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The seed of a crisis: Investor sentiment and bank liquidity

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ABSTRACT

This paper investigates the role of investor sentiment in bank liquidity. I argue that investor sentiment provides banks with a natural hedge against liquidity risk in normal times. However, banks are unaware that such hedge becomes invalid during a prolonging distress. I show that these together contribute to the excessive growth of credit lines in market booms, which may in turn plant the seed of a potential liquidity crisis.

1. Introduction

Traditional studies on bank liquidity usually emphasize the role of economic fundamentals. The most widely accepted notion among these works is that with both explicit and implicit government backing, deposits are unlikely to leave banking system during economic downturns. For example, Gatev and Strahan (2006) show that when liquidity dries up and commercial paper spreads widen, banks experience funding inflows from investors seeking a safe haven for their wealth. Gatev et al. (2009) provide additional evidences for this suggestion by showing that transactions deposits help banks to hedge against liquidity risk during periods of liquidity tightness.

During the early "liquidity phase" of the 2007–2009 crisis, however, many banks encountered great difficulties despite having adequate levels of capital, as the flash evaporation of funding liquidity damaged their abilities to meet short-term obligations (Acharya and Mora, 2015). This has brought forefront the importance of liquidity risk supervision, and also proposed challenges to the traditional viewpoints of previous studies.

Given the essential role of investor sentiment in the formation of asset bubbles (Baker and Wurgler, 2006), it seems incongruous that the existing literature has paid little attention to evaluate the relation between investor sentiment and bank liquidity. In this paper, I try to bridge this gap by providing a sentiment based theory to explain the seed of the recent liquidity crisis. As shown by a growing strand of literature, one major source of liquidity risk at the outset of the crisis is the excessive amount of credit lines guaranteed to firms during market booms (Cornett et al., 2011; Acharya and Mora, 2015). This paper takes a step forward and shows that a crucial contributing factor to the over-expansions of credit lines is investor sentiment. I provide both theoretical and empirical evidences to demonstrate that investor sentiment creates a natural advantage for banks to hedge against liquidity risk in normal time. However, such advantage becomes invalid during a prolonging market distress. I show how all these facts mentioned above induce banks to expand the scale of loan commitments disproportionally, and in turn lead to an aggravating condition of bank liquidity during crisis times.

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2. The model

2.1. Set up

In this model, there are two types of investors, sentiment traders and arbitragers. For simplicity, assume that investors of the same type are homogeneous. The investment opportunities are represented by a stock and bank deposit. The return on the stock (excluding the effects of market liquidity) is normally distributed with $R_s \sim N(\mu, \sigma^2)$, while bank deposit is risk-free with $R_f < \mu$. Sentiment traders have a total wealth of N which is allocated according to the optimal weights $\omega_{1,t} = (\omega_{N,t}, 1 - \omega_{N,t})$, where $\omega_{N,t}$ is the weight on the stock at time t. Similarly, arbitragers have a total wealth of M allocated according to $\omega_{2,t} = (\omega_{M,t}, 1 - \omega_{M,t})$. All investors have the same CARA utility function with constant risk aversion coefficient θ. Moreover, I address arbitrage opportunities by incorporating the effects of market liquidity (Acharya and Pedersen, 2005). Thus, I assume that the expected return function in the presence of market liquidity is $\mu_{L,t} = \mu(1 - \beta V_t)$, where V_t is the trading volume ($V_t > 0$ indicates long position and vice versa).

Because sentiment traders may have temporary distortions in their valuations of the stock, I assume that from their viewpoint the original expected return on the stock is $\mu_{N,t} = \mu + s_t > 0$. Accordingly, s_t is positive (negative) if sentiment investors are optimistic (pessimistic) at time t (Yu and Yuan, 2011). Sentiment traders are mainly individual traders who lack the knowledge to either realize their biases or distinguish between the two types of investors. If they otherwise can, they will adjust their perspectives accordingly or simply imitate the behaviors of rational investors and therefore not affected by sentiment anymore, which contradicts the definition of sentiment trader. Thus, suppose sentiment traders identify themselves as rational investors and mistakenly assume all investors are homogeneous. The resulting objective function of a representative agent is given by

$$\max_{\omega_{N,t}}\left(\omega_{N,t}\mu_{N,t}^{L} + (1 - \omega_{N,t})R_f - \frac{\theta}{2}\omega_{N,t}^2\sigma^2\right), \tag{1}$$

where $\mu_{N,t}^{L} = \mu_{N,t}[1 - \beta(M + N)\omega_{N,t}]$ is his estimation of the expected stock return in the presence of market liquidity. The first order condition with respect to $\omega_{N,t}$ yields $\omega_{N,t} = (\mu + s_t - R_f)/[2\beta(\mu + s_t)(M + N) + \theta\sigma^2]$. It can be inferred that $\omega_{N,t}$ is strictly increasing with the proxy for sentiment s_t. Similarly, the optimization problem of arbitragers can be obtained as

$$\max_{\omega_{M,t}}\left(\omega_{M,t}\mu_{L,t} + (1 - \omega_{M,t})R_f - \frac{\theta}{2}\omega_{M,t}^2\sigma^2\right), \tag{2}$$

where $\mu_{L,t} = \mu[1 - \beta(M\omega_{M,t} + N\omega_{N,t})]$. Solving the first order condition for Eq. (2), it yields $\omega_{M,t} = [\mu(1 - \beta N\omega_{N,t}) - R_f]/(2\mu\beta M + \theta\sigma^2)$, and $\omega_{M,t}$ is negatively correlated with sentiment.

I then analyze the short sell constraints faced by each type of traders. The condition that sentiment traders have the incentives to sell short of the stock is $s_t < R_f - \mu$, whereas arbitragers may sell short only if

$$s_t > R_f - \mu + [2\beta\mu_{N,t}(M + N) + \theta\sigma^2](\mu - R_f)/N\mu\beta \tag{3}$$

and

$$\mu - R_f < \mu N/2(M + N). \tag{4}$$

Thus, in this model, sentiment traders and arbitragers take short positions during utterly different periods. As sentiment traders, primarily individual traders, are reluctant to take short positions (Barber et al., 2008; Stambaugh et al., 2012), assume $\omega_{N,t} = 0$ if $s_t < R_f - \mu$. Arbitragers, which mainly consist of institutional traders, are also under restrictions when selling short due to arbitrage risk (Stambaugh et al., 2015). In other words, arbitragers only take short positions when the deviation in stock price is large enough to ensure profits. As a consequence, let α_t denote the percentage of arbitragers restricted by short sell constraints at time t, we have $\partial\alpha_t/\partial s_t < 0$.

2.2. Analysis

I now investigate the total change in deposit accounts between time $t = 1$, 2, which should be written as $\Delta D = -(M\Delta\omega_M + N\Delta\omega_N)$. It is noteworthy that μ is taken as constant, therefore the model is built upon the hypothesis that there are no fundamental changes. Thus, by allowing s_t, the proxy for sentiment, to change between $t = 1,2$ when other parameters remain constant, I can now study the effects of sentiment while controlling the effects from fundamental changes. Without loss of generality, let $s_2 > s_1$. The remaining analyses are conducted on three different scenarios.

Scenario 1. If $s_2 > R_f - \mu$, sentiment traders do not sell short at time 2. Suppose $R_f - \mu + [2\beta\mu_{N,t}(M + N) + \theta\sigma^2](\mu - R_f)/N\mu\beta > s_2 > s_1$ or $\mu - R_f > \mu N/2(M + N)$, arbitragers are therefore not restricted in both periods. The resulting deposit flow is given by $\Delta D \leq -(\mu\beta NM + \theta\sigma^2 N)\Delta\omega_N/(2\mu\beta M + \theta\sigma^2) < 0$. As the value of s_2 is in its mid-range or the stock is fundamentally valuable as μ is large enough, this scenario shows us the effects of sentiment on deposit growth during normal times. Specifically, as $\Delta D < 0$, bank deposit inflows are larger when sentiment decreases. The result accords with the conventional viewpoint that banks benefit from "fly-to-safety" behavior of investors during market tightness (Gatev and Strahan, 2006).

Scenario 2. If $s_1 < s_2 < R_f - \mu$, sentiment traders are restricted by short sell constraints in both periods. Then the total amount of deposit remains unchanged as $\omega_{N,1} = \omega_{N,2} = 0$. As s_1 and s_2 are both low in this case, I suggest this scenario represents prolonging market distress. An interesting finding here is that, "fly-to-quality" behavior disappears in distressed times, which in turn damages

banks' usual advantage in liquidity. In fact, the absence of "fly-to-quality" is exactly a major reason that many banks were trapped into liquidity problems during the 2007–09 crisis.[1]

Scenario 3. If $\mu - R_f < \mu N/2(M+N)$ and $s_2 > R_f - \mu + [2\beta\mu_{N,t}(M+N) + \theta\sigma^2](\mu - R_f)/N\mu\beta$, then sentiment traders take no short positions at time 2, whereas arbitragers may choose to sell short at time 2. The total change in bank deposit is therefore

$$\Delta D = \frac{[\mu(1-\beta N\omega_{N,2}) - R_f]}{2\mu\beta M + \theta\sigma^2} M\Delta\alpha - \frac{(\mu\beta NM + \theta\sigma^2 N)}{2\mu\beta M + \theta\sigma^2}\Delta\omega_N(1-\alpha_1) - N\Delta\omega_N\alpha_1, \tag{5}$$

where $\Delta\alpha = \alpha_2 - \alpha_1 < 0$. It is clear that if the change in the percentage of arbitragers restricted by short sell constraints satisfies

$$\Delta\alpha < \frac{(\mu\beta M + \theta\sigma^2)N\Delta\omega_N(1-\alpha_1) + N\Delta\omega_N\alpha_1(2\mu\beta M + \theta\sigma^2)}{[\mu(1-\beta N\omega_{N,2}) - R_f]M}, \tag{6}$$

banks will experience capital inflows at time 2. Otherwise, funds will be drained from deposit accounts. Eq. (6) characterizes the situation when market sentiment experiences a large boost. Together with the fact that the return on the stock μ is low, the condition specified in Eq. (6) suggests the formation of asset bubbles. This result shows that during market booms, deposit flows into banking systems along with the increase in sentiment, which could in turn induce banks to guarantee excessive amount of credit lines.

Taken together, the model shows that funds flow into banking sector when sentiment decreases unless in prolonging market distress or market booms. Cornett et al. (2011) provide empirical evidences to show how banks' positions in funding liquidity affect the management of bank assets. Thus, the implications for the effects of investor sentiment on bank assets are also straightforward. It can be inferred from Scenario 1 that banks could cater to investor sentiment by issuing loan commitments or other forms of liquidity insurance for non-financial firms during normal times. This result parallels to the empirical evidences provided by Gatev and Strahan (2006). Nevertheless, my theory is purely sentiment-based and therefore has different implications. First, as shown in Scenario 2, funding inflows disappear at the lower tail of the distribution of sentiment, which means the hedge against liquidity risk that banks usually have may become invalid during distress. Second, it can be inferred from Scenario 3 that the temporary deposit inflows during market booms may induce the banks to expand credit lines disproportionally. Third, the effects of sentiment are simply the results of temporary distortions in investors' expectations, which may lead to adverse effects when the biases are finally corrected. In sum, the seemingly advantageous position banks have in liquidity can lead to over-expansions of credit lines in booms and is vulnerable in distress. Both of these attributes contribute to the probability of bank liquidity shortage, and may even plant the seed of a potential liquidity crisis.

3. Empirical results

In this paper, I reply on the index proposed by Baker and Wurgler (2006) for the measurement of investor sentiment.[2] The index is constructed as the first principal component of five proxies of investor sentiment: the close-end fund discount, the number of IPOs, the average first-day return of IPOs, the equity share in new issues, and the dividend premium.[3] I also apply the orthogonalizing process in Baker and Wurgler (2006) to remove the effects of macroeconomic variables.

To examine the effects of sentiment on bank liquidity, I test the monthly growth rates of related bank variables. In particular, on the asset side I model the change in bank total assets, C&I loans, and cash assets; on the liability side I model the change in total deposits, demand deposits, large-time deposits and transactions deposits. I rule out alternative explanations by including: (1) for the proxy of market liquidity tightness, the spread between 3-month AA commercial paper rate and Treasury Bill rate (Gatev and Strahan, 2006); (2) for the measurement of macroeconomic conditions, the Industrial Production Index (Baker and Wurgler, 2006); (3) for the implementation of monetary policy, the effective federal funds rate; (4) for the measurement of credit risk, the AAA-Baa long-term bond spread (Covitz and Downing, 2007). The resulting equations are of the following form

$$\frac{\Delta X_{i,t}}{Asset_{t-1}} \equiv \frac{X_{i,t} - X_{i,t-1}}{Asset_{t-1}} = a + bSentiment_{t-1} + cSentiment_{t-1}^2 + \text{Controls} + u_t. \tag{7}$$

In addition, to compare the explanatory power of my theory and that of Gatev and Strahan (2006), I normalize the value of sentiment index so that it has the same standard deviation as paper-bill spread. This paper uses the St. Louis Federal Reserve "FRED" public database for all banking and macroeconomic data.

Table 1 reports the regression results. I first investigate the effects of sentiment on deposit growth. The results in the first row of column (1) ~ (3) are consistent with the hypothesis that banks experience deposit inflows from investors seeking a safe haven when sentiment declines. The regression results in the second row further indicate a U-shaped relation between deposit growth and investor sentiment. This accords with the previous suggestion that arbitragers transfer funds into deposit accounts in booms. It is noteworthy that the coefficients on sentiment index are both more statistically and economically significant than those of the paper-bill spread, which shows that investor sentiment has stronger explanatory power for the variations in bank liquidity, even compared with

[1] As quoted in the Treasury Committee Report, pp. 15/16, "Two aspects of this worldwide liquidity squeeze appeared to surprise Northern Rock, … One was the absence of a so-called 'flight to quality'".

[2] The monthly data of BW index are updated on the personal website of Jeffrey Wurgler.

[3] I exclude NYSE share turnover as one of the sentiment indicators compared with the original work of Baker and Wurgler (2006). As shown by these authors in their recent update on website, the explosion of high-frequency trading greatly undermines the explanatory power of NYSE share turnover for investor sentiment.

Table 1
Regression results.

	(1) $\Delta(\text{Deposit})_t$/ Asset_{t-1}	(2) $\Delta(\text{Transaction})_t$/ Asset_{t-1}	(3) $\Delta(\text{Large-time})_t$/$\text{Asset}_{t-1}$	(4) $\Delta(\text{Asset})_t$/ Asset_{t-1}	(5) $\Delta(\text{C\&I})_t$/ Asset_{t-1}
Sentiment_{t-1}	−1.004***	−0.385	−3.540***	−1.343***	−1.946***
	(0.304)	(0.395)	(0.920)	(0.387)	(0.622)
Sentiment_{t-1}^2	0.637***	0.622***	1.470***	−0.0372	−0.973**
	(0.185)	(0.240)	(0.560)	(0.236)	(0.379)
Paper-bill Spread	−0.968***	−0.349	−2.038**	−1.262***	−1.244*
	(0.322)	(0.419)	(0.975)	(0.410)	(0.660)
Industrial production index	6.056***	3.041	28.21***	3.080*	11.40***
	(1.449)	(1.884)	(4.388)	(1.847)	(2.969)
Federal	0.388***	−0.209**	2.400***	0.624***	1.554***
Funds rate	(0.0760)	(0.0989)	(0.230)	(0.0970)	(0.156)
AAA-Baa	−0.835**	−4.097***	7.633***	2.897***	7.726***
Bond spread	(0.384)	(0.499)	(1.163)	(0.490)	(0.787)
Constant	−0.00146	0.00322	−0.0469***	0.0136***	−0.00277
	(0.00381)	(0.00495)	(0.0115)	(0.00485)	(0.00780)
Observations	511	511	511	511	511
R-squared	0.077	0.150	0.233	0.144	0.297

Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

important economic fundamentals that have been discovered in existing literature.

On account of the implications of the theoretical model, I next examine how investor sentiment affects bank assets. Results in column (4) and (5) indicate that banks' balance sheets expand as sentiment decreases. This reveals the comprehensive effects of both more loans distributed and larger drawdown on existing commitments. It is also noteworthy that the coefficients of the variables on the asset side are significantly larger than those on the liability side. This indicates that the expansions of bank assets are disproportionate compared with the scales of funding inflows from panicked investors. More importantly, the coefficient on Sentiment_{t-1}^2 in column (5) is negative, which shows that banks actively cut down on their total lines of credit during market distress. Taken together, the paper concludes that the excessive amount of credit lines driven by sentiment can indeed lead to liquidity shortages in banking sector.

4. Concluding remarks

In this paper, I show that investor sentiment creates liquidity advantages for banks in normal times. These advantages, however, cannot persist in market distress and may contribute to the over-expansions of credit lines before crisis. The results of this paper bring forefront the importance of banks managing sentiment risk in a prudent manner. The results also suggest that dramatic changes in investor sentiment should be considered as a stress scenario specified in current monitoring tools of liquidity risk, such as the Liquidity Coverage Ratio and the Net Stable Funding Ratio.

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