Hedge Fund Leverage and Systemic Risk
－Endogenous Vulnerabilities via Pledged Collateral－

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Ⅰ. Introduction

The hedge fund industry has grown remarkably over the last two decades, and is now regarded as one of the key drivers of the structural changes that have occurred in global financial markets. The term "hedge fund" is applied to any pooled investment vehicle that is privately organized, and administered by investment managers.[1] In principle, hedge funds try to generate alpha (outperformance beyond the benchmark) by exploiting market imperfections. They often leverage their investment position to amplify their rate of return, and thus, they can manage market positions to a much greater extent than the amount of capital. Their activities not only offer investors the benefits but also help to increase market liquidity and to support the price discovery process, ultimately enhancing market efficiency. Moreover, they contribute to financial innovation by investing in novel and sometimes illiquid financial instruments. Hedge funds' cross-border trading styles beyond different market segments have increasingly interconnected national financial markets. Although these positive contributions of hedge funds are widely recognized, there are concerns about their

1 Although the term "hedge fund" is not statutorily defined, hedge funds have existed for more than 60 years. The creation of the first hedge fund is generally credited to Alfred Winslow Jones in 1949. Since then, the term comes into use to describe any investment fund that used incentive fees, short-selling and leverage. See Financial Stability Forum [2000], p.8 and Lhabitant [2002], p.7.

possible risks to financial stability in times of stress due to their activities under adverse market conditions.

How risky hedge funds are as a source of systemic risk is of great interest not only to investors, and academics, but also policy makers (e.g., market participants, regulators, etc.). The notion of systemic risk remains somewhat nebulous, and thus, can be defined by a variety of ways to reflect the thinking around what we mean by the term. Kambhu, Schuermann, and Stiroh [2007] describe an essential feature of systemic risk as a situation where:

> "the potential of financial shocks to lead to substantial, adverse effects on the *real* economy, for example, by causing a reduction in productive investment by reducing credit provision or destabilizing economic activity. Indeed, it is the transmission of financial events to the real economy that is the defining feature of a systemic crisis, and what distinguishes it from a purely financial event" (pp.5-6, emphasis in original).

Nowadays systemic risk can often taken other forms, while the classical case of systemic risk can be found in banking panics. During the last few decades the overall importance of banks within the U. S. financial system has declined with the growth of capital markets. The financial system has structurally changed from a banking-dominated financial intermediation to a market-based financial intermediation. Nonbank market participants have increasingly performed major roles in providing the liquidity and credit needs of the global economy. These participants include investment banks, hedge funds, mutual funds, insurance companies, pension funds, and various broker-dealers and related intermediaries. The advent of a so-called "shadow banking system" - consisting of these nonbank market actors- has changed the nature of systemic risk from a bank-oriented to a market-oriented crisis.

Rapid growth of the shadow banking system has expanded the type of activities that banks and other financial intermediaries engaged in and the assets that they invested in. Lo [2009] stresses that the definition of systemic risk has to capture the linkages and vulnerabilities of the global financial system, and it is unrealistic to expect a single measure of systemic risk. He proposes a more realistic measure of systemic risk as a collection of the following six risk measures to capture such complexity of the global financial system: leverage, liquidity, correlation, concentration, sensitivities, and connectedness.

The purpose of this paper is to consider how the confluence of leverage, market risk and (funding and market) liquidity risk can give rise to possible sources of systemic risk from hedge funds in adverse market conditions. This paper proceeds as follows. Section Ⅱ describes hedge fund leverage and examines the effect of leverage on risk and return of hedge fund portfolios. Section Ⅲ traces the potential channels of systemic risk from hedge funds through market and credit channels from reported data. Section Ⅳ considers the pledged collateral assets and discusses their acceptability in the adverse market conditions. Section Ⅴ

provides concluding remarks.

Ⅱ. Hedge Fund Leverage

From the advent of the hedge fund industry, leverage has been an integral part of hedge fund strategies, while certain strategies may not use it. Simply stated, hedge fund leverage means to carry market positions more than their capital. In practice, the concept of leverage is difficult to uniquely define across hedge funds, because they can achieve leverage in a variety of ways.[2] McGuire and Tsatsaronis [2008] broadly classified the main ways into two categories: funding leverage and instrument leverage. Funding leverage is leverage through debt: borrowing money to finance a position via pledged collateral from prime brokers, or repurchase agreements (repo financing). Instrument leverage is a way to create leverage through the choice of investment instruments, such as derivatives and structured securities (Figure 1).

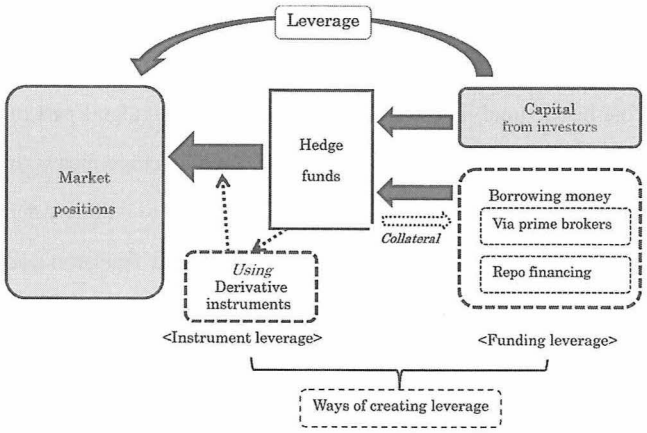
Funding leverage is achieved by creating debt, which is reflected in the balance sheets of hedge funds. First, pledged collateral borrowing is a transaction in which the hedge fund borrows some money from a prime broker (i.e. a cash lender) in margin accounts and exchanges it for buying the stock, which is called *buying on margin*. The prime broker requires some kind of collateral such as cash, securities and other financial assets to secure the loan. The pledged collateral is called the *margin*.

The second form of creating debt is repo financing, which is typically used to finance the purchase of debt securities. A repo is an agreement coupled with a sale and repurchase agreement, in which one party (a cash borrower) agrees to sell a security to another party (a cash lender) for a specified price and to buy it back at an agreed price at the end of the contract. Conceptually, a repo can also be regarded as a form of pledged collateral borrowing (or loan). A typical repo used in creating hedge fund leverage leads to an outflow of collateral and an inflow of cash, which is a cash-driven repo. A cash-driven repo is motivated by the desire to raise short-term funding, from overnight up to one year in maturity. From the point of view of the cash lender (who agrees to buy a security), the repo leads to an inflow of collateral and an outflow of cash, which is called a *reverse repo*. The reverse repo is typically a short-term loan, in which the money can be withdrawn easily by not rolling over the repo.

Next, instrument leverage is achieved by derivatives such as options, futures, swaps, credit derivatives and structured products. Structured products such as the high-risk portions of collateralized debt obligations (CDOs) contain implicit leverage. Structured credit instruments can offer hedge fund investors a multiple of

2 McCrary [2005] introduces ways of creating leverage by hedge funds through day trading, unsettled positions, stock loan, repo financing, derivative securities. pp.89-92.

Figure 1 : Hedge Fund Leverage



Source: Author's compilation.

the exposure they would otherwise obtain by directly purchasing an asset through the process of pooling and tranching, which is called *embedded leverage*. Instrument leverage is the implicit, off-balance-sheet leverage, while funding leverage are reflected in the balance sheet of hedge funds.

There are a number of measures for assessing hedge fund leverage.[3] Ang, Gorovyy and van Inwegen [2011] introduce three measures of financial statement-based leverage, which are widely used in the industry: long leverage, gross leverage and net leverage. In their formula, the (absolute) dollar values of long positions, short positions, and equity, are denoted by V_L, V_S and V_E respectively.

First, gross long is defined as the long position divided by equity.[4]

$$\text{Long Leverage} = \frac{V_L}{V_E} = \frac{Long\ Stock\ Position}{Equity} \quad (1)$$

Long leverage is a leverage measure of the reporting requirements of the hedge fund positions by the U.S. Securities and Exchange Commission (SEC) and involves only long positions.[5] Hedge funds can often use short selling. Short selling is one of the basic tools used to implement the various hedge fund strategies and is a trade that allows hedge funds to sell stocks they do not own by borrowing them in the stock loan market.

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3 Managed Fund Association [2009] explains that, for portfolios without derivative contracts, leverage may be defined as the market value of assets relative to the portfolio's capital (i.e., financial statement-based leverage measures), and for more complex portfolios or portfolios containing derivatives, it may be more appropriate to estimate leverage by analyzing the risk of different strategies and understanding the potential for extreme losses arising from those strategies (i.e., risk-based leverage measures).

4 Capital is the value of claim all investors have on a hedge fund, which is also called *equity*, *net asset value (NAV)*, or *assets under management (AUM)*.

5 Regulation 13-F filings are required by any institutional investor managing more than $100 million. See Ang, A., Gorovyy, S. and G. B. van Inwegen [2011], p.104.

The stock owner receives cash in exchange for the stock and gets it back at a future date. When a hedge fund carries short positions, those positions show up as liabilities. Therefore, long leverage could result in a large underestimate of leverage and the hedging effect by ignoring the short position.

Second, gross leverage is the sum of long and short positions divided by equity, often used as a rough measure of hedge fund risk.

$$\text{Gross Leverage} = \frac{V_L+V_S}{V_E} = \frac{Long\ Position + Absolute\ Value\ of\ Short\ Positions}{Equity} \quad (2)$$

It implicitly treats the long and short positions as separate sources of return and risk. However, gross leverage fails to capture the hedging effect if the short position is used for hedging. In the extreme example, if the long and short positions are invested in the same stock implying that both positions have the same value and market beta, there is no risk, even though gross leverage is high.

Third, net leverage is the difference between long and short positions divided by equity.

$$\text{Net Leverage} = \frac{V_L-V_S}{V_E} = \frac{Long\ Position - Absolute\ Value\ of\ Short\ Positions}{Equity} \quad (3)$$

Net leverage is adequate as a risk measure only under severe restrictive assumptions that the long and short positions have the same value and market beta. Potential divergences in the values and betas of the long and short positions in the hedge fund portfolio are not taken into account in this measure.

Impact of Leverage on Risk of Hedge Fund Portfolios

Leverage for hedge funds is often regarded as a synonym for risk because it may increase the return and risk of a portfolio compared to a long-only unleveraged portfolio of assets. The next question is how the use of leverage impacts the risk of a hedge fund portfolio. To assess the impact of leverage on hedge fund risk, the normal distribution hypothesis on risk and return of hedge fund portfolios is assumed.

The expected return for the unleveraged hedge fund portfolio is calculated as the weighted average of the returns of N assets invested:

$$\mathrm{E}(R_p) = \sum_i^N w_i E(R_i) \quad (4)$$

where the weights, w_i need sum to 1 (or 100 percent of the portfolio).

When the fund can borrow money from the prime broker through his margin account to buy more of the stock, leverage increases. The expected return on the leveraged portfolio is calculated as the weighted average of the returns of the assets in the portfolio minus borrowing costs:

$$\mathrm{E}(R_p) = \sum_i^N w_i E(R_i) - Borrowing\ Rate \times \left(\sum_i^N w_i - 1\right) \quad (5)$$

where the sum of the weights, w_i will exceed 1. If the portfolio is constructed by only two stocks, A and B, the equation (5) simplifies to:

$$\mathrm{E}(R_p) = w_A \times E(R_A) + w_B \times E(R_B) - Borrowing\ Rate \times (w_A + w_B - 1) \quad (6)$$

Portfolio risk is the standard deviation of the portfolio, which is calculated by using its variance-covariance matrix:

$$\sigma_{p=}\sqrt{\sum_i^N \sum_j^N w_i w_j \sigma_{i,j}} \quad (7)$$

For two stocks, A and B, the equation (7) reduces to:

$$\sigma_{p=}\sqrt{w_A^2\sigma_A^2 + 2w_A w_B \sigma_{A,B} + w_B^2\sigma_B^2} = \sqrt{w_A^2\sigma_A^2 + 2w_A w_B \sigma_A \sigma_B \rho_{A,B} + w_B^2\sigma_B^2} \quad (8)$$

where ρ denotes a correlation coefficient.

Suppose the hedge fund portfolio has an expected return of 18% (annual return) and a standard deviation of return equal to 20%, whose normal distribution is displayed in straight line (see Case A in Figure 2). In case of an unleveraged long position, potential losses on the portfolio cannot exceed the amount of investors' initial capital since the capital base covers 100% of the market value of long stock. The area to the left of 0 percent on the x-axis shows the percentage of the probability of the loss of the unleveraged portfolio. The investment would lose money 18.4% of the time.

The use of leverage directly affects the expected return of any investment strategy, but it may increase the risk of the fund portfolio such as the probability of a loss of a certain magnitude.[6] Let us examine the impacts of leverage on portfolio risk and return taking two cases of margin transactions.

First, consider the case of a hedge fund buying on margin (i.e., borrowing money from a prime broker). A hedge fund manager may create leverage by buying on margin if the expected return on an asset is higher than the borrowing rate (i.e., a risk-free rate). Borrowing money to buy more of the same asset can increases the expected return on the fund portfolio, however, as well as risk. Figure 2 displays the impact of leverage when the borrowed money is invested in more of the same stock A already held in the fund. When the fund increases the leverage from 1:1 to 2:1 by borrowing money to buy more of stock A, the standard deviation of return rises from 20% to 40% and the expected return also rises from 18% to 31% (see Case B: the normal distribution of undiversified portfolio depicted by the dotted line in Figure 2).[7] The doubling of portfolio risk that arises from leveraging leads to a probability of loss from 18.4% to 21.9%. In this case, as its leverage ratio increases, the hedge fund can amplify its portfolio return, but also increases its portfolio risk proportionally (Figure 3).

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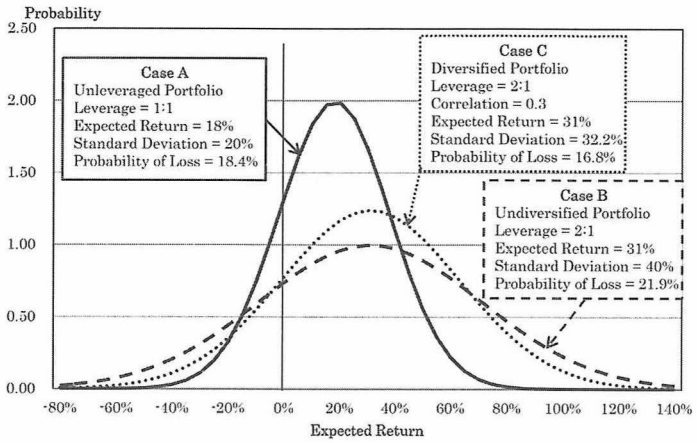
6 Most hedge funds are organized as limited partnerships or limited liability corporations so that potential losses on the hedge fund portfolio more than 100% of their capital do not affect hedge fund investors. See in more details about hedge fund business models in McCrary [2005], Chapter 5.

7 Leverage may be quoted as a ratio, percentage or as an incremental percentage, i.e., 3:1 (ratio), 300% (percentage), or 200% (incremental percentage. For no leverage, leverage may be quoted as 1:1, 100%, or 0% for no leverage.

Figure 2 : Distribution of Returns of Unleveraged and Leveraged Portfolios



Source: Author's compilation.

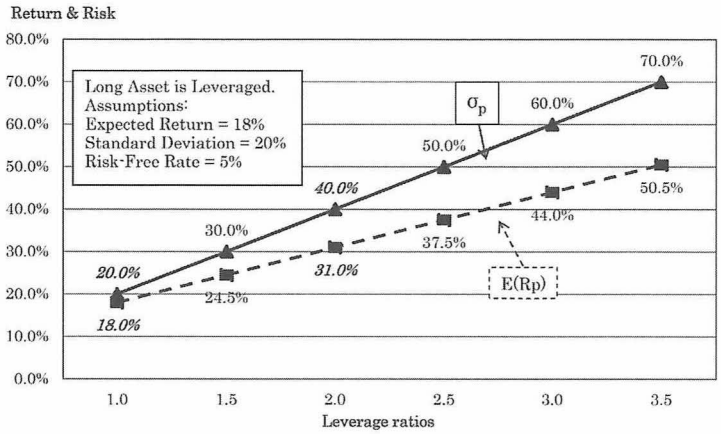
However, hedge funds may use the borrowed fund to buy a different stock such as stock *B* to pursue the risk reduction through portfolio diversification. Suppose the diversified portfolio is composed of stock *A* and stock *B* (Case C), and both stocks have the same risk and return (the expected return is 18%, the standard deviation is 20%) individually, but the correlation coefficient of stock *A* and *B* is 0.3. The expected return of the leveraged and diversified portfolio is 31% and its risk is 32.2%, which can be calculated by using equations (6) and (8). The diversification effect significantly reduces the leveraged portfolio risk from 40% to 32.2% and the probabilities of loss decrease from 21.9 to 16.8%, which is lower than the 18.4% loss probability of an unleveraged portfolio (see Case C: the normal distribution of diversified portfolio depicted by the fine dotted line in Figure 2).

Next, take the case of a hedged portfolio with long and short positions. Conceptually, selling short is a trade of buying on the margin in the opposite direction to the market. The purpose of selling a stock short is to hedge a portfolio's market exposure and/or sector exposure, profit from stock price declines, and capture relative value.[8] The combined purchase and sale of stocks (long/short stocks) is one of the most popular hedge fund strategies.

The risk of a hedge fund portfolio is significantly reduced by constructing it with opposite positions, i.e., with two nearly identical long- and short positions. For example, stocks *A* and *B* are assumed to be equal in value at $100 and 80% correlated. The expected return and the standard deviation of long stock *A* are 18% and 20%, respectively, and those of short stock *B* are 15% and 16%, respectively. (Here, some

8 On the other hand, risks of selling stocks short arise from unlimited losses, stock loans, and short squeezes.

Figure 3 : Impact of Leverage on Portfolio Risk and Return



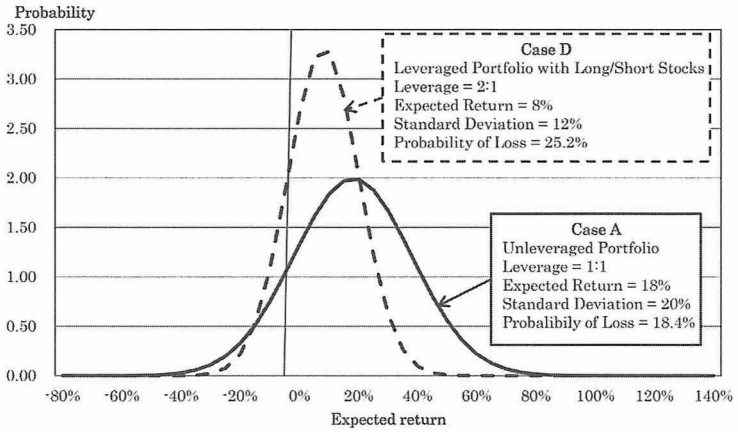
Source: Author's compilation.

assumptions for Case D are different than those for Case B). In addition, the cash generated by the short sale is assumed to be reinvested at the risk-free rate equal to 5%. The expected return and the standard deviation of the combined portfolio are 8% and 12%, respectively, (see the normal distribution of Case D depicted by the dotted line in Figure 4). While the combined portfolio risk of 12% (Case D) is much lower than the unleveraged portfolio risk of 20% (Case A), and leveraged diversified portfolio risk of 32.2% (Case C), the risk of loss is 25.2%, higher than the unleveraged- and leveraged diversified portfolios. Nevertheless, it is important to note that the probability of a large loss is much smaller for the unleveraged, and leveraged diversified portfolios.[9]

In summary, there is no simple relationship between leverage and risk of each individual hedge fund portfolio, while it seems that leverage often tends to create a riskier portfolio. In particular, financial statement-based leverage by itself is not an adequate measure of a hedge fund portfolio's risk since it does not shed light on the probability of change occurring or the likely magnitude of change in portfolio value. In short, the impact of using leverage on risk of hedge fund portfolios should be evaluated by taking into account the size of positions and volatilities, as well as correlations between assets and liabilities. Sometimes leverage can be a very effective risk management tool if properly employed.

9 The probabilities of loss at the expected return (−10%) of the unleveraged, leveraged and undiversified, leveraged and diversified, long/short portfolios are 8.1%, 15.3%, 10.1% and 6.7%, respectively.

Figure 4 : Distribution of Returns of Unleveraged and Leveraged L/S Portfolios



Source: Author's compilation.

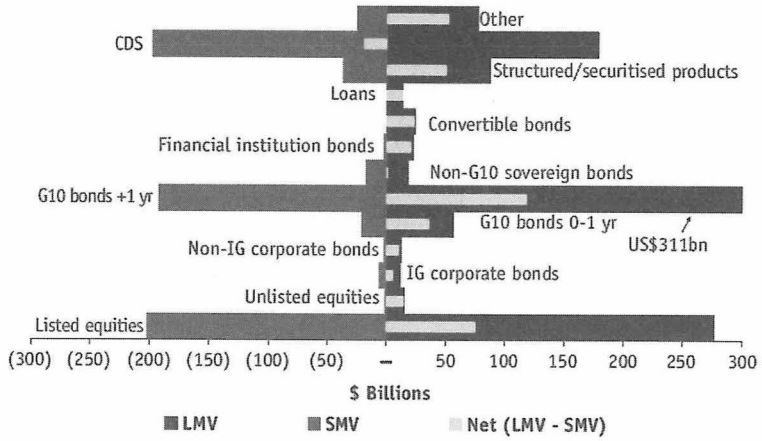
Ⅲ. Potential Channels of Systemic Risk

As examined in the previous section, leverage itself is not an independent source of risk. However, the Financial Services Authority [August, 2012] states that hedge funds did not play a major role in the financial crisis, though they do have the potential to pose systemic risks to financial stability if they are individually very large or leveraged. In the context of global financial stability, how hedge fund leverage affects systemic risk through market and credit channels has to be examined. Hedge funds invest in a number of asset classes, in which they are significant investors in certain markets. With their active trading styles, they are having a clear impact on global financial market dynamics. On the positive side, their trading behaviors have boosted market liquidity and enhanced price discovery in financial markets and they reduce the likelihood of pricing inefficiencies. However, in moments of financial crisis, forced selling (e.g., a fire sale caused by a margin call) may lead downward price adjustments to overshoot, and deplete market liquidity. Accordingly, it is possible for their collective behavior to be one of the drivers behind disruptions in liquidity and pricing. This market channel is where market dislocations can disrupt liquidity and pricing.

Reported Data

The potential stress within the hedge fund industry to be transmitted through the market channel may be estimated by the hedge funds' gross exposures relative to the size of the global markets they trade. The data used here is based on the semi-annual report of the Financial Services Authority (FSA), *Assessing the Possible Sources of Systemic Risk from Hedge Funds*. Figure 5 reports a hedge fund's total gross footprint to give an idea of the scale of its presence in the market. *Footprint* is defined by the FSA as the long and short

Figure 5 : Hedge Fund Gross Exposures (March 2012)



Source: FSA [2012], August, p.8.

Table 1 : Hedge Fund Gross Exposure to Relative to Market Size

[%]

	Oct-09	Apr-10	Sep-10	Mar-11	Sep-11	Mar-12
Listed Equities	0.5	0.6	0.6	0.7	0.6	0.8
Corporate bonds	0.3	0.3	0.3	0.2	0.2	0.3
G10 bonds 0-1 year	1.2	0.6	0.6	0.7	0.8	0.9
G10 bonds 1+ year	0.8	1.0	1.3	1.6	1.8	1.8
Non-G10 sovereign bonds	0.1	0.2	0.2	0.2	0.2	0.4
Financial institution bonds	0.2	0.1	0.0	0.1	0.1	0.1
Convertible bonds	10.1	8.1	8.3	7.0	6.9	7.3
Structured/securiti s ed products	0.2	0.3	0.3	0.4	0.5	0.9
Credit derivatives	0.8	1.0	1.1	1.4	1.0	1.3
Foreign exchange	0.3	2.4	0.8	1.2	1.3	1.4
Interest rate derivatives	2.9	4.7	4.0	3.5	2.8	2.7
Commodity derivatives	2.5	4.8	3.7	5.8	4.4	6.0

Source: *FSA, Assessing the Possible Sources of Systemic Risk from Hedge Funds*, various issues.
Note: Derivatives measured based on notional value.

positions (i.e., gross exposure) held in equities, corporate bonds, convertible bonds, sovereign bonds, loans, CDS and structured credit. In aggregate, surveyed hedge funds have sizable long and short exposures in listed equities, G10 bonds of one year or greater tenor, and credit default swaps (CDS). FSA [August 2012] points out that hedge funds' gross exposures are 55% in the U.S. for listed equities. Approximately 51% of gross CDS is on indices, 31% is single name CDS, and the rest in exotic positions such as credit default tranches. Figure 5 also reveals a clear tendency of hedge funds to use offsetting long and short positions (net exposures), which is one of the features differentiating hedge funds from other parts of the asset management industry.

While the growth trajectory of the hedge fund industry is impressive, the size of the gross exposure remain small compared to the global markets for equities or debt securities, as shown in Table 1. There are few asset classes where aggregate gross exposures were greater than 2% of total market size. However, the convertible bond, interest rate derivative and commodity derivative markets are exceptional cases. In addition, there are some financial instruments in which hedge fund gross exposures have increased remarkably from October 2009 to March 2012: G10 bonds of one year or greater tenor, structured/securitized products and commodity derivatives.

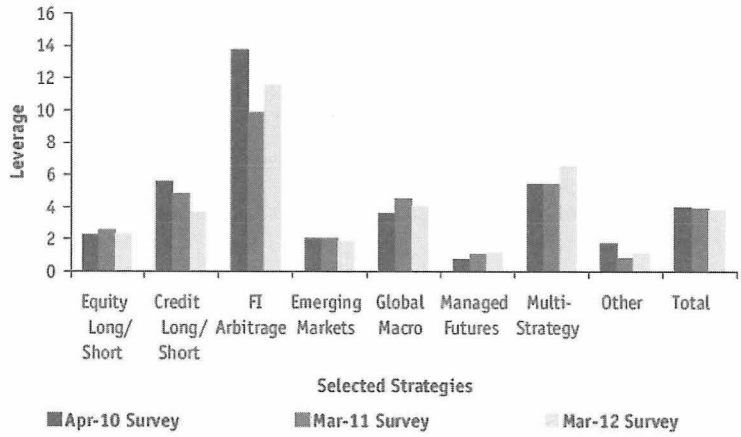
The gross leverage by hedge fund strategies is reported in Figure 6. Aggregate fund leverage (total) has remained stable across survey periods at about 3.8 times NAV. In general, hedge funds with 'spread-based' strategies can be expected to have greater gross leverage to those with 'fundamentals-based' strategies. As reflected in the results, gross leverage of fixed-income arbitrage is highest among hedge fund strategies, which decreased from 14 times NAV in the April 2010 survey to 10 times NAV in the March 2011 survey, and was reported at 12 times NAV in the March 2012 survey. Moreover, multi-strategy has seen an overall increase in gross leverage.

It is important to understand the source of hedge fund borrowing to achieve leverage because of the potential impact on systemic risk through credit channels. According to Figure 7, hedge funds rely on borrowing via repo in aggregate, with 47% coming from this source in March 2012. The FSA [August 2012] reports that a high portion of repo financing between surveyed banks and their hedge fund counterparties consisted of G10 government bonds as collateral. Hedge funds increased their borrowing via prime brokerage and their synthetic borrowing from September 2011 to March 2012.

Figure 8 exhibits total borrowings classified by hedge fund strategies expressed as a multiple of NAV. It provides useful information about hedge funds' interconnections with creditors such as banks and prime brokers, which reveals a key channel through which systemic risks may propagate. Typically, fixed-income arbitrage, convertible arbitrage and global macro seek higher leverage via repo financing and other strategies, especially quantitative long/short equities or event driven strategies borrowed from prime brokers. Managed futures are via cash that goes to an exchange like the Chicago Mercantile Exchange (CME), and thus not a collateral/ leverage based strategy. Emerging markets do not generally require leverage (Singh [2011]).

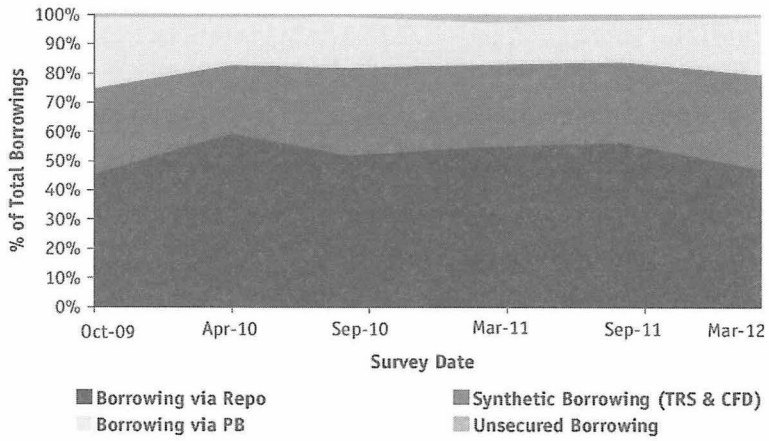
The interconnectedness has become considerably more complex within the growth of the shadow banking system over the past two decades, in which an intermediation chain binds a variety of non-bank market participants such as hedge funds, finance companies, etc. into a network through a wide range of securitization and secured funding techniques. In the context of hedge fund leverage, this interconnectedness can be considered from the view of the collateral chains in secured funding techniques such as repo, and pledged

Figure 6 : Gross Leverage by Hedge Fund Strategies



Source: Financial Service Authority [2012], August, p.14.
Note: The data originate from Hedge Fund Survey (HFS) conducted in March 2012 by FSA, U.K.

Figure 7 : Source of Hedge Fund Borrowings

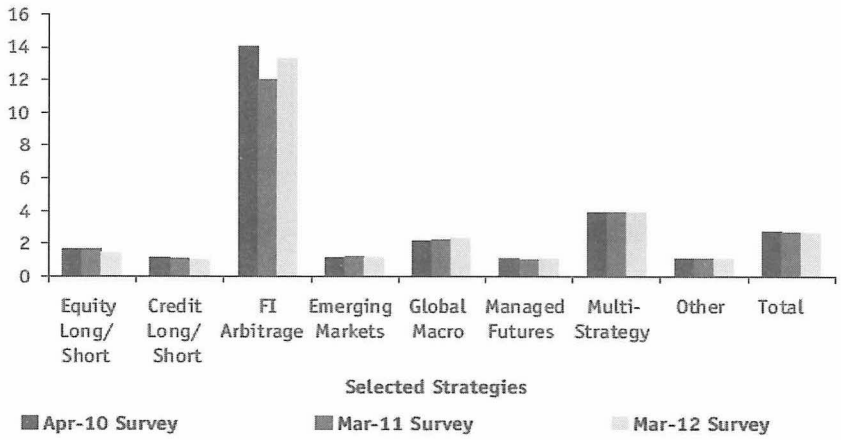


Source : Financial Services Authority [2012], August, p.13.
Note : In synthetic borrowing, TRS and CFD denote total return swaps and contracts for difference respectively.

collateral borrowing via prime brokers. The assets posted by hedge funds as pledged collateral (i.e., primary collateral) are continuously re-invested to maximize returns over their maturity tenor. Primary collateral is re-used as collateral that can be re-pledged. The primary collateral can be borrowed against assets that are less liquid, which also function as collateral, and these less liquid assets in turn can also be borrowed.[10]

10 Singh [2012] describes the collateral chains in the intermediation of credit as analogous to the money supply in

Figure 8 : Total Borrowing as a Multiple of NAV by Hedge Fund Strategies



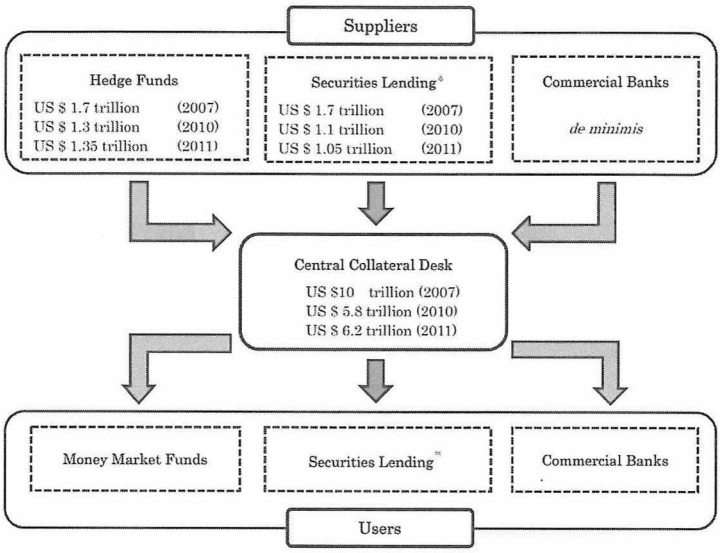
Source: Financial Service Authority [2012], August, p.15.
Notes: Total borrowing is shown as (Borrowing + Net Asset Value)/ Net Asset Value.

Singh [2012] estimates the collateral flows from 2007-2011 (Figure 9). Hedge funds are one of the major providers of (primary) collateral to large banks and dealers through leveraging their positions through repurchase agreements and loans made under prime broker agreements for finance. The other providers are securities lending via custodians on behalf of pension funds, insurers, official sector accounts and commercial banks. The pledged collateral is usually received by the central collateral desk of dealers and large banks.[11] They re-use the collateral (i.e., rehypothecation) to meet the 'demand' from the financial system. Total collateral from primary sources that could be re-pledged by the large dealers was $1.35 trillion (with hedge funds) plus $1.05 trillion via securities lending, for a total of $2.4 trillion, while total collateral received by the central collateral desk of large dealers was $6.2 trillion as of end of 2011. Therefore, the velocity of collateral was approximately 2.6, which was calculated as the ratio of the total collateral received to primary sources of collateral. The mark-to market value of total collateral from hedge funds that come to the large dealers is estimated to have been about $1.35 trillion as of end-2011, with $700 billion to have come via prime broker funding and $650 billion from repo funding outside the prime brokers. Table 2 provides summary statistics of how the sources and the collateral chains result in estimating the overall collateral.

traditional banking. The stock of high quality assets is 'high powered' money, the haircut is the reserve ratio, and the number of times collateral gets re-pledged is the equivalent of the velocity of money. Gordon and Metrick [2009] also have said that repos are considered part of the money supply.

11 In the U.S., Goldman Sachs, Morgan Stanley, JP Morgan, BoA/Merrill and Citibank are major dealers active in the collateral industry. In Europe and elsewhere, those dealers are Deutsche Bank, UBS, Barclays, Credit Suisse, Societe General, BNP Paribas, HSBC, Royal Bank of Scotland and Nomura. See Singh [2011], p.5.

Figure 9 : The Sources and Uses of Collateral (2007, 2010 and 2011)



Source: Author's compilations from Singh [2012], p. 13 (Figure 6).
Note: * Security lending via custodians for sovereigns/ official accounts, pension, insures, asset managers, ETF funds etc.

Table 2 : Sources of Pledged Collateral, Velocity and Overall Collateral

〈Trillions USD〉

Year	Sources		Total	Chain	Overall
	Hedge Funds	Others	Source	(Velocity)	Collateral*
2007	1.7	1.7	3.4	2.9	10.0
2010	1.3	1.1	2.4	2.4	5.8
2011	1.3	1.05	2.4	2.6	6.2

Source: Singh [2012], p. 13.
Note: *The amount of overall collateral is calculated as "total source" times "chain".

Ⅳ. Pledged Collateral and Liquidity Risk

Endogenous hedge fund vulnerabilities can be found when a large hedge fund or a group of hedge funds were faced with difficulties or failures, which could lead to far-reaching repercussions for exposed banks and broker-dealers. Hedge funds can fail in at least two ways: capital insolvency and liquidity insolvency (CRMPG [2005]). Capital insolvency means that their liabilities exceed assets. Liquidity insolvency means that they run out of cash and are unable to raise new funds, which come out of funding liquidity risk and asset liquidity risk. Both kinds of insolvency can be amplified through creating leverage by hedge funds.

Liquidity refers to the ability to trade quickly without moving the price.[12] There are two separate, but

12 From the viewpoint of information theory, Gordon and Metrick [2009] define liquidity as the ability to trade without the fear of adverse selection on either side of the transaction, and thus, liquidity requires symmetric information.

related types of liquidity: market liquidity and funding liquidity. First, market liquidity is the ability to liquidate an asset quickly, and in large volume, without substantially affecting the asset's price. Thus, market liquidity risk refers to the risk that a fund is unable to sell an asset quickly at reasonable price, where liquidation value of assets may differ significantly from their current mark-to-market values. An illiquid instrument is, in other words, an asset that cannot be liquidated in a short period of time without substantial loss in asset price. Second, funding liquidity is the ability to acquire funding in the event of credit impairment or some other shock. Therefore, funding liquidity risk refers to the risk that a fund may run out of cash and be unable to obtain sufficient new funds to meet its various obligations such as margin call to cover losses on assets used to collateral borrowing.

While distinct, these two types of liquidity are closely related to each other. For example, in the case of abundant funding liquidity, traders are able to finance their positions easily, trade in higher volume to support the price discovery and smooth price shocks, and keep high market liquidity. In contrast, market illiquidity leads to increased price volatility, which often causes margin calls that reduce funding liquidity. In adverse market conditions, deterioration in market liquidity and a dry-up in funding liquidity can reinforce each other (so-called liquidity spirals). This mutual dependence gives rise to the potential stress for market instability.

Singh and Stella [2012] have divided the collateral assets (denoted by *C*) into two categories (denoted by *C1* and *C2*). The first class, *C1* is comprised of a class of assets that in all states of the market conditions are accepted as collateral without losing value. This type is good collateral, which can be converted to a demand deposit at almost no haircut. For example, U. S. T-bills or U. S. Treasuries, which are direct-obligations of the central government, fall into this category. The second class, *C2* is composed of other assets considered to be acceptable as collateral at the time of normal market conditions, while losing value at the time of distress. The availability and acceptability of these assets as collateral depend on market sentiment, counterparty fears, the length of collateral chains, and market imposed haircuts. The two classes of collaterals, *C1* and *C2* can be considered liquid and illiquid assets, respectively.

The collaterals, *C1* and *C2*, can be explained as "information-insensitive" and "information-sensitive" assets, respectively, within the framework of information theory. In a trading context, information asymmetries are closely related to the concept of liquidity. Liquidity requires symmetric information, which is easiest to achieve when everyone is ignorant. In theory, the coexistence of uninformed and informed traders in one market means asymmetric information, which leads to reduced trade, and liquidity, ultimately, disappears from the market. This process is called *adverse selection*. An asset can be regarded as liquid if it has the characteristic to trade a given amount quickly without moving its prices, and without an uninformed trader losing money to a privately informed trader. Dang, Gorton and Holmström [2009] have said that this

is one form of symmetric information; symmetric ignorance. Under symmetric ignorance, the incentive for private information production about the asset is smallest even if there are informed and uninformed traders in the market. They identify this type of asset as *information-insensitive security*. Information-insensitivity means that the securities are immune from adverse selection when trading; in other words, trading can occur quickly without loss to insiders. However, if an economic shock is large enough then security that was information-insensitive becomes information-sensitive. This creates loss of confidence, and fear of adverse selection reduces liquidity of the security.

Under normal conditions, the volume of collateral *C* can support the transactions of collateral borrowing. More important than the sheer size of collateral *C*, however, is the behavior of the collateral itself and how it reacts to shifts in market conditions. In times of distressed market, the differentiation of *C2* collateral from *C1* collateral will happen, and subsequently lead to deleveraging. The differentiation of *C2* collateral from *C1* collateral can be seen in the changes of margins and haircuts of each asset.[13] Table 3 shows that haircuts vary with different asset classes and rating since they reflect the perceived underlying risk of the collateral and protect the lender against a counterparty default. As we have seen, the quantity and quality of assets comprising *C2* changed dramatically in the financial crisis of 2007-2009. In fact, haircuts and margins went up substantially during the credit crisis of 2008. Even for US treasuries, the most-credit-worthy and liquid securities on the table, haircuts went from 0.25% to 3%. For less liquid securities like ABS CDOs, haircuts went to 100%, which means these securities are no longer accepted as collateral. These sharp increases in margins and haircuts triggers margin call and aggravated deleveraging pressures, which reinforced interaction between valuation and leverage.

In summary, hedge funds become more vulnerable to liquidity shocks when they create leverage through short-term collateralized borrowing with the combination of any structured or illiquid positions (assets) whose full value cannot be realized in a quick sale.[14] Difficulties in valuation go hand in hand with the problems of illiquidity. Furthermore, in a volatile market, high levels of leverage increase the likelihood that hedge funds will fail. It is worth noting that the use of collateral in short-term credit mitigates counterparty risk, but it can also increase liquidity risk because borrowers have to provide additional collateral at short notice if market

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13 The difference between the sale and the repurchase prices is the repo rate, which means the interest rate to borrow cash. The sale price of the asset as collateral is below the current market price. The difference between the current market price of the asset and the price at which it is sold (collateralized) in the repo is called a haircut. The haircut is excess collateralization since it means the valuation discount applied collateral placed by counterparty. In effect, the haircut functions as an initial margin, or buffer, to protect the cash lender against a loss due to client default. See Adrian and Shin [2010B], p.13 and Jorion [2011], p.393.

14 Gordon and Metrick [2009] point out that an important feature of the repo market is that the collateral was often securitized bonds.

Table 3 : Typical Haircut or Initial Margin

	April2007	August2008
USTreasuries	0.25%	3%
InvestmentGradebonds	0-3%	8-12%
High-yieldbonds	10-15%	25-40%
InvestmentgradecorporateCDS	1%	5%
Seniorleveragedloan	10-12%	15-20%
Mezzanineleveragedloans	18-25%	35+
ABSCDOs		
AAA	2-4%	95%*
AA	4-7%	95%*
A	8-15%	95%*
BBB	10-20%	95%*
Equity	50%	100%*
AAACLO	4%	10-20%
PrimeMBS	2-4%	10-20%
ABS	3-5%	50-60%

Source: Joint Working Group of the Financial Stability Forum and the Committee on the Global Financial System [2009], p. 12.
Notes: ABS = asset-backed security; CDO=collateralized debt obligation; CDS=credit default swap; CLO=collateralized loan obligation; MBS=mortgage-backed security; RMBS=residential mortgage-backed security.* denotes that theoretical haircuts as CDOs are no longer accepted as collateral.

conditions change. The more hedge funds create leverage and widely collateralization is used, the more significant this risk becomes (Singh and Aitken [2009]).

V. Concluding Remarks

This paper examines the impact of hedge fund leverage as potential sources of systemic risk. The findings are as follows. First, leverage is often regarded for hedge funds as a synonym for risk, but leverage by itself is not an independent source of risk. For an individual hedge fund, there is no simple relationship between the use of leverage and risk on its portfolio risk. Sometimes leverage can be a very effective risk management tool if properly employed. Second, in the context of global financial stability, the confluence of leverage, market risk, credit risk and liquidity risk can give rise to systemic concerns in adverse market environments. More precisely, leverage influences the rapidity with which changes in market risk, credit risk and liquidity risk change the value of a hedge fund portfolio, which leads to liquidity spirals. Third, the short-term borrowing for creating leverage with the combination of any structured or illiquid positions makes hedge funds more vulnerable to liquidity shocks. Fourth, the pledged collateral from hedge funds induces the collateral chains (so-called rehypothecation), which increases the interconnectedness among market participants. Fifth, in the process of credit intermediation, a wide range of assets involving illiquid and structured products viewed as information-sensitive assets are used as pledged collaterals. During the

financial crises, their availabilities as pledged collaterals are extinguished.

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