposing there is orthogonality between the other explanatory variables and the regression's errors, then endogeneity of the fraction sought would impart no bias on the coefficient testing the primary hypothesis of the paper, as long as the fraction sought is orthogonal to the other explanatory variables.

An ideal model of the self-tender choice certainly would include, in addition to the structural model determining the choice of method, structural equations for both the fraction of shares sought and the price determination method (for the pre-set price for the fixed price tender offer or the upper range price for the Dutch auction). Since the primary purpose of this analysis is to examine the choice of self-tender method and to measure the influence of expected elasticity on the repurchase choice, rather than to model all aspects of the stock repurchase decision, the fraction of shares sought is taken as econometrically predetermined.

3. Sample description and data

The potential data set begins with all 166 exchange-listed and over the counter (OTC) traded firms announcing self-tender repurchases between January 1, 1984 and December 31, 1989, as identified by Comment and Jarrell (1991).[4] For each firm, the following information was collected from the

[4] I am grateful to Bob Comment for providing me with access to the data.

Comment and Jarrell data set: (1) The method of tender offer, generating a dummy variable which equals one for a Dutch auction, and is zero for a fixed price tender offer, (2) the fraction of shares sought in the offer, (3) the fraction of shares held by officers and directors at the time of the offer, (4) the market value of the equity, in tens of billions of dollars, (5) the fraction of shares tendered at or below the price paid in a Dutch auction, or the fraction of shares tendered at the price paid in a fixed price tender offer, (6) the price paid as a premium above the market price three days before the announcement, which can be expressed as a percent when multiplied by 100, (7) the fraction of shares repurchased, and (8) the calendar year of the repurchase announcement, generating a dummy variable which equals one if the repurchase announcement occurs during 1984–1986, and is zero otherwise.

For each firm, three pieces of information were gathered from the Standard and Poor's Security Owner's Stock Guide, for the end of the month preceding the expiration of the offer: (1) the fraction of shares held by institutional investors, (2) whether the firm was included in the S&P 500 Index, and (3) the stock exchange on which the firm was traded. This information generates an S&P 500 Index dummy variable which equals one if the firm is included in the Index, and is zero otherwise, as well as an NYSE dummy variable which equals one if the firm is listed on the NYSE, and is zero otherwise.

For each firm, information about whether the firm was a target of takeover activity was gathered from the Wall Street Journal, for the year preceding the announcement of the repurchase. A firm is deemed a target of takeover activity if the Wall Street Journal included a discussion of any of the following: the firm implemented any anti-takeover amendments; an offer or bid was made for the firm; a rumor of takeover activity was published; or a shareholder acquired a toehold or large block. This generates a takeover dummy variable which equals one if the firm is a target of takeover activity, and is zero otherwise.

For each firm, trading volume and stock price data were gathered from the Standard and Poor's Daily Stock Price Record. The data include the number of shares traded each day for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, in millions of shares, as well as the daily stock prices for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase. When available, closing prices are used. For OTC firms trading with bid-ask spreads, the average of the closing bid and ask prices is used. The data also include the daily stock prices for the seven trading days from three days prior to the announcement of the repurchase to three days after the announcement of the repurchase.

Daily return variance is estimated by multiplying the sample variance of the 25 daily returns, calculated from daily stock prices for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, by one hundred. Daily trading volume is estimated as the average number of shares traded each

Table 2
Comparison of the frequencies of self-tender repurchases for 1984 through 1989 for a subset of 141 firms relative to the sample of 166 firms used in Comment and Jarrell (1991)

The table displays the frequencies, by year, of self-tender repurchases by type, comparing the frequencies for this subset to the total number of exchange-listed and OTC-traded firms announcing self-tender repurchases between January 1, 1984 and December 31, 1989, as given in Comment and Jarrell (1991). The subset excludes those 25 firms for which additional necessary information from either the Standard and Poor's Security Owner's Stock Guide or the Daily Stock Price Record was unavailable.

Year	Number of Dutch auctions		Number of fixed price offers		Total number of repurchases	
	Subset	Total	Subset	Total	Subset	Total
1984	2	2	20	21	22	23
1985	6	6	8	11	14	17
1986	9	10	9	12	18	22
1987	9	9	15	21	24	30
1988	18	21	14	16	32	37
1989	21	24	10	13	31	37
1984–1989	65	72	76	94	141	166

day for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, in millions of shares. The fraction of shares traded daily is computed as the average of the number of shares traded each day for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, scaled by the total number of shares outstanding at the end of the quarter prior to the announcement of the repurchase. The fraction of shares traded daily is not highly correlated with other standard measures of liquidity (e.g., S&P correlation 0.13, NYSE correlation 0.19, equity market capitalization correlation 0.05), but is highly correlated with the fraction of shares sought (correlation 0.50), which has the same denominator. Hence, we employ the number of shares traded, rather than the fraction of shares traded, in the following analysis.

The sample used in the analysis is the 141 firms for which all data were available. This data set includes 65 Dutch auctions and 76 fixed price tender offers. Table 2 reports the repurchase frequencies in this sample as a subset of the 166 original firms from the Comment and Jarrell (1991) data set. This subset of firms appears to be fairly representative of the complete sample.

Table 3 reports summary statistics and compares the average characteristics of firms conducting Dutch auction and fixed price tender offers, with tests for differences in means. Dutch auction firms seek to repurchase a smaller fraction of outstanding shares than fixed price tender offer firms. Dutch auction firms typically have smaller insider holdings, larger market capitalizations, and larger

institutional holdings. They are more likely to be included in the S&P 500 Index and are more likely to be traded on the NYSE. Dutch auctions are more prevalent later in this period. Each of these differences in means is statistically significant at the 1% level.

Dutch auction firms appear to be no more likely to be takeover targets than firms conducting fixed price tender offers. Firms choosing Dutch auctions also have daily trading volumes and return variances that are similar to firms choosing fixed price tender offers. None of these differences in means is statistically significant at the 10% level in a one-sided test.

Table 3 also reports that the Dutch auction repurchases have a different outcome than the fixed price tender offers. Shareholders tender a smaller fraction of shares in Dutch auctions. Dutch auctions ultimately repurchase a smaller fraction of shares and pay a lower repurchase premium. Each of these differences in means is statistically significant at the 1% level.

Table 4 reports the correlations between firm characteristics. The existence of collinearity among the independent variables can increase the sampling variances of the estimates. Following the procedure in Belsley et al. (1980), we compute the condition number of the independent variable matrix scaled to have equal (unit) column lengths and including a column of ones, since constants are included in the analyses. For the square matrix L, the condition number is defined as the ratio of the largest singular value to the smallest. Since the condition number of 11.64 is below the recommended threshold, the dependancies among the columns of the data matrix are deemed insufficient to warrant further evaluation.

The most serious data limitation is the inability to observe directly the firm's expectation of its elasticity at the time of the repurchase decision. Any elasticity realization, therefore, must be viewed as the expected elasticity measured with error. To redress this limitation, we calculate two different measures of inverse elasticity for each firm. The first measure is the price paid as a premium above the market price three days before the announcement, scaled by the fraction of shares tendered at or below the price paid in the self-tender offer. Since this pre-announcement measure may contain information conveyed by the repurchase announcement, it may be biased if, as argued above, the choice of repurchase method is associated with the intention to signal information. For example, if the variables included to predict the expected inverse elasticity are also related to the information conveyed in the announcement, and if the Dutch auction choice conveys less information, then signaling may induce a negative relation between the likelihood of the Dutch auction and the inverse elasticity measure. Ideally, one would like to control for information revealed in an announcement, by investigating announcement effects for more senior securities, as in Loderer et al. (1991) or Kalay and Shimrat (1987). Unfortunately, only 23 of the 141 firms list preferred stock, a subset of which are convertible, and only 47 have bond price data in the S&P Bond Guide.

Table 3
Comparison of Dutch Auction and Fixed Price Tender Offers, 1984–1989

Summary statistics for a sample of 141 firms that announced self-tender repurchases, either Dutch auction or fixed price tender offers, between 1984 and 1989. Of the 141 offers, 76 were fixed price tender offers and 65 were Dutch auctions. Means, medians, and standard deviations are reported for the sample as well as for each type of repurchase method. The data began with the total number of exchange-listed and OTC-traded firms announcing self-tender repurchases between January 1, 1984 and December 31, 1989, as given in Comment and Jarrell (1991). The subset excludes those 25 firms for which additional necessary information from either the Standard and Poor's Security Owner's Stock Guide or the Daily Stock Price Record was unavailable. Takeover is a dummy variable which equals one if the firm is a target of activity, and is zero otherwise. Sought is the fraction of shares sought in the offer. Officers/directors is the fraction of shares held by officers and directors at the time of the offer. Equity is the market value of the equity, in tens of billions of dollars. Institutions is the fraction of shares held by institutional investors at the time of the offer. S&P is a dummy variable which equals one if the stock is included in the Standard and Poor's 500 Index, and is zero otherwise. NYSE is a dummy variable which equals one if the stock is traded on the NYSE, and is zero otherwise. Volume is the average number of shares that are traded per day for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, in millions of shares. Variance is the variance of the 25 daily returns for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, multiplied by one hundred. Premium paid is the price paid as a premium above the market price three days before the announcement, multiplied by 100. Shares tendered is the fraction of shares tendered at or below the price paid in a Dutch auction, or the fraction of shares tendered at the price paid in a fixed price tender offer. Shares bought is the fraction of shares repurchased. The pre-announcement inverse elasticity measure is the price paid as a premium above the market price three days before the announcement, scaled by the fraction of shares tendered at or below the price paid in the self-tender offer. The post-announcement inverse elasticity measure is the price paid as a premium above the market price three days after the announcement, scaled by the fraction of shares tendered at or below the price paid in the self-tender offer. The last column provides a t-test for the difference in means, by type of repurchase method, with asymptotic one-sided p-values in parentheses.

Variables	All offers (141)			Fixed price (76)			Dutch auction (65)			t-statistic (p-value)
	Mean	Median	Std Deviation	Mean	Median	Std Deviation	Mean	Median	Std Deviation	
Takeover	0.27	0.00	0.45	0.26	0.00	0.44	0.28	0.00	0.45	0.2 (0.428)
Sought	0.20	0.17	0.13	0.23	0.20	0.14	0.17	0.15	0.10	− 2.6 (0.005)
Officers/directors	0.20	0.14	0.20	0.26	0.22	0.21	0.13	0.06	0.16	− 4.2 (0.000)

Equity	0.14	0.03	0.23	0.09	0.01	0.18	0.19	0.10	0.28	2.7 (0.003)
Institutions	0.37	0.38	0.22	0.27	0.23	0.19	0.48	0.53	0.20	6.2 (0.000)
S&P	0.27	0.00	0.45	0.16	0.00	0.37	0.40	0.00	0.49	3.3 (0.001)
NYSE	0.62	1.00	0.49	0.51	1.00	0.50	0.75	1.00	0.43	3.0 (0.001)
Volume	0.11	0.03	0.19	0.10	0.01	0.22	0.12	0.05	0.16	0.9 (0.195)
Variance	0.06	0.03	0.13	0.07	0.04	0.09	0.05	0.02	0.17	− 0.7 (0.231)
Year	0.38	0.00	0.49	0.49	0.00	0.50	0.26	0.00	0.44	− 2.8 (0.002)
Premium paid	0.17	0.14	0.13	0.20	0.16	0.16	0.13	0.13	0.09	− 3.3 (0.001)
Shares tendered	0.27	0.17	0.25	0.35	0.23	0.28	0.18	0.13	0.17	− 4.2 (0.000)
Shares bought	0.18	0.15	0.13	0.20	0.16	0.15	0.15	0.13	0.09	− 2.7 (0.004)
Inverse elasticity measure (pre-announcement)	1.12	0.80	1.13	0.99	0.71	0.96	1.27	0.86	1.29	1.5 (0.071)
Inverse elasticity measure (post-announcement)	0.36	0.26	0.52	0.29	0.24	0.29	0.44	0.30	0.69	1.6 (0.055)

Table 4
Correlations between independent variables

This table provides the correlations between independent variables used in the analysis of firms conducting Dutch auction and fixed price tender offer repurchases from 1984 to 1989. Takeover is a dummy variable which equals one if the firm is a target of activity, and is zero otherwise. Sought is the fraction of shares sought in the offer. Officers/directors is the fraction of shares held by officers and directors at the time of the offer. Equity is the market value of the equity, in tens of billions of dollars. Institutions is the fraction of shares held by institutional investors at the time of the offer. S&P is a dummy variable which equals one if the stock is included in the Standard & Poor's 500 Index, and is zero otherwise. NYSE is a dummy variable which equals one if the stock is traded on the NYSE, and is zero otherwise. Volume is the average number of shares that are traded per day for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, in millions of shares. Variance is the variance of the 25 daily returns for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, multiplied by one hundred. Year is a dummy variable which equals one if the repurchase was announced 1984–1986, and is zero otherwise. The condition number is 11.64.

	Sought	Officers/ directors	Equity	Institutions	S&P	NYSE	Volume	Variance	Year
Takeover	0.31	− 0.38	0.21	0.18	0.24	0.27	0.41	0.00	− 0.05
Sought		− 0.15	− 0.22	0.08	− 0.16	− 0.06	0.14	0.11	− 0.06
Officers/directors			− 0.40	− 0.53	− 0.45	− 0.42	− 0.40	0.15	− 0.02
Equity				0.38	0.69	0.39	0.62	− 0.10	− 0.05
Inst.					0.46	0.49	0.40	− 0.18	− 0.11
S&P						0.47	0.57	− 0.10	0.08
NYSE							0.35	− 0.01	0.04
Volume								0.12	− 0.09
Variance									− 0.10

As a robustness check, an alternative measure is also computed. The post-announcement inverse elasticity measure uses the price paid as a premium above the market price three days after the announcement, so any information-based relation should be limited. This measure is also imperfect, however, as it excludes the market's expectation of movement along an upward-sloping supply curve which is generated by the announcement, and it excludes any changes in firm valuation associated with the offer. This second measure may be biased in the opposite direction of the pre-announcement measure. If fixed price tender offers generate more movement up the supply curve, then their measures may be deflated relatively. The correlation between the pre- and post-announcement measures is 67%. For completeness, empirical results based on both measures are provided.

Table 3 reports that for the Dutch auction firms, the average pre-announcement inverse elasticity is 1.27, compared to 0.99 for fixed price tender offer firms. The average post-announcement inverse elasticity is 0.44, compared to 0.29 for fixed price tender offer firms. The simplest test of a linkage between elasticity and the choice of repurchase method is a difference in means test. The difference in means across repurchase methods is statistically insignificant at the 5% level in a one-sided test for both elasticity measures. This evidence, however, does not discredit the key hypothesis of the paper, namely that a firm's expected stock price elasticity may affect its choice of self-tender method. The null hypothesis is best expressed as a negative conditional covariance between the firm's expected elasticity and the underlying incremental value of a Dutch auction choice, conditional on the information set of explanatory variables and unobservables. Section 4 presents direct econometric tests of the paper's hypothesis.

4. Structural model and empirical results

An examination of previous studies reveals that a common set of characteristics describe the firms that choose particular self-tender repurchase methods as well as the extent of a firm's stock price elasticity. The econometric analysis in this section explicitly examines the hypothesis that expected stock price elasticity might be a determinant of the self-tender repurchase choice, and it considers whether firm characteristics are important only as they affect stock price elasticity.

The analysis develops a system of equations. The first equation explains the choice of self-tender repurchase method in a probit model, and the second equation explains the extent of expected inverse elasticity in a linear regression. The hypothesis that expected stock price elasticity affects the repurchase choice is tested with cross-equation constraints.

The first empirical question is what determines the choice of self-tender repurchase method. The unobserved dependent variable y_{1i}^{*} measures the

additional, either positive or negative, value to the firm of choosing the Dutch auction instead of the fixed price tender offer, by implicitly subtracting the value of choosing the fixed price tender offer from the value of choosing the Dutch auction. The variable y_{1i}^* is modeled as a linear function of a set of explanatory variables $\{z_i, x_i\}$ and an error term v_{1i}. Those variables that are also employed as explanatory variables for the firm's expected inverse elasticity are denoted z_i, and additional explanatory variables are denoted x_i. Thus,

$$y_{1i}^* = a_1 + \beta_1 z_i + \beta_2 x_i + v_{1i}. \tag{1}$$

The econometric analysis assumes that v_{1i} is an independently and identically distributed (i.i.d.) normal random variable with zero mean and variance σ_1^2.

One cannot observe the underlying incremental value of choosing the Dutch auction repurchase instead of the fixed price tender offer; one can only observe the choice made. The observable dichotomous dependent variable representing this choice, y_{1i}, equals one when the Dutch auction is chosen and equals zero when the fixed price tender offer is chosen.[5] Thus,

$$y_{1i} = 1 \quad \text{if } y_{1i}^* > 0, \quad y_{1i} = 0 \quad \text{if } y_{1i}^* \leqslant 0. \tag{2}$$

Table 5 reports the estimated coefficients and t-statistics from the binary probit analysis of Eqs. (1) and (2). The results are largely consistent with the predictions summarized in Table 1. Firms choosing a Dutch auction repurchase instead of a fixed price tender offer seek to repurchase a smaller fraction of their outstanding shares. Firms choosing Dutch auctions are those with smaller insider holdings, larger institutional holdings, and smaller daily trading volume. They are more likely to announce a repurchase later in the sample period. These variables are each statistically significant at conventional levels. Five additional variables were included in the probit analysis, and none were found to be statistically significant at conventional levels.

The probit analysis correctly predicts 79% of the repurchase choices: 82% of the fixed price tender offers, or 62 out of 76, and 75% of the Dutch auctions, or 49 out of 65. The test of the joint hypothesis that all of the coefficients are zero yields a chi-square statistic, with ten degrees of freedom, of 63.9, with a corresponding p-value of 10^{-9}. Hence, we can reject the hypothesis that all of the coefficients are zero.

In interpreting these coefficients, recall that the parameters of this nonlinear regression model do not equal the marginal effects of each independent variable. Under probit analysis, the marginal effect of the vector of independent variables

[5] Since the dichotomous variable for the self-tender repurchase choice is a crude measure of the true incremental value of choosing the various repurchase methods, any test trying to differentiate inverse elasticity measures across the repurchase choices will have low precision.

Table 5
Binary probit estimates of the self-tender repurchase choice, 1984–1989

This table reports coefficient estimates, with t-statistics and marginal effects, of the equation:

$$y_{1i}^{*} = a_1 + \beta_1 z_i + \beta_2 x_i + v_{1i}.$$

The additional value of choosing the Dutch auction repurchase method instead of the fixed price tender offer, denoted y_{1i}^{*}, is modeled as a function of the explanatory variables, z_i and x_i, and an unobservable error. Only the dichotomous values for y_{1i}^{*} are observed. Takeover is a dummy variable which equals one if the firm is a target of activity, and is zero otherwise. Sought is the fraction of shares sought in the offer. Officers/directors is the fraction of shares held by officers and directors at the time of the offer. Equity is the market value of the equity, in tens of billions of dollars. Institutions is the fraction of shares held by institutional investors at the time of the offer. S&P is a dummy variable which equals one if the stock is included in the Standard & Poor's 500 Index, and is zero otherwise. NYSE is a dummy variable which equals one if the stock is traded on the NYSE, and is zero otherwise. Volume is the average number of shares that are traded per day for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, in millions of shares. Variance is the variance of the 25 daily returns for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, multiplied by one hundred. Year is a dummy variable which equals one if the repurchase was announced 1984–1986, and is zero otherwise.

Variable	Coefficient	t-Statistic	Marginal effect
Constant	0.19	0.4	
Takeover	− 0.06	− 0.2	− 0.02
Sought	− 3.54	− 2.9	− 1.42
Officers/directors	− 1.82	− 2.2	− 0.73
Equity	0.05	0.0	0.02
Institutions	3.44	4.1	1.38
S&P	0.43	0.9	0.17
NYSE	− 0.07	− 0.2	− 0.03
Volume	− 2.41	− 1.8	− 0.96
Variance	0.93	0.9	0.37
Year	− 0.87	− 3.1	− 0.35
Correctly predicted	79%		
$\chi^2(10)$	63.9		
p-value	(10^{-9})		

w on the probability that $y = 1$, when $\phi(\bullet)$ is the standard normal density and B is the vector of coefficients, is captured by the following:

$$\frac{\partial \mathrm{E}[y]}{\partial w} = \phi(B'w)B. \tag{3}$$

Since this marginal effect varies with the values of w, we interpret the coefficients of the estimated model at the sample means of the regressors. The results are substantively unchanged if, instead, we interpret the coefficients of the estimated model at either the Dutch auction offers' or the fixed price tender offers' sample means of the regressors.

The estimated marginal effect of the fraction of shares sought, -1.42, implies that when the fraction of outstanding shares sought is reduced by one sample standard deviation, or 13%, the probability of Dutch auction increases by 18%. The estimated marginal effect of the fraction of shares held by officers and directors, -0.73, implies that when the fraction of outstanding shares held by officers and directors is reduced by one sample standard deviation, or 20%, the likelihood of choosing the Dutch auction increases by 15%. The estimated marginal effect of the fraction of shares held by institutions, 1.38, implies that when the fraction of outstanding shares held by institutions is increased by one sample standard deviation, or 22%, the likelihood of choosing the Dutch auction increases by 30%. The estimated marginal effect of the daily trading volume, -0.96, implies that when the daily trading volume is reduced by one sample standard deviation, or 19%, the likelihood of choosing the Dutch auction increases by 18%.

The second equation of the model determines the firm's expected inverse price elasticity, denoted y_{2i}^*. The observable measure of realized inverse elasticity, y_{2i}, is defined to be the expected inverse elasticity measured with error, that is,

$$y_{2i} = y_{2i}^* + v_{2i}. \tag{4}$$

To identify the elasticity expected ex ante, rather than the realization ex post, we model the expected elasticity as some function of explanatory variables, z_i, and an unobservable error term:

$$y_{2i}^* = a_2 + \beta_3 z_i + v_{3i}. \tag{5}$$

The measurement error v_{2i} is assumed to be orthogonal to z_i, under a rational expectations assumption, wherein the ex post measure equals the expected elasticity plus noise. Eqs. (4) and (5) imply that the observable inverse elasticity can be modeled with the linear regression:

$$y_{2i} = a_2 + \beta_3 z_i + \varepsilon_{2i}, \tag{6}$$

where ε_{2i} equals $v_{2i} + v_{3i}$.

Table 6 reports the estimated OLS coefficients and heteroskedasticity-consistent t-statistics for Eq. (6). The results are largely consistent with the predictions summarized in Table 1. Firms realizing greater pre-announcement inverse elasticity have larger market capitalizations, with an estimated coefficient of 0.96. They are those not included in the S&P 500 Index, with an estimated coefficient of -0.42. Firms with greater inverse elasticities have smaller daily trading volume, with an estimated coefficient of -1.76, and higher daily return variance, with an estimated coefficient of 2.27. These variables are each statistically significant at conventional levels. The adjusted $\bar{R}^2$ for this equation is 0.12. The test of the joint hypothesis that all of the coefficients are zero yields a chi-square statistic, with seven degrees of freedom, of 20.9, with a corresponding p-value of 0.004. Hence, we can reject the hypothesis that all of the coefficients are zero.

Table 6
OLS estimates of the inverse elasticity, 1984–1989

The extent of pre-announcement or post-announcement inverse elasticity realization, denoted y_{2i}, is modeled as some function of the explanatory variables, z_i, and an unobservable error:

$$y_{2i} = a_2 + \beta_3 z_i + \varepsilon_{2i}.$$

Two dependent variables are used. Pre-announcement inverse elasticity is measured as the price paid as a premium above the market price three days before the announcement scaled by the fraction of shares tendered at or below the price paid when the offer is a Dutch auction, or the fraction of shares tendered at the price paid when the offer is a fixed price tender offer. Post-announcement inverse elasticity is measured as the price paid as a premium above the market price three days after the announcement scaled by the fraction of shares tendered at or below the price paid when the offer is a Dutch auction, or the fraction of shares tendered at the price paid when the offer is a fixed price tender offer. Officers/directors is the fraction of shares held by officers and directors at the time of the offer. Equity is the market value of the equity, in tens of billions of dollars. Institutions is the fraction of shares held by institutional investors at the time of the offer. S&P is a dummy variable which equals one if the stock is included in the Standard and Poor's 500 Index, and is zero otherwise. NYSE is a dummy variable which equals one if the stock is traded on the NYSE, and is zero otherwise. Volume is the average number of shares that are traded per day for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, in millions of shares. Variance is the variance of the 25 daily returns for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, multiplied by one hundred.

Variable	Pre-announcement measure	Heteroskedasticity-consistent *t*-statistic	Post-announcement measure	Heteroskedasticity-consistent *t*-statistic
Constant	1.02	3.4	0.34	3.3
Officers/directors	0.42	0.7	− 0.17	− 0.6
Equity	0.96	2.1	0.72	3.1
Institutions	− 0.06	− 0.1	− 0.18	− 1.3
S&P	− 0.42	− 1.7	− 0.06	− 0.7
NYSE	0.11	0.5	− 0.07	− 1.0
Volume	− 1.76	− 3.7	− 0.83	− 2.5
Variance	2.27	3.9	2.70	5.6
$\bar{R}^2$	0.12		0.46	
$\chi^2(7)$	20.9		54.3	
p-value	0.004		0.000	

When the realized post-announcement inverse elasticity is instead employed as the dependent variable, the results do not differ dramatically. The adjusted $\bar{R}^2$ rises to 0.46. The test of the joint hypothesis that all of the coefficients are zero yields a chi-square statistic, with seven degrees of freedom, of 54.3, with a *p*-value less than 0.001. Hence, we can reject the hypothesis that all of the coefficients are zero.

The results in Table 5 indicate that firm characteristics predict the choice of self-tender repurchase method. The results in Table 6 confirm that many of these

characteristics also predict the inverse elasticity that a firm faces. The hypothesis presented in Section 1 suggests that expected elasticity matters directly rather than only as correlated with firm characteristics. Thus, we modify the equation describing the choice of repurchase method to allow for an explicit role for the unobservable expected elasticity:

$$y_{1i}^{*} = a_1 + \beta y_{2i}^{*} + \gamma_1 z_i + \beta_2 x_i + v_{1i}. \tag{7}$$

If expected stock price elasticity does not determine the offer choice, then the β coefficient would fail to be statistically different from zero. If firms expecting greater stock price elasticity tend to use the Dutch auction method, as the theoretical arguments in Section 1 suggest, then the β coefficient would be negative.

Since the expected elasticity is not observable, one is tempted to use instead the observed elasticity. Unfortunately, using the realized elasticity as a proxy for the expected elasticity in Eq. (7) is inappropriate in this rational expectations setting, because it induces correlation between the realized elasticity and the error term of the equation. This misspecification error is essentially a form of measurement error, and it results in biased coefficient estimates. To obtain consistent estimates, we must estimate Eq. (7) using an instrumental variables technique.[6] For each of the realized elasticity measures, in the first stage we use the OLS regression reported in Table 6 to obtain a predicted elasticity. We then run the probit model of Eq. (7), including the predicted elasticity while omitting two z variables. This two-step estimation procedure yields a consistent estimate of the coefficient on the expected elasticity in the probit analysis (see Newey and McFadden, 1994, Section 6). The variables we omit as instruments for identification are the firm's institutional holdings and whether the firm is included in the S&P 500 Index.[7] As discussed in Section 2, on a priori grounds, the level of institutional holdings as well as whether a firm is included in the S&P 500 Index lack any obvious influence on the choice of repurchase method, other than the extent to which they serve as negative proxies for inelasticity induced by either taxation or asymmetric information.

The results in Table 7 suggest that expected elasticity is an important determinant of the choice of repurchase method even when other firm characteristics are allowed to have independent effects. Consider the pre-announcement elasticity measure first. The estimated β coefficient is -1.90, with a t-statistic of -1.9. Hence, at conventional levels of significance, we reject the null hypothesis that

[6] For an example of an analogous model in a very different context, see McCallum (1976).

[7] Omission of one variable would be sufficient for identification. Qualitatively similar results are found to emerge if either one of these variables is used as an instrument alone.

Table 7
Binary probit estimates of the self-tender repurchase choice using instrumental variables for predicted elasticity

This table reports coefficient estimates, with t-statistics and marginal effects, of the equation:

$$y_{1i}^{*} = a_1 + \beta y_{2i}^{*} + \gamma_1 z_i + \beta_2 x_i + v_{1i}.$$

The additional value of choosing the Dutch auction repurchase method instead of the fixed price tender offer, denoted y_{1i}^{*}, is modeled as some function of the explanatory variables, z_i and x_i, the predicted elasticity from Table 6, denoted y_{2i}^{*}, and an unobservable error. Only the dichotomous values for y_{1i}^{*} are observed. Some z variables are omitted for identification (Institutions and S&P). Takeover is a dummy variable which equals one if the firm is a target of activity, and is zero otherwise. Sought is the fraction of shares sought in the offer. Predicted elasticity is the elasticity predicted by the results in Table 6. Pre-announcement inverse elasticity is measured as the price paid as a premium above the market price three days before the announcement scaled by the fraction of shares tendered at or below the price paid when the offer is a Dutch auction, or the fraction of shares tendered at the price paid when the offer is a fixed price tender offer. Post-announcement inverse elasticity is measured as the price paid as a premium above the market price three days after the announcement scaled by the fraction of shares tendered at or below the price paid when the offer is a Dutch auction, or the fraction of shares tendered at the price paid when the offer is a fixed price tender offer. Officers/directors is the fraction of shares held by officers and directors at the time of the offer. Equity is the market value of the equity, in tens of billions of dollars. NYSE is a dummy variable which equals one if the stock is traded on the NYSE, and is zero otherwise. Volume is the average number of shares that are traded per day for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, in millions of shares. Variance is the variance of the 25 daily returns for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, multiplied by one hundred. Year is a dummy variable which equals one if the repurchase was announced 1984–1986, and is zero otherwise.

Variables	Pre-announcement measure			Post-announcement measure		
	Coefficient	t-Statistic	Marginal effect	Coefficient	t-Statistic	Marginal effect
Constant	3.03	2.8		5.71	4.6	
Takeover	− 0.25	− 0.8	− 0.10	− 0.10	− 0.3	− 0.04
Sought	− 2.47	− 2.1	− 0.99	− 3.14	− 2.6	− 1.24
Predicted elasticity	− 1.90	− 1.9	− 0.76	− 16.01	− 4.1	− 6.40
Officers/directors	− 1.79	− 1.9	− 0.72	− 4.53	− 4.8	− 1.81
Equity	1.68	1.7	0.67	11.18	4.1	4.48
NYSE	0.50	1.7	0.20	− 1.23	− 2.5	− 0.48
Volume	− 5.01	− 2.2	− 2.00	− 15.78	− 4.2	− 6.31
Variance	4.38	1.7	1.75	44.00	4.1	17.60
Year	− 0.97	− 3.7	− 0.39	− 0.94	− 3.4	− 0.38
Correctly predicted	70%			78%		
$\chi^2(9)$	46.28			62.09		
p-value	0.000			0.000		

expected inverse price elasticity does not determine the repurchase choice. Specifically, the firms choosing a Dutch auction repurchase instead of a fixed price tender offer are those expecting to face greater price elasticity, ceteris paribus. The estimated marginal effect of the inverse elasticity measure, -0.76, implies that when the predicted inverse elasticity measure is increased by one standard deviation, or 0.46, the probability of a Dutch auction decreases by 35%.

Firms choosing a Dutch auction repurchase instead of a fixed price tender offer are also found, as shown in Table 5, to be those seeking to repurchase a smaller fraction of shares, those with smaller daily trading volume, those with smaller insider holdings, and those who have announced a repurchase later in the sample period.[8] These firms are also found to be those listed on the NYSE, those with larger market capitalizations, and those with higher return variance. Whether they have been the target of takeover activity is statistically insignificant at conventional levels.

The probit analysis using the pre-announcement elasticity measure correctly predicts 70% of the repurchase choices. Since the same variables are included as before, though now with a constraint, the percent correctly predicted is necessarily less than or equal to 79%. Testing the joint hypothesis that all of the coefficients are zero yields a chi-square statistic, with nine degrees of freedom, of 46.28, with a corresponding p-value of less than 0.001. Thus, we can reject the hypothesis that all of the coefficients are zero.

The estimated marginal effect of the fraction of shares sought, -0.99, implies that when the fraction of shares sought is reduced by one sample standard deviation, or 13%, the probability of Dutch auction increases by 13%. The estimated marginal effect of the fraction of shares held by officers and directors, -0.72, implies that when the fraction of outstanding shares held by officers and directors is reduced by one sample standard deviation, or 20%, the likelihood of choosing the Dutch auction increases by 14%.The estimated marginal effect of the daily trading volume, -2.00, implies that when the daily trading volume is reduced by one sample standard deviation, or 19%, the likelihood of choosing the Dutch auction increases by 38%. The estimated marginal effect of the market capitalization, 0.67, implies that when the size is increased by one sample standard deviation, or 23%, the likelihood of choosing the Dutch auction increases by 15%. The estimated marginal effect of the return variance, 1.75, implies that when the variance is increased by one sample standard deviation, or 13%, the likelihood of choosing the Dutch auction increases by 23%.

[8] It is interesting to question whether the Dutch auction firms look more elastic because they are repurchasing fewer shares. The sample correlation between the fraction sought and the pre- and post-announcement measure of inverse elasticity is -36% and -24%, respectively.

Consider now the post-announcement elasticity measure. When the post-announcement inverse elasticity is instead employed as the dependent variable in the first stage, we continue to find that the firms choosing a Dutch auction, instead of a fixed price tender offer, are those expecting to face greater price elasticity. The estimated β coefficient is -16.01, with a t-statistic of -4.1. The firms choosing Dutch auctions are also those firms not listed on the NYSE.

The probit analysis using the post-announcement elasticity measure correctly predicts 78% of the choices. Testing the joint hypothesis that all of the coefficients are zero yields a chi-square statistic, with nine degrees of freedom, of 62.09, with a corresponding p-value of less than 0.001. Again, we can reject the hypothesis that all of the coefficients are zero.

We next consider whether the firm characteristics determine the repurchase choice only through their influence on expected elasticity. We re-estimate Eq. (7), modeling the choice of repurchase method as a function of the expected elasticity, the explanatory variables x_i only, and an unobservable error:

$$y_{1i}^* = a_1 + \beta y_{2i}^* + \beta_2 x_i + v_{1i}. \tag{8}$$

Combining Eq. (8) with Eq. (6) generates a system of equations which can be written as follows:

$$y_{1i}^* = \alpha_1 + \beta\beta_3 z_i + \beta_2 x_i + \varepsilon_{1i}, \tag{9}$$

$$y_{2i} = a_2 + \beta_3 z_i + \varepsilon_{2i}, \tag{10}$$

where ε_{1i} equals $v_{1i} + \beta v_{2i}$, ε_{2i} equals $v_{2i} + v_{3i}$, and α_1 equals $a_1 + \beta a_2$. Eq. (10) is a restatement of Eq. (6). We assume that $\{\varepsilon_{1i}, \varepsilon_{2i}\}$ are i.i.d. drawings from a bivariate normal distribution with zero mean, variances σ_1^2 and σ_2^2, and covariance σ_{12}. The set $\{y_{1i}, y_{2i}\}$ constitutes the observed dependent variables of the model. The constrained system simultaneously estimates 13 coefficients: a_1, a_2, β, β_2 (a 3-element vector), and β_3 (a 7-element vector), as well as σ_1^2, σ_2^2, and σ_{12}. Note that Eq. (10) identifies β_3, which then allows the identification of β in Eq. (9).

The likelihood function of this model is given by

$$L = \prod_0 f(y_{2i} \mid y_{1i}^* \leqslant 0) P(y_{1i}^* \leqslant 0) \prod_1 f(y_{2i} \mid y_{1i}^* > 0) P(y_{1i}^* > 0), \tag{11}$$

where Π_0 and Π_1 stand for the products over those i for which $y_{1i} = 0$ and $y_{1i} = 1$, respectively, and $f(\cdot \mid y_{1i}^* \leqslant 0)$ and $f(\cdot \mid y_{1i}^* > 0)$ stand for the conditional density of y_{2i} given y_{1i}^* is nonpositive or positive, respectively.

The system is estimated using the Quasi-Maximum Likelihood Estimation (QMLE) procedure, which is described in the Appendix. Standard maximum likelihood theory requires the correct distributional assumptions, which in this case includes bivariate normality of the two equations' errors. If the probability

model is misspecified, then QMLE standard errors may be consistent even when the conventional maximum likelihood standard errors are not. QMLE robust standard errors are calculated from the matrix of the outer products of the gradients post- and pre-multiplied by an estimate of the Hessian (White, 1982). The consistency of the standard errors is tested with the White Information Matrix Test.

Table 8 reports the thirteen coefficients and their associated t-statistics from the QMLE standard errors from the constrained system using the pre-announcement inverse elasticity measure. The estimated β coefficient is -1.27, with a t-statistic of -1.4. The sign of β supports the analysis, and given the p-value of 0.16, we weakly reject the null hypothesis that expected inverse price elasticity, measured through firm characteristics, does not determine the repurchase choice. Specifically, firms choosing a Dutch auction repurchase instead of a fixed price tender offer are those expecting to face greater price elasticity. The estimated marginal effect of the inverse elasticity measure, -0.51, implies that when the inverse elasticity measure is increased by one sample standard deviation, or 1.13, the probability of a Dutch auction decreases by 57%.

Firms choosing a Dutch auction repurchase instead of a fixed price tender offer are again found to be those seeking to repurchase a smaller fraction of shares. The estimated marginal effect of the fraction of shares sought, -0.38, implies that when the fraction of outstanding shares sought is reduced by one sample standard deviation, or 0.13, the probability of a Dutch auction increases by 5%. Firms choosing the Dutch auction repurchase method also tend to repurchase later in the sample period.

Firms with greater inverse elasticity are again found to be those firms with larger insider holdings, with an estimated coefficient of 0.52, and smaller institutional holdings, with an estimated coefficient of -0.82. These firms are typically not included in the S&P 500 Index, with an estimated coefficient of -0.20. They have larger trading volume, with an estimated coefficient of 0.23. Their exchange listing, return variance, and market capitalization are not statistically significant at conventional levels.

Table 8 also documents significant skewness and kurtosis present in the data. The skewness test statistic $\hat{S}$ for the normal distribution is distributed such that $n^{1/2}\hat{S} \sim \mathrm{N}(0, 6)$, where n is the number of observations, which, in this case, is 141. The z-statistics of 7.42 and 10.57 for the two equations respectively indicate severe skewness of the errors in both equations. The kurtosis test statistic $\hat{K}$ for the normal distribution is distributed such that $n^{1/2}(K-3) \sim \mathrm{N}(0, 24)$. The z-statistics of -0.75 and 14.03 for the two equations indicate severe kurtosis of the errors in the second equation. These results confirm that the QMLE procedure is appropriate, as the bivariate normality assumption is clearly violated, making the conventional standard errors suspect.

Model misspecification is examined with the White Information Matrix Test. Under the null hypothesis of no misspecification of the model, this test statistic

Table 8
Quasi-maximum likelihood estimates of the constrained system of equations

This table reports coefficient estimates, with QMLE t-statistics, of the constrained system of equations:

$$y_{1i}^{*} = \alpha_1 + \beta\beta_3 z_i + \beta_2 x_i + \varepsilon_{1i},$$

$$y_{2i} = a_2 + \beta_3 z_i + \varepsilon_{2i},$$

where α_1 equals $a_1 + \beta a_2$. The additional value of choosing the Dutch auction repurchase method instead of the fixed price tender offer, denoted y_{1i}^{*}, is modeled as some function of the explanatory variables, z_i and x_i, and an unobservable error. Only the dichotomous values for y_{1i}^{*} are observed. The stock price inverse elasticity realization, y_{2i}, is modeled as some function of the explanatory variables, z_i, and an unobservable error. The constrained model imposes that these characteristics matter in the repurchase equation only as they relate to price inverse elasticity, which in turn affects the repurchase choice. This hypothesis can be stated as:

$$y_{1i}^{*} = a_1 + \beta y_{2i}^{*} + \beta_2 x_i + v_{1i},$$

where β is a constant. Pre-announcement inverse elasticity is measured as the price paid as a premium above the market price three days before the announcement scaled by the fraction of shares tendered at or below the price paid when the offer is a Dutch auction, or the fraction of shares tendered at the price paid when the offer is a fixed price tender offer. Post-announcement inverse elasticity is measured as the price paid as a premium above the market price three days after the announcement scaled by the fraction of shares tendered at or below the price paid when the offer is a Dutch auction, or the fraction of shares tendered at the price paid when the offer is a fixed price tender offer. Takeover is a dummy variable which equals one if the firm is a target of activity, and is zero otherwise. Sought is the fraction of shares sought in the offer. Officers/directors is the fraction of shares held by officers and directors at the time of the offer. Equity is the market value of the equity, in tens of billions of dollars. Institutions is the fraction of shares held by institutional investors at the time of the offer. S&P is a dummy variable which equals one if the stock is included in the Standard & Poor's 500 Index, and is zero otherwise. NYSE is a dummy variable which equals one if the stock is traded on the NYSE, and is zero otherwise. Volume is the average number of shares that are traded per day for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, in millions of shares. Variance is the variance of the 25 daily returns for the 26 trading days from 50 to 25 days prior to the announcement of the repurchase, multiplied by one hundred. Year is a dummy variable which equals one if the repurchase was announced 1984–1986, and is zero otherwise.

Variables	Pre-announcement			Post-announcement		
	Coefficient	t-statistic	Marginal effect	Coefficient	t-Statistic	Marginal effect
First equation						
a_1	1.71	1.7		0.34	1.3	
Takeover	− 0.05	− 0.4	− 0.02	0.06	0.4	0.02
Sought	− 0.94	− 2.1	− 0.38	− 0.70	− 1.6	− 0.28
Officers/directors	− 0.66			− 0.02		
Equity	− 0.18			− 0.22		
Institutions	1.04			0.19		
S&P	0.26			0.04		

Table 8. Continued.

Variables	Pre-announcement			Post-announcement		
	Coefficient	*t*-statistic	Marginal effect	Coefficient	*t*-Statistic	Marginal effect
NYSE	− 0.03			0.02		
Volume	− 0.29			0.16		
Variance	− 0.23			− 0.87		
Year	− 0.34	− 3.0	− 0.14	− 0.32	− 3.4	− 0.13
β	− 1.27	− 1.4	− 0.51	− 0.39	− 0.5	− 0.15
Skewness (*z*)	1.53	7.42		1.50	7.27	
Kurtosis (*z*)	2.69	− 0.75		2.52	− 1.16	
Second equation						
a_2	1.30	9.2		0.42	4.2	
Officers/directors	0.52	1.6		0.04	0.1	
Equity	0.14	0.7		0.58	1.8	
Institutions	− 0.82	− 2.2		− 0.50	− 2.6	
S&P	− 0.20	− 1.4		− 0.11	− 1.4	
NYSE	0.03	0.3		− 0.06	− 1.1	
Volume	0.23	1.3		− 0.41	− 0.7	
Variance	0.18	0.6		2.25	1.9	
Skewness (*z*)	2.18	10.57		1.40	6.79	
Kurtosis (*z*)	8.79	14.03		7.78	11.59	
System						
correlation(ε_{1i}, ε_{2i})	0.18			0.35		
Log likelihood	− 277.97			− 142.56		

has a chi-square distribution, with the number of degrees of freedom equal to the number of observations (141). We fail to reject the null hypothesis that the model is correctly specified.

The restrictions of the constrained system can be examined with a likelihood ratio test, which compares Eqs. (9) and (10) to running Eqs. (1) and (6) as a system. The test statistic is:

$$LR = -2[L(B_0) - L(B_1)] \tag{12}$$

where B_0 are the restricted parameter estimates, B_1 are the unrestricted parameter estimates, and $L(\bullet)$ is the log likelihood. Under the null hypothesis that the restrictions from the constrained system are true, and that the distributional assumptions are correct, the likelihood ratio statistic has a chi-square distribution with q degrees of freedom, where q is the number of restrictions, which, in this case, is six. Since $L(B_0) = -277.97$ and $L(B_1) = -268.38$, the likelihood ratio test statistic is 19.18, with a corresponding p-value of less than 0.01. Hence,

we can reject the hypothesis that the restrictions hold. That is, we reject the constrained system in favor of the unconstrained system, suggesting that both the expected elasticity and firm characteristics matter. The constrained system is also tested against an intercept system, with dependent variables regressed only on intercepts. This is a general test of the power of the explanatory variables in the system of equations. In this test, the constrained system serves as the unrestricted model. We can reject the intercept system in favor of the constrained system.

Table 8 also reports thirteen coefficients and their associated *t*-statistics from the QMLE standard errors from the constrained system using the post-announcement inverse elasticity measure. The results are similar to those presented above. The estimated marginal effect of the inverse elasticity measure, -0.15, implies that when the inverse elasticity measure is increased by one sample standard deviation, or 0.52, this decreases the probability of a Dutch auction by 8%. Table 8 documents even more significant skewness and kurtosis present in the data for the second equation, with *z*-statistics of 6.79 and 11.59 for skewness and kurtosis, respectively.

5. Conclusions

The analysis in this paper suggests that firms choosing the Dutch auction instead of the fixed price tender offer between 1984 and 1989 are indeed those firms expecting to face greater stock price elasticity. They also seek to repurchase a smaller fraction of outstanding shares, have smaller insider and larger institutional holdings, have lower trading volume, are listed on the NYSE, and announce their repurchases later in the sample period. Firms that face greater elasticity are found to be those with larger institutional and smaller insider holdings, larger trading volume, smaller market capitalizations, smaller return variance, and inclusion in the S&P 500 Index.

These findings allow us to reinterpret the previous descriptive studies which reveal that a common set of characteristics describe the firms that choose particular self-tender repurchase methods as well as a firm's stock price elasticity. The econometric analysis in this paper provides the stronger interpretation that Dutch auctions may be chosen in expectation of greater stock price elasticity, and that the expectation can be captured, in part, with firm characteristics.

The findings in this paper also suggest, more generally, that expected stock price elasticity may be an important determinant in some corporate financial decisions. Future research can examine whether other corporate financial decisions, including the method of takeover offer, equity issue, block transaction, or bond auction may also be determined in part by price elasticity considerations. Future research can also examine whether the amount of

uncertainty about the expected elasticity is an important determinant of corporate financial decisions.

Appendix A. Quasi-maximum likelihood estimation procedure

The unconstrained and constrained systems are estimated using the Quasi-Maximum Likelihood Estimation (QMLE) procedure. The interested reader is referred to the results found in White (1982), which are briefly summarized here using the White notation.

Standard maximum likelihood theory requires the correct distributional assumptions, which in this case includes bivariate normality of the two equations' errors. The correct specification of the probability model is a sufficient but not necessary condition for the consistent estimation of parameters. When the model is correctly specified, the information matrix can be expressed in either Hessian form (the matrix of second order derivatives), $-A$, or outer product form (the cross-product matrix of the first derivatives), B, with the sum $A + B$ adding to zero, by the information matrix equivalence theorem.

QMLE robust standard errors are calculated from the matrix of the outer products of the gradients, post- and pre-multiplied by an estimate of the Hessian, $\hat{A}^{-1}\hat{B}\hat{A}^{-1}$. If the probability model is misspecified, then the asymptotic covariance matrix of the QMLE no longer equals the inverse of Fisher's information matrix. QMLE standard errors may nevertheless allow for asymptotic based inferences, even when the conventional maximum likelihood standard errors do not. The validity of these standard errors may be tested with the White Information Matrix Test on the restricted model, which provides a check on whether inferences can be drawn robustly from the model.

To compute the statistic, the likelihood procedure returns the log likelihood of each of $n = 1, \ldots, N$ observations, where $N = 141$. Then, for each observation, the outer product of the gradient is generated, $\partial \log f(u,\Theta)/\partial\Theta_i \bullet \partial \log f(u,\Theta)/\partial\Theta_j$, and the Hessian is calculated, $\partial^2 \log f(u,\Theta)/\partial\Theta_i \partial\Theta_j$, at the estimates of the coefficients, where $i = 1, \ldots, p$; $j = 1, \ldots, p$, and $p = 12$ is the number of regressors in the constrained model. The sum of the outer product matrix and the Hessian is then calculated for each observation. The indicators are the upper triangular elements of this $(p \times p)$ matrix. The p elements on the diagonal of the indicator matrix for each observation n are denoted $d(u_n, \hat{\theta}_n)$, which then constitute the nth row of a $(N \times p)$ matrix we denote W. W is pre-multiplied by the transpose of an $(N \times 1)$ vector of 1's, which when pre-multiplied by N^{-1} yields a $(1 \times p)$ matrix $D_N(\hat{\theta}_N).V_N(\hat{\theta}_N)$ is computed as $N^{-1}W'W$. Hence, the test statistic is:

$$I_N = 1'W*(W'W)^{-1}*W'1 \tag{A.1}$$

$$= ND_N(\hat{\theta}_N)'V_N(\hat{\theta}_N)^{-1}D_N(\hat{\theta}_N). \tag{A.2}$$

Under the null hypothesis of no misspecification of the model, this test statistic has an asymptotically chi-square distribution, with the number of degrees of freedom equal to the number of observations, which, in this case, is 141.

References

Amihud, Y., Mendelson, H., 1986. Asset pricing and the bid-ask spread. Journal of Financial Economics 17, 223–249.

Bagwell, L.S., 1992. Dutch auction repurchases: an analysis of shareholder heterogeneity. Journal of Finance 47, 71–105.

Bagwell, L.S., 1991. Share repurchase and takeover deterrence. RAND Journal of Economics 22, 72–88.

Bagwell, L.S., Shoven, J.B., 1989. Cash distributions to shareholders. Journal of Economic Perspectives 3, 129–140.

Belsley, D.A., Kuh, E., Welsch, R.E., 1980. Regression Diagnostics: Identifying Influential Data and Sources of Collinearity. Wiley, New York.

Bradley, M., Desai, A., Kim, E.H., 1988. Synergistic gains from corporate acquisitions and their division between the stockholders of target and acquiring firms. Journal of Financial Economics 21, 4–40.

Brealey, R., Myers, S., 1996. Principles of Corporate Finance. McGraw-Hill, New York.

Brennan, M., Thakor, A., 1990. Shareholder preferences and dividend policy. Journal of Finance 45, 993–1018.

Brown, D., Ryngaert, M., 1992. The determinants of tendering rates in interfirm and self-tender offers. Journal of Business 65, 529–556.

Comment, R., Jarrell, G.A., 1991. Signalling with stock buybacks: Dutch auctions and post-crash repurchase programs. Journal of Finance 46, 1243–1271.

Dann, L., 1981. Common stock repurchases: an analysis of returns to bondholders and stockholders. Journal of Financial Economics 9, 113–138.

Harris, L., Gurel, E., 1986. Price and volume effects associated with changes in the S&P 500 list: new evidence for the existence of price pressures. Journal of Finance 41, 815–829.

Hausch, D.B., Seward, J., 1993. Signaling with dividends and share repurchases: a choice between deterministic and stochastic cash distributions. Review of Financial Studies 6, 121–154.

Holthausen, R., Leftwich, R., Mayers, D., 1990. Large-block transactions: the speed of response, and temporary and permanent stock-price effects. Journal of Financial Economics 26, 71–95.

Kalay, A., Shimrat, A., 1987. Firm value and seasoned equity issues: price pressure, wealth redistribution or negative information. Journal of Financial Economics 19, 109–126.

Kamma, S., Kanatas, G., Raymar, S., 1992. Dutch auction versus fixed price self-tender offers for common stock. Journal of Financial Intermediation 2, 277–307.

Loderer, C., Cooney, J., Van Drunen, L., 1991. The price elasticity of demand for common stock. Journal of Finance 46, 621–651.

Marsh, T., Rock, K., 1986. Exchange listing and liquidity: a comparison of the American stock exchange with the NASDAQ national market system. Report #2. American Stock Exchange Transactions Data Research Project, New York.

Mayshar, J., 1979. Transaction costs in a model of capital market equilibrium. Journal of Political Economy 87, 673–700.

Mayshar, J., 1981. Transaction costs and the pricing of assets. Journal of Finance 36, 583–597.

McCallum, B., 1976. Rational expectations and the natural rate hypothesis: some consistent estimates. Econometrica 44, 43–52.

Newey, W., McFadden, D., 1994. Large sample estimation and hypothesis testing. In: Engle, R., McFadden, D. (Eds.), Handbook of Econometrics, vol. IV. Elsevier, Amsterdam, pp. 2113–2245.
Persons, J., 1994. Signaling and takeover deterrence with stock repurchases: Dutch auctions versus fixed price tender offers. Journal of Finance 49, 1373–1402.
Pruitt, S.W., Wei, K.C.J., 1989. Institutional ownership and changes in the S&P 500. Journal of Finance 44, 509–513.
Shleifer, A., 1986. Do demand curves for stocks slope down? Journal of Finance 41, 579–590.
Stulz, R.M., 1988. Managerial control of voting rights: financing policies and the market for corporate control. Journal of Financial Economics 20, 25–54.
Varian, H.R., 1985. Divergence of opinion in complete markets. Journal of Finance 40, 309–317.
Vermaelen, T., 1981. Common stock repurchases and market signalling: an empirical study. Journal of Financial Economics 9, 139–183.
White, H., 1982. Maximum likelihood estimates of misspecified models. Econometrica 50, 1–25.