

Chapter 17 Hedge Funds and Systemic Risk

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ABSTRACT

The public media and politicians regularly debate the potential for hedge funds to contribute to systemic risk in financial markets. Because the hedge fund industry experienced substantial growth since the 1990s, concerns about hedge funds' systemic risk have increased and regulators have taken measures to mitigate possible risks associated with these funds. The chapter summarizes the pre- and post-crisis debate and highlights the post-crisis evidence about hedge funds' alleged systemic risk. In particular, the chapter examines evidence about specific factors surrounding hedge funds' possible contributions to systemic risk, including risk management incentives, leverage, liquidity characteristics, regulation, financial stability, transparency, and their potential to induce and perpetuate market contagion.

INTRODUCTION

The controversy over hedge funds' alleged systemic risk is bitter and perhaps best illustrated by how government agencies assess this issue. In the United States after the financial crisis of 2007-2008, the Office of Financial Research (OFR) (2013) identified several activities of private fund managers that constitute important threats to the financial system, including but not limited to: (1) "reaching for yield," which is the potential for funds to lower credit standards to boost yields in a low interest rate environment; (2) investor "herding" toward the exits during market

downturns that may result in frequent or large-scale redemption requests; and (3) “fire sales” of assets at depressed prices in a liquidity crunch. The Financial Stability Board (FSB) (2011) and the International Organization of Securities Commissions (IOSCO) (2013) share the OFR’s assessment. Reports issued by the OFR, FSB, and IOSCO provide compelling reasons for designating financial institutions as systemically important. By contrast, the Financial Services Authority (FSA) (2010) in the United Kingdom concluded in its first comprehensive survey of London’s private fund industry that the hedge fund industry poses no systemic risk to the financial system. Despite the mixed evidence produced by government reports on hedge funds’ systemic risk, the majority of post-crisis evidence provided by leading financial economists suggests that hedge funds may play a role in introducing at least some systemic risk into the financial system. The results of the post-crisis studies provide regulators with methodologies to evaluate the extent of these risks and prescribe potential remedies.

This chapter contains three main sections in addition to the introduction. The following section provides an introduction to the issue of hedge funds’ systemic risk in the wake of the failure of Long-Term Capital Management (LTCM) in 1997 and the financial crisis of 2007-2008. A discussion of hedge funds’ systemic risk amplification and mitigation attributes is also provided, and the section concludes by exploring issues associated with hedge fund regulation and systemic risk, including private fund transparency under the Dodd-Frank Act, the Financial Stability Oversight Council, and systemic risk data generated through private investment adviser registration and disclosures. The second section explores the extensive post-crisis literature on potential relations among hedge fund activities and systemic risk, as well as the underlying factors that make hedge fund activities particularly important to academics, regulators, and market participants. The final section concludes.

THE DEBATE ON HEDGE FUNDS' SYSTEMIC RISK

The public's perception of the possible systemic risk of hedge funds largely drives the debate on hedge funds' systemic risk and policy responses. Several core factors drive this perception, including, most prominently, the growth of the hedge fund industry and the collapse of prominent hedge funds. Involving the growth of the private fund industry, assets under management (AUM) at hedge funds grew from \$118 billion at the end of 1997 to more than \$2.7 trillion by the end of 2014 (BarclayHedge 2016). This change represents a compound annual growth of 19 percent. According to some estimates, private funds surpassed banks in size and importance both during and after the financial crisis of 2007-2008. The unprecedented growth in the private fund industry combined with the low interest rate environment following the Federal Reserve's quantitative easing after the financial crisis resulted in private fund managers' increasingly "reaching for yield." The use of leverage and complex financial transactions, including derivatives, to increase private fund advisers' potential yield further increased private funds' systemic risk.

Spectacular hedge fund failures further exacerbate the public's perception that private funds pose systemic risk. Such failures include Long-Term Capital Management (LTCM), Marin Capital, Tiger Capital, and Amaranth Advisors. The financial crisis of 2007-2008 also included the failures of two Bear Stearns hedge funds that were heavily involved in the market for collateralized mortgage obligations (CMOs) of Bear Stearns Asset Management (BSAM) subgroups. But some research suggests that private fund advisers are unlikely to trigger a systemic event because losses in hedge funds are directly absorbed by the multitude of investors and their equity capital and may actually reduce market volatility (Fung and Hsieh 1997; Stulz 2007; Dixon, Clancy, and Kumar 2012). In the aftermath of LTCM, regulators have encouraged banks to monitor their hedge fund adviser clients through limitations on leverage through their counterparty risk management (CCRM) practices (Kambhu, Schuermann, and

Stiroh 2007). The lack of financial market repercussions after the Amaranth failure seems to suggest that this approach has been successful.

The debate on private funds' systemic risk centers around two major events: the collapse of LTCM and the financial crisis of 2007–2008. The collapse of LTCM in 1998 and the bailout orchestrated by the New York Federal Reserve Bank triggered the first wave of scholarly debate on the systemic risk of private funds. A large part of the literature recognizes that market events such as the LTCM failure may lead to global financial crises if many highly leveraged hedge funds with illiquid portfolios are obligors of a small number of major financial institutions (e.g. Pedersen 2009, Boyson, Stahel, and Stulz 2010, and Ben-David, Franzoni, and Moussawi 2012). These scholars see hedge funds' pursuit of aggressive investment strategies and a high level of leverage as the primary combination of factors causing hedge funds' systemic risk when combined with adverse fluctuations in market prices that can dry up credit and negatively affect the market price of collateral. Other scholars including Brown, Hwang, In, and Kim (2013) and Buraschi, Kosowski, and Trojani (2014) contend that the proliferation of private funds in combination with their risk/reward profile makes such funds systemically risky. Besides posing a direct systemic risk by damaging systemically important financial institutions, private funds can also pose an indirect threat to the financial system by generating liquidity shocks and increasing market volatility in key markets. Others such as Kambhu et. al. (2007), Sadka (2010), and Teo (2011) view the combination of leverage and the complexity of private funds' transactions employing derivative instruments and non-exchange traded derivative instruments as the main concerns associated with private funds' systemic risk.

The financial crisis of 2007-2008 triggered a second major wave of scholarship about the possible systemic risk implications of private funds. A large part of the post-crisis debate pertained to the role of the so-called shadow banking system in the financial crisis (e.g. Bengtsson 2016), European Financial Stability Board 2011). The *shadow banking system* refers to private fund advisers creating funds that may function as a close substitute for the money-like

liabilities created by banks. Like banks, private fund advisers can provide liquidity to clients and to financial markets and engage in various forms of liquidity transformation. The vulnerabilities created by private fund advisers engaging in bank-like activities may have large implications for financial stability. Given the changing conditions for private funds, additional factors could also be possible sources of hedge funds' systemic risk. These factors include redemption risk that causes sudden reductions in funding to banks and other financial entities, insufficient credit risk transfer to private fund managers, and contagion through business relationships connecting private fund managers with their sponsors.

Hedge Funds' Contributions to the Financial Crisis of 2007-2008

Measuring hedge funds' contribution to the financial crisis of 2007-2008 has proven difficult. Although the Securities and Exchange Commission (SEC) started collecting systemic risk data on hedge funds in the aftermath of the financial crisis and the enactment of Title IV of the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (Dodd-Frank Act), no such data were available before and during the crisis. Because of the hedge-fund industry's lack of transparency and preference for secrecy, many of the inferences on possible systemic risk associated with hedge funds and the financial crisis are circumstantial and/or indirect. Core data needed but unavailable for the evaluation of hedge funds' contribution to the financial crisis include data on hedge fund characteristics such as leverage, counterparty relations, AUM, and portfolio holdings. Without such data for a substantial time period before the financial crisis, concluding that hedge funds may have had a role in the financial crisis is circumstantial or anecdotal. Although indirect measures of hedge funds' role in the financial crisis and systemic risk can be extricated from existing data, the shadow banking system of hedge funds and the lack of sufficient transparency create substantial obstacles to implementing direct measures, especially without the access to primary sources of data regarding hedge funds before the crisis.

In theory and purely anecdotally, several hedge-fund-related factors could have contributed to the financial crisis. One factor is the growth of the hedge fund industry in combination with the increasing interconnectedness of global financial markets. In theory, if hedge funds experience losses, such losses may spread to other financial institutions and could undermine the stability of the financial system (“contagion”). These theoretical assumptions are, however, counterbalanced by several practical considerations. First, hedge fund collapses are rarely sudden but in practice almost always occur in incremental steps over a long time period. Hedge funds’ risk management practices are typically so evolved that they constitute a major barrier to systemic shocks. Hedge funds’ counterparties in trades and lenders to hedge funds can also help prevent large losses that could disrupt the financial system. In fact, evidence also exists that hedge fund losses that could have affected the overall economy did not occur until the financial crisis and the recession had been triggered by the mortgage market collapse and sustained stock market losses (e.g. Fung and Hsieh 1997: Stulz 2007: Dixon, Clancy, and Kumar 2012).

In the wake of the LTCM failure in 1998 but before the financial crisis of 2007-2008, regulators sought to determine the causes of hedge funds’ potential systemic failure. In a speech to the Federal Reserve Bank of Atlanta in 2006 (Bernanke 2006), former Federal Reserve Chairman Ben Bernanke suggests that a failure to manage counterparty risk was a primary cause for concern. He expresses concern that this risk was still not being properly measured and that banks should tie credit terms and conditions to hedge funds’ willingness and ability to provide transparency. The Securities and Exchange Commission (2003) addresses these issues in a 2003 report. The U.S. Senate Committee on Banking, Housing, and Urban Affairs (2006) also discusses these issues in a comprehensive hearing. The focus of both of these entities, however, centers more on the issue of hedge fund transparency than on counterparty risk.

Shortly thereafter, Stulz (2007) concludes that concerns over hedge funds' systemic risk to the economy and the banking system are generally overstated, providing evidence that hedge funds do not generally create volatility and may instead mitigate market instability. Investors in hedge funds are generally sophisticated and not subject to the investor suitability requirements of the SEC and/or the Financial Industry Regulatory Authority (FINRA). While the risks to financial institutions are often overstated, liquidity risk remains a serious issue due to the critical linkages created by over-the-counter credit risk relations.

Hedge Fund's Systemic Risk Amplification and Mitigation Attributes

Several core hedge fund attributes may both amplify and mitigate systemic risk. Such attributes include hedge funds' risk management incentives, leverage, returns, and investment strategies.

Risk-Management Incentives

First and foremost among the perceived systemic risk amplification attributes of hedge funds are their managers' risk management incentives. Hedge fund managers are tasked with generating profitable trading strategies and setting up the right portfolio structure while also managing the business and minimizing the risks of the fund investments. Arguably, in order to obtain sufficient returns for their clients, hedge fund managers are incentivized to take disproportionately high risks in their management strategies, which can translate into proportional systemic risks. However, because many hedge funds engage in some form of market-neutral arbitrage to ensure that returns do not depend on the direction of the market, they may implicitly minimize systemic risk.

Hedge funds' trading patterns during stock market liquidity crises can also contribute to systemic risk. Some evidence exists that hedge funds substantially reduce their equity holdings during stock market crises such as the financial crisis of 2007-2008 (e.g. Aragon and Strahan 2012; Brunnermeier and Pedersen 2009). Driven by investor and lender redemptions and the need to liquidate positions during the financial crisis, one in four hedge funds sold more than 40

percent of its equity portfolio, and the hedge fund industry liquidated about 30 percent of its stock holdings (Ben-David et. al. 2012).

Leverage

Portfolio leverage is another core amplification factor of hedge funds' systemic risk. Among financial intermediaries, the hedge fund industry has traditionally been the most exposed to leverage. The sophisticated use of leverage is a defining characteristic of the industry as calibrating the appropriate use of leverage plays a central role in the management of hedge funds. Leverage not only helps amplify or curtail market risk but also can be employed to take advantage of market mispricing opportunities, level return volatility desired by investors, and react to changing market and investment opportunities. Systemic risks associated with hedge funds' use of leverage stems from its ability to amplify liquidity losses and contribute to the overvaluation of assets during bull markets. If hedge funds simultaneously liquidate positions and reduce leverage, leverage can also increase the risk of a fire-sale externality that increases systemic risk. Such an externality might occur when a hedge fund needs to sell assets that it views as drastically undervalued but that it must sell to meet margin calls or redemption requests. Despite the risks associated with hedge fund leverage, evidence exists that the hedge fund industry's exposure to leverage has been relatively modest since the collapse of LTCM in 1998, especially compared with the mean leverage of investment banks and broker/dealers (Ang, Gorovyy, and Van Inwegen 2011).

Hedge Fund Returns and Investment Strategies

A third attribute that can play a role in hedge funds' systemic risk concerns the returns generated by hedge funds. Because hedge funds invest in a broad spectrum of assets and engage in different strategies, hedge fund returns should not affect their systemic risk. However, evidence exists that the returns of different hedge fund strategies were more correlated during the financial crisis of 2007-2008 than before the crisis, suggesting that the hedge fund industry

can pose systemic risks despite broad strategy diversification (Boyson et. al. 2010; Ben-David et. al. 2012).

Hedge funds' investment strategies can also play a role in hedge funds' systemic risk and their potential for contagion. Bekaert, Harvey, and Ng (2005, p. 40) define hedge fund contagion as the "correlation over and above what one would expect from economic fundamentals." Evidence shows that suboptimal hedge fund returns cluster across investment styles. Because risk factors associated with hedge fund performance cannot explain such clusters, they can reflect contagion (Boyson et. al. 2010). Others show that hedge funds' returns generated with dynamic management styles, such as global macro, emerging markets, and managed futures funds, among others, are associated with systemic risk (Bali, Brown, and Caglayan 2012). Hedge funds' systemic risk can also help explain cross-sectional differences in hedge fund returns (Brown et al. 2013). The growth of hedge fund replication strategies in exchange-traded funds (ETFs) may further increase hedge funds' systemic risks associated with certain strategies (Ramaswamy 2011).

Hedge Fund Regulation and Systemic Risk

In part to address hedge funds' alleged systemic risk, Congress enacted the Private Fund Investment Adviser Registration Act under Title IV of the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (the "Dodd-Frank Act," "Title IV," or "PFIARA") (Dodd-Frank 2010). The Dodd-Frank Act authorized the SEC to promulgate rules requiring registration and enhanced disclosure for private funds advisers, and facilitating data collection to assess hedge funds' systemic risk.

By amending the Investment Advisers Act, PFIARA gave the SEC authority to issue rules and regulations for the registration of private funds with the SEC, increasing record keeping and disclosure to close alleged regulatory gaps, and ending speculative trading practices that may have contributed to the financial crisis of 2007-2008. Under PFIARA, hedge

fund advisers with more than \$150 million AUM are required to register as investment advisers and must disclose systemically relevant information to the SEC. PFIARA also authorized the SEC to collect information from registered hedge fund advisers who are required to file confidential reports with the SEC containing information related to systemic risk.

Financial Stability Oversight Council

The Dodd-Frank Act created the Financial Stability Oversight Council (FSOC) to ameliorate the perceived regulatory weaknesses that contributed to the financial crisis of 2007–2008. The FSOC is tasked with curtailing the complexity of financial institutions and improving the coordination among financial regulators. Its supervisory responsibilities include evaluating and implementing supervisory priorities and principles. The FSOC's primary purposes include identifying and remedying insufficient supervision of large non-bank financial institutions, promoting market discipline, and responding to emerging threats to the stability of the U.S. financial system. The FSOC's core duties include identifying regulatory shortcomings that could pose systemic risk; collecting information on financial firms; making regulatory recommendations for financial regulators; suggesting regulatory changes to Congress for the promotion of efficiency, competitiveness, and stability; monitoring the financial system for potential systemic risks; facilitating information sharing and coordination among financial regulators; and providing a forum for the resolution of jurisdictional disputes among council members. The FSOC can request data and analyses from the Office of Financial Research (OFR) and provide direction to the OFR. The FSOC also has its own permanent staff at the OFR, tasked with collecting required data on the financial system as well as providing information and technical expertise.

The FSOC's powers over hedge funds and other nonbank financial institutions are broad and unprecedented in U.S. financial regulation. The FSOC has the power to subject hedge funds to extensive supervision by the Federal Reserve. It can also determine on its own

initiative with a two-thirds vote if a hedge fund or other nonbank financial institution is systemically important.

The Dodd-Frank Act mandates several factors that the FSOC must consider in determining which entities qualify as a systemically important financial institution (SIFI). Hedge funds and other investment funds that manage \$50 billion or more in aggregate total consolidated assets could be designated a SIFI. First, the FSOC assesses whether “material financial distress” at a nonbank financial institution could pose a threat to the stability of the financial system. Thereafter, in a second step, the FSOC takes into account in its assessment the nature, size, scope, scale, concentration, interconnectedness, and mix of the activities of the nonbank financial institution as possible threats to the financial system. Statutory considerations in determining whether a hedge fund meets either of the two standards include leverage, liquidity risk and maturity mismatch, size, interconnectedness, substitutability, and existing regulatory scrutiny. Designating a hedge fund as a SIFI subjects the hedge fund to substantial additional regulations and requires it to change the way it does business. However, hedge funds are unlikely to be designated as SIFIs because of the high threshold on AUM.

Systemic Risk Data

In an attempt to fulfill its data collection obligations under Title IV of the Dodd-Frank Act, the SEC Division of Investment Management adopted Form PF (Private Funds). The reporting obligations for hedge fund managers in Form PF are intended to enable the FSOC to fulfill its mandate. Form PF provides the FSOC with information about the private fund industry to enable it to assess risks in the financial system and support its mandate of designating SIFIs. The SEC and the Commodities and Futures Trading Commission (CFTC) can use Form PF filings for investigations and examinations. Title IV authorized the SEC to share Form PF data with institutions that are also required to maintain confidentiality of Form PF data, including the FSOC, Congress, courts, federal departments, and self-regulated organizations.

The SEC takes a tiered approach to Form PF filing requirements. Registered hedge fund advisers with \$150 million in AUM or more at the end of their most recently completed fiscal year are required to file Form PF. However, smaller hedge fund advisers — those with less than \$1.5 billion AUM — are required to complete and file Form PF annually. Large private fund advisers — those with at least \$1.5 billion AUM — must update their Form PF filings quarterly.

POST-CRISIS EVIDENCE ON THE SYSTEMIC RISK OF HEDGE FUNDS

In the wake of the financial crisis of 2007–2008, the Rand Corporation published an influential report (Dixon et al. 2012) about the association between hedge funds and systemic risk.

According to the report, about 18 percent of hedge funds ceased operations in 2008, although little evidence exists that these fund failures contributed to losses at prime brokers or other financial institutions. Nevertheless, because of increasing correlations among asset returns, the effects of high leverage, increasing financial interdependence in the global financial system, and the potential for “contagion,” academics and regulators remain concerned that hedge funds may contribute to systemic risk.

Brunnermeier (2009) and Brunnermeier and Pedersen (2009) provide the theoretical underpinnings that link systemic risks to hedge funds, and their “limits to arbitrage” arguments stem from the seminal work of Shleifer and Vishny (1997). These models rely on the concept that speculators’ capital is not unlimited, but rather that their ability to provide liquidity is dependent on funding, and that this funding can suddenly dry up in periods of financial distress and lead to liquidity spirals. These spirals can be exacerbated by increased correlations in security returns, increases in market volatility, and a “flight to quality” by market participants. Numerous empirical studies seek to examine the efficacy of the theoretical predictions of these models using actual hedge fund, macroeconomic, market, liquidity, and volatility/correlation data.

One strand of post-crisis research on this topic examines the links among liquidity, hedge funds, and systemic risk. Boyson et al. (2010) use multiple econometric techniques to provide strong evidence that large adverse shocks to liquidity contribute to hedge fund “contagion.” They use the definition of contagion from Bekaert et al. (2005, p. 40), which, as previously noted, is “correlation over and above what one would expect from economic fundamentals.” They also cite the theoretical motivation of Brunnermeier and Pedersen (2009) that adverse shocks to liquidity can affect speculators’ ability to provide liquidity and may force them to delever at the worst possible time, which then drives asset prices lower and leads to further deleveraging. In short, this hypothesis states that market efficiency and liquidity can be limited by speculators’ access to capital. The empirical results of Boyson et al. do not point to liquidity risk as a risk factor in hedge fund performance, but they do posit that large shocks to liquidity do contribute to contagion and to the liquidity spirals hypothesized by Brunnermeier and Pedersen (2009).

Ben-David et al. (2012) also examine a host of hedge-fund-related variables to conclude that hedge fund redemptions and margin calls, which are liquidity reducing events, were the primary drivers of selloffs during the financial crisis of 2007-2008. They demonstrate that hedge fund investors are three times more likely to withdraw capital during market downturns than are mutual fund investors. Their evidence shows that funds with higher proportions of institutional ownership are more likely to make redemptions since they may have a better ability to recognize potential liquidity problems and act more quickly than individual investors. Consistent with Boyson et al. (2010), hedge funds’ ability to avoid losses from liquidity runs is hampered by the limits-to-arbitrage and liquidity arguments of Brunnermeier and Pedersen (2009).

Besides liquidity, Adrian, Brunnermeier, and Nguyen (2013) identify several other factors that contribute to hedge fund tail risk and explain that capital flows and expected returns are positively related to this risk. These factors include market excess returns, VIX straddle excess returns, variance swap returns, the repo-treasury rate, carry trade excess returns, the 10-year

minus three-month treasury returns, and the 10-year corporate/treasury spread. They also demonstrate that hedge fund managers may be incentivized to increase their exposure to these factors since they often increase both management and incentive fees. Their study is closely related to that of Billio, Getmansky, and Pelizzon (2010), who also identify liquidity and three other factors (i.e., market, credit, and volatility risks) related to hedge fund risk but change depending on the state of the equity market. Using a regime switching model to estimate whether the S&P 500 Index is in an up, down, or tranquil regime, they demonstrate that their risk factors apply most strongly when the market is in a down state.

Billio, Getmansky, Lo, and Pelizzon (2012) estimate econometric measures of connectedness and systematic risk in two ways. First, they use principal components analysis (PCA) to demonstrate that hedge fund return volatility is sensitive to risks in the financial system, but much less so than are brokers, banks, and insurance companies. However, in a series of nonlinear Granger-causality tests of return volatility, they find that volatility between 2001 and 2008 is transmitted across all parts of the system, including from hedge funds to brokers and banks.

In a study that directly seeks to quantify the contribution of hedge funds to systemic risk, Brown et al. (2013) use marginal expected shortfall (MES), a measure of downside tail risk or downside beta. They find a positive and significant relation between systemic risk and hedge fund returns since MES predicts fund returns and covariances during the financial crisis. The authors conclude that investors demand a premium to carry tail risk during systemic events, and they also imply that hedge fund managers are incentivized to take risks with systematic exposures, consistent with Adrian et al. (2013).

Brandon and Wang (2013) also examine the liquidity risk of hedge funds, finding that when incorporating liquidity risk into the analysis of the returns of hedge funds, the superior performance of funds that incorporate predictability in managerial skills disappears. Their analysis is rooted in the studies of Avramov and Wermers (2006) and Avramov, Kosowski, Naik,

and Teo (2011). Avramov and Wermers find that predictability in mutual fund management skills, as measured by historical performance against various market and industry benchmarks as well as business cycle variables, is the dominant source of outperformance, especially during down markets. Their proposed framework is generally applicable to investment decisions in real time, including those of hedge funds. Avramov et al. thus apply this approach directly to hedge funds and find the similar result that predictability in managerial skills is once again the most important source of outperformance. Brandon et al. extend these results by incorporating the effect of liquidity risk into the analysis. They find that the outperformance previously attributed to predictability in managerial skills disappears in hedge fund portfolios when accounting for liquidity risk.

Teo (2011) also examines the issue of liquidity risk and finds results that are compatible with the liquidity funding hypothesis of Brunnermeier and Pedersen (2009). Specifically, he examines the issue of whether funds that allow redemptions on a monthly basis or sooner experience greater losses, challenging the assumption that redemption policies of hedge funds are irrelevant. In contrast, Teo finds that the rewards to liquidity risk are positive in part because redemption gates help hedge funds avoid asset fire sales.

In the same vein, Sadka (2010) finds that hedge funds with returns strongly related to liquidity risk outperform those that are not. Specifically, he finds that variations in systemic liquidity affect hedge fund performance. He measures the covariation of fund returns with unexpected changes in aggregate liquidity to the cross-section of hedge fund returns. Funds that are sensitive to liquidity risk outperform other funds by about 6 percent annually, and are independent of lockup and redemption periods. Thus, Sadka concludes that systematic liquidity variations are important to the evaluation of hedge fund performance. Billio, Frattarolo, and Pelizzon. (2016) develop several measures of tail risk as well and show that all hedge funds contribute to the downside risk of a portfolio of hedge funds, mainly due to their exposures to liquidity and credit risks. Even funds that are dedicated to short selling strategies contribute to

tail risk, consistent with Billio et al. (2012). Both of these papers use a regime switching empirical approach, thus the finding of similar results is unsurprising.

Taking a slightly different econometric approach, Aragon and Strahan (2012) examine liquidity in stocks that are held in large amounts by hedge funds whose prime brokers were Lehman Brothers and Bear Stearns, respectively. They find greater declines in stocks held in large quantity at Lehman Brothers and attribute this effect to the bankruptcy announcement that contributed to uncertainty during the crisis, concluding that a reduction in funding liquidity negatively affects market liquidity. This result is a direct confirmation of Brunnermeier and Pedersen (2009).

The links among liquidity, hedge fund returns, and systemic risk are an increasingly important topic in the finance literature as financial markets have become more and more interconnected. Additionally, many of the existing studies of and the potential for systemic risk focus on increasing correlations among asset class returns since the 1990s, including correlations among hedge fund returns. For example, Buraschi, Kosowski, and Trojani (2014) examine the cross-sectional hedge fund returns using various hedge fund characteristics. They find a significant negative market price of correlation risk. The authors also examine individual hedge fund returns, and once they control for correlation risk, previously observed significant hedge fund alphas disappear. This finding is important because traditional risk-adjusted alphas may underestimate hedge fund risk. Finally, their evidence shows a nonlinear relation between correlation risk and tail risk, indicating that hedge funds with large exposures to extreme downside risks experience large losses during market crashes, which is consistent with Billio et al. (2012). Buraschi et al. conclude from this analysis that correlation risk is a systematic risk factor for hedge fund returns.

Bali, Brown, and Caglayan (2014) approach these issues in a slightly different manner since they seek to quantify measures of macroeconomic risk, as opposed to most other studies that measure financial risk, and their effects on the risk exposures of hedge funds and mutual

funds. Specifically, they use measures of macroeconomic risk that are related to economic uncertainty by estimating the conditional volatilities of these variables using a GARCH model. The authors find that these “uncertainty betas” robustly explain hedge fund returns, but not mutual fund returns, suggesting that hedge fund managers may have greater abilities to detect potential future financial market volatility and adjust to changes in financial and macroeconomic conditions. These results are consistent with the similar supposition of Ben-David et al. (2012).

Bali et al. (2012) find that tail risk explains the cross-sectional dispersion in hedge fund returns, and that these risks are strongly related to market risk, residual risk, and tail risk. Kang, Kondor, and Sadka (2014) demonstrate that hedge funds contribute to increased idiosyncratic risk in single stocks, especially those with high initial levels of idiosyncratic risk. Conversely, hedge funds decrease idiosyncratic risk in stocks with low initial levels of idiosyncratic risk.

Finally, Di Cesare, Stork, and de Vries (2015) examine the autocorrelation in hedge fund returns in some previous studies and demonstrate the importance of accounting for serial correlation when conducting empirical research in this area. According to De Cesare et al. (p. 868), “unadjusted risk measures can considerably underestimate the true extent of individual and systemic risks for hedge funds.” This evidence confirms the earlier findings of Getmansky, Lo, and Makarov (2004) and provides an alternative to their approach that smooths returns to address serial correlation in hedge fund returns. All other studies examining hedge fund returns that are cited in this chapter include some type of adjustment for serial correlation.

Although not specifically related to hedge funds, another strand of research explores systemic risk more generally. The methodologies of these papers may prove useful for future research about hedge funds. For example, Acharya, Engle, and Richardson (2012) use a measure of capital shortfall to create a measure of systemic risk (SRISK) for U.S. and European banks and companies. They compare and contrast this measure to two alternatives based on the Conditional VaR (CoVaR) models of Adrian and Brunnermeier (2011): CoVaR and Exposure CoVaR. The authors contend that their CoVaR measure is superior because it accounts for both

firm size and leverage. Acharya et al. also use the empirical model of Brownlees and Engle (2011) to explore volatility, tail risk, and correlation in financial markets.

In a series of articles appearing in the *Journal of Banking & Finance* (JBF), several authors explore alternative measures of systemic risk that may be used to examine the relation between hedge funds and systemic risk. Rodriguez-Moreno and Peña (2013) find that credit default swap spreads outperform measures based on interbank interest rates or equity returns in estimating systemic risk measures. To achieve this result, they rank measures according to the Granger causality tests, the Gonzalo and Granger (1995) cointegration metric, and the correlation of an index of systemic events to policy actions. Puzanova and Düllmann (2013) use the expected shortfall approach to estimate the expected loss to depositors and investors in banks using credit portfolios. They propose capital surcharges to systemically risky banks in similar fashion to Brunnermeier and Cheridito (2014).

Two additional JBF papers address these issues in the CoVaR framework of Adrian and Brunnermeier (2011). Girardi and Ergün (2013) use this measure to determine that depository institutions were the primary drivers of systemic risk from 2000 to 2008, ahead of broker-dealers, insurance companies, and non-depository institutions, which is consistent with Billio et al. (2012). They also point to the importance of correctly estimating the underlying distribution of returns as a skewed t-distribution as opposed to the normal distribution that is often used in practice. Bernal, Gnabo, and Guilmin (2014, p. 270) also rely on the CoVaR framework “to provide a formal ranking of the financial services sectors with respect to their contribution to systemic risk.” They extend their approach based on the Kolmogorov-Smirnov test to show that a loosely defined “other” financial services sector contributes more to systemic risk than both the banking and insurance sectors. Their analysis, however, does not clearly identify firms included in this “other” financial services sector even though a substantial portion of these entities may be hedge funds.

Finally, Patro, Qi, and Sun (2013) seek to determine how relevant and effective stock return correlations are as an indicator of systemic risk among financial institutions. They find that daily stock return correlations and default correlations provide a significant and timely systemic risk indicator. These correlations provide additional information that is not captured by default correlations. The authors recommend that regulators monitor stock return correlations among large and systemically important financial institutions to estimate ongoing levels of systematic risk.

In the theoretical literature on this topic, Brunnermeier and Cheridito (2014) develop a theoretical model to measure the total systemic risk (SystRisk) in the financial system based on shocks to the financial system and the resulting feedback loop. They quantify institutions' specific contributions to systemic risk, including hedge funds, and propose an intriguing potential cap and trade system for systemic risk that regulators may apply to firms across the financial system. The model of Allen, Babus, and Carletti (2010) posits that interconnectedness among banks contributes to systemic risk, in concert with the empirical findings of Billio, et al. (2012). Finally, Billio et al. (2016) develop theoretical risk measures that capture the tail risk of single hedge fund strategies based on regime-switching models. Their model also demonstrates that liquidity risk and credit risk affect tail risk of hedge funds, especially during a crisis period.

Bengtsson (2016) examines the potential dangers of the "shadow banking" system, which has come to include hedge funds and similarly opaque entities. He highlights the risk that hedge funds are providing funding to the banking system, which may be rapidly withdrawn during a liquidity crisis. Additionally, he notes that hedge funds continue to supply a substantial proportion of the sellers' share of the market for credit default swaps. Thus, they are assuming risks that have been traditionally held by investment banks and insurance companies. Bengtsson calls for increased regulatory examination of these increasingly interconnected relationships. The Financial Stability Board (2011, p. 4) examines these risks as well, recommending a "monitoring framework to assess shadow banking risks."

SUMMARY AND CONCLUSIONS

Despite the mixed results of the pre-financial crisis evidence about hedge funds' systemic risk in both academic work and government reports, the evidence after the 2007-2008 financial crisis suggests that hedge funds may play a role in introducing at least some systemic risk into the financial system. Government officials and regulators have proposed various ways to address these potentially systemic issues. New regulations are gradually taking effect as regulators take steps to increase hedge fund transparency and improve methods for collecting data on the activities of hedge funds. The examination of hedge funds' potential contribution to market turbulence has proven difficult. Some academic studies find no evidence of systemic risks that are related to hedge funds while others find counter-effects. Hedge funds may have the potential to amplify and/or mitigate systemic risks due to their particular risk management incentives, leverage, and investment strategies. The implementation of the Dodd-Frank Act and the establishment of the FSOC ensure that these issues will continue to receive proper attention.

Several theoretical academic studies point to the potential for a possible link between hedge funds and systemic risk, especially as it relates to liquidity. The extensive results of the post-crisis empirical studies provide regulators with an abundance of methodologies to evaluate the extent of these risks and to prescribe potential remedies, especially regarding the counterparty credit measures of hedge funds and their prime brokers. The increasingly interconnected global financial system makes continued examination of these issues pertinent. Another strand of literature examines the potential for "tail risk" induced by hedge funds' risk management incentives that may increase risk-taking and leverage while shrinking hedge fund liquidity. Academic studies examine several additional factors in this process, including hedge funds' exposures to macroeconomic risks, their contribution to a "shadow banking" system, and the potential for hedge funds to induce and perpetuate market contagion. Although the existing

academic evidence on these topics is somewhat mixed, these issues merit further examination by regulators and further research by academics.

DISCUSSION QUESTIONS

1. Explain the relation between hedge fund characteristics and risk.
2. Discuss how hedge funds and the potential for “shadow banking” may contribute to systemic risk and the prospect for “contagion.”
3. Identify the most promising areas of research for future researchers in the area of hedge fund systemic risk.
4. Discuss the impact of hedge fund regulation on hedge funds’ ability to deliver positive alpha to hedge fund investors.

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