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Stock Market Liquidity and the Macroeconomy: Evidence from Japan

Woon Gyu Choi and David Cook

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Abstract

In a liquid financial market, investors are able to sell large blocks of assets without substantially changing the price. We document a steep drop in the liquidity of the Japanese stock market in the post-bubble period and a steep rise in liquidity risk. We find that, during Japan's deflationary period, firms with more liquid balance sheets were less exposed to stock market liquidity risk, while slowly growing firms were highly exposed to liquidity shocks. Also, aggregate liquidity had macroeconomic effects on aggregate demand through its effect on money demand.

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I. Introduction

In the early 1990s, Japanese equity prices fell drastically from heights that are now considered the effects of a stock market bubble. During the remainder of the decade, the value of the stock market stabilized at much lower values. Here, we examine the link between the liquidity of the Japanese stock market and the macroeconomy in a period of prolonged deflation, slow growth, and near zero interest rates.

Recent research has shown that the liquidity of major world financial markets substantially varied over time and that the unpredictability of market liquidity is an important source of risk for investors. In this paper, we document a large and persistent decline in Japanese stock market liquidity during the 1990s. In illiquid stock markets, investors are unable to sell large amounts of shares without a sharp decline in the price of the shares. We show that the impact of stock trading on share prices rose substantially after the collapse of the bubble. In addition, the volatility of liquidity shocks to the stock market increased dramatically.

A number of factors have led to a decline in asset market liquidity during the late 1990s. First, Japanese financial intermediaries experienced a substantial deterioration in their balance sheets. If market makers and other investors faced credit constraints, this may have reduced their ability to take advantage of high returns by providing liquidity to an illiquid market. Second, during much of this period, Japan was operating in a deflationary environment in which savers were able to earn real returns simply by holding money. This may have reduced their incentives to take speculative risks by providing liquidity to the market. Third, adverse shocks to liquidity in the world and East Asian financial markets potentially increased the exposure of Japanese firms. At the microstructure level, the Tokyo Stock Exchange implements a continuous-auction based order system in the late 1990s, dispensing with market makers (Tokyo Stock Exchange, 2003).[2]

We consider some channels through which financial market liquidity shocks may affect the macroeconomy. Naturally, a rise in equity risk tends to raise the cost of capital of firms through the cost of financing channel. Using cross-sectional data, we find that exposure to liquidity risk is an important determinant of investment. Another channel pertains to the effects of shocks on the portfolio of assets. Kiyotaki and Moore (2001) construct a theory in which liquid assets are held primarily as a hedge against the illiquidity of real assets. A rise in money held for financial liquidity may reduce money available for transactions. In an economy with nominal rigidities, an increase in money demand can have real effects on the economy. Nagayasu (2003) finds evidence of a structural break in money demand in Japan during the crisis. Indeed there is a sharp decline in the velocity of money in the late 1990s. We find, using time-series data, that shocks to

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[2] Buy and sell orders are matched first according to price (highest buy to lowest sell offer) and second by time of placement. Also, important features of the Tokyo Stock Exchange include the intraday price limit rule and limit-order trading—for the institutional features of trading, see, for example, Ahn et al. (2002).

financial market liquidity have effects on the economy, which are similar to textbook effects of money demand shocks.

In measuring stock market liquidity, we closely follow Pastor and Stambaugh's (2003) measure of United States equity market liquidity. They measure liquidity by the degree to which the quantity of stocks traded affects the market price of stocks. In a liquid market, large sales of stocks can be made without substantially changing the price of the stocks. In an illiquid market, however, they can have an adverse impact on stock prices. Amihud and Mendelson (1986) is an early study of the relationship between market liquidity and stock returns. Campbell, Grossman, and Wang (1993) construct a model in which risk-averse market makers require a premium to buy large quantities of stock. Chordia, Sarkar, and Subrahmanyam (2002) find that aggregate liquidity fluctuations in the United States affect both bond and stock markets and are correlated with monetary policy. Stahel (2004) finds that global liquidity shocks affect stock markets in both the United States and Japan. Hamao, Mei, and Xu (2003) find a dramatic decrease in trading volumes in the Japanese stock market after the bubble bust.

Section II describes the technique for measuring stock market liquidity and some of the time-series properties of market liquidity shocks. We find that, during the 1990s, stock market liquidity fell, and the volatility of liquidity shocks increased. Moreover, the exposure of individual firms' equity shares to liquidity shocks rose during the same period. Section III presents some firm-level cross-sectional determinants of liquidity risk and the real impact of exposures to liquidity risk. We find that the liquidity of individual corporate balance sheets predicts how exposed their shares will be to liquidity shocks. Moreover, exposures to liquidity shocks help determine the capital growth and sales growth of firms during the crisis. In Section IV, we examine the dynamic interaction between stock market liquidity and the macroeconomy using vector autoregressions (VARs). An examination of money markets suggests that a decline in stock market liquidity leads to a rise in the demand for real money balances. Section V concludes. The data used are described in an appendix.

II. Measure of Liquidity Risk

A. Measuring Stock Market Liquidity

In measuring Japanese aggregate stock market liquidity, we closely follow Pastor and Stambaugh's (2003) measure for the United States' equity markets. For a group of Japanese common shares indexed by *k*, we estimate the effect of order flows on excess daily returns for each month from January 1975 to December 2001. Using time-series ordinary least squares (OLS), we estimate the following equation:

$$r^{xs}_{k,d,t} = \theta^0_{k,t} + \theta^1_{k,t} \cdot r_{k,d-1,t} + \theta^2_{k,t} \cdot \text{sign}(r^{xs}_{k,d-1,t}) \cdot vol_{k,d-1,t} + \varepsilon_{k,d,t}, \qquad (1)$$

where $r_{k,d,t}$ is the return on the stock of company *k* on day *d* of month *t*. Define $r^{MKT}_{d,t}$ as the equal-weighted return on Japanese stocks in the Pacific Capital Markets (PACAP) database (see Appendix I). The excess return $r^{xs}_{k,d,t} = r_{k,d,t} - r^{MKT}_{d,t}$ is measured as the difference between the return on stock k and the market return. The sign ($r^{xs}_{k,d-1,t}$) variable is equal to 1 when lagged excess returns are positive and equal to -1 when lagged excess returns are negative. We define $vol_{k,d,t}$ as the value of shares traded, measured in billions of yen. The signing of the trading volume is meant to distinguish whether trades are driven by selling pressure from investors or by buying pressure. When investors are selling shares in a company to market makers or other short-term liquidity providers such as speculators, excess returns on that company should be negative. When investors are buying from market makers, excess returns should be positive. The lagged return is included to capture inertia effects that are not volume-related.

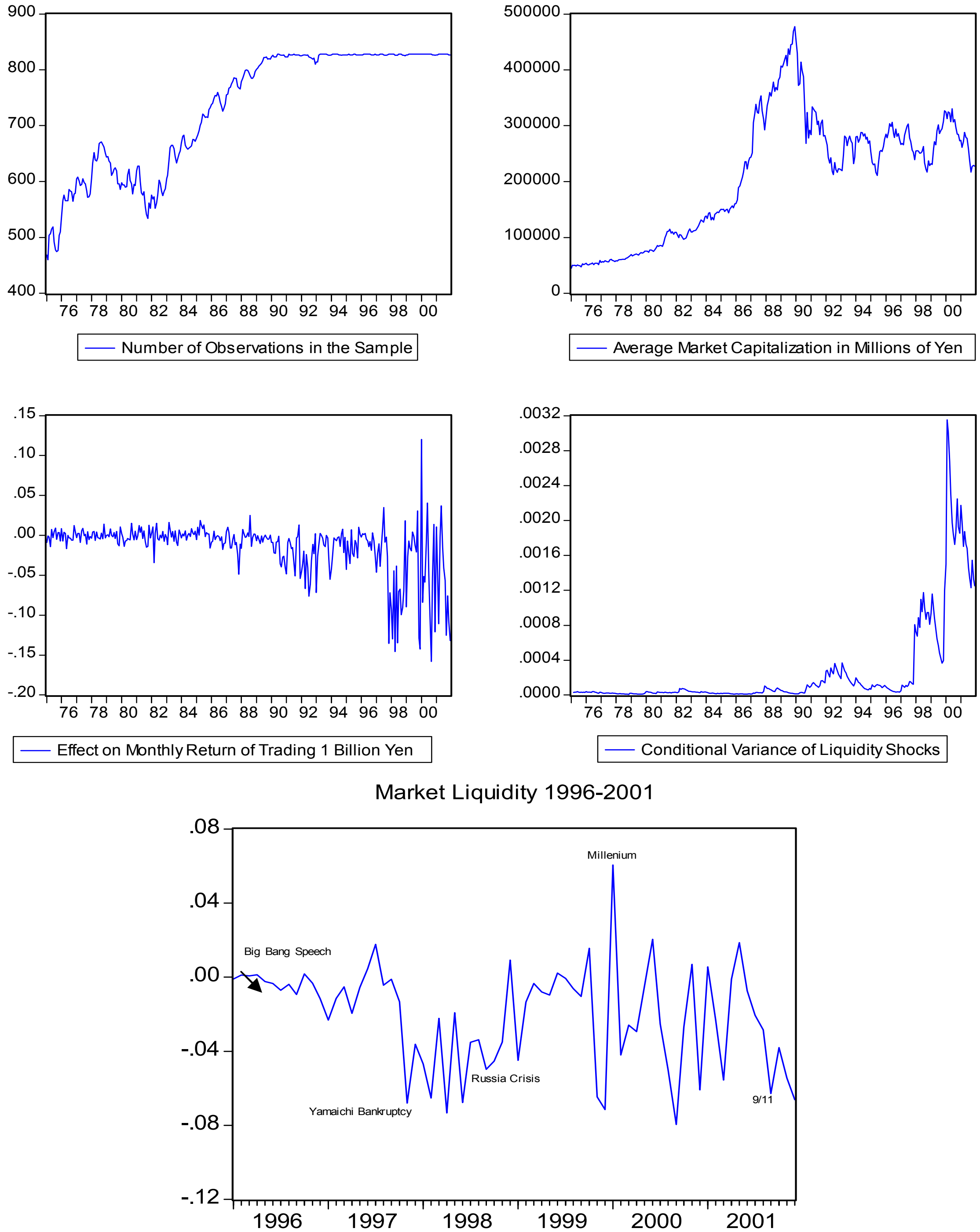
The parameter $\theta^2_{k,t}$ measures the degree to which sales affect returns and thus might be thought of as a measure of liquidity in that particular market. One would expect $\theta^2_{k,t}$ to be negative in general and more negative when liquidity is lower. This idea is rooted in Campbell, Grossman, and Wang's model (1993) in which a large value of shares traded generates reversals in returns in illiquid markets.[3] In their model, risk-averse market makers demand higher than expected returns to buy or sell a large volume of shares. When there are large sales at day *d*-1, the market makers offer a relatively low price, generating negative excess returns in period *d*-1 and predicting relatively high returns in the subsequent period. Under this theory, trading volume should be associated with return reversals, if the stock is not perfectly liquid. Technically, the Tokyo Stock Exchange (Tokyo Stock Exchange, 2003) does not operate on a system in which specified market makers are responsible for the trading of individual stocks. The Campbell, Grossman, and Wang theory can apply more generally to a case in which there are a limited number of investors willing and able to engage in short-term speculation in individual stocks. It is therefore interesting to see whether the Pastor and Stambaugh (2003) model captures some features of market liquidity in a market without market makers.

We estimate $\theta^2_{k,t}$ for each stock-month for which there are at least 9 usable observations during the month and for which both the previous month and the subsequent month have at least 9 usable observations. To obtain a consistent sample of firms during the 1990s, we choose from the PACAP database a set of 828 non-financial firms for which we are able to estimate $\theta^2_{k,t}$ for at least 140 of the 144 months between January 1990 and December 2001 and for which we can obtain balance sheet data (from the same source) in years 1990, 1995, and 2000. To avoid contaminating the sample with the results of buyouts or bankruptcies, we exclude firms whose equity permanently ceases trading at some point.

The upper left panel of Figure 1 shows the number of shares, N_t, for which we are able to estimate the effect of trading value on returns for each month between in the time period between January 1975 and December 2001. We begin with approximately 500 different shares, a number that grows with time. By construction, the number of firms after 1989 is approximately constant. (Other panels of the figure will be discussed later.)

[3] Chao and Hueng (forthcoming) show that return reversals are a prevalent phenomenon of the Japanese stock market.

Figure 1. Time-Series Liquidity Measures



Notes: The figure shows the details of aggregate market liquidity. The upper two panels show the details of the sample of firms including the number of firms in the sample observed in any period and the market capitalization of those firms. The bottom left panel shows the aggregate market liquidity measure, *LIQ*, which essentially is the average cost, in terms of returns, of trading a 1 billion of 2001 yen. The bottom right panel shows the conditional heteroscedasticity of shocks to an AR(2) process in *LIQ*. The final panel is a closeup of the lower left panel with the indication of episodic dates.

Table 1. Descriptive Statistics of Stock Market Aggregates

	Entire Period January, 1975 – December, 2001	Early 1990s January, 1990 – December, 1995	Late 1990s January, 1996 – December, 2001
Mean Return			
PACAP Index r^{MKT}	0.80%	–0.37%	–0.55%
Our Sample	0.61%	–0.28%	–0.49%
Standard Deviation of Market Return			
PACAP Index	5.90%	8.04%	6.97%
Our Sample	5.74%	8.67%	7.38%
Monthly Turnover			
TOPIX	4.38%	2.19%	3.22%
Our Sample	5.08%	3.38%	3.62%

Notes: This table characterizes some of the statistical properties of time series from the Japanese stock markets. We compute the mean and standard deviation of returns from an equal-weighted index calculated by PACAP and those from an equal-weighted average of our sample of firms. We also compare the turnover (ratio of monthly value traded to market capitalization) for the Tokyo Stock Exchange and our sample of firms.

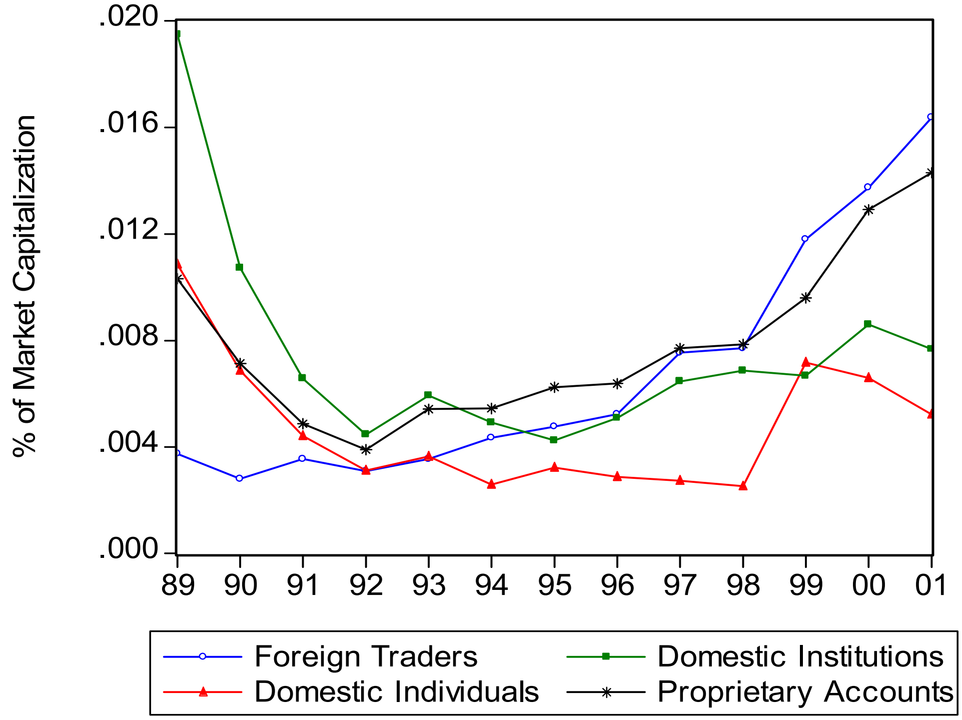
B. Descriptive Statistics of the Aggregate Stock Market

Table 1 also shows some properties of the shares of our sample in comparison with a broader index of stocks from PACAP. The equal-weighted average monthly return (excluding dividends) for shares in the overall sample of firms is about 0.8 percent per month; in our smaller sample, the average return is slightly smaller at 0.6 percent per month. We will focus on two sub-periods: the early 1990s (January 1990–December 1995) and the late 1990s (January 1996–December 2001). In both the early and late 1990s, mean returns are negative and slightly lower for the large sample than for our narrower sample. This may not be surprising since our sample drops those shares that stop trading at some point during the 1990s. In all sub-periods, the standard deviation of the equal-weighted monthly returns in our sample is similar to that in the PACAP sample. The volatility of returns increases during the 1990s in both samples and is largest during the early 1990s.

C. Dissecting Changes in Market Turnover

To access stock market liquidity, we compare the average monthly turnover of the shares of our sample, relative to the turnover of the stocks measured in the Topix index of the Tokyo Stock Exchange. Turnover is defined as the value of shares traded in a month as percentage of end-of-period market capitalization (bottom panel of Table 1). In the whole period, about 4 percent of the value of shares in the Topix index is traded in the average month. Our sample is slightly more liquid with about 5 percent of the value traded. While turnover is slightly higher in our sample than the Topix sample in both sub-periods, it is lower in the early and late 1990s than in the entire period in both samples.

Figure 2. Purchases of Shares by Type of Investor



Notes: The figure shows Tokyo Stock Exchange data on the quantity of shares purchased by four types of investors relative to aggregate market capitalization. Data reported are yearly averages of monthly data.

Given the overall decline in market liquidity, we look more closely at which investors left the market. Figure 2 shows the path, from 1988 to 2001, of average monthly purchases of stocks (relative to overall market capitalization) by investors trading for their proprietary accounts and by three other types of investors trading through brokerages. The three types include domestic individuals, domestic financial institutions, and foreign traders. All trading is reported relative to the aggregate market capitalization. Purchases by foreign traders grew throughout the period, while trading by all three types of domestic investors initially declined following the burst of the stock market bubble. Over the course of the 1990s, trading on proprietary accounts recovered. However, trading through brokerages by individuals and institutions persistently declined during the first half of the period. In particular, by the end of the period the share traded by domestic institutions had fallen to less than the half of its initial level.[4]

[4] Wang (2003) shows that institutional participation is a significant determinant of market liquidity in the U.S.

D. Properties of the Liquidity Measure

The aggregate measure of the market value, m_t, of the shares for which we are able to calculate $\theta^2_{k,t}$ is given by

$$m_t = \sum_{k=1}^{N_t} mktcap_{k,t}, \tag{2}$$

where $mktcap_{k,t}$ is the end-of-month market capitalization of stock k in month t, and N_t is the number of shares in month t. The upper right panel of Figure 1 shows the average market capitalization m_t / N_t during each period. In the mid-1970s, the average firm in the sample had a market capitalization of approximately 45 billion yen. During the 1970s and 1980s, average market capitalization grew rapidly to a peak of nearly 500 billion yen in late 1989 before falling rapidly to a level near 200 billion yen. During the 1990s, average market capitalization fluctuated between 200 and 300 billion yen.

Chordia, Roll, and Subrahmanyan (2002) find that average market liquidity in the United States (as measured by bid-ask spreads) shows substantial variation over time. Following Pastor and Stambaugh (2003), we measure average market liquidity, LIQ_t, as follows:

$$LIQ_t = \frac{m_t}{m_{Dec,2001}} \sum_{k=1}^{N_t} \theta^2_{k,t} / N_t$$

We average the liquidity parameter across the firms with usable observations in a particular month t. The parameter measures the effect of a billion yen trading on stock returns. To reflect the growth in size of the stock market over time, the average of $\theta^2_{k,t}$ across firms is multiplied by the ratio of the sum of the market capitalization of the firms to the market capitalization at a fixed date, December 2001.

The lower left panel of Figure 1 shows the time path of LIQ_t. The aggregate market liquidity is negative in most of the time, suggesting—in accord with theory—that heavy trading results in return reversals due to illiquidity. Further, aggregate market liquidity varies substantially. Table 2 (part A) shows that the mean level of liquidity is −0.014 so that sales of 1 billion yen (roughly in 2001 yen) result in expected returns of 1.4 percent in a month. The market became less liquid over time, and the average level of LIQ_t fell to −0.02 in the early 1990s and fell further to below −0.04 by the late 1990s, approximately twice the entire period mean. A simple Chow breakpoint test at January 1996 rejects the stability of the mean at any reasonable critical value. However, an Adjusted Dickey-Fuller test with 12 lags rejects the hypothesis of a unit root at the 1 percent critical value (regardless of whether a deterministic trend term is included). Although Pastor and Stambaugh (2003) document substantial and persistent variations in the U.S. equity market, such variations do not involve so prolonged liquidity drought as observed in the Japanese market in the late 1990s.

Table 2. Liquidity Measure and Liquidity Beta

	Entire Period January, 1975 – December, 2001	Early 1990s January, 1990 – December, 1995	Late 1990s January, 1996 – December, 2001
A. Liquidity Measure			
Mean	–0.0143	–0.0200	–0.0401
Shock Volatility	0.0147	0.0102	0.0274
Correlation w/ PACAP Index	0.268	0.424	0.252
Covariance w/ PACAP Index	0.000226	0.000342	0.000425
B. Liquidity Beta			
Mean	--	1.573	0.536
Std. Deviation	--	1.150	0.567
% firms with significant *t*-statistics		32.6%	27.3%

Notes: Part A characterizes the mean and standard deviation of our measure of market liquidity, *LIQ,* as well as its correlation and covariance with the PACAP equal weighted index. Part B characterizes the cross-sectional distribution of the partial betas from regressions of individual stock returns on the aggregate index and liquidity shocks. The characterization includes mean and cross-section standard deviation of the coefficient on liquidity shocks as well as the percentage of firms with significant *t*-statistics based on Newey and West's heteroscedasticity-autocorrelation consistent standard errors.

The bottom of Figure 1 shows more closely the time series of aggregate market liquidity over the period 1996–2001 (essentially a close-up of the lower left panel of Figure 1). Over this period, market liquidity seems to reflect a response to both national and international events. Perhaps coincidentally, in the periods following the November 1996 announcement of the "Big Bang" market liberalization, there was a persistent decline in market liquidity, followed by a recovery over the summer of 1997. However, in November 1997, market liquidity suddenly plunged to a level dramatically lower than that observed in any prior period. This episode coincides with major turmoil in the Japanese financial system (as well as the East Asian financial crisis) since a number of intermediaries including the fourth largest securities firm (Yamaichi Securities) and one of the city banks (Hokkaido Takushoku) were forced into bankruptcy. This low level of liquidity persisted through 1998, including a negative spike in September coincident with the Russian crisis and the collapse of LTCM.[5]

Liquidity recovered to more normal levels through 1999. However, a new persistent decline in liquidity occurred in November 1999 and was punctuated by a number of periods in which

[5] Crises can be internationally transmitted through diverse channels. In particular, a crisis in one market causes institutional investors to sell liquid assets in other markets to meet regulator requirements (a forced-portfolio recomposition effect). Forbes (2000), using firm-level cross-country data, shows that individual company's stock market returns are affected by global trading liquidity during the East Asian and Russian crises through a forced-portfolio recomposition.

liquidity increased rapidly but temporarily. In one of these periods, January 2000, liquidity reached a level much higher than previously observed. During the turn of millennium period the level of bank reserves held at the Bank of Japan also spiked.

We also observe another sharp decline in liquidity after September 2001, despite that Japan has undergone reforms to liberalize its financial markets in ways that may allow the additional participation of external investors and institutions. Persaud (2000), however, argues that the common use of modern risk management practices leads to herding behavior that may reduce market liquidity despite a large number of market participants. Also, such a decline in liquidity might be associated with heightened perceptions of risk after the 9/11 terrorist attack.

E. Robust Measures

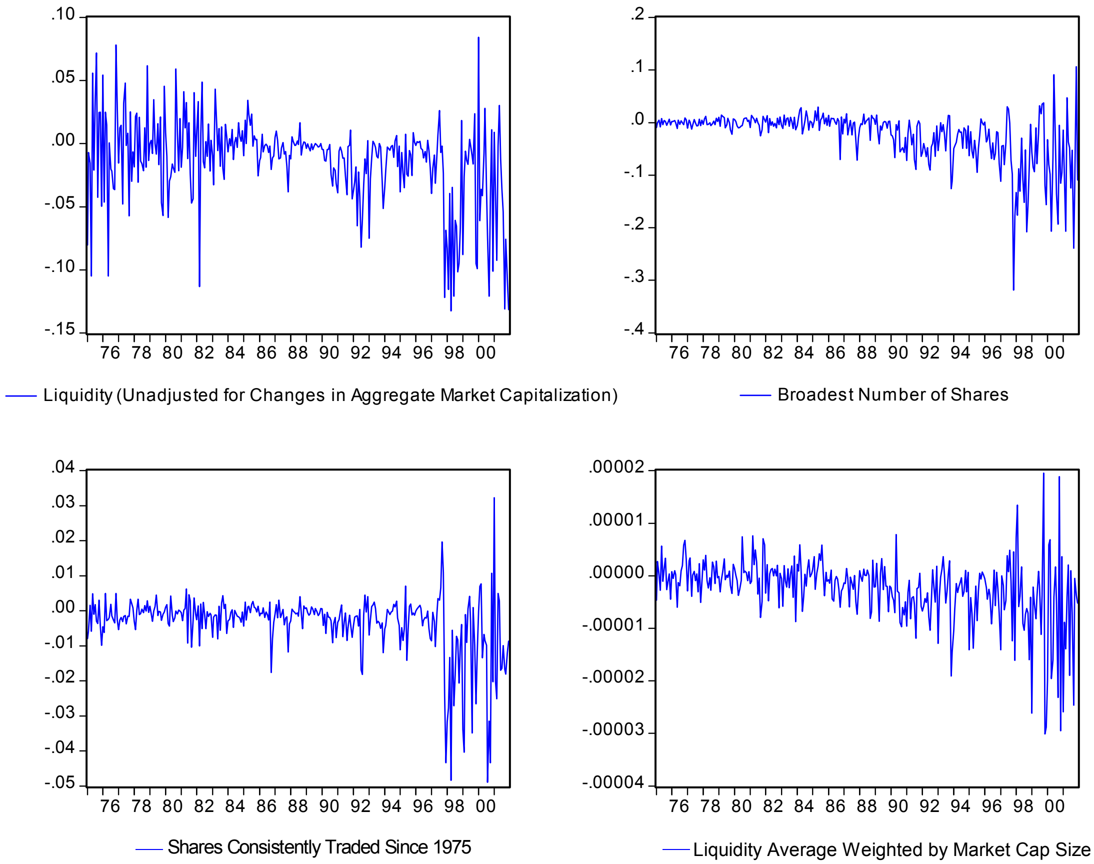
We also examine some alternative measures of liquidity. Figure 3 (first panel) shows the pattern of $\sum_{k}^{N_t} \theta_{k,t}^2 / N_t$, which is unadjusted for changes in market capitalization over time. According to this measure, the impact of trading a billion yen worth of shares during the mid-to-late seventies was indeed very large and comparable with more recent periods. However, during the 1980s, return reversals associated with large stock sales became much smaller, beginning to rise dramatically again in the 1990s just as in the benchmark series, *LIQ*.

The second and third panels show alternative measures of LIQ_t for different sets of firms. The second panel pertains to the set of firms that includes all of the nonfinancial firms available in which an estimate of $\theta_{k,t}^2$ is available in that time period. The number of firms ranges from about 500 in 1975 to about 1400 by 2001. The measure of liquidity with this broad set of firms shows a similar pattern, compared to our benchmark measure of liquidity. During the 1970s and 1980s, stock market liquidity was relatively high. During the 1990s, the aggregate liquidity began to fall. After 1997, stock market liquidity on average dropped dramatically and the volatility of liquidity rose.

The third panel depicts a liquidity measure defined by the average $\theta_{k,t}^2$ (weighted across time by aggregate market capitalization) of a group of approximately 370 firms for which we are able to measure liquidity for at least 320 out of the 324 months in the years between 1975 and 2001. This measure of liquidity shows again a similar path with a fall in liquidity in the 1990s and a more dramatic decline after 1997 along with an increase in volatility of liquidity. The average level of liquidity of this group of more established companies was higher than that of the broader sample.

Finally, the last panel displays a weighted average of $\theta_{k,t}^2$ with the weight for each firm being the end of month market capitalization. This measure shows the same pattern as the other measures with a marked drop in liquidity in the 1990s. In the weighted average, the size of return reversals is smaller, indicating that big cap stocks are more liquid.

Figure 3. Alternative Liquidity Measures



Notes: Upper left panel shows the average liquidity in terms of return of trading a billion yen in current dollars (unadjusted for changes in aggregate market capitalization). Upper right panel shows the average liquidity using a sample of all available firms including those that joined or left the sample during the 1990s. Bottom left shows the average liquidity of a group of firms that were observed for the entire 27 year period between 1975 and 2001. Bottom right shows the weighted (by market capitalization) average liquidity of the sample.

F. Measuring of Shocks to Market Liquidity

A measure of innovations to liquidity is the adjusted average of innovations to the liquidity of each firm:

$$\Delta LIQ_t = \frac{m_t}{m_{Jan,1990}} \cdot \frac{\sum^{N_t} \{\theta^2_{k,t} - \theta^2_{k,t-1}\}}{N_t}.$$

Aggregate liquidity shocks are estimated as innovations to the following dynamic process:

$$\Delta LIQ_t = \beta_0 + \beta_1 \cdot \Delta LIQ_{t-1} + \beta_2 \cdot LIQ_{t-1} + \omega_t,$$

where the predicted change in liquidity depends on the lagged change and the deviation of the lagged level from its long-run mean (impounded in β_0). The fitted residuals are a measure of liquidity shocks:

$$lshock_t = \hat{\omega}_t \,.$$

Table 2 (part A) shows that the average standard deviation of liquidity shocks varies from period to period. The standard deviation for the entire sample is about 0.015. However, much of this volatility is concentrated in the late 1990s, where the standard deviation is above 0.027 as compared with that of 0.010 in the early 1990s.

We conduct a Breusch-Pagan LM test for conditional heteroscedasticity on the residuals and reject conditional homoscedasticity with a *p*-value of less than 10^{-4} using any number of lags between 1 and 12. We estimate a GARCH (1, 1) process for $lshock_t$.

$$\sigma_t^2 = \underset{(0.000)}{0.000} + \underset{(0.025)}{0.851}\sigma_{t-1}^2 + \underset{(0.030)}{0.190}\, lshock_{t-1}^2 . \tag{3}$$

(standard errors in parentheses)

The bottom right panel of Figure 1 shows the fitted value of the conditional variance of the shock. The volatility of the liquidity shock increased sharply during the early 1990s. Such a sharp rise was followed by a much larger rise in conditional variance in 1998 and finally an even larger jump in 2000–2001.

We calculate the correlation between the PACAP equal-weighted stock return, r_t^{MKT} and $lshock_t$ (part A of Table 2). The correlation in the entire period is about 0.27. During the early 1990s, the correlation between liquidity shocks and aggregate stock returns was as high as 0.42 and fell to 0.25 in the late 1990s. However, despite the fall in correlation, the overall exposure of firms' shares to aggregate liquidity shocks rose over the decade because of the increased variance of shocks. The covariance between the aggregate return index and the liquidity shock was about 20 percent larger in the late 1990s sample than in the early 1990s sample.

G. Liquidity Risk and Asset Pricing

To check if there is some relationship between liquidity risk exposure and the average returns, we estimate a partial liquidity beta, $\beta_{k,period}^{liquid}$, by regressing the monthly excess return on the liquidity shock over the period January 1990–December 1995.

$$r_{k,t} - i_{t-1} = \alpha + \beta_{k,period}^{MKT} \cdot \left(r_t^{mkt} - i_{t-1} \right) + \beta_{k,period}^{liquid} \cdot lshock_t + e_{k,t} \,, \tag{4}$$

where *period* is equal to the early 1990s or the late 1990s, $r_{k,t}$ is the monthly return on stock *k*, and i_t is the collateralized overnight call money rate.

The average $\beta_{k,90-95}^{liquid}$ across firms is about 1.6 while the average $\beta_{k,96-01}^{liquid}$ is slightly greater than 0.5 (part B of Table 2). Note that the median is very close to the mean for both figures. Although a given shock on returns has a smaller effect in the later period, the overall rise in the volatility of the liquidity shock means that the partial covariance of the shock (measured as the product of $\beta^{liquid}_{k,period}$ and the variance of $lshock_t$) is higher in the later period. Using Newey-West corrected, heteroscedasticity-autocorrelation consistent standard errors, we find that the percentages of firms that have significant exposures to the liquidity shocks at the 5 percent level in two sub-periods are not much different: about 33 percent of the firms have liquidity beta's which are significantly different from zero in the first sub-period while approximately 27 percent of the firms in the second sub-period do.

H. Banking Risk and Liquidity Shocks

We examine the connection between liquidity shocks and banking risk. Liquidity shocks may be the result of credit rationing which prevents speculators from borrowing money which could be used to buy stocks. We can measure banking risk by the premium that Japanese banks pay to borrow from abroad. In the late 1990s, Japanese banks paid a premium to borrow in euro markets. Ito and Harada (2000) show that this premium is connected to incidents related to both the failures of Japanese financial firms and the excess returns on banking stocks. The Bank of Japan collects data on the Japan premium from 1997. The Japan premium is persistently high during 1997 and 1998, a period when stock market liquidity is also persistently low.[6]

Table 3 summarizes the regressions results for the relationship between liquidity shocks, banking risk, and market returns. The estimated coefficient (along with Newey-West corrected standard errors) from a regression of liquidity shocks, *lshock*, on the first difference in the Japan premium, Δ*jpnprem*, suggests that increases in the Japan premium are associated with negative shocks to stock market liquidity (Table 3, column 1). This association is significant at the 1 percent level. However, the adjusted R^2 from the regression is less than 0.03, suggesting much of the variation in liquidity shocks is not directly caused by the Japan premium.

Table 3. Banking Risk Measure, Liquidity Shocks, and Market Returns

	$lshock$	r^{MKT}	r^{MKT}	r^{MKT}
$lshock_t$		0.636^{**}		0.458^{*}
		(3.35)		(2.13)
$\Delta jpnprem$	-0.056^{**}		-0.270^{**}	-0.247^{**}
	(−2.67)		(−4.29)	(−3.53)
Adjusted R^2	0.021	0.052	0.141	0.161

Notes: Regression results with the PACAP equal-weighted stock index on liquidity shocks and the change in the Japan premium. The Japan premium, as a measure of banking risk, is defined as the spread between the interest rate paid on dollar borrowing in the Japanese interbank market and the rate paid on dollars in London. The coefficient estimates are reported with Newey-West's heteroscedasticity-autocorrelation consistent *t*-values (in parentheses). **, *, † coefficients are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

[6] Banks whose credit ratings deteriorate upon adverse aggregate shocks may drop out of the international interbank market. Such dropouts are positively correlated with country risk and thus reflected in the measured Japan premium.

To examine how liquidity shocks and the Japan premium are associated with innovations to stock returns, we regress the PACAP equal-weighted market return, r^{MKT}, on *lshock* and Δ*jpnprem* over the period January 1997–December 2001. Positive innovations in liquidity are associated with relatively high stock returns (column 2). The association is statistically significant in each case at the 1 percent level. Increases in the Japan premium are significantly (at the 1 percent level) negatively associated with stock returns (column 3). Also, when we include both variables (column 4), changes in the Japan premium are still significant at the 1 percent level. The effect of the liquidity shock remains significant for the equal weighted return at the 5 percent level, even with the inclusion of the Japan premium.

III. Cross-Sectional Evidence on Market Liquidity and Growth

A. Firm-Level Variables and Descriptive Statistics

From PACAP, we extract additional firm-level variables that we consider as factors to explain cross-sectional exposure to liquidity risk. Descriptive statistics are reported in Table 4. Additional information on the data used in the paper is provided in Appendix I.

First, a large percentage of shares of the firms in our sample are owned either by financial institutions or by corporations. Shares with these kinds of cross-holdings may be less liquid. We construct a variable:

- *% of Stocks Held by Banks or Corporate Sector*–the number of shares owned by financial institutions plus shares owned by other businesses divided by the total number of shares in 1995.

In 1995, approximately two thirds of the shares of the mean and median firm are held by banks and other corporations.

Firms with high liquidity needs may be especially vulnerable to aggregate liquidity shocks. We construct a variable to measure short-term debt at the firm level:

- *Short-term Loans to Asset Ratio*–The measure of short-term loans includes accounts and notes payable, short-term loans and paper (due within one year) as well as the current portion of long-term bonds and loans which are due within the year. Short-term loans are normalized by dividing by total assets in 1995.

These liabilities constitute approximately 30 percent of assets for the mean and median firm, though the number ranges between 0 and nearly 95 percent.

To control for overall leverage, we include other kinds of liabilities.

- *Other Liabilities to Asset Ratio*–the sum of all other liabilities relative to total assets in 1995.

Other types of liabilities are approximately 30 percent of assets for the mean and median firm and are on average equal in size to short-term liabilities.

Table 4. Descriptive Statistics of Firm-Level Variables

Variable	Mean (S.D.)	Median	[Min, Max]
% of Stocks Held by Banks or Corporate Sector	0.650 (0.115)	0.661	[0.086, 0.921]
Short-Term Debt to Asset Ratio	0.304 (0.17)	0.280	[0.000, 0.942]
Other Liabilities to Asset Ratio	0.292 (0.146)	0.276	[0.016, 0.964]
Liquid Assets to Assets Ratio	0.308 (0.181)	0.272	[0.019, 0.986]
Log of Assets	11.990 (1.279)	11.862	[8.666, 16.440]
Financial Value to Book Assets	1.471 (0.397)	1.393	[0.780, 6.042]
Return on Equity	0.018 (0.152)	0.034	[–2.859, 0.460]
Growth in Net Fixed Assets (in log difference) End of 1995 to end of 2001	0.037 (0.419)	0.030	[–3.573, 1.696]
Growth in Sales (in log difference) End of 1995 to end of 2001	–0.056 (0.306)	–0.041	[–2.961, 1.237]

Notes: The table summarizes the descriptive statistics for balance sheet data from PACAP for the period 1995–2001. We also report the growth in fixed assets and sales between 1995 and 2001.

If a firm has more liquid assets, it will be less exposed to liquidity shocks. However, financially weak firms that do not have access to financial markets will fear financial strains caused by insufficient reserves of liquidity and thus try to hold more liquidity. Empirical studies with U.S. firm-level data (Opler et al., 1999; Choi and Kim, 2001; Hubbard et al., 2002) suggest that high-information-cost firms hold comparatively larger cash reserves than do other firms.[7] Thus, controlling for the size and quality of firms, we examine if firms with more liquid assets are less exposed to liquidity shocks. We construct a variable which measures firms' liquidity positions.

- *Liquid Assets to Assets Ratio*–the currency, bank deposits, and marketable securities held by the firm relative to total assets in 1995.

About 30 percent of the average firms' assets are liquid. Naturally, this constitutes a large range.

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[7] Almeida et al. (2004) suggest that financially weaker firms' liquidity position is more sensitive to cash flow shocks, compared to financially stronger firms. This reflects that financially weak firms strive to accumulate reserves of liquidity to hedge against liquidity risk while financially strong firms can raise funds from financial market in the event of financial strains.

Since liquidity shocks may be less important for large firms, which have better access to financial markets, than for small firms, we also include an asset variable as a proxy of firm size.

- *Assets*–the logarithm of the total assets (measured in millions of yen).

In addition, we include some additional balance sheet measures to control for the overall quality of the firm.

- *Financial to Book Value*–the sum of total liabilities plus market capitalization divided by total assets in 1995. This measures the cost of purchasing the firm outright relative to the accounting cost valuation of assets which is considered as a proxy of Tobin's *q*-ratio.
- *Return on Equity*–net income divided by book equity value in 1995.

The typical financial-to-book value in the sample is approximately 1.4. The average return on equity in 1997 was approximately 4 percent but the range is extremely large. Further, PACAP categorizes firms by sector at the approximately one- or two- digit level. Appendix I lists the sectors and the number of firms in our sample that fall into these shares.

B. Determinants of the Liquidity Premium

To access the determinants of the liquidity exposure of individual firms during the liquidity trap period, we regress the partial liquidity beta, $\beta_{k,96-01}^{liquid}$, which are obtained from estimating equation (4) for January 1996–December 2001, on our firm-level variables. We scale all coefficients by multiplying each by the ratio of the cross-sectional standard deviation of that variable and dividing by the standard deviation of the dependent variable, $\beta_{k,96-01}^{liquid}$. The results are reported in Table 5 (column 1), along with heteroscedasticity consistent *t*-statistics.

In general, we find evidence on the link between firms' exposures to liquidity shocks and liquidity in their equity markets or balance sheets. Indicators of equity market liquidity are associated with less exposure to liquidity shocks. We find that large firms (in terms of assets) have less exposure to liquidity shocks than small firms and this is significant at the 10 percent critical value. Firms whose shares are owned in large part by financial institutions, non-financial corporations or the government also have relatively high risk exposure, though this is marginally insignificant at the 10 percent critical value (*p*-value=0.102).

Perhaps more interestingly, firms with more liquid balance sheets are less exposed to liquidity shocks, whereas firms with more short-term debt are more exposed to the shocks. A one-standard deviation increase in short-term debt is significantly associated (at the 1 percent level) with an increase in liquidity exposure equal to 14.3 percent of a standard deviation. By comparison, a one-standard deviation increase in longer-term liabilities relative to assets is associated with an increase in liquidity exposure of 5 percent of a standard deviation. This association, however, is not significant at even the 10 percent level. Further, firms with large holdings of liquid assets are less sensitive to liquidity shocks. A one-standard deviation increase in the liquid assets to assets ratio will reduce partial liquidity exposure by 8 percent of a standard error: this relationship is significant at the 5 percent level. The positive link between

Table 5. Firm-Level Regressions

Firm Characteristics	Partial Liquidity Beta $\beta^{liquid}_{k,96-01}$	% Growth in Net Fixed Assets End of 1995 to end of 2001	% Growth in Sales End of 1995 to end of 2001
Partial Liquidity Beta: $\beta^{liquid}_{k,96-01}$		-0.130^{**}	-0.144^{**}
		(–2.61)	(–4.89)
% of Stocks Held by Banks or Corporate Sector	0.061	0.020	0.015
	(1.64)	(0.48)	(0.55)
Short-Term Debt to Asset Ratio	0.143^{**}	–0.052	-0.288^{**}
	(2.77)	(–0.90)	(–6.34)
Other Liabilities to Asset Ratio	0.050	–0.076	-0.093^{*}
	(0.93)	(–1.49)	(–2.28)
Liquid Assets to Assets Ratio	-0.083^{*}	0.002	-0.086^{*}
	(–2.04)	(0.05)	(–2.07)
Log of Assets	$-0.079^{\dagger}$	–0.029	–0.024
	(–1.89)	(–0.63)	(–0.68)
Financial Value to Book Assets	$-0.083^{\dagger}$	0.081	0.082^{*}
	(–1.85)	(1.25)	(2.20)
Return on Equity	-0.115^{*}	0.077	$0.123^{\dagger}$
	(–2.49)	(1.12)	(1.80)
Industry Dummies	Yes	Yes	Yes
No. of Observations	774	773	772
R^2	0.167	0.084	0.272

Notes: The table reports the coefficient estimates of the regressions of measures of exposure to liquidity risk and performance on firm characteristics. All variables have been scaled by their cross-sectional standard deviation so that the coefficient represents the impact (as a share of one-standard deviation of the left-hand variable) of a one-standard deviation increase in each right hand side variable. Also reported are heteroscedasticity consistent *t*-statistics. **, *, † coefficients are significantly different from zero at the 1%, 5%, and 10% levels, respectively.

corporate balance sheet liquidity and stock market liquidity perhaps indicates that stock market liquidity shocks occur simultaneously with broader shocks to liquidity in the economy including credit markets.

Higher quality firms have less exposure to liquidity shocks. Firms with high financial value relative to book value and firms that earn high profits relative to book equity have significantly less exposure to liquidity shocks. These relationships are statistically significant at the 10 percent and 5 percent critical value, respectively. Overall, the regression has an R^2 of about 17 percent.

C. Liquidity Exposure and Growth

To examine the relationship between liquidity exposure and firm growth, we first measure the growth of a firm in terms of capital investment.

- *Growth in Net Fixed Assets*–the logarithm of the ratio of net fixed assets in 2000 to net fixed assets in 1995.

Over 5 years from 1995 to 2001, our sample firms grew at 3.7 percent (an annual growth of about 0.7 percent) in net fixed assets. The cross-sectional variation of fixed asset growth is large with a standard deviation of almost 40 percent.

We also measure real growth in sales.

- *Growth in Sales*–the logarithm of sales in 2000 relative to sales in 1995.

Sales declined during the period by almost −1 percent on annual average. Again, there is large cross-sectional variation in this measure with a standard deviation of over 30 percent.

In Table 5 (columns 2 and 3), we regress measures of firm growth on liquidity exposure and other firm-level characteristics (as well as some industry dummies). The measure of liquidity exposure is the partial liquidity beta from the late 1990s period, $\beta_{k,96:01}^{liquid}$. The additional firm characteristics are those listed in the previous section. We find that firms that have high liquidity exposure also have statistically significantly (at the 1 percent critical value) slower capital growth. One-standard deviation higher in liquidity exposure is associated with 13 percent of a standard deviation decline in capital growth (which is approximately 1 percent lower fixed investment growth per year). None of the other firm-level characteristics are significant at even the 10 percent critical value.

Firms with high liquidity exposures also tend to have lower sales growth. A one-standard deviation increase in liquidity exposure is statistically significantly associated (at the 1 percent critical value) with a 15 percent of standard deviation decrease in sales growth (approximately 1 percent lower annual growth in sales). Variables related to market liquidity, such as size and shares cross-held, are not significant. However, overall high leverage levels and, especially, high short-term debt are associated with slow sales growth. A one-standard deviation increase in the short-term debt to asset ratio is significantly associated (at the 1 percent critical value) with a near 30 percent of a standard deviation lower level of sales growth (approximately 3 percent annual lower sales growth). Other liabilities relative to assets are also significantly associated with slow sales growth though the effect is smaller quantitatively. Interestingly, firms with a high liquid assets to total assets ratio in 1995 have statistically significantly (at the 5 percent critical value) slower subsequent sales growth. This result perhaps reflects that holding liquid assets to hedge against liquidity risk is costly and that such a precautionary liquidity holding may postpone or hinder investment and production for sales. A high market-to-book valuation of assets ratio significantly (at the 5 percent level) predicts subsequent sales growth and a high return on equity in 1995 also significantly (at the 10 percent level) predicts subsequent sales growth.

IV. Time-Series Evidence on Market Liquidity and the Macroeconomy: Vector Autoregression

Monetary assets are part of larger portfolios of assets. Agents may hold more liquid assets as a hedge when the liquidity risk of interest or dividend paying assets rises. In Kiyotaki and Moore (2001), money is held entirely to as a hedge against the illiquidity of real assets. An increase in money demand might lead to less liquidity available for the purchase of goods and, as in standard IS-LM analysis, lead to a decline in economic activity. Thus, one may propose that a negative shock to market liquidity increases money demand and affects adversely economic activity.

To assess this proposition, we estimate a dynamic system with a VAR with terms for real shocks, money demand shocks and money supply shocks during the post-bubble period (1990–2001). We use an economic activity/production index, y_t, for all sectors of the economy (excepting agriculture) as a measure of real activity. Ueda (1993) argues that Japanese monetary policy targets the call money rate, and Miyao (1996, 2002) describes as the operating target of the Bank of Japan during the period under consideration. We include the uncollateralized over-night call money rate, $call_t$. We use broad real money balances as a proxy for real money demand. Specifically, the variable, mp_t, is the logarithm of the ratio of M2 plus CDs—which Ito (1994) reports as the most commonly used broad money aggregate for Japan—divided by the core CPI (i.e., CPI not including food and energy). Sekine (1998) argues that financial wealth is a determinant of money demand. We include the log of the Topix stock market index, *topix*, as a proxy for wealth and to control for the effects of stock market return shocks on market liquidity. This may be important as Bayoumi (2001) has shown that shocks to asset prices have substantial real effects on the Japanese economy during this period.

Since the stock market does not display much in the way of secular growth during the post-bubble period, we measure the level of liquidity as the simple average of the response of returns to signed trading volume.

$$liquidity_t = \sum_{k=1}^{N_t} \theta_{k,t} / N_t \tag{5}$$

We do not multiply this liquidity measure by the aggregate market capitalization that may have macroeconomic effects separate from financial liquidity. The time series for *liquidity* is shown in the first panel of Figure 3.

We first conduct ADF tests on each of the variables to test for unit roots. Using a specification with four lags and including a trend term, we are unable to reject the null hypothesis of a unit root at the 10 percent level for any of the variables with the exception of *liquidity* for which the null hypothesis is rejected at any reasonable critical value. Using the Johansen trace statistic in a specification with four lags and a trend term we are unable to reject the hypothesis that *y, mp,* or *call* is cointegrated with *topix*. We therefore estimate the VAR in a level specification.

We estimate a VAR in [*y, call, mp, liquidity, topix*] with 12 lags, a trend term and a dummy variable for January 2000, the millennium period with the anomalously large, positive liquidity realization. The Akaike Information Criterion indicates a second order VAR. However, this strikes us as too few lags to capture the dynamics of the monthly system.[8] Instead, we estimate the VAR with 12 lags which may be fairly typical for the VAR estimation with monthly data.

We identify shocks to the system using the Choleski decomposition interpreting them as, in order: real shocks, money supply shocks, money demand shocks, liquidity shocks and stock price shocks. Ordering the variables in this way, [*y, call, mp, liquidity, topix*], implies a number of identifying assumptions about the short-run dynamics of the model. We assume each of the shocks could have immediate effects on the price of the stock market. In particular, this ordering implies that innovations in the aggregate price of stocks have no immediate impact on stock market liquidity. However, we do allow market liquidity to respond immediately to all macroeconomic shocks. Following Miyao (2002), we treat exogenous innovations in the call money rate as monetary policy shocks and allow the call money rate to respond immediately to real output shocks. Also, we allow money demand to respond immediately to output and the interest rate. However, real output responds only with a lag to monetary policy shocks.

Figure 4 displays all of the impulse responses along with two-standard error bands. However, we concentrate on discussing the effects of liquidity shocks on the macroeconomic variables and the effects of various shocks on stock market liquidity. We find that liquidity shocks affect significantly macroeconomic variables. Liquidity shocks affect output in the real economy, but the impact of stock market liquidity on the economic activity index is small and short-lived. A one-standard deviation increase in liquidity results in an initial increase in output of about 0.2 percent. After 1 period, the increase in output is not statistically significant at even the 10 percent level. Liquidity shocks never explain more than 7 percent of variation in *y* at any frequency.

Liquidity shocks have persistent and statistically significant impacts on real balances. A positive shock to stock market liquidity leads to a reduction in the demand for more liquid real balances. Indeed, variance decomposition shows that liquidity shocks explain more than 16 percent of the variation in real balances at a frequency of 18 months. Liquidity shocks have macroeconomic effects which are consistent with persistent money demand shocks. A positive liquidity shock also leads to a statistically significant decline in (nominal) interest rates, consistent with the reduced money demand after the shock. However, the effects of liquidity shocks on asset markets themselves seem more transitory. Liquidity shocks have very short-lived effects on the stock market index, *topix,* reverting to mean after a couple of periods.

Next, we find that market liquidity is significantly affected by shocks to output and *topix* but not by shocks to money market variables, call rates and real balances. Shocks to *topix* have a short-lived impact on stock market liquidity, suggesting that a rise in the stock price index attracts liquidity to the stock market at least temporarily. Shocks to economic activity also have

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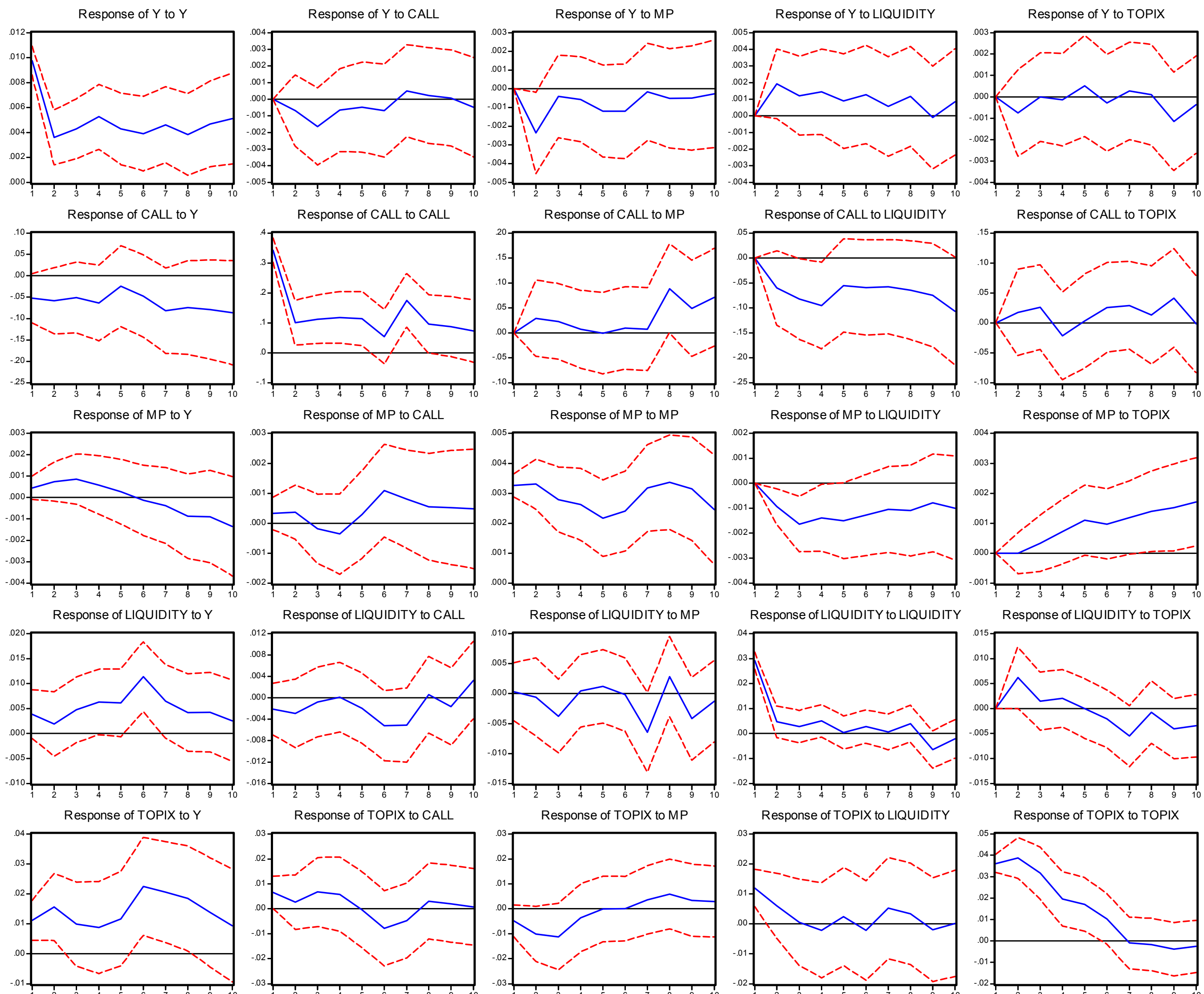
[8] In particular, a very low order VAR suggests that liquidity shocks have fairly large and persistent effects on output and real balances. In such a low order VAR, macroeconomic shocks have insignificant effects on liquidity.

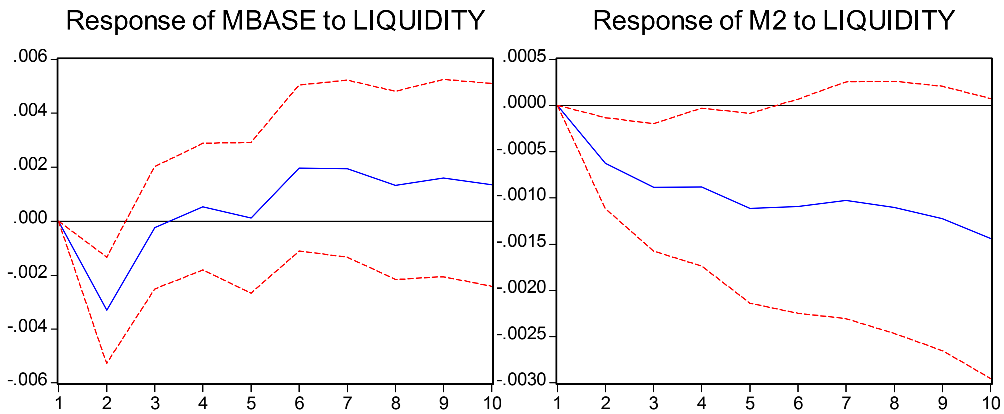
significant impacts on stock market liquidity. A positive innovation in *y* leads to a persistent increase in *topix* and an increase in stock market liquidity that persists for about 6 months. At the 18 month frequency, about 20 percent of the variation in stock market liquidity comes from shocks to *y.* However, neither shocks to call rates nor shocks to real balances have significant effects on stock market liquidity, while liquidity shocks significantly affect both call rates and real balances: in essence, the liquidity shocks could be thought of as general liquidity preference shocks which feed into money and asset markets.

Figure 4. Impulse Responses of a Five-Variable VAR



Notes: The figure shows the impulse response functions (along with two-standard error bands) of a five variable VAR, including in order economic activity index, *y*, the uncollateralized call money rate, *call*, real balances, *mp*, which is M2 plus CDs divided by the core CPI, our measure of average stock market liquidity, *liquidity*, and a stock market index, *topix.* The VAR is estimated with 12 lags, a trend term, and a dummy for the anomalous millennium period.

Figure 5. Money and Interest Rate Responses



Notes: The figure shows the responses (along with two-standard error bands) of two monetary aggregates to identified stock market liquidity shocks. The monetary aggregates are the monetary base, *mbase*, and M2 plus CDs, *m2*. Shocks are identified using VARs with 12 lags, a trend, and a millennium dummy.

We are also interested in the response of the nominal money supply to stock market liquidity shocks. To look at the response of narrow money, we define *mbase* as the natural log of the monetary base; to look at broad money, we define *m2* as the log of M2 plus CDs. We estimate VARs in [*y, call, mbase, liquidity, topix*] and [*y, call, m2, liquidity, topix*] with 12 lags, a trend term, and a millennium dummy. Figure 5 depicts the impulse responses of the monetary aggregates to a one-standard deviation along with two-standard error bands. There seems to be a qualitative difference. The amount of banks reserves held after a positive liquidity shock declines sharply and immediately. However, after just one period, the supply of reserves returns to the pre-shock level. By contrast, the positive liquidity shock leads to a reduction in the demand for M2 that occurs much more slowly but more persistently. Interpreted as a persistent decline in money demand that occurs due to a decrease in asset market liquidity risk which is not fully accommodated by a reduction in the monetary base, this could explain why the interest rate in interbank lending markets fall persistently following a liquidity shock.

V. CONCLUSIONS

We find evidence that during the recent deflationary period, Japanese equity markets were highly illiquid and subject to increasingly volatile liquidity shocks. Our intention in this paper was to show some of the causes of this decline in liquidity as well as some of the interactions between stock market liquidity and the macroeconomy.

Financial market evidence suggests that these liquidity shocks affected the equity returns of firms during the slump that followed the bursting of Japan's late-1980s bubble. We find cross-sectional evidence that firms with illiquid balance sheets and illiquid markets for their equity were more exposed to these shocks and that this exposure was a predictor of the performance of the firms during this period. We interpret the high exposure to equity liquidity shocks of firms with high short-term debt as indicating that the liquidity shocks to the stock market were also correlated with liquidity shocks in broader financial markets, including credit markets. This interpretation is supported by time-series evidence that liquidity shocks have even more persistent effects on money demand than on equity market prices.

Using aggregate market liquidity, we find evidence that liquidity shocks in the Japanese stock market are associated with some macroeconomic events. Large declines in liquidity occurred simultaneously with international financial shocks such as those that occurred in September 1998 and September 2001. Exogenous liquidity shocks seem to have a persistent negative effect on money demand and interest rates, as well as some short-term effects on output. Time-series evidence also shows that the large initial declines in liquidity occurred simultaneously with a wave of bankruptcies of Japanese financial intermediaries, including financial firms. Statistically, the Japan premium (i.e., the extra cost of short-term borrowing imposed on Japanese banks) is strongly associated with stock market liquidity. In general, exogenous negative business cycle shocks reduced stock market liquidity. Stabilizing aggregate demand in the face of such a liquidity shock may require the monetary authority to reduce interest rates. Since 1999, Japanese monetary policy has been characterized by zero interest rates, the lower bound that prevents the full accommodation of liquidity shocks. The policy of quantitative easing undertaken by the Bank of Japan since March 2001, which led to an unprecedented high level of current account balances, may have provided ample reserves to the financial sector. However, such a measure was not promptly transmitted into the expansion of lending and broad money (M2+CDs) enough to stimulate the economy and to reverse lowered stock market liquidity.[9]

Since interest rates cannot fall below zero, whether the monetary authorities can provide an additional stimulus to the economy remains in question. However, the evidence presented here suggests channels through which the central bank can affect the real economy at zero interest rates. Enhancing stock market liquidity and reducing liquidity risk faced by investors could promote firm-level growth. By providing liquidity to equity markets, through easy credit to securities firms or other market makers, the central bank could reduce the liquidity risk faced by investors. It has long been recognized that providing liquidity to financial markets during panics is an important part of central bank management. In the environment faced by Japan over the last decade, with a persistently illiquid market buffeted by volatile liquidity shocks, a more systematic provision of liquidity to equity markets may offer substantial benefits. In the face of deflationary conditions, this is likely to be advantageous. However, it should be cautioned that a commitment to providing liquidity to financial markets on a permanent basis may have an inflationary bias in the long run.

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[9] The intermediary functions of the money market declined at the extremely low interest rate. With the quantitative easing policy, financial institutions—including banks, securities companies, and securities finance companies—have accumulated rapidly current balance accounts with the Bank of Japan. Despite the resulting large increases in monetary base, however, financial intermediation was not revived because financial institutions built up the unprecedented level of excess reserves (see Hetzel, 2004).

A. Stock Market Data

Data on individual firms' returns are from the PACAP (Pacific Capital Markets) database. For each share in our sample, we use daily returns without dividends reinvested (PACAP mnemonic: DRETND) and trading values (TRDVAL). Daily returns are daily equally weighted market returns without cash Dividends reinvested (DERMND). We also use (TRDVAL) monthly data on trading values and market capitalization (MKTCAP). We also use a PACAP monthly return which is monthly equally weighted market returns without cash dividends reinvested (MERMND). Turnover and market capitalization in the stocks in the Tokyo Stock Exchange Topix Index are from CEIC DRI Asia Database.

B. Cross-Sectional Data

To construct cross-sectional data on firms, we use data from a PACAP database on balance sheets that contains our main measure of firm size and normalization variable on Total Assets (PACAP mnemonic: BAL22). *Short-term Loans to Asset Ratio* is the sum of Accounts & Notes Payable (BAL10) and Short-term Loans (BAL11) divided by Total Assets. *Other Liabilities to Asset Ratio* is Total Liabilities (BAL17) divided by Total Assets minus *Short-term Loans to Asset Ratio*. We measure *Liquid Assets to Assets* ratio is the sum of Cash (BAL1) plus Marketable Securities (BAL2) divided by Total Assets. *Financial to Book Value* is the sum of Total Liabilities plus the product of number of shares of common stock (MKT5) and share price (MKT3) divided by Total Assets. *Return on Equity* is Net Income (INC9) divided by Total Shareholder's Equity (BAL21). We construct *% of Stocks held by banks or corporate sector* as the number of Shares Owned by Government & Local Government (JAF75) plus the number of Shares Owned by Financial Institutions (JAF76) plus the number of Shares Owned by Other Business Corporations (JAF78) divided by Total Shares Owned (JAF81). We also measure growth in *Net Fixed Assets* (BAL7) and *Sales* (INC1).

Industry-level dummy variables are also created to match the following industries:

AGRICULTURE AND FORESTRY	1	MINING	8
AIR TRANSPORTATION	3	NONFERROUS METALS	20
CHEMICALS	107	OTHER MANUFACTURING	24
COMMUNICATIONS	1	PETROLEUM	6
CONSTRUCTION	75	PRECISION EQUIPMENT	18
ELECTRIC MACHINERY	99	PULP AND PAPER	12
ELECTRIC POWER AND GAS	14	REAL ESTATE	15
FINANCIAL (Non Bank & Securities)	10	RETAIL	39
FISHERY	5	RUBBER	8
FOODS	51	SERVICES	22
GLASS AND CERAMICS	21	SHIPPING	8
IRON AND STEEL	30	TEXTILES	34
LAND TRANSPORTATION	22	TRANSPORTATION EQUIPMENT	56
MACHINERY	56	WAREHOUSING AND WHARFING	7
METAL PRODUCTS	13	WHOLESALE	43
TOTAL	828		

C. Time-Series Data

Time-series data are obtained from the OECD Main Economics Indicators.

topix: The Tokyo Stock Exchange Topix Index
cpi: CPI Services Less Housing (1995 = 100)
M2: M2 plus CD (trillions of yen, seasonally adjusted)

Additional data are obtained from the CEIC DRI Asia database.

MB: Monetary Base (monthly average, billions of yen, seasonally adjusted with X-12)
y: All Industry Activity Index (1995 = 100, seasonally adjusted with X-12)
call: Uncollateralized Overnight Rate (%)

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