The Macroeconomic Effects of Stock Market Liquidity:
Evidence from Japan

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Abstract In a liquid financial market, investors are able to sell large blocks of assets without significantly changing the price. We document a steep drop in the liquidity of Japanese stock markets in the post-bubble period and a steep rise in liquidity risk. We find that firms with more liquid balance sheets are less exposed to stock market liquidity risk, while high exposure to liquidity shocks is associated with slow firm-level growth during Japan's deflationary period. Aggregate liquidity has macroeconomic effects on aggregate demand through its effect on demand for monetary assets which has not been fully accommodated by the monetary authorities.

I.   Introduction

In a liquid financial market, investors can buy or sell large asset stakes without changing the market price. Recent research has shown that there is substantial variation over time in the liquidity of major world financial markets and that the unpredictability of market liquidity is an important source of risk for investors. Here, we study some of the implications of liquidity risk for the aggregate economy. We find that, over the last decade, liquidity shocks in the Japanese economy have been an important source of real and nominal macroeconomic volatility. Financial liquidity shocks impact the demand for monetary assets and thus can affect the real demand for goods.

During the late 1990s, Japan entered a period of prolonged deflation, slow growth and near zero interest rates. In this paper, we examine one aspect of the Japanese stock market during this period. During the very early 1990s, equity prices fell drastically from heights which 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. In this paper, we document a large and persistent decline in stock market liquidity during the 1990s. In illiquid stock markets, investors will be unable to sell large amounts of shares in a stock without a sharp decline in the price of the shares. We show that the impact of stock trading on share prices increased dramatically following the collapse of the bubble. Further, the volatility of shocks to financial market liquidity also increased dramatically during the 1990s.

A number of factors may have led to less asset market liquidity during the late 1990s. First, Japanese banks experienced substantial shocks to their balance sheets

during the 1990s. If market makers and other investors in Japan face credit constraints, this may reduce 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. Third, during this time period, there were substantial shocks to liquidity in world and East Asian financial markets potentially increasing the exposure of Japanese firms. At the microstructure level, the Tokyo Stock Exchange implemented an auction based order system in late 1990 dispensing with market makers (Tokyo Stock Exchange).

We consider some channels through which financial market liquidity shocks may affect the macroeconomy. Naturally, a rise in equity risk will tend to raise the cost of capital for firms that finance investment through this channel. Using time-series and cross-sectional data, we find that exposure to liquidity risk was an important determinant of investment.

Another channel through which liquidity shocks may affect the economy is through their effects on the liquidity portfolios. 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 portfolio balancing 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 breakdown 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 evidence that shocks to financial market liquidity have effects on the economy that are similar to textbook effects of money demand shocks.

In measuring stock market liquidity, we closely follow Pastor and Stambaugh's (2003) measure of U.S. equity market liquidity. Those author's use the degree to which the quantity of trading of stocks affects the market price of stocks to measure liquidity. In a liquid market, large sales of stocks can be made without substantially changing prices. Campbell, Grossman and Wang (2003) construct a model in which risk-averse market makers require a premium to buy large quantities of stock. Amihud and Mendelson (1986) is an early study of the relationship between market liquidity and stock returns. Chordia, Sarkar and Subrahmanyam (2002) find that there are aggregate liquidity fluctuations in the U.S which affect both bond and stock markets and which are correlated with monetary policy. Stahel (2004) finds that there is a global liquidity shock which affects stock markets in both the US and Japan. Hamao, Mei, and Xu (2003) find a dramatic decrease in trading volumes in the Japanese Stock market after the bubble burst.

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. Section III looks at some firm level cross-sectional determinants of liquidity risk and the real impact of exposure to liquidity risk. We find that the liquidity of individual corporate balance sheets predict how exposed their shares will be to liquidity shocks. Moreover, exposure to liquidity shocks helped determine the extent to which firms are able to grow during the crisis. In Section IV, we examine the dynamic response of some macroeconomic variables to liquidity shocks using vector auto-regressions. We find that a decline in stock market liquidity is followed by a decline in output, investment, employment and aggregate price levels.   An examination of money

markets suggests that a decline in stock market liquidity leads to rising demand for real monetary balances which have not been fully accommodated by monetary authorities.

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 share 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 OLS, we estimate the following equation:

$$r_{k,d,t}^{xs} = \theta_{k,t}^0 + \theta_{k,t}^1 \cdot r_{k,d-1,t} + \theta_{k,t}^2 \cdot \text{sign}(r_{k,d-1,t}^{xs}) \cdot vol_{k,d-1,t} + \varepsilon_{k,d,t} \qquad (1.1)$$

where $r_{k,d,t}$ is the return on the stock of company k on day d of month t. Define $r_{d,t}^{MKT}$ as the equal weighted return on Japanese stocks in the Pacific Capital Markets (PACAP, see Data Appendix) database. The excess return, $r_{k,d,t}^{xs} = r_{k,d,t} - r_{d,t}^{MKT}$ is measured as the difference between the return on stock k and the market return. The $\text{sign}(r_{k,d-1,t}^{xs})$ 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, positive excess returns will be observed.

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Campbell, Grossman, and Wang (1993) construct a model in which a large value of shares traded generates reversals in returns.[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.

The parameter $\theta_{k,t}^2$ measures the degree to which sales affect returns and thus might be thought of as a measure of liquidity in that particular market. In illiquid markets, we should expect to see $\theta_{k,t}^2$ at negative levels. Further, the less liquid the markets, the more negative will be $\theta_{k,t}^2$. The parameter measures the cost in terms of returns of selling a billion yen worth of shares.

We estimate $\theta_{k,t}^2$ for each stock-month for which there are at least 9 usable observations and for which the previous and the subsequent month has at least 9 usable observations. From the PACAP database, we choose a set of 828 non-financial firms for which we are able to estimate $\theta_{k,t}^2$ 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[4]. We choose this criterion so that we have a consistent sample of firms during the 1990s. In particular, we exclude firms whose equity permanently ceases trading at some point, so as to avoid contaminating the sample with the results of buyouts or bankruptcies.

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[3] Chao and Hueng (2003) show that return reversals are a prevalent phenomenon of the Japanese stock market.

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 which grows with time. By construction, there are an approximately constant number of firms after 1989.

Table 1 also shows some properties for the shares of our sample in comparison to a broader index of stocks from PACAP. The equal-weighted average monthly return (not including dividends) for shares in the overall sample of firms is about .8% per month; in our smaller sample, the average return is slightly smaller at .6% per month. We later 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, returns are negative. In both periods, they are slightly worse for the large sample as for our narrower sample. We also calculate the standard deviation of monthly returns for the overall period and for the sub-periods in the 1990s.

As the paper discusses liquidity, we report 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 relative to end of period market capitalization. In the whole period, about 4% of the value shares in the Topix index are traded in the average month. Our sample is slightly more liquid with about 5% value traded. In both samples, turnover is lower in the early and late Nineties than in the entire period. In both sub-periods, turnover is slightly larger in our sample than the Topix sample.

We calculate an aggregate measure of the market value, m_t, of the shares for which we are able to calculate $\theta_{k,t}^2$.

$$m_t = \sum^{N_t} mktcap_{k,t} \qquad (1.2)$$

where $mktcap_{k,t}$ is the end-of-month market capitalization of stock k in month t. Panel B in Figure 1, shows the average market capitalization m_t/N_t during each period. In the mid-1970s, the average firm in the sample has a market cap of approximately $45 billion yen. Over the 1970s and 1980s, average market capitalization grows rapidly to a peak of nearly $500 billion in late 1989 before falling rapidly to a level near $200 billion. Over the 1990s, average market capitalization fluctuates between $200 and $300 billion.

Chordia, Roll, and Subrahmanyan (2000) find that average market liquidity in the US (as measured by bid ask spreads) shows substantial variation over time. Following Pastor and Stambaugh (2003), we calculate a measure of average market liquidity, LIQ_t, as follows:

$$LIQ_t = \frac{m_t}{m_{Dec,2001}} \left. \sum_k^{N_t} \theta_{k,t}^2 \middle/ N_t \right.$$

We average the liquidity parameter across the firms for which we have usable observations in a particular month t. The parameter measures the effect of a billion yen on stock returns. Since the impact of a billion yen may change over time due to market growth and inflation, the average of $\theta_{k,t}^2$ 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.

Panel C in Figure 1 shows the time path of LIQ_t. The aggregate market liquidity is negative in almost every period. This fits the theory that heavy trading results in return reversal due to illiquidity. Further, there is substantial variation in aggregate market liquidity. The mean level of liquidity is -.014 so that sales of 1 billion yen (roughly in 2001 yen) result in expected returns of 1.4% in a month. The market is becoming less liquid over time. The average level of LIQ_t falls to -.02 in the

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early 1990s and falls further to below -.03 by the late 1990s, approximately double 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% critical value (regardless of whether a deterministic trend term is included).

Interestingly, there are deep declines in liquidity in October 1987, November 1997, and September 1998, indicating that the Japanese stock market may be exposed to international liquidity shocks. Note also there is a large, anomolously positive observation in the first month of the new millennium.

We also examine some alternative measures of liquidity shown in Figure 1A. The first panel shows the pattern of $\sum^{N_t} \theta_{k,t}^2 \Big/ N_t$, which is unadjusted for changes in market capitalization over time. This measure shows that the impact of trading of 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 sales of stock become much smaller, beginning to rise dramatically again in the 1990s just as in the benchmark series, *LIQ*. The second and third panel shows alternative measures of *LIQ$_t$* for different sets of firms. The first set of firms includes all of the non-financial firms available in which an estimate of $\theta_{k,t}^2$ in that time period. The number of firms ranges from about 500 in 1975 to about 1400 by 2001. In this broad set of firms we find a similar pattern as in our benchmark model of liquidity. During the 1970's and 1980s, we find that stock market liquidity is relatively high. During the 1990s, the aggregate liquidity begins to fall. After 1997, stock market liquidity on average drops dramatically and the volatility of liquidity movements rises. The third alternative measure of liquidity is a the average $\theta_{k,t}$

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(weighted across time by aggregate market cap) 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. We also see that amongst this group of more established companies; the average level of liquidity is higher than in the broader sample. We also construct a weighted average of the $\theta_{k,t}$ with the weight for each firm being the end of month market capitalization. This weighted average again shows the same pattern as the other measures with a marked drop in liquidity in the 1990s. It should be noticed that in the weighted average, the size of return reversals is smaller indicating that big cap stocks are more liquid.

B. **Measuring Shocks to Stock Market Liquidity**

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

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

Aggregate liquidity shocks are estimated as innovations to the dynamic process

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

The fitted residuals are a measure of liquidity shocks.

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

The average standard deviation of liquidity shocks varies from period to period. The standard deviation for the entire sample is about .014. However, much of this volatility is concentrated in the late 1990s sub-period, where the standard deviation is above .027 as compared to a standard deviation of .01 in the early 1990s sub-period.

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We conduct a Breusch-Pagan LM test for conditional heteroskedasticity on the residuals. We reject conditional homoskedasticity with a p-value of less than .0001 using any number of lags between 1 and 12. We estimate a GARCH (1,1) process for $lshock_t$.

$$\sigma_t^2 = \underset{(.000)}{.000} + \underset{(.025)}{.851}\,\sigma_{t-1}^2 + \underset{(.030)}{.190}\,lshock_{t-1}^2 \tag{1.3}$$

In Figure 1, the last panel shows the fitted value of the conditional variance of the shock. A sharp increase in the volatility of the liquidity shock occurs during the early 1990s followed by a much larger rise in conditional variance in 1998 and finally an even larger jump in year during 2000-2001.

We calculate the correlation between the PACAP equal-weighted stock return, r_t^{MKT} and $lshock_t$. The correlation in the entire period is about .27. During the early 1990s, the correlation between liquidity shocks and aggregate stock returns is as high as .42 and falls to .25 in the late Nineties. However, despite the fall in correlation, the overall exposure of firm's shares to aggregate liquidity shocks rises over the decade due to the increase in the variance of shocks. The covariance between the aggregate return index and the liquidity shock is about 20% larger in the later Nineties sample than in the early 1990s sample.

We observe that the average returns in the later period are also lower. To check if there is some relationship between liquidity risk exposure and these returns, we estimate a total liquidity beta by regressing the monthly return on the liquidity shock over the period January 1990 to December 1995.

$$r_{k,t} - i_{t-1} = \alpha + \beta_{k,period}^{MKT} \cdot \left(r_t^{mkt} - i_{t-1} \right) + \beta_{k,period}^{liquid} \cdot lshock_t + e_{k,t} \tag{1.4}$$

where period is equal to the early 90's or the Late 90's; $r_{k,t}$ is the monthly return on stock k and i_t is the collateralized overnight call money rate. The average $\beta_{k,90:95}^{liquid}$

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across firms is about 1.5 while the average $\beta_{k,96:01}^{liquid}$ is slightly greater than .5. Note that

the median is very close to the mean for both figures. Though the size of the effect of

a given shock on returns is smaller 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 $\beta_{k,period}^{liquid}$ and the variance of lshockt) is higher in the later part of the

sample. Using Newey-West corrected, heteroskedasticity auto-correlation consistent

standard errors, we find that approximately the same % of firms have significant

exposure to the liquidity shocks in both sub-periods at a 5% significance level:

approximately 33% in of the firms have liquidity beta's which are significantly

different from zero in the first sub-period while approximately 27% of the firms in the

later sample do.

III.   Cross-Sectional Evidence

A. Firm level variables

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 2. First, a large percentage of shares of the firms in our sample are

owned either by financial institutions or by business corporations. Shares with these

kinds of cross-holdings may be less liquid.

We construct a variable:

- ◆ *% of Stocks held by banks or corporate sector* that is the number of
  shares owned by financial institutions plus shares owned by other
  businesses divided by the total number of shares in 1995.

We see that in 1995, approximately two thirds of the shares of the mean and median

firm are held by banks and other corporations.

Firms with high needs for liquidity may be especially vulnerable to aggregate liquidity shocks. We construct a variable measuring firm's level of short-term debt:

◆ *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 with the year. Short-term loans are normalized by dividing by total assets in 1995.

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

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

◆ *Other Liabilities to Asset Ratio* which is the sum of all other liabilities relative to total assets in 1995.

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

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 market will fear financial strains caused by insufficient reserves of 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 stocks of cash reserves than do other firms.[5] 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' liquid asset holdings.

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[5] Almeida et al. (forthcoming) 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.

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

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

Liquidity shocks may naturally be less important for large firms than for small firms. We also include the log of total assets as a proxy of firm size.

◆ *Assets* which is 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* which is 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* which is 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% but the range is extremely large.

In addition, PACAP categorizes firms by sector at the approximately 1 or 2 digit level. Table 3 lists the sectors and the number of firms in our sample that fall into these shares.

B. Liquidity Premium

We estimate some of the determinants of the liquidity exposure of individual firms during the liquidity trap period. We regress the partial liquidity beta, $\beta_{k,96:01}^{liquid}$, from January 1996 to December 2001on 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 3, along with heteroskedasticity

consistent t-statistics.

In general, we find evidence that firms with high exposures to liquidity shocks

are those whose equity markets or balance sheets might be thought to have been

illiquid. 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% 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% critical value (*p*-value .102).

Perhaps more interestingly, firms whose balance sheets are liquid also have

less exposure to the shocks. Firms with high shares of short-term debt have greater

exposure to the shock. A one standard deviation increase in short-term debt is

significantly associated (at the 1% critical value) with an increase in liquidity

exposure equal to 14.3% 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% of a standard deviation. This association is not

significant at even the 10% level. Further, firms which themselves have large holdings

of liquid assets are less sensitive to liquidity shocks. A one standard deviation

increase in the liquid assets to total assets ratio will reduce partial liquidity exposure

by 8% of a standard error. This relationship is significant at the 5% critical value. This

positive link between corporate liquidity and stock market liquidity perhaps indicates

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that stock market liquidity shocks occur simultaneously with broader shocks to liquidity in the economy.

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% and 5% critical value respectively. Overall, the regression has an R^2 of about 17%.

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* measures the logarithm of the ratio of net fixed assets in 2000 to net fixed assets in 1995.

Over 5 years, the firms in our sample experience average growth in their fixed assets of 3% for an annual growth rate of less than .6%. The cross-sectional variation of fixed asset growth is large with a standard deviation of almost 40%.

We also measure real growth in the sales of firms.

◆ *% Growth in Sales* measures the logarithm of sales in 2000 relative to sales in 1995.

The average growth in sales is negative over the period, averaging an annual negative growth rate of almost -1%. Again, there is large cross-sectional variation in this measure with a standard deviation of over 30%.

In Table 3, (columns B and C), 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% critical value) slower capital growth. One standard deviation higher in liquidity exposure is associated with 13% of a standard deviation decline in capital growth (which is approximately 1% lower fixed investment growth per year). None of the other firm-level characteristics are significant at even the 10% critical value.

Liquidity exposure is also an important determinant of sales growth. A one standard deviation increase in liquidity exposure is statistically significantly associated (at the 1% critical value) with a 15% of standard deviation decrease in sales growth (approximately 1% lower annual growth in sales). Variables related to market liquidity such as size and shares cross-held are not significant. However, overall leverage levels and, especially, 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% critical value) with a near 30% of a standard deviation lower level of sales growth (approximately 3% 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% critical value) slower subsequent sales growth. This 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% level) predicts subsequent sales growth and a high return on equity in 1995 also significantly (at the 10% level) predicts subsequent sales growth.

IV.   **Time Series Evidence**

In this section, we examine the dynamic response of the economy to liquidity shocks during the post-bubble period (1990-2001). During the post-bubble period, we observe that the stock market does not display much in the way of secular growth. Therefore we measure the level of liquidity as the negative of the simple average of the response of returns to signed trading volume.

$$liquidity_t = \frac{\sum_{N_t} \theta_t}{N_t} \qquad (1.5)$$

We do not multiply this liquidity measure by the aggregate market capitalization since changes in the value of the stock market may have macroeconomic effects separate from financial liquidity. The time series for *liquidity* is shown in the first panel of Figure 2.

A. Financial Market Effects

First, we estimate the dynamic inter-relationship of the response of this variable with the Tokyo stock market index, *topix*. An adjusted Dickey-Fuller test on *liquidity* (with 4 lags allowing for a constant and linear trend) rejects the hypothesis that the measure of stock market liquidity has a unit root at the 1% critical value. A similar test performed on the log of $topix_t$ fails to reject a hypothesis of a unit root at the 10% critical value. We estimate a monthly VAR in [$liquidity_t$, $\Delta topix_t$] over the post-bubble period January, 1990 to December, 2001. Our method for choosing VAR lag-lengths will be to choose the maximum of either 2 or the argmax of the Akaike, Schwarz, or Hannan Quinn Information criterion, a methodology we follow throughout. We choose a lag length of 3 and include a linear trend as well as a dummy variable equal to 1 in January 2000, the period of the anomalously large positive measure of liquidity.

In Figure 2, we show the impulse response to shocks to the VAR identified through Cholesky decomposition along with two-standard-error bands. Our ordering of the series indicates liquidity shocks can have an immediate effect on stock returns, but shocks to stock returns will only draw liquidity to the market with a lag. We see that a negative shock to liquidity has a contemporaneous negative effect on the stock market (which is unsurprising given our results in section II). A decrease in liquidity will cause negative growth in the stock market (with a permanent negative decline in the level of the stock market). Conversely, with some lag, a positive shock to stock prices results in a long-lasting, statistically significant increase in market liquidity. This inter-relationship between stock prices and stock market liquidity indicates that may be important to control for shocks to stock market returns in assessing the impact of market liquidity on the macroeconomy. This is especially true since Bayoumi (2001) has shown that shocks to asset prices have substantial real effects on the Japanese economy during this period.

B. Real Effects

We examine some of the effects of liquidity shocks on some real variables including production and employment. Using an adjusted Dickey-Fuller test (with 4 lags and a trend), we are unable to reject (at the 10% level) a unit root in the total labor force unemployment rate, ur_t, the natural log of the final goods industrial production index, IP; and the natural log of the consumer price index, CPI. Using a Johansen co-integration test (again with four lags, an intercept and trend in the data and an intercept in the co-integrating vector), we reject at the 1% level, the hypothesis that any of these three variables is not co-integrated with the stock market index.

Estimating a VAR will provide consistent estimators when co-integrating

vectors exist [6]. We estimate a VAR in the levels [*CPI, ur, IP, liquidity, topix*] with 2

lags, a linear trend and a millennium dummy. Using a Granger style block exogeneity

test, we cannot reject (at the 10% level) the hypothesis that lags of *CPI, ur,* or *IP* do

not directly predict *liquidity*. We reject the hypothesis that lags of *liquidity* do not

directly predict *CPI* and *ur* at the 10% level and the 5% level. In other words, stock

market liquidity Granger causes prices and the unemployment rate. We cannot reject

the hypothesis that lags of *liquidity* do not directly predict *IP*.

We also report (in Figure 3) impulse response functions for the response of the

unemployment rate to equity market based shocks identified through a Cholesky

decomposition along with two standard error bands. The ordering of our vector

assumes that liquidity shocks and stock market shocks do not have contemporaneous

impacts on the unemployment rate, prices or industrial production while the stock

market does not have contemporaneous impacts on liquidity. Consistent with sticky

prices, our ordering assumes that shocks to other variables do not have

contemporaneous effects on the price index. We also assume that the unemployment

rate does not respond contemporaneously to shocks to industrial production,

identifying the latter as productivity shocks.

We find that a shock that reduces financial market liquidity leads to a

persistent rise in the unemployment rate that is significant for more than a year. Note,

that this result is not dependent on the Cholesky ordering of stock market liquidity

and stock returns. A shock that reduces stock market liquidity will lead to a persistent

decline in production and prices. A one standard deviation decrease in stock market

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[6] A VAR model in levels is consistent with a vector error correction representation. It accounts for
information contained in long-run relationships while a VAR in first difference may not. We estimate
the VAR without imposing cointegrating vectors, since our main purpose is to obtain consistent
estimates of impulse responses.

liquidity leads to a statistically significant, approximately .1% decline in *CPI* and a statistically significant, .3-.4% decline in industrial production. Using a variance decompositions, we see that liquidity shocks explain about 10% of variation in *IP* and about 25% of the variation in *CPI* and *ur* at the horizon of 24 months.

C. Real Demand for Investment

To assess the channel through which shocks to liquidity affect the real economy, we turn to quarterly national income data. We construct a variable $(bfi/gdp)_t$ which is the natural log of the ratio of non-residential fixed investment to GDP. An adjusted Dickey fuller test with 4 lags and a trend fails to reject the hypothesis of a unit root in $(bfi/gdp)_t$ as shown in Table 5. We fail to reject the hypothesis of no co-integration between $(bfi/gdp)_t$ and *topix$_t$*. To convert the monthly measure of *liquidity* into a quarterly measure, we use the most negative (least liquid) observation of *liquidity* for each quarter. We estimate a VAR in $[\Delta (bfi/gdp)_t, liquidity, \Delta topix_t]$ with 2 lags and a linear trend. Using a block exogeneity test, we are able to reject the hypothesis that *liquidity* does not Granger cause $\Delta (bfi/gdp)_t$ at the 5% critical value. We report the impulse response function which shows the response of business investment demand to a stock market liquidity shock. We find that a one-standard-deviation negative liquidity shock leads to a statistically significant and persistent two percent decline in business investment relative to GDP. We find that at a horizon of 2 years, the liquidity shock explain about 14% of the forecast variance of $\Delta \frac{bfi}{gdp}_t$.

D. Money Demand and Money Supply

What explains the real effects of liquidity shocks on employment, production and demand? Money assets are part of a larger portfolio of assets. When the liquidity risk

of interest or dividend paying assets increases, agents may hold more liquid assets as a hedge against the risk. In Kiyotaki and Moore (2001), money is held entirely 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.

To assess this hypothesis, we examine the response of velocity of money as a proxy for (the inverse of) real money demand. The variable $velocity_t$ is specifically the logarithm of the ratio of the product of industrial production and the CPI divided by broad money. For broad money, we use M2 plus CDs, which Ito (1992) reports as the most commonly used broad money aggregate for Japan. Interest rates are a traditional determinant for money demand, so we include an interest rate in the VAR. Ueda (1993) argues that Japanese monetary policy targets the call money rate. We include the uncollateralized over-night call money rate, $call_t$, which Miyao (2001) describes as the operating target of the Bank of Japan during the period under consideration. Sekine (1998) argues that financial wealth is a determinant of money demand. The *Topix* index can act as a proxy for wealth; including the Topix index also allows us to control for the effects of stock market return shocks on market liquidity.

Using an ADF test, we are unable to reject (at the 10% level) a unit root in *call,* and *velocity.* We are able to reject (at the 1% level) the hypothesis of no co-integration between *topix* and the *call* or *topix* and *velocity*. We estimate a VAR in the levels of [*velocity, call, liquidity, topix*] including a linear trend and a millennium dummy. The Akaike Information Criterion is maximized by a model with 2 lags. Using a likelihood ratio test, we are unable to reject the hypothesis that the coefficients in the third lags are zero. Therefore, we estimate the model with two lags. We reject (at the 10% level) the hypothesis that the coefficients on lagged *liquidity* are

zero in the equations for velocity and the call money rate. We also reject (at the 5%

level) the hypothesis that the coefficients on the lagged call money rate in the

equation for *liquidity* are zero.

We identify shocks to the system using a Cholesky decomposition. Our

ordering suggests that the interest rate and the stock market variables have no within

month effect on velocity. We treat exogenous innovations in velocity as money

demand shocks. Further, monetary policy does not respond within the month to stock

market liquidity or return shocks. Following Miyao (2001), we treat exogenous

innovations in the in the call money rate as monetary policy shocks.

Figure 5 depicts the response of *velocity* and *call* to a negative liquidity shock

along with two standard error bands. We find that a negative liquidity shock has

persistent negative effects on velocity for a period of nearly 2 years. Variance

decompositions show that the liquidity shock explain approximately 20% of velocity

at a horizon of 2 years. In the standard IS-LM model, a money demand shock has

negative effects on output through their impact on interest rates. Indeed, we find that

the negative liquidity shock do have positive and significant impacts on *call*. A one

standard deviation negative shock to stock market liquidity leads to a persistent rise in

interest rates which reach a peak of around 10 basis points. Variance decompositions

show that liquidity shocks explained less than 10% of the variance of the call money

rate at horizons of zero to two years.

We are also interested in the response of the nominal money supply to a

negative stock market liquidity shocks. To look at the response of narrow money, we

define MB_t as the natural log of the monetary base. We are unable to reject a unit root

in the monetary base at the 10% level, but we can reject the hypothesis of no co-

integration with *topix* at the 1% level. We estimate a VAR in [*MB, call, liquidity,*

topix] and show the response of narrow money to a negative liquidity shock. What we find is that in the initial period after a liquidity shock, there is a large and significant spike in the monetary base. However, this spike reverses after only one period and thereafter the money supply continues to shrink.

Next, we look at the response of broad money, *M2$_t$* as the natural log of M2 plus CDs. We are unable to reject a unit root in *M2* at the 10% level, but we also find that we cannot reject the hypothesis that *M2* is not co-integrated with *topix* or *call* at the 10% level. Miyao (1996) also finds that M2 is not co-integrated with output in a money demand equation. We estimate a VAR in [*ΔM2, call, liquidity, topix*] and show the response of broad money to the negative liquidity shock. As shown in Figure 6 (second panel), we find a persistent and significant increase in broad money lasting for up to a year. These two responses may explain the pattern of interest rates. As liquidity risk increases, savers shift their portfolios toward money-like assets, increasing the demand for money. The transient response of reserves to this shift will increase yields on the reserves in the money market.

We also show the responses to financial liquidity shocks of some broader interest rate measures including average loan rates on new bank loans, *loanrate*, and yields on commercial paper, *cpaper*. Note that commercial paper yields are available only from 1994. We cannot reject the hypothesis of a unit root in *loanrate*, at the 10% level, but we can reject the hypothesis of a unit root in *cpaper* at the 5% level. We can reject the hypothesis of no co-integration between *loanrate* and *topix*. We estimate VAR's in [*loanrate liquidity, topix*] and [*cpaper, liquidity, topix*] with trend and millennium dummy and 4 and 2 lags respectively. The impulse responses are in Figure 6. We see that liquidity shocks lead to a significant and persistent rise in the

interest rate. However, this rise is relatively small with a one standard deviation shock leading to a 4-8 basis point rise in the interest rate.

E.   Foreign Exchange Operations

Another important means of conducting monetary policy during the 1990s was through foreign exchange operations. Large purchases of U.S. dollars occurred frequently during the 1990s as well as occasional purchases of yen. An increase in the purchase of U.S. dollars will make the exchange rate to depreciate and increase capital outflows, resulting in a negative effect on stock prices. We define *forex* as the ratio of trillions of yen spent buying US dollars (or when negative trillions of yen purchased) to M2 and *exchange* as the log of the exchange rate (yen/dollar). We estimate a VAR in [*forex_t, exchange_t, liquidity_t, Topix_t*] with 5 lags (chosen by Akaike Information Criterion), a time trend, and a millennium dummy.

Figure 7 reports the responses of variables. Panels on the first row show that foreign exchange intervention and the exchange rate significantly or insignificantly increase in response to a negative shock to stock market liquidity. Panels on the second row indicate that the stock market becomes less liquid upon a positive foreign exchange intervention and upon a positive shock to the exchange rate (depreciation). Also, the depreciation of the exchange rate will lead to an increase in capital outflows and thus further deterioration in stock prices (first panel in the last row). Therefore, the responses suggest that foreign exchange intervention and exchange rate policy have not been proactively used to promote stock market liquidity when the stock market becomes less liquid.

Foreign exchange intervention is intermittent and in many cases equal to zero. Nonetheless, a positive foreign exchange intervention is significantly associated with a positive response in the exchange rate (last panel). We also find that neither foreign

exchange intervention nor the exchange rate responds significantly to *topix* (not reported). As Ito and Yabu (2004) point out, a non-linear model may be a more accurate model than a linear VAR.

V.   Banking Risk

Liquidity shocks may be the result of credit rationing which prevents speculators from borrowing money which could be used to buy stocks in an illiquid market. During the 1990s, during the 1990s, asset price deflation has damaged the balance sheets of many Japanese financial corporations. A number of securities firms, banks, and other financial intermediaries were closed during the deflationary period. Over a period in the late 1990s Japanese banks paid a premium to borrow in Euro markets. Ito and Harada (2000) shows that this premium was connected to incidents related to the failures of Japanese financial firms and shows that the Japan premium is connected to the excess returns on banking stocks. The Bank of Japan collects data on the Japan Premium from 1997 on. During 1997 and 1998, the Japan premium is persistently high, a period when stock market liquidity is also persistently low. We examine the connection between the Japan premium and stock market liquidity in Table 6. Column 1 reports the coefficient and Newey-West corrected standard errors from a regression of liquidity shocks, *lshock,* on the first difference in the Japan premium, $\Delta jpnprem$. Increases in the Japan premium are associated with negative shocks to stock market liquidity. This association is significant at the 5% level. However, the adjusted R^2 from the regression is less than .03, suggesting much of the variation in liquidity shocks is not directly caused by the Japan premium.

We also assess whether the correlation between liquidity shocks and the Japan premium can explain the effects of the liquidity shocks. Both liquidity shocks and the Japan premium are associated with innovations to stock returns. We regress to

measures of stock returns, the first difference of *topix* and the equal weighted market return from PACAP on *lshock* and Δ*jpnprem* over the period from January 1997 and December 2001. Positive innovations in liquidity are associated with relatively high stock returns. The association is statistically significant in each case, at the 10% level in the case of the *topix* return and 1% in the case of the PACAP return. The reaction of the PACAP return is sharper than with the *topix* return during this period. Increases in the Japan premium are significantly (at the 1% level) negatively associated with stock returns on both indices.

We find that when we include both variables, changes in the Japan premium are still significant at the 5% level for both indices. The effect of the liquidity shock on the *topix* return is no longer significant at the 10% level once the change in the Japan premium. However, the effect of the liquidity shock remains significant for the equal weighted return. Perhaps this is not surprising since the liquidity shock is constructed using equal weighting.

VI.   Conclusion

We find evidence that during the recent deflationary period, Japanese equity markets were highly illiquid and subject to increasingly volatile liquidity shocks. At the firm level, exposure to these shocks are associated with slow growth. These shocks also have significant real effects on the economy through their effects on investment demand and money demand. The effects of negative liquidity shocks on money markets seem analogous to positive shocks to money demand. After market liquidity drops, the velocity of broad money declines and interest rates increase. However, the increase in interest rates seems small relative to the decline in investment observed following market liquidity shocks. We also see that firms with liquid balance sheets are less exposed to liquidity risk. A negative shock to liquidity

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may induce firms to shift their balance sheets toward liquid assets reducing investment. To stabilize demand in the face of such a liquidity shock may require that the monetary authority reduce interest rates. Since 1999, Japanese monetary policy has been characterized by a zero interest rate. The lower bound may prevent the full accommodation of liquidity shocks.

As interest rates cannot go below zero, whether monetary authorities can provide additional stimulus to the economy remains in question. The evidence presented here may suggest channels through which the central bank can affect the real economy at zero interest rates. Our findings suggest that enhancing stock market liquidity and reducing liquidity risk faced by investors could promote firm-level growth. Providing liquidity to equity markets, either through direct purchases of stocks or by easy credit to securities firms or other market makers the central bank might 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 benefit.

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Data Appendix

A.   Stock Market Data

Data on individual firms returns are from PACAP. For each share in our

sample, we use daily returns without dividends reinvested (PACAP mnemonic:

DRETND) and trading values (PACAP mnemonic: TRDVAL). Daily returns are

daily equally weighted market returns without cash Dividends reinvested

(DERMND). We also use (also PACAP mnemonic: 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 PACAP

databases on balance sheets which 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
AIR TRANSPORTATION	3
CHEMICALS	107
COMMUNICATIONS	1
CONSTRUCTION	75
ELECTRIC MACHINERY	99
ELECTRIC POWER AND GAS	14
FINANCIAL (Non Bank & Securities)	10
FISHERY	5
FOODS	51
GLASS AND CERAMICS	21
IRON AND STEEL	30
LAND TRANSPORTATION	22
MACHINERY	56
METAL PRODUCTS	13
MINING	8
NONFERROUS METALS	20
OTHER MANUFACTURING	24
PETROLEUM	6
PRECISION EQUIPMENT	18
PULP AND PAPER	12
REAL ESTATE	15
RETAIL	39
RUBBER	8
SERVICES	22
SHIPPING	8
TEXTILES	34
TRANSPORTATION EQUIPMENT	56
WAREHOUSING AND WHARFING	7
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)
◆ *ur:* Seasonally Adjusted % of Total Labor Force
◆ *M2:* M2 plus CD. Seasonally Adjusted. Trillions of Yen

Additional Data is obtained from the CEIC DRI Asia database.

◆ *MB*: Monetary Base, Monthly Average, billions of yen (Seasonally Adjusted with X-12)

- ◆ *IP*: Industrial Production Index, Final Demand Goods Seasonally adjusted, (1995 = 100)
- ◆ *call*: Uncollateralized Overnight Rate
- ◆ *forex*: Foreign Exchange Intervention Operations, billions of Japanese yen.
- ◆ *loanrate*: Average Loans & Discounts Rate on New Loans from All Banks
- ◆ *cpaper:* Commercial Paper Rate Three month average yields on new issues.
- ◆ Return on Bank Index: Growth in Tokyo Stock Exchange Index, First Section, (1992 = 100)
- ◆ *bfi*: SNA 93 Domestic Demand, Private Domestic Non-residential Investment, seasonally adjusted, 1995 prices (billions of Yen).
- ◆ *gdp*: SNA 93 Gross Domestic Product, 1995 prices, seasonally adjusted (billions of yen).

Table 1. Descriptive Statistics of Stock Market Aggregates and Measures of Liquidity

	Entire Period January, 1975 – December, 2001	Early 1990s January, 1990 – December, 1995	Late 1990s January, 1996 – December, 2001
Stock Market Aggregates Mean			
Pacap Index r^{MKT}	.80%	-.37%	-.55%
Sample	.605%	-.28%	-.49%
Volatility			
Pacap	5.90%	8.04%	6.97%
Sample	5.74%	8.67%	7.38%
Monthly Turnover			
TOPIX	4.38%	2.19%	3.22%
Sample	5.08%	3.38%	3.62%
Liquidity Measure			
Mean	-.0143	-.019968	-.0401311
Shock Volatility	.0147	.0102	.0274
Correlation w/ PACAP Index	.268	.424	.252
Covariance w/ PACAP Index	.000226	.000342	.000425
Liquidity Beta			
Mean	--	1.573	0.536
Std. Deviation	--	1.150	0.567
% with significant t-statistics		32.6%	27.3%

Table 2 Descriptive Statistics

	Mean (S.D.)	Median	[Min, Max]
Total Liquidity Beta β^{96}	0.704 (.589)	0.671	[-1.263, 6.383]
Tstat^{96}	2.465 (.83)	2.481	[0.116, 4.732]
% of Stocks held by banks or corporate sector	0.650 (.115)	0.661	[0.086, 0.921]
Short-term Debt to Asset Ratio	0.304 (.17)	0.280	[0.000, 0.942]
Other Liabilities to Asset Ratio	0.292 (.146)	0.276	[0.016, 0.964]
Liquid Assets to Assets Ratio	0.308 (.181)	0.272	[0.019, 0.986]
Ln(Assets)	11.990 (1.279)	11.862	[8.666, 16.440]
Financial Value to Book Assets	1.471 (.397)	1.393	[0.780, 6.042]
Return on Equity	0.018 (.152)	0.034	[-2.859, 0.460]
% Growth in Net Fixed Assets End of 1995 to end of 2001	0.037 (.419)	0.030	[-3.573, 1.696]
% Growth in Sales End of 1995 to end of 2001	-0.056 (.306)	-0.041	[-2.961, 1.237]

Table 3 Firm Level Regression Coefficients: 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 heteroskedasticity consistent t-statistics. The symbol ♠ implies significance at the 1% level; ♥ at the 5% level, and ♦ at the 10% level.

	Partial Liquidity Beta $\beta_{k,96:01}^{liquid}$	% 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 $\beta_{k,96:01}^{liquid}$		-0.130♠ (-2.61)	-0.144♠ (-4.89)
% of Stocks held by banks or corporate sector	0.061 (1.64)	0.020 (.48)	0.015 (.55)
Short-term Debt to Asset Ratio	0.143♠ (2.77)	-0.052 (-.9)	-0.288♠ (-6.34)
Other Liabilities to Asset Ratio	0.050 (.93)	-0.076 (-1.49)	-0.093♥ (-2.28)
Liquid Assets to Assets Ratio	-0.083♥ (-2.04)	0.002 (.05)	-0.086♥ (-2.07)
Ln(Assets)	-0.079♦ (-1.89)	-0.029 (-.63)	-0.024 (-.68)
Financial Value to Book Assets	-0.083♦ (-1.85)	0.081 (1.25)	0.082♥ (2.20)
Return on Equity	-0.115♥ (-2.49)	0.077 (1.12)	0.123♦ (1.8)
Industry Dummies	Yes	Yes	Yes
N	774	773	772
R^2	.167	.084	.272

Table 5. Stationarity Tests. Column A reports p-values from Adjusted Dickey-Fuller tests of the hypothesis that there is a unit root with 4 lags and an intercept and trend. Column B reports p-values from Johansen trace statistics of the hypothesis that the variable is not co-integrated with *topix* with 4 lags and an intercept and trend.

	ADF Test p-value	Johansen Trace Statistic P-value Co-integrated with *Topix*
Topix	.981	
CPI	.941	.001
Ur	.485	.000
IP	.660	.002
Velocity	.914	.009
M2	.300	.201
Monetary Base	.958	.012
Loanrate	.614	.016
cp	.012	.001
Quarterly Data		
$bfi\big/gdp_t$	.292	.111

Table 6 Measures of Banking Risk

	lshock	$\Delta topix$	$\Delta topix$	$\Delta topix$	r^{MKT}	r^{MKT}	r^{MKT}
$lshock_t$		.409♦ (.243)			.636♠ (.190)		.458♥ (.215)
$\Delta jpnprem$	-.056♥ (.021)		-.167♠ (.037)	-.151♠ (.040) .292 (.218)		-.270♠ (.063)	-.247♠ (.070)
Adjusted R^2	.021	.052	.133	.154	.052	.141	.161

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Figure 1 Time Series Liquidity Measures

Number of Observations in the Sample

Average Market Capitalization in Millions of Yen

Effect on Monthly Return of Trading 1 Billion Yen

Conditional Variance of Liquidity Shocks
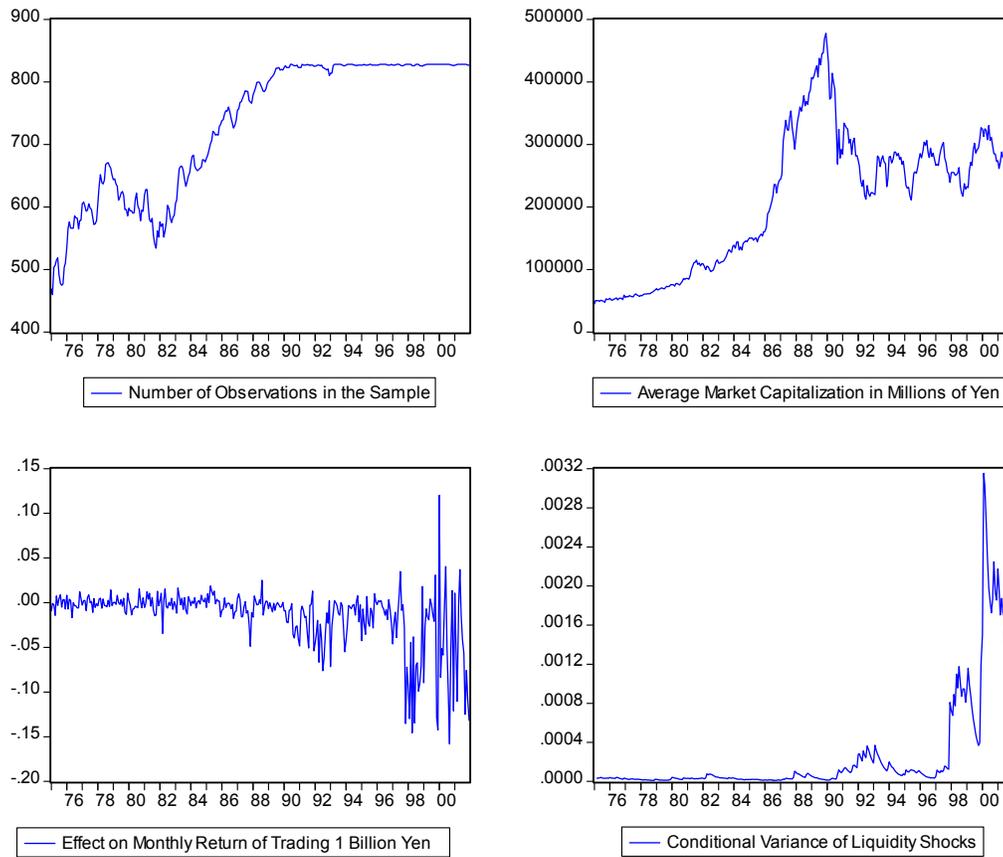
Figure 1A Alternative Liquidity Measures

Liquidity (Unadjusted for Changes in Aggregate Market Capitalization)

Broadest Number of Shares

Shares consistently traded since 1975

Liquidity Average Weighted by Market Cap Size
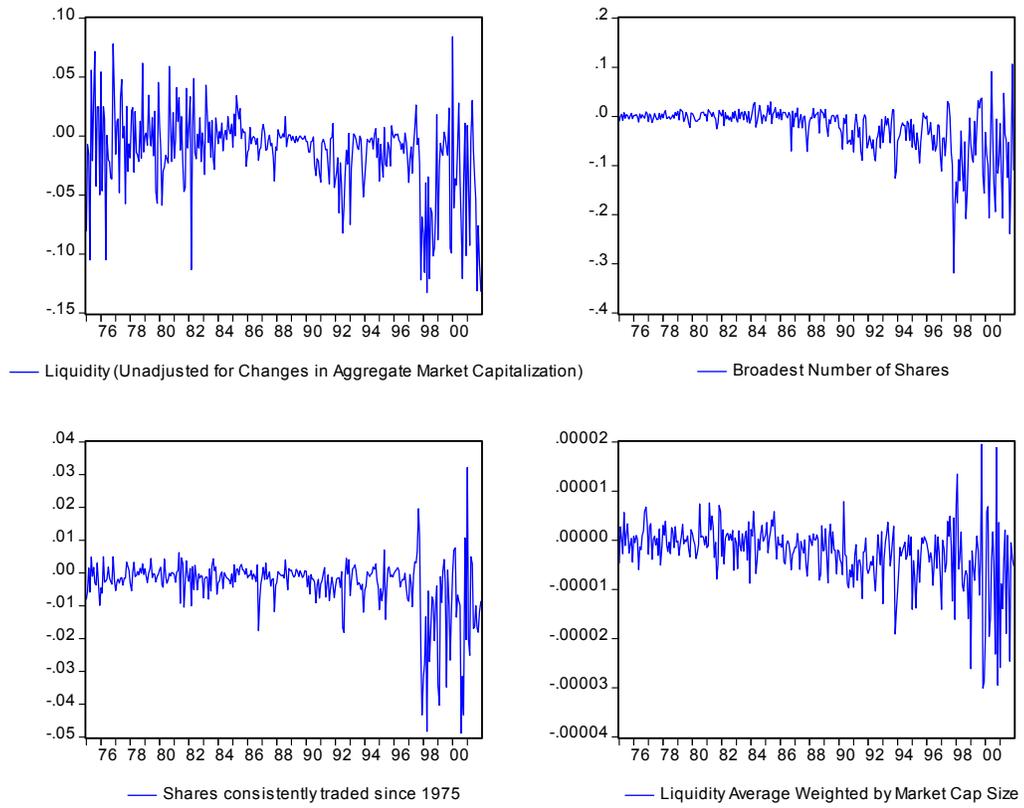
Figure 2 Stock Market Liquidity Shocks

Response of Liquidity to Positive Liquidity Shock

Response of Liquidity to Stock Return Innovations

Response of Stock Return to Negative Liquidity Shocks

Response of Stock Returns to Stock Return Innovations

Response to Cholesky One S.D. Innovations ± 2 S.E.
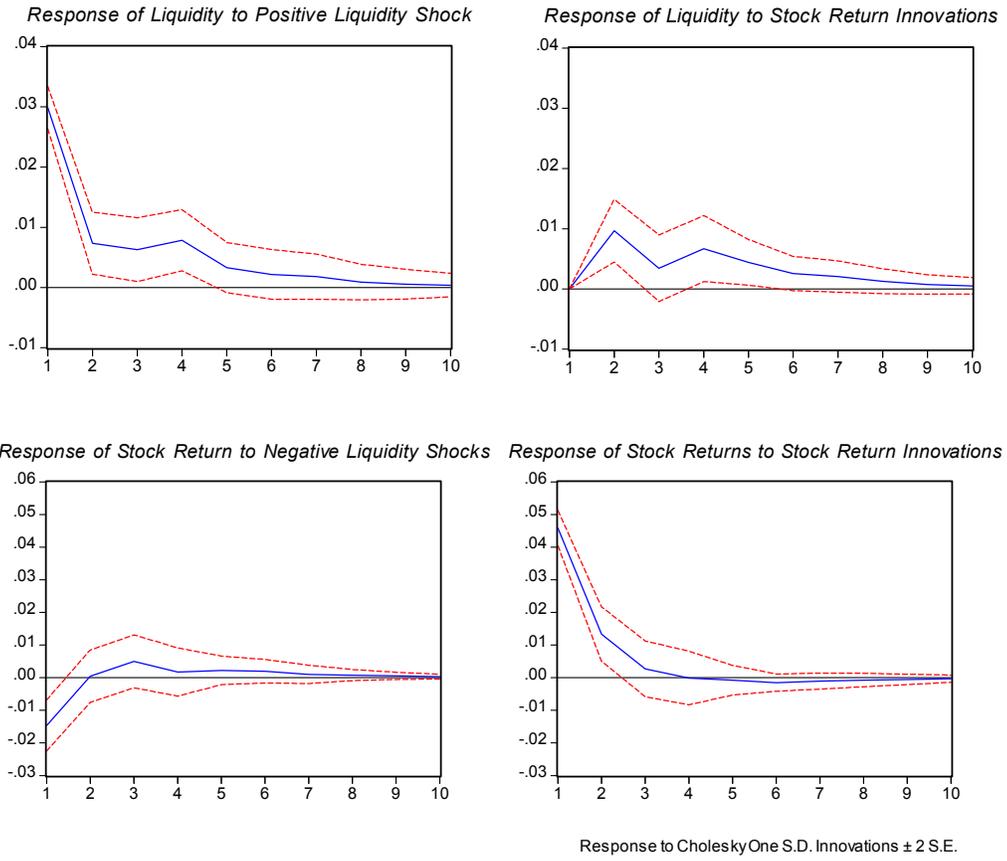
Figure 3 Response of Prices and Output and Unemployment to Liquidity Shocks

Response of CPI to a Negative Liquidity Shock

Response of ur to a Negative Liquidity Shock
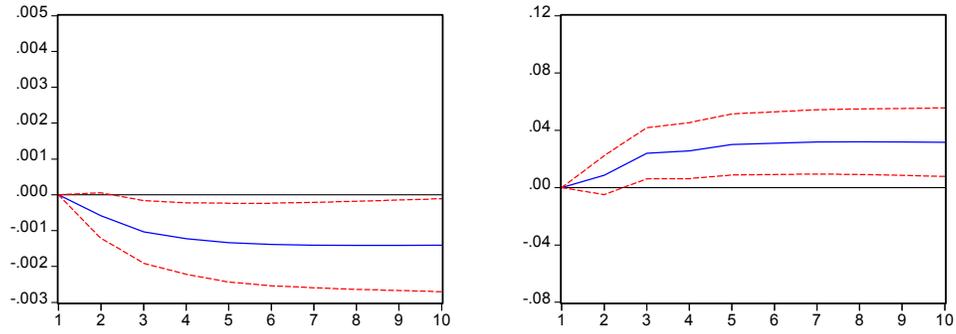
Response of IP to a Negative Liquidity Shock

Response to Cholesky One S.D. Innovations ± 2 S.E.

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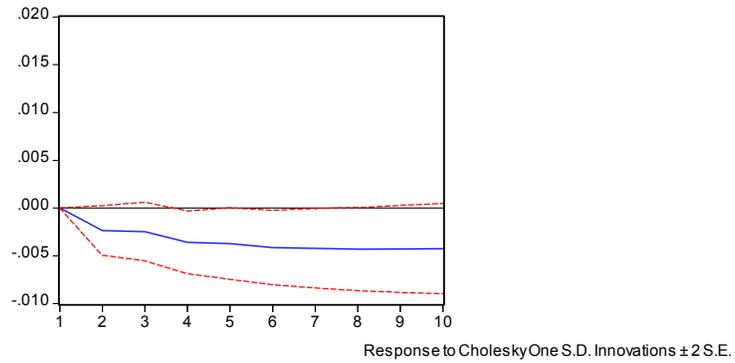
Figure 4. Response of Business Investment to a Liquidity Shock.

Response of bfi/gdp to a Negative Liquidity Shock

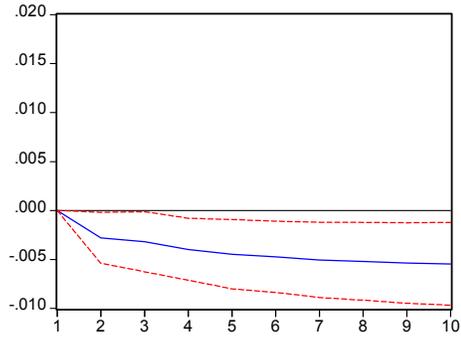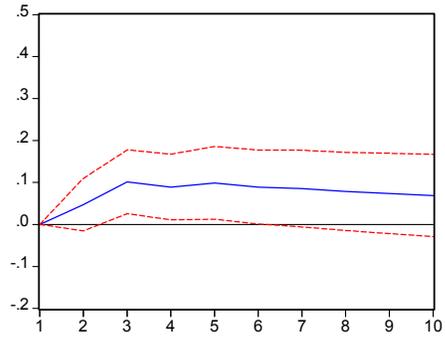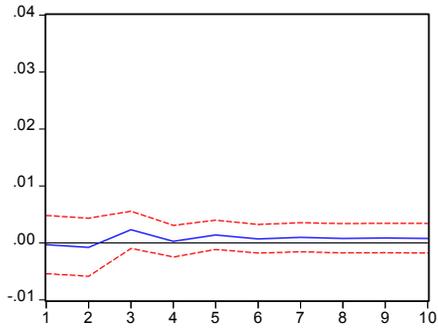Response to Cholesky One S.D. Innovations ± 2 S.E.
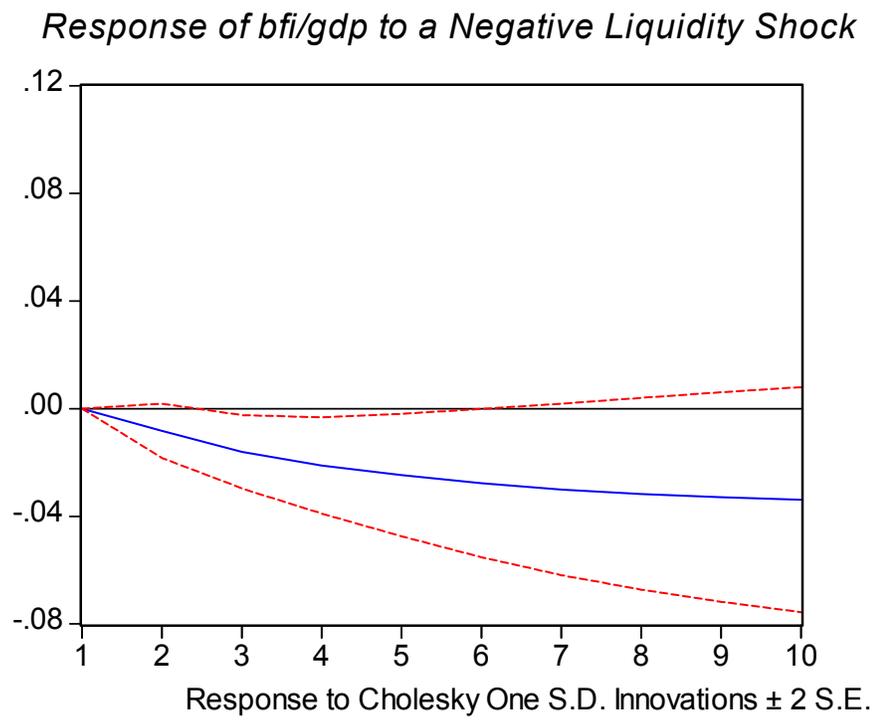
Figure 5 Money Demand and Liquidity Shocks

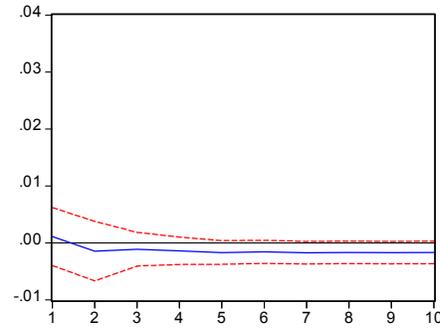*Response of Velocity to Negative Liquidity Shocks*

Response of call to Negative Liquidity Shocks

Response of Liquidity to Money Demand Shocks

Response of Liquidity to Contractionary Money Supply Shocks

Response to Cholesky One S.D. Innovations ± 2 S.E.

Figure 6 Money and Interest Rate Responses

Response of MB to Negative Liquidity Shocks

Response of M2 to Negative Liquidity Shocks

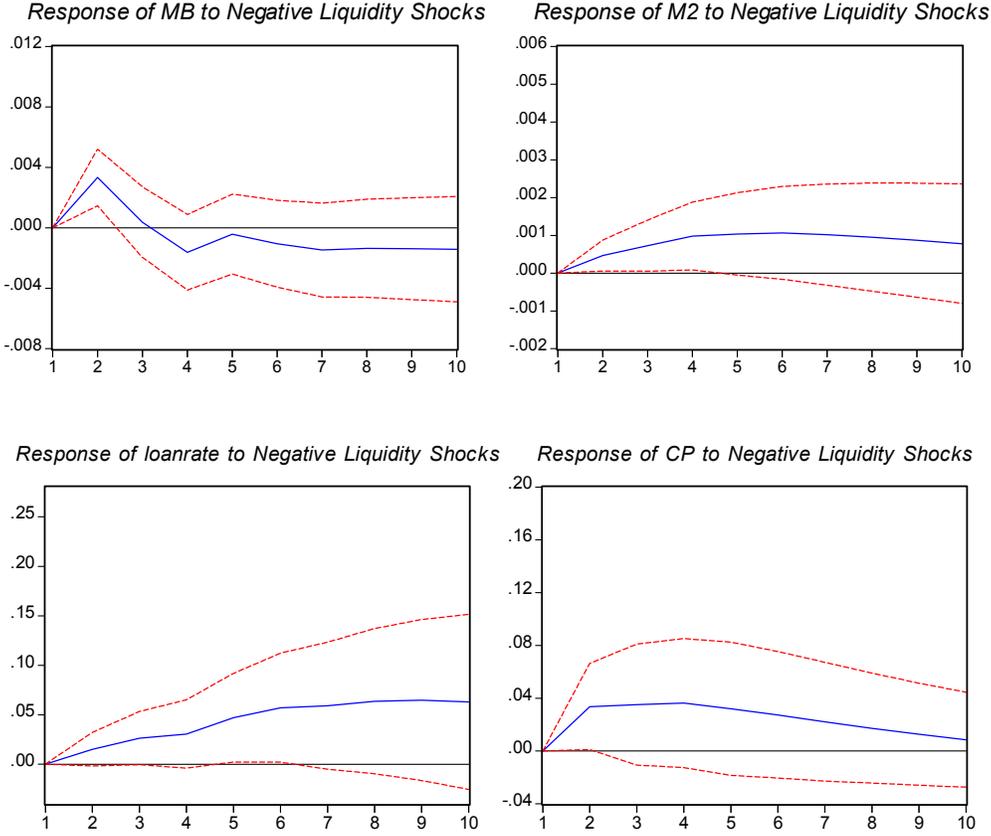*Response of loanrate to Negative Liquidity Shocks*

Response of CP to Negative Liquidity Shocks

Figure 7 Foreign Exchange Intervention

Response of forex to Negative Liquidity Shocks

Response of exchange to Negative Liquidity Shocks

Response of liquidity to forex

Response of liquidity to exchange

Response of topix to forex

Response of exchange to forex

Response to Cholesky One S.D. Innovations ± 2 S.E.

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