Firms as Buyers of Last Resort: Financing Constraints, Stock Returns and Liquidity

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Abstract: We develop a model to explore the effects of firms being buyers of last resort on stock returns and liquidity. Those with more ability to repurchase shares should prices drop far below fundamental value (less financially constrained ones) should have lower short-horizon relative to long-horizon return variance and more positively skewed returns than other firms. Using standard proxies for financing constraints such as past repurchases and firm age, we find strong support for both of these predicted relationships in the U.S. stock market. Consistent with our theory, these relationships are stronger in the U.S. after 1982 when regulatory reforms lowered the legal cost of conducting repurchases; and among the ten largest stock markets in the world, they are stronger in countries where share repurchases are legally easier to execute. Using data on bid-ask spreads and price impact costs, we also find some support for the proposition that firm intervention makes it less risky for other traders to provide liquidity for its stock.

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1. Introduction

In this paper, we explore the idea of firms being buyers of last resort for their own stocks. The phrase "buyers of last resort" is inspired by the vast literature started by Bagehot (1873) on the role of central banks as lenders of last resort for their economies. Just as central banks make funds available to markets in times of crises, a firm can provide liquidity to its investors, when no one else will, by repurchasing shares of its own stock. Such firm intervention can have macroeconomic consequences. For instance, many companies quickly bought back a large fraction of their shares after the stock market crash of 1987. Via the coordination of stock exchanges, a large number of firms also announced repurchase programs immediately after the events of September 11, 2001. These anecdotes suggest that companies were and can be important liquidity providers along side the Federal Reserve Bank.

There is evidence beyond these anecdotes that firms intervene in their stocks when prices move significantly away from fundamental value. First, in a survey by Brav, Graham, Harvey, and Michaely (2004) of 384 CFOs, the most popular response for why firms repurchase stocks (86.6% of those surveyed agree) is that their stock is cheap relative to its true value. Second, other work finds positive abnormal returns for firms conducting repurchases (see Ikenberry, Lakonishok and Vermaelen (1995, 2000)). And third, using large panel datasets, several studies confirm the relative importance of valuation as a motive for this financial decision (see e.g., Dittmar (1999) and Stephens and Weisbach (1998)). There is also a similar set of evidence suggesting that firms issue equity when they perceive their shares to be over-valued (see Baker, Ruback and Wurgler (2004) for a review of this evidence).

We develop a model to explore the effects of firms being buyers of last resort for their stocks. We extend the Grossman and Miller (1988) model to allow firms to intervene in their own stocks when liquidity shocks are big enough.[1] We focus on two predictions for asset prices. First, those with less ability to intervene (either through repurchases or issuances) should prices deviate too far from fundamental value ought to have a higher short-horizon return variance when compared to an appropriately scaled version of long-horizon return variance. Intuitively, firms with low-intervention ability end up with greater deviations of price from fundamental value and hence greater return reversals as liquidity shocks are assumed to mean revert over long enough horizons. Since long-term price variance corresponds to fundamental variance in our model, this means a higher short-horizon relative to long-horizon price variance compared to high-intervention ability firms.

Second, with an additional assumption that intervention is more likely through repurchases than issuances, at least in short-horizons, our model provides a novel rationale for why there is positive skewness in short-horizon returns at the individual firm level. Moreover, our model predicts that those firms with more capacity to repurchase shares quickly after a market crash (e.g. crash of 1987) should have more positively skewed short-horizon (e.g. daily or weekly) returns. The assumption that there is an asymmetry in the likelihood or cost of intervention in the short-run is a plausible one. It probably takes longer to execute issuances than repurchases and managers may care more about falling stock prices in the short-run than rising ones. Hence, our analysis regarding skewness is focused on short-horizon returns.

We test these two predictions by measuring the ability of different firms in the cross-section to be buyers of last resort for their own stocks and relating this to the stock's return variance and skewness. Our basic premise is that the capability of the firm to be the buyer of last resort for its own stock or to intervene more generally depends on the extent to which it

[1] Firms are not in the business of being market makers. They only intervene when the liquidity shocks are sufficiently large. We model this by assuming that firms have a higher cost of participating in the market than other traders.

is financially constrained. In particular, firms that are equity dependent are unlikely to execute repurchases. As such, the main predictions of our model are that more financially constrained firms ought to have a higher ratio of short-horizon to long-horizon return variance and less positively skewed short-horizon returns.

To avoid data-mining biases, we use standard measures of financing constraints from the recent corporate finance literature. In particular, we use the measures advocated by Kaplan and Zingales (1997), Lamont, Polk and Saa-Requejo (2001), Baker, Stein and Wurgler (2003).[2] The first and closest to our theory is stock repurchases (relative to net income) since our model emphasizes the ability of firms to execute share repurchases to counter liquidity shocks. A broader rationale is that since repurchases and investments are competing uses of funds, firms facing severe financing constraints would do less buy backs. Our second measure is firm age, which is based on the premise that younger firms have a harder time getting access to public debt markets.

Corporate-finance considerations also suggest that equity-dependent firms will tend to have high leverage (either market or book), low cash balances and pay less dividends. So our third measure is the Kaplan-Zingales index and various versions of it, which take into account whether a firm is paying dividends, leverage, cash balances, cash flow, and a firm's Tobin's Q (i.e. its market-to-book ratio).[3] Not surprisingly, our three sets of financing constraint measures are quite correlated. Indeed, younger firms and higher KZ index firms are much less likely to execute repurchases, consistent with the premise that financially constrained firms are less likely to intervene in their stocks.

[2] Note that a number of the variables in these three recent papers are used in earlier work on financing constraints such as Gertler and Gilchrist (1994) and Fazzari, Hubbard and Petersen (1988).

[3] As we explain below, firm leverage and market-to-book may be difficult to interpret in certain contexts, so we will end up controlling for these two firm characteristics in some of our regressions below.

Using data from 1963 to 2003, we begin our investigation in the U.S. stock market by using cross-sectional variation to see whether short-horizon return variance (anywhere from daily to annual returns) is higher for financially constrained firms, controlling for long-horizon price variance, which we take to be the variance of three-year returns. Consistent with our model, we find that our measures of financing constraints all come in with the right sign and are statistically and economically significant, regardless of the frequency at which we measure short-horizon return variance. For instance, a two-standard deviation increase in KZ (more financially constrained) leads to an increase in weekly return variance that is anywhere from 30% to 38% of the standard deviation of weekly return variance depending on the version of the KZ index used.

Another test of our model has to do with the prediction regarding positive return skewness for stocks in which the firm is able to execute repurchases. First, it is well known that stocks returns are positively skewed on average, consistent with our model. Second, we also find that a stock's daily and weekly return skewness increase with a number of the same proxies of financing constraints. A two-standard deviation increase in the level of lagged firm repurchases leads to an increase in the positive return skewness of daily returns of the firm that is about 3.8% of the standard deviation of firm return skewness. A similar exercise for firm age leads to about a 5% effect. However, the coefficients in front of KZ indices are not significant. Hence, the findings regarding return skewness are somewhat weaker than for return variances.

We then attempt to rule out a number of alternative hypotheses for these findings. First, we control for firm leverage and proxies for noise trading or sentiment shocks such as the stock's turnover, past returns, market-to-book ratio and size. Hence, these findings are not simply an artifact of financially constrained firms having higher return volatility because of a leverage effect or there being more noise trading in these stocks---i.e. it is about heterogeneity in liquidity shocks as opposed to variation in the ability to intervene. However, it is difficult to rule out all forms of omitted variables with this approach.

As such, we turn to two sources of what can arguably be deemed as exogenous variation to better identify our theory. The first is regulatory reform in the U.S. stock market in 1982 in the form of SEC Rule 10b-18 that encouraged repurchases. While share repurchases had always been legal in the U.S., companies still worried about class-action lawsuits accusing them of manipulating their stock prices with repurchases. The passage of SEC Rule 10b-18 shielded firms from such lawsuits. This law is attributed by many for the rise of share repurchases since (see, e.g., Grullon and Michaely (2002)). Since the price effects arise from firms being able to legally execute repurchases in the first place, our theory suggests that the (cross-sectional) relationships between financing constraints and return variances and skewness ought to be stronger after 1982 when the legal cost of doing repurchases went down. We find that this is indeed the case. The variance result is statistically significant, while the skewness results are a bit mixed in terms of significance.

The second source of variation we use to better identify our theory comes from the cross-section of stock markets around the world. Survey evidence from Kim, Schremper and Varaiya (2004) on stock repurchases across the ten largest stock markets, U.S., Japan, U.K., France, Germany, Canada, Italy, the Netherlands, Switzerland and Hong Kong, indicates that these countries fall naturally into three groups in terms of legal ease of repurchases: easy medium and difficult. Our time period of analysis is 1993-1998. During this period, the easy group comprises of the U.S., U.K. and Canada, and the difficult group comprises of France and Germany (in which repurchases were basically illegal). The other five countries in the medium category are more heavily regulated than the U.S. but repurchases were not illegal during this period. Remarkably, we find, consistent with our theory and following the same logic as for the US regulatory experiment, that the predicted relationships between financing constraints and return volatility and skewness are stronger in the easy group than in the medium group and stronger in the medium group than in the difficult group. Again, the variance result is statistically significant, while the skewness results are a bit mixed in terms of significance.

Having established these effects of financing constraints on stock return variance and skewness, we then explore the implications of firms being buyers of last resort on stock liquidity. That firms can come in and provide liquidity should prices drop too far or rise too much may make it less risky for other liquidity providers to step in before hand.[4] Using data available only for the U.S. stock market, we test this prediction using measures of short-run liquidity such as bid-ask spreads and a price impact measure from the market microstructure literature estimated using intraday data. In implementing these regressions, we have to be aware that there are other important determinants of stock liquidity even in the absence of our proposed mechanism.

But even controlling for a host of these well-known determinants of stock liquidity, we find that firms with a higher ratio of short-horizon return variance relative to fundamental variance and less positively skewed returns have significantly higher bid-ask spreads and price impact costs. For instance, a two-standard deviation increase in weekly return variance controlling for fundamental variance leads to an increase in bid-ask spreads and price impact costs that are about 30% of the standard deviation of bid-ask spreads and about 34% of the standard deviation of price impact costs. Similarly, a two-standard deviation increase in weekly return skewness leads to a decrease in bid-ask spreads that is about 7.5% of the standard deviation of spreads.

[4] One might wonder why we do not directly run a regression of stock liquidity (e.g. spreads) on our financing constraint proxies. The reason is that a firm's capital structure might depend on the stock's liquidity (i.e. firms with more liquid stocks (for whatever reason) may issue more equity and hence use less debt than other firms). As a result, stock liquidity and some of our financing constraint proxies might be related for some obvious reasons giving rise to potential endogeneity concerns.

Our paper is novel in exploring the effects of firm intervention (particularly of firms being buyers-of-last resort for their own stock) on stock returns and liquidity. Our findings further develop the connection between corporate finance (e.g. the financing constraints literature) and asset pricing/market micro-structure (see Stein (1997) and Baker and Wurgler (2002)). Our paper introduces the firm as an important set of traders in the market and is of general interest since the model and implications developed here would seem to apply equally well in other contexts such as the Federal Reserve Bank or the government more generally being lenders-of-last resort for the aggregate market.[5]

Our paper proceeds as follows. We develop a simple model to analyze the effect of firm intervention on stock return variance and skewness in Section 2. We describe the dataset in Section 3 and the main empirical results in Section 4. We consider the auxiliary implications for stock liquidity in Section 5. We conclude in Section 6. All proofs are in the Appendix.

2. Model

In this section, we develop a simple model which captures how a firm's intervention in the market in response to large liquidity shocks affects the liquidity and the price behavior of its own stock. The framework we adopt is similar to that of Grossman and Miller (1988), in which liquidity shocks to a subset of investors give rise to temporary shifts in the demand of a stock. These shifts in demand cause temporary deviations in the stock price, given

[5] One might wonder why we do not extend our model to develop implications for expected returns and relate them to financing constraints. One potential implication is that financing constrained firms have higher expected returns precisely because they are less liquid. There is already a large literature that looks at the relationship between liquidity and expected returns (see, e.g., Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Pastor and Stambaugh (2003)) and some find that more illiquid stocks indeed have higher expected returns. Additional regressions of returns on financing constraints would be difficult to interpret since there are mechanisms other than liquidity through which financing constraints might affect expected returns (e.g. financially constrained firms undertake less of certain kinds of investments, thereby giving the company a different risk profile).

limited market making capacity in the market. When the firm intervenes in the market for its own stock, it effectively serves as a market maker together with the other market makers. Thus, when a firm is less constrained and more willing to act as a market maker, the liquidity for it own stock also increases.

We do not explicitly model the objective of the firm (i.e. the agent running the firm). We are simply assuming the reduced form that the firm intervenes when prices deviate significantly from fundamental value. One justification is that accommodating liquidity shocks can sometimes be a profitable line of business because of frictions outlined in Grossman in Miller (1988). Suppose investors are heterogeneous in facing liquidity shocks. If some investors want to cash out for liquidity reasons, other existing investors (the firm) can provide liquidity by buying their shares if there are not enough market makers around.[6]

2.1 Set-up

Suppose there are three dates: $t = 0,1,2$. A stock is traded in a competitive market, whose cash flow is $\tilde{v}_t$ at $t = 1,2$ and $\tilde{v}_t$ is an i.i.d. normal random variable with a mean of zero and a variance of σ_v^2. At $t = 1$, $\tilde{x}$ shares of the stock is dumped into the market by a set of investors for liquidity reasons, where $\tilde{x}$ is a normal random variable with a mean of zero and a variance of σ_x^2 .

There is a set of market makers in the market who can absorb the liquidity shock. For now we assume that their population is μ and their risk tolerance is τ. The total risk tolerance of market makers is $\tau_M = \mu\tau$.[7] Moreover, the firm can also intervene in the market of its own shares when short-term liquidity shocks move the price of the stock far

[6] Another justification is based on agency in which the manager gets compensated for a high stock price and counters liquidity shocks so that the stock price more accurately reflects his ability (i.e. fundamentals). See Stein (1997) and Baker, Ruback and Wurgler (2004) for additional justifications.

[7] These market makers are needed to set the price under normal circumstances when the firm is not intervening.

away from its fundamental value. In deciding on its intervention policy, the firm has an effective risk tolerance of τ_F and faces a cost to intervene. For convenience, we assume that both the market makers and the firm are endowed with no shares of the stock.[8]

Let θ_F denote the position the firm takes in the stock market to moderate its share price. We assume that the intervention cost is linear in the size of the position:

$$c(\theta_F) = \begin{cases} \kappa_+ |\theta_F|, & \theta_F > 0 \\ 0, & \theta_F = 0 \\ \kappa_- |\theta_F|, & \theta_F < 0 \end{cases} . \tag{1}$$

The intervention cost assumed above is intended to capture several characteristics of a firm's intervention behavior. First, the cost to intervene prevents the firm from trading its own shares at all times. Instead, it intervenes only when price deviations caused by the liquidity shock is sufficiently large. Second, the threshold and the strength of the intervention may both depend on the firm's ability to adjust its financial position. In the case of share repurchase, for example, the firm's ability to intervene in the market clearly depends on how constrained it is in amassing the funds needed. In the case of seasoned equity issues, its ability depends on the cost to issue new equity. The linear form of the cost function makes the cost dependent on the size of the intervention.

The proportionality coefficients, κ_+ and κ_-, reflect the firm's ability to intervene. Moreover, the cost coefficient is in general different between share repurchases and sales, reflecting the fact that constraints and costs can be asymmetric between these two operations.

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[8] It may seem artificial to assume that the firm has zero shares of its own stock. Other than simplicity, the motivation for such an assumption is as follows. A firm's intervention in the market is an activity separate from its usual business operations. Thus, it may treat it separately when considering its merit, in particular, its risk-return trade-off. Our results do not depend on this simplifying assumption.

In particular, we will assume that $\kappa_{-} > \kappa_{+}$. That is, other things equal, it is easier for the firm to repurchase its shares from the market than issuing new shares.

In the remainder of the paper, we will further assume that $\kappa_{-} = \infty$. Thus, the firm's intervention only takes the form of share repurchase. Also, we set $\tau_F = \infty$, i.e., the firm is risk neutral. These two assumptions help to simplify the analysis, but are not critical to the results. To simplify notation, we let $\kappa = \kappa_{+}$.

2.2 Equilibrium and Price Behavior

We now consider the market equilibrium in the simple model described above and the resulting stock price. Let $\widetilde{P}_t$ denote the stock price at t, after payoff $\widetilde{v}_t$, $t = 0, 1, 2$. No arbitrage insures that the stock price at $t = 2$ is simply 0, i.e., $\widetilde{P}_2 = 0$. At $t = 1$, there is a liquidity shock $\widetilde{x}$. Both the market makers and the firm will attempt to accommodate the liquidity shock. Their desire to provide liquidity depends on three factors, the expected payoff when they unload the position in the future, the current price of the stock and their risk tolerance. By assuming that the payoff next period is $\widetilde{v}_2$, we are effectively assuming that the liquidity providers can unload their positions at $\widetilde{v}_2$. The uncertainty in $\widetilde{v}_2$ reflects the risk they have to bear to make the market.

Theorem 1: At $t = 1$, the equilibrium stock price is

$$\widetilde{P}_1 \quad = \quad -\left(\sigma_v^2/\tau_M\right)\min\left(\widetilde{x},\ x^*\right), \tag{2}$$

where $x^* = (\tau_M / \sigma_v^2)\kappa \geq 0$. At $t = 0$, the equilibrium stock price is given by

$$P_0 = \mathbf{E}_0\left[\ \widetilde{P}_1 e^{-\widetilde{P}_1^2/2}\right] / \left\{\mathbf{E}_0\left[e^{-\widetilde{P}_1^2/2}\right]\right\}. \tag{3}$$

From the solution to the equilibrium, we observe the following. In absence of any liquidity shock, the stock price at $t=1$ is also zero, which reflects the fundamental value of the stock. Note that the expected payoff of the stock is assumed to be zero. Although the realized payoff is risky, market makers and the firm bear no risk in absence of any liquidity shocks since their holdings are zero. Consequently, the price of the stock is also zero. When there is a liquidity shock, however, market makers and the firm have to bear the risk of the stock if they accommodate the order. Naturally, the price has to adjust to compensate them for the risk. The price adjustment depends on the risk of the stock σ_v^2 , the size of the order $\tilde{x}$ and the overall risk tolerance of the market.[9]

When the liquidity shock $\tilde{x}$ is smaller than x^*, the firm does not intervene and the liquidity shock is fully absorbed by market makers. The price is determined by their risk tolerance. Although the stock price deviates from its fundamental, the size of the deviation, given by $-(\sigma_v^2/\tau_M)\tilde{x}$, is not large enough to trigger the firm to intervene. When the liquidity shock $\tilde{x}$ is larger than x^*, however, the price deviation becomes sufficiently large for the firm to step in. Given that the firm is assumed to be risk neutral, it will absorb the liquidity shock alone and the deviation of the stock price from its fundamental is limited at the threshold level $-(\sigma_v^2/\tau_M)x^*$. The maximum deviation is determined by κ , the firm's intervention cost.

Given the equilibrium price process, we obtain several properties of the stock's returns. For simplicity, we consider the dollar returns on the stock:

[9] Please see, among others, Campbell, Grossman and Wang (1993) and Grossman and Miller (1988) for a more elaborate analysis of this.

$$\tilde{r}_t \equiv \tilde{v}_t + \tilde{P}_t - \tilde{P}_{t-1}, \tag{4}$$

where $t = 1,2$. Let $\sigma^2(n)$ denote the stock return variance over n periods, where $n = 1,2$. Thus, we have $\sigma^2(1) = \mathbf{Var}[\tilde{r}_1] = \mathbf{Var}[\tilde{r}_2]$ and $\sigma^2(2) = \mathbf{Var}[\tilde{r}_1 + \tilde{r}_2]$. We can then define the variance ratio by

$$\gamma \equiv \frac{2\sigma^2(1)}{\sigma^2(2)} \tag{6}$$

which is the ratio between the variances of short- and long-horizon returns, properly adjusted for the horizon. It is easy to show that this variance ratio is greater than one and increases in κ.

Proposition 1: Short-horizon return variance is greater than long-horizon or fundamental variance. Controlling for long-horizon or fundamental variance, short-horizon return variance increases with the cost of intervention κ (i.e. financing constraint).

The fact that short-horizon returns are more volatile than long-horizon returns implies that stock returns exhibit negative autocorrelation. Indeed, we have

$$\rho \equiv \frac{\mathbf{Cov}[\tilde{r}_1, \tilde{r}_2]}{\sqrt{\mathbf{Var}[\tilde{r}_1]}\sqrt{\mathbf{Var}[\tilde{r}_2]}} = -\frac{\mathbf{Var}[\tilde{P}_1]}{\sigma_v^{\ 2} + \mathbf{Var}[\tilde{P}_1]} \leq 0 \tag{7}$$

Moreover, the magnitude of the serial correlation increases with the firm's intervention cost κ. Firms with lower intervention cost are likely to participate in the market to support its share price. As a result, we will see less deviation in its stock price from its fundamentals in response to liquidity shocks. The stock returns will exhibit less negative serial correlation.[10]

[10] Several authors have suggested that the magnitude of the negative serial correlation provides a measure of liquidity in the market (see, for example, Campbell, Grossman and Wang (1993) and Pastor and Stambaugh (2004)).

Let s denote the skewness of the stock return:

$$s \equiv \mathbf{E}\left[\left(\tilde{r}_1 - \mathbf{E}[\tilde{r}_1]\right)^3\right]. \tag{5}$$

We have the following result:

Proposition 2: For large κ, return skewness s is positive and decreases with κ.

Our empirical analysis below assumes that intervention costs are indeed large. We think this is a reasonable assumption since firms are not in the business of being liquidity providers.

3. Data

Our data on U.S. firms come from the Center for Research in Security Prices (CRSP) and COMPUSTAT. From CRSP, we obtain daily closing stock prices, daily shares outstanding, daily dollar trading volume, and daily closing bid-ask spreads for NYSE, AMEX and NASDAQ stocks. From COMPUSTAT, we obtain annual information on a variety of accounting variables. To be included in our sample, a firm must first have the requisite financial data on CRSP and COMPUSTAT. We follow other studies of the U.S. market using market-to-book ratios in excluding firms with one-digit SIC codes of 6, which are in the financial-services industry.

Our data on firms for the other nine countries come from the COMPUSTAT GLOBAL database, which begins in 1993. From this database, we obtain monthly closing prices, dividends, shares outstanding and trading volume, which only allow us to calculate variables such as return variances and skewness at monthly or lower frequencies. Moreover, we are only able to obtain a subset of the accounting variables that are available in the U.S. Namely, this database does not have information on stock repurchases nor are we able to obtain firm age. Fortunately, we do have enough data to construct various versions of the Kaplan-Zingales index of financing constraints.

A. Return Variance and Skewness Measures

For each year, we begin in the U.S. stock market by calculating for each stock the variance of 3-year log returns using overlapping six-year windows. For instance, firm i's 3-year return variance in 1963 (the first year for this variable) is calculated using annual data from 1963 to 1968. Using four three-year over-lapping returns (i.e. the log return from the beginning of 1963 to the end of 1965, the return from the beginning of 1964 to the end of 1966, and so forth), we calculate this 3-year return variance and annualize it by dividing it by three. This variable is denoted by $TVAR_{it}$. Firm i's 3-year return variance in 1964 is calculated with the same procedure using data from 1964 to 1969, and so forth for all the other years in our sample. The last year that we can calculate TVAR is 1998 since our dataset ends in 2003.

For each observation of TVAR, we then calculate the corresponding shorter horizon return variances. For instance, for firm i in 1963, we calculate the variance of daily returns (denoted by $DVAR_{it}$), weekly returns (denoted by $WVAR_{it}$), monthly returns ($MVAR_{it}$), quarterly returns (denoted by $QVAR_{it}$), semi-annual returns (denoted by $SVAR_{it}$) and annual returns (denoted by $AVAR_{it}$) using data from 1963 to 1968---all these variances are calculated using non-overlapping returns and are annualized. We repeat the same procedure for 1964 using data from 1964 to 1969 and so forth for all the other years in the sample.

Our measure of daily return skewness, which we denote $DSKEW_{it}$, is calculated by taking the sample analog to the third moment of daily (raw) returns, and dividing it by the sample analog to the standard deviation of daily returns raised to the third power. Thus for any stock i in year t, we have:

$$\text{DSKEW}_{it} = \left(n\,(n-1)^{3/2}\sum R_{it}^{\;3}\right) \Big/ \left((n-1)(n-2)\left(\sum R_{it}^{\;2}\right)^{3/2}\right) \qquad (8)$$

where R_{it} represents the sequence of demeaned daily returns to stock i during period t, and n is the number of observations on daily returns during the period. These daily "returns" are, more precisely, actually log changes in price and dividends. We use log changes as opposed to simple daily percentage returns because they allow for a natural benchmark—if stock returns were lognormally distributed, then an DSKEW measure based on log changes should have a mean of zero. Scaling the raw third moment by the standard deviation cubed allows for comparisons across stocks with different variances; this is the usual normalization for skewness statistics.[11]

In addition to DSKEW, we calculate the skewness in weekly returns for each stock i in each year t the same skewness definition as in (8) (denoted by WSKEW_{it}). A similar calculation using twelve monthly returns and four quarterly returns in year t yields the skewness in monthly and quarterly returns (denoted by MSKEW_{it} and QSKEW_{it}, respectively).

For the other nine markets during the period of 1993-2003, we calculate the same individual stock return variance and skewness measures, except that we are unable to calculate any daily or weekly numbers.

B. Financing Constraint Proxies

Our financial constraint proxies for U.S. companies are the following. The first financing constraint proxy is REPURCHASE, a firm's repurchases divided by net income (Item 115 minus preferred stock reduction all divided by Item 172). Our second financing constraint proxy is AGE---the number of years a stock has price data in CRSP.

[11] See, e.g., Greene (1993).

Our third financing constraint proxy is the KZ index. Following Lamont, Polk and Saa-Requejo (2001) and Baker, Stein and Wurgler (2002), we construct the five-variable KZ index for each firm-year as the following linear combination:

$$KZ_{it} = -1.002\ CF_{it}/A_{it-1} - 39.368\ DIV_{it}/A_{it-1} - 1.315\ C_{it}/A_{it-1} + 3.139\ BLEV_{it} + 0.283\ Q_{it} \quad (9)$$

where CF_{it}/A_{it-1} is cash flow (Item 14+Item 18) over lagged assets (Item 6); DIV_{it}/A_{it-1} is cash dividends (Item 21+Item 19) over assets; C_{it}/A_{it-1} is cash balances (Item 1) over start-of-the-year book assets (Item 6); book leverage, denoted by $BLEV_{it}$, which is total debt divided by the sum of total debt and book equity ((Item 9+Item 34)/(Item 9+Item 34+Item 216))---this is measured at fiscal year-end; and Tobin's Q is the market value of equity (price times shares outstanding from CRSP) plus assets minus the book value of equity (Item 60+Item 74) all over assets. We winsorize the ingredients of the index before constructing it.

We also use a modified version of the KZ index that differs from the original score in that it excludes a measure of leverage and Tobin's Q:

$$KZ3_{it} = -1.002\ CF_{it}/A_{it-1} - 39.368\ DIV_{it}/A_{it-1} - 1.315\ C_{it}/A_{it-1} \quad (10)$$

We use KZ3 because highly levered firms may have higher short-horizon volatility relative to fundamental volatility if leverage ratios change in a particular manner over time and Q may proxy for both investment opportunities and mis-pricing. To the extent that we want to rule out alternative explanations related to mechanical leverage effects and mispricing, we will drop leverage and Q from the KZ index.[12] We view the use of these proxies as simply an

[12] A word of warning regarding cash and leverage as proxies for financing constraints is that constrained firms should endogenously try to save more cash (see Almeida, Campello and Weisbach (2004)) and

effort to restrict ourselves to these previously nominated variables, so as to avoid data mining.

For international companies, the corresponding data item numbers from COMPUSTAT GLOBAL are the following. CF_{it}/A_{it-1} is cash flow (Item 11+Item 32) over lagged assets (Item 89); DIV_{it}/A_{it-1} is cash dividends (Item 36+Item 35) over assets; C_{it}/A_{it-1} is cash balances (Item 60) over start-of-the-year book assets (Item 89); book leverage, denoted by $BLEV_{it}$, is ((Item 106+Item 94)/(Item 106+Item 94+Item 135; and Tobin's Q is the average market cap plus assets minus the book value of equity (Item 146+Item 105) all over assets.

B. Liquidity Measures

In addition, we will also use two other standard proxies for liquidity, which are available only for the U.S. stock market. The first is bid-ask spreads obtained from CRSP, which is available mostly for Nasdaq stocks. Our variable $PSPREAD_{it}$ is simply the average over the year of the ratio of daily closing bid-ask spreads to the bid-ask mid point. In addition, we obtain from Piqueira (2004) monthly estimates of price impact for each stock, using the Trade and Quote Database (TAQ) for the period of January 1993 to December 2002. The estimates of price impact or cost of trading use the Glosten and Harris (1988) model, which is widely used in the market microstructure literature. Many consider this price impact cost to be a superior measure of the liquidity of a stock when compared to the bid-ask spread. One reason is that the bid-ask spread may overstate the cost of trading since many trades are executed within the spread. Hence, the price impact cost derived from actual trade data gives us a more accurate gauge of actual trading costs faced by traders. We refer the

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perhaps save some debt capacity for the future (thus having lower leverage). Almeida, Campello and Weisbach (2004) show that the KZ index, which loads heavily on cash and leverage, might sort firms cross-sectionally in an unintuitive way. Hence, we want to also rely on other, perhaps more exogenous, proxies such as firm age to make inferences.

reader to Piqueira (2004) for more details on these estimates. We create a variable $PIMPACT_{it}$ which is the average of these monthly price impact measures---these measures are scaled by stock price just like our spread variable.

C. Other Variables

The other variables that we use are very familiar and do not merit much discussion. $LOGSIZE_{it}$ is the log of firm i's average daily stock-market capitalization in year t. $TURNOVER_{it}$ is the average daily share turnover in stock i—defined as shares traded divided by shares outstanding—over year t. RET_{it} is the average monthly return on stock i, also measured over the 12-month period t. $LOGMB_{it}$ is the log of firm i's average market cap during year t divided by its book value in year t. We also use market leverage which is denoted by $MLEV_{it}$, which is the same as BLEV except that we replace Item 216 with a firm's market capitalization (which is the average of the market capitalization for that calendar year). VOL_{it} is just the volatility of daily (simple, raw) returns in year t. We can calculate these variables for U.S. and international companies.

In addition, we will utilize a number of other firm characteristics for U.S. companies that might be related to stock liquidity. The first is institutional ownership (IO_{it}), which is the fraction of the shares of a company held by institutions (from the Thomson Financial database's 13-F filings). The second is $LOGCOVER_{it}$ is the log of one plus the number of analysts (from the I/B/E/S database) covering firm i at the end of period t. The third is idiosyncratic volatility ($IDIOVOL_{it}$), which is just the volatility of stock returns net of the market return (use daily returns during the year).

D. Summary Statistics

The summary statistics for the variables used in the financing constraints related regressions are presented in Table 1. We report the time series average of cross-sectional means and standard deviations. We start with the statistics for the U.S. stock market and then report the analogous numbers for the other countries in turn. We first present the statistics for annualized return variances at different horizons. Notice that the mean return variances decreases monotonically with horizon (from daily to three-year returns). The mean of DVAR is 0.2284, which corresponds to an annualized daily volatility of about 47%. In contrast, the mean of TVAR is 0.0797, which corresponds to an annualized three-year return volatility of about 28%. In other words, annualized three-year price volatility is nearly half that of daily volatility, indicating substantial mean reversion in returns at long-horizons. The numbers for the other nine countries are similar in magnitude.

We next present the summary statistics for return skewness. Recall that skewness is calculated using log price changes so that the benchmark assuming stocks returns are lognormally distributed should be zero. Observe that stock returns are positively skewed on average in the U.S., with the degree of positive skewness decreasing towards zero as we move to longer-horizons. This is consistent with findings in existing studies (see, e.g., Chen, Hong and Stein (2001)). Again, the summary statistics for the other countries are similar in magnitude. We then present the summary statistics for our financing constraint proxies. We have checked that these statistics are similar to those found in other studies such as Baker, Stein and Wurgler (2003). Finally, we present the summary statistics for the other variables.

In Panel B of Table 1, we present the variables for the liquidity regressions for the U.S. stock market. We report the summary statistics two sub-samples, the 1983-2003 period for the bid-ask spread regressions and the 1993-2003 period when the price impact measure is available. Since we will not be working with the financing constraint proxies for this sub-period, we do not report those here. The mean of the PSPREAD variable 0.0408, which means that bid-ask spread is about 4% of price during this period. We also report summary statistics for IO (institutional ownership), LOGCOVER (log of analyst coverage) and IDIOVOL (idiosyncratic volatility), which are only available starting in the eighties. In the next two columns, we report a similar set of summary statistics, except that we now report the mean and standard deviation for PIMPACT instead of PSPREAD.

E. Correlatedness of Financing Constraint Proxies and Likelihood of Initiating Repurchase Programs

Before turning to our main results, we briefly analyze the relationship between our financing constraint proxies in Table 2. In Panel A, we calculate the contemporaneous correlation between the various proxies in a given year. We find that older firms and firms with lower values of KZ (less constrained) are more likely to conduct repurchases and older firms are more likely to have lower KZ scores. In other words, these financing constraint proxies are correlated. In Panel B, we focus on what determines (predicts) whether a firm executes repurchases. While this issue has been covered in previous papers, we just want to point out that one can predict repurchases using firm age and the KZ index. To this end, we gather additional data on which firms initiate a stock buy-back program in a given year from the SDC Database, which reports for each year the firms that have obtained authorization from their board to initiate repurchases. The SDC data spans the period of 1993-2003. The variable $REPINITIATE_{i,t}$ equals one if a firm i initiates a repurchase program in year t and zero otherwise. About 6.5% of firms in a given year initiate a new repurchase program. Importantly, we find in Panel B that younger firms are less likely to initiate a repurchase program as are higher KZ index value firms. The results are similar when we use REPURCHASE (repurchases in a year as a fraction of net income) in Panel C. These findings are consistent with the idea that financially constrained firms are less likely to execute repurchases.

4. Empirical Results

A. Return Variance and Financing Constraints, U.S. Stock Market

We begin by looking at whether financially constrained firms have a higher short-horizon return variance relative to long-horizon return variance (Proposition 1). To this end, we will implement the following cross-sectional regression specification:

$$STVAR_{it} = a_{0t} + a_{1t}*CONSTRAINT_{it-1} + a_{2t}*TVAR_{it} + a_{3t}\ LOGSIZE_{it-1} + a_{4t}*MLEV_{it-1} + a_{5t}*LOGMB_{it-1} + a_{6t}*RET_{it-1} + a_{7t}*TURNOVER_{it-1} + INDUSTRYDUMMIES_{it-1} + \varepsilon_{it}\ , \quad i=1,\ldots,N \qquad (11)$$

where $STVAR_{it}$ is short-horizon return variance (including DVAR, WVAR, QVAR, SVAR, AVAR), and CONSTRAINT is a proxy for the degree to which a firm is financing constrained (including REPURCHASE, AGE, KZ3 and KZ). Here, ε_{it} again stands for a generic error term that is uncorrelated with all other independent variables. The coefficient of interest is a_{1t}, which captures the relationship between financing constraints and short-horizon return variance controlling for the firm's long-horizon return variance and a host of other firm characteristics (LOGSIZE, MLEV, LOGMB, RET, TURNOVER and INDUSTRYDUMMIES).[13] We then take the estimates from these annual regressions and follow Fama and MacBeth (1973) in taking their time series means and standard deviations to form our overall estimates of the effects of financing constraints on the short-horizon return variance.[14]

Notice that we include MLEV and LOGMB as control variables in equation (11). While these two variables are thought of as financing constraint proxies in their own right,

[13] The industry dummies use the Fama and French (1997) 48 industry classification.
[14] Instead of having TVAR on the right hand side, one could have one of the short-term variances, e.g. look at how the ratio of DVAR (daily variance) to WVAR (weekly variance) varies with financing constraints. We do not expect to find much since this ratio is close to one to begin with and firms do not intervene at such short horizons. We have run these alternate regressions and found as expected little effect of financing constraints in this set-up.

they may also affect short-horizon return variance for other reasons. For instance, highly-levered firms may have a higher short-horizon return variance relative to its long-term counterpart if a firm's debt-to-equity ratio declines over time. And high market-to-book companies may be more volatile because they are growth stocks. As a result, we take the conservative stance in seeing to what extent our financing constraint proxies hold up even after controlling for firm leverage and market-to-book. In addition, we include a firm's size, past returns and past turnover as control variables. These variables are meant to pick up potential differences in investor sentiment across firms.

The results are presented in Table 3. The dependent variable in Panel A is DVAR, the variance of daily returns. In column (1), the measure of financing constraint is REPURCHASE. Notice that the coefficient in front of REPURCHASE is negative (-0.0110 with a t-statistic of 2.89), which is consistent with our model. A two-standard deviation increase in REPURCHASE leads to a decline in short-horizon return variance of -0.006 (-0.011x2x0.2787), which is 2.4% (-0.006/.2585) of the cross-section standard deviation of short-horizon return variance.

Notice that the coefficients on the control variables all come in with expected signs (see Chen, Hong and Stein (2001)). DVAR increases with higher fundamental variance TVAR, firm leverage MLEV, firm market-to-book LOGMB and stock turnover TURNOVER and decreases with LOGSIZE and RET. The coefficients in front of these variables are all statistically significant, except for the one in front of TURNOVER. These coefficients do not change much as we utilize different financing constraint proxies in columns (2)-(4). The only things to note are that the coefficient in front of MLEV is no longer significant when we use the KZ indices as financing constraint proxies and that the coefficient in front of TURNOVER increases in economic magnitude when we use these other proxies.

In column (2), we consider our second financing constraint proxy, firm age. The coefficient in front of AGE is negative and statistically significant. A two-standard deviation increase in firm age lowers DVAR by about 3.2% as a fraction of the standard deviation of DVAR. In columns (3)-(4), we consider various permutations of the KZ index in explaining DVAR. The coefficients in front of KZ3 and KZ are all positive and statistically significant---higher KZ index firms, which are more financially constrained, end up with higher return variance. A two-standard deviation increase in KZ3 leads to an increase in DVAR that is 22% of the standard deviation of DVAR. The implied magnitude for KZ is even higher at about 28%.

In Panel B, we re-run the same regressions but consider return variances at different horizons, from weekly return variance to annual return variance. We only report the coefficient in front of the financing constraint variables for brevity. Notice that the signs in front of all the financing constraints all go the right way and the coefficients in front of financing constraint proxies are almost always significant. The one exception is for AVAR in column (1) where REPURCHASE has the right sign but attracts only a t-stat of 1.24.

Finally, a straightforward calculation of economic significance in Panels B indicates that the economic magnitudes are roughly similar to that of Panel A. We obtain the largest results for weekly return variance. The implied economic magnitude is 3.7% for REPURCHASE, 6.3% for AGE, 30.2% for KZ3 and 38.2% for KZ. We obtain the smallest results for annual return variance. The implied economic magnitude for REPURCHASE is about 1%, for AGE 3.4% for KZ3 13.2% and for KZ 16.5%. In sum, the results in Table 3 strongly support the first prediction of our model that more financially constrained firms end up with higher short-horizon return variance relative to fundamental variance.

B. Return Skewness and Financing Constraints, U.S. Stock Market

We next look at whether financially constrained firms also have less positively skewed returns (Proposition 2). To this end, we will implement the following cross-sectional regression specification:

$$SKEW_{it} = b_{0t} + b_{1t}*CONSTRAINT_{it-1} + b_{2t}*LOGSIZE_{it-1} + b_{3t}\ MLEV_{it-1} + b_{4t}*VOL_{it-1} + b_{5t}*LOGMB_{it-1} + b_{6t}*RET_{it-1} + b_{7t}*TURNOVER_{it-1} + INDUSTRYDUMMIES_{it-1} + \varepsilon_{it},$$

$$i=1,\ldots,N \qquad (12)$$

where $SKEW_{it}$ is short-horizon return skewness (including DSKEW, WSKEW, MSKEW and QSKEW), and CONSTRAINT is a proxy for the degree to which a firm is financing constrained (including REPURCHASE, AGE, KZ3 and KZ). Here, ε_{it} again stands for a generic error term that is uncorrelated with all other independent variables. The coefficient of interest is b_{1t}, which captures the relationship between financing constraints and return skewness controlling for the firm's volatility (VOL) and a host of other firm characteristics (MLEV, LOGSIZE, LOGMB, RET, TURNOVER and INDUSTRYDUMMIES). The specification in (12) is similar to that of Chen, Hong and Stein (2001) except for the financing constraint proxies. We then take the estimates from these annual regressions and follow Fama and MacBeth (1973) in taking their time series means and standard deviations to form our overall estimates of the effects of financing constraints on short-horizon return skewness.

The results are presented in Table 4. The dependent variable in Panel A is DSKEW, the skewness of daily returns. In column (1), the measure of financing constraint is REPURCHASE. The coefficient in front of REPURCHASE is of the right sign (0.0782) and statistically significant (with a t-statistic of 2.73). A two-standard deviation movement in

REPURCHASE leads to an increase in firm return skewness that is 3.8% of the standard deviation of DSKEW.

Moreover, the coefficients on the control variables all come in with expected signs as found in Chen, Hong and Stein (2001). DSKEW increases with volatility (VOL) and decreases with firm market-to-book LOGMB, past returns RET and stock turnover TURNOVER. Interestingly, firm leverage MLEV leads to more negative return skewness. Up until this point, we have treated MLEV as a control variable for fear of alternative interpretations for short-horizon return variance. However, this is much less of an issue when it comes to return skewness. To the extent we are willing to treat MLEV as a proxy for financing constraint, we find supporting evidence for Proposition 2.

In column (2), we consider our second financing constraint proxy, firm age. The coefficient in front of AGE is positive and statistically significant. A two-standard deviation increase in firm age increases DSKEW by about 5% as a fraction of the standard deviation of DSKEW. However, in column (3)-(4), we consider various permutations of the KZ index in explaining DSKEW and find that neither is significant. In sum, there is some evidence in support of Proposition 2, though it is somewhat weaker than for Proposition 1.

In Panel B, we re-run the same regressions but consider return skewness at different horizons, from weekly skewness to quarterly skewness. Again, we only report the coefficient in front of the financing constraint proxy for brevity. Notice that the results for weekly return skewness in Panel B are similar to those for daily return skewness in Panel A, though the economic magnitudes are slightly weaker. The effects of financing constraints on return skewness all but disappear when we move to the monthly and quarterly horizons, confirming our initial premise to focus on very short-horizons.

C. Relationships between Financing Constraints and Variances and Skewness, US Stock Market Before and After Regulatory Reforms of 1982

We now turn to the first of our two sources of what can arguably be deemed as exogenous variation to better identify our theory: the major regulatory reform in the U.S. stock market in 1982 that encouraged repurchases. While share repurchases had always been legal in the U.S., companies still worried about class-action lawsuits accusing them of manipulating their stock prices with repurchases. The passage of the SEC 10b-18 in 1982 shielded firms from such lawsuits. This law is attributed by many for the rise of share repurchases since (see, e.g., Grullon and Michaely (2002)). Since the price effects arise from firms being able to legally execute repurchases in the first place, our theory suggests that the (cross-sectional) relationships between financing constraints and return variances and skewness ought to be stronger after 1982 when the legal cost of doing repurchases went down.

To see if this is the case, we take the regression coefficients in front of CONSTRAINT from the annual Fama-MacBeth regressions in Tables 3 and 4 and regress these coefficients on a constant and a dummy variable AFTER82 that equals 1 if the year is after 1982 and zero otherwise. Since higher values of REPURCHASE and AGE should lead to lower variance, we expect that the coefficients in front of these two variables should become more negative after 1982. Since higher values of KZ index should lead to higher variance, we expect the coefficients in front of KZ3 and KZ to become more positive after 1992.

The results are presented in Table 5. In Panel A, we report the results for the variance regressions. We first report the results for the DVAR regressions, then WVAR, then MVAR and so on until AVAR. Notice that for REPURCHASE, the coefficient in front of AFTER82 is negative as predicted for each of these variance regressions. In each case except for the DVAR regressions, the coefficient in front of AFTER82 is statistically significant. Moreover, the economic difference is large. For instance, for the QVAR to

AVAR regression, most of the effect is coming from after 1982. Importantly, the results are similar for AGE, KZ3 and KZ, though the statistical significance is somewhat weaker for KZ3 and KZ.

In Panel B, we report the results for the skewness regressions; SKEW, WSKEW, MSKEW and QSKEW. The results for these regressions are a bit mixed to start with, as only AGE is coming in significantly in the regressions in Table 4. Hence, we do not expect the AFTER82 variable to come in except for AGE. As expected, the results for REPURCHASE, KZ3 and KZ are very mixed, with no consistency in signs across the different skewness regressions. However, AGE does come in with the expected positive sign for AFTER82---the effect of AGE on skewness is bigger after 1982 than before.

D. International Evidence

We next examine the second source of variation associated with the variation in the legal ease of repurchases across countries. Survey evidence from Kim, Schremper and Varaiya (2004) on stock repurchases across the ten largest stock markets, U.S., Japan, U.K., France, Germany, Canada, Italy, the Netherlands, Switzerland and Hong Kong, suggest that these countries can be placed into three groups in terms of legal ease of repurchases: easy medium and difficult. During the period of 1993-1998, the sample of our analysis, the easy group comprises of the U.S., U.K. and Canada, and the difficult group comprises of France and Germany (in which repurchases were basically illegal).[15] The other five countries in the medium category are more heavily regulated than the U.S. but repurchases were not illegal during this period.[16]

[15] Share repurchases were illegal in France and Germany until 1998, whereas share repurchases have been legal in US, UK and Canada for a long period of time.
[16] Share repurchases became legal in Japan in 1994, in Switzerland in 1992, in Hong Kong in 1991and as for Italy and the Netherlands, share repurchases were legal by the early nineties.

Using the same logic as for the regulatory reforms in the U.S., our theory suggests that the predicted relationships between financing constraints and return volatility and skewness are stronger in the easy to repurchase group than in the medium difficulty group and stronger in the medium group than in the difficult to repurchase group. To test this prediction, we run a pooled regression of the ten countries in our sample analogous to those in Tables 3 and 4. In running this pooled regression, we allow the effect of each of the control variables to vary by country and the effect of the financing constraint to vary by our three groups of countries.

The regression specification is the following:

$$STVAR_{it} \text{ (or } SKEW_{it}) = (d_1*US_i + d_2*CN_i + d_3*UK_i + \ldots + d_{10}*HK_i) + c_1*CONSTRAINT_{it-1}*EASY_i + c_2*CONSTRAINT_{it-1}*MEDIUM_i + c_3*CONSTRAINT_{it-1}*DIFFICULT_i + TVAR_{it}*(e_1*US_i + e_2*CN_i + e_3*UK_i + \ldots + e_{10}*HK_i) + LOGSIZE_{it-1}*(f_1*US_i + f_2*CN_i + f_3*UK_i + \ldots + f_{10}*HK_i) + MLEV_{it-1}*(g_1*US_i + g_2*CN_i + g_3*UK_i + \ldots + g_{10}*HK_i) + LOGMB_{it-1}*(h_1*US_i + h_2*CN_i + h_3*UK_i + \ldots + h_{10}*HK_i) + RET_{it-1}*(k_1*US_i + k_2*CN_i + k_3*UK_i + \ldots + k_{10}*HKi) + TURNOVER_{it-1}*(m_1*US_i + m_2*CN_i + m_3*UK_i + \ldots + m_{10}*HK_i) + \varepsilon_{it}, \qquad (13)$$

where STVAR is one of the short-term variance measures, US, CN, UK, …, HK are country dummies, CONSTRAINT is either KZ3 or KZ, EASY equals 1 when the country is US, Canada or UK and zero otherwise, MEDIUM equals 1 when the country is Japan, Italy, Switzerland, Netherlands or Hong Kong and zero otherwise, DIFFICULT equals 1 when the country is Germany or France and zero otherwise. The remaining variables are the same as from the regressions in Tables 3 and 4.[17] The t-statistics are Newey-West (1987), though we have also clustered standard errors at the country level and found similar results.

The coefficients for CONSTRAINT*EASY (c_1), CONSTRAINT*MEDIUM (c_2) and CONSTRAINT*DIFFICULT (c_3) measure the effect of the various financing constraint variables on variance and skewness for each of these three groups. We then test that the coefficient in front of CONSTRAINT*EASY is greater than the coefficient in front of CONSTRAINT*MEDIUM, which is greater than the coefficient in front of CONSTRAINT*DIFFICULT.

The results are reported in Table 6. Panel A reports the results for variances and skewness. Lets start with the variances in the first four columns. Notice that for MVAR, QVAR, SVAR and AVAR, the effect of constraints on variance is larger in the easy group than the medium group and larger in the medium group than the difficult group. The results are not only economically large but statistically significant. For instance, the coefficient for MVAR on EASYxKZ3 is 0.0229 compared to 0.0124 for MEDIUMxKZ3 compared to -0.0236 for DIFFICULTxKZ3. This ordering is consistent for the other measures of variances. In Panel C below, we find that this ordering is in fact statistically significant. In columns (5)-(6), we find that results for skewness are mixed. For QSKEW, we find, as predicted, that the effect of KZ3 is bigger (more negative) for EASY countries than for MEDIUM countries than for DIFFICULT countries. However, neither the results for MSKEW or QSKEW are statistically significant. The results for the KZ are given in Panel B. They are similar to those of KZ3.

Finally, in Panel C, we report the upper-bound on the p-value for testing the inequalities regarding the effect of financing constraints on variances: $c_1 > c_2 > c_3$.[18] These

[17] Industry dummies are omitted from these regressions because industry classifications vary greatly by country.

are given in the first four columns. The upper-bound on the p-values for testing the inequalities regarding the effect of financing constraints on skewness, $c_1 < c_2 < c_3$, are given in the last two columns. Notice that for both KZ3 and KZ, the predicted inequality is statistically significant for variances but not for skewness. In sum, we conclude that the international evidence is strongly supportive of our first prediction regarding variances and is only somewhat supportive of our second prediction.

5. Auxiliary Implications for Short-Horizon Stock Liquidity

Having established these effects of financing constraints on stock return variance and skewness, we then explore the implications of firms being buyers of last resort on stock liquidity. That firms can come in and provide liquidity should prices drop too far or rise too much may make it less risky for other liquidity providers to step in before hand. An important caveat to this analysis is that a realistic model of bid-ask spreads or price impact costs is beyond the scope of this paper. We think of this auxiliary analysis as providing stylized facts motivated by theory.

We test this prediction using standard measures of liquidity such as bid-ask spreads and a price impact measure from the market microstructure literature due to Glosten and Harris (1988) estimated using intraday data. In implementing these regressions, we have to be aware that there are other important determinants of stock liquidity even in the absence of our proposed mechanism.

We first consider the following regression specification for stock liquidity and return variances:

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[18] The upper-bound on the p-value is derived in the following manner. Let p denote the p-value of the joint test that $c_1 > c_2 > c_3$, which is defined as p=1-Prob($c_1 > c_2$ and $c_2 > c_3$). The p-value can be rewritten as: p=1-[Prob($c_1 > c_2$) + Prob($c_2 > c_3$)-Prob($c_1 > c_2$ or $c_2 > c_3$)]=[1- Prob($c_1 > c_2$)]+[1- Prob($c_2 > c_3$)]-1+ Prob($c_1 > c_2$ or $c_2 > c_3$). Since Prob($c_1 > c_2$ or $c_2 > c_3$)-1 is always less than zero, it follows that $p \leq$ 1-Prob($c_1 > c_2$) +1-Prob($c_2 > c_3$).

$$TRADINGCOST_{it} = c_{0t} + c_{1t}*STVAR_{it-6} + c_{2t}*TVAR_{it-6} + c_{3t}*LOGSIZE_{it-1} + c_{4t}*LOGMB_{it-1} + c_{5t}*RET_{it-1} + c_{6t}*TURNOVER_{it-1} + c_{7t}*IO_{it-1} + c_{8t}*LOGCOVER_{it-1} + c_{9t}*NASDAQ_{it-1} + INDUSTRYDUMMIES_{it-1} + \varepsilon_{it}, \quad i=1,\ldots,N \qquad (14)$$

where TRADINGCOST is either PSPREAD or PIMPACT, $STVAR_{i,t}$ is short term return variance (including DVAR, WVAR, QVAR, SVAR, AVAR) and TVAR is three-year return variance. The coefficient of interest is c_{1t}, which captures the relationship between financing constraints and short-horizon return variance controlling for the firm's long-horizon return variance and a host of other firm characteristics known to predict stock liquidity from Amihud and Mendelson (1986), Hasbrouck (1991a), Glosten and Harris (1988), Breen, Hodrick and Korajczyk (2002). These include firm size (LOGSIZE), market-to-book ratio (LOGMB), past returns (RET), share turnover (TURNOVER), institutional ownership (IO), analyst coverage (LOGCOVER) and INDUSTRYDUMMIES. Here, ε_{it} again stands for a generic error term that is uncorrelated with all other independent variables. We then take the estimates from these annual regressions and follow Fama and MacBeth (1973) in taking their time series means and standard deviations to form our overall estimates.

The results are presented in Table 7. In Panel A, we look at how bid-ask spread varies with a firm's stock return variance at different horizons. Consider column (1) where STVAR is daily return variance (DVAR). Notice that the coefficient in front of DVAR is positive (0.030) and statistically significant with a t-statistic of 4.30. So a two-standard deviation movement in daily return variance controlling for fundamental variance leads to an increase in bid-ask spreads that is about 43% of the standard deviation of bid-ask spreads. The coefficient in front of TVAR is basically zero. And consistent with earlier studies, we find that bid-ask spreads decrease with firm size, past returns, turnover, institutional ownership, and analyst coverage.

As we consider the impact of return variances at different horizons on bid-ask spreads, controlling for fundamental variance (columns (2)-(6)), we find that the coefficients in front of WVAR through AVAR are all positive and are statistically significant for WVAR, MVAR and AVAR. The economic magnitudes implied by the coefficients in front WVAR and MAR remain quite large. A two-standard deviation movement in weekly return variance controlling for fundamental variance leads to an increase in bid-ask spreads that is about 30% of the standard deviation of bid-ask spreads. A two-standard deviation movement in monthly return variance controlling for fundamental variance leads to an increase in bid-ask spreads that is about 21% of the standard deviation of bid-ask spreads. The coefficients in front of the well-known determinants of stock liquidity remain largely unchanged as we move from columns (2) through (6).

In Panel B, we present the results for PIMPACT. As we move from DVAR in column (1) to AVAR in column (6), the coefficients in front of STVAR are positive for all horizons but are only statistically significant for DVAR and WVAR. The economic magnitudes are also quite similar. For example, a two-standard deviation movement in weekly return variance controlling for fundamental variance leads to an increase in PIMPACT that is about 34% of the standard deviation of PIMPACT. The effects of the other control variables on PIMPACT are similar to those for PSPREAD.

We next consider the regression specification involving stock liquidity and return skewness:

$$TRADINGCOST_{it} = d_{0t} + d_{1t}*SKEW_{it-1} + d_{2t}*IDIOVOL_{it-1} + d_{3t}*LOGSIZE_{it-1} + d_{4t}*LOGMB_{it-1} + d_{5t}*RET_{it-1} + d_{6t}*TURNOVER_{it-1} + d_{7t}*IO_{it-1} + d_{8t}*LOGCOVER_{it-1} + d_{9t}*NASDAQ_{it-1} + INDUSTRYDUMMIES_{it-1} + \varepsilon_{it}, \quad i=1,\ldots,N \qquad (15)$$

where TRADINGCOST is again either PSPREAD or PIMPACT, $SKEW_{it}$ is short term return skewness (including DSKEW, WSKEW, MSKEW, QSKEW) and IDIOVOL is firm idiosyncratic volatility. The coefficient of interest is d_{1t}, which captures the relationship between financing constraints and short-horizon return skewness. We also include the usual predictors of stock liquidity from equation (14).

The results are presented in Table 8. In Panel A, we look at how firm bid-ask spread varies with firm return skewness. Notice that the coefficients in front of SKEW are negative and statistically significant at various horizons, suggesting that firms with more positively skewed returns have lower bid-ask spreads. Consider the results in column (2). The coefficient in front of WSKEW is -0.0017 with a t-statistic of 3.99. So, a two-standard deviation increase in weekly return skewness leads to a decrease in bid-ask spreads that is about 7.5% of the standard deviation of spreads. However, the results do no carry over to price impact costs, the results of which are presented in Panel B. The coefficients in front of SKEW here are basically zero. In sum, there is substantial evidence that a firm's return variance relative to fundamental variance and return skewness influence its stock liquidity.

6. Conclusion

Motivated by substantial evidence that firms are buyers-of-last resort for their own stocks, we develop a model to explore the effects of such firm intervention on stock returns and liquidity. Our model generates two key predictions. Those with more ability to repurchase shares should prices drop far below fundamental value (less financially constrained ones) should have lower short-horizon relative to long-horizon return variance and more positively skewed returns than other firms. Using standard proxies for financing constraints such as firm payout ratios, firm age and the Kaplan-Zingales index, we find strong support for both of these predictions. That a firm can intervene may also make it less risky for other market makers to provide liquidity for its stock. We find support for this prediction as firms with lower short-horizon relative to long-horizon return variance or more positively skew returns have lower bid-ask spreads and price impact costs.

As we made clear in the introduction, there is an analogy of firms being buyers of last resort for their own stocks to central banks being lenders of last resort for their economies. Moreover, we may be under-appreciating the macroeconomic significance of coordinated firm intervention as witnessed by the events of the Crash of 1987 and the events of September 11. As such, there can also be theoretical inquires into the role of such firm intervention along the lines of the vast literature on lenders of last resort. Much more work can be done on the topic of firms as buyers of last resort for their own stock and firm intervention in markets more generally.

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Appendix

Solution to Equilibrium

We first solve for the equilibrium at date 1 and 0 recursively. Let θ_M and θ_F denote the stock holding at date 1. The optimization problem of a market maker is given by

$$\max_{\theta_M} \mathbf{E}\left[-e^{-\theta_M (\tilde{v}_2 - \tilde{p}_1)/\tau} \right].$$

The solution is

$$\theta_M = \left(\tau / \sigma_v^2\right)(-\tilde{p}_1).$$

The optimization problem of the firm is given by

$$\max_{\theta_F \geq 0} \mathbf{E}\left[-e^{-\theta_F (\tilde{v}_2 - \tilde{p}_1 - \kappa)/\tau_F} \right].$$

The solution is

$$\theta_F = \begin{cases} (\tau_F / \sigma_v^2)(-\tilde{p}_1 - \kappa), & \tilde{p}_1 < -\kappa \\ 0, & \text{otherwise} \end{cases}$$

The market clearing condition requires that

$$\mu\theta_M + \theta_F = \tilde{x}$$

which leads to the equilibrium price:

$$\tilde{p}_1 = \begin{cases} -\kappa - \frac{\sigma_v^2}{\tau_M + \tau_F}(\tilde{x} - x^*), & \tilde{x} \geq x^* \\ -\frac{\sigma_v^2}{\tau_M}\tilde{x}, & \tilde{x} < x^* \end{cases}$$

where $x^* = (\tau_M / \sigma_v^2)\kappa$. In the limit of $\tau_F \to \infty$, we have

$$\tilde{p}_1 = \begin{cases} -\frac{\sigma_v^2}{\tau_M} x^*, & \tilde{x} \geq x^* \\ -\frac{\sigma_v^2}{\tau_M}\tilde{x}, & \tilde{x} < x^* \end{cases} = -\left(\sigma_v^2 / \tau_M\right) \min\left(\tilde{x}, x^*\right).$$

Now let us consider the equilibrium at date 0. Only market makers are present then. Let θ_{M0} denote a market maker's stock holding at date 0. His optimization problem is

$$\max_{\theta_{M0}} \mathbf{E}\left[- e^{-\theta_{M0}(\tilde{p}_1 - p_0)/\tau - \frac{1}{2\sigma_v^2}(-\tilde{p}_1)^2} \right].$$

Since $\theta_{M0} = 0$ in equilibrium, from the optimality condition for θ_{M0} we obtain Equation (3) for the equilibrium stock price at 0.

Proof of Propositions

Without loss of generality, we set $\sigma_v^2 / \tau_M = 1$ and $\sigma_x = 1$. Then, $x^* = \kappa$. Let m_k denote the k -th moment of $\tilde{p}_1$:

$$m_k \equiv \mathbf{E}\left[\tilde{p}_1^k\right] = (-1)^k \mathbf{E}\left[\{\min(\tilde{x},\ \kappa)\}^k\right].$$

Give that $\tilde{x}$ is a standard normal, we have

$$\begin{aligned} m_1 &= \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}\kappa^2} - \kappa[1 - N(\kappa)] \\ m_2 &= \int_{-\infty}^{\kappa} x^2 n(x)dx + \int_{\kappa}^{\infty} \kappa^2 n(x)dx \\ m_3 &= -\int_{-\infty}^{\kappa} x^3 n(x)dx - \int_{\kappa}^{\infty} \kappa^3 n(x)dx \end{aligned}$$

and

$$\frac{dm_1}{d\kappa} = -[1 - N(\kappa)],\quad \frac{dm_2}{d\kappa} = 2\kappa[1 - N(\kappa)],\quad \frac{dm_3}{d\kappa} = -3\kappa^2[1 - N(\kappa)].$$

The variance of return $\tilde{r}_1$ is given by

$$v(1) \equiv \mathbf{Var}[\tilde{r}_1] = \mathbf{Var}[v_1 + \tilde{p}_1] = \sigma_v^2 + m_2 - m_1^2.$$

We have

$$\frac{dv(1)}{d\kappa} = 2[1 - N(\kappa)](\kappa + m_1) \geq 0.$$

Since $v(2) = 2\sigma_v^2$, Proposition 1 follows.

The skewness of return $\tilde{r}_1 = \tilde{v}_1 + \tilde{p}_1 - p_0$ is

$$s \equiv \mathbf{E}\left[(\tilde{r}_1 - \mathbf{E}[\tilde{r}_1])^3\right] = \mathbf{E}\left[(\tilde{p}_1 - \mathbf{E}[\tilde{p}_1])^3\right] = m_3 - 3m_2 m_1 + 2m_1^3.$$

Then, it is easy to show that

$$\frac{ds}{d\kappa} = -3[1 - N(\kappa)][(\kappa + m_1)^2 - (m_2 - m_1^2)].$$

For $\kappa = \infty$, $m_3 = 0$ and $ds/dk < 0$. Thus, for κ sufficiently large, s is positive and decreases with κ as stated in Proposition 2.

Table 1: Summary Statistics

This table reports various time-series averages of cross-sectional means and standard deviations. Return variance at various horizons include DVAR (daily), WVAR (weekly), MVAR (monthly), QVAR (quarterly), SVAR (semi-annual), AVAR (annual) and TVAR (three-year). Return skewness at various horizons include DSKEW (daily), WSKEW (weekly), MSKEW (monthly) and QSKEW (quarterly). REPURCHASE is firm repurchases to net income. AGE is the number of years a stock has price data in CRSP. KZ is the Kaplan-Zingales index of financing constraints and KZ3 is the KZ index net of book leverage and firm market-to-book ratio. TURNOVER is daily turnover for US stocks and monthly turnover for international stocks. RET is average monthly return in a year. LOGMB is log market-to-book ratio. MLEV is market leverage. VOL is daily return volatility in a year for US stocks and monthly return volatility for international stocks. PSPREAD is the average daily closing bid-ask spread divided by bid-ask mid point. PIMPACT is a price impact measure. LOGSIZE is log market capitalization. IO is proportion of institutional ownership. LOGCOVER is log of 1 plus the number of analysts covering a stock. IDIOVOL is volatility of daily returns in excess of market return. US data is from 1963-2003. All other countries are from 1993-2003.

Panel A: Variables for Financing Constraints Regressions

	US		UK		Canada		Germany		France	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Annualized return variance										
DVAR	0.2284	0.2585								
WVAR	0.1894	0.1521								
MVAR	0.1743	0.1363	0.1889	0.1993	0.2873	0.3139	0.1432	0.1336	0.1700	0.1978
QVAR	0.1818	0.1564	0.2059	0.2414	0.2935	0.3470	0.1595	0.1561	0.1832	0.2109
SVAR	0.1836	0.1776	0.2048	0.2652	0.2914	0.3843	0.1567	0.1671	0.1688	0.2052
AVAR	0.1874	0.2166	0.2445	0.3662	0.3346	0.4582	0.1539	0.2078	0.1629	0.2345
TVAR	0.0797	0.1197	0.1099	0.1947	0.1446	0.2412	0.0563	0.0862	0.0718	0.1139
Standardized return skewness										
DSKEW	0.2981	1.1602								
WSKEW	0.2826	0.8637								
MSKEW	0.1166	0.8025	0.1536	0.9801	0.1358	0.8296	0.1625	0.9217	0.1229	0.8679
QSKEW	0.0052	1.0248	-0.0267	1.0393	-0.0089	1.0409	0.0296	1.0441	-0.0636	1.0295
Financing constraint measure										
REPURCHASE	0.0839	0.2787								
AGE	16.6920	14.9280								
KZ3	-0.9912	0.9621	-1.5666	1.2786	-0.7189	1.0631	-0.8394	1.0543	-0.3555	0.3653
KZ	0.4585	1.2922	-0.0095	1.5955	0.9879	1.5083	0.8127	1.5797	1.3536	0.8895
Other										
LOGSIZE	11.5871	1.7118	4.2241	2.3020	5.3735	1.7013	5.7055	1.8806	6.9385	2.0195
TURNOVER	0.0035	0.0039	0.0480	0.0572	0.0408	0.0430	0.0378	0.0884	0.0296	0.0502
RET	0.0037	0.0360	0.0086	0.0391	0.0177	0.0531	0.0028	0.0470	0.0107	0.0423
LOGMB	0.2771	0.7983	0.3200	1.7660	0.4078	1.0652	0.5551	0.9845	0.4372	1.0979
MLEV	0.2910	0.2365	0.2456	0.2575	0.2831	0.2728	0.2939	0.2675	0.3232	0.2512
VOL	0.0298	0.0158	0.1066	0.0672	0.1407	0.0998	0.1110	0.0672	0.1167	0.0759

	Japan		Italy		Switzerland		Netherland		HongKong	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Annualized return variance										
DVAR										
WVAR										
MVAR	0.1923	0.1520	0.1728	0.0905	0.1372	0.1550	0.1448	0.1643	0.3790	0.3449
QVAR	0.2108	0.1813	0.2040	0.1036	0.1696	0.2011	0.1714	0.2119	0.3976	0.4252
SVAR	0.2671	0.2313	0.1364	0.1034	0.1633	0.2118	0.1600	0.1986	0.3401	0.3628
AVAR	0.2073	0.2640	0.1616	0.1582	0.1735	0.2718	0.1614	0.2070	0.3634	0.4486
TVAR	0.0822	0.1084	0.0948	0.1181	0.0865	0.1759	0.0647	0.0972	0.1118	0.1423
Standardized return skewness										
DSKEW										
WSKEW										
MSKEW	0.1587	0.8359	0.2471	0.9132	0.0698	0.9259	0.0774	0.8553	0.1422	0.9686
QSKEW	-0.0133	0.9890	0.0715	1.0129	-0.0848	1.0438	-0.0372	1.0259	0.0262	1.0310
Financing constraint measure										
REPURCHASE										
AGE										
KZ3	-0.4745	0.2789	-0.5299	0.6999	-1.6194	6.8418	-1.1941	1.0023	-1.6119	2.8976
KZ	1.2651	1.0389	1.2314	1.1827	0.4100	5.7943	0.4712	1.3817	-0.3478	3.2866
Other										
LOGSIZE	9.9378	1.5475	12.5805	2.1072	5.7134	1.8047	6.0141	2.0578	7.3497	1.8528
TURNOVER	0.0280	0.0421	0.0548	0.0883	0.0594	0.1079	0.0842	0.0873	0.0558	0.0905
RET	-0.0017	0.0325	0.0109	0.0360	0.0105	0.0357	0.0089	0.0346	0.0097	0.0479
LOGMB	0.2236	0.6672	-0.5661	1.6905	0.0966	1.0303	0.5481	1.3393	-0.1711	0.9141
MLEV	0.3676	0.2533	0.5030	0.3220	0.3952	0.2544	0.2685	0.2447	0.3053	0.2483
VOL	0.1131	0.0564	0.1180	0.0575	0.0945	0.0657	0.1001	0.0647	0.1509	0.0944

Panel B: Summary Statistics for Liquidity Regressions, U.S. Stock Market

	1983-2003		1993-2003	
	Mean	Std Dev	Mean	Std Dev
Annualized return variance				
DVAR	0.2581	0.2923	0.3288	0.3786
WVAR	0.2061	0.1673	0.2487	0.2136
MVAR	0.1888	0.1498	0.2251	0.1930
QVAR	0.1920	0.1685	0.2327	0.2189
SVAR	0.1883	0.1887	0.2196	0.2362
AVAR	0.1905	0.2288	0.2422	0.3006
TVAR	0.0793	0.1243	0.1023	0.1607
Standardized return skewness				
DSKEW	0.1338	1.1986	0.0782	1.2054
WSKEW	0.1371	0.9010	0.0976	0.9111
MSKEW	0.0338	0.8192	0.0361	0.8259
QSKEW	-0.0464	1.0320	-0.0375	1.0321
Liquidity measure				
PSPREAD	0.0408	0.0399		
PIMPACT			0.0200	0.0298
Other				
LOGSIZE	11.9647	1.7902	12.2004	1.8550
TURNOVER	0.0048	0.0056	0.0063	0.0078
RET	0.0007	0.0434	-0.0032	0.0505
LOGMB	0.3781	0.9330	0.4545	1.0802
IO	0.3070	0.2319	0.3504	0.2586
LOGCOVER	1.2855	1.0273	1.2793	0.9814
IDIOVOL	0.0350	0.0205	0.0399	0.0229

Table 2: Correlatedness of Financing Constraint Proxies, U.S. Stock Market

This table reports the results of the correlation of the various financing constraint proxies. Panel A reports the time-series average of the cross-sectional correlation matrix for the four financing constraint proxies. Panel B reports the results of Fama-MacBeth regressions of REPURCHASE on previous year values of AGE, KZ3 and KZ. Panel C reports the results of Fama-MacBeth regression of REPINITIATE (a dummy variable that equals 1 if a firm initiated a repurchase program in a given year and zero otherwise) on previous year values of AGE, KZ3 and KZ. Newey-West (1987) t-statistics are in parentheses.

Panel A: Correlation matrix

	REPURCHASE	AGE	KZ3	KZ
REPURCHASE	1			
AGE	0.042	1		
KZ3	-0.007	-0.173	1	
KZ	-0.025	-0.110	0.772	1

Panel B: Dependent Variable is indicator of share repurchase authorization (REPINITIATE)

	AGE (1)	KZ3 (2)	KZ (3)
CONSTRAINT	0.0008	-0.0112	-0.0064
	(7.74)	(12.93)	(9.34)
Constant	0.0581	0.0597	0.0744
	(3.58)	(3.23)	(4.14)

Panel C: Dependent Variable is firm repurchases to net income (REPURCHASE)

	AGE (1)	KZ3 (2)	KZ (3)
CONSTRAINT	0.0016	-0.0148	-0.0189
	(2.81)	(1.63)	(2.81)
Constant	0.0623	0.0790	0.1087
	(4.75)	(4.80)	(4.41)

Table 3: Stock Return Variance and Financing Constraint, U.S. Stock Market

This table reports the Fama-MacBeth regression results of return variances at various horizons on financing constraint measures. Return variance at various horizons include DVAR (daily), WVAR (weekly), MVAR (monthly), QVAR (quarterly), SVAR (semi-annual), AVAR (annual) and TVAR (three-year). CONSTRAINT is given by the following six financing constraint proxies. PAYOUT is dividends and repurchases to net income. DIVIDEND is dividends to net income. REPURCHASE is firm repurchases to net income. AGE is the number of years a stock has price data in CRSP. KZ is the Kaplan-Zingales index of financing constraints and KZ3 is the KZ index net of book leverage and firm market-to-book ratio. LOGSIZE is log market capitalization. TURNOVER is daily turnover. RET is average monthly return in a year. LOGMB is log market-to-book ratio. MLEV is market leverage. The sample period is 1963-2003. Newey-West (1987) t-statistics are in the parentheses.

Panel A: Dependent variable is daily return variance (DVAR)

	REPURCHASE (1)	AGE (2)	KZ3 (3)	KZ (4)
CONSTRAINT	-0.0110	-0.0003	0.0291	0.0277
	(2.89)	(2.85)	(9.10)	(9.78)
TVAR	0.5978	0.6863	0.6561	0.6545
	(3.02)	(4.53)	(4.59)	(4.57)
LOGSIZE	-0.0440	-0.0409	-0.0386	-0.0390
	(4.33)	(4.15)	(4.22)	(4.17)
MLEV	0.0809	0.0735	0.0351	-0.0556
	(2.22)	(2.08)	(0.99)	(1.45)
LOGMB	0.0444	0.0465	0.0463	0.0242
	(3.60)	(4.96)	(5.18)	(3.15)
RET	-0.9667	-0.9627	-1.0430	-1.1160
	(3.77)	(3.93)	(4.40)	(4.47)
TURNOVER	2.0259	5.1611	4.7489	4.5296
	(0.81)	(1.38)	(1.42)	(1.37)

Panel B: Coefficient in front of CONSTRAINT from regressions in which the dependent variables are weekly return variance (WVAR), monthly return variance (MVAR), quarterly return variance (QVAR), semi-annual return variance (SVAR), and annual return variance (AVAR)

	REPURCHASE (1)	AGE (2)	KZ3 (3)	KZ (4)
WVAR	-0.0101	-0.0003	0.0239	0.0225
	(3.39)	(2.45)	(10.44)	(10.69)
MVAR	-0.0082	-0.0003	0.0210	0.0197
	(3.12)	(2.26)	(9.32)	(9.93)
QVAR	-0.0076	-0.0004	0.0213	0.0199
	(2.76)	(2.82)	(9.80)	(9.89)
SVAR	-0.0052	-0.0003	0.0199	0.0188
	(1.64)	(3.95)	(8.37)	(8.33)
AVAR	-0.0031	-0.0003	0.0148	0.0138
	(1.24)	(2.21)	(7.46)	(7.05)

Table 4: Stock Return Skewness and Financing Constraint, U.S. Stock Market

This table reports the Fama-MacBeth regression results of skewness of various horizons on financing constraint measures. Return skewness at various horizons include DSKEW (daily), WSKEW (weekly), MSKEW (monthly) and QSKEW (quarterly). CONSTRAINT is given by the following six financing constraint proxies. PAYOUT is dividends and repurchases to net income. DIVIDEND is dividends to net income. REPURCHASE is firm repurchases to net income. AGE is the number of years a stock has price data in CRSP. KZ is the Kaplan-Zingales index of financing constraints and KZ3 is the KZ index net of book leverage and firm market-to-book ratio. LOGSIZE is log market capitalization. TURNOVER is daily turnover. RET is average monthly return in a year. LOGMB is log market-to-book ratio. MLEV is market leverage. The sample period is 1963-2003. Newey-West (1987) t-statistics are in the parentheses.

Panel A: Dependent variable is daily return skewness (DSKEW)

	REPURCHASE (1)	AGE (2)	KZ3 (3)	KZ (4)
CONSTRAINT	0.0782	0.0019	0.0122	-0.0030
	(2.73)	(2.58)	(0.95)	(0.31)
LOGSIZE	-0.0756	-0.0789	-0.0729	-0.0739
	(7.44)	(6.44)	(7.11)	(7.04)
MLEV	-0.1947	-0.2422	-0.2574	-0.2250
	(1.75)	(2.19)	(2.58)	(2.36)
VOL	0.5361	4.4476	3.8765	3.7017
	(0.19)	(1.27)	(1.11)	(1.09)
LOGMB	-0.0682	-0.1207	-0.1318	-0.1261
	(0.93)	(2.86)	(2.98)	(3.07)
RET	-2.0284	-2.1190	-2.3560	-2.4431
	(4.64)	(7.86)	(6.74)	(7.09)
TURNOVER	-3.1421	-5.8512	-3.2607	-4.6672
	(0.28)	(0.50)	(0.28)	(0.41)

Panel B: Coefficient in front of CONSTRAINT from regressions in which the dependent variables are weekly return skewness (WSKEW), monthly return skewness (MSKEW), quarterly return skewness (QSKEW)

	REPURCHASE (1)	AGE (2)	KZ3 (3)	KZ (4)
WSKEW	0.0344	0.0012	0.0062	-0.0013
	(2.18)	(2.45)	(0.73)	(0.26)
MSKEW	0.0125	0.0010	-0.0011	-0.0033
	(1.38)	(2.74)	(0.24)	(0.96)
QSKEW	0.0014	0.0004	0.0155	0.0134
	(0.16)	(1.68)	(1.58)	(1.54)

Table 5: The Relationship between Return Variances and Skewness and Financing Constraints in the U.S. Stock Market, Before and After the Regulatory Reforms of 1982

This table reports the results of a time-series regression of the coefficients in front of CONSTRAINT from the annual cross-sectional regressions in Tables 3 and 4. These coefficients are regressed on a constant and a dummy variable AFTER82 that equals one if the year of the cross-sectional regression is after 1982 and zero otherwise. The first four columns report the results for the cross-sectional regressions of variances (DVAR, WVAR, MVAR, QVAR, SVAR, AVAR) on financing constraints; the next four report the results for the cross-sectional regressions of skewness (DSKEW, WSKEW, MSKEW, QSKEW) on financing constraints. Newey-West (1987) t-statistics with six lags are in parentheses.

	REPURCHASE (1)	AGE (2)	KZ3 (3)	KZ (4)		REPURCHASE (5)	AGE (6)	KZ3 (7)	KZ (8)
DVAR					DSKEW				
Constant	-0.0081	-0.0001	0.0245	0.0246	Constant	0.0928	0.0003	-0.0042	-0.0021
	(1.93)	(2.81)	(5.17)	(5.48)		(1.92)	(0.90)	(0.22)	(0.13)
AFTER82	-0.0065	-0.0004	0.0102	0.0069	AFTER82	-0.0286	0.0032	0.0313	-0.0018
	(0.90)	(3.27)	(2.09)	(1.41)		(0.62)	(4.39)	(1.55)	(0.09)
WVAR					WSKEW				
Constant	-0.0059	-0.0001	0.0222	0.0217	Constant	0.0388	0.0001	-0.0105	-0.0069
	(2.30)	(3.49)	(5.86)	(6.32)		(1.86)	(0.22)	(1.23)	(1.02)
AFTER82	-0.0094	-0.0004	0.0036	0.0015	AFTER82	-0.0085	0.0022	0.0318	0.0107
	(1.91)	(1.96)	(0.84)	(0.38)		(0.39)	(4.31)	(2.87)	(1.15)
MVAR					MSKEW				
Constant	-0.0043	-0.0001	0.0194	0.0189	Constant	0.0083	0.0003	-0.0078	-0.0077
	(2.16)	(4.62)	(5.35)	(5.91)		(0.46)	(1.18)	(1.00)	(1.20)
AFTER82	-0.0089	-0.0004	0.0035	0.0019	AFTER82	0.0080	0.0014	0.0128	0.0085
	(2.08)	(1.73)	(0.82)	(0.47)		(0.39)	(2.65)	(1.61)	(1.21)
QVAR					QSKEW				
Constant	-0.0024	-0.0002	0.0212	0.0204	Constant	-0.0104	0.0005	0.0331	0.0292
	(1.43)	(5.08)	(5.75)	(6.31)		(0.81)	(1.00)	(2.60)	(2.68)
AFTER82	-0.0118	-0.0004	0.0002	-0.0011	AFTER82	0.0229	-0.0001	-0.0335	-0.0301
	(3.82)	(1.63)	(0.04)	(0.28)		(1.69)	(0.13)	(2.05)	(2.12)
SVAR									
Constant	-0.0002	-0.0002	0.0213	0.0205					
	(0.05)	(4.32)	(5.56)	(6.17)					
AFTER82	-0.0113	-0.0002	-0.0030	-0.0039					
	(2.60)	(1.21)	(0.71)	(1.00)					
AVAR									
Constant	0.0002	-0.0001	0.0146	0.0144					
	(0.06)	(2.41)	(4.70)	(4.94)					
AFTER82	-0.0075	-0.0003	0.0004	-0.0012					
	(1.86)	(1.23)	(0.10)	(0.30)					

Table 6: Relationship Between Return Variances and Skewness and Financing Constraints, International Evidence

This table reports the results of pooled regressions of return variances and skewness on financing constraint measures KZ3 and KZ using all stock markets during the period of 1993-1998. These regressions are analogous to those in Tables 3 and 4 except that the regressions are pooled and we allow the effect of each of the control variables (LOGSIZE, TURNOVER (daily for US, monthly for other countries), RET, LOGMB, MLEV) to vary by country (US, Canada, UK, Germany, France, Japan, Italy, Switzerland, Netherlands, Hong Kong) and the effect of the financing constraint variables (KZ3 and KZ) to vary by ease-of-repurchase country groups (EASY which includes US, Canada and UK, DIFFICULT which includes Germany and France, and MEDIUM which includes the remaining countries). We only report the coefficients in front of EASYxCONSTRAINT, MEDIUMxCONSTRAINT and DIFFICULTxCONSTRAINT. Panel A reports the results for KZ3 and B reports the results for KZ. Newey-West (1987) t-statistics are reported in paranetheses. Panel C reports the upper bound of the p-value of the following two joint tests. For variances, the test is that the coefficient in front of EASYxCONSTRAINT is greater than the coefficient in front of MEDIUMxCONSTRAINT is greater than the coefficient in front of DIFFICULTxCONSTRAINT. For skewness, the test is that the coefficient in front of EASYxCONSTRAINT is less than the coefficient in front of MEDIUMxCONSTRAINT is less than the coefficient in front of DIFFICULTxCONSTRAINT.

Panel A: Results for KZ3

	MVAR (1)	QVAR (2)	SVAR (3)	AVAR (4)	MSKEW (5)	QSKEW (6)
EASYxKZ3	0.0229	0.0224	0.0209	0.0228	0.0030	-0.0185
	(6.55)	(5.81)	(5.29)	(5.61)	(0.33)	(1.77)
MEDIUMxKZ3	0.0124	0.0125	0.0119	0.0085	0.0067	0.0016
	(4.20)	(3.62)	(3.10)	(2.80)	(0.44)	(0.16)
DIFFICULTxKZ3	-0.0236	-0.0290	-0.0296	-0.0187	0.0411	0.0370
	(2.01)	(2.34)	(2.25)	(1.48)	(1.16)	(0.90)

Panel B: Results for KZ

	MVAR (1)	QVAR (2)	SVAR (3)	AVAR (4)	MSKEW (5)	QSKEW (6)
EASYxKZ	0.0241	0.0236	0.0221	0.0239	-0.0032	-0.0138
	(7.19)	(6.52)	(5.79)	(5.81)	(0.37)	(1.42)
MEDIUMxKZ	0.0118	0.0119	0.0113	0.0081	0.0064	-0.0015
	(4.29)	(3.65)	(3.19)	(2.60)	(0.44)	(0.14)
DIFFICULTxKZ	-0.0187	-0.0240	-0.0274	-0.0145	0.0021	0.0382
	(1.76)	(2.19)	(2.33)	(1.29)	(0.06)	(0.98)

Panel C: Upper bound of the p-value of Joint Test that The Financing Constraint Effect is Stronger in Easier to Repurchase Countries

	MVAR (1)	QVAR (2)	SVAR (3)	AVAR (4)	MSKEW (5)	QSKEW (6)
KZ3	0.012	0.029	0.054	0.021	0.603	0.289
KZ	0.005	0.009	0.02	0.027	0.739	0.365

Table 7: Stock Liquidity and Stock Return Variances, U.S. Stock Market

This table reports the Fama-MacBeth regression results of liquidity measures on variances of various horizons. Panel A uses bid-ask spread (PSPREAD) as a measure of liquidity and the sample period is 1983-2003. Panels B uses price impact (PIMPACT) as a measure of illiquidity. The sample period is 1993-2003. STVAR is return variance at various horizons, including DVAR (daily), WVAR (weekly), MVAR (monthly), QVAR (quarterly), SVAR (semi-annual), AVAR (annual) and TVAR (three-year). LOGSIZE is log market capitalization. TURNOVER is daily turnover. RET is average monthly return in a year. LOGMB is log market-to-book ratio. MLEV is market leverage. IO is proportion of institutional ownership. LOGCOVER is log of 1 plus the number of analysts covering a stock. Regressions include a dummy for whether a stock is listed on Nasdaq. The Newey-West (1987) t-statistics are in the parentheses.

Panel A: Dependent variable is bid-ask spread (PSPREAD)

	DVAR (1)	WVAR (2)	MVAR (3)	QVAR (4)	SVAR (5)	AVAR (6)
STVAR	0.030	0.035	0.028	0.016	0.012	0.008
	(4.30)	(2.65)	(2.00)	(1.72)	(1.41)	(2.35)
TVAR	-0.005	-0.002	0.005	0.008	0.009	0.009
	(0.69)	(0.24)	(0.77)	(1.12)	(1.07)	(2.12)
LOGSIZE	-0.010	-0.011	-0.012	-0.013	-0.013	-0.013
	(7.10)	(7.04)	(6.84)	(6.43)	(6.29)	(5.82)
LOGMB	0.002	0.003	0.003	0.004	0.004	0.004
	(2.48)	(3.54)	(4.18)	(4.11)	(3.93)	(3.75)
RET	-0.216	-0.214	-0.215	-0.218	-0.220	-0.224
	(4.28)	(4.32)	(4.38)	(4.28)	(4.23)	(4.15)
TURNOVER	-1.661	-1.830	-1.763	-1.672	-1.622	-1.546
	(3.32)	(3.23)	(3.16)	(3.19)	(3.29)	(3.10)
IO	-0.001	-0.004	-0.005	-0.006	-0.006	-0.007
	(0.33)	(1.35)	(1.85)	(1.91)	(2.08)	(2.02)
LOGCOVER	-0.002	-0.002	-0.002	-0.001	-0.001	-0.001
	(2.03)	(1.67)	(1.46)	(1.29)	(1.31)	(1.21)

Panel B: Dependent variable is price impact (PIMPACT)

	DVAR (1)	WVAR (2)	MVAR (3)	QVAR (4)	SVAR (5)	AVAR (6)
STVAR	0.020	0.024	0.017	0.009	0.004	0.001
	(7.31)	(2.25)	(1.53)	(1.09)	(0.82)	(0.38)
TVAR	-0.010	-0.009	-0.003	0.000	0.002	0.003
	(4.44)	(2.13)	(1.18)	(0.10)	(1.22)	(2.78)
LOGSIZE	-0.004	-0.004	-0.004	-0.005	-0.005	-0.005
	(7.57)	(14.47)	(16.23)	(12.54)	(10.38)	(9.05)
LOGMB	-0.002	-0.002	-0.002	-0.002	-0.002	-0.002
	(7.20)	(19.29)	(19.87)	(19.39)	(17.81)	(15.87)
RET	-0.092	-0.083	-0.081	-0.082	-0.083	-0.084
	(6.77)	(7.69)	(8.11)	(7.79)	(6.93)	(6.83)
TURNOVER	-0.798	-0.924	-0.886	-0.834	-0.782	-0.741
	(5.68)	(3.52)	(3.02)	(2.98)	(3.27)	(3.46)
IO	-0.008	-0.010	-0.011	-0.012	-0.012	-0.012
	(18.70)	(19.34)	(24.58)	(27.67)	(26.62)	(25.60)
LOGCOVER	0.001	0.001	0.001	0.001	0.001	0.001
	(3.84)	(6.80)	(7.96)	(6.73)	(6.00)	(5.10)

Table 8: Stock Liquidity and Stock Return Skewness, U.S. Stock Market

This table reports the Fama-MacBeth regression results of liquidity measures on return skewness of various horizons. Panel A uses bid-ask spread (PSPREAD) as a measure of liquidity and the sample period is 1983-2003. Panel B uses price impact (PIMPACT) as a measure of illiquidity. The sample period is 1993-2003. SKEW is return skewness at various horizons, including DSKEW (daily), WSKEW (weekly), MSKEW (monthly) and QSKEW (quarterly). LOGSIZE is log market capitalization. TURNOVER is daily turnover. RET is average monthly return in a year. LOGMB is log market-to-book ratio. MLEV is market leverage. IO is proportion of institutional ownership. LOGCOVER is log of 1 plus the number of analysts covering a stock. IDIOVOL is volatility of daily returns in excess of market return. Regressions include a dummy for whether a stock is listed on Nasdaq. Newey-West (1987) t-statistics are in the parentheses.

Panel A: Dependent variable is bid-ask spread (PSPREAD)

	DSKEW (1)	WSKEW (2)	MSKEW (3)	QSKEW (4)
SKEW	-0.0005	-0.0017	-0.0009	-0.0002
	(2.67)	(3.99)	(2.33)	(1.73)
IDIOVOL	1.207	1.208	1.208	1.212
	(5.48)	(5.48)	(5.48)	(5.47)
LOGSIZE	-0.005	-0.005	-0.005	-0.005
	(11.67)	(12.20)	(11.95)	(12.32)
LOGMB	-0.003	-0.003	-0.003	-0.003
	(6.08)	(6.24)	(6.44)	(6.47)
RET	-0.038	-0.032	-0.040	-0.044
	(8.69)	(7.95)	(9.38)	(7.95)
TURNOVER	-1.577	-1.609	-1.675	-1.724
	(4.11)	(4.08)	(4.13)	(4.16)
IO	0.006	0.005	0.006	0.006
	(2.76)	(2.69)	(2.84)	(2.93)
LOGCOVER	-0.003	-0.003	-0.002	-0.002
	(11.74)	(12.15)	(13.33)	(11.09)

Panel B: Dependent variable is price impact (PIMPACT)

	DSKEW (1)	WSKEW (2)	MSKEW (3)	QSKEW (4)
SKEW	0.0000	-0.0002	0.0002	0.0000
	(0.15)	(1.21)	(2.17)	(0.02)
IDIOVOL	0.665	0.665	0.665	0.668
	(3.47)	(3.47)	(3.48)	(3.51)
LOGSIZE	-0.003	-0.003	-0.003	-0.003
	(8.86)	(8.96)	(8.80)	(9.07)
LOGMB	-0.003	-0.003	-0.003	-0.003
	(13.20)	(13.17)	(13.19)	(13.23)
RET	-0.051	-0.049	-0.053	-0.053
	(9.41)	(9.71)	(9.46)	(10.42)
TURNOVER	-0.900	-0.906	-0.906	-0.914
	(4.11)	(4.14)	(4.23)	(4.33)
IO	-0.006	-0.006	-0.006	-0.006
	(4.20)	(4.29)	(4.08)	(4.11)
LOGCOVER	0.000	0.000	0.000	0.000
	(0.99)	(1.10)	(0.78)	(1.13)