Managerial Timing and Corporate Liquidity: Evidence from Actual Share Repurchases

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Abstract: We investigate the timing of open market share repurchases and the resultant impact on firm liquidity. Using Hong Kong's unique disclosure environment, we identify the exact implementation dates for over 5,000 equity buybacks. We find that managers exhibit substantial timing ability. Consistent with the information-asymmetry hypothesis, bid-ask spreads widen and depths narrow during repurchase periods. We decompose bid-ask spreads and show that adverse selection costs increase substantially as market participants respond to the presence of informed managerial trading. Our findings provide additional insight into how markets process information and have significant implications for corporate payout and disclosure policies.

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Abstract

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1. Introduction

Extraordinary growth in open market share repurchases has attracted considerable attention in the business press and academic literature. U.S. corporations announced repurchases of approximately $550 billion between 1996 and 1998. Over the same period, NYSE firms returned $490 billion in cash dividends to their shareholders (Ikenberry, Lakonishok, and Vermaelen (2000)). Aggregate NYSE, AMEX, and Nasdaq share repurchases represented 3.47% of aggregate earnings from 1973 to 1977 and climbed to 27.06% of aggregate earnings from 1993 to 1997 (Fama and French (1999)). This trend suggests that repurchasing stock in the open market is the preferred method of distributing cash to shareholders in U.S. equity markets (Grullon and Michaely (2000)). In spite of this growth in repurchase activity, there is a general lack of U.S. disclosure requirements associated with this form of wealth distribution. Firms can repurchase shares without making announcements, and firms that make announcements are under no obligation to implement their proposed plans. This disclosure environment makes it very difficult to study actual share repurchases, particularly if the issues under investigation require the precise timing, prices, or magnitudes of the repurchases.

Two fundamental and related issues regarding open market share repurchases are whether managers use private information to time company repurchases and whether their repurchases affect firm liquidity (Barclay and Smith (1988)). These questions can only be addressed in a convincing manner if actual share repurchases can be identified. In the U.S. environment, researchers must rely on monthly or quarterly estimates of repurchases (Stephens and Weisbach

(1998)) or voluntary questionnaires returned by the repurchasing firms (Cook, Krigman, and Leach (1999a,b)). In our study, we overcome this problem by using data from the Stock Exchange of Hong Kong (SEHK). Because SEHK-listed firms are required to disclose all repurchases by the start of the following business day, our database of over 5,000 executed repurchases enables us to investigate the related issues of managerial timing and its impact on corporate liquidity with unique precision.

Our first objective is to determine whether corporate managers use private information to time equity repurchases in the open market. We compare the costs of 5,111 actual repurchases over an 81-month period to the costs of a bootstrapped (uninformed) accumulation strategy. The results demonstrate that managers possess substantial timing abilities. These timing abilities are significantly related to overall market conditions and firm-specific attributes.

Our second and perhaps most important objective is to analyze the effect of managerial trading on corporate liquidity. Barclay and Smith (1988) hypothesize that the presence of informed managers can reduce the secondary-market liquidity of repurchasing firms. Accordingly, repurchases do not dominate dividends as a distribution mechanism because the tax disadvantages of dividends are offset by the higher liquidity costs of repurchases. Barclay and Smith (1988) also posit a competing-market-maker hypothesis whereby managerial repurchasing activity increases secondary market liquidity. Unlike previous studies that test these hypotheses based on repurchase announcement dates, we measure firm liquidity changes on the precise day of the repurchase and the subsequent public disclosure.[1] We compare absolute and relative bid-ask spreads on days of executed repurchases to benchmark non-repurchase days and find a significant reduction in firm liquidity. The spread results are robust to the inclusion of price, volume, and volatility control variables, and to alternative model specifications. In contrast, firm

depth tends to improve slightly during the repurchase period as managers submit limit buy orders, consistent with the competing-market-maker hypothesis. However, after controlling for concurrent changes in price, volume, and volatility, we show that firm depth deteriorates during repurchase periods. Taken as a whole, the findings demonstrate that buyback activities impose a cost in the form of lower liquidity.

Lastly, we decompose the bid-ask spread in order to measure changes in the adverse selection component during repurchase periods. Informed managerial trading should generate an increase in the adverse selection component of the spread. In fact, it is the increase in this component that is expected to produce both wider spreads and lower depths.[2] We estimate adverse selection components and test for changes caused by managerial repurchasing activity. The empirical results are consistent across all models and confirm the hypothesis that adverse selection is significantly higher during the repurchase period relative to non-repurchase benchmarks.

These findings paint an economically intuitive picture of managerial and investor behavior in the secondary market. Managers possess information that outside market participants do not observe (Jaffe (1974) and Seyhun (1986)). Managerial wealth is tied to the value of the firm either directly through the ownership of stock, stock options, or stock appreciation rights, or indirectly through salaries based on sales or profitability measures. Our results confirm that managers use their private information to their advantage, as well as to the advantage of buy-and-hold shareholders. Market participants understand that some traders possess information advantages. When they suspect the presence of informed traders, they partially or completely withdraw from the market, thereby increasing bid-ask spreads and reducing depths. This liquidity-provision dynamic is important because lower liquidity can lead to higher costs of

capital and lower firm values.[3] We provide compelling empirical evidence that market participants are able to detect the presence of informed trading. Secondary-market investors adjust spreads, adverse selection costs, and depths in a manner consistent with the information-asymmetry hypothesis. The spread and depth measures generally return to benchmark levels on the following trading day when managers disclose that they are the source of the informed trading.

In the next section, we discuss the Hong Kong disclosure environment, the SEHK market structure, and our data set. Section 3 presents and interprets the empirical results, and Section 4 summarizes and concludes the study.

2. Disclosure environment, market structure, and data

2.1. Hong Kong's disclosure environment

The legal and regulatory environment in Hong Kong is very different from that in the U.S. with respect to equity repurchases (Barham, Hallsworth, and Jackson (1998)). An ordinary shareholder resolution (simple 50% majority) must be approved in advance of any share repurchases. Such resolutions are valid for one year and must be re-approved at future meetings if management is to have the right to repurchase during the subsequent fiscal year. The 10% rule sets an upper bound on the quantity of repurchases within the yearly mandate: managers cannot repurchase more than 10% of the shares issued at the time of resolution passage. The 25% rule sets an upper bound on the quantity of repurchases within a calendar month: managers cannot repurchase more than 25% of the previous month's traded volume. The Listing Rules prohibit repurchases during periods of price sensitive developments (information events), at least until such developments are made public. For example, managers may not repurchase shares during

the month preceding preliminary announcements of annual results or the publication of interim reports. The Rules also prohibit managers from knowingly repurchasing shares from connected persons, including directors, chief executives, and substantial shareholders, or their associates. Likewise, connected persons are prohibited from knowingly selling shares to the company. The source of funding restriction states that repurchases must be funded out of profits available for distribution and/or the proceeds from newly issued shares.

The most important Listing Rule for our purposes is the disclosure requirement. Any shares repurchased on a given day must be reported to the SEHK not later than 9:30 a.m. on the following business day. This information is then aggregated by the Exchange and disseminated to data vendors usually at or around the start of trading at 10:00 a.m.. This means that share repurchase activity, including price and volume, is fully disclosed to the public within one business day of the actual repurchase. In addition, the repurchasing company's annual report must include repurchased prices and volumes aggregated on a monthly basis. Thus, Hong Kong's mandated disclosure environment contrasts sharply with that of the U.S. where corporate managers have no obligation to disclose repurchase activity. Instead of estimating share repurchases or relying on voluntary disclosures, we can identify the universe of actual share repurchases in Hong Kong beginning in 1991 when such activities were first permitted by amendments to the Companies Ordinance. The resulting data set provides a unique perspective from which to analyze the ability of managers to time their repurchases, and to measure consequent effects on corporate liquidity.

2.2. SEHK market structure

The SEHK is a thoroughly continuous, electronic limit order market.[4] Order entry and execution begins with the submission of a limit order. If a buyer (seller) requires an immediate fill, then he will submit a limit bid (ask) price that is high (low) enough to touch the lowest posted ask (highest posted bid) price. The limit order is entered into the Automatic Order Matching and Execution System (AMS) which prioritizes it by price and then by time. Although order sizes are posted for each bid or ask price level, trade size is not a priority in execution. The bid-ask spread is simply the difference between the lowest ask and highest bid price. Depth is defined as the market value of all shares posted at the highest bid and lowest ask prices. Actual and potential traders are able to observe bid (ask) prices and depths, and the buying (selling) broker's identity. Exchange members observe this trading information on both floor-based and remote trading terminals, and non-Exchange members access the same information through (real-time) data providers.

2.3. Data

We use data from several sources in order to construct a comprehensive database for all SEHK repurchases beginning with the first legal buyback in November 1991 and continuing until August 1999. The SEHK's Share Repurchase Report (SRR) provides the name of the repurchasing company, day of repurchase, number of shares repurchased, and the daily total repurchase value. This information is also available electronically via data vendors to market participants typically before the open of trading at 10:00 a.m. on the business day following a repurchase. In addition, the SRR contains the number and percentage of outstanding shares repurchased since the date of the shareholder resolution. The SEHK's teletext (newswire)

reports major news events for Hong Kong firms, including earnings, dividends, and split announcements. We compare each repurchasing company and date in the Share Repurchase Report with newswire reports to check for confounding events.[5]

Following previous studies (e.g., Stephens and Weisbach (1998), Ikenberry, Lakonishok, and Vermaelen (1995)), we exclude the abnormal repurchase period following stock market crashes.[6] The 1997 Asian financial crisis led to severe equity losses in Hong Kong and across the region. Similar to Netter and Mitchell's (1989) study for the 1987 U.S. crash, we find that SEHK-listed firms repurchased unusually large quantities of their own shares following Hong Kong's October 1997 crash. However, just as Hong Kong's crisis was deeper than that experienced in the U.S., the SEHK's abnormal level of repurchases also extended for a longer period than that in the U.S.. Consequently, we exclude the "crash period" from October 1997 until October 1998 from our sample.[7] The resulting data set covers 81 months (November 1991 to September 1997, and November 1998 to August 1999).

For each of 190 repurchasing firms, we collect daily prices, returns, trading volume, and market capitalization from the Pacific-Basin Capital Markets (PACAP) and SEHK's Research and Planning Division (RPD) databases. Our PACAP database covers the period from November 1991 until December 1996. We use the RPD database, along with detailed records of dividends, splits, rights, etc. provided directly from RPD personnel, to extend PACAP's daily data records through August 1999.

We use RPD intra-day data to test the information-asymmetry and competing-market-maker hypotheses. These data include both transaction prices and volumes, and liquidity measures (bids, asks, and depths) taken at 30-second intervals for all SEHK-listed companies over the period from May 1, 1996 to August 31, 1999.[8] We require intra-day prices, volumes,

spreads and depths in order to analyze changes in firm liquidity and to estimate spread decompositions. Excluding the crash period as before, the intra-day data set includes 103 firms, 1,526 repurchases, and 27 months (May 1996 to September 1997, and November 1998 to August 1999).

3. Empirical Findings

Table 1 provides summary statistics for all SEHK-listed companies and the subset of repurchasing firms. Approximately 27% of SEHK-listed firms repurchased some of their shares over our sample period. Although repurchasing firms are fairly representative of the population, they tend to have lower price levels, market capitalizations, and trading volumes than non-repurchasers. Average daily returns are also lower for repurchasing firms than for the overall population. It is also interesting to note that repurchasing firms have a higher percentage of days with at least one trade (87.32%) than non-repurchasers (81.23%).

The 5,111 repurchases account for over 2.57 billion shares valued at almost HK$8.5 (US$1.09) billion. The typical firm repurchases about 27 times with each buyback amounting to 566,244 shares valued at HK$2,138,036 (US$274,107). The average buyback represents slightly over 44% of the repurchase day's total trading volume, and less than 0.1% of the firm's total shares outstanding. The wide variation in repurchase frequencies is similar to that reported by Cook, Krigman, and Leach (1999a,b) using U.S. data. Almost 20% of the firms repurchase five or fewer times, while slightly over 15% of the firms repurchase more than 50 times.

3.1. Managerial Timing

First, we investigate the ability of corporate managers to time their repurchasing activities. Although it is unlikely that cost minimization is the sole objective when implementing

a repurchase plan, we expect that managers typically make use of private information to buy back shares at the lowest cost possible. The ideal data set would include only those cases where managers believe that they posses superior information and intend to trade on such information. The existence of alternative (but not mutually-exclusive) objectives, such as altering the firm's capital structure, fulfilling executive stock ownership plans, or defending against hostile takeovers, will only make it more difficult to find empirical evidence in favor of managerial timing ability. That is, to the extent that managers repurchase shares for objectives other than perceived underpricing, our empirical tests will favor the null hypothesis of no timing ability. In section 3.1.2., we provide some evidence for the existence of alternative objectives.

3.1.1. Bootstrapping

We design our timing ability tests to mimic management's decisions as closely as possible. In other words, we attempt to hold constant all aspects of the repurchase decision with the exception of its precise timing. As mentioned above, Hong Kong's disclosure environment requires the firm to pass a resolution at the annual shareholders' meeting before implementing a buyback plan. Passage of the resolution provides management with a one-year window during which to implement the plan. For the year following resolution passage, we record the number of repurchases and the total cost of the repurchase plan.[9]

Our bootstrapping technique treats as given (1) the authorized repurchasing period (i.e., one year following resolution passage), (2) the number of actual repurchase days during the authorized period, and (3) the number of actual shares repurchased on each repurchase day during the authorized period. For each firm-year in the sample, we randomly generate 50,000 alternative repurchase plans holding constant (1), (2), and (3) from above, and allow only the

timing of the buyback to vary. We then construct empirical distributions of the (bootstrapped) repurchase costs and compare these results to the actual costs (Efron (1979)).[10]

We can demonstrate the bootstrapping procedure by examining the relatively simple case of Asia Standard International Group (ASIG) Ltd.'s repurchases for 1996 (the firm-year beginning with resolution passage on September 4, 1995 and ending on August 28, 1996, the date of the next resolution). ASIG repurchased on six separate trading days during the authorized period. The trade sizes were 494, 384, 194, 298, 1,036 and 1,176 shares (in thousands), and the total cost was $3,705,100. Based on these figures, our program randomly selects six days over the same authorized period and repurchases a total of 3,582 shares in trade sizes of 494, 384, 194, 298, 1,036 and 1,176. The cost of each bootstrapped repurchase plan is divided by the actual repurchase cost to produce a percentage. We repeat the process 50,000 times in order to generate an empirical distribution of bootstrapped-to-actual costs.

The ASIG minimum, mean (median), and maximum bootstrapped costs are 84%, 121% (121%), and 152%, respectively, of the actual repurchasing costs. From the 50,000 bootstrapped repurchase programs, we find only 3,225 examples with total costs less than the actual cost of $3,705,100. Therefore, the probability that a randomly-generated repurchase program incurs costs below those of the actual program (i.e., pseudo *p*-value) is 6.45%. We interpret this result as mildly supportive of managerial timing ability in the ASIG 1996 case.

Table 2 presents the market timing results for all 370 firm-years. The number of repurchasing firms and total number of repurchase days are listed by year in the second and third columns. The bootstrapped results are listed in the fourth through eighth columns. The overall minimum (maximum) bootstrapped costs are 85% (145%) of the actual repurchase costs. Minimum bootstrapped costs range from 82% in 1997 to 95% in 1998, and maximum values

range from 111% in 1998 to 167% in 1999. The overall mean (median) bootstrapped costs represent 109% (104%) of the actual repurchase costs, suggesting that managers are able to acquire shares at lower costs than a naïve accumulation strategy. It should also be noted that mean (median) bootstrapped costs exceed 100% of actual costs for every year in our sample.

The last two columns in Table 2 give the number (percent) of firms that demonstrate market timing ability at the 5% and 1% significance levels. Overall, 37.3% (25.7%) of the firm-years are significant at the 5% (1%) percent level. Although there is some variation in the significant percentages from year to year, the results reveal consistent evidence in favor of managerial timing. The percentage of firms with timing ability at the 5% level ranges from 28.1% in 1993 to 50% in 1992, and the percentage significant at the 1% level ranges from 21.1% in 1997 to 37.5% in 1992. There does not appear to be any obvious trend across the nine-year period. To the best of our knowledge, these findings are the first empirical evidence of significant managerial timing with respect to actual open market repurchases.

In Table 1, we show that repurchase volume represents 44.48% of the total daily trading volume. This suggests that repurchase trade sizes might be larger than average trade sizes, although we cannot confirm this supposition with our database. Two possible consequences of large trade sizes are price pressure effects and momentum effects. To the extent that large repurchase trades induce upward price pressure on the day of the repurchase, the bootstrapping procedure will bias against finding evidence of significant market timing. However, if large trades cause a momentum effect on subsequent trading days, then this could bias in favor of market timing. We perform several additional tests in order to distinguish managerial timing from the possible effects of momentum trading. In all cases, the findings show that trade size and momentum are unable to account for managerial timing ability.[11]

3.1.2. Determinants of Managerial Timing

Before turning our attention to the liquidity effects of share repurchases, we investigate potential determinants of managerial timing ability. We identify variables that represent each of the following categories; (1) overall market conditions, (2) industry-based factors, and (3) firm-specific attributes. Under the market conditions category, we hypothesize that managers will have greater timing opportunities when the overall market exhibits large price swings. We define $MKTMOV_i$ as the range of price changes for the value-weighted portfolio of all listed companies during firm-year *i*. In addition, lower market interest rates reduce the opportunity cost of using company cash to repurchase shares. Because a low interest environment encourages share buybacks for reasons other than managerial timing (i.e., low returns on cash balances, as opposed to perceived differences between intrinsic value and current market price), we posit a direct relation between market interest rates and managerial timing ability. We define $INTEREST_i$ as the average daily savings deposit rate as reported by the Hong Kong Monetary Authority for firm-year *i*.

The repurchasing sample includes firms from each of the SEHK's seven industry classifications: industrials, hotels, properties, consolidated enterprises, finance, utilities, and miscellaneous. The ability of managers to identify periods of undervaluation can be a function of the company's industry because firms in the same industry often hold similar assets and liabilities. In addition, firms in the same industry often experience similar changes in income, both in terms of magnitudes and timing, during the business cycle. We define $INDUSTRY_{i,j}$ as a dummy variable that takes the value of one when firm *i* belongs to industry *j*, and zero otherwise. This specification allows us to determine whether timing abilities are more or less concentrated in particular industries.

Next, we identify firm-specific variables in order to capture the company's relevant financial position (i.e., cash flow availability), as well as the company's information environment (i.e., level of information asymmetry). Similar to Stephens and Weisbach (1998), we define $CASHFLOW_i$ as the company's cash flow from operations scaled by total assets over firm-year *i*. We expect higher cash flow levels to be associated with lower timing abilities. Firms with relatively large cash flows are more likely to repurchase shares for the purpose of wealth distribution, and are therefore less likely to be motivated by underpricing considerations. We use the company's equity size during firm-year *i*, $FIRMSIZE_i$, to proxy for the firm's overall information environment. Large-firm managers are expected to have fewer opportunities to trade on private information, since larger firms tend to disclose more information to the public and are more carefully followed by analysts and regulators. We also use the number of repurchases made during firm-year *i*, $NUMREP_i$, to capture the firm's information environment. Because frequent repurchases lead to frequent disclosures (i.e., a reduction in information asymmetries), we expect a negative relation between timing ability and the number of repurchases.

Finally, we develop an interaction variable, $LOWINTEREST_i*CASHFLOW_i$, to identify the firms that are most likely to execute buybacks for reasons other than perceived undervaluation. $LOWINTEREST_i$ is a dummy variable that takes the value of one if firm-year *i* is ranked in the lowest quartile of the interest rate variable, $INTEREST_i$, and zero otherwise. We posit that when market interest rates are low and company cash flows are high (i.e., relatively low returns on relatively large cash balances), managers have an incentive to execute repurchases with less regard to their assessment of intrinsic firm value. From a different perspective, we expect managers' repurchases to be highly motivated by perceived undervaluation when interest rates are high and cash flows are low, that is, when the opportunity cost of repurchasing is high.

We estimate the following regression model using the independent variables defined above:

$$TIMING_i = \alpha + \beta_1 MKTMOV_i + \beta_2 INTEREST_i + \beta_3 CASHFLOW_i + \beta_4 (LOWINTEREST_i * CASHFLOW_i) + \beta_5 NUMREP_i + \beta_6 FIRMSIZE_i + \sum_{j=1}^{6} \theta_j INDUSTRY_{i,j} + \varepsilon_i \,. \quad (1)$$

The dependent variable, $TIMING_i$, is defined as one minus the pseudo-*p*-value (in firm-year *i*) obtained from our bootstrapping procedure. The pseudo-*p*-value measures the probability of randomly selecting a repurchase plan with a lower cost than the actual repurchase plan. The lower the pseudo-*p*-value, the higher the manager's timing ability. All non-dummy variables are transformed by taking natural logarithms, and all *t*-statistics are corrected for heteroscedasticity using White's (1980) procedure.

The results from model (1) are reported in Table 3. We include some variations to demonstrate the robustness of the significant explanatory variables. Consistent with our market conditions hypotheses, timing ability is positively related to market movements and interest rates. During periods of wide price swings in the stock market, managers have greater opportunities to identify mispricings. And when interest rates are high, buybacks are predominately motivated by underpricing considerations. The results from the full model show that managerial timing ability is not significantly influenced by industry-based factors. None of the industry coefficients is significant at the 5% level.

The findings regarding firm-specific variables are also generally consistent with expectations. Firms that frequently execute repurchases generate more public disclosures, and this acts to reduce information asymmetries. As anticipated, frequent repurchasers display significantly lower timing abilities. The estimated coefficient for firm cash flow is insignificant,

thus rejecting our hypothesized negative relation. However, the interaction term that combines low interest rates with company cash flow is negative and significant, as hypothesized. Our interpretation is that large cash balances alone do not impair managerial timing ability, but large cash balances in a low interest rate environment (i.e., low opportunity cost of repurchasing) encourage managers to buy back equity for reasons other than perceived mispricing. Although firm size has a negative relation with timing ability, its estimated coefficient is insignificant. Two possible explanations for the lack of significance between firm size and timing ability are that firm size could be too crude a proxy for the firm's information environment, or that the other independent variables adequately capture all relevant firm-specific attributes.[12]

3.2. Corporate Liquidity Effects

Table 4 presents summary statistics for the corporate liquidity sample requiring intra-day data on spreads, depths, volumes, and transaction prices. Similar to the market timing sample, we provide parallel comparisons to the population of SEHK firms over the same trading period. The repurchasing sample's average market capitalization is approximately two-thirds the size of the overall population. Average daily trading volumes, both in terms of number of shares and dollar values, are between 75% and 80% of the population averages. We also find that the probability of a trade within a daily, five-minute, or 30-second interval is consistently higher for repurchasing firms than for non-repurchasing firms.

The average share price of repurchasing firms, taken at 30-second intervals throughout the trading day, is approximately 85% of the average share price of the overall population. The average absolute (relative) bid-ask spread of repurchasing firms is \$0.061 (2.204%), while the average absolute (relative) bid-ask spread of the population is \$0.059 (2.496%). The average

depths of repurchasing firms, both in terms of the number of shares and market values, are slightly lower than the population figures. Overall, the 14% of SEHK-listed firms that repurchased shares during the sample period are not markedly different from their non-repurchasing counterparts.

In Table 5, we analyze differences between the repurchase period and the surrounding non-repurchase period. We define the repurchase period to include both the day of the repurchase and the following day of disclosure. Because it is not clear (ex ante) on which day the market actually learns that managers are buying shares, we include both days in our initial definition. Another consideration is that there are numerous examples of a single trading day being both a repurchase day and a disclosure day from a previous repurchase.[13] We define the five trading days before and the five trading days after a repurchase period as the surrounding non-repurchase period.[14] Unlike previous studies based on a single announcement event, repurchase implementations consist of multiple events both within and across authorized periods. The period *after* one repurchase is not mutually exclusive with respect to the period *before* the next repurchase. Because there is no clear interpretation of *before* and *after* periods, we rely on the surrounding non-repurchase period as our benchmark.

We calculate means and medians for various measures across repurchase periods and surrounding non-repurchase periods for each sample firm. Table 5 provides summary statistics for the repurchase and surrounding non-repurchase periods, along with paired *t*-test and sign test results. *Volume* is the total trading volume recorded on a per day basis. *Price* is the average daily transaction price, and *Returns* represent a daily average of continuously compounded returns over 30-second intervals. *Volatility* measures the variance of returns, where returns are calculated as the logarithm of bid-ask midpoint relatives over 30-second intervals. Similarly, *Ask*

Spread, *Relative Spread*, *Total Depth*, *Ask Depth* and *Bid Depth* are daily averages over 30-second intervals for the absolute dollar spread, relative spread, total dollar depth, ask-side dollar depth and bid-side dollar depth, respectively.

The test results show that average volumes and volatilities are significantly higher (sign test only) during the repurchase period. Average prices are significantly lower during the repurchase period, while average returns are significantly higher. This is consistent with the findings in section 3.1. that price levels are relatively low when managers implement their repurchase plans. The higher average returns mean that (intra-day) prices increase more than usual during the buyback execution period. Our liquidity measures yield mixed results. Spreads tend to widen, thereby reducing liquidity, while depths tend to increase, thereby increasing liquidity. Wider spreads during repurchase periods are consistent with the information-asymmetry hypothesis. Higher depths are consistent with the competing-market-maker hypothesis. It is also interesting to note that bid-side depth test statistics are larger than their ask-side counterparts: repurchasing managers place buy limit orders and thereby increase (asymmetrically) the bid-side of depth.

We have established that actual repurchase periods are associated with significant changes in price, volume, and volatility. Our univariate tests have also shown that liquidity improves in one dimension (depth), yet worsens in another (spread). We next turn our attention to measuring the impact of buyback implementation on firm liquidity after controlling for changes in price, volume, and volatility. These three independent variables are widely used in the market microstructure literature to control for general effects of trading activity on firm liquidity (e.g., Tinic and West (1974), Weston (2000)).

3.2.1. Regression analysis

Table 6 presents the results from the following regression model.

$$Liquidity_i = \alpha + \beta\, REPURCH_i + \delta_1 Volume_i + \delta_2 Price_i + \delta_3 Volatility_i + \varepsilon_i \qquad (2)$$

$Liquidity_i$ is the dependent variable represented by our various liquidity measures, *Ask Spread*$_i$, *Relative Spread*$_i$, *Total Depth*$_i$, *Ask Depth*$_i$, and *Bid Depth*$_i$, as defined above. *Volume*$_i$, *Price*$_i$, and *Volatility*$_i$ are the independent (control) variables. $REPURCH_i$ is a dummy variable that takes the value of one if the trading day falls on a repurchase period, and zero otherwise. All variables represent daily averages (on a firm-by-firm basis) taken at 30-second intervals. As in Table 5, these results are based on observations from the repurchase and surrounding non-repurchase periods. All non-dummy variables, *Ask Spread*$_i$, *Relative Spread*$_i$, *Total Depth*$_i$, *Ask Depth*$_i$, *Bid Depth*$_i$, *Volume*$_i$, *Price*$_i$ and *Volatility*$_i$ are transformed by taking natural logarithms. We adjust the *t*-statistics for arbitrary cross-correlations, serial correlation and heteroskedasticity using the Newey and West (1987) procedure with Hansen's (1982) generalized method of moments (GMM) technique.

Table 6 provides the results from estimating model (2) for each of the five liquidity measures (*Ask Spread*, *Relative Spread*, *Total Depth*, *Ask Depth*, and *Bid Depth*). The estimated coefficients for all control variables are highly significant at the 1% level, and their signs are consistent with market microstructure theory and previous empirical findings. Due to the impact on individual liquidity components (see section 3.2.2.), higher volumes and prices are associated with higher firm liquidity, while higher volatility levels are associated with lower firm liquidity. The estimated volume coefficients are negatively related to absolute spreads and relative spreads, and positively related to firm depths. Higher stock prices are associated with wider absolute

spreads and narrower relative spreads, consistent with previous findings. Higher stock prices are also directly related to firm depth. And finally, higher volatility levels reduce overall firm liquidity. Volatility is positively related to spreads and negatively related to depths.

The most important results are the estimated coefficients for the repurchase-period dummy variables. The positive and highly significant repurchase-period coefficients for both the absolute spread and relative spread regressions demonstrate that bid-ask spreads widen during buyback activity, even after controlling for changes in price, volume, and volatility. The negative and significant bid-side depth coefficients show that managerial repurchasing activity reduces firm depth. This finding stands in contrast to the univariate results in Table 5. Once we control for the rising (intra-day) prices, volumes, and volatilities induced by managerial trading, the bid-side dummy coefficient is negative and statistically significant at the 5% level, and the ask-side dummy coefficient is negative but insignificant. Overall, the total depth dummy coefficient is negative and insignificant at the 5% level.

We interpret these results as evidence in favor of the asymmetric-information hypothesis. When traders detect the presence of informed trading, they reduce firm liquidity by widening bid-ask spreads and reducing depths. We show that spreads widen significantly in both univariate and multivariate testing. The impact of buyback execution on firm depth, however, is sensitive to the inclusion of control variables. Without accounting for the rise in (intra-day) price, volume, and volatility during the repurchase periods, depth appears to increase (Table 5). But given the rise in price, volume, and volatility, firm depth is actually lower during repurchase periods than surrounding non-repurchase periods. For instance, higher trading volume is generally associated with higher levels of firm depth. But higher trading volume attributable to repurchasing activity will increase company depth by a significantly smaller amount than an equivalent volume

increase from a non-repurchasing source. The negative and statistically significant bid-side dummy coefficient suggests that managers submit fewer buy limit orders, per unit of volume, than non-managerial traders.

In Table 7, we partition the repurchase period into pure repurchase days and pure disclosure days. Previously, the repurchase period includes 713, 793, and 591 firm-days representing pure repurchase days, joint repurchase and disclosure days, and pure disclosure days, respectively. The Table 7 partitioning comes with the cost of a reduced sample size because days on which both events occur are eliminated. This represents a 52.7% reduction in the number of actual repurchase days. However, the benefit is that we are now able to disentangle the liquidity effects of repurchasing from the effects of disclosure. We estimate the following regression equation using repurchase, disclosure, and surrounding non-repurchase period data.

$$\begin{aligned} Liquidity_i = \alpha + \beta_1\, DAYZERO_i + \beta_2\, DAYONE_i + \\ \delta_1 Volume_i + \delta_2\, Price_i + \delta_3 Volatility_i + \varepsilon_i \end{aligned} \tag{3}$$

DAYZERO is a dummy variable that takes the value of one on actual repurchase days, and zero otherwise. *DAYONE* is a dummy variable that takes the value of one on disclosure days, and zero otherwise.

As before, the control variables in Table 7 are all highly significant and exhibit the expected signs. The difference between repurchase day and disclosure day coefficients is rather striking.[15] On repurchase days (*DAYZERO*), absolute spread and relative spread dummy coefficients are positive, highly significant, and considerably larger than those reported in Table 6. The economic interpretation of these findings is that spreads increase by more than 10% on the days when managers repurchase company shares. Perhaps more significantly, all repurchase

day coefficients for the depth dummy variables are negative and highly significant. This is clear and unambiguous evidence that managerial trading activity reduces firm liquidity. Although not reported, we also show that the reduction in liquidity is not simply the result of large trade size.[16]

On disclosure days (*DAYONE*), absolute and relative spread coefficients are insignificantly different from the surrounding non-repurchase days. Spreads widen only when informed managers are actually repurchasing shares in the open market, and then fall back within normal ranges once the source of informed trading is disclosed on the following business day. We briefly discuss the disclosure policy implications of this finding in the conclusion of the paper. Interestingly, firm depth tends to improve on disclosure days relative to the surrounding non-repurchase days. Although all three depth dummy coefficients are positive, only the ask-side is statistically significant at the 5% level. Market participants are apparently more likely to submit sell limit orders on the disclosure day following repurchases. This behavior is consistent with the belief that repurchasing activity, and its associated rise in intra-day returns, creates a temporary selling opportunity on the subsequent trading day.

The empirical evidence in Tables 6 and 7, combined with additional robustness testing, consistently support the following conclusions.[17] When managers enter the market as informed traders, absolute and relative bid-ask spreads widen significantly and firm depth falls significantly. When managers disclose their activities on the following business day, absolute and relative bid-ask spreads return to non-buyback levels and firm depth actually improves over non-buyback/non-disclosure levels. Market participants are apparently able to identify the presence of an informed trader when managers repurchase company shares. Besides market rumors or analyst forecasts, participants might be able to detect informed trading by observing irregular trading patterns. We show in Table 1, for instance, that the average buyback represents

slightly over 44% of the repurchase day's total trading volume. When investors suspect informed trading, they are far less willing to supply immediacy to the affected firm.

In the next section, we focus our analysis on the adverse selection component of the bid-ask spread. Consistent with the information-asymmetry hypothesis, we posit that adverse selection is the mechanism through which information asymmetries are transformed into the wider spreads and lower depths documented above.

3.2.2. Bid-ask spread decompositions

The market microstructure literature distinguishes three components of the bid-ask spread. Demsetz (1968) and Tinic (1972) identify an order processing cost that is made up of exchange and clearing fees, bookkeeping and back office costs, the market maker's time and effort, and other "costs of doing business." Because at least part of this cost is fixed, order processing costs (per trade) are lower for more heavily traded securities. Inventory holding costs are due to order flow imbalances that cause the market maker's inventory position to deviate from optimal levels (Stoll (1978) and Ho and Stoll (1983)). The greater the deviation, the larger the inventory holding cost and the wider the bid-ask spread. Copeland and Galai (1983), Glosten and Milgrom (1985), and Easley and O'Hara (1987) posit a third spread component caused by asymmetric information and its consequent informed trading. Market participants include an adverse selection cost in the spread to cover their expected losses to informed traders.

We have shown in section 3.2.1. that managerial trading is associated with wider spreads and lower depths, particularly after controlling for changes in price, volume, and volatility. In this section, we focus on the adverse selection component of the spread in order to isolate the (hypothesized) underlying cause of these unfavorable changes in corporate liquidity. According

to the information-asymmetry hypothesis, managerial trading will intensify adverse selection costs. The validity of our empirical results, however, is dependent on the accuracy of the component estimation technique.[18] We therefore estimate the adverse selection component using several decomposition models in order to address the related issues of accuracy and robustness.

Our goal is to measure changes in adverse selection caused by managerial trading. In each of the four decomposition models, we introduce an interaction term, $REPURCH_t$, which takes the value of one for trades associated with buyback activity, and zero otherwise. We define $REPURCH_t$ to include the actual repurchase day, disclosure day, and five subsequent trading days. Unlike our spread and depth measures, bid-ask spread components must be estimated. We include several days in the repurchase period definition in order to increase the efficiency of the component estimates. Alternative definitions provide the same results as those reported herein.[19] Positive and significant coefficients on the $REPURCH_t$ terms would confirm the hypothesis that managerial trading induces higher adverse selection costs. Measures such as bid-ask midpoints and transaction prices are transformed by taking natural logarithms as in Lin, Sanger and Booth (1995). Each decomposition model is estimated on a pooled cross-sectional time-series basis.[20]

The decomposition model based on Lin, Sanger and Booth (1995) is specified as

$$\Delta M_{t+1} = \lambda(z_t) + \lambda_{repurch}(z_t * REPURCH_t) + e_{t+1} \qquad (4)$$

where $\Delta M_{t+1} = M_{t+1} - M_t$; M_t is the quoted bid-ask midpoint at time t; $z_t = P_t - M_t$; P_t is the price at time t; λ is the adverse selection component of the bid-ask spread; and $\lambda_{repurch}$ is the incremental adverse selection component during the repurchase period. This model defines adverse selection as the change in the bid-ask spread midpoint caused by the direction (buy versus sell) and the magnitude (price versus midpoint) of transactions. Our estimated adverse

selection component (λ) of 0.1235 (standard error = 0.0002) is comparable to Huang and Stoll's (1997) estimate. The economic interpretation is that 12.35% of the bid-ask spread is attributable to information costs. More importantly, the estimated interaction term ($\lambda_{repurch}$) of 0.0793 (standard error = 0.0011) is highly significant at the 0.1% level, thereby confirming that managerial trading increases adverse selection. During repurchase periods, adverse selection increases by 7.93% from 12.35% to 20.28% of the bid-ask spread.

We use this same approach to test for incremental changes to the adverse selection component under three alternative specifications. The Glosten and Harris (1988) model defines adverse selection as the change in the transaction price caused by the direction (buy versus sell) and the magnitude (trade size) of transactions. The third model is based on Huang and Stoll (1997), as implemented by Weston (2000). They define adverse selection as the change in the bid-ask spread midpoint caused by the direction (buy versus sell) and the magnitude (half spread) of transactions. The coefficient of interest represents a combined adverse selection and inventory cost component. The fourth model is also based on Huang and Stoll (1997) and includes trade size indicator variables to classify individual trades into one of three size categories.

We estimate a regression (4) equivalent for each alternative specification. We find that the incremental adverse selection term is always positive and highly significant at the 0.1% level. The results from Lin, Sanger and Booth's (1995) decomposition model are robust to alternative specifications and trade sizes. Market participants are able to detect the presence of informed trading regardless of the trade size, and the resulting increase in adverse selection leads to the widening of spreads and thinning of depths observed in Tables 6 and 7.

Overall, the decomposition results are consistent with the market timing results in section 3.1., and the spread and depth regressions in section 3.2.1.. Managers behave as informed traders

when repurchasing company shares in the open market. At the time of execution, market participants detect the presence of informed trading and respond to the consequent rise in adverse selection by reducing overall firm liquidity. Our bid-ask spread component estimates suggest that the increase in adverse selection persists beyond the day of actual repurchases. Recall from section 3.2.1. that spreads and depths tend to return to normal levels or slightly improve once the buyback activity is disclosed. It is possible that adverse selection remains high in spite of disclosure because investors revise expectations of trading against informed traders. However, it is also possible that spread decomposition techniques are too blunt an instrument, relative to exact spread and depth measures, to gauge precisely when adverse selection subsides. Under either interpretation, however, our decomposition results confirm that managerial trading reduces liquidity by raising the firm's adverse selection costs.

4. Summary and Conclusion

This study is motivated by recent growth in the use of open market share repurchases as a major vehicle for distributing wealth to shareholders. Although share buybacks have a long history of legality in markets such as the U.S., corporate managers have only recently begun substituting repurchases for dividends on a large scale. In many other markets, recent growth in open market repurchases is due to the fact that such activities had been prohibited until fairly recently. In spite of these developments, lack of disclosure rules or short repurchase histories make it very difficult to address important issues related to the precise timing of equity buybacks.

We contribute to this growing literature by analyzing share repurchases on the Stock Exchange of Hong Kong (SEHK). SEHK-listed companies have been permitted to conduct open market share repurchases since November 1991, thereby providing a sample of over 5,000

buybacks. More importantly, SEHK-listed companies are required to disclose all repurchases by 9:30 a.m. on the following business day. The ability to identify the precise day that managers repurchase company shares provides us with a unique vantage point from which to investigate the related issues of managerial timing and its hypothesized impact on corporate liquidity.

Our first objective is to test the ability of corporate managers to time their repurchases. There currently exists little empirical evidence on actual share repurchases and managerial timing. We use a bootstrapping method to distinguish managerial timing ability from a naïve accumulation plan. The results show that managers outperform an uninformed strategy in every year of our sample using conventional levels of significance. The implication is that managers use private information when trading company shares. We show that their timing ability is significantly related to general market conditions and firm-specific attributes, but unrelated to industry membership.

Our second objective is to measure the impact of repurchases on firm liquidity. Before controlling for systematic changes in price, volume, and volatility surrounding the repurchases, we find that bid-ask spreads generally widen and depths generally increase. The first result is consistent with the information-asymmetry hypothesis, and the second is consistent with the competing-market-maker hypothesis. However, after controlling for changes in price, volume, and volatility, we find overwhelming evidence in favor of the information-asymmetry hypothesis.

We also decompose bid-ask spreads in order to measure the effect of repurchases on adverse selection costs. The component estimates confirm our earlier findings that market participants are able to detect the presence of informed trading, and reduce the firm's liquidity in response. Adverse selection costs increase significantly during the repurchase period in all four decomposition models. Overall, our market timing, spread and depth, and decomposition results

reveal a coherent picture of managerial buyback behavior and its impact on firm liquidity. Consistent with the information-asymmetry hypothesis, secondary-market share repurchases impose additional liquidity costs on the firm.

Our findings raise interesting policy questions with respect to disclosure rules. The evidence shows that managers use private information to benefit one class of shareholders (including managers) over another class of shareholders. Without required disclosures, there is little to no accountability with respect to this trade-off. The results also have direct implications for voluntary disclosure policy. We show that firm liquidity deteriorates when market participants detect the presence of informed trading, at least in part, because they are unable to identify the source of such trading. However, we find that firm liquidity generally reverts to normal levels when managers subsequently disclose their identity. We can only speculate on what would have happened to firm liquidity had managers not disclosed their identity, but it is certainly plausible that the firm's liquidity would not have rebounded so quickly.

Endnotes

[1] Wiggins (1994), Singh, Zaman, and Krishnamurti (1994), Miller and McConnell (1995), Franz, Rao, and Tripathy (1995) provide evidence on liquidity changes surrounding buyback announcements. Market makers will adjust spreads and depths following announcements only to extent that they expect imminent (informed) trading.

[2] The positive relation between adverse selection and bid-ask spreads is well documented in the literature. See Brockman and Chung (1999a) and Heflin and Shaw (2000) for evidence of the inverse relation between adverse selection and firm depth.

[3] See Amihud and Mendelson (1986), Barclay and Smith (1988), and Jacoby, Fowler, and Gottesman (2000) for theoretical expositions, and Chalmers and Kadlec (1998), Datar, Naik, and Radcliffe (1998), and Brennan and Subrahmanyam (1996) for empirical evidence.

[4] For a more complete description of the SEHK market structure, see Brockman and Chung (1998), Ahn and Cheung (1999), and Ahn, Bae, and Chan (2000).

[5] Although the number of days excluded varies with the particular data set employed, we find very few examples of concurrent announcements and repurchases. For example, we exclude only two observations from the 1,528 original repurchases in the intra-day data set.

[6] We replicate all empirical tests with the crash period included. The results are not significantly different from those reported herein.

[7] On October 3, 1997 the Hang Seng Index (HSI) closed at 15,128.02. By October 28, the HSI had fallen by over 40 percent to a closing value of 9,059.89. Over the following 12 months (i.e., covering the excluded time period), the HSI was extremely volatile ranging from a high of 11,722.94 on December 8, 1997 to a low of 6,660.42 on August 13, 1998. Companies responded to the crisis by expanding their repurchase programs. During the crisis period (October 1997 to October 1998), SEHK-listed firms averaged approximately 191 repurchases per month, compared to an average of 63 per month during the non-crisis period.

[8] Minor adjustments are made to the time-of-day for the first eight months of the sample period due to an internal clock misalignment in the original data capturing process. These adjustments

are made based on information provided by SEHK's Research and Planning officials and verified by our program filters.

[9] Data availability constrains our ability to identify the exact dates of all annual shareholders' meetings. We have the exact dates for all repurchasing firms in 1996, and incomplete data in other years. Because shareholders' meetings tend to be consistently scheduled, we use the known dates for any other year in which the firm repurchases. For the sub-sample of firms without repurchases in 1996 but with repurchases in other years (20 percent of the total), we estimate the shareholder meeting date based on the 1996 average number of days between fiscal year-end and the shareholder meeting. We find an average of 45 days and add this number to the sub-sample fiscal year-ends to estimate the meeting dates.

[10] We test alternative specifications as well. In addition to the constraints of holding constant the repurchase period, number of repurchase days, and number of actual shares repurchased on each day, we also require that randomly selected repurchase days include only those days with sufficient trading volume to cover the desired quantity repurchased. We also test a less restrictive specification by allowing the number of repurchase days, as well as the number of shares repurchased on each day, to be selected randomly. In both cases, the bootstrapped results confirm those reported in Table 2.

[11] First, we replicate our bootstrapping procedure for the subset of repurchase days with average daily trade sizes in the lowest one-third percentile of own-firm trade sizes. The results reveal significant timing abilities for this small trade-size subset. Second, we create a matched sample based on the average daily (buy-side) trade sizes of each repurchase day. If trade size and momentum are responsible for our timing results, then we would expect to find significant timing ability for the matched sample. In contrast to actual repurchases, the matched sample shows very weak evidence of timing. Third, we eliminate any possible contamination from trade size or momentum by using only the data prior to the first repurchase to construct the bootstrapped repurchase plans for each firm year. Again, the results show that managers possess significant timing ability. We thank an anonymous referee for suggesting this direction of additional testing.

[12] Following Bailey, Chung, and Kang (1999), we also quantify the firm's information environment by counting the number of company-specific news items. We define $NUMNEWS_i$

as the number of news items about the firm that are picked up by the Reuters Business Briefing service during firm-year *i*. In addition, we use the number of analysts following the firm as a proxy for its information environment. Both the number-of-news-items coefficient and the analysts following coefficient are insignificant. We also investigate whether timing ability is more or less prevalent among certain sub-categories, including blue chips (i.e., members of the Hang Seng Index), red chips (i.e., members of the Hang Seng China-Affiliated Corporations Index), and cross-listed firms. None of the dummy variable coefficients is significant at conventional levels.

[13] We separate repurchase days and disclosure days in Table 7. The benefit is that we are able to measure individual liquidity effects for each day, and the cost is that we reduce the sample size by discarding days with both activities.

[14] Alternative definitions of surrounding non-repurchase periods, including three-day and ten-day periods, do not produce substantive changes in any of the reported results.

[15] Without controlling for price, volume, and volatility, absolute and relative spreads are higher and depths are lower on repurchase days relative to disclosure days, although differences are not always significant. And differences between repurchase day and disclosure day price, volume, and volatility are not significant at the 5% level using either parametric *t*-tests or non-parametric sign tests.

[16] We test for the effect of trade size by partitioning our sample into high, medium, and low trade-size categories. We divide the average trade size on a repurchase day by the repurchasing firm's average trade size over the sample period, and then rank this ratio across all sample repurchases. The high (medium, low) trade-size category consists of those ratios that fall in the top (middle, bottom) one-third percentile. We re-estimate model (3) for each trade-size category and find that spreads widen and depths decrease significantly for each of the three sub-samples during the repurchase period. The results are also unaltered if we use only buy-side trades when defining the three trade-size categories.

[17] In addition to the results in Tables 6 and 7, we estimate regression models (2) and (3) using all available trading days (as opposed to only the surrounding non-repurchase days). By including all available trading days, our sample size increases from 4,674 to 41,367, but the findings are

unaltered. We re-estimate models (2) and (3) using a one-factor fixed effects model, as well as a one-factor random effects model (controlling for firm differences). In both cases, the estimated coefficients and levels of significance are consistent with the findings reported above. We also replicate the regression estimates in Tables 6 and 7 using alternative definitions of surrounding non-repurchase periods, including three-day and ten-day periods. The results demonstrate that our reported findings are robust to alternative surrounding-period benchmarks.

[18] See Brockman and Chung (1999b) and Chan (2000) for decomposition results in an electronic, limit-order environment.

[19] We test several alternative specifications for the interactive $REPURCH_t$ term, including (1) actual repurchase days only, (2) actual repurchase and disclosure days only, (3) actual repurchase days, disclosure days, and three subsequent trading days, and (4) the actual repurchase days, disclosure days, and ten subsequent trading days. In all cases, adverse selection is significantly higher during the repurchase period than the non-repurchase period.

[20] We re-estimate all decomposition models on a firm-by-firm basis. The results, based on a percentage of positive and significant repurchase day coefficients, strongly confirm the findings reported herein.

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Table 1. Summary statistics on market and share repurchase activities of Hong Kong listed companies. The sample period spans nine calendar years starting from November 1991, when share repurchase was first allowed in Hong Kong, to the end of August 1999. A period of 13 months between October 1, 1997 and October 31, 1998 is excluded from the sample period due to possible confounding effects of the Asian financial crisis. The share repurchase sample is made up of all companies listed on the Stock Exchange of Hong Kong (SEHK) which had implemented open market share repurchases over the 81-month sample period. Comparative market statistics over the same period are also provided for the population of all companies with ordinary shares listed on the SEHK.

	Sample of share repurchase companies	**Population of all SEHK listed companies**
Number of companies	190	716
Average market capitalization per company	$4,095,693,748	$4,576,988,212
Average daily trading volume in number of shares	3,432,909	3,632,226
Average daily trading volume in total dollar volume	$9,845,462	$10,551,170
Average daily closing price	$3.975	$4.680
Average daily returns (with dividends reinvested)	0.0016	0.0021
Number of trading days covered by the sample period	1,675	1,675
Average percentage of trading days with one or more shares traded	87.32%	81.23%
Total number of repurchase cases made by all repurchase companies over the sample period	5,111	-
Total number of shares repurchased by all repurchase companies over the sample period	2,571,493,455	-
Total dollar value of shares repurchased by all repurchase companies over the sample period	$8,494,407,436	-
Average number of shares repurchased by a company on a repurchase day	566,244	-
Average dollar value of shares repurchased by a company on a repurchase day	$2,138,036	-
Average size of share repurchase by a company on a repurchase day expressed as a percentage of the total trading volume of that day	44.48%	-
Average size of share repurchase by a company on a repurchase day expressed as a percentage of the total number of outstanding shares of the company	0.08%	-
Average number of share repurchase days per repurchase company over the sample period	26.90	-
Number (percentage) of companies with 1 repurchase day	12 (6.3%)	-
Number (percentage) of companies with 2 to 5 repurchase days	25 (13.2%)	-
Number (percentage) of companies with 6 to 10 repurchase days	33 (17.4%)	-
Number (percentage) of companies with 11 to 20 repurchase days	46 (24.2%)	-
Number (percentage) of companies with 21 to 50 repurchase days	45 (23.7%)	-
Number (percentage) of companies with 51 to 100 repurchase days	22 (11.6%)	-
Number (percentage) of companies with over 100 repurchase days	7 (3.7%)	-

Table 2. Evidence of managerial inter-day timing ability in share repurchase decisions: actual repurchase costs compared with the bootstrapped repurchase costs of randomly-generated repurchase programs. The sample period comprises 81 months from November 1991 to August 1999. 13 months between October 1, 1997 and October 31, 1998 are excluded from the sample period due to possible confounding effects of the Asian financial crisis. The sample of share repurchase firms is made up of all companies listed on the Stock Exchange of Hong Kong (SEHK) which implemented open market share repurchases over the 81-month sample period. Repurchases made after the last days of firm-years in 1999 are excluded from the bootstrapping analysis. A firm-year is defined as the period between shareholders' annual resolutions giving company management the power to carry out open market share repurchases. The actual cost of all repurchases made by a repurchase firm in a firm-year is compared with a distribution of bootstrapped repurchase costs. A pseudo-*p*-value is computed representing the percentage of the distribution that is smaller than the actual repurchase cost. A small pseudo-*p*-value is interpreted as an indication that the repurchase cost of an actual repurchase program is significantly lower than the bootstrapped costs of a randomly-generated program, implying managerial timing ability. For each firm-year, the distribution is formed by repeating the bootstrapping procedure 50,000 times and computing in each round a total cost for the same number of shares repurchased by the company on the same number of days in the firm-year. The bootstrapped total cost is calculated assuming that the repurchases are made on randomly assigned trading days in the firm-year rather than on the actual repurchase days. All historical prices are adjusted to correct for the effects of stock splits, stock dividends, and rights offerings during the sample period. For presentation in this table, bootstrapped costs are first scaled by the actual repurchase cost for each firm-year and the minimum, mean, median and maximum statistics are then obtained across all firm-years.

Company firm-year ended in	**Number of firm-years with share repurchases**	**Total number of share repurchases included**	**Minimum bootstrapped cost scaled by actual cost**	**Mean (median) bootstrapped cost scaled by actual cost**	**Maximum bootstrapped cost scaled by actual cost**	**Number (percent) of firm-years with pseudo-*p*-value less than 0.05**	**Number (percent) of firm-years with pseudo-*p*-value less than 0.01**
1992	8	63	0.90	1.16 (1.09)	1.54	4 (50.0%)	3 (37.5%)
1993	32	434	0.85	1.07 (1.01)	1.36	9 (28.1%)	8 (25.0%)
1994	54	691	0.87	1.15 (1.11)	1.51	24 (44.4%)	16 (29.6%)
1995	100	1,820	0.84	1.06 (1.04)	1.35	37 (37.0%)	23 (23.0%)
1996	51	654	0.87	1.09 (1.04)	1.37	20 (39.2%)	14 (27.5%)
1997	57	746	0.82	1.08 (1.04)	1.58	20 (35.1%)	12 (21.1%)
1998	18	99	0.95	1.02 (1.01)	1.11	7 (38.9%)	4 (22.2%)
1999	50	551	0.83	1.16 (1.06)	1.67	17 (34.0%)	15 (30.0%)
Total	370	5,058	0.85	1.09 (1.04)	1.45	138 (37.3%)	95 (25.7%)

Table 3. Determinants of managerial timing ability in share repurchase decision.

$$TIMING_i = \alpha + \beta_1 MKTMOV_i + \beta_2 INTEREST_i + \beta_3 CASHFLOW_i + \beta_4 (LOWINTEREST_i * CASHFLOW_i) + \beta_5 NUMREP_i + \beta_6 FIRMSIZE_i + \sum_{j=1}^{6} \theta_j INDUSTRY_{i,j} + \varepsilon_i$$

The dependent variable, $TIMING_i$, is managerial timing ability in share repurchases for firm-year *i* and is measured as one minus the pseudo-p-value obtained from the bootstrapping procedure. A small pseudo-*p*-value is interpreted as an indication that the repurchase cost of an actual repurchase program is significantly lower than the bootstrapped costs of a randomly-generated program, implying managerial timing ability. $MKTMOV_i$ measures the dispersion of market movements during firm-year *i* and is calculated as the range of price changes for the value-weighted market portfolio across all trading days over the firm-year. $INTEREST_i$ is the average interest rate over firm-year *i* and is measured as the savings deposit rates averaged across all repurchase days during the firm-year. $CASHFLOW_i$ measures a firm's cash flows from operations as reported in the company financial statements for each fiscal year involving share repurchase and an average cash flow measure scaled by total assets is obtained across all repurchases over the firm-year *i*. $LOWINTEREST_i$*$CASHFLOW_i$ is an interaction variable between $LOWINTEREST_i$ and $CASHFLOW_i$, where $LOWINTEREST_i$ is a dummy variable coded with a value of one if firm-year *i* is ranked among the firm-years in the lowest quartile of the variable $INTEREST_i$, and zero otherwise. $NUMREP_i$ is the total number of share repurchases made by the company during firm-year *i*. $FIRMSIZE_i$ is the market capitalization of the company averaged over all months during the firm-year. $INDUSTRY_{i,j}$, j = 1, 2, …, 6, are dummy variables identifying the company's industry sector (i.e., *FINANCE*, *UTILITIES*, *PROPERTIES*, *CONSOLIDATED ENTERPRISES*, *INDUSTRIALS*, *HOTELS*, or *MISCELLANEOUS*) as classified by the Stock Exchange of Hong Kong. No dummy variable is included for the *MISCELLANEOUS* category to avoid perfect collinearity among the set of industry variables. All non-dummy variables, $TIMING_i$, $MKTMOV_i$, $INTEREST_i$, $CASHFLOW_i$, $NUMREP_i$, and $FIRMSIZE_i$, are transformed by taking natural logarithms. Observations with missing or invalid data are excluded from the analysis. All *t*-statistics are corrected for heteroscedasticity using the White (1980) procedure. Significance is indicated at the 0.05 and 0.01 levels by one and two asterisks respectively and all results are presented on the basis of two-tail significance.

	I		**II**		**III**	
Variable	estimated coefficient	*t*-statistic	estimated coefficient	*t*-statistic	estimated coefficient	*t*-statistic
Intercept	1.1677	0.58	1.7403	0.59	0.1088	0.03
MKTMOV	2.2911	2.56 *	2.3166	2.58 *	2.1458	2.40 *
INTEREST	3.0202	3.46 **	3.0322	3.39 **	2.9157	3.27 **
CASHFLOW	0.0217	0.17	0.0245	0.19	0.0159	0.12
*LOWINTEREST*CASHFLOW*	-0.6409	-2.72 **	-0.6425	-2.70 **	-0.6160	-2.61 **
NUMREP	-0.5317	-3.41 **	-0.5361	-3.25 **	-0.5537	-3.24 **
FIRMSIZE	-	-	-0.0243	-0.22	-0.0174	-0.14
FINANCE	-	-	-	-	1.5512	1.23
UTILITIES	-	-	-	-	1.8493	1.55
PROPERTIES	-	-	-	-	1.1509	0.93
CONS. ENTERPRISES	-	-	-	-	1.2649	1.07
INDUSTRIALS	-	-	-	-	1.3642	1.12
HOTELS	-	-	-	-	2.2158	1.69
Overall model statistics (n=266):						
adjusted R^2		0.09		0.09		0.08
F-statistic		6.56 **		5.45 **		2.95 **

Table 4. Selected market and intra-day statistics on trading activities of sample companies. The sample period is reduced to 27 months between May 1, 1996 and August 31, 1999 as intra-day transaction data on Hong Kong listed companies are not available prior to May 1, 1996. The period between October 1, 1997 and October 31, 1998 is excluded from the sample period due to possible confounding effects of the Asian financial crisis. The sample is made up of 103 companies listed on the Stock Exchange of Hong Kong (SEHK) which had implemented open market share repurchases during the 558-day reduced sample period. Comparative market statistics are also provided for the population of all firms with ordinary shares listed on the SEHK over the same period. Two trading days (October 14, 1996 and December 12, 1996) are not included because data on the bid and ask quotes were not available from the SEHK for these two particular days.

	Sample companies with share repurchase	**Population of companies listed on the SEHK**
Number of companies	103	717
Average market capitalization per company	$3,561,918,436	$5,315,444,890
Average daily trading volume in number of shares	4,423,693	5,501,706
Average daily trading volume in total dollar volume	$10,705,455	$14,281,925
Average percentage of trading days with one or more shares traded	85.11%	78.22%
Average percentage of five-minute intervals with one or more shares traded	33.52%	30.98%
Average percentage of thirty-second intervals with one or more shares traded	8.11%	7.41%
Average share price in thirty-second intervals	$4.321	$5.101
Average absolute dollar bid-ask spread in thirty-second intervals	$0.061	$0.059
Average relative bid-ask spread in thirty-second intervals	0.02204	0.02496
Average volume depth in thirty-second intervals	396,677	469,628
Average dollar depth in thirty-second intervals	$888,644	$952,854

Table 5. Transaction and liquidity measures during periods of share repurchase and surrounding periods of non-repurchase. The reduced sample period covers 27 months from May 1, 1996 to August 31, 1999 as intra-day transaction data on Hong Kong listed companies are not available prior to May 1, 1996. The period between October 1, 1997 and October 31, 1998 is excluded from the sample period due to possible confounding effects of the Asian financial crisis. *Volume* is the total trading volume recorded over a trading day. *Returns* is the continuously compounded returns over each trading day. *Volatility* measures the variance of returns over a trading day where returns are calculated by taking the logarithms of bid-ask midpoint relatives thirty seconds apart. *Price* is the transaction price of a sample firm averaged over a trading day and is calculated as the mean of transaction prices recorded thirty seconds apart. Similarly, *Absolute Spread*, *Relative Spread*, *Total Depth*, *Ask Depth* and *Bid Depth* are averages for the absolute dollar bid-ask spread, relative bid-ask spread, total dollar depth, ask-side dollar depth and bid-side dollar depth respectively over each trading day. The day on which a firm implements an open market share repurchase and the following business day on which the firm reports the share repurchase are both included in the definition of a REPURCHASE period. The five trading days before and the five trading days after a REPURCHASE period which by themselves are not days of other REPURCHASE periods are included in the definition of a SURROUNDING NON-REPURCHASE period. Data affected by stock splits, stock dividends and major announcements (e.g., earnings and dividends announcements) are removed from the dataset. For each repurchase , a set of means and medians of the different measures are first calculated across all days in the REPURCHASE periods and another set across all days in the SURROUNDING NON-REPURCHASE periods. The difference in these means and medians between the two periods are then computed for all repurchases. Repurchases that do not have valid matching measures for both the REPURCHASE and the SURROUNDING NON-REPURCHASE periods are excluded from the analysis. The *t*-statistics are from the paired *t*-test for the difference in the mean measures between the REPURCHASE and the SURROUNDING NON-REPURCHASE periods across repurchases. The sign test statistics are from the nonparametric sign test for the differences in the median measures between the REPURCHASE and the SURROUNDING NON-REPURCHASE periods across repurchases. All *p*-values are reported on the basis of two-tail significance level.

Mean (median) measure of variables					
Variable	**REPURCHASE periods**	**SURROUNDING NON-REPURCHASE periods**	**difference between the repurchase periods and the surrounding non-repurchase periods**	***t*-statistic [*p*-value] in paired-t test**	**test statistic [*p*-value] in sign test**
Volume	1,871,133 (651,000)	1,713,065 (477,000)	158,068 (63,000)	1.35 [0.1781]	185.00 [0.0001]
Price	4.14278 (1.80901)	4.15755 (1.84389)	-0.01477 (-0.00233)	-2.20 [0.0278]	-72.50 [0.0002]
Returns	0.00224 (0.00000)	0.00054 (-0.00000)	0.00176 (0.00172)	3.17 [0.0001]	80.00 [0.0001]
Volatility (x 10^{-3})	0.00338 (0.00169)	0.00315 (0.00149)	0.00021 (0.00013)	1.00 [0.3178]	92.00 [0.0001]
Absolute Spread	0.05943 (0.03063)	0.05564 (0.02995)	0.00380 (0.00022)	1.50 [0.1330]	39.50 [0.0445]
Relative Spread	0.02157 (0.01542)	0.02161 (0.01507)	-0.00005 (0.00012)	-0.17 [0.8676]	45.50 [0.0204]
Total Depth	789,025 (308,731)	752,496 (275,643)	36,529 (13,280)	2.24 [0.0255]	113.50 [0.0001]
Ask Depth	359,186 (149,656)	350,048 (131,940)	9,138 (7,111)	1.39 [0.1636]	96.00 [0.0001]
Bid Depth	429,940 (143,143)	402,448 (129,265)	27,391 (6,726)	2.23 [0.0258]	135.00 [0.0001]
number of repurchases	1,511	1,511	1,511	1,511	1,511

Table 6. Regression of liquidity measures across repurchase and surrounding non-repurchase periods controlling for the effects of price, volume and volatility.

$$Liquidity_i = \alpha + \beta\, REPURCH_i + \delta_1 Volume_i + \delta_2 Price_i + \delta_3 Volatility_i + \varepsilon_i$$

$Liquidity_i$ is the dependent variable and is represented by either *Absolute Spread*$_i$, *Relative Spread*$_i$, *Total Depth*$_i$, *Ask Depth*$_i$ or *Bid Depth*$_i$. *Absolute Spread*$_i$ is a measure of the average absolute dollar bid-ask spread of a sample firm over a trading day and is calculated as the mean of all absolute dollar spreads recorded thirty seconds apart during the day. Similarly, *Relative Spread*$_i$, *Total Depth*$_i$, *Ask Depth*$_i$ and *Bid Depth*$_i$ are the daily averages for the relative bid-ask spread, total dollar depth, ask-side dollar depth and bid-side dollar depth respectively. The dataset used in the regression analysis includes observations from only the REPURCHASE and the SURROUNDING NON-REPURCHASE periods. The day on which a firm implements an open market share repurchase and the following business day on which the firm reports the share repurchase are both included in the definition of a REPURCHASE period. The five trading days before and the five trading days after a REPURCHASE period which by themselves are not days of other REPURCHASE periods are included in the definition of a SURROUNDING NON-REPURCHASE period. The variable $REPURCH_i$ is coded with a value of one if the trading day is within a REPURCHASE period, and zero otherwise. Data affected by stock splits, stock dividends and major announcements (e.g., earnings and dividends announcements) are removed from the dataset. Observations from days between October 1, 1997 and October 31, 1998 are excluded due to possible confounding effects of the Asian financial crisis. *Volume*$_i$, *Price*$_i$ and *Volatility*$_i$ are additional control variables introduced to the regression. *Volume*$_i$ is the total trading volume during the trading day. *Price*$_i$ is the average of all transaction prices recorded thirty seconds apart over the trading day. *Volatility*$_i$ measures the variance of returns over the trading day and returns are calculated by taking the logarithms of bid-ask midpoint relatives thirty seconds apart. All non-dummy variables, *Absolute Spread*$_i$, *Relative Spread*$_i$, *Total Depth*$_i$, *Ask Depth*$_i$, *Bid Depth*$_i$, *Volume*$_i$, *Price*$_i$ and *Volatility*$_i$ are transformed by taking natural logarithms. The *t*-statistics are adjusted for arbitrary cross-correlations, serial correlation and heteroskedasticity using Hansen's (1982) generalized method of moments (GMM) with the Newey and West (1987) procedure. Significance is indicated at the 0.05 and 0.01 levels by one and two asterisks respectively and all results are presented on the basis of two-tail significance.

	Absolute Spread		***Relative Spread***		***Total Depth***		***Ask Depth***		***Bid Depth***	
	estimated coefficient	***t*-stat.**	**estimated coefficient**	***t*-stat.**	**estimated coefficient**	***t*-stat.**	**estimated coefficient**	***t*-stat.**	**estimated coefficient**	***t*-stat.**
Intercept	8.4476	17.99 **	8.5231	18.02 **	-2.5999	-4.14 **	-2.7799	-4.26 **	-4.1210	-5.85 **
REPURCH	0.0487	4.03 **	0.0496	4.09 **	-0.0270	-1.40	-0.0175	-0.79	-0.0480	-2.13 *
Volume	-0.2266	-56.00 **	-0.2265	-55.84 **	0.4292	58.23 **	0.4243	54.03 **	0.4659	54.34 **
Price	0.6648	105.27 **	-0.3341	-52.86 **	0.6569	67.22 **	0.6579	60.43 **	0.6732	59.71 **
Volatility	0.8338	21.15 **	0.8407	21.18 **	-0.8180	-15.76 **	-0.7711	-14.20 **	-0.8426	-14.59 **
Number of observations	4,674		4,674		4,674		4,674		4,674	
Adjusted R^2	0.8225		0.7210		0.7714		0.7126		0.7326	
F-statistic (4, 4,669)	5,415.24 **		3,020.06 **		3,944.26 **		2,897.28 **		3,202.17 **	

Table 7. Regression of liquidity measures across repurchase day, reporting day and the surrounding non-repurchase period controlling for the effects of price, volume and volatility.

$$Liquidity_i = \alpha + \beta_1 DAYZERO_i + \beta_2 DAYONE_i + \delta_1 Volume_i + \delta_2 Price_i + \delta_3 Volatility_i + \varepsilon_i$$

$Liquidity_i$ is the dependent variable and is represented by either *Absolute Spread*$_i$, *Relative Spread*$_i$, *Total Depth*$_i$, *Ask Depth*$_i$ or *Bid Depth*$_i$. *Absolute Spread*$_i$ is a measure of the average absolute dollar bid-ask spread of a sample firm over a trading day and is calculated as the mean of all absolute dollar spreads recorded thirty seconds apart during the day. Similarly, *Relative Spread*$_i$, *Total Depth*$_i$, *Ask Depth*$_i$ and *Bid Depth*$_i$ are the daily averages for the relative bid-ask spread, total dollar depth, ask-side dollar depth and bid-side dollar depth respectively. The dataset used in the regression analysis includes observations from only the REPURCHASE and the SURROUNDING NON-REPURCHASE periods. The day on which a firm implements an open market share repurchase and the following business day on which the firm reports the share repurchase are both included in the definition of a REPURCHASE period. The five trading days before and the five trading days after a REPURCHASE period which by themselves are not days of other REPURCHASE periods are included in the definition of a SURROUNDING NON-REPURCHASE period. Data affected by stock splits, stock dividends and major announcements (e.g., earnings and dividends announcements) are removed from the dataset. Observations from days between October 1, 1997 and October 31, 1998 are excluded due to possible confounding effects of the Asian financial crisis. The variable $DAYZERO_i$ is coded with a value of one if the day is an implementation day of an open market share repurchase, and zero otherwise. The variable $DAYONE_i$ is coded with a value of one if the day is a reporting day (i.e., the day following the implementation day) of a share repurchase, and zero otherwise. Days that are both an implementation day and a reporting day are excluded from the analysis. $Volume_i$, $Price_i$ and $Volatility_i$ are additional control variables introduced to the regression. $Volume_i$ is the total trading volume during the trading day. $Price_i$ is the average of all transaction prices recorded thirty seconds apart over the trading day. $Volatility_i$ measures the variance of returns over the trading day and returns are calculated by taking the logarithms of bid-ask midpoint relatives thirty seconds apart. All non-dummy variables, *Absolute Spread*$_i$, *Relative Spread*$_i$, *Total Depth*$_i$, *Ask Depth*$_i$, *Bid Depth*$_i$, $Volume_i$, $Price_i$ and $Volatility_i$ are transformed by taking natural logarithms. The *t*-statistics are adjusted for arbitrary cross-correlations, serial correlation and heteroskedasticity using Hansen's (1982) generalized method of moments (GMM) with the Newey and West (1987) procedure. Significance is indicated at the 0.05 and 0.01 levels by one and two asterisks respectively and all results are presented on the basis of two-tail significance.

	Absolute Spread		***Relative Spread***		***Total Depth***		***Ask Depth***		***Bid Depth***	
	estimated coefficient	***t*-stat.**	**estimated coefficient**	***t*-stat.**	**estimated coefficient**	***t*-stat.**	**estimated coefficient**	***t*-stat.**	**estimated coefficient**	***t*-stat.**
Intercept	7.9704	15.63 **	8.0361	15.68 **	-2.3401	-3.62 **	-2.6188	-3.66 **	-3.6610	-5.32 **
DAYZERO	0.1045	5.92 **	0.1052	5.94 **	-0.0901	-3.52 **	-0.1001	-3.34 **	-0.0846	-2.78 **
DAYONE	0.0041	0.23	0.0046	0.27	0.0475	1.65	0.0879	2.56 *	0.0027	0.08
Volume	-0.2263	-51.96 **	-0.2261	-51.84 **	0.4259	54.97 **	0.4247	50.28 **	0.4568	51.51 **
Price	0.6617	96.17 **	-0.3372	-49.01 **	0.6551	62.35 **	0.6588	54.58 **	0.6726	57.36 **
Volatility	0.7917	18.52 **	0.7978	18.57 **	-0.7989	-14.96 **	-0.7563	-12.70 **	-0.8125	-14.39 **
Number of observations	3,881		3,881		3,881		3,881		3,881	
Adjusted R^2	0.8210		0.7337		0.7797		0.7222		0.7416	
F-statistic (5, 3,875)	3,560.23 **		2,138.48 **		2,747.25 **		2,018.35 **		2,227.74 **	