Leverage and Liquidity
-- Evidence from the Closed-End Fund Industry [1]

Yuehua Tang [2]

Georgia State University

This Draft: June, 2011

ABSTRACT

This paper uses the setting of closed-end fund industry to examine the effects of an exogenous funding liquidity shock on market liquidity of the assets held by financial institutions. Closed-end funds (CEFs) which use the auction-rate security (ARS) market as their main source of borrowing experienced a funding liquidity shock as the ARS market froze in February 2008. Consistent with theory (e.g. Acharya and Viswanathan (2010), Brunnermeier and Pedersen (2009)), I find that the common stocks commonly-held by leveraged CEFs experienced larger declines in market liquidity and lower returns than other stocks not held by leveraged CEFs after the shock to the funding liquidity. These effects are more pronounced when (i) leveraged CEFs hold a substantial fraction of shares outstanding, (ii) the leverage of CEFs is higher or closer to the legal limits, (iii) the stock is less liquid before the funding liquidity shock, and (iv) the overall market liquidity is lower. Moreover, these adverse effects can be entirely attributed to CEFs' borrowing from the ARS market, rather than their borrowing from banks. I do not find similar results in counterfactual tests before the funding liquidity shock (i.e. in 2006 and 2007). My study provides new evidence on the effects of funding liquidity on market liquidity and the fire-sale externalities associated with the leverage in the financial sector. It also sheds light on the unintended consequences of imposing *constant* leverage ratio on financial institutions (e.g. Geanakoplos (2010)).

JEL Classification: G01, G12, G20

Key Words: Leverage; Funding liquidity; Market liquidity; Closed-end funds; Rollover risk

---

[1] The paper has benefited comments and suggestions from Viral Acharya, Vikas Agarwal, Tarun Chordia, Conrad Ciccotello, Jean Helwege, Lixin Huang, Wei Jiang, Linlin Ma, Chip Ryan, Jay Shanken and Baozhong Yang. The author thanks George Connaughton for the assistance on the balance sheet data of closed-end funds. I am grateful for the research support from the Center for the Economic Analysis of Risk (CEAR) at Georgia State University and the Max Burns Fellowship from Georgia State University.

[2] J. Mack Robinson College of Business, Georgia State University, 35 Broad Street, Suite 1242, Atlanta, GA 30303. Tel: +1 (404) 413- 7319, Email: fncyttx@langate.gsu.edu.

Leverage and Liquidity
-- Evidence from the Closed-End Fund Industry

A prominent feature of the finance sector is the short-term rollover debt in capital structure of financial institutions.[1] The use of leverage in the financial sector exposes financial firms to potential funding liquidity shocks, which may adversely affect market liquidity of the assets that they trade. Theoretical literature identifies several micro-economic mechanisms that link funding liquidity to market liquidity (e.g. Acharya and Viswanathan (2010), Stein (2009), Brunnermeier and Pedersen (2009), Diamond and Dybvig (1983), Shleifer and Vishny (1997)).[2] Previous empirical studies show that the bankruptcy of a main broker (i.e. Lehman Brothers) or investors' redemption can be transmitted to market liquidity (e.g. Aragon and Strahan (2010), Coval and Stafford (2007)). However, there is little empirical evidence on the effects of leverage in terms of short-term rollover borrowing on market liquidity. This study uses the setting of closed-end fund industry to examine empirically the deleveraging consequences of financial institutions after experiencing an adverse shock to the rollover of their short-term borrowing.

Why does the CEF industry provide a unique setting to examine the issues related to leverage and market liquidity? First, as one main type of investment companies, closed-end funds are

[1] Many types of financial institutions (i.e. banks, broker-dealers, hedge funds, closed-end funds) have substantial short-term rollover debt on their balance sheets. The short-term borrowing can be in form of asset-backed commercial paper (ABCP), repurchase agreements (repos), unsecured commercial paper (CP), and auction rate securities (ARS) that have to be rolled over at short maturities (from overnights to a few months).

[2] In the theoretic literature, there are mainly three micro-economic mechanisms underlying the transmission of funding liquidity to market liquidity: (i) rollover risk (e.g. Acharya and Viswanathan (2010), Stein (2009)); (ii) margin funding risk (e.g. Brunnermeier and Pedersen (2009)); (iii) redemption risk (e.g. Diamond and Dybvig (1983), Shleifer and Vishny (1997)). As summarized by Brunnermeier (2009), rollover risk is the risk that it will be more costly or impossible to roll over short-term borrowing; margin funding risk is the risk that margins and haircuts will change; redemption risk is the risk that depositors of banks or investors of mutual funds or hedge funds withdraw funds.

frequent users of leverage as well as not subject to investors' redemption.[3] Second, CEFs typically need to rollover their short-term borrowing, as in theoretical models (e.g. Acharya and Viswanathan (2010), Acharya, Gale and Yorulmazer (2010)). Specifically, their main source of borrowing is auction-rate securities (ARS), which are a type of long-term borrowing with short-term interest rates that are reset through auctions every one or four weeks.[4] Finally, the simple structure of CEFs allows one to measure the explicit level of leverage from the balance sheet data, defined as (Total assets - Total NAV) / Total assets, and directly examine effects on market liquidity of stocks in their portfolio during times of deleveraging.[5]

Using the leverage and portfolio holdings data of all the U.S. domestic equity closed-end funds, this study examines deleveraging effects on market liquidity of stocks that are held by leveraged CEFs after they experienced a funding liquidity shock. The effects of a change in funding liquidity of financial institutions on market liquidity of the securities that they trade are not easily identifiable in a usual setting. In February 2008, leveraged CEFs experienced a decline in funding liquidity as their main source of borrowing, the auction-rate security (ARS) market, froze up.[6] This

[3] According to Cherkes, Sagi, and Stanton (2009), the average leverage ratio, defined as (total assets - total net asset value) / total assets, of the over 700 U.S. closed-end funds was 25% during the period 1994-2006.

[4] Auction rate securities (ARS) are long-term debt instruments whose interest or dividend rates are regularly reset through modified Dutch auctions, usually every 7, 28, or 35 days. The main issuers are municipalities, closed-end funds, and student loans authorities. The total size of the ARS market reached to about $330 billion at the end of 2007 (Han and Li (2008)). Closed-end funds typically issue auction-rate preferred stocks (ARPS) in that market. Different from the usual auction-rate securities with long-term debt maturity, auction-rate preferred stocks have perpetual maturity and are typically redeemable. For more detailed discussions about auction-rate securities and auction-rate preferred stocks, please refer to Han and Li (2008), Alderson, Brown, and Lummer (1987), and Alderson and Fraser (1993).

[5] In contrast, other frequent users of leverage either have more complex organizational structures (multiple business divisions as in commercial/investment banks case) or engage in many off-balance sheet activities (trade on various types of derivatives as in hedge funds case). Two recent studies by Adrian and Shin (2010) and Ang, Gorovyy, and van Inwegen (2010) examine the leverage behavior of broker-dealers/investment banks and hedge funds respectively.

[6] Since February 2008, most such auctions have failed, and the auction market has been largely frozen (e.g. Han and Li (2008), McConnell and Saretto (2010)). If auction fails, the borrowing rate is automatically reset to the predetermined maximum rate according to the rules specified in the security prospectus (i.e. as high as 20%). Thus, closed-end funds issued auction-rate preferred stocks (ARPS) experienced a sharp increase in rollover cost after the shock. The ARS market was frozen for the rest of 2008 and is still in recovery in 2010.

adverse shock increased CEFs' borrowing cost substantially and forces them to deleverage and redeem the auction-rate preferred stocks (ARPS) that they issued. According to a report by FitchRatings, over 70% of the 437 U.S. closed-end funds that they reviewed undertook redemptions of their ARPS after the auction-rate security market froze, which together totaled $35.6 billion.[7] While the deleveraging of the CEF industry may not have a large impact on the overall stock market liquidity, it could have substantial effects on the commonly-held securities when a number of CEFs that experienced the funding liquidity shock attempt to sell these positions simultaneously. This study uses this natural experiment to identify the effects of a funding liquidity shock on market liquidity of stocks held by closed-end funds.

Consistent with the theoretical predictions (e.g. Acharya and Viswanathan (2010), Brunnermeier and Pedersen (2009)), I find that the common stocks commonly-held by highly leveraged CEFs experienced larger declines in market liquidity and deeper discounts in prices than other stocks that were not held by them after the ARS market froze in February 2008. These effects are more pronounced when (i) leveraged CEFs held a larger fraction of shares outstanding of the stock, (ii) the leverage is higher or closer to the legal limits, (iii) the stocks are less liquid before the funding liquidity shock. Moreover, these deleveraging effects are economically significant.[8] For instance, a one percent increase in the holdings of leveraged CEFs with above 30% total leverage induces an additional increase of 0.08 in the log of relative spread measure (the mean change is 0.21), an additional increase of 0.13 in the log of Amihud measure (the mean change is 0.41), and an additional decrease in daily stock return by 15 basis points (average daily return is -14 basis points).

[7] "Closed-End Funds: Redemptions Provide Some Liquidity to Illiquid ARPS Market" by FitchRatings, August 31, 2010, http://www.fitchratings.com/creditdesk/reports/report_frame.cfm?rpt_id=552106.

[8] Many CEFs specialize in asset markets that are less liquid than the U.S. equity market, such as the municipal bond markets, corporate bond markets, and international equity markets (Cherkes, Sagi, and Stanton (2009)). For those CEFs, one would expect the deleveraging to have larger deleveraging effects on the liquidity of assets that they hold. By focusing on U.S. equity closed-end funds, this study provides a lower bound of the effects associated with the deleveraging behavior.

As a counterfactual test, I carry out the empirical tests using the data from the period before the ARS market shock (i.e. in the period of 2006 and 2007) and do not find similar results.

I further examine the effects of different borrowing sources on stocks held by leveraged CEFs after the funding liquidity shock in the ARS market. Specifically, rather than looking at the total leverage of CEFs, I examine separately the effects of the borrowing from the ARS market and the borrowing from other sources (i.e. bank loans). Consistent with my test design, I find that only leverage using the ARS market was associated with a larger drop in market liquidity and deeper discounts in stock prices after the ARS market shock. Thus, these adverse effects on stocks held by leveraged CEFs can be entirely attributed to their borrowing from the ARS market, rather than their borrowing from banks. Moreover, I find evidence that the deleveraging effects on market liquidity are stronger in the fourth quarter of 2008 when there was a sharp drop in overall market return and market liquidity. This finding is supportive to the idea that the adversity of the deleveraging effects also depends on the overall market conditions (e.g. Acharya and Viswanathan (2010)). Overall, this study provides empirical evidence on the deleveraging effects on market liquidity and stock returns of highly leveraged financial firms after they experienced an exogenous funding liquidity shock.

This paper contributes to the literature by providing new evidence on funding liquidity and market liquidity. Previous empirical studies provide some evidence on the transmission of a margin funding shock or investors' redemption to market liquidity (e.g. Aragon and Strahan (2010), Coval and Stafford (2007)).[9] For closed-end funds, the funding liquidity risk that they face takes the form of rollover risk of short-term borrowing, different from the ones studied in the existing empirical

[9] Aragon and Strahan (2010) study the effects of a margin funding shock due to Lehman's bankruptcy on market liquidity of stocks held by hedge funds which use Lehman as the prime broker. Unlike this study which uses the data of leverage and holdings of closed-end funds, Aragon and Strahan (2010) only observe the prime broker relationship, not the extent of borrowing from Lehman Brothers. Moreover, they examine the holdings at the hedge fund family level while the prime broker relationship is observed at individual fund level. Coval and Stafford (2007) provide evidence on the price pressure in equity markets of mutual funds due to investors' redemption.

literature. Thus, this study provides new evidence that supports the models which link funding liquidity in terms of short-term borrowing of financial institutions and market liquidity of assets that they hold (e.g. Acharya and Viswanathan (2010)). Moreover, it helps our understanding of the fire-sale externality associated with the leverage in the financial sector on financial markets and the deleveraging or fire sale behavior of financial firms during crises (e.g. Stein (2009)). Thus, this paper is also related to empirical studies on funding liquidity shock and asset fire sales (e.g. Boyson, Helwege, and Jindra (2010), Ben-David, Franzoni, and Moussawi (2010), He, Khang, and Krishnamurthy (2010)), market liquidity during the crisis period (e.g. Anand, Irvine, Puckett, and Venkataraman (2010)), funding liquidity risk and stock returns (e.g. Adrian, Etula, and Muir (2010)), and funding liquidity and contagion (e.g. Boyson, Stahel, and Stulz (2010)). By using an exogenous shock for identification, this study provides direct evidence that declines in funding liquidity *caused* declines in market liquidity and discounts in asset prices.

This study also shed light on the unintended consequences of imposing constant leverage ratio on financial institutions (i.e. investment companies). Under the Investment Company Act of 1940, investment companies can only borrow debt up to 33.3% of total assets or issue preferred stocks up to 50% of total assets.[10] These unconditionally *constant* legal limits may have potential perverse effects on market liquidity when they force the investment companies to liquidate assets to stay within the legal bounds. My findings are supportive to the idea that the regulators (i.e. the Fed) should manage system wide leverage along with market cycles (i.e. curtail leverage in good times

[10] Closed-end funds can have both debt and preferred stocks on their balance sheets. They are required to maintain $3 of assts for every $1 borrowed as debt, and $2 for every $1 issued as preferred stocks. Moreover, investment companies with leverage higher than the legal limits have three days to deleverage to stay in line with the federal requirements.

and prop up leverage in bad times) (e.g. Geanakoplos (2010)). [11]

The remainder of the paper is organized as follows. Section I briefly discusses the motivation and develops the main hypotheses of my empirical tests. Section II describes the data and variable construction. Section III describes the empirical methodology used in this study. Section IV examines the effects of deleveraging on market liquidity using the auction-rate security market freezing as a nature experiment. Section V concludes the paper.

I. Motivation and Empirical Hypotheses

Theoretical models predict that an adverse shock to financial firms' funding liquidity or asset value will cause a severe decline in market liquidity of underlying assets and deep discounts in asset prices (e.g. Acharya and Viswanathan (2010), Stein (2009), Brunnermeier and Pedersen (2009)). Acharya and Viswanathan (2010) model the leverage behavior in the financial sector to explain why adverse asset shocks in good economic times lead to a sudden drying up of market liquidity.[12] Their model provides a microeconomic foundation for the linkage between market liquidity, the ease of selling assets, and funding liquidity, the ease of rolling over existing debt. Based on their model, the extent of the funding liquidity problem and the induced de-leveraging or fire sales faced by each financial firm are determined by (i) the level of its own short-term debt, (ii) the adversity of the asset shock, and (iii) the extent of short-term debt of potential buyers of assets (i.e., other financial firms).

[11] In the second half of 2008, SEC implemented temporary relief measures available to certain closed-end funds, designed to afford greater flexibility in avoiding forced deleveraging. The temporary relief measures were only for closed-end funds with above 33% preferred stock leverage, which makes them impossible to refinancing with debt to redeem all their preferred stocks. Moreover, it is subject to SEC approval and applies only to debt issued during the next two years for the purposes of redeeming outstanding auction rate preferred stock.

[12] Acharya and Viswanathan (2010) focus on the agency problem of risk-shifting by borrowers (Jensen and Meckling (1976)) where a borrower, after raising debt, has incentives to transfer wealth away from lenders by switching to riskier assets. This risk-shifting moral hazard problem rations potential borrowers in that it limits the maximum amount of financing that they can get from lenders.

Stein (2009) also shows that leverage that privately optimally chosen by arbitrageurs has a fire-sale externality when they simultaneously unwind positions to reducing leverage.

Brunnermeier and Pedersen (2009) also model the linkage between an asset's market liquidity and traders' funding liquidity by looking at traders' margin requirements. They show that under certain conditions, margins are destabilizing and market liquidity and funding liquidity are mutually reinforcing, leading to liquidity spirals. Moreover, these liquidity spirals are more pronounced if the stock is ex ante less liquid. There are also many amplification models that propose that funding disruptions force financial institutions to engage in asset sales (e.g. Diamond and Rajan (2010), Garleanu and Pedersen (2009), Geanakoplos (2010), Krishnamurthy (2009)).

There are mainly three forms of funding liquidity risk: (i) margin funding risk; (ii) rollover risk; (iii) redemption risk (Brunnermeier (2009)). The underlying micro-economic mechanisms considered in Acharya and Viswanathan (2010) and Brunnermeier and Pedersen (2009) are different. In Acharya and Viswanathan's (2010) model the funding liquidity of a financial institution is limited due to credit rationing caused by risk-shifting problem of borrowers, essentially the rollover risk of short-term borrowing. In Brunnermeier and Pedersen (2009), funding liquidity risk arises due to the margin or collateral requirements. Leveraged CEFs usually borrow money at short-term interest rates and invest in securities that they expect to earn higher returns. Thus, leveraged CEFs are exposed to rollover risk that it will be more costly to rollover the short-term borrowing (e.g. Acharya, Gale, and Yorulmazer (2010), Brunnermeier and Oehmke (2010)).[13] They are different from open-end mutual funds that mainly face redemption risk and hedge funds that mainly face margin funding

[13] Acharya, Gale, and Yorulmazer (2010) present a model that can explain the sudden freeze in the market for short-term, asset-backed financing in the recent crisis. Another study by Brunnermeier and Oehmke (2010) shows that a maturity rat race can occur for financial institutions that borrow from multiple creditors, especially during volatile periods. Both studies provide micro-foundations for the rollover risk arising in capital structures of financial institutions.

risk and redemption risk.[14] In this sense, this paper is a direct empirical test of the model by Acharya and Viswanathan (2010); it is different from the study by Aragon and Strahan (2010) which examines the effects of a funding liquidity shock to hedge funds due to Lehman's bankruptcy, more related to Brunnermeier and Pedersen (2009).

The effects of funding liquidity of financial institutions on market liquidity of the assets they hold are not easily identifiable. As one important type of investment companies, closed-end funds are frequent users of leverage to enhance the returns. Their main borrowing source is auction rate preferred stocks issued in the ARS market, whose dividend rates are regularly reset through auctions every one or four weeks. In early February 2008, leveraged CEFs experienced a sharp increase in their borrowing costs as the auction-rate security market froze up. This shock in the ARS market forces CEFs to liquidate some assets and redeem the ARPS that they issued to reduce their leverage. According to Investment Company Institute (ICI), more than half of the 668 closed-end funds have ARPS outstanding with a total liquidation preference of about $64 billion as of the end of the first quarter of 2008.[15] For instance, the Claymore Dividend & Income Fund redeemed more than $300 million auction-rate preferred shares in the second half of 2008, about half the size of their total assets under management.[16] The forced deleveraging of leveraged CEFs can affect the market liquidity of the securities that they hold. It is especially true for the commonly-held securities when leveraged CEFs attempt to unwind these positions simultaneously.

[14] Open-end mutual funds are generally less aggressive in using leverage to enhance returns (e.g. Almazan, Brown, Carlson, and Chapman (2004), Koski and Pontiff (1999)) and are exposed mainly to redemption risk of fund outflow (e.g. Coval and Stafford (2007), Chen, Goldstein, and Jiang (2010)). Moreover, hedge funds have some unique features, such as lock-up periods, notice periods, and redemption periods, to protect their investments (e.g. Aragon (2007), Agarwal, Daniel, and Naik (2009)), which may alleviate potential redemption risk.

[15] Please refer to a report by Investment Company Institute (ICI): http://www.ici.org/policy/markets/domestic/08_sec_amps_com

[16] "Leverage Shakes Up Mutual Funds, Which Discover a Strategy's Downside" by Shefali Anand, *The Wall Street Journal*, January 24, 2009.

This study uses this natural experiment to identify the effects of funding liquidity on market liquidity and prices of assets held by leveraged CEFs. Specifically, I obtain the quarterly holdings of CEFs and examine market liquidity and returns of the stocks held by leveraged CEFs which experienced the ARS market shock. Based on the above discussion, I have the following hypothesis:

H1: The stocks held by leveraged CEFs experienced larger declines in market liquidity and deeper discounts in prices after February 2008 than other stocks that were not held by them, with these effects being larger (i) if leveraged CEFs held a larger fraction of the stocks, (ii) if CEFs have higher leverage, and (iii) if the stock is ex ante less liquid.

Other than borrowing from the ARS market, there are other routes that CEFs can obtain funding to lever up their returns, such as bank loans. The natural experiment that I use in this study is the liquidity drying up in the ARS market. Intuitively, the shock in the ARS market will have adverse affects on leveraged CEFs using ARS as the main source of borrowing but not the ones that borrow mainly through other channels. For this reason, I differentiate the effects of CEFs' borrowing from the ARS market from their borrowing from other sources on stocks that they hold, which allows me link the deleveraging with the sources. I expect that CEFs' leverage from the ARS market has adverse effects on market liquidity of stocks that they held after February 2008, not their borrowing from other sources. Thus, I have the following hypothesis:

H2: The stocks held by leveraged CEFs borrowing from the ARS market, not the stocks of CEFs borrowing from other sources, experienced larger declines in market liquidity and deeper discounts in prices after February 2008 compared to other stocks.

The adversity of deleveraging effects also depends on the spare debt capacity of the economy (Acharya and Viswanathan (2010)). In the last quarter of 2008, there was a severe drop in overall

market return and market liquidity. There are two effects that intensify the effects of fire sales by leveraged CEFs. First, in the last quarter of 2008, the overall market decline is associated with large reduction in the spare debt capacity in the financial market. The reduction in debt capacity may make the deleveraging of CEFs more costly and thus have larger effects on market liquidity of stocks that they held. Second, the market-wide adverse shock further reduced the asset value of CEFs, which made the legal requirements on asset coverage bind more tightly leveraged CEFs. Thus, in the fourth quarter of 2008, the sharp decline in overall stock market may also intensify the deleveraging effects of leveraged CEFs in addition to the funding liquidity shocks since February 2008.[17] For the reasons discussed above, I have the following empirical hypothesis:

H3: The deleveraging effects on market liquidity are larger at the fourth quarter of 2008 when there was a severe drop in the overall market return and market liquidity.

II. Data

I first obtain from CRSP database the information on all the U.S. closed-end funds that ever existed during the period from 2006 to 2009, including permno, fund names, market capitalization, stock returns among others.[18] The closed-end funds are then classified based on the objectives in the prospectus using the business descriptions of the funds.[19] I focus domestic equity CEFs in my study as they mainly invest in the U.S. domestic equity market. Excluded from the sample are CEFs

[17] In my empirical tests, I reply on cross-sectional difference to identify the effect of deleveraging on the market liquidity of stocks held by closed-end funds. This procedure can alleviate the concern that, in the fourth quarter of 2008, the market liquidity of an individual stock dropped due to the commonality of market liquidity (e.g. Chordia, Roll, and Subrahmanyam (2000), Hasbrouck and Seppi (2001), Huberman and Halka (2001)).

[18] Closed-end funds in CRSP are with the second digit of share code 4, mostly with share code 14 or 44.

[19] I use the information on the CEF's websites and SEC filings as well as business descriptions available on websites such as BusinessWeek (www.businessweek.com). Closed-end funds are classified into the following main categories: domestic equity, municipal bond, taxable fixed income, international equity, and others. I also verified my classifications with the information from Morningstar database.

investing in municipal bonds, taxable bonds, international equity, REITs, and preferred stocks.[20] The final sample includes 103 domestic equity closed-end funds during the period 2006-2009. After that, I obtain the information on quarterly portfolio holdings of closed-end funds from S12 data of Thomson Reuters Ownership Database. I manually matched the data from CRSP database and Thomson Reuters by fund names. As a result, I obtain the quarterly holdings of 84 unique domestic equity closed-end funds in the year of 2008.

The variables related to leverage of CEFs are calculated using the balance sheet data. The balance sheet data are obtained from the Form N-SAR that CEFs filed to SEC semi-annually and are retrieved from the SEC EDGAR database. As in Cherkes, Sagi, and Stanton (2009), the total leverage of a closed-end fund (*Leverage_total*) is calculated as the difference between total assets and total net asset value over the total assets. The leverage through the auction-rate security market (*Leverage_pref*) is measured as total preferred stocks divided by total assets and the leverage from other sources (*Leverage_other*) is the difference between total leverage and the preferred stock leverage.

$$Leverage\_total_{i,t} = \left(Total\ Assets_{i,t} - Total\ NAV_{i,t}\right)/Total\ Assets_{i,t} \quad (1)$$

$$Leverage\_pref_{i,t} = Preferred\ Stocks_{i,t}/Total\ Assets_{i,t} \quad (2)$$

Since the balance sheet data are available only at semi-annual frequency, I create a quarterly series by assuming the leverage ratios in the non-reporting quarters are the same as the previous quarters.

[20] CEFs with other objectives (i.e. international equity closed-end funds) invest in assets across different asset markets, while domestic equity closed-end funds hold mainly U.S. domestic equity. Focusing on them offers me a clean setting to test the deleveraging effect on the assets that CEFs held. There are 32 international equity closed-end funds that also have some exposure to U.S. equity market in 2008. My results are robust if I include these closed-end funds.

Table I presents the summary statistics of fund characteristics. The average total assets and market capitalization (share price times the shares outstanding) of the closed-end funds are $557.3 and $411.9 million, respectively. The mean (median) total leverage ratio of the closed-end funds in my sample is 19.7% (20.7%). Moreover, closed-end funds tend to borrowed mainly through one channel, either the ARS market or bank loans.[21] I also separate the sample into closed-end funds with high and low leverage using 30% total leverage as the cutoff.[22] In Table II Panel C, I present the fund characteristics in the year of 2008 for the two groups separately. The results suggest that closed-end funds with total leverage above and below 30% have similar market capitalizations, larger total assets, more concentrated portfolios. Moreover, the two groups held stocks with similar market liquidity, which is important for my empirical test when I compare the deleveraging effects of the two groups.

[Insert Table I here]

In my empirical tests, I compare market liquidity and returns of common stocks held by leveraged CEFs and other stocks in CRSP database. The stock characteristics are obtained from CRSP database. I use two variables to measure market illiquidity. The first measure is relative bid-ask spread, which is defined as the difference between ask and bid prices divided by the midpoint. It measures the cost of making a small round-trip trade. The second one is Amihud's (2002) measure, which is defined as the ratio of absolute value of daily return over daily dollar volume. It is a measure of the average price impact of all trades and corresponding to the inverse of Kyle's (1985) lambda, or inverse of market depth.

[21] The correlation of the two types of leverage are negative (-0.25) and significant at 1% level.

[22] The choice of cutoff is, to some extent, arbitrary. The results, however, are similar if I use other cutoffs (i.e. 35% and 40%).

$$Rspread_{i,t} = \left(Ask_{i,t} - Bid_{i,t}\right) / \left(\frac{Ask_{i,t}+Bid_{i,t}}{2}\right) \quad (3)$$

$$Amihud_{i,t} = \left|r_{i,t}\right| / \left(P_{i,t} * Vol_{i,t}\right) \quad (4)$$

For both measures, the higher the value the more illiquid the stock is. Both measures are averaged across all the trading days within a quarter to obtain a quarterly measure; the changes in quarterly market liquidity are used as dependent variables in the empirical tests.

For each stock, I aggregate the quarterly holdings as a percentage of shares outstanding of all closed-end funds in my sample, as well as all other open-end mutual funds. I also separate the ownership of closed-end funds with total leverage above or below a cutoff point (i.e. 30% or 40%). Moreover, to differentiate the effects of preferred stock leverage from the leverage from other borrowing sources, I also construct continuous variables of different types of leverage of CEFs at stock level. Specifically, for each stock, I calculate the average level of total leverage, preferred stock leverage and other leverage of CEFs that hold that stock in their portfolios as follows:

$$Leverage_{i,t} = \sum_{j=1}^{n} \omega_{i,j,t} * Leverage_{j,t} \quad (5)$$

$$where\ \omega_{i,j,t} = shares_{i,j,t} / \sum_{j=1}^{n} shares_{i,j,t}$$

where *i* indexes stocks; *j* indexes closed-end funds; and *t* indexes quarters. For instance, suppose two closed-end funds hold stock *i* at quarter *t*: the first one, with total leverage of 30%, owns 10K shares and the other one, with total leverage of 15%, owns 5K shares. Based on equation (1), the average total leverage for stock *i* at quarter *t* is 25% (=30%*10/15 +15%*5/15).[23] If there is not closed-end fund hold that stock in a given quarter, the variable takes value of zero. Based on equation (1), I

[23] These average leverage variables do not take into account of the aggregate holding level of CEFs.

calculate three weighed average measures at stock level for total leverage, preferred stock leverage, and other leverage, respectively.

Table II Panel A presents the summary statistics for all the common stocks on CRSP for the four quarters in 2008. The mean and median values of changes in relative spread and Amihud measure are positive and negative for average daily stock returns, which suggests that, for an average stock, the market liquidity increased and stock prices dropped in the year of 2008. In my empirical design, I do not try to explain the overall drop in market liquidity and stock prices in 2008; rather adopt a difference-in-difference approach to identify the deleveraging effects on stocks that were held by highly leveraged CEFs.[24] It is worth noting that when calculating the average market liquidity measures and average daily returns for the first quarter of 2008, the trading days before the February 7, 2008 auction-ration security market shock are excluded. The average (median) total leverage of a stock is 6.9% (2.3%), while the average (median) leverage from the ARS market is 2.9% (0%). The market beta and liquidity beta for a stock at a given month are obtained from a regression of monthly stock returns on the value-weighted CRSP stock returns and the liquidity innovation factor of Pastor and Stambaugh (2003) in the previous five years. [25]

[Insert Table II here]

As shown in Table II Panel A, the average ownership of all closed-end funds in my sample in term of percentage of shares outstanding is 0.18%, with median close to 0.01%. In Table II Panel B, I also show the ownership distribution of closed-end funds at the end of the fourth quarter of 2007. The closed-end funds in my sample as a group have ownership in more than 60% of all common

[24] See Section III for more details of the difference- in-difference approach in the empirical tests.

[25] The liquidity innovation factor of Pastor and Stambaugh (2003) is obtained from WRDS. To get the market beta and liquidity beta, I require a stock to have at least 24 monthly observations to be included in the regressions.

stocks (share code 10 or 11) on CRSP database, with more than 1% ownership in 245 stocks (about 5% of all common stocks on CRSP).

III. Empirical Methodology

The goal of my empirical design is to identify the effects on market liquidity and stock prices of deleveraging by leveraged closed-end funds after the ARS market shock in February 2008. I first estimate the following panel regression model over the four quarters in 2008:

$$Y_{i,j,t} = \alpha_t + \alpha_j + \beta_1 * Shrpct\_CEF\_above_{i,j,t-1} + \beta_2 * Shrpct\_CEF\_below_{i,j,t-1} + \beta_3 * Shrpct\_MF_{i,j,t-1} + \gamma_1 * Liquidity_{i,j,t-1} + \gamma_2 * Controls_{i,j,t-1} + \alpha_t + \alpha_j + \varepsilon_{i,j,t} \quad (6)$$

where *i* indexes stocks; *j* indexes industries (2-digit SIC code level) ; and *t* indexes quarters. $Shrpct\_CEF\_above_{i,j,t-1}$ ($Shrpct\_CEF\_below_{i,j,t-1}$) is the holdings of stock *i* at the end of quarter *t-1* as percentage of shares outstanding by CEFs with total leverage above (below) the cutoff (i.e. 30% and 40% in Table III), while $Shrpct\_MF_{i,j,t-1}$ is the aggregate holding level of open-end mutual funds. In other words, in this model, I use a cutoff of total leverage to divide the closed-end funds into two groups and include the holding levels of the two groups separately in the regressions. The dependent variables, $Y_{i,j,t}$, used in the regressions are changes in quarterly market liquidity (the log of relative spread or the log of Amihud ratio) or quarterly average daily returns.

As specified in Hypothesis 1 in Section I, I expect the deleveraging effects to concentrate on the ownership of highly leveraged CEFs. The coefficients $\beta_1, \beta_2,$ and β_3 measure the effects of holdings by highly leveraged CEFs, slightly leveraged CEFs, and open-end mutual funds,

respectively. To test Hypothesis 1, I carry out the following comparison tests in this regression: (i) test $\beta_1 = 0$ to see whether the effects of holding by highly leveraged CEFs on market liquidity and stock returns are significantly different from zero or not; (ii) test $\beta_1 = \beta_2$ to compare the effects of holding by highly leveraged CEFs with holdings by lowly leveraged CEFs; (ii) test $\beta_1 = \beta_3$ to compare the effects of holding by highly leveraged CEFs with holdings by open-end mutual funds.

To further differentiate the effects of the preferred stock leverage from the leverage from other borrowing sources, I consider a different model as in equation (7) with continuous leverage variables included in the regressions. As shown in Section II, continuous leverage variables at stock level are the weighted average of total leverage, preferred stock leverage, and other leverage of all closed-end funds that hold that stocks. One attractive feature of model (7) is that it allows me to examine the different effects of the two types of leverage simultaneously in one regression, while model (6) only uses the information about the total leverage.[26] To take into account of the aggregate level of holdings by CEFs, in model (7) I interact the two types of leverage at stock level with dummies that indicate the ownership of all closed-end funds is above or below a certain level (i.e. 1% of shares outstanding).

$$
\begin{aligned}
Y_{i,j,t} = \alpha_t + \alpha_j + \ & \beta_1 * LEV\_pref_{i,j,t-1} * I(Hold \geq 1\%) + \beta_2 * LEV\_pref_{i,j,t-1} * I(Hold < 1\%) \\
& + \beta_3 * LEV\_other_{i,j,t-1} * I(Hold \geq 1\%) + \beta_4 * LEV\_other_{i,j,t-1} * I(Hold < 1\%) \\
& + \beta_5 * I(Hold \geq 1\%) + \gamma_1 * Liquidity_{i,j,t-1} + \gamma_2 * Controls_{i,j,t-1} \\
& + \mu_{i,j,t} \qquad (7)
\end{aligned}
$$

where *i* indexes stocks; *j* indexes industries (2-digit SIC code level) ; and *t* indexes quarters.

[26] I can also divide closed-end funds into two groups based on the leverage from the ARS market or leverage from other sources instead of total leverage. However, model (6) cannot be used to examine the effects of the two types of leverage simultaneously in the same regression. The attractive feature becomes available in model (7) where I include in the regressions the average level of both types of leverage at stock level.

$LEV\_pref_{i,j,t-1}$ ($LEV\_other_{i,j,t-1}$) is the weighted average of preferred stock leverage (other leverage) of closed end funds that held stock i at the end of quarter *t-1*; $I(Hold \geq 1\%)$ ($I(Hold < 1\%)$) is a dummy variable that indicates the aggregate ownership of stock *i* by all domestic equity closed-end funds at the end quarter t-1 is above (below) 1% of shares outstanding. The dependent variables used in the model are changes in quarterly market liquidity (the log of relative spread or the log of Amihud ratio) or quarterly average daily returns.

As specified in Hypothesis 2, since the exogenous shock used in this study is the liquidity drying up in the ARS market, I expect the deleveraging effects mainly come from preferred stock leverage rather than other types of leverage used by CEFs. Specifically, in model (7), I expect β_1 and β_2 to be positively significant when looking at market liquidity and negatively significant when looking at daily returns. In contrast, I have no prediction on β_3 and β_4. To test Hypothesis 3 that the deleveraging effects were stronger in the fourth quarter 2008, I modify model (7) by further interacting the two interaction terms ($LEV\_pref_{i,j,t-1} * I(Hold \geq 1\%)$ and $LEV\_pref_{i,j,t-1} * I(Hold < 1\%)$) with a quarter dummy of the fourth quarter of 2008 and see whether the three-way interaction terms are significant or not.

The identification of both models (6) and (7) relies on cross-sectional comparison of stocks that held by leveraged closed-end funds and those that were not held by them. My empirical design does not aim to explain the overall drop in market liquidity and stock prices after February 2008. Rather, both equations (6) and (7) actually use a difference-in-difference approach. Specifically, the first step is to take the difference in average market liquidity before and after the ARS market shock, for stocks held by highly leveraged CEFs (the treatment group) and stocks that were not held by them

(the control group).[27] This gives us two differences in market liquidity, one for each group. The second step is to look at the difference between these two differences in market liquidity, which is an estimate of the effects of the ARS market shock on stocks' market liquidity.

In both models, I included quarter fixed effects as well as industry fixed effects (2-digit SIC level). The overall market liquidity changes over time will be absorbed by the time fixed effects, while any industry level changes will be captured by the industry fixed effects. Moreover, I control for the lagged market liquidity, size, and market beta of the stock in the regressions. I also include liquidity beta of the stock to control for liquidity risk (Amihud and Mendelson (1986), Pastor and Stambaugh (2003), Acharya and Pedersen (2005)). I adjust standard errors for heteroskedasticity and cluster them at the stock level with quarter dummies.[28]

IV. The Funding Liquidity Shock and Deleverage of Closed-End Funds

A. Deleveraging of Closed-end Funds after February 2008

Table III presents the pooled OLS regression results using model (6) with quarter and industry fixed effects. The dependent variables are changes in the log of relative spread (columns 1 and 4), changes in the log of Amihud ratio (columns 2 and 5), and average daily stock returns (columns 3 and 6).[29] I report the estimation results using total leverage of 30% as the cutoff to divide closed-end funds into two subgroups in columns (1)-(3) and 40% as the cutoff in columns (4)-(6).

[27] For the second, third, and fourth quarters in 2008, the differences are between the average market liquidity of current quarter and previous quarter.

[28] This procedure accounts for potential cross-sectional correlations of the error terms across different firms and serial correlation of the error terms within the same firm over time (Petersen (2009)). Moreover, my results are similar if I cluster the standard errors at the industry level (i.e. 4-digit SIC code level).

[29] I use log of the market liquidity measure to normalize the distribution of the two measures.

[Insert Table III here]

According to Hypothesis 1, due to the deleveraging caused by the liquidity drying up of the ARS market, stocks held by highly leveraged CEFs before the ARS market shock experienced larger drop in market liquidity and deeper price discounts than stocks that were not held by them. The results in the first three columns are consistent with this hypothesis. When changes in market liquidity are the dependent variables in columns (1) and (2), the coefficients on the ownership of highly leveraged CEFs, namely β_1, are significantly positive (7.83 with t-stat. 2.52 for relative spread measure, 13.30 with t-stat. 2.52 for Amihud measure), while the coefficients on the ownership of CEFs with below 30% total leverage, namely β_2, are generally not significant. When looking at the daily stock returns as in column (3), the coefficient on the ownership of highly leveraged CEFs is negative (β_1 = -14.61) and significant (t-stat.= -2.81), which suggests that the higher ownership of highly leveraged CEFs, the larger decline in the stock returns after the ARS market shock. As reported in the bottom part of the table, the results also reject at 5% level in all columns the two hypotheses that the effects of highly leveraged CEFs are the same as the those of CEFs with leverage below 30% or of open-end mutual funds, namely $\beta_1 = \beta_2$ and $\beta_1 = \beta_3$. It's worth noting that the loading on open-end mutual fund holdings are significantly negative, suggesting that mutual funds as a group generally alleviated the drop in the market liquidity after the ARS market shock.[30] Aragon and Strahan (2010) find similar results on stocks that held by hedge funds with Lehman Brothers as the prime broker after Lehman's bankruptcy in September 15, 2008.

As I use total leverage of 40% as the cutoff rather than 30%, the results become more pronounced. As shown in columns (4)-(6), the coefficients on holding of CEFs with total leverage

[30] This finding is consistent with the results in Aragon and Strahan (2010) on the ownership by institutional investors other than hedge funds.

above 40% are much larger in magnitude than the corresponding ones reported in columns (1)-(3). These results support the idea that the deleveraging effects are larger when a closed-end fund's borrowing is higher.

Moreover, these deleveraging effects are also economically significant. With total leverage of 30% as the cutoff, a one percent increase in holdings by leveraged CEFs with above 30% total leverage induces an additional increase of 0.08 (=7.83* 1%) in the log of relative spread measure (the mean change is 0.21), an additional increase of 0.13 (=13.30*1%) in the log of Amihud measure (the mean change is 0.41), and an additional decrease in daily stock return of 15 basis points (= -14.61%*1%) (average daily return is -14 basis points). These effects are much larger in magnitude when I consider total leverage of 40% as the cutoff point.

I also consider counterfactual tests for the main findings in Table III by looking at the period before the ARS market shock (i.e. the period from 2006 to 2007). Specifically, I estimate the same regressions of model (6) as in Table III, but with a different sample period 2006-2007. The results are reported in Table IV. The coefficients on the ownership of CEFs with total leverage above 30% are not significant at convention level in all the three columns, while the other coefficients are quite similar to those reported in column (1)-(3) of Table III. In other words, I do not find similar effects on market liquidity and stock returns of holdings by highly leveraged CEFs. These falsification tests suggest that the deleveraging effects by leveraged CEFs that I find in Table III are due to the liquidity drying up in the ARS market.

[Insert Table IV here]

B. Different Effects of Leverage using the ARS Market and Leverage from Other Channels

To differentiate the effects of leverage from the ARS market from the leverage from other borrowing sources (i.e. bank loans), I consider the regression model (7) with both types of leverage at stock level included in the regressions. As a first set of tests, I estimate the model (7) without considering the aggregate holding level of closed-end funds. The results are presented in Table V. In columns (1)-(3), I include the average total leverage at stock level in the regressions, while in columns (4)-(6) I divide total leverage of CEFs into two types, preferred stock leverage and leverage from other sources. When I consider the total level of leverage in columns (1)-(3), the coefficients are the opposite as predicted in all three columns. However, after separating the two types of borrowing, the coefficients on the leverage from the ARS market are significant at 1% level with predicted sign in all three regressions: 0.28 (t-stat. = 6.72) for relative spread measure in column (4), 0.32 (t-stat. =4.47) for Amihud measure in column (5), and -0.19 (t-stat. =-1.87) for daily returns in column (6). These results suggest that it is CEFs' borrowing from the ARS market that caused the drop in market liquidity and discounts in stock prices after the ARS market shock, not the borrowing from other sources. [31]

[Insert Table V here]

Table VI reports the estimating results of model (7) with the consideration of the aggregate holding level of closed-end funds. Two dummy variables indicating the aggregate level of holding of closed-end funds above or below 1% are interacted with the two types of leverage variables at stock level. [32] The results first show that there is a distinct difference in the effects of CEFs' borrowing from the ARS market and their borrowing from other sources. In other words, the deleveraging

[31] The coefficients on the leverage from banks are negatively significant. It seems that those closed-end funds borrowing mainly from banks, to some extent, alleviate the liquidity drop in stocks that they held.

[32] My results are not sensitive the choice of 1% level. Results on the average level of holdings are presented in Table V.

effects can be entirely attributed to CEFs' borrowing in the ARS market, not the other borrowing sources. This finding is intuitive because only those CEFs who borrow heavily from the ARS market were adversely affected and forced to deleverage or fire sale assets by the ARS market shock. Moreover, the effects of leverage on market liquidity and stock prices increase with the holding level of CEFs, which confirms the main findings in Table III. For instance, using Amihud ratio as the dependent variable as in column (2), the coefficients on preferred stock leverage are 0.80 (t-stat. =3.71) and 0.28 (t-stat. =3.68) for the ownership above and below 1% respectively, with the difference 0.52 significant at 5% level.

[Insert Table VI here]

In terms of economic significance, with CEFs' ownership level of above 1%, a 10% increase of leverage from the ARS market is associated with an additional increase of 0.04 (=0.41*10%) in the log of relative spread measure (the mean change is 0.21), an additional increase of 0.08 (=0.80*10%) in the log of Amihud measure (the mean change is 0.41), and an additional drop in daily stock returns of 3.4 basis points (= -0.34*10%) (average daily return is -14 basis points).

C. Pre-Crisis Liquidity Level and Deleveraging Effects

Brunnermeier and Pedersen (2009) predict that the liquidity spirals are more pronounced if the stock is ex ante less liquid. To empirically test this prediction, I estimate the regression model (7) separately for two subsamples with above or below the median liquidity level of stocks in CRSP database. Specifically, the sample of common stocks in CRSP is split into two subsample based on the median liquidity level in 2007.

Table VII presents the results for both liquidity measures, with columns (1) & (2) for relative

spread measure and columns (3) & (4) for Amihud measure. The results are generally consistent with the prediction by Brunnermeier and Pedersen (2009). For both market liquidity measures, coefficients on preferred stock leverage are larger in magnitude for the subsample with less liquid stocks. For instance, for the relative spread measure, the two coefficients on leverage from preferred stocks for illiquid stock subsample are 0.72 and 0.47 for CEFs' ownership above and below 1% level respectively, about twice in magnitude as the corresponding ones for the subsample with liquid stocks (0.32 and 0.24 respectively). Aragon and Strahan (2010) find similar results using a different exogenous event, the Lehman Brothers' bankruptcy.

[Insert Table VII here]

D. Deleveraging Effects in the Fourth Quarter of 2008

In the last quarter of 2008, there was a severe drop in overall market return and market liquidity, which might intensify the effects of fire sales by leveraged CEFs (Hypothesis 3). I test this hypothesis by interacting preferred stock leverage with a dummy of the fourth quarter of 2008. Based on the hypothesis, I expect the sign of the coefficients on the interaction terms are positive when looking at market liquidity and negative if looking at the daily stock returns.

The results are presented in Table VIII. When using relative spread measure as the dependent variable in column (1), the coefficients of the two interaction terms between preferred stock leverage and the 2008Q4 dummy are positive (0.43 and 0.48 respectively) and significant (t-stat. of 2.15 and 5.45 respectively). The results are slightly weaker when using the Amihud measure as the dependent variable as in column (2) since only one of the two interaction terms comes out positively significant. To summarize, I find some evidence for Hypothesis 3 that the deleveraging in the last quarter of 2008 had larger impacts on market liquidity of stocks that leveraged CEFs held. Moreover, the

coefficients on the two interaction terms between preferred stock leverage and the holding level dummies in all three columns are significant with predicted sign as in Table VI, which suggests that my main findings are not driven by the last quarter of 2008. Lastly, I also find that the deleveraging effects of leveraged CEFs did not extend to the first quarter of 2009 (untabulated).

[Insert Table VIII here]

E. Additional Tests

I carried out a couple of additional empirical tests. First, there are some international equity closed-end funds that also have a certain portion of their assets invested in the U.S. domestic equity market. I find that some international closed-end funds, 32 of them, held U.S. domestic common stocks in their portfolios during the year of 2008. Though I do not have the complete portfolio holdings by these international equity CEFs, my results are robust if I include those international equity closed-end funds in my sample (untabulated).

Second, I also examined the determinants of leverage of the U.S. closed-end funds industry over the period from 1994 to 2009. Specifically, I estimate a pooled OLS regression of the total leverage of 677 closed-end funds in U.S. with all objectives (i.e. domestic equity, municipal bond, taxable bond, international equity, and others CEFs) on lagged macro-economic variables and fund characteristics. Consistent with theory (e.g. Acharya and Viswanathan (2010), Fostel and Geanakoplos (2008), Geanakoplos (2010)), the results show that closed-end fund industry tend to borrow more during good times, proxied by higher term spread, low VIX index, and higher dividend yields of the overall stock market (untabulated).[33] This finding is consistent with the evidence of

[33] The term spread is calculated as the difference in the returns of long term treasury bonds and three-month treasury bills; the VIX index is the option-implied measure of volatility from Chicago Board Options Exchanges; dividend

Adrian and Shin (2010) that the leverage ratio of the main investment banks in U.S. is high during boom times and low during bust times.

V. Concluding Remarks

The use of leverage in the financial sector exposes financial firms to potential funding liquidity shocks, which may adversely affect market liquidity of the assets that they trade. Using the freezing of ARS market in February 2008 as an exogenous shock, I find that the stocks commonly-held by highly leveraged CEFs experienced larger declines in market liquidity and deeper discounts in stock prices than other stocks after the ARS market froze in February 2008. These effects are more pronounced when leveraged CEFs held a substantial fraction of shares outstanding, when the leverage is higher, when the stocks are ex ante less liquid, and when the overall market liquidity is lower. In contrast, I do not find similar results before the funding liquidity shock (i.e. in the period of 2006 and 2007).

This paper contributes to the literature by provide new evidence on the transmission of funding liquidity to market liquidity (e.g. Acharya and Viswanathan (2010), Brunnermeier and Pedersen (2009)). It also helps our understanding of the fire-sale externality associated with the leverage in the financial sector on financial markets and the deleveraging or fire sale behavior of financial firms during crises (e.g. Stein (2009)). Moreover, this study has policy implications on the leverage regulation of financial intermediaries (i.e. investment companies). During the crisis period, unconditionally *constant* legal limits on assets coverage ratio or capital requirement ratio are more likely to bind financial firms, which may force them to deleverage and liquidate assets to stay in line

yields of the overall stock market are calculated as the difference between CRSP value-weighted stock returns with and without dividends.

with the legal requirements. My findings are supportive to the idea that the regulators should manage system wide leverage along with market cycles (i.e. curtail leverage in good times and prop up leverage in bad times) (e.g. Geanakoplos (2010), Wang (2010)).

Lastly, my study provides a lower bound of the liquidity effects associated with deleveraging as I mainly focus on the U.S. domestic equity closed-end funds. Many CEFs specialize in asset markets that are less liquid than the U.S. equity market, such as the municipal bond markets, corporate bond markets, and international equity markets (Cherkes, Sagi, and Stanton (2009)), where one would expect the deleveraging of CEFs to have even larger effects on the liquidity of assets that CEFs hold. Moreover, future research may also examine the relation between CEF discounts and the extent of leverage that they use after the ARS market shock. Also, it would be interesting to examine the exit (i.e. default, open-end, or merge) of CEFs after the ARS market shock as the deterioration of debt market liquidity may lead to the firm to default even when the firm's fundamental is still high (e.g. He and Xiong (2010)).

References

Acharya, Viral, Douglas Gale, and Tanju Yorulmazer, 2010, Rollover Risk and Market Freezes Journal of Finance, forthcoming

Acharya, Viral and Lasse Pedersen, 2005, Asset Pricing with Liquidity Risk, Journal of Financial Economics 77, 375-410.

Acharya, Viral and S. Viswanathan, 2010, Leverage, Moral Hazard and Liquidity, Journal of Finance, forthcoming

Adrian, Tobias, Erkko Etula, and Tyler Muir, 2010, Funding Liquidity Risk and the Cross-Section of Stock Returns, Working Paper

Adrian, Tobias and Hyun-Song Shin, 2010, Liquidity and Leverage. Journal of Financial Intermediation 19:418-437.

Agarwal, Vikas, Naveen Daniel, and Narayan Naik, 2009, Role of managerial incentives and discretion in hedge fund performance, Journal of Finance 64, 2221-2256

Alderson, Michael J., Keith C. Brown and Scott L. Lummer, 1987, Dutch auction rate preferred stock, Financial Management 16, 68–73.

Alderson, Michael J. and Donald R. Fraser, 1993, Financial innovations and excesses revisited: The case of auction rate preferred stock, Financial Management 22, 61–75.

Almazan, Andres, Keith C. Brown, Murray D. Carlson, and David A. Chapman, 2004, Why Constrain Your Mutual Fund Manager? Journal of Financial Economics 73, 289-321.

Amihud, Yakov, 2002, Illiquidity and Stock Returns: Cross Section and Time Series Effects, Journal of Financial Markets 5, 31-56

Amihud, Yakov and H. Mendelson, 1986, Asset Pricing and the Bid-Ask Spread, Journal of Financial Economics 17, 223-49.

Anand, A., P. J. Irvine, A. Puckett, and K. Venkataraman. 2010. Market Crashes and Institutional Trading. Working paper.

Ang, Andrew, Sergiy Gorovyy, and Gregory van Inwegen, 2010, Hedge Fund Leverage, Working Paper

Aragon, George O., 2007. Share Restrictions and Asset Pricing: Evidence from the Hedge Fund Industry. Journal of Financial Economics 83, 33-58.

Aragon, George. O. and Philip. E. Strahan. 2010. Hedge Funds as Liquidity Providers: Evidence

from the Lehman Bankruptcy. Working paper

Ben-David, I., F. Franzoni, and R. Moussawa. 2010. The Behavior of Hedge Funds during Liquidity Crises. Working paper, Ohio State Univeristy

Boyson, Nicole, Jean Helwege, and Jan Jindra, 2010, Crises, Liquidity Shocks, and Fire Sales at Financial Institutions, Working paper

Boyson, Nicole, Christof Stahel, and Rene Stulz, 2010, Hedge Fund Contagion and Liquidity Shocks, Journal of Finance 65, 1789–1816

Brunnermeier, Markus, 2009. Deciphering the 2007-2008 Liquidity and Credit Crunch. Journal of Economic Perspectives 23, 77-100.

Brunnermeier, Markus and Martin Oehmke, 2010, The Maturity Rat Race, Working Paper

Brunnermeier, Markus and Lasse H. Pedersen, 2009. Market Liquidity and Funding Liquidity, Review of Financial Studies, 22, 2201-2238.

Chen, Qi, Itay Goldstein, and Wei Jiang, 2010, Payoff Complementarities and Financial Fragility: Evidence from Mutual Fund Outflows, Journal of Financial Economics 97, 239-262.

Cherkes, Martin, Jacob Sagi, and Richard Stanton, 2009, A liquidity-based theory of closed-end funds, Review of Financial Studies 22, 257-297

Chordia, Tarun, Richard W. Roll, and Avanidhar Subrahmanyam, 2000, Commonality in liquidity, Journal of Financial Economics 56, 3–28.

Coval, Joshua, and Erik Stafford. 2007, Asset Fire Sales (and Purchases) in Equity Markets. Journal of Financial Economics 86, 479–512

Diamond, Douglas and Philip Dybvig. 1983. Bank Runs, Deposit Insurance, and Liquidity. Journal of Political Economy 91 (5): 401–19.

Diamond, Douglas and Raghuram Rajan. 2010. Fear of Fire Sales and the Credit Freeze. Working paper, University of Chicago

Fostel, Ana and John Geanakoplos, 2008, Leverage Cycles and the Anxious Economy, American Economic Review, 98, 1211-1244.

Garleanu, Nicolae and Lasse Pedersen, 2009. Margin-Based Asset Pricing and Deviations from the Law of One Price, Review of Financial Studies, forthcoming.

Geanakoplos, John, 2010, The Leverage Cycle, In D. Acemoglu, K. Rogoff and M. Woodford, eds., NBER Macroeconomic Annual 2009, Vol. 24, University of Chicago Press, 2010, 1-65

Han, Song and Dan Li, 2008, Liquidity Crisis, Runs, and Security Design: Lessons from the Collapse of the Auction Rate Securities Market, Working paper

Hasbrouck, Joel, and Duane J. Seppi, 2001, Common factors in prices, order flows and liquidity, Journal of Financial Economics 59, 383–411

He, Zhiguo, In Gu Khang, and Arvind Krishnamurthy, 2010, Balance Sheet Adjustments in the 2008 Crisis, IMF Economic Review, Forthcoming

He, Zhiguo and Wei Xiong, 2010, Rollover Risk and Credit Risk, Working Paper, University of Chicago

Huberman, Gur, and Dominika Halka, 2001, Systematic liquidity, Journal of Financial Research 24, 161-178.

Jensen, Michael, and William Meckling, 1976. Theory of the Firm: Managerial Behavior, Agency Costs, and Capital Structure, Journal of Financial Economics 3, 305-360.

Krishnamurthy, Arvind. 2009. Amplification Mechanisms in Liquidity Crises. American Economic Journal 2, 1-33.

Koski, Jennifer Lynch, and Jeffrey Pontiff 1999, How Are Derivatives Used? Evidence from the Mutual Fund Industry. The Journal of Finance 54, 791–816

Kyle, Albert S., 1985, Continuous auctions and insider trading, Econometrica 53, 1315-1335.

McConnell, John and Alessio Saretto, 2010, Auction failures and the market for auction rate securities, Journal of Financial Economics 97, 451-469

Pastor, Lubos and Robert Stambaugh, 2003, Liquidity Risk and Expected Stock Returns, Journal of Political Economy 111, 642-85.

Petersen, Mitchell, 2009. Estimating standard errors in finance panel data sets: Comparing pproaches. Review of Financial Studies 22, 435-480.

Shleifer, A., and R. W. Vishny. 1997. The Limits of Arbitrage. Journal of Finance 52:35–55.

Stein, Jeremy C., 2009, Sophisticated Investors and Market Efficiency, Journal of Finance, 64, 1517-1548.

Wang, Yajun, 2010, So What Else Will Margin Requirements Do? Working Paper

Table I

Summary Statistics of Closed-end Fund Characteristics

This table reports the summary statistics of the variables of closed-end funds in my sample from 2006-2009. Leverage_total is the total leverage of a closed-end fund, calculated as (Total Assets – Total NAV)/ Total Assets; Leverage_pref is the leverage using auction-rate preferred stocks from the auction-rate securities market, measured as (Total preferred stocks / Total assets); Leverage_other is the borrowing from sources (i.e. bank loans) other than the ARS market, calculated as the difference between total leverage (Leverage_total) and leverage from the ASR market (Leverage_pref). Total Assets, Total preferred stocks, and Total NAV are obtained from balance sheet and income statement data on the N-SAR reports that CEFs filed to SEC. Market Cap is the product of stock price of the closed-end fund and shares outstanding. Fund Return is the quarterly return of the stock of the closed-end fund and Dividend Yield is the difference between the quarterly return of the stock of the closed-end fund with and without dividends. Age is defined as the number of years that the fund first appeared in CRSP database.

Variables	Mean	Median	Std.	1% Percentile	99% Percentile	N
Total Assets	557.3	298.7	664.0	11.6	3478.4	1,524
Market Cap.	411.9	241.5	466.3	8.5	2375.7	1,507
Leverage_total	19.7%	20.7%	16.3%	0.1%	51.5%	1,524
Leverage_Pref	9.8%	0.0%	13.9%	0.0%	43.5%	1,524
Leverage_other	9.9%	3.6%	12.6%	0.1%	48.8%	1,524
Fund Return	0.94%	0.89%	18.25%	-50.37%	54.61%	1,506
Dividend Yield	2.26%	2.11%	1.83%	0.00%	9.42%	1,506
Age	9.6	4.8	10.7	0.8	76.0	1,523

Table II

Stock Characteristics and Holdings of Closed-end Funds

This table reports the summary statistics of stock characteristics in the four quarters of 2008 used in this study. Amihud ratio is the Amihud (2002) illiquidity measure, defined as quarterly average of the ratio of absolute value of daily return over daily dollar volume ($\times 10^6$). Rspread is relative bid-ask spread in percentage points, defined as the difference between ask and bid prices over the midpoint, while Spread is bid-ask spread, the difference between ask and bid prices. ΔAmihud and ΔRspread are the changes in Amihud ratio and Rspread measure over previous quarter. Daily Return is the quarterly average of daily return of a stock. Log(Size) is the log of quarter-end market capitalization of a stock in millions of dollars. The market beta and liquidity beta for a stock at a given month are obtained from a regression of monthly stock returns on value-weighted CRSP stock returns and liquidity innovation factor of Pastor and Stambaugh (2003) in the previous five years. Shrpct_CEF is the aggregated ownership by the closed-end funds in my sample, as a percentage of shares outstanding of a stock; Shrpct_CEF_above and Shrpct_CEF_below are the ownership by closed-end funds with total leverage above or below 30%; Shrpct_MF is the aggregate ownership by open-end mutual funds. Leverage_total, Leverage_pref, and Leverage_other are the weighted average total leverage, leverage from the ARS market, and leverage from other sources of closed-end funds that held that stock using the number of shares as the weight: $Leverage_{i,t} = \sum_{j=1}^{n} \omega_{i,j,t} * Leverage_{j,t}$; $where\ \omega_{i,j,t} = shares_{i,j,t} / \sum_{j=1}^{n} shares_{i,j,t}$ where i indexes stocks; j indexes closed-end funds; and t indexes quarters. Panel B of this table present the distribution of aggregate ownership as percentage of shares outstanding by closed-end funds at the fourth quarter of 2007, before the ARS market froze. Panel C of this table compares the fund characteristics and holding characteristics in 2008 of closed-end funds with total leverage below or above 30%. The holding information is from Thomson Reuters Ownership Database. Size is the weighted average market capitalization of the stocks in the quarterly portfolio using the value share of each component position as the weight. PortHHI is the Herfindahl index of the portfolio, calculated from the market value of each component of the stock. All characteristics at the portfolio level, including Size, Rspread, Amihud Ratio, Market Beta, and Liquidity Beta, are weighted average using the value share of each component position as the weight.

Panel A. Summary Statistics of Stock Characteristics

Variables	Mean	Median	Std.	Min	Max	N
Stock Characteristics						
Amihud Ratio	11.98	0.024	170.61	0.00	17460.03	18,311
Rspread (%)	0.020	0.004	0.036	0.000	0.572	18,316
Spread	0.23	0.05	5.72	0.00	626.20	18,316
Daily Return	-0.14%	-0.08%	0.72%	-18.28%	8.26%	18,313
ΔAmihud	6.30	0.001	167.08	-3383.20	17073.24	18,176
ΔRspread (%)	0.006	0.001	0.019	-0.375	0.396	18,184
Log(Size)	12.60	12.49	2.06	5.62	19.98	18,316
Market Beta	1.249	1.143	0.848	-3.894	8.062	16,042
Liquid Beta	0.018	0.012	0.336	-5.425	4.169	16,042
Holdings Related Variables						
Shrpct_CEF	0.178%	0.013%	0.62%	0.00%	14.55%	18,364
Shrpct_CEF_above	0.025%	0.000%	0.29%	0.00%	13.71%	18,364
Shrpct_CEF_below	0.143%	0.012%	0.52%	0.00%	14.55%	18,364
Shrpct_MF	17.91%	16.03%	14.56%	0.00%	81.01%	18,364
Leverage_total	6.93%	2.28%	9.11%	0.00%	48.81%	18,364
Leverage_pref	2.89%	0.00%	6.45%	0.00%	39.68%	18,364
Leverage_other	4.04%	1.98%	5.32%	0.00%	48.78%	18,364

Panel B. Distribution of Ownership by Domestic Equity Closed-end Funds at the end of 2007Q4

Ownership Range	No. of stocks	Percentage
No. of stocks held by CEFs	**2,880**	**61.4%**
No. of stocks with less than 0.5% held by CEFs	2,407	51.3%
No. of stocks with 0.5% to 1% held by CEFs	228	4.9%
No. of stocks with 1% to 3% held by CEFs	194	4.1%
No. of stocks with more than 3%held by CEFs	51	1.1%
No. of stocks not held by CEFs	**1,810**	**38.6%**
Total	**4,690**	**100.0%**

Panel C. Comparison of CEFs with Total Leverage Above and Below 30%

	CEFs with below 30% leverage (N=56)				CEFs with over 30% leverage (N=33)				Diff. in	
	N	**Mean**	**Median**	**Std.**	**N**	**Mean**	**Median**	**Std.**	**Mean**	**t-stat.**
Fund Characteristics										
Total Assets	182	516.5	312.1	566.0	99	845.8	662.1	862.3	-329.3***	-3.85
Market Cap.	182	457.9	287.1	488.1	99	523.3	401.3	547.7	-65.4	-1.03
Leverage_total	182	7.6%	3.6%	8.5%	99	39.8%	39.6%	6.0%	-32.2%***	-33.54
Leverage_Pref	182	2.1%	0.0%	6.2%	99	20.4%	24.9%	14.8%	-18.4%***	-14.61
Leverage_other	182	5.5%	2.9%	6.5%	99	19.4%	19.4%	14.9%	-13.8%***	-10.77
Portfolio Holdings										
# of Stocks	182	156	61	274	99	22	7	45	134***	4.83
Size ($ Billions)	182	60.0	58.5	39.7	99	32.6	17.3	38.3	27.4***	5.60
PortHHI	182	0.05	0.02	0.14	99	0.36	0.203	0.36	-0.31***	-10.33
SQR (Amihud)	182	0.031	0.009	0.085	99	0.020	0.018	0.013	0.011	1.28
Rspread (%)	182	0.150	0.102	0.195	99	0.137	0.124	0.059	0.013	0.65
Market Beta	182	0.99	0.93	0.25	96	0.72	0.70	0.30	0.27***	7.96
Liquidity Beta	182	-0.003	-0.006	0.062	96	-0.009	-0.013	0.064	0.006	0.74

Table III Deleveraging Effects of Leveraged Closed-End Funds

This table reports pooled OLS estimation results of equation (6) with the time and industry fixed effects over the four quarters of 2008. The dependent variables used are changes in the log of relative spread in columns (1) and (4), changes in the log of Amihud ratio spread in columns (2) and (5), and quarterly average daily returns in columns (3) and (6). Variables are defined in Table II. Standard errors are adjusted for heteroskedasticity and clustering at the stock level; t-statistics are reported in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level respectively.

	Leverage cutoff=30%			Leverage cutoff=40%		
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ΔLog(Rspread)	ΔLog(Amihud)	Daily Return (%)	ΔLog(Rspread)	ΔLog(Amihud)	Daily Return (%)
Shrpct_CEF_above (a)	7.828**	13.298**	-14.614***	147.990***	175.096***	-176.462***
	(2.52)	(2.52)	(-2.81)	(4.81)	(3.95)	(-3.37)
Shrpct_CEF_below (b)	1.360*	-0.443	3.421**	1.026	-0.101	2.551**
	(1.90)	(-0.31)	(2.37)	(1.39)	(-0.08)	(1.98)
Shrpct_MF (c)	-0.434***	-0.708***	0.063	-0.430***	-0.706***	0.065
	(-10.49)	(-12.53)	(1.35)	(-10.34)	(-12.46)	(1.40)
Lagged Log(Rspread)	-0.107***		0.109***	-0.108***		0.110***
	(-13.01)		(10.30)	(-13.04)		(10.36)
Lagged Log(Amihud)		-0.224***			-0.224***	
		(-29.55)			(-36.069)	
Log (Size)	-0.089***	-0.381***	0.091***	-0.090***	-0.381***	0.092***
	(-15.39)	(-30.16)	(14.18)	(-15.54)	(-30.12)	(14.14)
Market Beta	0.033***	0.047***	-0.061***	0.033***	0.047***	-0.061***
	(6.54)	(4.78)	(-7.01)	(6.52)	(4.79)	(-7.00)
Liquid Beta	0.059***	0.058***	0.041*	0.058***	0.058***	0.042*
	(6.18)	(3.23)	(1.67)	(6.16)	(3.21)	(1.69)
Constant	0.739***	1.107***	-0.552***	0.746***	1.110***	-0.553***
	(15.93)	(17.84)	(-11.13)	(16.16)	(17.89)	(-11.10)
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,010	16,007	16,010	16,010	16,007	16,010
R-squared	0.412	0.425	0.059	0.413	0.425	0.059
Additional Tests						
(a)- (b)	6.47**	13.74**	-18.04***	146.96***	175.20***	-179.01***
p-value	4.0%	1.5%	0.1%	0.0%	0.0%	0.1%
(a)- (c)	8.26***	14.01***	-14.68***	148.42***	175.80***	-176.53***
p-value	0.8%	0.8%	0.5%	0.0%	0.0%	0.1%
(b)- (c)	1.79**	0.27	3.36**	1.46*	0.61	2.49*
p-value	1.3%	85.1%	2.0%	5.1%	62.2%	5.4%

Table IV Contrafactual Tests of Deleveraging Effects

This table reports pooled OLS estimation results of equation (6) over the period 2006-2007. The dependent variables used are changes in the log of relative spread in column (1), changes in the log of Amihud ratio spread in column (2), and quarterly average daily returns in column (3). Variables are defined in Table II. Standard errors are adjusted for heteroskedasticity and clustering at the stock level; t-statistics are reported in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level respectively.

	(1)	(2)	(3)
VARIABLES	ΔLog(Rspread)	ΔLog(Amihud)	Daily Return (%)
Shrpct_CEF_above	3.138	-1.634	-1.403
	(1.152)	(-0.426)	(-0.542)
Shrpct_CEF_below	-0.783**	0.827	0.164
	(-2.015)	(0.998)	(0.308)
Shrpct_MF	-0.120***	-0.430***	0.030
	(-6.576)	(-9.603)	(1.292)
Lagged Log(Rspread)	-0.117***		0.081***
	(-26.917)		(14.613)
Lagged Log(Amihud)		-0.166***	
		(-32.817)	
Log (Size)	-0.064***	-0.253***	0.059***
	(-21.910)	(-31.818)	(17.771)
Market Beta	-0.004**	-0.038***	0.002
	(-2.164)	(-7.815)	(0.716)
Liquid Beta	-0.005	-0.032***	-0.009
	(-1.234)	(-3.320)	(-0.866)
Constant	0.039*	0.031	-0.085***
	(1.931)	(0.789)	(-3.176)
Quarter Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	33,162	33,162	33,163
R-squared	0.221	0.236	0.068

Table V Different Effects of Leverage from the ARS Market and Leverage from Other Channels

This table reports pooled OLS estimation results of equation (7) over the four quarters of 2008 without considering the holding level of CEFs. The dependent variables used are changes in the log of relative spread in columns (1) and (4), changes in the log of Amihud ratio spread in columns (2) and (5), and quarterly average daily returns in columns (3) and (6). Variables are defined in Table II. Standard errors are adjusted for heteroskedasticity and clustering at the stock level; t-statistics are reported in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ΔLog(Rspread)	ΔLog(Amihud)	Daily Return (%)	ΔLog(Rspread)	ΔLog(Amihud)	Daily Return (%)
Leverage_total	-0.070**	-0.255***	0.283***			
	(-2.32)	(-4.73)	(5.55)			
Leverage_pref				0.276***	0.322***	-0.187***
				(6.72)	(4.47)	(-2.90)
Leverage_other				-0.655***	-1.217***	1.108***
				(-11.60)	(-12.75)	(12.27)
Shrpct_MF	-0.380***	-0.632***	0.022	-0.366***	-0.589***	0.001
	(-14.30)	(-13.48)	(0.56)	(-13.90)	(-12.65)	(0.03)
Lagged Log(Rspread)	-0.116***		0.099***	-0.127***		0.115***
	(-21.77)		(12.10)	(-23.34)		(13.76)
Lagged Log(Amihud)		-0.232***			-0.238***	
		(-36.45)			(-36.89)	
Log (Size)	-0.095***	-0.392***	0.082***	-0.101***	-0.402***	0.090***
	(-27.14)	(-42.08)	(16.97)	(-28.39)	(-42.63)	(18.47)
Market Beta	0.042***	0.055***	-0.058***	0.045***	0.059***	-0.061***
	(10.42)	(6.90)	(-8.33)	(11.18)	(7.52)	(-8.89)
Liquid Beta	0.063***	0.057***	0.067***	0.061***	0.052***	0.070***
	(6.61)	(3.16)	(3.80)	(6.42)	(2.86)	(4.02)
Constant	0.576***	0.924***	-0.478***	0.615***	0.978***	-0.533***
	(21.92)	(21.63)	(-13.05)	(23.24)	(23.05)	(-14.46)
Quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16,010	16,007	16,010	16,010	16,007	16,010
R-squared	0.422	0.434	0.092	0.428	0.439	0.098

Table VI Interaction of Leverage and the Holding Level of Closed-End Funds

This table reports pooled OLS estimation results of equation (7) with time and industry fixed effects over the four quarters of 2008. The dependent variables used are changes in the log of relative spread in column (1), changes in the log of Amihud ratio spread in column (2), and quarterly average daily returns in column (3). Variables are defined in Table II. Standard errors are adjusted for heteroskedasticity and clustering at the stock level. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level respectively.

	(1) ΔLog(Rspread)	(2) ΔLog(Amihud)	(3) Daily Return (%)
Lever_pref × Shrpct>=1%	0.409***	0.802***	-0.340*
	(2.89)	(3.71)	(-1.68)
Lever_pref × Shrpct < 1%	0.270***	0.279***	-0.198***
	(6.25)	(3.68)	(-2.93)
Lever_other × Shrpct>=1%	0.353*	-0.065	-0.016
	(1.66)	(-0.20)	(-0.06)
Lever_other × Shrpct < 1%	-0.753***	-1.331***	1.189***
	(-12.78)	(-13.32)	(12.10)
Shrpct>=1%	-0.090***	-0.123***	0.126***
	(-3.57)	(-3.31)	(3.35)
Shrpct_MF	-0.356***	-0.576***	-0.010
	(-13.51)	(-12.30)	(-0.27)
Lagged Log(Rspread)	-0.128***		0.115***
	(-23.51)		(13.81)
Lagged Log(Amihud)		-0.238***	
		(-36.86)	
Log (Size)	-0.101***	-0.402***	0.090***
	(-28.45)	(-42.56)	(18.53)
Market Beta	0.045***	0.060***	-0.061***
	(11.24)	(7.56)	(-8.88)
Liquid Beta	0.060***	0.051***	0.071***
	(6.36)	(2.83)	(4.06)
Constant	0.616***	0.974***	-0.537***
	(23.25)	(22.92)	(-14.49)
Quarter Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
Observations	16,010	16,007	16,010
R-squared	0.429	0.439	0.098

Table VII Deleveraging Effects and Liquidity Level before the ARS Market Shock

This table reports pooled OLS estimation results of equation (7) over two subsamples divided based the median liquidity level in 2007. The dependent variables used are changes in the log of relative spread in columns (1) and (3), changes in the log of Amihud ratio spread in columns (2) and (4). Variables are defined in Table II. Standard errors are adjusted for heteroskedasticity and clustering at the stock level; t-statistics are reported in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level respectively.

	ΔLog(Rspread)		ΔLog(Amihud)	
VARIABLES	(1)	(2)	(3)	(4)
Lever_pref × Shrpct>=1%	0.721***	0.319**	1.387***	0.183
	(2.89)	(2.42)	(3.67)	(0.80)
Lever_pref × Shrpct < 1%	0.472***	0.240***	0.310	0.247***
	(3.93)	(5.50)	(1.56)	(3.13)
Lever_other × Shrpct>=1%	0.057	0.237	0.132	-0.495
	(0.13)	(1.49)	(0.21)	(-1.45)
Lever_other × Shrpct < 1%	-1.108***	-0.051	-0.845***	-0.339***
	(-8.49)	(-0.73)	(-3.90)	(-3.16)
Shrpct>=1%	-0.070	-0.048*	-0.177**	0.031
	(-1.27)	(-1.95)	(-2.50)	(0.74)
Shrpct_MF	-0.136**	-0.279***	-0.531***	-0.493***
	(-2.07)	(-8.89)	(-5.04)	(-8.42)
Lagged Log(Rspread)	-0.205***	-0.187***		
	(-23.60)	(-13.14)		
Lagged Log(Amihud)			-0.242***	-0.352***
			(-26.45)	(-26.81)
Log (Size)	-0.193***	-0.071***	-0.474***	-0.468***
	(-25.29)	(-14.71)	(-29.51)	(-30.58)
Market Beta	0.021***	0.097***	0.037***	0.106***
	(3.81)	(16.46)	(3.34)	(10.12)
Liquid Beta	0.020*	0.092***	-0.002	0.092***
	(1.65)	(6.34)	(-0.09)	(3.59)
Constant	1.389***	-0.357***	1.762***	-1.185***
	(20.09)	(-5.55)	(4.72)	(-12.13)
Quarter Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
Observations	7,336	8,670	7,533	8,470
R-squared	0.422	0.506	0.337	0.632

Table VIII Deleveraging Effects in the Fourth Quarter of 2008

This table reports pooled OLS estimation results of equation (7) with interaction terms of leverage and the fourth quarter of 2008. The dependent variables used are changes in the log of relative spread in column (1) and changes in the log of Amihud ratio spread in column (2). Variables are defined in Table II. Standard errors are adjusted for heteroskedasticity and clustering at the stock level; t-statistics are reported in parentheses. Coefficients marked with ***, **, and * are significant at the 1%, 5%, and 10% level respectively.

VARIABLES	(1) ΔLog(Rspread)	(2) ΔLog(Amihud)
Lever_pref × Shrpct>=1%	0.302**	0.842***
	(2.04)	(3.29)
Lever_pref × Shrpct>=1% × 2008Q4	0.432**	-0.194
	(2.15)	(-0.60)
Lever_pref × Shrpct<1%	0.134***	0.198**
	(2.97)	(2.31)
Lever_pref × Shrpct<1% × 2008Q4	0.479***	0.284*
	(5.45)	(1.94)
Lever_other × Shrpct>=1%	0.359*	-0.065
	(1.69)	(-0.20)
Lever_other × Shrpct < 1%	-0.720***	-1.310***
	(-12.29)	(-13.20)
Shrpct>=1%	-0.087***	-0.125***
	(-3.43)	(-3.36)
Shrpct_MF	-0.354***	-0.575***
	(-13.41)	(-12.25)
Lagged Log(Rspread)	-0.128***	
	(-23.42)	
Lagged Log(Amihud)		-0.238***
		(-36.85)
Log (Size)	-0.102***	-0.402***
	(-28.52)	(-42.55)
Market Beta	0.045***	0.060***
	(11.12)	(7.53)
Liquid Beta	0.060***	0.051***
	(6.32)	(2.83)
Constant	0.623***	0.977***
	(23.48)	(22.89)
Quarter Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Observations	16,010	16,007
R-squared	0.430	0.439