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Hedge funds

Hedge funds are lightly regulated investment firms funded by large investors and creditors. Often, complex investment strategies are followed, using futures, swaps, options, make extensive use of short-selling and tend to be highly leveraged. Hedge funds invest in liquid assets and thereby differ from private equity funds that typically invest in highly illiquid assets. The industry of hedge funds has rapidly expanded over the past decade. Most hedge funds follow a particular strategy such as market neutral, convertible arbitrage or distressed securities. In general, the hedge fund industry comprises four major sets of styles or strategies: directional, market neutral, event driven and fund of hedge funds.

Hedge funds' functions

The role of hedge funds in the financial markets is to exploit arbitrage opportunities and to take risks that cannot be easily performed by more strongly regulated financial services institutions. Banks, insurance companies and pension funds are constrained in their actions with regard to risk taking and leverage and have to be open regarding their exposures. Through their activities the hedge funds increase the efficiency of financial markets in allocating capital. Given the considerable differences in strategies, the spectrum of risk and return of hedge funds is also quite broad. Whether hedge funds create or reduce financial market volatility the jury is still out and the question may never be answered given the diversity of strategies and as this may vary over time.

Features of hedge fund returns

Hedge funds follow different strategies and hence their return characteristics differ considerably. Hedge fund data have a number of peculiarities in comparison to say mutual fund data. The high entry and attrition rates create biases in the index of hedge fund returns. The strategies and secrecy surrounding hedge funds make that only monthly return data are available. Partly for this reason, the returns appear to be smoother than these may be in reality. Nevertheless, when compared to the behaviour of bank returns or to the returns on insurance companies, hedge fund strategies are often less volatile (less uncertain). Over time the excess returns delivered by the hedge fund industry have come down on average.

Bank fragility and the Externality of the Payment System

Banks borrow short (deposits) and lend long (commercial loans, mortgages). Since depositors can run a bank any time, while loans cannot be sold or liquidated instantly, the liquidity of a bank is fragile. The paradigm for strong regulation and supervision of banks is the protection of small depositors and the protection of the banking system as a whole for the maintenance of the payment and clearing functions, which is a huge positive externality to the real economy. Both of these motives for public intervention in the banking system are not an issue for hedge funds, since there are no small financiers who at the same time rely on the network of hedge funds for clearing their transactions. The direct consequence of a failure of a hedge fund for the real economy is comparable to what is at stake if a particular non-financial firm fails. Banks, though, are the main suppliers of credit to hedge funds, are important participants in hedge funds, and banks are also living of their prime brokerage functions performed for hedge funds. The systemic stability of banks may therefore be endangered through the failure of large hedge funds.

[1] We thank Chen Zhou for his excellent technical assistance and Celia Taia-Boneco and Sytske Martens for their administrative support.

Risk management at hedge funds

The hedge fund industry consists of a very heterogeneous group of investment vehicles. As a consequence, risk management requirements and reporting system needs are extremely diverse. There can be no 'one size fits all' risk management or reporting system, neither now or in the near future. Prior demises of hedge funds teach us that a strict division between front and back office is needed. Moreover, fair valuation of positions as well the measurement of complex non-linear sensitivities should be included in the risk management system. We stress the importance of liquidity risk management, including the need to limit the size of positions relative to the market. Finally, the importance of operational risk is clarified, especially for young and small hedge funds. The difference between liquidation and attrition was discussed shortly.

Limited Impact of Hedge Funds on Systemic Stability

This study investigates the effects that hedge funds can have on the stability of the financial system. Even though the spectacular demise of LTCM at the time seemed to pose a risk for the stability of the leading investment banks, our empirical investigation concludes that hedge funds are in general less risky than banks. Over time the index of bank returns has shown higher volatility than the overall hedge fund return index. More important, hedge fund indices and the bank index do generally not become distressed simultaneously. Per contrast, the insurance sector co-moves more intensely with the banking sector. These conclusions are obtained by using simple statistical analyses such as a cross plot of returns and are backed up by more sophisticated extreme value analysis. In summary, we do not find much evidence for the fear that hedge fund failures can trigger a systemic crisis in the banking sector.

Possible Explanations

The study does not explicitly investigate the explanations for the limited impact of hedge funds on the stability of the banking sector. One reason may be that many hedge funds follow contrarian and other strategies that have little relationship with the long positions banks necessarily have to hold in the real economy. Moreover, risk management at banks and hedge funds since the demise of LTCM has been improved. This is not to say that a failure of a particular hedge fund strategy cannot stress the banking sector. Similarly, it is conceivable that a money market squeeze results from the failures of some hedge funds, in case the bank exposures to these funds are not known in the market, just as has happened recently due to the failure of conduits loaded with sub-prime mortgages. But hedge fund strategies are much more diverse.

Motives for Regulation

Banks are heavily regulated through the Basel II accord to safeguard the public externality of the payment and clearing system and to protect the many small uninformed depositors. The insurance industry is more lightly regulated through Solvency II, since there is no such thing as an insurance run and there is no systemic risk emanating from the industry itself. If we look at hedge funds that are mostly financed by large investors and banks, the issue of direct protection of uninformed parties is not of an immediate concern. Large investors and creditors have much more at stake and can more easily pay for the monitoring costs than small depositors or consumers. Nor is there systemic risk endogenous to the hedge fund industry itself. Hedge fund strategies are quite different, so that it is somewhat unlikely that a failure of one particular hedge fund spills over to hedge funds with alternative strategies. Contagion of hedge funds with similar strategies may be possible. The main risk, though, resides in hedge fund failures that may bring down a bank and thereby also endanger the stability of other banks and the payment system. If the hedge fund industry is to be regulated, it should be for this reason.

Instruments of Regulation

When it comes to regulatory instruments, we divided these into two categories: direct and indirect measures. In each category we discussed price and quantity constraints. Given the motive for hedge fund regulation, direct instruments do not seem to be appropriate, except for the requirement that participants should have a large stake in the hedge fund. Indirect instruments seem better able to deliver a measured response. This involves that banks as main brokers and creditors are required to collect ample information from hedge funds, demand sufficient collateral and reserve sufficient capital. Many of these measures will become active once Basel II takes hold. Other indirect measures such as the review of hedge fund managers instead of the funds and industry self regulation were considered as well.

1. What are hedge funds?

Hedge funds are lightly regulated investment firms funded by large investors and creditors. Below, we provide a more elaborate description of hedge funds and what distinguishes them from private equity. The main hedge fund strategies are reviewed. The section concludes with a short discussion of their place of residence and legal structure.

1.1 Description

There is much confusion about what hedge funds are and what they do. Part of the reason for this confusion is that there does not exist a legal or even generally accepted definition of a hedge fund[2]. Concisely stated a hedge fund is a privately unregulated investment pool funded by large investors and creditors that places counterbalancing bets on a variety of assets, often with considerable leverage. Though the funds do not necessarily hedge their investments against adverse market moves, the term[3] is used to distinguish them from regulated retail investment funds such as mutual funds and pension funds, and from insurance companies who have to bear the market risk.

Complex strategies and unregulated

Often, complex investment strategies are followed, using futures, swaps, options and other derivative contracts. In contrast to most other pooled investment vehicles, such as venture capital firms, private equity funds, real estate funds and commodity pools, hedge funds make extensive use of short-selling, leverage, and derivatives. Of course, other financial companies, like the proprietary trading desks of banks, also engage in such operations. The main distinguishing criterion is that hedge funds are much less regulated and restricted in the extent to which they are allowed and able to use complex strategies and derivative instruments. Moreover, the success of a hedge fund often depends on proprietary trading strategies that offer arbitrage opportunities unknown to the market at large.

Plethora of definitions

As there is no generally accepted definition of the term hedge fund, various organisations use different definitions. The European Parliament adopted the term "Sophisticated Alternative Investment Vehicles" (SAIVs), which would encompass other alternative investment funds that differ from conventional UCITS (Undertakings for Collective Investments in Transferable Securities). In the United States, hedge funds are open to accredited investors[4] only. For this reason, hedge funds are usually exempt from any direct regulation by SEC, NASD and other regulatory bodies that offer investor protection.

Characteristics

More important than having a single definition is to have a clear understanding of what the market perceives as what constitutes a hedge fund. A hedge fund can be seen as[5] "a fund whose managers receive performance-related fees and can freely use various active investment strategies to achieve positive absolute returns, involving any combination of leverage, derivatives, long and short positions in securities or any other assets in a wide range of markets."

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[2] According to McCarthy (2006) hedge funds are "an ill defined class" and there is "no legal definition of a hedge fund in either the UK or Germany". He states that a survey by IOSCO showed that none of the responding jurisdictions reported a legal definition.

[3] See Garbaravicius and Dierick (2005).

[4] In the United States, for an individual to be considered an accredited investor, they must have a net worth of at least one million US dollars, or have made at least $200,000 each year for the last two years ($300,000 with his or her spouse if married) and have the expectation to make the same amount this year.

[5] See Garbaravicius and Dierick (2005).

Another distinguishable aspect of hedge funds is that the management is typically compensated on the basis of both scale and absolute performance through a dual fee structure. Managers often retain 2% of the net asset value of the fund and receive 20% of returns in excess of some predetermined benchmark return. In addition, hedge funds use hurdle rates (no fee if returns are below the hurdle rate) and high water marks (fee only if new profits are made, thus past losses are compensated).

Expansion of financial instruments

As a result of the expanded universe of securities and strategies available, hedge funds have often been presented as suitable investments to help diversify risk and increase the expected risk/return ratio when combined with traditional asset portfolios. Funds can access both financial and non-financial (commodity) markets and can easily take long, short, spread, and option positions in any of these markets. Expanding the set of investment opportunities results in providing diversification benefits to a portfolio that cannot be replicated through traditional stock, bond, and real estate investment strategies, which is the realm of traditional pension funds and mutual funds. Lately, pension funds have entered the realm of private equity and allocate some part of their portfolio to hedge fund like strategies or are investors in hedge funds. But the extent of this is limited.

1.2 Difference with private equity

It is important to sketch the differences between hedge funds and private equity, since the two are often confused. Hedge funds and private equity are both lightly regulated, private pools of capital that invest and compensate their managers with a share of the fund's profits. However, most hedge funds invest in liquid assets whereas private equity funds typically invest in highly illiquid assets. Moreover, the investment horizon of the hedge fund industry is much shorter in comparison to the horizon of private equity.

Private equity

Private equity is usually seen as composed of two broad categories. The first is a venture capital segment which provides funding to entrepreneurial undertakings and less mature businesses with undeveloped or developing products or revenues. The second category is the buyout segment which provides funding to mature companies that finance expansions, consolidations, turnarounds or sales of divisions or subsidiaries. Banks in the Euro area have seen a strong growth of their business with buy-out funds. Leveraged buy-out (LBO) volume and issuance of LBO loans in 2006 have surpassed levels last seen in the 1990s. Banks' exposures to private equity activity and in particular the LBO segment have been extensively analyzed in a recent Banking Supervision Committee (BSC) report, ECB (2007).

Hedge funds

In comparison with hedge funds, neither private equity nor venture capital funds pursue active strategies that extensively employ short-selling or derivatives and usually have much longer lock-up periods. Private equity funds specialize in privately held investments as opposed to hedge funds that typically will focus on publicly listed and traded instruments. The valuation of private equity holdings is often non-market based on a manager's best estimates. The redemption possibilities for private equity funds typically are less than for hedge funds. Finally, private equity fund managers usually receive performance-related compensation only after several years, when the return on investment is realised. Hedge fund managers, on the other hand, receive performance fees every year, both on realised and on unrealised gains, since these are based on market prices. Note that the lines between the two can be blurred, as some hedge funds have recently moved into private equity.

1.3 Growth of the Industry

Hedge funds have existed for a long time. Alfred Winslow Jones, who was a writer for Forbes and had a Ph.D. in sociology, is generally accredited with the honour of having started the first hedge fund in 1949, which he ran until the early 1970's. He invested in shares like any other investor, but he hedged his positions with short selling other shares, he used leverage, and a limited partnership structure. The combination was quite new at that time. Although hedge funds now have been around for quite some time, real growth in the hedge fund industry was slow until at least the 1990's.

Rapid growth

Per contrast, the hedge fund industry has witnessed very strong growth over the last decade, with growth percentages around 15%-20% per year. Total assets under management have grown to more than 1 trillion Euros[6]. Because of the leverage and gearing that hedge funds typically use to invest, their positions in the financial markets are much larger than their assets under management[7]. In several markets, hedge funds have become the main players. Kambhu et al. (2007) report an estimate in which hedge funds account for more than 50% of trading in U.S. convertible bonds, distressed debt and credit derivatives.

Institutional investors

However, many institutional investors still do not consider hedge funds to have a significant role to play in their portfolios in comparison to other alternative classes. The share of funds invested in hedge funds is often still smaller than the share that is invested in commodities, private equity or real estate and of course the traditional main categories bonds and shares. Some large pension funds such as the Dutch ABP have set up their own internal hedge funds.

1.4 Main Strategies

There are several different types of hedge funds. In general[8], the hedge fund industry comprises four major sets of styles or strategies: directional, market neutral, event driven and fund of hedge funds. Various other classifications exist and the above list is not exhaustive[9]. We also refer to Dor et al. (2006) who outline a methodology that may be used to analyse the style of a hedge fund. It identifies inconsistencies between a fund's factual and its self-reported strategy. The following table gives the hedge fund styles that are analyzed in some detail in this paper. A detailed description of these strategies is provided in the Annex I.

[6] According to Chicago-based Hedge Fund Research Inc. Moreover, according to HFR by the end of 2006 the global hedge fund industry had about US$ 1.43 billion in assets. Centre for International Securities and Derivatives Markets (CISDM) calculated in an August 2006 paper that the assets under management for hedge funds have grown from US$30 billion in 1990 to over US$1.2 trillion in 1995. The number of hedge funds in that period has grown to 11,000, one third of which are fund-of-funds (ECB, 2006).

[7] See also ECB (2007), Financial Stability Review, page 49.

[8] See Garbaravicius and Dierick (2005).

[9] More detailed categories are distinguished by the Centre for International Securities and Derivative Markets, by Credit Suisse Tremont and by Hedge Fund Research. Another overview is given by Stulz (2007).

Table 1.1 Hedge Fund Strategies

Strategy	Abbreviation
Convertible Arbitrage	Convert. Arb.
Distressed Securities	Distres. Sec.
Equity Hedge	Equity Hedge
Equity Market Neutral	Market Neutr.
Event Driven	Event Driven
Fixed Income Arbitrage	Fix. Inc. Arb.
Fixed Income High Yield	Fix. Inc. HY
Fund of Funds	Fund of Fds
Global Macro	Macro
Merger Arbitrage	Merger Arb.
Short Selling	Short Selling

1.5 Legal structure and place of residence

The legal structure of a hedge fund is often determined by the tax environment of the fund's investors. Many hedge funds have their legal residence offshore, in countries unrelated to the manager, investor or investment manager of the fund. This poses intricate issues for regulation and supervision. In order to have complete freedom and discretion over the implementation of their innovative investment strategies, hedge fund managers often try to find a geographic location with minimum regulatory intervention and with a favourable tax treatment. Offshore tax havens are ideal domiciles[10], as these places offer low levels of regulation and external control and because it is relatively easy to set up and operate a hedge fund there[11]. The most popular offshore financial centres are the Cayman Islands, the British Virgin Islands, Bermuda and the Bahamas.

EU hedge funds and managers

EU hedge funds are often located in Ireland and Luxembourg, where a listing on the stock exchange is perceived as an attractive characteristic. For EU hedge funds, the managers themselves are often based in London, the leading centre for the management of hedge funds. In Europe, the UK has a dominant position, when measured in the number of funds and assets under management[12]. Nearly 80 percent of all European hedge fund assets are managed by FSA authorised managers[13]. This amounts to around 300 asset managers who are responsible for managing about one quarter of the world's hedge fund assets. Thus the UK hedge fund managers themselves (in person) are regulated, controlled and influenced by the FSA, even though the funds may be outside the control of the supervisor.

[10] The domicile is the place where the legal entity of the fund is located.
[11] As Garbaravicius and Dierick (2005) describe.
[12] There are few funds as such located in the UK. The funds themselves are located in offshore tax efficient jurisdictions. The hedge fund managers however are often located in the UK.
[13] The UK, unlike many other countries, does regulate those who manage hedge funds. This percentage is based on McCarthy (2006), the Chairman of the FSA.

Hedge fund size

The market share of EU hedge funds has continued to expand, mainly at the expense of funds managed from the United States[14]. Nevertheless, the biggest hedge funds are still based in the United States. Goldman Sachs Asset Management in New York is reportedly the biggest hedge fund manager with 2005 Year-end assets of US$ 21.0 billion[15]. Most hedge funds are relatively small: the vast majority has less than US$ 100 million of capital under management[16], while nearly half of the funds have even less than US$ 25 million. EU hedge funds managed or based in the EU do not differ significantly from their peers in this respect.

Costs and size

The costs of running a hedge fund increase as managers are facing more complex regulatory, tax and anti-money laundering issues. The minimum investments with regard to infrastructure and risk management systems have gone up and only the larger funds have the economies of scale to survive. It can therefore be expected that the hedge fund industry will consolidate in the coming years.

1.6 Summary

Hedge funds are lightly regulated investment firms funded by large investors and creditors. Often, complex investment strategies are followed, using futures, swaps, options, make extensive use of short-selling and tend to be highly leveraged. Hedge funds invest in liquid assets and thereby differ from private equity funds that typically invest in highly illiquid assets. The industry of hedge funds has rapidly expanded over the past decade. In general, the hedge fund industry comprises four major sets of styles or strategies: directional, market neutral, event driven and fund of hedge funds. A detailed description of their strategies is in Annex I.

[14] According to Garbaravicius and Dierick (2005).
[15] See Ferguson and Laster (2007).
[16] Based on Garbaravicius and Dierick (2005).

2. The role of hedge funds in the financial system

We first discuss the functions performed by the financial services industry. Thereafter we focus on the various economic functions that hedge funds perform, like the provision of liquidity, financial innovation, and dispersion of risk.

2.1 A functional perspective

The standard industry classification of banks, insurance companies, pension funds, mutual funds and their further subdivisions (savings banks, investment banks, etc.) has been blurred. Financial innovations have enabled financial service institutions to cross the borders of what used to be fairly well delineated financial industries. Hence regulation and supervision organized along the lines of industries no longer suffices, as it calls for regulatory arbitrage (e.g. the shifting risks in financial conglomerates by moving assets from the banking book to the insurance book, as insurance tends to be lighter regulated). Nowadays the functional perspective has become the standard view. The functional perspective classifies the institutions along the lines of the functions that they perform. Due to financial innovation and liberalization, different industries may perform the same functions (e.g. banks selling insurance products). For example, the Dutch supervisory structure has recently been reorganized along these lines. In the functional perspective, one looks at the functions performed by a financial service institution in order to decide over its regulation and supervision. The following functions performed by financial service institutions can be distinguished[17].

Economic functions

1. Clearing and settlement (CS)
2. Pooling concentration and subdividing of risks (PCSR)
3. Transfer of risk across actors and time (TR)
4. Transfer of resources across actors and time (TI)
5. Management of risk (MR)
6. Provision of public price signals (PPSA)
7. Resolving asymmetric information and incentive issues (RAI)

   (reduction of moral hazard and adverse selection).

Banks perform all of the functions, whereas hedge funds are not involved in clearing and settlement (CS) or in the transfer of resources across time and actors (TI). The maintenance of the payment, clearing and settlement system is the unique function of banks. Stock exchanges and brokers support the clearing and settlement of equities and derivative instruments. Both hedge funds and banks are engaged in the pooling and subdivision of risks. Hedge funds are more focussed on arbitrage and hence deal with transferring risk (TR) and reduce mis-pricing (PPSA). Pension funds are focussed on pooling and transferring risk (PCSR and TR). The insurance industry mainly deals with the pooling of risk (PCSR).

[17] We refer to Merton and Bodie (1995).

2.2 Further focus on hedge funds

In general a hedge fund is a particular financial intermediary that serves a number of the functions performed by the financial sector. Hedge funds typically do focus on a subset of these functions such as risk taking, liquidity provision, dispersion of risk, financial innovation and the channelling of risk through investment and arbitrage. As discussed above, hedge funds do not perform a role in clearing and settlement, which is mostly the prerogative of banks, nor are they actively involved in providing insurance.

Below a number of the key functions of hedge funds are discussed in further detail:[18]

Provision of liquidity (PPSA)

Hedge funds often are active traders and contribute significantly to price discovery thereby increasing market efficiency and liquidity through their frequent trading[19]. Moreover, hedge funds often take contrarian positions, thus dampening market volatility and acting as a counterbalance to market herding. Thereby they generate greater market liquidity, lower volatility, and more stable relationships in the relative prices of financial assets. By providing liquidity, hedge funds help to open up new markets and help to transfer new products, by taking the leap from a theoretical existence to a real market product with active trading and price discovery.

Financial innovation (PCSR, MR)

It is a well-known fact that regulation leads to financial innovation in order to work around the barriers to trade. The stellar growth of hedge funds is at least partly explained by the fact that regulation invites financial innovation. Hedge funds take on risks for parties who are otherwise constrained by the limitations placed by financial supervision (such as the Basel bank charters and mutual fund regulation[20]). In this view hedge funds came about to circumvent strict financial regulation and supervision. Hedge funds can therefore more easily develop new investment strategies, without being held back by bank-oriented risk management rules or supervisory mechanisms. By taking contrarian positions, they often provide liquidity when banks are constraining credit. Hedge funds also deliver a public service through their arbitrage activities.

Dispersion of risk (PCSR)

Because hedge funds act as counterparties to banks, they fulfil an important role in the financial system by taking on risk that prior to the existence of these hedge funds remained on the balance sheets of banks. Banks (and of course other parties) are now able to offload various types of risks that a decade ago simply remained on their books. The risks are dispersed over various parties, by selling it to hedge funds and also pension funds and other investment vehicles like the conduits in the mortgage industry. From the current havoc in the CDO markets and the large write-offs at several investment banks, it follows that not all risks are offloaded and that the complexity of the products can lead to further valuation problems when the liquidity disappears and price formation becomes highly uncertain[21].

[18] These are the functions that were described in the original "Provision of External Expertise" request, in the "Description of services".
[19] The ECB concurs; see the Financial Stability Review (2007), page 50.
[20] We refer to Annex VI.
[21] We refer to Annex IV for three case studies, including the recent problems of two Bear Stearns hedge funds.

Leverage of positions (MR)

Hedge funds are often allowed to leverage their positions by using credit lines from banks, making use of derivatives and by applying other techniques. If the hedge fund actively pursues a leverage of the positions, its presence in the markets increases as well. This is one of the reasons that hedge funds – although their assets under management are not yet even close to being of the same size as the regular mutual fund business – in certain markets and products create a very substantial share of total turn-over. The other main reason is that hedge funds are often quite active traders, depending on their investment strategy.

As a provider of diversification and liquidity, hedge funds contribute to the integration and completeness of financial markets. This should ultimately result in greater social welfare. According to the ECB's Financial Stability Review of June (2007): "some individual hedge funds and the whole sector have probably become as important as large banks for the smooth functioning of most financial markets."

2.3 The Credit Risk Transfer Market

A special role is played by the markets for credit risk transfers. Over the last few years, the creation of Credit Risk Transfer (CRT) instruments has been the main market-driven innovation in European credit markets. These instruments have had a major effect on the management of credit risk by banks and other financial institutions, and are playing an increasingly important role in the functioning of credit markets both in quiet and distressed conditions.

Tradeoffs

The role of hedge funds in the credit risk transfer market illustrates the tradeoffs that supervisors face. Because hedge funds are very active in the credit derivatives market, they play an increasingly important role as providers of liquidity and the ultimate holders of risk in the growing credit transfer markets. Hedge funds are thus investing in assets once widely held by banks through lending activities. These comprise such products as credit derivatives, secondary loans, securitizations such as mortgage-backed securities, and other structured credit products. The concern of regulators is that in the event of a major financial shock, the complex web of exposures among highly leveraged hedge funds and dealer institutions may increase the risk that problems at one financial institution would spread to other institutions.

Contagion

The participation of hedge funds can affect the ability of borrowers near default to work out their problems. In this way, hedge funds, through the use of derivatives, could ultimately contribute to either an increase or decrease in defaults. Of course, such contagion risk is not limited to hedge funds; banks for instance bear the same intrinsic risk. The recent turmoil in the credit markets was sparked by loan-defaults in the sub-prime mortgage market due to uncertainty about the obscure way in which these markets have redistributed and packaged credit risks. Thereafter the turmoil has spread to other asset classes, causing volatility in the stock market and affecting hedge funds with exposure to collateralized debt obligations (CDOs) – financial products that pool and securitize different kinds of corporate bonds, mortgages and derivatives[22].

[22] Consider the recent demise of the Bear Stearns hedge funds that invested in CDOs, as described in Annex IV.

Hedge funds and the Credit Risk Transfer market

It is difficult to assess how the market would react in the event of the demise of a key hedge fund or of a cluster of smaller hedge funds that were particularly active in the protection selling side of the CRT market. For instance, there are some concerns[23] that a hedge fund failure could imply that credit protection is not available for protection buyers when it is most needed. Clearly it could render banks more cautious in providing loans if they can no longer lay the credit risk off in the market. The growing unease is not so much because of doubts about the risk management capacities of hedge funds, which often are quite advanced, but because very little is known about how the CRT markets in the aggregate would function under stressed conditions. The problems in the market for conduits, which were not foreseen, may or may not constitute a proper analogy.

Herding

Herding or so-called crowding of trades is perceived as a potential aggravation of this type of risk. Compared to the corporate bond market for instance, crowded trades in the credit derivatives market are less visible and potentially larger, and therefore potentially can create greater systemic problems. The ECB notices that as evidence of the possibility of the increase in herding behaviour of hedge funds, that the correlations of hedge fund returns both within and across investment strategies surpassed levels seen just before the near-collapse of Long Term Capital Management in 1998. However, if flexibility and innovation are the key characteristics of hedge funds, one might expect hedge funds to be less likely to herd than other institutions. Furthermore, since herding requires that trades are observable either directly or indirectly through prices, the secrecy of hedge fund trading makes wide ranging copy-cat herding unlikely[24].

Do hedge funds create volatility?

Garbaravicius and Dierick (2005) analyse the behaviour of hedge funds and try to answer the question whether hedge funds do or do not create volatility. This is an age old question first discussed by Friedman, but without a definite answer. Amplification of price swings may be caused by certain trading strategies like dynamic hedging of option positions, the use of stop-loss orders, herding behaviour, forced liquidations or trend-following trading. Chan-Lau (2007) also refers to the risk of so-called self-sustaining perverse price dynamics and he lists similar sources for such market behaviour (such as delta-hedging[25]). However, many hedge funds are on average contrarians, as trading against the crowd is the only way to make persistent excess profits at an acceptable risk. Several of the hedge fund categories are more likely to be involved in taking contrarian views, like event-driven and market-neutral.

[23] See the ECB's Financial Stability Review of December 2006. ECB concludes that more and better quality data are needed to asses the interplay.

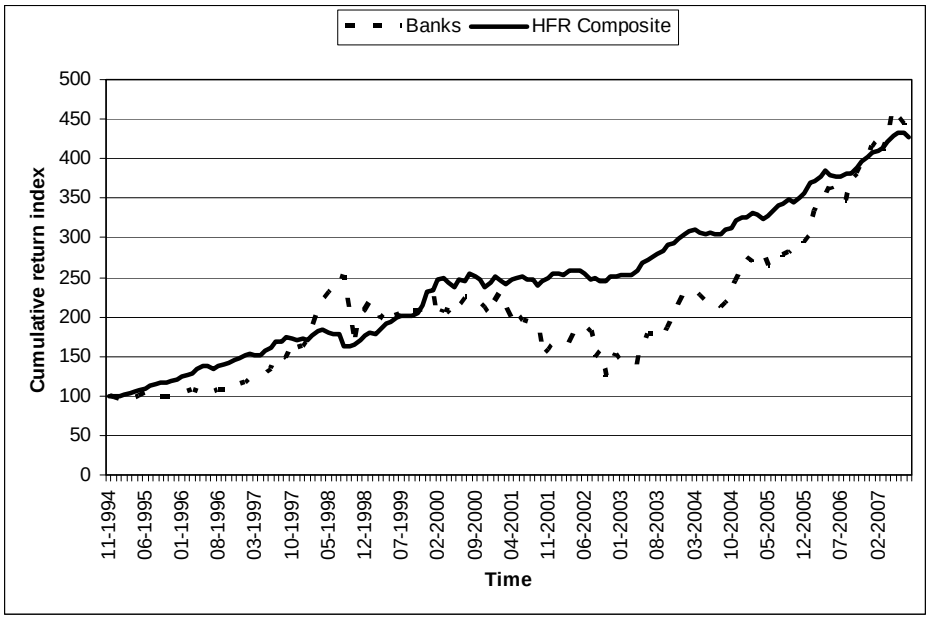
[24] Based on Danielsson et al. (2005).

[25] Delta-hedging is a type of dynamic hedging, where a trader hedges his delta, which reflects the option position's sensitivity to small changes in the price of underlying value (for instance the stock price in case of a stock option) dynamically. This means that the trader buys and sells other instruments than the option, for instance the stock itself, in order to keep the delta of his position within certain small limits. As the delta depends on many factors like the interest rate, the dividend level, the time to expiration and the stock price itself, this is a near-continuous process. Because in delta hedging the trader that is short the option, tends to "buy high and sell low", this type of hedging often thought to amplify the movements of the market.

Volatility evidence

In short, it appears to be very difficult to conclude clearly whether hedge funds on average reduce or exacerbate volatility in the markets. With regard to the question whether hedge funds profit more in volatile markets, the jury also is still out; again no conclusive evidence has yet been found to answer this question. Some casual evidence on this issue is presented in Figure 2.1. In this figure we plot the HFR Composite Weighted Hedge Fund index, which combines the equal-weighted results of over 2000 hedge funds together with the Dow Jones Euro Stoxx Banks Index (dotted line)[26]. Over the period 1994-2007 the total return of both indices is comparable, but the bank returns appear to have been more volatile than the overall hedge fund returns.

Figure 2.1 Cumulative results banks vs. HFR Composite



2.4 Conclusion

Hedge funds serve a number of key functions performed by the financial sector, with a focus on risk taking, arbitrage, liquidity provision, and financial innovation. Some of these functions can be more easily performed by hedge funds since, banks, insurance companies and pension funds are more constrained in their actions with regard to risk taking and leverage and have to be open regarding their exposures. When performing these activities, hedge funds in general contribute to the integration and completeness of financial markets, and enhance the efficiency of these markets in allocating capital.

Possible negative effects of hedge funds occur through the impact the demise of a large hedge fund could have on other market participants such as banks. These contagion effects are thought to be more pronounced in the case of herding or so-called crowding of trades and in markets like the Credit Risk Transfer markets where hedge funds have a major share of the total positions. Whether hedge funds create or reduce financial market volatility the jury is still out and the question may never be answered given the diversity of strategies and as this may vary over time.

[26] Although when comparing a hedge fund index with the bank index, one has to keep in mind the various biases that (slightly) distort the hedge fund index, like the selection bias due to the high attrition rate. We refer to paragraph 3 for more information on the various biases that generally are found in hedge fund data.

3. Data

This section discusses the data and their basic statistical properties. The next section uses these data to investigate the systemic risks posed by the hedge fund industry for the banking industry. We start by a short description of the data providers. Hedge fund data have a number of peculiarities in comparison to mutual fund data. This creates biases that make a comparison with other investments haphazard. The data characteristics are presented graphically and elementary statistical properties such as mean and variance, as a measure of uncertainty, are reviewed.

3.1 Biases and methodology

For the empirical analysis we use monthly data from Hedge Fund Research (HFR). This is one of the major hedge fund index data providers. Two other key providers are The Centre for International Securities and Derivative Markets (CISDM) and Credit Suisse Tremont[27] index LLC.

Data sources

These three companies provide industry standards on hedge fund data. For a general overview of the existing hedge funds, monthly data suffice. All three providers give free access to hedge fund data on their respective websites[28]. In this section we further clarify the precise nature of these data. We use so-called non-investment indices, as opposed to indices that are tradable. Both types track the hedge fund industry. Investable indices are created from funds that can be bought and sold, as with a traditional equity index such as the S&P500 or FTSE100. Only hedge funds that agree to accept investments on terms acceptable to the constructor of the index are included. Indices that can be traded are attractive to investors because these indices increase their investment universe. Non-investment indices are indicative in nature, and aim to represent the performance of the universe of hedge funds. Participation in the database is always voluntary.

Index biases

The different databases cover only part of the global hedge fund industry and to some extent overlap, as some funds report to more than one data provider. The main biases[29] are "survivorship bias", "self reporting bias", "backfill bias", and "liquidation bias". Various other shortcomings exist in terms of scope, quality and homogeneity of the data. The main biases are described in more detail:

1. **Survivorship bias**[30] is the statistical bias in performance aggregates due to the inclusion of only live funds and the exclusion of liquidated, no longer operating, or non-reporting funds. Reporting does not only stop when a fund falters because of poor returns or excess volatility, but also stops when it reaches capacity limits or enjoys spectacular returns and does not want to attract new investors[31].

[27] Tremont Capital Management, Inc. sold its TASS Research database to Lipper, a subsidiary of Reuters in 2005. The TASS database is seen as one of the industry standards in hedge fund data.
[28] A description of the companies is given in Annex II.
[29] Garbaravicius and Dierick (2005) provide a sound overview of the databases and the typical problems that are encountered in hedge fund data.
[30] For instance, Credit Suisse/Tremont states on their website that "Most indices are affected by some sort of survivorship bias. In order to minimize this effect, the index does not remove funds in the process of liquidation, and therefore captures all of the potential negative performance before a fund ceases to operate."
[31] We also refer to the paper by Baquero et al. (2005).

2. **Self reporting bias** stems form the voluntary nature of the contributions. Each database represents only a sample of the entire hedge fund universe. Funds that do not report due to superior returns offset to some extent the returns of those that do not report due to poor performance, which may render the survivorship bias less important. Hedge funds join public databases mainly for marketing purposes in order to attract additional funds for investment.
3. **Backfill bias**[32] occurs when a fund is attached to the database and when a part or the entire historical performance, which is usually quite positive, is added to the database. It is thought that as managers often establish a hedge fund with seed capital, they begin reporting their results at some later date and only if the initial results are favourable. Moreover, the more favourable of the first results are then "filled back" into the database together with the contemporaneous returns.
4. **Liquidation bias** arises because disappearing funds may not report final periods leading up to and including their liquidation. Fund liquidation is driven by historical returns, attrition rates being higher for funds that perform poorly[33].

High attrition rate

In addition to these biases in the indices, the population of hedge funds is marked by high mortality rates. This makes that the survivorship bias is very prominent. The half life of a fund is around 5 years. It is reported[34] that 30% of funds do not make it past three years and 40% of funds do not survive past the fifth year. It is difficult to evaluate hedge fund performance and its persistence due to the relatively high attrition rate[35]. Other statistical problems are that hedge funds can appear in more than one database and that they can be marketed under different names.

Caveat

Due to these biases and high attrition rates, any statistical analysis on basis of these indices has to be interpreted with care.

3.2 Summary Statistics.

We discuss the basic statistical properties of the hedge fund data. First, the data are presented graphically. Second, some statistical properties such as mean returns and variance, as a measure of uncertainty, are tabulated.

Overall returns of hedge funds and banks

Figure 3.1 provides a comparison between the development of the HFR composite hedge fund index and the index of the EU banking sector (Dow Jones Euro Bank Index). During the early nineties the hedge fund index strongly outperformed the EU banking sector. This might be due to the fact that at time hedge funds were something new, filling a niche. Over time excess profits have possibly been eradicated due to entry.

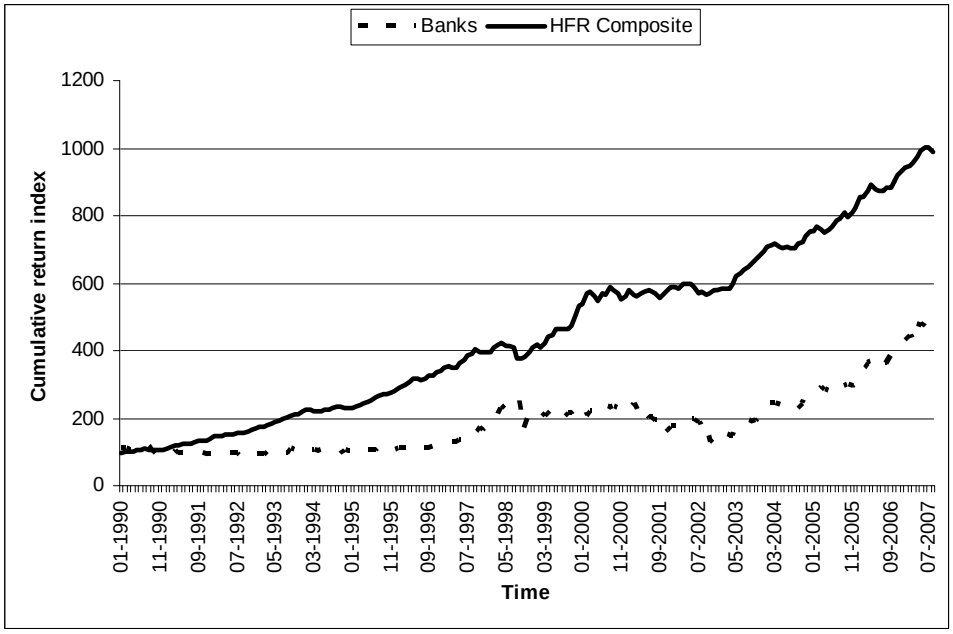
A caveat

In the beginning the hedge fund industry was still quite immature and reporting mechanisms were not as advanced as they are today. Some of the biases were more strongly present in the first years of the datasets, enlarging the (over-)estimation error.

[32] Malkiel and Saha (2005, page 87) focus on survivorship bias and backfill bias and find that "hedge funds have returns lower than commonly supposed".
[33] As shown by Baquero et al (2005).
[34] By Kambhu et al. (2007).
[35] Baquero et al (2005) discuss this in extenso.

This is why in most analyses only the data from 1994 onwards are being used, see Figure 2.1. Adding just four years of data as in Figure 3.1 dramatically alters the perspective on the cumulative returns. But due to a reduction in the biases and probably due to the growth of the hedge fund industry (increased competition), in the later years the returns of the hedge funds relative to those of banks are less spectacular. This can be seen by comparing the monthly returns instead of the cumulative returns.

Figure 3.1 Cumulative returns



Monthly returns

Monthly return plots for an investment in the tradable EU-bank index and in the hedge fund composite index (non-tradable) are presented in Annex III. When banks became distressed at the end of 2001, the hedge fund index continued to rise. But since 2003, the bank and hedge fund index show returns of comparable magnitude. Over the entire sample, hedge fund returns also seem to be less volatile. This may in part be due to their contrarian strategies. But the lower volatility may also be due to the biases in the index as we discussed above. In particular valuation problems due to the fact that hedge funds often invest in illiquid assets lower the perceived instantaneous volatility. This smoothing causes autocorrelation that increases the unconditional volatility.[36]

Extremes

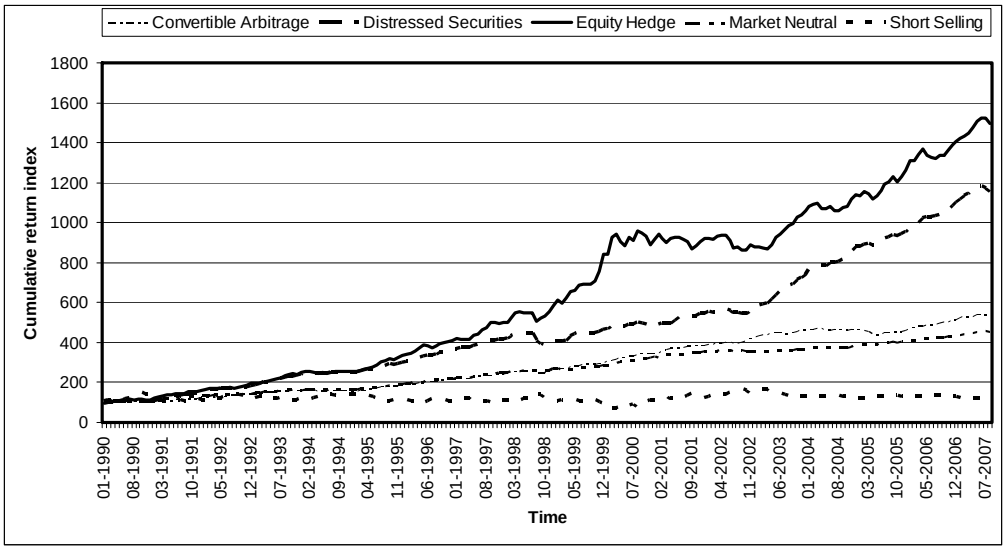
The monthly returns of the bank index[37] range from -25% to + 25%, whereas the hedge fund index moves between -10% and + 10%. This clearly shows that the monthly returns of an investment in the bank index are more volatile than in a composite hedge fund index. Moreover, since 1999, the returns in the hedge fund index hover between only -4% and + 4% after 1999, which shows the relative stability of the industry averages after the LTCM debacle of 1998.

[36] The biases and autocorrelation in the data do reduce the swings in the returns. We refer to the more detailed elaboration below Table 3.4.
[37] As depicted in Annex III.

Cumulative returns of individual hedge fund strategies

More details on the success of particular strategies can be gleaned from Figure 3.2. We chose five indices relatively arbitrarily from the available set of HFR indices. Regardless the biases, what springs to the eye are the considerable differences in performance. It is an indication of the risk an investor runs by investing in a particular hedge fund or hedge fund strategy.

Figure 3.2 Cumulative results hedge funds



The Equity Hedge index outperformed the other four indices, respectively, Distressed Securities, Convertible Arbitrage, Market Neutral and Short Selling, in declining order of success. The Short Selling index underperformed the other four indices by a large margin.

Summary statistics

The summary statistics for the set of hedge fund strategies are given in Table 3.1. Returns are denoted in percentage points and are on a per monthly basis.

Mean and variance

The mean return is an indicator of how much one makes on average, the variance is an indicator for the risk as it gives the variability of the returns. The mean returns are all positive, but there are big differences between the various categories, witness Figure 3.2. The Short Selling index gave the lowest mean returns at 0.29% per month, whereas the Equity Hedge index has the highest mean at 1.31% per month. The standard deviation also shows large differences, the largest is the Short Selling index with 5.79% and the lowest is the Equity Market Neutral index with 0.88%.

Skewness and kurtosis

The skewness is a measure of the asymmetry of the probability distribution around the mean. The kurtosis is a measure that signals either peakedness, or fat tails or both. Fat tails arise if there are outliers. If the left tail of a distribution is fat tailed, it means that the probability of high losses is considerable.

The skewness is negative for most hedge fund categories, although several categories do show a positive skew. A negative skew means that the left tail is longer and that the mass of the distribution is concentrated on the right side of the mean. The kurtosis is a measure of the "peakedness and tail fatness" of the return distribution. A higher than normal kurtosis, i.e. above 3, indicates that the probability distribution has a sharper "peak" and/or fatter "tails" than the normal distribution.

Table 3.1 shows that the kurtosis measures are widely spread, ranging from 0.56 for the Equity Market Neutral index to 11.34 for the Fixed Income Arbitrage index. By this measure the fixed income arbitrage and merger arbitrage strategies appear to be the most risky strategies. This is partly confirmed if we take a look at the highest loss returns. The minimum and maximum monthly returns are within the range -9% to +11%, except for the Short Sale index. As we will see below, this nevertheless constitutes a far more modest range than is the case for the bank and insurance indices.

Table 3.1. Summary Statistics Hedge Fund Categories

Category	Mean	St.dev.	Median	Skew	Kurtosis	Minim.	Maxim.
Convert. Arb.	0.79	1.00	0.99	-1.08	2.03	-3.19	3.33
Distres. Sec.	1.18	1.68	1.14	-0.63	6.02	-8.50	7.06
Equity Hedge	1.31	2.46	1.35	0.21	1.60	-7.65	10.88
Market Neutr.	0.72	0.88	0.65	0.19	0.56	-1.67	3.59
Event Driven	1.14	1.83	1.34	-1.27	4.82	-8.90	5.13
Fix. Inc. Arb.	0.65	1.17	0.63	-1.71	11.34	-6.45	4.70
Fix. Inc. HY	0.75	1.74	0.83	-0.81	7.27	-7.16	9.54
Fund of Fds	1.10	1.91	1.32	-0.59	3.05	-8.70	7.65
Macro	1.19	2.30	0.85	0.41	0.80	-6.40	7.88
Merger Arb.	0.83	1.20	1.04	-2.50	11.27	-6.46	3.12
Short Selling	0.29	5.79	-0.15	0.17	1.99	-21.21	22.84

A benchmark

To provide a benchmark for these summary statistics and to be able to investigate the systemic stability later on, we also collected some indices on the insurance industry and the banking sector. The indices are taken from Datastream[38] over the period from January 1990 to August 2007, using a monthly frequency[39]. The bank and insurance indices summary statistics are reported in Table 3.2, where "DJ" denotes "Dow Jones Euro Stoxx", "FTSE" denotes "FTSE Euro 1st 300", "NL" denotes "FTSE Non Life" and "L" denotes "FTSE Non-Life". The returns are again denoted in percentage points on a per monthly basis.

[38] These indices are all denoted in US$ in order to facilitate comparison with the hedge fund indices.

[39] HRF provides estimated return figures for the last 3 months: June, July and August of 2007, which we used. These figures have therefore not been finalized by HFR, as per contrast to the monthly data prior to June 2007. We expect the changes after finalization to be small and have little effect on our general conclusions.

Table 3.2 Summary Statistics Banks and Insurers

Index	Mean	Std.dev.	Median	Skew	Kurtosis	Minim.	Maxim.
World Banks	0.59	4.91	1.17	-0.22	2.76	-18.60	23.14
DJ Banks	0.87	5.80	1.40	-0.58	3.36	-21.47	23.89
FTSE Banks	0.96	5.55	1.43	-0.45	3.32	-19.17	25.68
DJ Insurance	0.75	6.86	1.03	-0.20	3.90	-26.90	31.41
NL Insurance	0.74	6.81	0.86	-0.18	3.80	-26.19	31.85
L Insurance	0.89	6.77	1.03	-0.25	2.30	-23.61	26.36

From Table 3.2 we see that the means for all the European indices are very similar. The World banking index has a somewhat lower average. The other characteristics are quite similar across the different indices, both in sign and in size.

Comparison of summary statistics

More interesting is the comparison with the hedge fund indices data from Table 3.1. The mean, median and skew statistics are of comparable magnitude. But the standard deviation and the extremes are much lower for the hedge fund indices. As we pointed out before, one should be cautious in comparing the hedge fund monthly returns with the returns of the financial institutions. The hedge fund data are known to exhibit relatively high autocorrelation, i.e. are trending, and therefore have a "smooth" appearance. This is for instance the result of an investment in illiquid assets, for which price movements are difficult to determine and the fact that price changes are slow, or at least end up in the reported results more slowly than changes in regular share prices of listed banks. Moreover, hedge fund investors are often confronted with lockup periods, which can be as long as one year. During this time the invested money cannot be withdrawn. Redemption notice periods of 90 days are no exception, both of which will contribute to the so-called persistence in hedge fund performance[40].

Autocorrelation

We tested the above series for autocorrelation patterns and found strong evidence for first and second order autocorrelation in nearly all the series. The presence of autocorrelation causes the reported standard deviations to be lower and reduces the minima and maxima of the observations.[41] But even if we keep this caveat in mind, the differences between Tables 3.1 and 3.2 are quite impressive. The results for the hedge fund indices and the indices of banks and insurers are comparable in magnitude to those reported by Chan et al. (2006, Table 6.11) for hedge funds and several mutual funds. In Chan et al. the hedge funds have a standard deviation that is about ¼ of the standard deviation of the mutual funds. But the hedge funds exhibit strong autocorrelation patterns, whereas the mutual funds do not[42].

[40] See Baquero et al (2005).

[41] For example, suppose that reported returns are smoothed by averaging the raw returns over two months, implying an MA(1) process for the reported returns. This would reduce the return volatility as measured by the variance by 50% and imply a first order autocorrelation coefficient of ½. The mean returns, however, would be almost identical.

[42] An exception is the Short Selling index.

3.3 Conclusion

Hedge funds follow different strategies and hence their return characteristics differ considerably. Hedge fund data have a number of peculiarities in comparison to say mutual fund data. The high entry and attrition rates create biases in the index of hedge fund returns. The strategies and secrecy surrounding hedge funds make that only monthly return data are available. Partly for this reason, the returns appear to be smoother than these may be in reality. Nevertheless, when compared to the behaviour of bank returns or to the returns on insurance companies, hedge fund strategies are often less volatile (less uncertain). Over time the excess returns delivered by the hedge fund industry have come down on average.

4. Application of Extreme Value Theory

This section addresses the core question of this study. It investigates the effect hedge funds can have for the systemic stability of the financial sector. We narrow this question down to the stability of the banking sector, since this is the sector that is most exposed to financial fragility and that has an important positive externality to the real economy. Banks have a maturity mismatch by lending long and borrowing short. The depositors can instantly withdraw their funding. But commercial loans cannot be liquidated quickly without severe loss of value. Moreover, banks are highly leveraged. This together makes that the liquidity of a bank is fragile. Banks collectively maintain the payment and clearing system, and an undisrupted service is vital for the economy. This positive externality of the banking industry to the real economy makes why makes that banks are intensely supervised.

Extreme Value Theory

To analyze the central question, a somewhat unconventional methodology is needed. Systemic instability issues are about the number of bank failures that can be triggered by high losses in the hedge fund industry. Such events are by their very nature rare or may be totally absent from the (data) history. A simple sort of averaging that is the basis for many statistical procedures is not possible. To obtain reliable estimates about such rare events, we will make use of statistical Extreme Value Theory (EVT). This technique is especially suited for questions regarding reliability and rare events that can trigger a crisis. Below we first review the essence of this approach. Subsequently we use graphical devices to depict the systemic risk and also give some estimates of the probability that hedge funds and banks become jointly distressed.

4.1 Methodology

The central question is the effect that hedge funds can have on the systemic stability of the banking sector. To address this question, we investigate in particular:

***To what extent do large negative realizations of the banking index occur simultaneously with large negative realizations of hedge fund indices?**

This question is in fact nothing but the question of how frequent a crash in one market occurs jointly with the crash of another market. Thus it is a question about the probability or frequency of joint failures. The subsequent question is how this joint failure probability can be measured in a reliable way. We employ three devices to measure the joint failure probability:

1. **Cross plots** plot the returns of banks versus hedge fund indices against each other. Then one inspects whether large losses do occur together, or appear to be separate.
2. **Conditional joint failure probabilities** are extreme value based estimates of the probability that the large losses will realize together, given that there is a problem in one or the other market.
3. **Correlation** analysis is a more conventional measure of the interdependencies. Correlation analysis does look at the interdependency in the centre as well in the tail region. It is therefore less focussed on the loss region as the other two devices. Regression analysis is the multivariate extension of correlation analysis.

The following discussion of the three devices is somewhat technical. The reader may immediately turn the next section without missing the flow of the analysis.

Correlation measure inappropriate?

To study interdependencies between different random events, the concept of correlation is traditionally used. Correlations fully characterize all the interdependencies if the random variables are multivariate normally distributed. There are two drawbacks to this measure for the purpose of our study. First, as we show in section 4.2 the distribution of financial returns is not (multivariate) normally distributed. The tails of the return distributions are much fatter tailed. Second, the correlation concept is a global measure and empirically under weighs the dependency in the tail region. Systemic risk concerns the dependency in especially the tail regions, as this is the area where the failures occur. Therefore the correlation measure may be inadequate. For example, even when two normal distributions are correlated, their interdependency fades in the tail regions, while this is not the case for fat tailed correlated Student-t distributions.

Failure probability

Instead of using indirect measures such as the correlation coefficient, one can also directly try to measure the joint failure probability. In fact this is what EVT does without predicating on specific prior assumptions regarding the type of distribution. Univariate (one dimensional) EVT is used to estimate the likelihood of financial market crashes and multivariate EVT is used to measure the risk of financial market contagion[43]. For the univariate question of the Value-at-Risk determination and Stress test exercises, the extreme value approach has become an industry standard in the world of banking and insurance. More recently, the same is happening regarding the multivariate question of systemic risk[44].

Linkage theory

A theoretical framework that links economic theory to the multivariate empirical results is available from De Vries (2005). The linear portfolio structure of the financial service sector, in combination with the marginal return distributions that are fat tailed distributed, explains the strong systemic risk observed in practice; the annex VII contains a more technical exposition.

Joint crash probabilities

In a bivariate setting there is a simple way to visualize the probability of joint failures. One plots the outcomes of say a hedge fund index against the outcomes of the bank index. If from such a plot it appears that the bad outcomes realize along the diagonal in the South West corner, one knows that there is a lot of dependence. If on the other hand the largest negative outcomes of the bank index come with realizations for the hedge fund index that are all over the place, there is little evidence for systemic risk spilling over from the hedge fund industry to the world of banking. Below we will use this graphical device of cross plotting outcomes to support the more formal EVT based analysis. Annexes VI and VII provide a number of other cross plots to support our findings and to provide further detail to the EVT methodology.

[43] See the ECB Financial Stability Review of June 2006.

[44] We refer to e.g. Hartmann, Straetmans, and De Vries (2004 and 2006) and Koedijk, Stork and De Vries (1992). As another example of the increased use of multivariate EVT, see the ECB's Financial Stability Review of December 2006 (page 159 and further), which focuses on gaining insight into systemic risk within the insurance sector.

4.2 The non-normal fat tailed world of financial risk

The common assumption in finance is that asset returns are normally distributed[45]. While this serves wonderfully well to address many finance related questions, it turns out that the tails of the probability distribution in practice are much fatter than the exponential tails of the normal probability distribution function. This implies that the loss events are more frequent. For our study the tail area is of crucial importance, since this is the area where the highest losses are realized. We first show this feature in one dimension, i.e. for a single investment, before we turn to the multivariate issue.

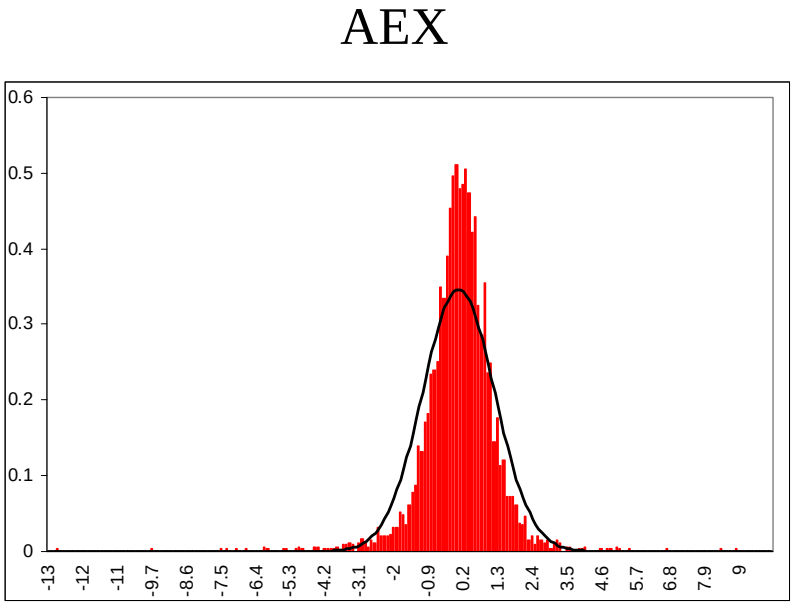
Fat or thin?

EVT shows under quite weak assumptions that the tails of the return distributions either decline at exponential rates, just like the normal distribution does, or decline more slowly at a power rate. The latter distributions are the class of fat tailed distributions[46].

Histogram

We investigate the tail properties of an individual return series by means of a histogram. Figure 4.1 depicts the histogram (empirical density function) of the daily returns of the Dutch AEX share price index. We use this series as an example since these data come on a daily basis and therefore more clearly reveal the difference with the thin tailed normal distribution[47]. The vertical bars in Figure 4.1 indicate the relative frequency by which returns of certain sizes occurred. The thick curve drawn into the histogram gives the familiar bell-shaped normal density (on basis of the mean and the variance of the AEX return data).

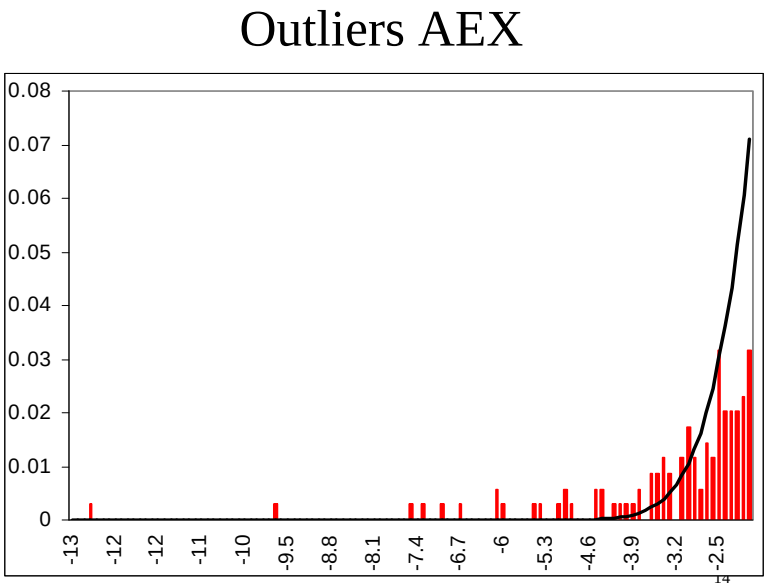
Figure 4.1 The histogram of the AEX returns and the normal probability density



[45] The standard Value-at-Risk methodology assumes normality of the empirical distributions and various other financial statistics are based on the same assumption, like the mean-variance framework of the efficient frontier used to optimize portfolios.
[46] Examples are the Pareto distribution and the Student-t distribution.
[47] Most financial time series would show similar fat-tailed characteristics.

Figure 4.1 shows that there is indeed a considerable difference between the shape of the empirical density plot and the theoretical normal density curve. The empirical density has a higher peak and fatter tails. In order to make this latter discrepancy better visible, Figure 4.2 focuses on the left-tail of the densities from Figure 4.1.

Figure 4.2 The left tail



Zooming in on the tail

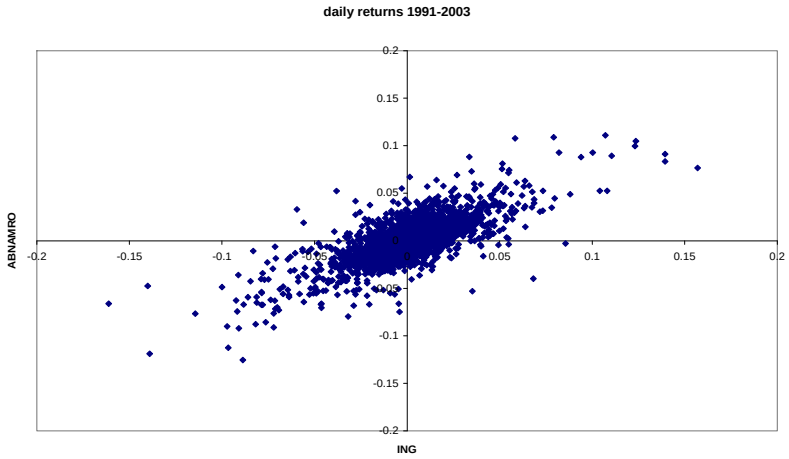
The differences in the tails between the normal and the empirical density curves are impressive. The normal density shows no observations below the modest daily loss of 4.5%, whereas the empirical density shows a number of much higher losses. Some of these loss returns occurred during the short lived crash of October 1987. The assumption of normality would clearly lead to underestimation of the real crash risk. In reality the left tail is much fatter than in the normal distribution which is used in theory. This gives:

> ***Empirical fact 1. Asset return distributions have fat tails. This means that the probability of an extreme loss is relatively high.**

4.3 Multivariate Extreme Value Theory

To analyze the issue of systemic stability, we first use the cross plot technique. Such plots directly visualize the dependency. Before we turn to the hedge fund data, which are only available on a monthly basis, we first present a cross plot of daily return data to familiarize the reader with the cross-plot technique. In a cross plot the data for one series is cross plotted against another series. In Figure 4.3 the daily returns of two Dutch banks, ING Bank and ABN/AMRO respectively, are cross plotted against each other over a twelve year period.

Figure 4.3 Cross plot of daily stock returns of ABNAMRO bank versus ING bank



Cross-plot interpretation

From Figure 4.3 one sees that the two Dutch banks had quite a bit in common as the returns present a disk like figure with ravels at the ends. Both on the upside in the North East quadrant as well as on the downside in the South West quadrant, the two banks experienced the most extreme outcomes jointly. For the systemic stability this is an issue, since it implies that if there is a problem at one bank, the other bank will likely also be in trouble. One of the explanations for this joint behaviour stems form the fact that both banks operated in the same environment and hence were exposed to the same type of macro risks.[48] The high interconnectivity of the banking sector network, in combination with the fat tailed nature of the marginal (individual) return distributions implies that the extremes will occur together. A normal based simulated remake of the cross-plot of the bank returns is in Figure VI.0 in Annex VI. Using the same correlation, variances, and means as those of the actual returns, one can simulate returns by drawing from a normal distribution with the same characteristics. A comparison of with the normal based remake shows the fat tail property in two dimensions. It also shows that under the normal distribution extremely high joint losses are very rare.

Thus the systemic risk in the banking sector is for real. We conclude

*** Empirical fact 2. Extreme losses in the banking sector occur jointly.**

4.4 Bank systemic risk and hedge funds

The cross plot analysis is now applied to investigate the systemic risk of hedge funds for the banking sector. Below we provide a number of the more interesting cross plots for the hedge fund indices versus the bank index. We have plotted the returns (denoted in percentage points) of the Dow Jones Euro Stoxx Bank index (DEB) versus the Dow Jones Euro Stoxx Insurance index (DEI) and the HFR Fund Weighted Composite Index (Fund of Fds).

[48] The connectivity derives on the asset side of the banks' balance sheets from exposures in the inter-bank deposit market, syndicated loans, and the similar risks in other assets such as mortgage loans and equities; the liabilities are even more homogenous, as they largely consist of deposits. Interconnectedness of bank returns then manifests itself both on the macro level, through changes in the fundamentals (e.g. deposit rates, short-term mortgage rates, etc), as well as on the micro level, for instance through the failure of a large company and its subsequent inability to pay a large syndicated loan.

The bank and insurance industries

We start with the cross plot for the bank and insurance index. This cross-plot gives an idea about the interdependencies between two different financial sectors. Figure 4.4 shows that the dependency between changes in the banks index and changes in the insurance companies' index is quite strong. The plot is quite similar to the cross-plot for the two bank return series[49]. Many of the observations are close to the imaginary diagonal that runs from the left bottom to the right top of the figure. The South-West quadrant shows that banks and insurers have the most extreme losses in common. Thus if one index crashes, the other tends to crash as well. There is quite a bit of evidence for systemic risk between the two sectors. Joint losses in the order of 15% per month are not rare events. Next, we consider the case of hedge funds and banks.

Figure 4.4 Cross plot Banks vs. Insurance Companies

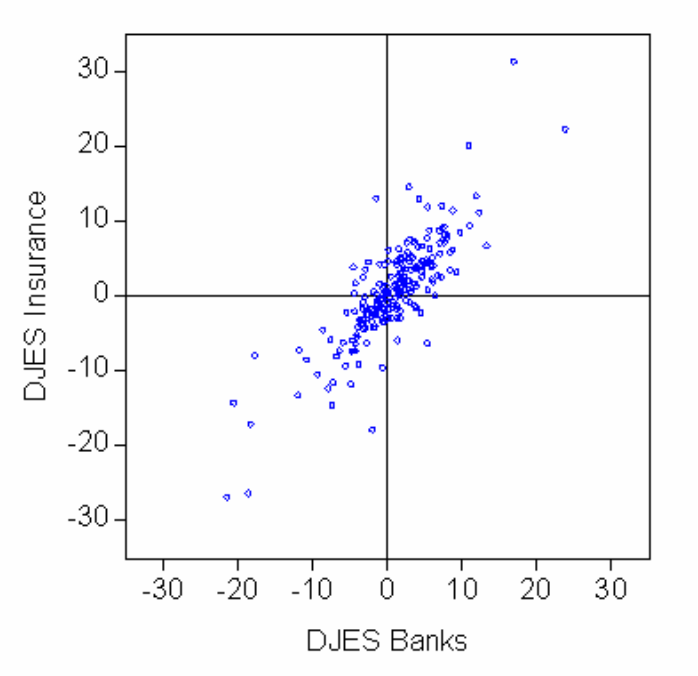
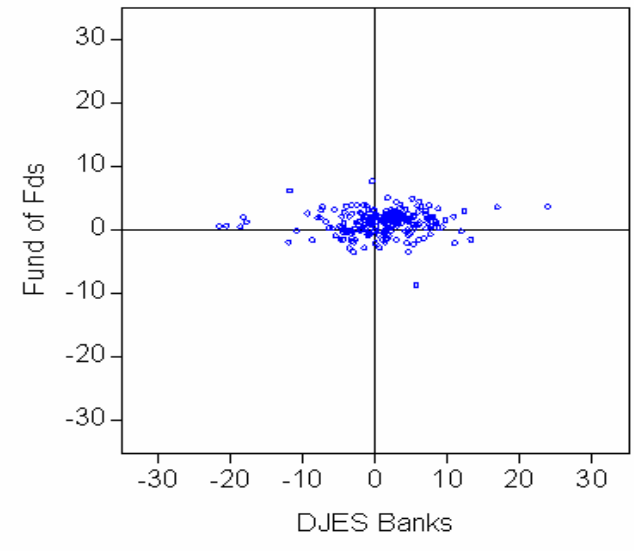


Figure 4.5 Cross plot Banks vs. HFR Composite Index



[49] As is shown in Figure 4.3.

Hedge funds and banks

In Figure 4.5 we investigate the interdependencies between the banking sector and the hedge fund industry. The cross-plot for the HRF Composite hedge fund index versus the bank index yields an altogether different picture in comparison with the bank versus insurance industry plot. There appears to be little or no relation between the largest changes in the values of the bank index and those of HRF Composite index. In the Annex VI we provide two cross-plots for two of the specific hedge fund strategies, i.e. the High Yield Index and the Equity Market Neutral index, and the bank index. These cross-plots for specific strategies to a large extend tell the same story as Figure 4.5. Only the High Yield Index and the Bank Index do show some weak dependency. This is perhaps not too surprising, as negative extreme events for the High Yield markets and the banks strongly depend on interest rates and credit ratings. The dependence between the Equity Market Neutral index and the Bank index is again minimal. It appears that hedge funds and banks do not jointly experience extreme losses; nor is it the case that hedge funds profit from the misery of banks. In summary, we have established

*** Empirical fact 3. Hedge funds and banks do not become distressed together. The two sectors seem to be independent in the systemically sensitive area.**

Reader's guide

These visual impressions are now backed up by a more formal statistical analysis based on EVT. The reader who is more interested in the implications of this analysis than in the EVT technique, may skip the next section and turn directly to section 5.1.

4.5 Multivariate Extreme Value Theory analysis

In order to objectify the amount of dependence in the high loss regions, we turn to a more formal analysis based on multivariate EVT[50]. Systemic risk in a bivariate setting can be defined as the conditional probability on a joint failure, given that at least one of the two sectors is in dire straits. We condition on the fact that there is a problem in at least one of the markets or sectors. This allows one to infer how frequent a systemic crisis happens relative to the occurrence of a crisis in any of the markets. We do not condition on a specific market failure, since any of the two sectors may be unaffected. We say that a sector is in a state of crisis if the index is below a certain threshold, which we take to be the Value-at-Risk (VaR) level[51]. Subsequently, we lower the probability level at which the VaR's are calculated, in order to obtain the limiting conditional failure probability[52]. This probability is always between zero and one. If it is zero, the probability of a joint crash is negligible. If the two concerned series are independent this probability is zero. But it can also be zero even if the two sectors are dependent. Below we estimate this extreme joint failure probability.

[50] See the ECB "Financial Stability Review", June 2006, pages 155-162, with the Special Feature on "Assessing banking system risk with extreme value analysis", where this approach is used for the banking sector. Note that part of the methodology in this review was based on the work by Hartmann, Straetmans and De Vries (2004, 2005).

[51] A typical threshold is the downside VaR of the corresponding return series. The VaR is determined by the univariate EVT analysis. Thus different series can have different VaR thresholds. It is also possible to choose the same threshold arbitrarily. In this study, we use the VaR threshold.

[52] EVT shows that this limiting probability is a good approximation to the probability at large but finite VaR levels.

Interpretation of the conditional joint failure probability

For example, if the two series are positively correlated and normally distributed, the conditional joint crash probability is still zero. This follows from the fact that the joint probability on exceeding any finite VaR levels is of smaller order than the probability that one of the two sectors is in excess of its VaR level. If the joint conditional failure probability is one, then a crisis in one sector failure always goes hand in hand with the demise of the other sector. For example, the bivariate Student-t distribution induces numbers between zero and one. For the example of the two Dutch banks, this conditional probability is about 30%. In Table 4.1 we present EVT based estimates of the conditional joint failure probability for the Dow Jones Euro Stoxx Bank index, the Dow Jones Euro Stoxx Insurance index, and three hedge fund indices. The EVT based estimation technique is explained in some detail in the Annex VII.

Table 4.1. Conditional Joint Failure Probability

Hedge Fund Index and Bank Index	Conditional Joint Failure Probability	Correlation Coefficient
Insurance – Banks	0.33	0.83
Equity Market Neutral - Banks	0.07	-0.03
Fixed Income High Yield - Banks	0.15	0.24
HFR Composite Index – Banks	0.03	0.13

Estimates of the conditional joint failure probability

The estimates reported in Table 4.1 confirm the observations from the cross plots in Figures 4.3-4.6. The dependence between the bank index and the insurance index is considerably higher than the dependence between the bank index and any of the three hedge funds indices. The 0.33 figure for the asymptotic dependence between Dow Jones Euro Stoxx Banks Index and Dow Jones Euro Stoxx Insurance Index indicates that in one out of the three cases that the bank or insurance index is severely stressed, the other will be stressed as well. For the Fixed Income High Yield and the Dow Jones Euro Stoxx Bank indices this is already reduced to one in six cases. The High Yield index shows dependence with the bank index that is at least twice as high as the other two hedge fund indices. Apparently the Equity Market Neutral index and the HFR Composite indices have few sources of risk in common with the bank index. Finally, we also briefly consider the normal based correlations in the last column of the table. Note that the normal based correlations give a quite different picture of the interdependencies. But even from these correlations one takes away the impression that hedge and bank returns do not have so much in common.

4.6 Conclusion

In this section we analyzed to what extent large negative realizations of the banking index occur simultaneously with large negative realizations of hedge fund indices. We first argued that for questions concerning systemic risk one has to employ statistical techniques that are especially suited for analyzing extremes. We first presented a visual technique based on cross-plots and subsequently used a more formal based statistical analysis to investigate the interdependencies between hedge funds and banks. It was found that these interdependencies in the failure area are quite low. At least, these are much lower than the interdependencies within the banking sector and between the banking and insurance sector. Thus hedge funds and banks do not become simultaneously distressed.

5. Hedge funds and financial stability

We interpret the results of the empirical analysis in the preceding section for the stability of the financial system. To this we add other evidence from the literature. Statistical analysis can only go so far in analyzing systemic risk. It can indicate that overspill exists, but has less to say on the causes. Therefore we add a discussion of the main characteristics of a systemic crisis, the potential transmission mechanisms and we review the importance of counterparty risk management.

5.1 Interpretation of empirical finding

Hedge funds need banks for their credit to be able to leverage their positions. Banks profit from hedge funds as prime brokers and from financing the hedge funds. The banking sector and hedge fund industry are also strongly intertwined during times of stress. For instance, banks that deal directly with hedge funds usually have provisions for exits in place, which allow banks to terminate transactions with the hedge fund in case the risk profile worsens significantly. In such a scenario, the bank would seize the collateral that it already held[53], and would try to reduce its exposure by selling these assets in the market. Evidently, in such a scenario, the bank's returns will directly depend on the value of the collateral in relation to the debt of the hedge fund.

The credit crunch example

An illustration of the extent to which banks and hedge funds are linked in times of stress are the recent examples of BNP Paribas, Goldman Sachs and Bear Stearns that were all three affected by hedge funds bearing the names of these banks[54]. BNP Paribas suspended withdrawals from its funds that invested in illiquid and thus hard-to-value credit securities. This news was the direct cause for the spike in the inter-bank market lending rates and a catalyst in the process that led to the loss of confidence in the inter-bank market. In the end this forced the Central Banks in Europe, the US and Asia to provide for unusual large amounts of additional liquidity in the payment system. Goldman Sachs on 13th August 2007 had to come to the rescue of its leading global equity fund, that relies on a quantitative trading model, and which had lost 30% of its value in a week. Goldman Sachs waived fees to attract new investors to the fund after it lost US$ 1.4 billion in assets. The bank injected about US$ 2 billion of its own money and received another US$ 1 billion from outside investors. All this shows that a study of the consequences for systemic risk is highly opportune[55].

[53] This is what Merril Lynch did in June 2007 when two Bear Stearns hedge funds got into trouble. Merril seized US$ 800 million of assets from the ailing funds, which were used as collateral for loans made to the two funds and in order to cover its exposure. These were sold off, as far as was deemed necessary. JP Morgan Chase reportedly had put some of the Bear Stearns assets that were used as collateral up for sale, but sold these back to Bear Stearns instead of placing these in the market. The idea was that this would prevent further pressure on the already depressed broader market. We refer to Annex IV for further details on the Bear Stearns hedge funds case.

[54] We refer to The Economist (August 2007) for more details and context.

[55] As is also noted in the European Parliament Report – White Paper 2006/2270(INI).

Increased correlation

The market speak holds that at times of stress correlations increase dramatically. The ECB (2006, page 142) issued the following warning on hedge fund risk for financial stability and systemic risk: "... the increasingly similar positioning of individual hedge funds within broad hedge fund investment strategies is another major risk for financial stability which warrants close monitoring despite the essential lack of any possible remedies.

This risk is further magnified by evidence that broad hedge fund investment strategies have also become increasingly correlated, thereby further increasing the potential adverse effects of disorderly exits from crowded trades".

Empirical EVT based evidence

The aim of the empirical analysis in section 4 was to quantify the likelihood of such fears materializing. We have used simple statistical devices such as cross plots in combination with the more sophisticated results from statistical extreme value theory (EVT). To this end we looked both at the risks posed by investing in hedge funds (univariate risks) and the risks for the rest of the financial sector (multivariate or systemic risks). Our main conclusion is that:

The systemic risk posed by hedge funds appears to be relatively small, since the likelihood that banks and hedge funds become jointly distressed is low.

The cross plots in section 4 reveal that the dependence between for instance banks and insurance companies is much higher than is the case between hedge funds and banks. The low conditional joint failure probability (EVT based) estimates confirm this finding. This probability is at least twice as high for the banks and insurance indices as it is for the banks and a number of hedge fund indices. Calculations for the other hedge fund indices showed that similar results are obtained. The contagion risk from hedge funds to banks proved to be much smaller than from insurance companies to banks. To conclude, there is little evidence for the fears expressed by the ECB report. This is not to say that the probability of a financial crisis is low, nor that hedge funds cannot play a role in such an event.

Regression based evidence

This conclusion is further supported by the few other studies that have investigated the issue of hedge funds and systemic stability. This literature is mostly based on correlation analysis. By nature such an analysis gives less weight to extremes and overweighs the events in the centre around the mean outcomes. The failure probabilities and correlation measure are both reported in Table 4.1, but provide different signals. There is some multiple correlation based literature that has studied the issue of how hedge funds impact on the systemic stability of the banking industry. The recent elaborate study by Chan et al. (2006)[56] reports regressions of the banking sector index (both equally weighted and value weighted) on the S&P 500 index and various hedge fund indices. The result is that the goodness of fit measure R^2, which is between zero and one,[57] hardly changes in value when hedge fund indices are added as an additional explanatory variable over and above the S&P index. If the R^2 measure does not increase, the additional variables have no explanatory power. This again suggests that hedge funds add not much extra risk to the exposures of the banking sector. Most common risk is captured by the movement of the general stock index.

[56] In Tables 6.25 and 6.26.
[57] One indicates a perfect fit, zero no fit at all.

5.2 Systemic crisis features

We discuss the economic aspects of a systemic crisis.

The transmission to the real economy

It is the transmission of financial events to the real economy that is the defining feature of a systemic crisis, and which distinguishes it from a purely financial crisis[58]. The Counterparty Risk Management Policy Group (CRMPG, 2005) describes a financial shock with systemic consequences as one with: "major damage to the financial system and the real economy".

The concern is for the consequences of a disruption of the ability of financial intermediaries or financial markets to efficiently provide credit. If a bank has a large exposure to a hedge fund that defaults or operates in markets where prices are falling rapidly, the bank's greater exposure to risk may reduce its ability or willingness to extend credit to worthy borrowers. If bank-dependent borrowers cannot access alternative sources of funding, this would result in a "credit crunch" that would also have real economic repercussions. A second possible transmission mechanism from hedge fund risk to systemic risk consists in a disruption of the broader financial markets, after a large hedge fund melt-down. This would basically reflect a general loss of confidence with market participants and a reduced willingness to bear risk[59]. Such a contagion effect may be caused by irrational, informational and fundamental reasons, where for instance an extreme shock can cause investors to ignore economic fundamentals, leading to excess volatility and even panic.

Systemic risks posed by hedge funds

To understand the risks posed by hedge funds, one needs to realize that in comparison to banks and insurers, hedge funds play on a wider range of assets, are more arbitrage than intermediation oriented while being much less regulated. Banks and hedge funds both have large short and long positions with a very small capital base. Not without reason do supervisors worry about the risks of these financials. Historically, financial economists and policy-makers have focused on banks as prospective channels of systemic distress through, for instance, bank runs and the possibility of a subsequent "credit crunch". However, since the demise of LTCM, supervisors are very worried about the systemic risk for the banking sector posed by the hedge fund industry.

Contagion risk

The recent near-collapse of two Bear Stearns hedge funds[60] in June 2007 illustrates the potential for contagion of risks to other hedge funds. An infusion of cash into one of the funds was necessary, but no outside assistance. Nevertheless it was a very big fund bailout. Stulz (2007) also states[61]: "The collapse of a hedge fund could have far-reaching implications if the fund is large enough, possibly leading to a chain reaction of collapses in the financial system." Although it is uncertain how large the exposure of the banking sector to the hedge fund industry is, it is estimated[62] that banks' direct exposure to hedge funds has been growing proportionately with the hedge fund industry itself.

[58] According to Kambhu et al. (2007).
[59] This is sometimes also referred to as "domino risk". Moreover, some models of investor behaviour assume that large negative shocks have a tendency to instigate an irrational market response.
[60] We refer to Annex IV for more information on the Bear Stearns hedge funds problems.
[61] On page 23.
[62] By Garbaravicius and Dierick (2005).

The LTCM debacle also illustrates the potential of hedge funds to affect in a harmful way financial institutions and financial markets. A sequence of negative effects can start with losses on leveraged market positions[63]. When liquidity is reduced[64] and markets are stressed (which typically happens simultaneously), forced margin calls and sale of assets will take place[65].

Leveraged market risk is then likely to force a troubled hedge fund to sell assets at lower prices than expected and possibly default on its obligations. This could have a spill-over effect to the prime brokers and other financial institutions that service it, especially so if in the wake of the looming crisis the credit collateral suddenly appears to be of less quality (price) than first estimated.

Increased vulnerability

The ECB expressed the opinion[66] that "the vulnerability of the financial system to an abrupt and unexpected loss of market liquidity appears to be increasing". Factors like the size of the hedge fund, the relative importance of the fund in the specific market and asset, the level of leverage and whether or not it was involved in crowded trades (herding[67]), will determine the extent of spill-over effects to other market participants. Regulators are worried that a large hedge fund like LTCM might trigger a sequence of events that could ultimately lead to a systemic crisis.

5.3 Diminishing systemic hedge fund risks

FSA (2005) however, states that "the risk of an individual hedge fund posing a threat to the financial system on the scale of the LTCM episode, or even approaching it, has significantly diminished since 1998."

Amenc and Vaissie (2005) give reasons for this perceived reduction in systemic risk following from the potential demise of a large hedge fund:

1. banks use more sophisticated techniques to manage their exposure to hedge funds;
2. as more players have entered the market, positions are probably much less concentrated in one or a few funds;
3. leverage levels taken on by funds are presently lower.

Moreover, Ferguson and Laster (2007) state that "Some analysts believe that hedge funds pose systemic risks. However, this is unlikely. A thorough review of the avenues through which hedge funds could cause systemic problems indicates that, although a major disruption from the hedge fund sector is possible, it would be difficult for the sector to be highly disruptive to financial markets. Post-LTCM, regulatory authorities have encouraged banks to monitor their hedge fund clients through constraints on their leverage.

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[63] Chan-Lau (2007) notes that derivative instruments enable investors to leverage their positions, making their balance sheets more sensitive to price swings and especially, more vulnerable to adverse price movements. He states that the recognition that derivative instruments could pose systemic risk has motivated the passage of legislation granting extraordinary protection under insolvency resolution laws in the United States and other countries with well-developed derivatives markets.

[64] The ECB states in its June 2006 Financial Stability Review that recently hedge funds have reportedly been acquiring less liquid assets.

[65] Hedge funds run funding liquidity risk because short-term financing by banks is not matched with long-term illiquid holdings and because they run investor redemption risk.

[66] In its Financial Stability Review (June 2007, page 9).

[67] The ECB discusses herding risks extensively in its Financial Stability Review of June 2005 and June 2006. The Counterparty Risk Management Policy Group noted that "the concept of crowded trades has entered the lexicon as one the most significant risks to be identified and mitigated".

This has thus far proven effective, as the recent failure of Amaranth demonstrates[68]. That failure, the largest yet, caused hardly a ripple in the wider financial markets." They are of the opinion that on balance hedge funds enhance market stability and that they are unlikely to be the source of a systemic failure[69].

The ECB[70] appears to concur at least on the fact the recent demise of Amaranth had little discernible impact on the markets, even though Amaranth was a multi-strategy hedge fund around twice the size of LTCM. Although better market liquidity will in general and under normal market circumstances, enhance the stability of financial systems, the flipside is that a loss of market liquidity after a period of continued abundance can reveal vulnerabilities that were undetected during the preceding period. Risk assessment may have been less disciplined and strict, especially in credit markets, and the competitive pressures might have pushed parties into taking too much risk, where "priced for perfection" was already nearly applicable. The assumption that favourable economic conditions will persist, can not remain true indefinitely and a sudden reversal of fortune could potentially lead to an abrupt drying up of liquidity in financial markets.

Main protection from financial contagion

Kambhu, Schuermann and Stiroh (2007) of the Federal Reserve Bank of New York analyze the systemic risk caused by hedge funds. They argue that traditionally the set of Counterparty Credit Risk Management (CCRM) practices has been the main protection from financial market disruptions created by hedge funds. Essentially, hedge funds cause counterparty risk for regulated trading partners (such as banks and prime brokers) and investors, thus creating credit risk in the regulated part of the financial system. Banks traditionally are seen as the main prospective channels of systemic distress. In order to mitigate such risks, banks establish limits, implement reporting infrastructures, and define haircut, margining and collateral policies, all designed to assess credit risk and limit counterparty exposure. There are strong links between hedge funds and banks, through for instance prime brokerage, various services like trading, execution, clearing, custody[71], securities lending, technology, data, and financing. Moreover, prime brokers now also have expanded their business by providing seed money and knowledge to starting hedge funds, in order to gain an edge over competition in winning the hedge fund's business. Such investments can improve the prime broker's profitability, but will further increase the dependency of the broker on the hedge fund's success.

[68] See Annex IV.

[69] Amenc and Vaissie (2005) appears to concur with this assessment, page 6, although they also concur with the statement that it is inherently difficult to draw any firm conclusion in this regard. As they argue, no study has so far been able to demonstrate the implication of hedge funds in any systemic crisis.

[70] In its December 2006 Financial Stability Review.

[71] The assets of a hedge fund are sometimes deposited with a custodian bank instead of a prime or clearing broker. Compared to the latter, a custodian bank is held by fiduciary duties and is obliged to protect the fund's assets and act in its best interests. This provides an additional protection to the investors of the fund, as compared to a prime broker that holds the fund's assets primarily as a principal and as collateral for underlying fund positions (in its own interest thus).

Counterparty Credit Risk Management has improved

The characteristics of hedge funds make CCRM more difficult as they exacerbate market failures linked to agency problems, externalities, and moral hazard. While various market failures make CCRM imperfect, it remains the best line of defence against systemic risk[72]. Essential elements of CCRM are the use of initial and variation margins, the use on internal ratings, monitoring and evaluation of exposures[73], stress testing, due diligence, frequent contact with the fund to understand the strategies, limits on specific trades, exposures or concentrations, procedures and reporting protocols.

Counterparty risk was an important issue in the LTCM crisis[74], where a key concern was the potential domino style default effect on major investment banks through LTCM settlement risk and lack of information about overall exposures.

As a result of the LTCM crisis, CCRM has strongly improved[75]. In particular supervision, disclosure and risk management techniques by counterparties have improved. Prime brokers have become much more concerned about counterparty risk[76], and tend to require full position level and loan disclosure in the case a hedge fund uses more than one prime broker. The reason being that excessive concentration of positions, together with the directional nature of some positions and illiquidity risks, has in the past proven to be the major cause for hedge fund demises.

5.4 Conclusion

The hedge fund industry and the banking sector are strongly intertwined. During times of stress, there is a potential of contagion from one hedge fund to another or to the banking sector. Empirical EVT analysis as well as regression based research conclude that the systemic risk posed by the hedge fund sector has proven to be relatively small. The main transmission mechanism of a financial shock with systemic consequences is through a credit crunch with real economic repercussions. CCRM is seen as the main line of defence against systemic risk caused by hedge funds. Since LTCM, CCRM practice has strongly improved, and more recent hedge fund demises have not led to new systemic crises.

[72] According to Kambhu et al. (2007)
[73] Especially the risk of over-reliance on marked-to-market exposures could prove to be problematic in times of seriously distressed markets and asset prices, see also Banque de France (2007), page 98.
[74] We refer to Annex IV for the LTCM case.
[75] As noted by the Financial Stability Forum (2007) and CRMPG (2005).
[76] We refer to Danielsson et al (2005).

6. Risk management and supervision

The hedge fund industry is heterogeneous and hence different risk management systems and reporting methodologies are needed depending on the specificity of the hedge fund. We discuss a number of elements of the risk management system requirements. This section concludes by describing some of the main sources of risk as well as the difference between hedge fund attrition and liquidation.

6.1 A heterogeneous industry

The hedge fund industry consists of a number of very different and heterogeneous investment strategies. This implies that the appropriate risk management systems' requirements are quite diverse as well. It is not possible to describe all the different risk management systems that are being used by the funds themselves. Partly this is caused by the fact that little is known about the different systems used by the hedge funds. These vary from simple single-user proprietary systems, to large risk management systems provided and serviced by third parties. For certain hedge funds, simple excel-based risk management systems suffice. Such spreadsheet models have the benefit of flexibility and reporting ease for a small user. However, such a reporting mechanism will not cope with a growth of the fund, nor will they easily withstand the scrutiny of external auditors or independent risk managers.

Location is important

Again, as previously discussed in section 1.5, the extent to which supervisors are actively involved and really grasp the intricacies of the hedge fund's risk management system, will to a large extent depend on the location of the hedge fund manager. If the hedge fund manager is located in for instance London, the FSA will find it much easier to have an up-to-date understanding of its risk management system. If either the managers or the fund is located within the EU there will be more direct supervisory control, and a better chance to influence the choice of system and for instance the scenarios and stress tests that are being run by the hedge fund risk management system. The same argument holds when the hedge fund and its managers are located outside of the EU, but the fund is listed on an EU-exchange like Luxembourg or Ireland; in such a case the supervisory control improves and more direct regulation becomes possible as compared to the typical offshore hedge fund that doesn't have an EU-listing.

Risk management requirements in complex environments

More extensive systems encompass both pre-trade and post-trade activities, employ accurate pricing modules on a range of asset classes, have risk analytics including scenario and what-if analyses, and offer various risk management and compliance reporting modules. Of foremost importance for proper implementation of risk management is the organisation of information collection and reporting. Often the administrative hurdles in an organisation are larger than the quantitative questions. A first principle is a division between front and back office. The back office needs to collect all the necessary information, which may not be a sinecure in case complex trading strategies are followed. This is discussed in more detail below.

6.2 Diverse risk management requirements

Thus as hedge funds differ very much in strategy, their needs for risk management are quite diverse as well. The same holds for the differences in reporting requirements. Some hedge funds trade continuously, have many small positions in all kinds of underlying products, and in many different markets simultaneously.

This requires very quick and highly automated information and risk management systems, based on straight-through processing, good clearing and settlement procedures, adequate back-office functionality, etc. Per contrast, other hedge funds specialize in executing only a very limited number of trades, sometimes only once per week or so. For instance, in distressed loans or merger arbitrage the frequency of trades is lower and the clearing and settlement risks are smaller. The need for straight-through processing is very limited for these hedge fund strategies. On the other hand, for this type of funds, excellent and consistent valuation systems need to be in place, with good audit trails, consistent reporting procedures and high emphasis on a sufficient knowledge level comparable to that of an accountant. The definition of tasks and responsibilities from a control perspective becomes of more importance.

One size doesn't fit all

On a case-by-case basis, some of the recent failures in the hedge fund industry are analyzed and their causes and possible remedies are discussed in Annex IV. Evident examples are LTCM, Amaranth[77], and Bear Stearns. The three biggest losses by hedge funds until 2006 are, respectively Amaranth (US$ 6.4 billion, 2006), LTCM (US$ 3.6 billion, 1998) and Tiger Management (US$ 2.0 billion, 2000)[78]. These examples serve to illustrate the diversity of the funds in the industry and the heterogeneity of the risk management systems, as well as the impossibility to find one all-encompassing reporting and risk management system. Nevertheless, it is possible to describe some of the characteristics of the hedge fund risk management, supervision and reporting issues. A non-exhaustive list of typical hedge fund risks is discussed below, as an illustration of key risk management issues: the need for a strict division between font and back office, extra attention for operational risk, fair valuation of positions, the non-linear sensitivities, the size of the positions versus the size of the market, and the need for excellent liquidity management. These aspects are discussed consecutively in more detail below.

Strict division between front and back office

As in all good risk management frameworks, there needs to be a strict division between on the one side the trading and dealing room functions where the positions are taken and on the other side the control, back office, valuation, risk management and accountancy functions. This need for a strict separation of these two types of functions is not unique to hedge funds. The collapse of Barings Bank in 1995 is generally seen as a good example for the necessity to have separate reporting lines for the trading and risk management departments. In the case of Barings, losses kept accumulating over a long period of time and were kept hidden from top management. One of the main reasons that these losses were not discovered earlier was that the person responsible for the losses was also responsible for reporting these. Simply put, with regard to certain positions the trader was allowed to report to himself.

[77] See G.A. Martin (2007), "Who Invested in Amaranth?" and Annex III.
[78] According to Ferguson and Laster in the Financial Stability Review of Banque de France's Special issue on hedge funds (2007).

Since the demise of Barings, this deficiency in risk and auditing practices is one of the key lessons taught on risk management, both of banks and hedge funds. The demise of LTCM is another example, albeit more indirect, for the need for a strong separation of risk management and trading. In the case of LTCM, position taking was based on specific assumptions with regard to co-movements of markets, as measured by correlation indices. A problem with LTCM was that the risk managers used the same underlying assumptions and correlation indices as the trading department. Hence, LTCM's sensitivity to the underlying assumptions in calculating the correlations was increased unnecessarily.

Basically, risk management was not independent enough from trading and this allowed for too much reliance on one type of risk estimation. When this estimate proved incorrect, both trading and risk management were badly prepared. This certainly contributed to the extent in which the problems proved unmanageable.

Fair valuation of positions

Certain categories of hedge funds try to generate returns by investing in less liquid instruments. A clear example is the so-called 'Distressed Securities' category, that invests in for instance claims on bankrupt companies, or in often unrated securities of companies that are perceived as being close to bankruptcy. For such investments, there is no central market with continuous prices. More explicitly, price formation is quite unclear and actual trades will often be undisclosed and rare. Nevertheless, for a hedge fund, specialization in such an illiquid market may prove to be a very rewarding strategy. A major difficulty then becomes to formulate robust procedures that guarantee fair valuation of the hedge fund's positions. Neither being too careful nor too optimistic in it's valuation will ultimately serve the fund or the investor best.

The recent problems of two Bear Stearns hedge funds illustrate the difficulty to consistently and fairly value complex positions for which little or no market prices are available. For the auditor, approving the books of such a hedge fund is quite risky as well as in case events take a turn for the worse, the auditor will be easily held responsible.

Non-linear sensitivities

Performance evaluation (and thus also risk management) of hedge funds is difficult because the manager may invest in any asset class, trade in derivatives and follow a myriad of dynamic trading strategies[79]. Most of the hedge fund investments show option-like features in their returns. A straightforward classical long-only equities fund will usually increase in value in case the underlying share market goes up and will loose value if the same share market goes down. A hedge fund, per contrast, might have a completely different exposure to that same share market. The hedge fund could for instance loose money if the share market doesn't move much and gain value if the move of the share market is large enough, independent of whether the market moves up or down. Or, the hedge fund could have taken such a position that it earns money if the interest rate moves in opposite direction of the equity market. Alternatively, the hedge fund's return might be time-dependent and only positive if the movement over the next month is upward, followed by a downward in the month thereafter. These examples serve to show that basically any conceivable pay-off can be replicated by hedge funds. A key characteristic of hedge funds is therefore that they display a non-linear risk exposure to standard asset markets. Moreover, as asset markets show so-called fat tails[80], with a non-normal distribution of returns, risk management must be able to take these characteristics into account as well. Again, with LTCM the fat tails characteristic wasn't adequately captured by its risk management system.

[79] See Agarwal and Naik (2004).
[80] We refer to section 4 for more information on fat tails and other financial time series characteristics.

The conclusion must be that any benchmarking model employed to evaluate the performance of hedge funds should account for the non-linear and specifically the option-like features exhibited by hedge fund payoffs. Fat tails, options and their characteristic non-linear sensitivities (e.g. their so-called "Greeks") need to be incorporated in the risk management system.

Size of positions versus size of the market

One of the key aspects for sensible hedge fund risk management is that the size of the hedge fund positions should be in line with the size of the market in which these positions are taken. The demise of Amaranth[81] in 2006 nicely illustrates the risk that is run if a single hedge fund (or any party for that matter) becomes responsible for a too large part of the total trading volume in a specific market. In the case of Amaranth, relatively very large positions were taken in the market for Natural Gas, using both listed derivatives and Over-The-Counter derivatives. The market for Natural Gas derivatives was relatively immature until Amaranth started taking increasingly bigger positions. The direction of the positions themselves was economically defensible, but the size was clearly not sensible. Because Amaranth was the main player in the Natural Gas market, it proved to be very difficult to unwind or hedge its existing positions when the need arose. Liquidity quickly vanished and positions became suddenly either without a price, or were priced in such a way that unwinding them would become very costly. This is typical behaviour for any market in which there is only one very large player; if ever this party has to unwind its positions quickly, it will find that this has become very hard if not impossible without incurring major losses. Decent scenario analysis and stress testing prior to taking the positions would have revealed this risk and possibly prevented Amaranth from executing the respective trades that led to its unmanageable positions.

The need for liquidity risk management

Hedge funds often use both derivatives, repurchase agreements and short sales in order to obtain leverage, but credit lines for liquidity purposes are also widely used[82]. The LTCM debacle illustrated the need for a hedge fund to have sufficient liquidity when losses in market positions occur[83]. To be able to de-leverage market risk exposures by being able to sell illiquid assets, the effects of illiquidity should be gauged beforehand. In the case of LTCM this was not analysed adequately beforehand, as fast unwinding of the positions proved either impossible or too expensive. Scenario analyses and stress-tests in general are good instruments for preparing the fund and its counterparties, like prime brokers[84] and banks, for the eventuality of a forced reduction in market risk in conjunction with pressure on liquidity. It would be prudent for hedge funds with assets that are not easily sold at market prices to have an appropriate risk measurement framework in place, which could entail e.g. longer lock-up and redemption periods and notices, penalties for early redemptions, higher liquidity reserves or more liquid assets, and larger credit lines. To a certain extent, the recent demise of two Bear Stearns hedge funds[85] again illustrated the need for good liquidity management.

[81] We refer to Annex IV for more details on the Amaranth case.
[82] Garbaravicius and Dierick (2005).
[83] The Economist (August 2007) calls the need to offload illiquid instruments by banks and hedge funds 'one of the fastest ways to lose money yet devised'. The Economist also states that such indiscriminate selling has been affecting hedge funds over the past couple of weeks, which has led to unusual movements in debt and equity markets.
[84] Another risk is that the prime brokerage market itself is highly concentrated whereby the three biggest prime brokers Goldman Sachs, Morgan Stanley and Bear Stearns are estimated to have a combined market share of more than 50%, Garbaravicius and Dierick (2005).
[85] We refer to Annex IV for more details.

When the CDO market took a hit, certain positions of the Bear Stearns hedge funds became very difficult to value and even more difficult to sell. Some of its positions apparently were quite esoteric and even in a liquid market quite complex. When market liquidity disappears, such a position will prove to be near-impossible to unwind. In order to withstand a flow of redemptions by the clients of the fund, a sufficient liquidity buffer must be in place and credit lines need not be fully used.

Although scenario analysis and stress testing are appropriate risk management mechanisms, deciding upon what level and type of liquidity is sufficient, remains very difficult and almost more of an art than science, which is to be performed by seasoned risk managers only.

6.3 Extra attention for operational risk

The average hedge fund will more easily than the average overlook operational risk, as hedge funds often are young[86], small, and rapidly developing organisations, where a clear division of tasks and responsibilities is much more difficult to obtain than within banks. Banks are usually older organisations, with existing procedures and reporting frameworks that will take into account the need for a clear division of tasks. Moreover, as the nature of the money makers (the traders) in a hedge fund tends to be more focused on the markets and the positions than on the other organisational functions, there is a natural inclination within younger and smaller hedge funds for these aspects to be pursued less diligently.

Moreover, many hedge funds are relatively unregulated or at least less diligently supervised by external and unbiased parties. Therefore, hedge funds are more prone to operational risk than many other financial services institutions that often already have existing operational procedures in place, have enough people and funding to exercise adequate operational control and are under direct supervision by local regulators. Operational risk is therefore one of the most important types of risk encountered by especially younger hedge funds and it deserves extra attention.

Fraud

Many hedge funds end in fraud, as the largely unregulated nature of the hedge fund business makes it particularly vulnerable to misrepresentation and fraud. Recent Securities and Exchange Commission (SEC) cases include the gross overstatement of hedge fund performance, the payment of unnecessary and undisclosed commissions, and misappropriation of client assets by hedge funds, late trading and inappropriate market timing. Proper internal organization and separation of duties and reporting lines must ensure that the chances for fraud are kept within limits. Due to the international nature of the hedge fund business, it is thought to be more vulnerable to money laundering attempts. Although new regulation in for instance the U.S. is trying to address this issue by requiring more information and transparency from the hedge funds and its employees, this clearly is an area which deserves more attention and it is likely to witness the development and implementation of new rules and regulations in the years to come.

[86] We refer to section 1.5: the vast majority has capital under US$ 100 million under management.

Liquidation is not the same as attrition

Hedge fund liquidation and attrition rates are different things[87]. Attrition also includes all cases where a hedge funds ceases reporting to databases for a myriad of different reasons, among which are the fund being closed to new investments (which could be due to good results), a merger of the fund with another fund, the fund becoming dormant or other unknown and uncategorized reasons. Based on the TASS database since 1994, annual hedge fund liquidation and attrition rates fluctuated around 5% and 10% respectively.

Liquidation may be either forced or voluntary

Liquidations can be either involuntary or voluntary, at the initiative of the hedge fund manager. Typical examples of forced liquidations occur after operational risk materializes as in cases of misrepresentation of investments, misappropriation of funds, general fraud, unauthorised trading and style breaches, inadequate resources and infrastructure[88]. If investors withdraw a substantial part of their money from the fund, the remaining assets under management could prove to be insufficient for the fund to remain economically viable, because of insufficient economies of scale and as a result inadequate fees for the manager. This could be a reason for a voluntary liquidation, as is for instance the departure of key managers, or unsuccessful fund-raising. The number of fund collapses tends to be relatively small, running at about 0.3 per cent of the funds in existence[89].

6.4 Conclusion

The hedge fund industry consists of a very heterogeneous group of investment vehicles. As a consequence, risk management requirements and reporting system needs are extremely diverse. There can be no 'one size fits all' risk management or reporting system, neither now or in the near future. Prior demises of hedge funds teach us that a strict division between front and back office is needed. Moreover, fair valuation of positions as well the measurement of complex non-linear sensitivities should be included in the risk management system. We stress the importance of liquidity risk management, including the need to limit the size of positions relative to the market. Finally, the importance of operational risk is clarified, especially for young and small hedge funds. The difference between liquidation and attrition was discussed shortly.

[87] Based on the ECB's Financial Stability Review (June 2007).
[88] Amenc and Vaissie (2005) also refers to the fact that often operational weaknesses are the cause of a crisis situation at a hedge fund, page 6.
[89] According to McCarthy (2006).

7. Hedge fund regulation: motives and instruments

We first discuss the basic motivation for the need of regulation and supervision, with a focus on the public externality of the payment, clearing and settlement functions performed by the banking industry and the protection of the small deposit holders. We continue by discussing the key principles regarding supervision and regulation of financial services industries. Subsequently, these principles are then applied to hedge funds, insurance companies and mutual funds. Once confronted with the principles for regulation, we argue that the case for regulation of hedge funds differs considerably from the case for regulation of banks.

Finally, a non-exhaustive list of regulatory instruments is provided, with at least standard price and quantity measures. The list is divided into direct and indirect instruments. The pros and cons of the various instruments for supervision and regulation of hedge funds are discussed, based on the principles for public intervention. An extensive overview of the main regulatory issues in Europe, including the views of the ECB, Banque de France and FSA is relegated to the Annex V.

7.1 Motives for regulation and supervision of banks

The basic motivation for the need of public or private regulation and supervision of an industry are market failures that can be better dealt with through non-market based solutions. The usual argument for the public provision of a good or service is that its consumption is *non-rival* (the fact that someone's consumption does not affect the benefits of someone else's consumption) and *non-exclusive* (the fact that everyone consumes the good or service if it is provided). The classic examples are the protection derived by citizens from a national defence infrastructure and the rule of law. We note that often the case for a market based provision versus the public provision of a service is not so clear-cut. Take for example the case of police services that can at least be partially provided through private security firms.

Money is like a language

What are the elements in the financial sector that call for the public provision of a service? Consider the provision of legal tender notes, i.e. money, which nowadays is a government monopoly. Monetary exchange is non-rival, but it is in effect exclusive since one can revert to barter. Nevertheless, other aspects make that central banking is virtually a natural monopoly in our current societies. Money is like a language and there are huge positive externalities in trade from using the same currency. The provision of money is a business with important fixed costs, implying declining average costs and a tendency towards monopoly, so that market power needs to be regulated. Lastly, moral hazard on part of the issuers of fiat currency requires carefully designed contracts, such as the Maastricht treaty, to restrain over issue.

Banks and information asymmetries

Commercial banking is in part a normal industry that needs some regulation such as anti-trust, as any other industry. But some aspects make that banks require more stringent (public) intervention than other industries, including other parts of the financial service industry like insurance. The raison d'être for the financial service industry is the existence of information asymmetries that imply moral hazard and adverse selection problems. The function of banks is to help overcome these problems, but as a result these intermediaries themselves may display moral hazard and apply adverse selection. Therefore extra public supervision may be desirable.

Disciplining devices

Traditionally banks are viewed as efficient institutions for transferring resources of (small) depositors to investments (commercial loans, mortgages). To discipline the banker in their role as delegated monitors of loans to businesses, the deposit contract is an immediately callable bond with the sequential service constraint. Since small depositors do not have the means for elaborate supervision of the banker, they are offered this trigger contract as a disciplining device. In fact, a transfer of ownership from equity holders to claim holders in case of adverse outcomes is in general the mechanism by which incentive problems regarding limited liability companies are resolved. Over time this transfer of ownership of a bank has been delegated to bank supervisors to prevent runs on the bank as much as possible.

Fragility, protection and moral hazard

The features of the deposit contract and the bank loans on the other side of the balance sheet characterize the banking business as borrowing short term and lending long term with leverage. This explains the fragility of the banking business. With or without unfounded doubts about the solvency of the bank, a bank run can develop rendering the bank illiquid, albeit being solvent. To protect small uninformed depositors (as in the food safety administration by the U.S. organisation FDA), safety standards against such bank runs were needed and the idea of deposit insurance was born. Moreover, Bagehot already in the 19th century put forward the paradigm that a central bank should always be willing to act as a lender of last resort to illiquid but solvent commercial banks.

Both devices are ways to eliminate (Pareto) suboptimal bank runs. The idea that small depositors should be protected by a public agency emanates from the free rider nature in a group of numerous stakeholders and the large fixed costs for any party involved with monitoring in an environment of asymmetric information. The protection of deposit insurance, though, takes away the incentive from depositors to monitor the prudential behaviour of the banker. Given the limited liability structure of banks, the banker is then inclined to take on more risk. This is the moral hazard that needs to be regulated by further public intervention.

Payment system externality

Apart from the protection of small depositors, there is another motive for public interference in the banking industry. This derives from the positive public externality obtained from the payment, clearing and settlement functions performed by the banking industry. This by-product of banking is very important for the efficient working of the real economy. A bank can only perform these functions efficiently in case counterparties, i.e. other banks, are reliable. A failure of one bank can easily disrupt the (international) payment system, as was illustrated by the Herstatt affaire or the current sub-prime loans crisis. Due to this externality, the failure of a single bank has higher public costs than say the failure of a single pension fund. Hence banks, because they maintain the payment system, are more strongly regulated and supervised than other parts of the financial service industry.

Summary

This short review of the motives and issues regarding bank regulation and supervision touched on the basic elements regarding regulation and supervision of financial service institutions. These elements are now discussed on a more general and structured level. Subsequently, we apply the ensuing principles to discuss the regulation and supervision of hedge funds. Lastly a number of instruments to regulate the hedge fund industry are considered. Their appropriateness is judged in light of the principles for intervention. In the end this yields a list with alternative modes of regulation and supervision.

7.2 Principles of regulation and supervision of the financial service sector

The standard argument for public intervention in the provision of a service is that its consumption is non-rival and non-exclusive. A number of special features of the financial markets make that these conditions are met to a larger degree than in other industries; although the non-rivalry and non-exclusivity also vary with the type of financial service and technological developments. These special market features are as follows:

Market Power

The provision of legal tender has considerable fixed costs, apart from the variable printing costs. Any fixed costs industry tends towards monopoly, as this reduces the average costs. The seignorage or inflation tax also makes that the provision of money is a standard source of income for the government. Market power is also rampant in commercial banking due to the numerous small depositors versus the large size of a bank. Large fixed costs in monitoring, organization etc. and many small claim holders create a free rider problem in disciplining a bank or insurance company. This implies that depositors and claim holders require collective action to share the cost of monitoring the banker or insurance firm (comparable to the function of the FDA in the USA, as it would be too costly for individual consumers to do food and drug quality inspection). Public action to organize the dispersed claim holders (depositors) or customers (insurance) can be an efficient mechanism to create a balance between the two sides of the money market. Moreover, entry barriers due to existing regulation and supervision act as a collusion device, requiring further supervision.

Externalities

Positive and negative externalities which are not properly priced by the market are a standard public finance argument for market interference. Banks are special since depositors are financiers, but are also customers of the payments system and may simultaneously be borrowers as well (by holding e.g. a mortgage). The payment-clearance-settlement system has important network effects. Its efficiency is increased by the participation of as many banks as possible. But a simple failure of a single bank can through contagion infect the entire industry and may bring the entire payment system to a halt. Thus bank runs create systemic risk, a negative externality, while participation in the network of any bank creates a positive externality.

Asymmetric Information

Asymmetric information between two sides of the market creates at least two problems: adverse selection and moral hazard. Consider for example the case of unemployment insurance, where individuals know more about their own capabilities than the insurance company. This creates adverse selection as the pool of agents seeking a specific insurance contract will be worse than a pool of randomly chosen agents from the entire population. Only agents who know that they are prone to becoming unemployed will opt for the insurance. Thus the fair insurance premium has to take this self selection effect into account. Furthermore, moral hazard may ensue once agents become unemployed. If agents receive the unemployment benefit, their incentive for seeking a job decreases. Thus agents adapt their behaviour. The implicit insurance provided by lax monetary policy in case of adverse economic conditions, known as the Greenspan put, may have lead to excessive risk taking on part of the banks. Lastly, incomplete information regarding fundamental values also stimulates the herd mentality and creates investment bubbles.

Incomplete Contracts

Most public enterprises are financed by a mixture of debt and equity. Such a mixture is found useful in disciplining the management of the firm. Since outside financiers cannot observe the efforts of management, a trigger point is created at which change of ownership takes place. In a limited liability environment this point is usually reached when loans and bonds are no longer repaid and the enterprise goes into receivership. Under the presumption that management prefers to keep control, it will at least put in effort to try to steer away from this event. Transfer of ownership in adverse circumstances[90] is also efficient from the societal point of view.

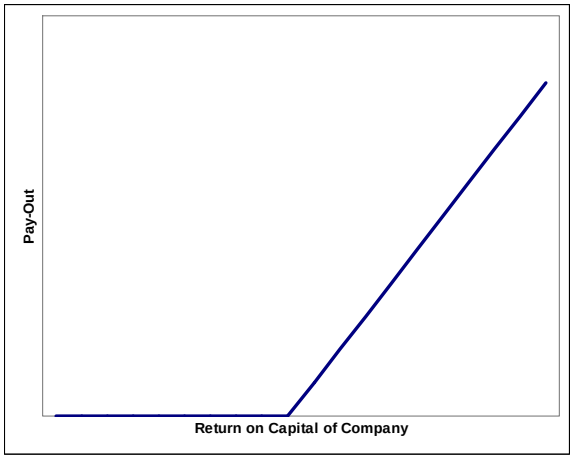
Convex pay out for equity holders

Equity holders in a limited liability company basically hold a call option on the returns to capital[91]. If these returns are leveraged by debt, this call option becomes "in the money" once creditors can be repaid. Thus equity holders are induced a convex pay-out structure and are thereby made risk loving. In other words, equity holders benefit from the upside potential and are thus willing to take on more risk than a risk neutral agent.

Concave pay out for creditors

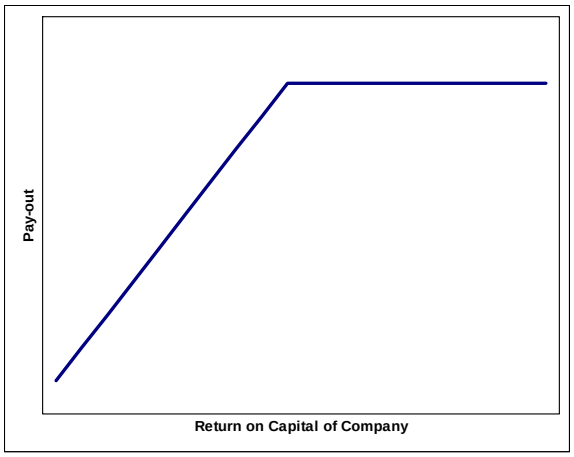
Per contrast, creditors in fact hold a concave claim on the returns of the company. They receive whatever there is until the exercise price of the predetermined coupon payment is reached; the residual goes to the equity holders. These payoff streams are depicted in the figures below.

Figure 7.1 Equity holders pay out structure



[90] As discussed in Dewatripont and Tirole (1993).
[91] As noted by Merton and Bodie (1995).

Figure 7.2 Creditors pay out structure



A switch of ownership under adverse conditions

Since the debt providers cannot benefit from the upside potential above the coupon payment, a creditor is mostly interested in ensuring that the coupon payments are made, while the equity holder is interested in taking on more risk to enhance upside potential. From this Dewatripont and Tirole (1993) conclude that it is beneficial in positive economic environments to allocate ownership to equity holders, while under adverse economic conditions the creditors should be allocated ownership. Under positive economic conditions debt holders, by playing safe, destroy the growth options, and hence equity holders should be in the driving seat. Under adverse economic conditions equity holders have the incentive to "gamble for resurrection", such as happened during the S&L crisis in the USA. In such a scenario the creditors should take over as they can be expected to choose the less risky investment strategies. Note that the switch of ownership in case of adverse conditions can also be delegated to a public entity that acts on behalf of the (small) creditors. This is particularly relevant for the banking industry, where the financial supervisor acts on behalf of the depositors. For small depositors it is very costly to deal with bankruptcy proceedings of an insolvent bank and whose least cost option is to try to 'run' the bank.

The relevance of these four principles for the different parts of the financial sector is summarized in the Table 7.1.

Table 7.1. Principles affecting the financial services industry

Principles		Banks	Insurance	Hedge funds	Mutual funds
I Market Power	Size of equity	-/X (bank concentration)	-/X (insurance concentration)	-	X
	Size of debt	X (small depositors)	-	-	-
	Size of customer	X (mortgages, small enterprise loans)	X (protection of the small claim holders)	-	X (small investor)
II Externality	Positive	X (payments, clearing & settlement)	-	-	-
	Systemic risk (negative)	X (due to bank network structure)	-	-/X (only vis a vis banks)	-
III Asymmetric Information	Information asymmetry	X (uninformed depositors, while banks are informed)	X (informed claimholders, while insurer is uninformed)	X (manager is informed, creditors and equity are uninformed)	-
	Fragility	X (due to deposit contract bank run prone)	-	-/X (only vis a vis banks)	-
IV Incomplete Contracts		X (transfer of ownership to public agent)	X (transfer of ownership to public agent)	X (transfer of ownership to creditors)	-

The insurance and banking industries are different

The Table 7.1 reveals that the story for the insurance industry is different from the case of the banking industry. The reason is that for insurers:

- There is no fragility as there can be no insurance run.
- There is no systemic risk due to the absence of insurance runs. But systemic risk may arise due to macro factors, as is the case for all industries.
- Due to inversion of production cycle (first pay premium, then possibly submit claim), protection of small claimholders is required. Hence, in case of insolvency a public agent may resolve the receivership.
- There is no public externality in the sense of the payment system.
- The claimholder is often better informed than the insurer, giving rise to adverse selection.

The hedge fund and banking industries are different

For hedge funds the situation differs from the situation of banks as well, since:

- Almost by definition, there are only large equity holders[92]. So there exist strong incentives for monitoring the hedge fund.
- The creditors are also large, mostly banks, so this poses a question for systemic risk in case of a hedge fund failure. Although the recent turmoil in the financial markets was channelled through conduits and not through hedge funds, it could also emanate from a large scale failure of one or more hedge funds that have large positions with banks[93]. The fear for systemic break down was the concern at the time of the failure of LTCM.
- Many hedge funds actually follow less risky strategies than banks (lower leverage, more arbitrage oriented); also the investment strategies are quite different across hedge funds. Therefore typically only a few hedge funds will be affected in a financial crisis.
- A hedge fund run is conceivable in principle, but rather unlikely as it would play out more slowly. A withdrawal of equity by participants takes time as most hedge funds have lockup periods. Creditors can also `run' a hedge fund by withdrawing credit lines, but this also takes time. Nevertheless, there are no network effects, such as is the case among banks, by which a run on one hedge fund leads to the demise of another fund. Only hedge funds that have similar exposures may experience similar withdrawals, whereby the running of one fund may act as a signal to run the other funds with similar exposures.
- Directors do create for themselves an equity-like steep convex payoff structure and are therefore prone to taking considerable risk.
- There is by the very nature of a hedge fund a huge information asymmetry between directors, investors and debt holders. Thus in case the hedge fund can no longer service its debt, ownership is transferred to the creditors, equity holders are disowned and management is replaced.
- Hedge funds are useful insofar as they complete financial markets through providing liquidity, arbitrage and the dispersion risk.

[92] If we go by U.S. definitions: "accredited investors"; for funds of funds the intermediaries take over the risk.
[93] Or when banks are the owners, see the Goldman Sachs and Bear Stearns examples in Annex IV.

The above investigation provides the motives for public supervision and regulation. Moreover, in sections 4 and 5 we investigated the empirical magnitude and relevance of systemic risk that hedge funds pose for the banking sector. The above analysis suggests that:

*** The main motive for public intervention is the exposure to systemic risk in the banking sector created by hedge funds**[94].

Since our empirical analysis showed that:

*** This effect is quite limited for most of the hedge fund strategies**,

and given the fact that:

*** The protection of small stakeholders is not an issue**,

we conclude that:

*** The search is for regulatory and supervisory environments that provide a measured and restrained response to market failures**.

We discuss a list of possible types of regulatory instruments that is divided into two categories of direct and indirect modes of regulation. Because hedge funds have only limited impact on the stability of the banking industry, the indirect measures appear to have higher relevance.

7.3 Pros and cons of various types of regulation

Below we present a list of possible regulatory instruments[95]. The list is divided into two broad categories of direct and indirect measures. Standard regulatory instruments in any market are price and quantity restrictions. The list is not exhaustive, but at least the standard instruments are discussed. The relevance of each instrument should be judged against the motives for public intervention and their relevance for the hedge fund industry, see Table 7.1.

Before we review a number of instruments, we like to point out a few observations. First, as is well known from e.g. international trade theory, one should always choose instruments that most directly affect the desired outcome. This is to circumvent undesired side effects. Secondly, the currently existing regulatory frameworks already enables supervisors to sort many of the desired effects if properly enforced.

Direct Instruments

Capital Requirements

Imposing capital requirements on hedge funds would be similar to the current practice in the banking and insurance industry. To a limited extent this already happens through Mifid for EU based investment firms[96]. But note that hedge funds were in part created with the specific purpose to benefit from highly leveraged positions (low capital, high exposure) that cannot be pursued by banks.

Pro: It would put banks and hedge funds on a similar funding footing. It could create a higher minimum buffer for hedge funds against unforeseen losses.

[94] This conclusion concurs with Danielsson et al. (2005) who state "...we do not see a need for direct regulation of the hedge fund industry for reasons of consumer protection. The case for direct regulation of the hedge fund industry because of concerns for financial stability is more compelling."
[95] Some of these regulatory instruments are also discussed in Annex V.
[96] We refer to Annex VI for more background on Mifid.

Con: It would probably mean that hedge funds massively move offshore. It would also trigger financial innovation to work around such restrictions. It requires worldwide close cooperation. It requires difficult choices regarding the appropriate levels of capital to be held against each specific risk factor.

Portfolio Restrictions

Almost by definition hedge funds are there to do what other financial service firms are not permitted to do. Other parts of the financial service sector are restricted in various ways concerning the type of exposures that are permitted. For example, investment banks, commercial banks and savings banks all have their specific asset restrictions.

Pro: It would make hedge funds look alike one of the existing type of financial service industries, rendering the hedge funds a superfluous category.

Con: Again, such restriction would probably trigger financial innovation to work around the restrictions as long as certain investments are not made illegal. This requires worldwide close cooperation.

Price and Tax Measures

One might cap the returns that can be paid out to investors or management. This is comparable to the old regulation Q in the US that capped interest rates and stimulated the city as an offshore centre for US capital. Taxation is another method for redressing returns of investors and management.

Pro: It would drastically reduce the incentive for investors to participate.

Con: A rather draconian measure that would be hard to supervise. Hedge funds would start to smooth their returns and change the payout structure to work around the restriction. One looses price signals to the market indicating scarcity.

Participation Restrictions

Minimum capital participation requirements are standard fare in the industry. In fact, such requirements come close to what defines a hedge fund in the US, where only accredited investors (with a minimum amount of wealth or income) are allowed to participate. UCITS is another example of consumer participation protection. Furthermore, pension fund oversight should be structured in such a way that these semi-public funds do manage their concentration risk and are not overexposed to hedge funds.

Pro: Such restriction ensures that the small investor issue is of no concern. It provides a clear delineation of the hedge fund industry.

Con: It restricts participation of the small investor and shuts such investors out of the market of the most risky investments. The market has found a solution for this through the fund-of-funds mutual fund construction and through the participation of pension funds.

Location Restrictions

Such requirement might stipulate that in order to be active in a country (to be marketed for instance), the hedge fund should operate under local law and have an office in that jurisdiction.

Pro: It facilitates improved direct supervisory access and control.

Con: Restriction to be easily evaded in the current liberal international environment enabling the free movement of capital. It would also trigger the relocation of hedge funds.

Public Guarantees

A public agent might be vested with the right to transfer ownership in case of illiquidity or insolvency. The private bailout orchestrated by the New York FED at the time of the LTCM default indirectly performed this function[97].

Pro: Reduce the ad hoc nature of rescue operations such as in the case of LTCM.

Con: Trigger of moral hazard by the creditors. It would indirectly undermine the stability of the banking system as investment banks would be stimulated to tolerate even higher leverage of their debtors. It also acts as an indirect subsidy to the wealthy who might not even be citizens.

Insolvency Resolution Mechanisms

A framework could be drafted that would deal with the potential failure of systemically important hedge funds[98]. In a way it would be a formalization of the Fed-LTCM approach. The ongoing activities of successful hedge funds would not be regulated. The supervisor would have the duty and power to carry through the resolution process, if it judges the failure of the fund(s) to have sufficient systemic implications. The prime broker(s) and other banks could be obliged to participate, also financially[99]. Under no circumstances should public funds be used because of the resulting moral hazard.

Pro: If successful this could be a way to prevent systemic crises arising from the (potential) demise of one or more hedge funds.

Con: Difficult to realize as it would need cooperation between many supervisory bodies and far reaching changes in legislature nationally and internationally. The procedural issues and related incentive effects are complex.

Supervision and Code of Conduct

This would be similar to the supervision of other parts of the financial service sector. A special code of conduct would have to be drawn up specifying such elements as eligible actions (investments and strategies), reporting standards, minimum level of transparency, risk management and capital requirements. A public agent would have to oversee the adherence to such rules.

Pro: This seems to be the most comprehensive way to directly intervene in the behaviour of hedge funds.

Con: It requires worldwide cooperation between financial supervisors as otherwise many funds would evade these requirements by moving outside the borders of the jurisdictions that would implement such rules. By moving off-shore, the hedge funds would in fact exploit and benefit from the restrictions imposed on the onshore institutions.

In summary, a participation restriction can ensure that investors are (wealthy) individuals and large creditors (banks) who can be expected to have sufficient stake in the hedge fund to engage in proper monitoring, and who can bear the risk. A fact is that hedge fund investors are not at the same time clients who benefit from an externality like the payment and clearing network as in the banking industry. So there is not a direct need to safeguard against systemic breakdowns as there exists for the case of the banking industry. Thus apart form the participation restriction, we did not find many compelling reasons for imposing direct instruments.

[97] See Annex III.
[98] This is based on Danielsson et al. (2005).
[99] Danielsson et al (2005) suggests that prime brokers and other market participants be required to hold a certain amount of traded subordinated debt in systemically important hedge funds.

Indirect Instruments

Again we start by discussing quantity and price instruments first, followed by other more implicit instruments. The indirect instruments do have something to their favour. Given that the main concern of hedge fund behaviour is indirect via the effects they may have on banks; indirect instruments that for require banks to adhere to certain standards in their dealings with hedge funds make sense.

Bank capital provisions

This is the already existing line of defence to ensure that the buffer is sufficient in relation to the risks that are taken. The exposure of a bank to a hedge fund is classified in either the trading book or the banking book. The regulatory capital requirements of both books are quite different. Basel I did not allow for the complex risks being translated into appropriate capital buffer calculations, cf. the capital reservations for exposures to conduits. For instance the inclusion of hedge funds exposure in the trading book did not take into account the illiquidity sometimes encountered, especially when liquidity was drying up and hence, led to insufficient capital being reserved for such adverse conditions. Although Basel II does not provide for a treatment of hedge funds specifically, such typical risks are dealt with in more detail and the regulatory framework has become more suitable for such risks. For instance, banks will need to put in place a clear set of policies and procedures to determine whether a hedge fund exposure is included in the trading or the banking book, whereas the low liquidity of certain hedge fund investments will lead to classification in the banking book, with accordingly higher capital requirements.

Pro: Fits within existing regulatory framework and prevents regulatory arbitrage.

Con: Given the framework adopted for bank supervision, there seems to be no compelling reason against implementing this across the board.

Market Based

An indirect requirement of the price variety would be the requirement for hedge funds to be traded on a public exchange. Some funds in fact do trade in this way, within the EU for instance in Ireland and Luxembourg[100]. This would be comparable to the difference in exchange traded options and over the counter traded options. The former send price signals to all market participants, while the latter do not. It is generally agreed that portfolio insurance would not have had its dramatic impact in 1987 if the options would have been bought in the market rather than being constructed artificially. An alternative market based solution would be to stimulate the market to develop a rating agency industry for hedge funds.

Pro: Market based prices better aggregate and disseminates information than over the counter based prices.

Con: This requires hedge funds to disseminate information that is likely to reveal their positions and may lead to their demise since many funds profit from arbitrage opportunities not recognized by other market participants. Rating agencies have lately been accused, at least in part unjustified, for the crisis in the sub-prime market for mortgages (rating agencies do not rate the liquidity of debt instruments).

[100] There are many reasons for obtaining a listing for a fund on a recognized stock exchange. The main reason usually is to facilitate the marketing of the fund to specific categories of investors. Institutional investors, in particular, are often prohibited from investing in unlisted securities or in securities which are not listed on a recognized or regulated stock exchange. Retail funds are eligible for listing also if they are domiciled outside of either Ireland or Luxembourg, but for instance in the Channel Islands, Bermuda or Hong Kong.

Price Measures

A poison pill for takeover targets reduces the incentives for hedge funds to participate in merger arbitrage. Other measures could be to impose a minimum lock-up period for the shareholders following a merger or take-over. Tax measures such as the Tobin tax on foreign exchange trades potentially reduce the returns to arbitrage.

Pro: Protects current firm structure and provides a first barrier to short-term profit taking.

Con: Has considerable side effects as it reduces the ability for takeovers generically and reduces market liquidity.

Voting rights and board structure

Large shareholders like pension funds lend out stocks (and other securities) while retaining dividends, in order to enhance their returns by the fee paid by the borrower. In the process the voting rights are temporarily transferred to the borrower. One may ask whether this temporary transfer of voting rights is desirable from the point of view of corporate governance[101]. Corporate board structures, poison pills and codes of good governance are other elements that can be used to reduce the hit and run tactics associated with some hedge funds.

Pro: Align long term ownership structure with voting rights and other elements of corporate governance.

Con: Reduces the profitability of equity leases, which could lower the attraction of the stock-lending market and thereby reduce the liquidity and efficiency of the stock and equity-derivatives markets. Without stock lending, certain investment (short selling), hedging or arbitraging strategies would become extremely difficult to execute.

Industry self-regulation and code of conduct

Industry self regulation is found in many other industries, such as accountancy. In the hedge fund industry several initiatives have been developed[102]. A code of conduct would have to be drawn up specifying such elements as eligible actions (investments and strategies), reporting standards, and minimum level of transparency, risk management and capital requirements. Educational standards can be part of the code of conduct. Mandatory membership of industry organizations with best-practice codes is conceivable. Voluntary membership with hurdle rates to admittance provides a quality signal.

Pro: Little or no additional costs for central banks or supervisory organisations. Potential pro is that the market experts are directly involved and this could in theory create the best possible set of rules.

Con: It is unlikely that the industry will be as diligent and strict as the central supervisors would like them to be. Moreover, in case a hedge fund does not abide by the rules, what are the (legal) repercussions (naming and shaming)?

General Law

Rules that hold for corporations and individuals in general, like those to prevent fraud, to enhance fair trade, regarding due care and the obligation to have an acceptable administrative standard also apply to hedge funds.

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[101] Of course, if the lender wants to exercise its right to vote it can recall the stock in time so that a proxy voting form can be completed and returned to the registrar by the required deadline.

[102] See Annex V

This is already the main safeguard against fraud and misconduct by management. Reporting restrictions as specified under IFRS should be required. More focus on a greater level of hedge fund transparency would be possible.

Pro: Framework is already existent, consistency with other rules, ease of interpretation, and imposes few additional costs.

Con: Not specific enough leaves too much room for various types of (hedge fund) specific problems without control.

Information Requirements to the public

This is currently of less importance as the small investor often is not allowed to invest directly in single hedge funds and the large investor is thought to be capable enough to either monitor the risks himself and/or to withstand the potential loss of his investment in the hedge fund and therefore needs less protection.

Pro: Reduces asymmetric information.

Con: Limits the incentive for arbitrage by hedge funds as their strategies would become public.

Via the managers of the hedge funds

An example is the way the FSA in the UK supervises the managers of the (largest) hedge funds that are operated out of London[103]. The UK FSA holds regular 6-months supervisions of the prime brokers and has selected some 30 UK hedge fund managers that are supervised more intensively. The FSA clearly states that it doesn't seek knowledge of individual positions, which it considers at best useless but probably counterproductive, so that its desired level of transparency also has its limits. Educational standards can be part of the discussions.

Pro: Indirect control, good contact with the funds, high influence and opportunity to continually improve best practices.

Con: Not all funds are regulated; if too much pressure is exerted the fund manager will simply relocate.

Via regulation and supervision of banks and their distribution channels

Comprehensive information on the hedge funds can be demanded by the banks, prime brokers, etc. who collaborate with the hedge funds[104]. This might include the credit quality of the collateral, the measurement of the often complex positions, not just with the bank or broker itself but for the whole hedge fund, measurement of model risk, enhanced stress testing including liquidity stress tests. The bank needs to be able to fully understand the risk profile of its counterparty, i.e. the hedge fund. A periodic review of the risk-metrics, stress-testing and behavioural characteristics of the hedge fund is necessary. As the costs of such ongoing monitoring and reviews is quite high, they may prove to be prohibitive for smaller banks and unacceptable for the hedge funds themselves, who often compete with the banks' proprietary trading desks. This leads to the limits of the transparency provided by the hedge fund. Further, collateral needs to be set at a level that varies with the hedge funds' credit worthiness and should be sustainable over time and be able to cope with market gaps. Both initial margin and variation margin are needed.

[103] See Welch (2007) or McGreevy (2007)

[104] Halstead et al. (2005) advocate in their conclusion that in order to improve market transparency, regulatory changes to promote greater disclosure of the ties between financial institutions and large hedge funds is important to ensure that investor reaction is informed and not born out of fear.

Pro: Bank stability is the main motive for desiring financial regulation. Since banks are also the main sponsors of hedge funds, it stands to reason to apply the regulatory framework that is in place for banks in their dealings with hedge funds. Use can be made of existing rules and existing monitoring schemes and officers, therefore entailing little extra costs. These rules (and especially the new Basel II) require hedge funds to be aware or even focus on the investment strategies and (liquidity) risks of hedge funds, including their total exposure, market experience and would require them to hold sufficient capital to withstand the worst case scenarios.

Con: Difficult to construct indirect rules that have maximum direct effect and speed of innovation is typically higher than the speed of new regulation.

7.4 Conclusion

In this section we discussed the basic motivation for the need for regulation and supervision of the financial services industry. The key principles were applied to the hedge fund industry. We conclude that the main motive for public intervention in the hedge fund industry is the exposure it creates to systemic risk in the banking sector. Our empirical analysis shows that this effect is quite limited for most of the hedge fund strategies, and because the protection of the small stakeholders is not an issue, we conclude that the search is for regulatory and supervisory environments that provide a measured and restrained response to market failures.

Direct versus indirect regulation

We provided an extensive list of possible types of regulations. The range is broad; certain choices are possible only in theory whereas others have already been (partially) implemented in practice. As the regulatory landscape is changing rapidly, an interesting question is the extent to which hedge funds should be supervised directly or indirectly in order to keep pace with the developments in the markets. A distinction can be made between direct regulation and a risk based approach that involves indirect supervision via the major broker dealers. The indirect supervision method relies heavily on the various rules and regulations that are already in place, such as Capital Requirement Directive (CRD), Solvency II, Markets in Financial Instruments Directive (Mifid) and the Directive on Institutions for Occupational Retirement Provisions (IORP)[105]. The objective of such rules is to have in place a comprehensive and risk-sensitive framework and to foster enhanced risk management amongst financial institutions. This should maximise the effectiveness of the capital rules in ensuring continuing financial stability, maintaining confidence in financial institutions and protecting consumers. The underlying rationale of focusing on the indirect approach[106] is that this probably is more effective than the direct regulation of hedge funds, which can move their domicile quite easily from one country to another and therefore can engage in regulatory arbitrage. A further example of indirect control is the FSA that combines prime broker surveys with selective supervision of the major hedge funds.

[105] See Annex V for more details on these regulations.

[106] Indirect supervision of hedge funds has also been addressed through various public and private initiatives by, amongst other, the Financial Stability Forum, the Basel Committee on Banking Supervisions, the International Organization of Security Commissions, the Multidisciplinary Working Group on Enhanced Disclosure and the Counterparty Risk Management Policy Group. Most believed that supervisors and regulators could achieve through indirect regulation much of what could be achieved by direct regulation.

Current regulatory issues in the EU and industry development

As the regulations are changing rapidly, the consequences for the hedge fund industry are profound. Annex V presents a concise overview of the various contemporary regulatory issues in the EU. Mifid is seen as the next step to regulate hedge funds and Pillar 2 of Basel II will also contribute to further improve the risk management framework for hedge funds. Implementation of UCITS III will reduce the barriers to retail cross-border distribution of hedge fund products. Annex V also describes the broader push among both key industry organizations and regulators alike for more transparency and disclosure, as well as a movement towards setting up a code of conduct and best practices standards. Finally, we describe how the industry is likely to move forward in the next years, with further consolidation of the larger hedge fund parties and an increasing bifurcation between the smaller and bigger funds.

In the end, we conclude that the main motive for public intervention is the exposure to systemic risk in the banking sector created by hedge funds. Since our empirical analysis showed that this effect is quite limited for most of the hedge fund strategies, and given the fact that the protection of small stakeholders is not an issue, indirect measures except the participation constraints, appear most appropriate.

8. Conclusion

The main elements of our study were as follows.

Hedge funds

Hedge funds are lightly regulated investment firms funded by large investors and creditors. Often, complex investment strategies are followed, using futures, swaps, options, make extensive use of short-selling and tend to be highly leveraged. Hedge funds invest in liquid assets and thereby differ from private equity funds that typically invest in highly illiquid assets. The industry of hedge funds has rapidly expanded over the past decade. Most hedge funds follow a particular strategy such as market neutral, convertible arbitrage or distressed securities. In general, the hedge fund industry comprises four major sets of styles or strategies: directional, market neutral, event driven and fund of hedge funds.

Hedge funds' functions

The role of hedge funds in the financial markets is to exploit arbitrage opportunities and to take risks that cannot be easily performed by more strongly regulated financial services institutions. Banks, insurance companies and pension funds are constrained in their actions with regard to risk taking and leverage and have to be open regarding their exposures. Through their activities the hedge funds increase the efficiency of financial markets in allocating capital. Given the considerable differences in strategies, the spectrum of risk and return of hedge funds is also quite broad. Whether hedge funds create or reduce financial market volatility the jury is still out and the question may never be answered given the diversity of strategies and as this may vary over time.

Features of hedge fund returns

Hedge funds follow different strategies and hence their return characteristics differ considerably. Hedge fund data have a number of peculiarities in comparison to say mutual fund data. The high entry and attrition rates create biases in the index of hedge fund returns. The strategies and secrecy surrounding hedge funds make that only monthly return data are available. Partly for this reason, the returns appear to be smoother than these may be in reality. Nevertheless, when compared to the behaviour of bank returns or to the returns on insurance companies, hedge fund strategies are often less volatile (less uncertain). Over time the excess returns delivered by the hedge fund industry have come down on average.

Bank fragility and the Externality of the Payment System

Banks borrow short (deposits) and lend long (commercial loans, mortgages). Since depositors can run a bank any time, while loans cannot be sold or liquidated instantly, the liquidity of a bank is fragile. The paradigm for strong regulation and supervision of banks is the protection of small depositors and the protection of the banking system as a whole for the maintenance of the payment and clearing functions, which is a huge positive externality to the real economy. Both of these motives for public intervention in the banking system are not an issue for hedge funds, since there are no small financiers who at the same time rely on the network of hedge funds for clearing their transactions. The direct consequence of a failure of a hedge fund for the real economy is comparable to what is at stake if a particular non-financial firm fails. Banks, though, are the main suppliers of credit to hedge funds, are important participants in hedge funds, and banks are also living of their prime brokerage functions performed for hedge funds. The systemic stability of banks may therefore be endangered through the failure of large hedge funds.

Risk management at hedge funds

The hedge fund industry consists of a very heterogeneous group of investment vehicles. As a consequence, risk management requirements and reporting system needs are extremely diverse. There can be no 'one size fits all' risk management or reporting system, neither now or in the near future. Prior demises of hedge funds teach us that a strict division between front and back office is needed. Moreover, fair valuation of positions as well the measurement of complex non-linear sensitivities should be included in the risk management system. We stress the importance of liquidity risk management, including the need to limit the size of positions relative to the market. Finally, the importance of operational risk is clarified, especially for young and small hedge funds. The difference between liquidation and attrition was discussed shortly.

Limited Impact of Hedge Funds on Systemic Stability

This study investigates the effects that hedge funds can have on the stability of the financial system. Even though the spectacular demise of LTCM at the time seemed to pose a risk for the stability of the leading investment banks, our empirical investigation concludes that hedge funds are in general less risky than banks. Over time the index of bank returns has shown higher volatility than the overall hedge fund return index. More important, hedge fund indices and the bank index do generally not become distressed simultaneously. Per contrast, the insurance sector co-moves more intensely with the banking sector. These conclusions are obtained by using simple statistical analyses such as a cross plot of returns and are backed up by more sophisticated extreme value analysis. In summary, we do not find much evidence for the fear that hedge fund failures can trigger a systemic crisis in the banking sector.

Possible Explanations

The study does not explicitly investigate the explanations for the limited impact of hedge funds on the stability of the banking sector. One reason may be that many hedge funds follow contrarian and other strategies that have little relationship with the long positions banks necessarily have to hold in the real economy. Moreover, risk management at banks and hedge funds since the demise of LTCM has been improved. This is not to say that a failure of a particular hedge fund strategy cannot stress the banking sector. Similarly, it is conceivable that a money market squeeze results from the failures of some hedge funds, in case the bank exposures to these funds are not known in the market, just as has happened recently due to the failure of conduits loaded with sub-prime mortgages. But hedge fund strategies are much more diverse.

Motives for Regulation

Banks are heavily regulated through the Basel II accord to safeguard the public externality of the payment and clearing system and to protect the many small uninformed depositors. The insurance industry is more lightly regulated through Solvency II, since there is no such thing as an insurance run and there is no systemic risk emanating from the industry itself. If we look at hedge funds that are mostly financed by large investors and banks, the issue of direct protection of uninformed parties is not of an immediate concern. Large investors and creditors have much more at stake and can more easily pay for the monitoring costs than small depositors or consumers. Nor is there systemic risk endogenous to the hedge fund industry itself. Hedge fund strategies are quite different, so that it is somewhat unlikely that a failure of one particular hedge fund spills over to hedge funds with alternative strategies. Contagion of hedge funds with similar strategies may be possible. The main risk, though, resides in hedge fund failures that may bring down a bank and thereby also endanger the stability of other banks and the payment system. If the hedge fund industry is to be regulated, it should be for this reason.

Instruments of Regulation

When it comes to regulatory instruments, we divided these into two categories: direct and indirect measures. In each category we discussed price and quantity constraints. Given the motive for hedge fund regulation, direct instruments do not seem to be appropriate, except for the requirement that participants should have a large stake in the hedge fund. Indirect instruments seem better able to deliver a measured response. This involves that banks as main brokers and creditors are required to collect ample information from hedge funds, demand sufficient collateral and reserve sufficient capital. Many of these measures will become active once Basel II takes hold. Other indirect measures such as the review of hedge fund managers instead of the funds and industry self regulation were considered as well.

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Annex I. Hedge fund strategies details

This annex provides an alphabetical summary and description of the main strategies of hedge funds[107]. The list is more extensive than the strategies that we analyze in the main body of the paper and as summarized in Table 1.1.

Convertible Arbitrage involves purchasing a portfolio of convertible securities, generally convertible bonds, and hedging a portion of the equity risk by selling short the underlying common stock. Certain managers may also seek to hedge the interest rate exposure. Most managers employ some degree of leverage, ranging from zero to 6:1. The equity hedge ratio may vary from 30 to 100 percent. The average grade of a bond in a typical portfolio is BB-, with individual ratings ranging from AA to CCC. However, as the default risk of the company is hedged by shorting the underlying common stock, the risk is considerably better than the rating of the unhedged bond indices.

Distressed Securities strategies invest in, and may sell short, the securities of companies where the security's price has been, or is expected to be, affected by a distressed situation. This may involve reorganizations, bankruptcies, distressed sales and other corporate restructurings. Depending on the manager's style, investments may be made in bank debt, corporate debt, trade claims, common stock, preferred stock and warrants. Strategies may be sub-categorized as "high-yield" or "orphan equities". Leverage may be used by some managers. Fund managers may run a market hedge using put options or put option spreads.

Emerging Markets funds invest in securities of companies or the sovereign debt of developing or "emerging" countries. Investments are primarily long. "Emerging Markets" include countries in Latin America, Eastern Europe, the former Soviet Union, Africa, and parts of Asia.

Equity Hedge investing consists of a core holding of long equities hedged at all times with short sales of stocks and/or stock index options. Some managers maintain a substantial portion of assets within a hedged structure and commonly employ leverage. Where short sales are used, hedged assets may be comprised of an equal dollar value of long and short stock positions. Other variations use short sales unrelated to long holdings, use puts on an equity index and employ put spreads. Conservative funds mitigate market risk by maintaining market exposure from zero to 100%. Aggressive funds may magnify market risk by holding more than 100%. While in other circumstances a short position is maintained. In addition to equities, some funds may have limited assets invested in other types of securities.

Equity Market Neutral strategies seek to profit from exploiting pricing inefficiencies between related equity securities, neutralizing exposure to market risk by combining long and short positions. One example of this strategy is to build portfolios made up of long positions in the strongest companies in several industries and by taking corresponding short positions in those companies that show signs of weakness. A sub-category, statistical arbitrage, utilizes quantitative analysis of technical factors to exploit pricing inefficiencies between related equity securities, neutralizing exposure to market risk by combining long and short positions. The strategy is based on quantitative models for selecting specific stocks with equal dollar amounts comprising the long and short sides of the portfolio. Portfolios are typically structured to be market, industry, sector and dollar neutral.

Equity long/short involves equity-oriented investing on both the long and the short sides of the market. The objective is not to be market neutral. Managers have the ability to shift from value to growth, from small to medium to large capitalisation stocks, and from a net long position to a net short position.

[107] The description of these categories is taken from Hedge Fund Research, Inc.

Managers may use futures or options to hedge their positions. Long/short equity funds tend to hold portfolios that are substantially more concentrated than those of more traditional stock funds.

Since 1995, long/short equity funds have remained the largest single strategy and represented around one-third of the industry at the end of 2004[108]. Event driven and market neutral strategies have gained in importance during the last decade.

Event Driven is also known as "corporate life cycle" investing. This involves investing in opportunities created by significant transaction related events, such as spin-offs, mergers and acquisitions, bankruptcy reorganizations, recapitalizations and share buybacks. The portfolio of some Event-Driven managers may shift in majority weighting between Risk Arbitrage and Distressed Securities, while others may take a broader scope. Instruments include long and short common and preferred stocks, as well as debt securities and options. Leverage is used by some managers. Fund managers may hedge against market risk by purchasing equity index put options or put option spreads.

Fixed Income Arbitrage is a market neutral hedging strategy that seeks to profit by exploiting pricing inefficiencies between related fixed income securities while neutralizing exposure to interest rate risk. Fixed Income Arbitrage is a generic description of a variety of strategies involving investment in fixed income instruments. Many strategies attempt to eliminate or reduce exposure to changes in the yield curve. Managers attempt to exploit relative mispricing between related sets of fixed income securities. The generic types of fixed income hedging trades include: yield-curve arbitrage, corporate versus Treasury yield spreads, municipal bond versus Treasury yield spreads and cash versus futures. Various Fixed Income subcategories exist, among which are convertible bonds, high-yield and mortgage backed securities.

Fixed Income High Yield managers invest in non-investment grade debt. Objectives may range from high current income to acquisition of undervalued instruments. Emphasis is placed on assessing credit risk of the issuer. Some of the available high-yield instruments include extendible/reset securities, increasing-rate notes, pay-in-kind securities, step-up coupon securities, split-coupon securities and usable bonds.

Fund of Funds invest with multiple managers through funds or managed accounts. The strategy designs a diversified portfolio of managers with the objective of significantly lowering the risk (volatility) of investing with an individual hedge fund manager. The Fund of Funds manager has discretion in choosing the strategies in which he likes to invest. A manager may allocate funds to numerous managers within a single strategy, or with numerous managers in multiple strategies. The minimum investment in a Fund of Funds may be lower than an investment in an individual hedge fund or managed account. The investor has the advantage of diversification among managers and styles with significantly less capital than investing with separate managers.

Global Macro places leveraged bets on anticipated price movements of stock markets, interest rates, foreign exchange and physical commodities. Macro managers employ a "top-down" global approach, and may invest in any market using any instruments to participate in expected market movements. These movements may result from forecasted shifts in economies, political fortunes or global supply and demand for resources. Exchange-traded and over-the-counter derivatives are often used to magnify these price movements.

[108] According to Garbaravicius and Dierick (2005).

Managed Futures are otherwise known as "commodity trading advisors"[109] (CTAs), manage clients assets on a discretionary basis, using global futures markets (government securities, futures contracts and options on futures contracts) as an investment medium. CTAs generally manage their clients' assets using a proprietary trading system or a discretionary method that may involve long/short investments in future contracts. Typical areas of focus include metals (gold/silver), grains (soybeans, corn and wheat), equity indices (S&P futures, Dow futures, NASDAQ futures) and soft commodities (cotton, cocoa, coffee, sugar) as well as foreign currency and US government bond futures. As an asset class, managed futures are known to be inversely correlated with stocks and bonds.

Merger Arbitrage, sometimes called Risk Arbitrage, involves investment in event-driven situations such as leveraged buy-outs, mergers and hostile takeovers. Normally the stock of an acquisition target appreciates while the acquiring company's stock decreases in value. These strategies generate returns by purchasing stock of the company being acquired, and in some instances, selling short the stock of the acquiring company. Managers may employ the use of equity options as a low-risk alternative to the outright purchase or sale of common stock. Most Merger Arbitrage funds hedge against market risk by purchasing equity index put options or put option spreads.

Short Selling involves the sale of a security not owned by the short seller. This is a technique used to take advantage of an anticipated price decline. To implement a short sale, the short seller borrows securities from a third party and sells these in the market while promising to the lender to return these securities at some future date together with some fee. The seller returns the borrowed securities to the lender by purchasing the securities back in the open market, or by borrowing these again. If the seller can buy the securities back at a lower price, a profit results. If the price rises, however, a loss results. A short seller must generally pledge other securities or cash with the lender in an amount equal to the market price of the borrowed securities plus a margin of the collateral value as a buffer against adverse price movements. This deposit may be increased or decreased in response to changes in the market price of the borrowed securities (mark-to market).

[109] In the United States, funds that trade in commodities are registered with the Commodity Futures Trading Commission as commodity pools and commodity trading advisors, or CTAs.

Annex II. Description of Hedge Fund Data Providers

Below we provide an overview of three main hedge fund databases. This annex serves to give the reader an insight into the main providers, the characteristics of the data, the availability of the various underlying elements, the sources of the data and other relevant characteristics.

II.1 Hedge Fund Research, Inc. (HFR) is a research firm specializing in the aggregation, dissemination and analysis of alternative investment information. The company produces HFR Database, which is thought to be one of the industry's most widely used commercial databases of hedge fund performance as well as HF Industry Reports, a quarterly offering of hedge fund industry statistics and graphs. HFR also produces and distributes the HFRX Indices and HFRI Monthly Indices – industry standard benchmarks of hedge fund performance.

There currently are over 7.000 funds in the HFR Database. As an illustration of the extent to which details are available, the following fields are provided for each hedge fund in de database: fund name, money management firm, legal structure (e.g. Caymans Corporation, Delaware LP, etc.), principals of the Money Management firm, Street & Suite details, phone number, contact individuals at the money management firm, inception date of the fund, main investment strategy that the fund uses, brief description of the sub-strategy if necessary, detailed description of the investment instruments used in the fund, total assets in the fund, currency denomination, date of latest fund asset size, total assets under money management firm, currency denomination of firm assets, date of latest firm assets size, specification if fund intends to use leverage or not, returns denomination, annual management fee percentage, annual incentive fee percentage (if available), high watermark, hurdle rate, sales commission fee, other fees for the fund, minimum investment, additional investments allowed, minimum assets allowed for an account, new investments accepted by the fund or not, type of investors the fund will accept, interval between performance reports to investment partners, fund performance reporting style, indication if annual audit is performed or not, last date of audit, audit firm, is the fund an offshore vehicle or not, the name of the offshore vehicle if one exists, redemption intervals, subscription interval, lockup interval, advance days notice required for redemption, administrator to the fund, custodian to the fund, prime brokerage to the fund, banking agent, legal adviser.

The HFRX Indices are a series of benchmarks of hedge fund industry performance which are engineered to achieve representative performance of a larger universe of hedge fund strategies. Constituents of HFRX Indices are selected through a robust and quantitative process. The model output constitutes a sub-set of strategies which are representative of a larger universe of hedge fund strategies, geographic constituencies or groupings of funds maintaining certain specific characteristics. In order to be considered for inclusion in the HFRX Indices, a hedge fund must be currently open to new transparent investment, maintain a minimum asset size and meet the duration requirement.

The HFRI are fund-weighted (equal-weighted) indices. According to HFR, unlike asset-weighting, the equal-weighting of indices presents a more general picture of performance of the hedge fund industry. Any bias towards the larger funds potentially created by alternative weightings is greatly reduced, especially for strategies that encompass a small number of funds.

This and more information can be found on www.hedgefundresearch.com.

II.2 Centre for International Securities and Derivatives Markets (CISDM) is a non-profit academic research centre which focuses on security and investment fund performance in both U.S. and international asset markets. The goals of CISDM are to facilitate research in both traditional and alternative investment markets, to promote interactions between the academic and business communities, and to make available CISDM educational material on international financial markets to financial and non-financial firms.

According to CISDM, the CASAM CISDM Database is the oldest hedge fund and CTA database (established in1979), and currently tracks quantitative and qualitative information for over 4,500 hedge funds, fund of funds and CTAs. The CASAM CISDM Database is widely used as a research tool by institutional investors, consultants, pension funds, and hedge fund of fund managers looking to identify the universe of hedge funds as a basis for investment, as well as by academics in their studies and in articles related to the hedge fund and CTA industries. Enhanced functionality provides convenient online access, analytical tools and reports to enable you to quickly research and evaluate funds in the CASAM CISDM Database based on hundreds of differentiating investment variables.

This and more information can be found on http://cisdm.som.umass.edu/index.asp.

II.3 Credit Suisse First Boston Tremont Index LLC is the joint venture company of Credit Suisse First Boston Index Co., Inc. a subsidiary of Credit Suisse First Boston Inc., and Tremont Capital Management, Inc. From the website the following information was distilled: "The Credit Suisse/Tremont Hedge Fund Index is the industry's first asset-weighted hedge fund index. The website states that asset-weighting, as opposed to equal-weighting, provides a more accurate depiction of an investment in the asset class. The methodology utilized in the Credit Suisse/Tremont Hedge Fund Index starts by defining the universe it is measuring. The Index Universe is defined as funds with:

- A minimum of US$ 50 million assets under management
- A minimum one-year track record
- Current audited financial statements

Funds are separated into ten primary subcategories based on their style. The index in all cases represents at least 85% of the AUM in each respective category of the Index Universe. The Credit Suisse/Tremont database tracks more than 4500 funds, it includes funds worldwide and the Index is calculated from 1994 onwards. Credit Suisse/Tremont analyzes the percentage of assets invested in each subcategory and selects funds for the Index based on those percentages, matching the shape of the Index to the shape of the Universe. The Index is calculated and rebalanced monthly. Funds are reselected on a quarterly basis as necessary.

Further information may be found on www.hedgeindex.com

Annex III Monthly Return Plots

The monthly returns for an investment in banks and in the HRF Composite index are given in Figures III.1 and III.2 below. Over the entire sample, hedge fund returns seem to be less volatile. This may in part be due to their contrarian strategies. But the lower volatility may also be due to the biases in the index as we discussed above. In particular valuation problems due to the fact that hedge funds often invest in illiquid assets lower the perceived instantaneous volatility. But this smoothing causes autocorrelation that increases the unconditional volatility.[110]

Figure III.1. Monthly returns bank index

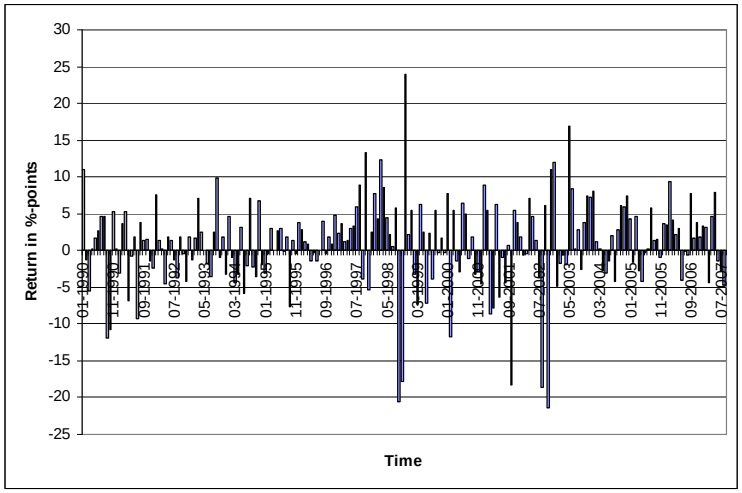
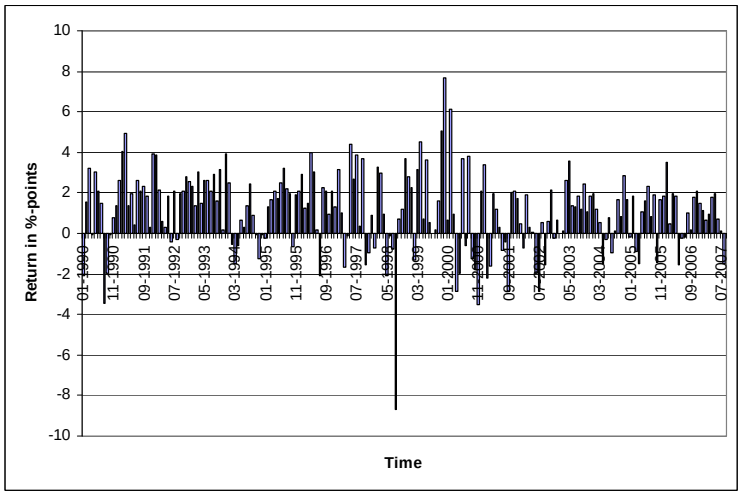


Figure III.2. Monthly returns hedge fund index



Please note that the scales of the two figures are quite different. The monthly returns of the bank index range from -25% to + 25%, whereas the hedge fund index moves between -10% and + 10%. It is also interesting to see that the swings in the hedge fund index hover between -4% and + 4% after 1999, thus over the last 8-9 years, which shows the relative stability of the industry average returns after the LTCM debacle of 1998.

[110] The biases and autocorrelation in the data reduce the swings in the returns. We refer to the more detailed elaboration below Table 3.2.

Annex IV. Three Case Studies

Below we describe the cases of LTCM, Amaranth and, more recently, Bear Stearns as examples of hedge funds that got into serious trouble.

IV.1 Long Term Capital Management

The Long Term Capital Fund (LTCM) was founded in 1994 by a number of Wall Street star traders and well-known academics among which Nobel Prize laureate Myron Scholes and Robert Merton. LTCM was a Delaware limited liability partnership, and its main fund, Long-Term Capital Portfolio, was domiciled in the Cayman Islands.

LTCM pursued a trading strategy based on relative value arbitrage ideas, which were supported by complex quantitative models and past correlations. LTCM took positions under the assumption that liquidity, credit and volatility spreads would narrow from their historically high levels. LTCM was very successful in the first period. In the first years 1995-1997 the fund's average yearly return net of fees was 33.4%. It had a capital of US$4.8 billion and assets of US$120 billion at the beginning of 1998. At the same time, LTCM was managing total gross notional off-balance-sheet derivative contracts amounting to US$ 1.3 trillion[111]. During this period, LTCM operated in a favourable macroeconomic environment, with a worldwide decline of inflation and a substantial convergence in interest rates associated with the prospect of the European and Monetary Union.

Demise

The Russian debt crisis in August 1998[112], however, caused significant disruptions of prior relationships that existed under normal market circumstances. Investors rushed into a "flight-to-quality" and credit spreads widened dramatically. Correlations turned from positive to negative and vice versa. Because of the high leverage, LTCM was forced to unwind positions on a large scale in order to meet margin calls and satisfy other liquidity demands. The size of the fund and extent of leverage made this unwinding practically impossible[113] and this led to the demise of the fund. LTCM lost almost all of its capital in the span of one month, more than US$ 4 billion in total in August and September 1998. On Tuesday, September 23, 1998, LTCM's equity stood at US$ 600 million, implying a balance-sheet leverage of 167 times capital; 90% of its equity had been lost by then. The Federal Reserve Bank of New York organized a US$ 3.6 billion rescue by a consortium of 14 private banks in order to prevent a possible widespread contagion effect resulting from disorderly liquidation or bankruptcy of the fund. The implication of a forced and sudden liquidation of the fund was seen as worrisome and would entail the risk of a rapid draining of liquidity from world securities markets[114]. The following quote from Alan Greenspan's 1998 testimony before Congress is illustrative: "The act of unwinding LTCM's portfolio in a forced liquidation would not only have a significant distorting impact on market prices but also in the process could produce large losses, or worse, for a number of creditors and counterparties, and for other market participants who were not directly involved with LTCM… Had the failure of LTCM triggered the seizing up of markets, substantial damage could have been inflicted on many market participants .. and could have potentially impaired the economies of many nations, including our own."

[111] See Eichengreen and Mathieson (1999).
[112] On 17 August 1998, Russia devalued the ruble and declared a moratorium on future debt payments.
[113] Moreover a complicating factor was that the fund was organized in the Cayman Islands, implying uncertainty as to whether the lenders could have liquidated their collateral. In contrast, such liquidation is explicitly allowed under the U.S. Bankruptcy Code. As it was believed that the fund could have sought bankruptcy protection under Cayman law, LTCM's lenders could have been exposed to major losses on their collateral, see Jorion (2000).
[114] See Halstead et al. (2005) for a good overview of the LTCM debacle.

It is often argued that the rescue of LTCM can be seen as an out-of-court bankruptcy-type reorganization in which LTCM's major creditors became its new owners. Halstead et al. (2005) come to the conclusion that as a results of the near-demise of LTCM, the market response to the financial turmoil at LTCM was rational and that the contagion effects were limited to firms associated with hedge fund activities. Their primary finding is that there is weak evidence at best of pure contagion.

Strategy

LTCM specialized in fixed-income and convergence strategies, taking complex and often highly leveraged positions in order to profit from sometimes small apparent inefficiencies in the relative prices of various tradable instruments. Often the more illiquid instruments were bought and more liquid securities were sold, betting on a convergence of the price or rates between the two. A well-known illustration by a partner of LTCM, was that their strategies amounted to vacuuming pennies. Others have described it as picking pennies from of a steamroller. Various authors have shown that such strategies are in a way comparable to selling short far out of the money put options: this will lead to positive results for long periods of time but every now and then a big loss will occur. In combination with the high degree of leverage of LTCM[115] – at a certain point in time, more than 25 dollars of assets were supported by one dollar or equity capital – this was a recipe for disaster.

LTCM was highly secretive about its trading strategies. Prior to the crisis in 1998, LTCM had a lower volatility than the S&P for almost all its existence, but nevertheless lost almost all its capital in one single month. Jorion (2000) pieced together publicly available information and concluded that LTCM had severely underestimated its risk due its reliance on short-term history and risk concentration. In a nutshell, LTCM's strategy exploited the intrinsic weakness of its risk management system that was caused by the fact that it used the same covariance matrix to measure risk and to optimize positions. It based its risk management on heroic assumptions like constant volatility, a symmetrical distribution of profits and losses, normality instead of fat tails of the return distribution, and constant correlations. LTCM therefore missed the true risk of the portfolio and exposed itself to so-called "catastrophic risk", without having the capital ride out the turbulence of 1998.

IV.2 Amaranth

Amaranth Advisors, LLC was a large multi-strategy hedge fund, which was founded in 2000 by Nick Maounis[116]. Its headquarters were based in Greenwich, Connecticut. The founder's original expertise was in convertible bonds. The fund later specialized in merger arbitrage, leveraged loans, and in energy trading. Reportedly, by June 2006, energy trades accounted for about half of the fund's capital and generated about 75% of its profits.

In September 2006, Amaranth, reported losses of more than US$6 billion apparently incurred in only one month. This represented a negative return over that month of roughly 66%. More precisely, Amaranth was a highly-regarded multi-strategy fund with US$ 9 billion in assets. It lost 35% of its value during the week of 11 September 2006 employing a highly leveraged natural gas spread strategy. Amaranth tried unsuccessfully to sell its positions to other financial institutions over the week-end of 16-17 September. On Wednesday, 20 September, it sold its positions to JP Morgan Chase and Citadel Investments Group at US$ 1.4 billion discount from its previous day's market-to-market values[117].

[115] Because LTCM was regarded as "safe" by its lenders, the fund was able to obtain next-to-zero haircuts on its repo agreements, see Jorion (2000).
[116] Based on Till (2006), we refer to this publication for more details.
[117] Ferguson and Laster in the Financial Stability Review of Banque de France's Special issue on hedge funds (2007).

These parties were willing and able to sustain in their views temporary price declines, because of which immediate large sell-offs were avoided. Forced liquidations of other parts of Amaranth's holdings (including leveraged loans) did not disrupt the functioning of seemingly unrelated markets. These markets proved to be sufficiently liquid to absorb the unexpected spill-over. In total, Amaranth sold 70% of its US$ 9.2 billion in assets in September 2006 alone.

Strategy

Amaranth employed a Natural Gas spread strategy that would have benefited under a number of different weather-shock scenarios. According to EDHEC, these strategies were economically defensible, but the scale of their position-sizing clearly was not. For instance their over-the-counter contracts in Natural Gas were very big when compared to the rest of the market and therefore very illiquid if ever came the need to close them (as clearly was the case). Decent scenario analysis and stress testing would have revealed such inherent risks in the positions that Amaranth held.

The debacle at Amaranth, the largest known sudden hedge fund loss so far, had only trivial impact on the markets. Moreover, until its demise, Amaranth clearly provided an economic service for physical Natural Gas participants as it opened up a whole new market and new liquidity through its sheer size alone.

The Amaranth losses led to calls for regulation of hedge funds. These losses of course were dramatic for the parties involved, but posed little or no systemic risk as they occurred in a relatively small and isolated market. LTCM's problems, by contrast were more dangerous, because they could have affected the US Treasury market.

IV.3 A recent example: Bear Stearns

The Economist (August 2007) states that both Bear Stearns and Goldman Sachs have found that when funds bearing their name get into trouble the desire to preserve their reputations soon leads to a rescue. Sometimes the risk is not as far away from the banks as it seems. The Bear Stearns example is described in further detail below.

Strategy

The example concerns two hedge funds managed by Bear Stearns Asset Management (BSAM), which in the second quarter of 2007 reported heavy losses from investing in Collateral Debt Obligations (CDOs) tied to loans in the subprime mortgage market. The two funds, the High-Grade Structured Credit Strategies Fund and the High-Grade Structured Credit Strategies Enhanced Leverage Fund, borrowed money to invest in CDOs in order to increase their returns. Bear Stearns reportedly initially raised more than US$ 600 million from investors to start the second fund, while adding US$ 35 million of its own capital as well. Bear Stearns then borrowed from the major investment banks Goldman Sachs, Merril Lynch, Morgan Stanley, Lehman Brothers and Banc of America, to buy more CDOs. This is not untypical behaviour for a hedge fund; leveraging of positions is a commonly used technique. The fund expanded its holdings to more than US$ 6 billion. Thereby the fund became highly leveraged to a fairly illiquid trade. In the first months the strategy worked well and results were encouraging with a cumulative 4.44% return over its first four months, according to a Bear Stearns investor letter.

However, as subprime mortgages are offered to poorer home buyers with low credit ratings, rising delinquencies and defaults in this once-booming part of the mortgage market triggered a credit crunch that started early in 2007 and left several lenders bankrupt. The default rates of the CDOs started climbing in February 2007 and the value of the CDOs started to tumble. The funds had to take losses and coming into April was down 4% for the year.

Then in April, the hedge fund posted an 18.79% decline, according to BusinessWeek. Redemptions were suspended shortly thereafter. Calculation of the losses proved very difficult as liquidity vanished and trading in certain investments came to (nearly) complete stop. The High-Grade Structured Credit Strategies Enhanced Leverage Fund sold most of its best investments, which were AAA and AA rated securities

More recent articles in BusinessWeek shed new light on the practices at the two Bear Stearns hedge funds. Apparently, a large part of their net worth was tied up in exotic securities whose reported value was estimated by the manager's own team – something the funds' auditor, Deloitte & Touche, warned investors of in its 2006 report, released in May 2007. The risk of so-called "fair value" accounting, the practice that allows money managers to estimate the value of securities for which they cannot find true market prices, is thrown into sharper focus by the Bear Stearns case. Deloitte apparently warned that a high percentage of net assets at both funds were being valued using estimates provided by the managers' own team "in the absence of readily ascertainable market values" and Deloitte went on to caution "These values may differ from the values that would have been used had a ready market for these investments existed, and the differences could be material.".

An initial conclusion is that the managers used the investors money to leverage it to high levels and then invested it in complex bonds that were backed by subprime and other mortgages. The fund held very low levels of cash, apparently only 1%, which is much lower than industry averages, and leaves little manoeuvring room in case of emergencies. Another characteristic that contributed to the demise is that in its quest for generating returns, the fund invested in increasingly esoteric bonds and other lightly traded securities. Business Week reports that the funds were big buyers of so-called CDO-squareds – CDOs that invest in other CDOs. Over time the holdings got so esoteric that some had no published credit ratings and couldn't be valued by outside pricing services.

According to the New York Times, as the Bear Stearns hedge fund demise unfolded, lenders to the funds tried to ascertain what they could expect if they auctioned off mortgage securities with a face value of up to US$ 2 billion. The solicitations were hastily withdrawn when investors reacted with little enthusiasm. As most parties involved wanted to avoid a fire sale in the already troubled mortgage-securities market, but at the same time, not get stuck with a deteriorating liability and potentially steep losses. In June a deal was reached between the fund itself, the bank Bear Stearns and most of the lenders to the fund. The deal forestalled a need to sell securities in the open market, over concerns that a large liquidation would have on bond prices and investor confidence. While the securities involved represented only a fraction of the market, liquidation could have forced a bigger sell-off while setting a lower price. Many of the assets were sold back by the lenders to Bear Stearns. The ultimate effects on the results of Bear Stearns are not yet known.

IV.4 Risk management conclusions

Both Amaranth and LTCM traded investment strategies that under certain scenarios were quite profitable. For both funds the magnitude of the positions was inappropriate in relation to its capital base. Risk management was of insufficient quality; the trades were undertaken at such a large scale and leveraged to such an extent, that as the market risk turned against them, forced selling was nearly impossible without greatly increasing the losses already incurred, thereby exacerbating the problem.

Thorough risk management through for instance stress testing could have made clear that the liquidity risk in conjunction with negative changes in the asset prices, made the trading strategies and positions (too) dangerous for both LTCM and Amaranth[118].

[118]Amenc and Vaissie (2005) is of the opinion that if the financial institutions from which LTCM borrowed money had properly followed their internal risk procedures, LTCM would not have been able to increase its leverage in such extreme proportions and the collapse would have been avoided, or in the worst-case scenario, its bankruptcy would have remained an idiosyncratic event.

Annex V. Overview Current Regulatory Issues in the EU

V.1. Introduction

We provide a concise overview of various regulatory issues and methods in the EU. We first discuss shortly several key EU regulations with a focus on the Markets in Financial Instruments Directive (Mifid), Basel II and Undertakings for Collective Investments in Transferable Instruments (UCITS). Then we outline the broad push for a greater transparency of hedge funds, by both market initiatives and supervisors. Next, we describe that current changes in regulation have already strongly affected the hedge fund industry and are likely to lead to a further consolidation and bifurcation in the years to come. Moreover, the hedge funds are introducing codes of conduct and best practices.

V.2. Key EU regulations

There are a wide range of EU measures which apply to the activities of the fund manager, the prime broker and other counterparties[119]. Mifid has come into force in November 2007 and regulates the separate investment activities of dealing in investments, portfolio management and investment advice, but not the management of collective investment schemes themselves, for which the UCITS directive is more relevant. Hence, prime brokers for hedge funds will be subject to the requirements of Mifid and the Capital Requirements Directive (CRD). The marketing of hedge funds to EU investors, both by bank and non-bank investment firms, will also have to comply with Mifid. Other relevant regulations are the EU Distance Marketing Directive, the 2003 Prospectus Directive, the EU Market Abuse Directive, the Transparency Directive and the Takeover Directive, although the details of these different regulations fall outside the realm of this paper.

V.2.1 Mifid

The conduct of business rules with which hedge fund managers operating in the EU must comply are currently based on the EU's Investment Services Directive (ISD). The ISD contains only high-level requirements and there has been considerable variation in the manner in which national regulators have applied detailed conduct of business rules. Mifid is the next step to regulate hedge funds. It requires EU members to amend their business of conduct rules. Mifid has a significant impact on hedge fund managers across the EU/EEA (European Union / European Economic Area). Hedge fund managers are obliged to complete the legal and structural work and if they do not comply, they may have to cease trading until they are Mifid compliant. Most firms that fall within the scope of the Mifid will also have to comply with the new CRD which will set requirements for the regulatory capital a firm must hold. Those firms newly covered by Mifid will be subject to directive-based capital requirements for the first time. Many hedge funds will be considered "investment firms" and will be within the scope of Mifid (and the CRD / Basel II). This development will lead to large changes in the extent to which hedge funds are regulated and the extent to which they report on their activities.

V.2.2 Basel II

Banking supervisors, through Pillar 2 of Basel II should incorporate the risks specifically concentrated in hedge fund exposures. It appears to be the most promising manner to limit the risks to the banking sector and to financial markets as a whole, which is generated by the development of hedge funds. Among others, it is intended to deal with risks which are not fully captured by the capital requirements in Pillar 1.

[119] Based on J. Welch (2007).

For instance, Basel II introduces, for the first time, a capital requirement for operational risk, including operational risks associated with complex derivatives and capital markets activities[120]. The supervisory review process which deals with all banking risks beyond those covered by Pillar 1 regulatory capital charges, allows for such incorporation and focus on liquidity risk, concentration risk, tail risk, model risk, etc. Especially the interaction between credit risk and liquidity risk deserves more attention, as this interaction is often one of the major risks in case a hedge fund comes into trouble. Basel II enables banks to model their potential future exposure using portfolio simulation methodologies that reflect netting and collateral. In practice however, there is little consensus on how to measure this risk, nor on which valuation measures to use in case of various negative scenarios and stress tests. On site examinations and in-depth assessment of the risk management process are advocated[121].

V.2.3 UCITS

It has long been accepted that high net worth individuals should be allowed to invest directly in hedge funds. Consumer protection is deemed of less importance than for the retail investor. Under the amended UCITS Directive, it is now easier to invest for authorised collective schemes. Large parts of the consumer protection regulatory questions have already been adequately dealt with and require little new action, as current rules appear to function smoothly. The implementation of UCITS III across the European Union offers the possibility of a pan-European "passport" for hedge fund-like products launched by hedge fund managers and established institutions alike, provided that such products satisfy the UCITS Directive. The availability of such a passport should significantly reduce the barriers to cost effective retail cross-border distribution of such products by limiting the regulatory burden associated with the need to ensure compliance with different sets of regulations issued by a plethora of national regulators. UCITS III funds can offer fund managers greater product development scope as well as access to a greater investor base[122]. The difference between UCITS I and UCITS III that some hedge fund managers are exploring lies in the fact that they can now use a much broader range of Financial Derivative Instruments (FDIs) and that they can use such derivatives to leverage these funds up to 100%.

V.3. A push for greater transparency and cooperation

There is a call for greater transparency of hedge funds[123]. In order to head off politicians' calls for greater regulation, very recently for instance, a working group made up of top hedge funds suggested[124] that hedge funds should disclose indirect investments in companies and better inform clients and banks about the risks they take and how they value their assets. Moreover, funds would be required to follow best-practice guidelines on operations such as their risk management and governance. This particular working group is headed by Andrew Large, a former Bank of England deputy governor and the group includes 14 senior executives of large hedge funds. Large said he hoped the initiative would create a best-practice standard that hedge funds would adhere to or otherwise risk losing clients.

[120] The CRD will become fully operational in January 2008.
[121] The U.S. have a relatively long history of regulating the local industry of hedge funds and regularly controls the due diligence on institutions in which a bank has counterparty risk, the implementation of quantitative limits of risk exposure, sound practices regarding evaluation, risk control, and regarding internal control of operational risk.
[122] According to Donohoe (2006).
[123] A. Russel-Jones reports that 100% of the respondents in a recent survey amongst institutional investors agreed that there would be a need for further transparency in a hedge fund manager's operations to encourage more investors to allocate to hedge fund strategies in the future.
[124] International Herald Tribune, 11 October 2007 and Wall Street Journal, 11 October 2007.

This appears to be in line with comments by Ben Bernanke, the U.S. Federal Reserve chairman who earlier had said that the best approach was for hedge funds to regulate themselves and disclose more information voluntarily. It is likely that although it is difficult to coerce hedge funds to do anything they don't want to do, there will be peer pressure as other funds sign up and their own investors ask them to do so too.

With regard to this call for increased transparency, it is still open for debate whether the reporting of large investment positions or large clients is useful or not. The FSA clearly is of the opinion that these should not be reported[125]. High levels of transparency on issues like the fee structure, the redemption policy, valuation procedure, investment strategy and result reporting are obvious. Better transparency on these issues was and still is seen as one of the main instruments to make market discipline effective and for preventing systemic disruptions[126].

Another broad-based consensus approach is the push for more cooperation on an international level between the various supervisors and regulators. The European Parliament (EP)[127] is also concerned that the current nationally and sectorally based supervisory framework may potentially fail to keep pace with the financial market dynamics and stresses that it must be sufficiently well resourced and coordinated to give adequate and quick responses in cases of major systemic crises that affect more than one Member State. Moreover, the European Parliament notes that for effective oversight of the systemic and prudential risks of the top market players, the present system of cooperation may need to be strengthened on the basis of the system of cooperation that exists among supervisors. Further the EP encourages greater coordination in particular with respect to prudential risk supervision of multi-jurisdictional and cross-sectional entities and financial conglomerates.

Nouy in the Banque de France (2007) report, is of the opinion that more general market transparency of hedge funds would be useful and beneficial, for instance under Pillar 3 of the Basel II framework. He states that as an illustration, that banks have made much more progress on Value-at-Risk disclosure than hedge funds, notwithstanding the well known limitations of such figures[128], and that there is no reason why hedge funds could not communicate such figures to the market. Amenc and Vaissie (2005) even recommend activity reports should first inform investors about the levels of risk and performance of the fund of hedge funds. To this end, a series of risk and return measures with corresponding risk-adjusted performance indicators should be disclosed to measure the returns per unit of risk that the fund generated.

V.4. Expected industry developments

The flow of institutional funds into hedge funds is creating a significant change in the regulatory environment[129]. Increased industry participation is bringing a greater focus on areas such as asset valuation, risk monitoring and internal operational and management controls. Regulation is going to have the single biggest influence on shaping the future of the hedge fund industry. Firms seeking to develop business with institutional investors believe improved regulation will help them boost their inflows by creating an asset class which provides the transparency and integrity demanded by their investors. They see it as an integral part of improvement in professional standards, which would encourage more

[125] See McCarthy (2006).
[126] See Garbaravicius and Dierick (2005).
[127] In its White Paper (2006/2270(INI)).
[128] As a portfolio gets larger and more complicated, Value at Risk becomes increasingly irrelevant and of little use. Furthermore, it says nothing about the losses that can happen in exceptional circumstances, like systemic risk in the tails of the probability distribution.
[129] As shown in The Northern Trust survey reported by Russel-Jones (2006).

investors to diversify into hedge funds. In contrast, those managers focused on the high net worth market feel the opposite, viewing increased regulation as a barrier to their talent and performance, stifle creativity and discourage managers from setting up new hedge fund firms. Moreover, they fear increased regulation could lead to higher infrastructure and compliance overheads. The increased inflow of money in the hedge fund industry will act as a catalyst to the emergence of a two-tier industry in Europe, divided into boutiques and institutional oriented firms. Boutique managers service private clients and high net worth individuals. "Supra" alternative asset managers have the size and the infrastructure to service large institutional clients.

Bifurcation of the hedge fund sector

The ECB[130] provides further evidence for the above expectation. The ECB reports that the share of capital managed by the largest hedge funds has grown. The sector can be seen as increasingly bifurcating into two groups: a smaller number of large institutionalised firms – often backed by large financial groups – managing the bulk of capital, and a much larger number of smaller hedge fund managers with less developed business administration and risk management systems. The largest funds have reportedly benefited from occasional "flight-to-quality" episodes, such as those of May/October 2005 and May/June 2006. Considerable structural changes have already taken place, as hedge funds are increasingly receiving large inflows from institutional investors as opposed to high net worth individuals who historically formed their traditional investor base. The large hedge funds have grown much faster than the smaller hedge funds.

Private sector initiatives

Clearly, hedge fund managers and promoters have an important role to play in shaping the future regulatory landscape by, for example, responding to regulators' consultation papers and making use of industry-wide representation through bodies such as the Alternative Investment Management Association (AIMA)[131]. AIMA (2007) has recently published a set of 15 sound practices recommendations for hedge funds, concerning topics as valuation, governance, transparency, procedures, processes & systems and on sources, models & methodology. This is a good example of the hedge fund industry driving forward initiatives in order to enhance sound practices. Interestingly, as another illustration, the International Organisation of Securities Commissions (IOSCO) is working with recognised industry experts to develop a set of principles representing good practice for valuations by hedge funds and their counter parties. Other significant private sector initiatives include those of the Counterparty Risk Management Policy group (CRPMG), the International Swaps and Derivatives Association (ISDA), The Greenwich roundtable, the Managed Funds Association (MFA) and the Institute of International Finance (IIF). A disadvantage of such Codes of Conducts is that they are non-binding, only set minimum principles without being exhaustive and often are the result of a compromise between the more and less strict members of the (hedge fund) industry, thereby not fully reaching the level or depth really needed.

It is obvious though that hedge funds are more and more becoming part of the main stream asset management industry and compliance with the common regulatory policies is a logical consequence. This development is fully in line with Stulz (2007) who concludes that the performance gap between hedge funds and mutual funds will narrow, that regulatory developments will limit the flexibility of hedge funds, and that hedge funds will become more institutionalized.

[130] In the Financial Stability Review of December 2006.
[131] See "AIMA's guide to sound practices for hedge fund valuation", March 2007,

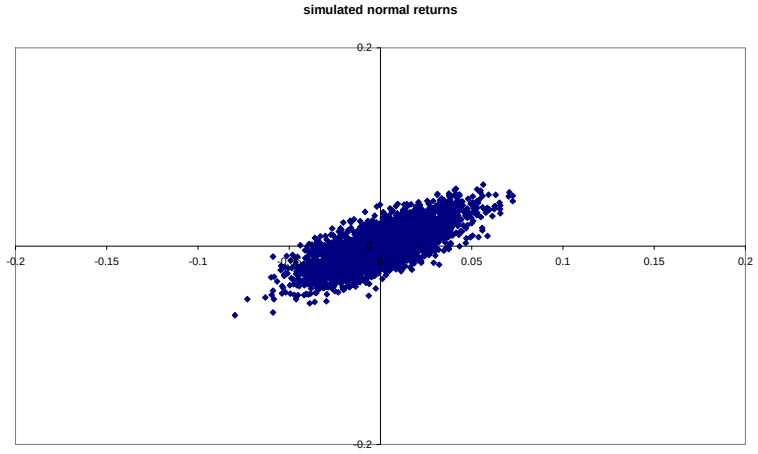
Annex VI. Empirical illustration of Extreme Value Theory

In this Annex we provide a number of simulated plots that intend to capture how the cross plots would look like if the returns are counterfactually normally distributed. We also complement the analysis of the main text by providing cross plots for a number of specific hedge fund strategies.

Normal Comparison

We start by showing a normal distribution based remake of Figure 4.3. As we pointed out in the main text there are far more outliers in the actual returns than there are in the normally distributed ones, and they almost invariably occur together. The former data feature reveals the fat-tailed nature of the distribution of the bank returns. The fact that the outliers do occur jointly in Figure 4.3 shows that the interdependence of the banks' returns persists in the extremes. The remake shows that in a normal world, the risk of a systemic breakdown is more or less absent. It shows why normal based correlation analysis may leave the wrong impression about the substance of systemic risk, while a simple unsophisticated cross-plot tells a different story.

Figure VI.0 Normal remake of the ABNAMRO versus ING cross-plot



Further hedge fund evidence

We provide two cross plots that further demonstrate the relative independence between the bank returns and hedge fund returns. Figures VI.1 and VI.2 cross plot the European Bank index against the indices of respectively the Fixed Income High Yield and the Equity Market Neutral strategies.

Figure VI.1 Cross plot Banks vs. HFR Fixed Income High Yield Index

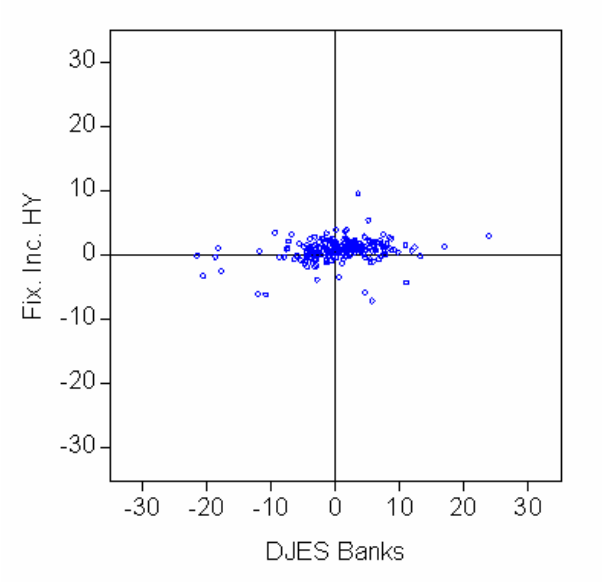
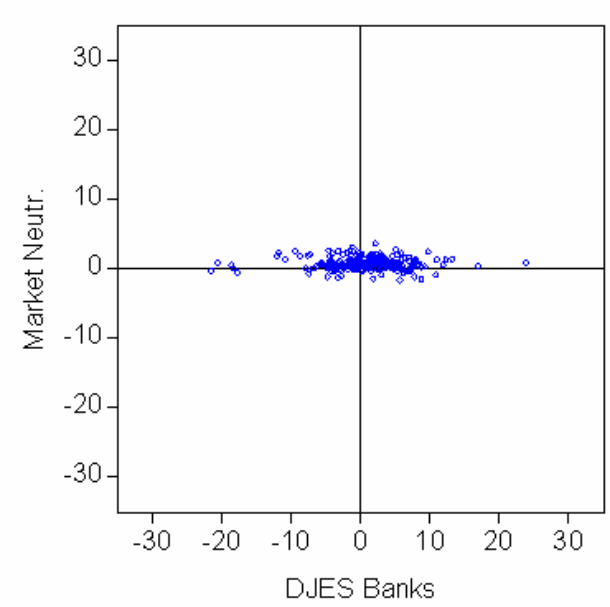


Figure VI.2 Cross plot Banks vs. HFR Equity Market Neutral



The two cross-plots in Figures VI.1 and VI.2 for the hedge fund indices versus the bank index are similar to Figure 4.6 and yield an altogether different picture in comparison to the bank versus insurance industry plot in Figure 4.5 from the main text. There appears to be little or no relation between the largest changes in the values of the bank index and those of the HFR Composite index (as in Figure 4.6) or the Equity Market Neutral index (as in Figure VI.2). For the Fixed Income High Yield Index there seems to be some weak dependence in the south-west quadrant of Figure VI.1. This is perhaps not too surprising, as negative extreme events for the High Yield markets and the banks both strongly depend on interest rates and credit ratings.

Simulated remakes bank and insurance cross-plots

To benchmark these cross-plots and the results in Section 4.3 on the systemic risk posed by hedge funds for the banking sector, we report a number of simulations. We provide two simulated remakes of the data for the bank index versus the High Yield index.

The simulations are on basis of the bivariate normal distribution and the bivariate Student-t distribution (with 2.1 degrees of freedom), using the same means, variances and correlation coefficients as estimated for the bank index and High Yield index. When we cross plotted the two Dutch bank returns in the main text, we noted that the bivariate normal remake failed in part since the normal distribution did not capture the fat tail phenomenon. The Student-t distribution is known for its heavy tails. Moreover, it can also capture the strong tail dependence that we noted in the bank data and the bank cum insurance data.

Figure VI.3 Bivariate normal distribution based simulation

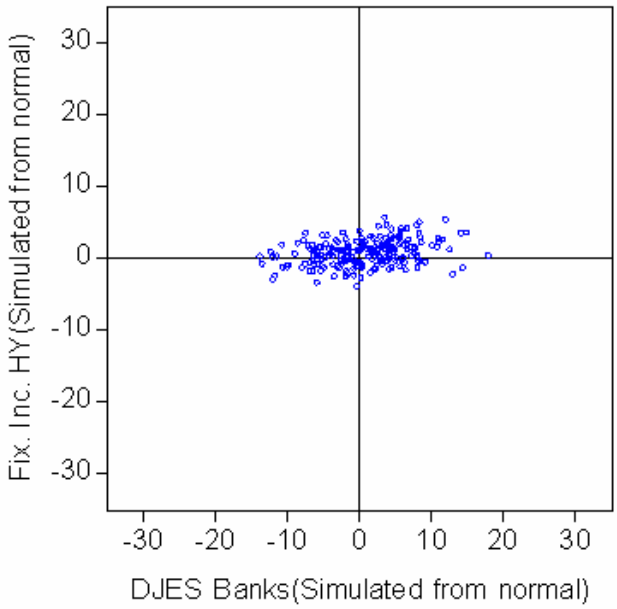
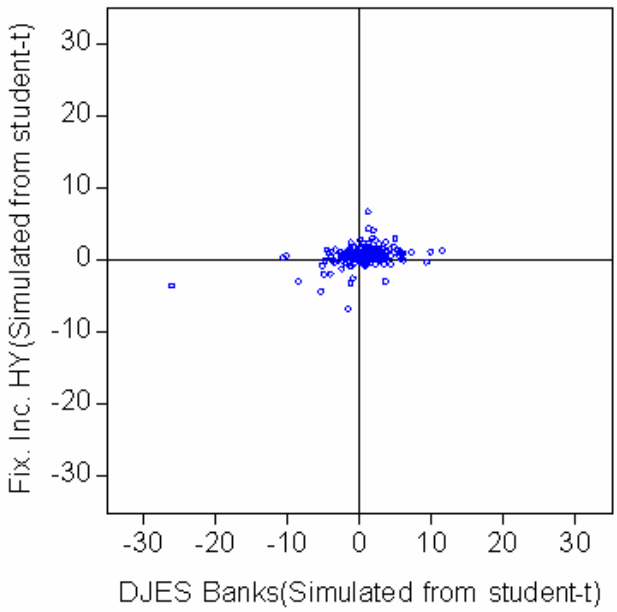


Figure VI.4 Bivariate Student-t distribution based simulation



In the normal based cross plot of Figure VI.3 one observes little or no strong dependence in the tail areas. The oval shaped cloud almost coincides with the x-axis, with a slight upward tilt.

The Student-t based simulation shows some outliers relative to the cloud in the centre, but again the dependence is as strong as in the cross plot for the bank and insurance cross plot.

Further evidence

We repeat this remake procedure for the insurance index and the Equity Market Neutral index, which are simulated under the assumption of normality and a Student-t distribution. The figures VI.5 and VI.6 show that the dependence between the bank and the insurance industry is quite high, both using the normal and the Student-t assumption. This is clear from the observation that along the imaginary axis running from the left bottom to the right top, there are quite a few observations, also in the extremes, meaning that the banking and insurance industries often are hit by large shocks simultaneously.

Figure VI.5 Bivariate normal distribution based simulation

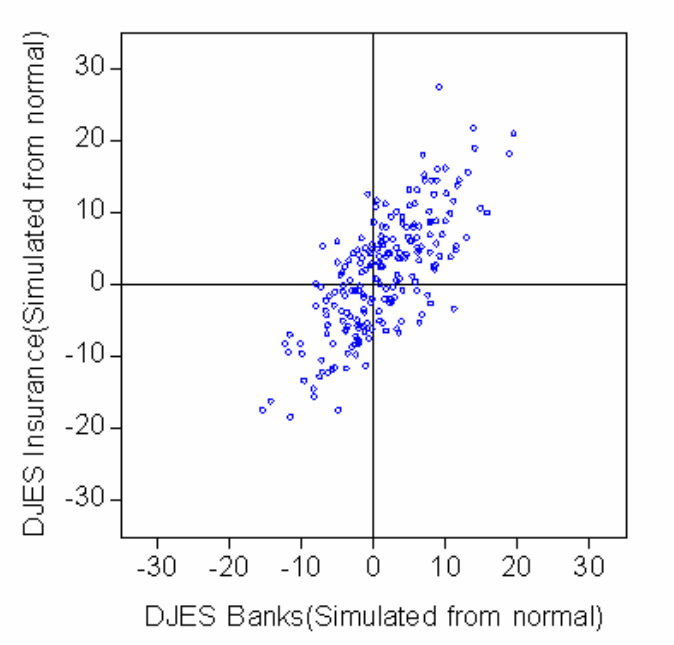
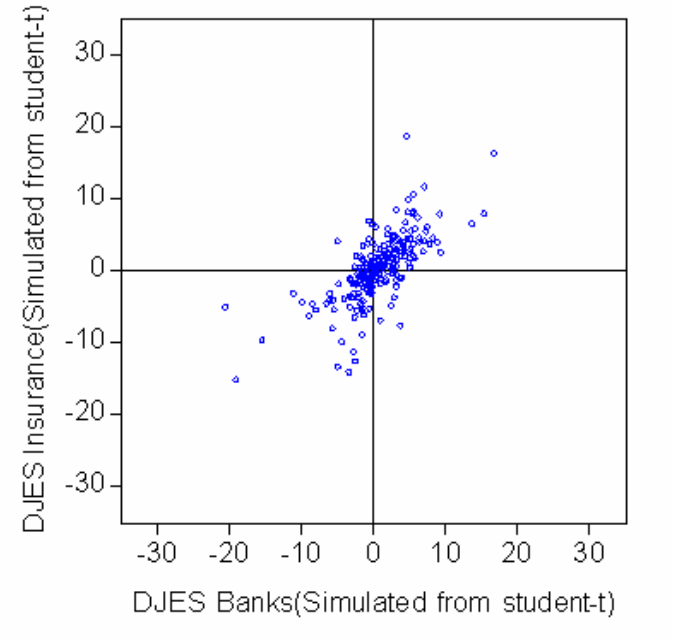


Figure VI.6 Bivariate Student-t distribution based simulation



The dependence between the Equity Market Neutral strategy and the banking industry is very low. The observations lie around a more or less horizontal line. This is quite different from the dependence observed between the banks and insurers in the previous plots (simulated and actual data).

Figure VI.7 Bivariate normal distribution based simulation

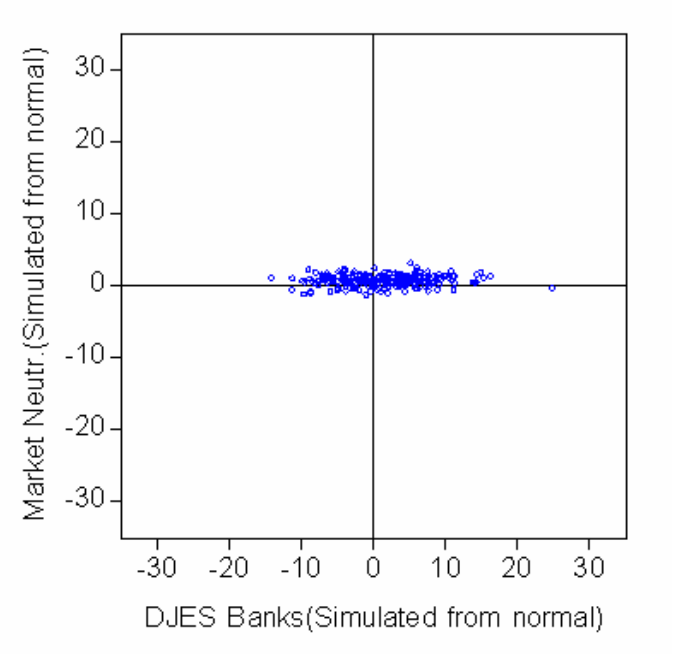
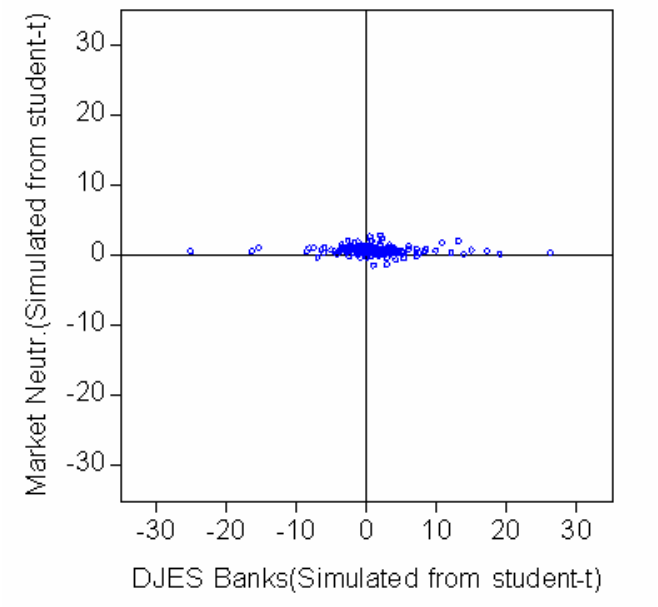


Figure VI.8 Bivariate Student-t distribution based simulation



Annex VII. Technical notes on Extreme Value Theory

In this annex we provide the technical background of EVT. We compare the light tails of a normal distribution with the heavy tails of a Pareto distribution. Next, we graphically illustrate how we define systemic risk in a bivariate setting. We continue by explaining how we apply EVT and more specifically how we choose the threshold level that defines a state of crisis. We conclude the annex by showing the difference between systemic risk in a theoretical setting that is governed by normally distributed returns versus the more realistic world with fat tailed distributions of returns.

VII.1 Light versus heavy tails

We compare the tails of the normal distribution to the tail of the Pareto distribution. EVT shows that these examples are representative, in the sense that distributions with unbounded support must either have an exponential decline or a power decline. The normal distribution can be approximated in the tail by the ratio of the density to the quantile (failure level or VaR level):

$$\Pr\{Y > s\} \approx \frac{1}{s}\frac{1}{2\pi}e^{-s^2/2}$$

The fat tailed Pareto distribution has the following tail probability:

$$\Pr\{X > s\} = s^{-\alpha}$$

and where the power $\alpha > 1$ to ensure a finite mean. This tail exponent determines how heavy the tail is, the lower it is the fatter the tail.

Taking ratios of the tail probabilities and letting the VaR level s tend to infinity shows that

$$\frac{P\{Y > s\}}{P\{X > S\}} = \frac{e^{-s^2/2}}{s^{1-\alpha}} \to 0$$

And that

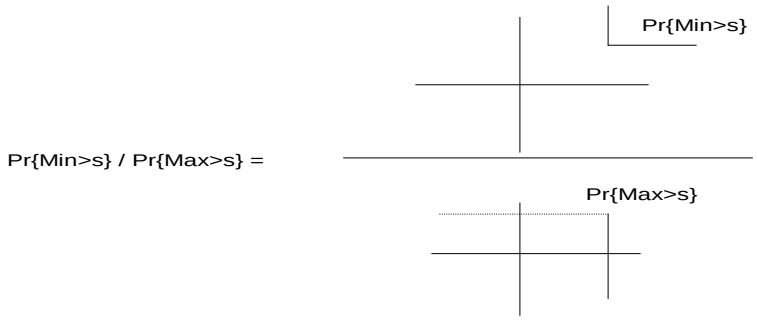
$$\frac{P\{X > s\}}{P\{Y > S\}} = \frac{s^{1-\alpha}}{e^{-s^2/2}} \to \infty$$

Thus eventually for any heavy tail (α - value) the exponential tail declines faster.

VII.2 Systemic Risk Estimation Methodology

Systemic risk in a bivariate setting can be defined as the conditional probability on a joint failure, given that at least one of the two sectors is in dire straits. This conditional probability is represented graphically in Figure VII.1 as the ratio of the joint failure area divided by the area in which there is at least one excess loss. We condition on the fact that there is a problem in at least one of the sectors. This allows one to infer how frequent a systemic crisis is relative to occurrence of a crisis in any of the markets. We do not condition on a specific market failure, since any of the two sectors may be unaffected.

Figure VII.1 Risk measure



We say that a sector is in a state of crisis if the index is below a certain threshold, which we take to be the Value-at-Risk (VaR) level.[132] Subsequently, we lower the probability level at which the VaR's are calculated, in order to obtain the limiting conditional failure probability[133]. For a specific index, we take the 15th order statistics from the top to be the threshold. The corresponding probability level of the VaR is therefore 15/212= 7%.[134] For two series, we simply count the number of the days when both of these are above their thresholds and the number of the days when at least one of these is above its thresholds. Their conditional probability on a joint failure is the ratio between these two numbers. This probability is always between zero and one. If it is zero, the probability of a joint crash is negligible. If the two concerned series are independent this probability is zero. But it can also be zero even if the two sectors are dependent. For example, if the two series are positively correlated and normally distributed, the conditional joint crash probability is still zero. This follows from the fact that the joint probability on exceeding any finite VaR levels is of smaller order than the probability that one of the two sectors is in excess of its VaR level. If the joint conditional failure probability is one, then a crisis in one sector failure always goes hand in hand with the demise of the other sector. For example, the bivariate Student-t distribution induces numbers between zero and one. For the example of the two Dutch banks, this conditional probability is about 30%. In Table 4.1 in the main text we present EVT based estimates of the conditional joint failure probability for the bank index and the four hedge fund indices analyzed graphically before.

VII.3 Systemic risk and the normal distribution

Under normality the sum of two independent random variables is distributed as the square root of two times one of the random variables. This shows that the rate declines with the number of summands and that the joint failure probability is of smaller order than marginal failure probabilities.

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[132] In the Figure VII.1 the VaR levels are indicated by the threshold s. A typical threshold is the downside VaR of the corresponding return series. The VaR is determined by the univariate EVT analysis. Thus different series can have different VaR thresholds. It is also possible to choose the same threshold arbitrarily. In this study, we use the VaR threshold.

[133] EVT shows that this limiting probability is a good approximation to the probability at large but finite VaR levels.

[134] The analysis is initially done for all possible number of highest upper order statistics, i.e. 1,2,…, 212 by plotting a curve of all the pre-estimated conditional probabilities on a joint failure against the number of upper order statistics under consideration. The final number we used in this analysis is judged by finding a flat part on the curve to balance bias against variance. A similar type of technique is commonly used in EVT, for example, in estimating the tail index; this is the so called Hill plot.

Normal

Normal $$\Pr\{Y > s\} \approx \frac{1}{s}\frac{1}{2\pi}e^{-s^2/2}$$

Sum / Fractal Nature (square root rule)

$$\Pr\{Y_1 + Y_2 > s\} = \Pr\{\sqrt{2}Y > s\} = \Pr\{Y > \frac{s}{\sqrt{2}}\} \approx \frac{\sqrt{2}}{s}\frac{1}{2\pi}e^{-s^2/4}$$

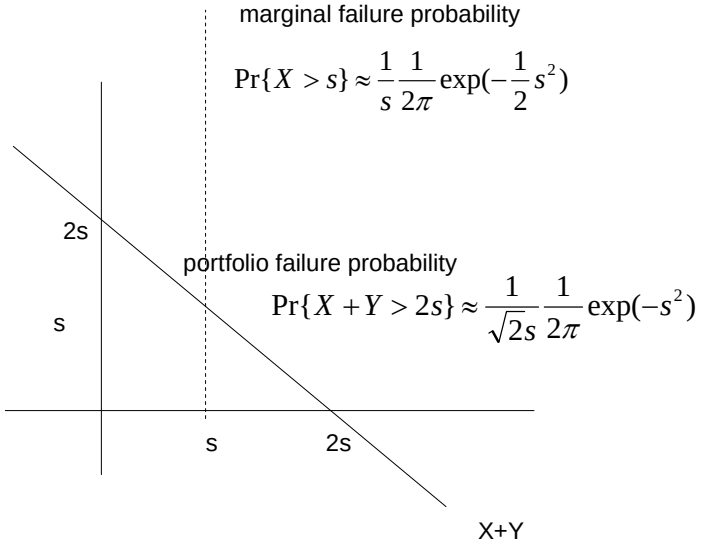
with n

$$\Pr\{\sum_{i=1}^{n} Y_i > s\} \approx \frac{\sqrt{n}}{s}\frac{1}{2\pi}e^{-s^2/2n}$$

Rate Declines with Sum

$$d\log \Pr\{\sum_{i=1}^{n} Y_i > s\} / d\log n \approx \frac{d[\frac{1}{2}\log n - \log s - \log 2\pi - \frac{s^2}{2n}]}{d\log n} = \frac{1}{2} + \frac{s^2}{2n}$$

Portfolio X+Y composed of indepedent normal returns X and Y
Portfolio failure probability is of lower order than marginal failure probabilities



VII.4 Systemic risk and fat tails

With fat tails, the probability of the sum is linear in the number of summands. Hence, the rate is independent of the number of summands. This implies that the joint and marginal failure probabilities are of equal order of magnitude.

Fat Tail

Pareto $\Pr\{X > s\} = s^{-\alpha}$

Sum / Fractal Nature $\Pr\{X_1 + X_2 > s\} \approx 2s^{-\alpha}$

with n $\Pr\{\sum_{i=1}^{n} X_i > s\} \approx ns^{-\alpha}$

Rate Independent of Summation

$$d \log \Pr\{\sum_{i=1}^{n} X_i > s\} / d \log n \approx \frac{d[\log n - \alpha \log s]}{d \log n} = 1$$

Portfolio X+Y composed of independent fat tailed returns X and Y
Marginal and portfolio failure probabilities are of the same order