“Hedge funds and leverage estimation”

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Hedge funds and leverage estimation

Abstract

Leverage is an essential component of hedge funds industry and performance. This paper proposes a definition of hedge funds based on their use of leverage. Leverage could be of investment and derivatives. Most of the time, leverage is an information given by the funds managers themselves. But we cannot check it and have to trust hedge funds when they deign to give it. Using Sharpe regression style method (1992), this work will extract, from prices only, a quantitative leverage measure, which reveals us the part of performance due to leverage.

Keywords: hedge funds, leverage, regression style.
JEL Classification: G11, C58.

Introduction

The rapid growth of the hedge fund industry over the last decade has inevitably given rise to a multitude of studies, research and analyses, both academic and practioner-led; however, despite all this works, it is difficult to find a simple, common definition of the term hedge fund. For the purposes of this article we shall try to define them not according to the often used characteristics of speculation and hedging, but rather by their use of leverage on financial markets. The ability to deploy leverage, amongst other tools, allows hedge funds to manage assets against an absolute return benchmark so that whilst they do not emerge from the recent crisis unscathed, the future looks bright for those managers that can evolve and adapt to the new environment whilst maintaining the absolute return objective.

We are thus going to suggest in this paper an innovative measure of hedge funds leverage by means of factorial models inspired by Sharpe (1992). To our knowledge, one paper has the same purpose: McGuire & Tsatsaronis (2008). This paper uses the same idea as Sharpe (1992) but estimates structurally only one part of leverage, *on balance sheet one* ("funding leverage" for the authors). As Ang et al. (2010) reveal it, *on balance sheet leverage* understates real leverage, by forget leverage due to use of derivatives ("instrument leverage" for McGuire & Tsatsaronis, 2008). It is really difficult to distinguish the two types of leverage by a factor model. We do not try to separate them but we want to avoid the underestimation of leverage. We then innovate here in this paper by capturing the performance due to leverage, in all its shapes, and not *on balance sheet leverage* directly which will underestimates real leverage.

After defining hedge funds and statistical model in the first section, we will reveal by empirical studies really interesting results to measure hedge funds leverage in the second section.

1. Definition of hedge funds

Hedge funds have a multiplicity of definitions: given by regulators first of all (also different between SEC[1], FSA[2], AMF[3], etc.), by the financial industry itself also (distinction between classical traditional funds and complex hedge funds), and finally by the clients too (through the hedge funds performance). It is difficult to choose one of them. We will try to convince that we can extract one fundamental and objective characteristic of hedge funds to define them.

1.1. Speculate or hedge? The French translation of *hedge fund* alone gives rise to variants which illustrate the controversy in definition: "*fonds de couverture*" (focusing on the hedging characteristic) for the Quebecois, "*fonds spéculatifs*" (focusing on the speculative characteristic) for French people. That said, does not a *mutual* fund manager hedge risks and speculate? Likewise, banks have demonstrated extreme speculative behavior as illustrated by the causes of the recent crisis.

In reality, all investors in financial markets must speculate in order to survive. In chapter 12 of *The General Theory of Employment, Interest and Money*, Keynes (1936) develops an interesting thesis. He writes:

"Thus the professional investor is forced to concern himself with the anticipation of impending changes, in the news or in the atmosphere, of the kind by which experience shows that the mass psychology of the market is most influenced. This is the inevitable result of investment markets organized with a view to so-called "liquidity".

Such liquidity is necessary to financial markets so that they can exist and drain new investment flows. Liquidity here means fluidity in transactions. With-

[1] Securities and Exchange Commission (USA).
[2] Financial Services Authority (UK).
[3] Autorité des Marchés Financiers (France).

out speculation, there is no liquidity and no financial markets. A fund manager, even for mutual funds, has to be a speculator, with more or less clear-sightedness.

A fund manager can employ hedging in many different guises to remove certain risks from the balance sheet and protect from the risk of total loss. It is the same for hedge fund managers who hedge their portfolios with the aim of insulating themselves from market trends that might negatively affect their positions.

Therefore, speculation and hedging are not the preserve of hedge funds. Actually, we believe that what really differentiate them from mutual funds is the level of speculation and hedging they use and that leverage is in fact the discriminating factor.

1.2. Use of leverage. In April 1966, the journalist Carol J. Loomis wrote in *Fortune magazine* about Alfred Winslow Jones' peculiar investment fund: *the fund's capital is both leveraged and "hedged"*. In recent history, this description was simplified by deleting the leverage reference and sticking hedge together with fund. Yet, it is in the ability to utilize leverage that I believe the essence of a hedge fund lies.

There are two kinds of leverage. On balance sheet leverage, whereby a manager borrows physical assets (cash or stock) with the aim of creating additional return. For example a manager with €20 to invest can increase their exposure by borrowing €80 so that their total investment is now €100. If the investment returns 20% the unlevered return would be €4 (€20 x 20%), the levered return would be €20 (€100 x 20%), less the marginal cost of borrowing. Naturally, one can also lose everything, and even more, in case the loss is higher than 20%. The borrowing can also be created through shorts on financial securities.

Mathematical definition. Let an investment at t equal to I_t. The return of this investment at the horizon h is:

$$r_{t|t+h} = \frac{I_{t+h}}{I_t} - 1.$$

If the investment I_t is completed by a capital D_t borrowed at the rate $r_{f,t|t+h}$, is added to the return without loan a leverage effect. The return with leverage effect $r^l_{t|t+h}$ is then:

$$r^l_{t|t+h} = \frac{(I_t + D_t)(1 + r_{t|t+h}) - (I_t + D_t) - D_t r_{f,t|t+h}}{I_t} =$$

$$= r_{t|t+h} + \frac{D_t}{I_t}(r_{t|t+h} - r_{f,t|t+h}) = r_{t|t+h} + \frac{D_t}{I_t}\tilde{r}_{t|t+h}.$$

The factor $\frac{D_t}{I_t}$ is the investment leverage. The leverage is interesting if the investment return without leverage is greater than the loan cost.

Off balance sheet leverage, through the use of derivatives: e.g. a European call option on an underlying product, with a value of €100, will generally have a relatively low premium (let's say €5); if the underlying value is €105 at the point of redemption, the return would be 100% (€105 – €100 = €5 / €5) as opposed to 5% (€105/€100) if the investor had bought and sold the underlying asset.

Mathematical definition for a call option. When we buy an underlying asset of value S_t at time t of a call C_t with maturity T and strike price K, the return is:

$$r_{t|T} = \frac{S_T}{S_t} - 1.$$

When we buy the call option, the return is:

$$r^c_{t|T} = \frac{(S_T - K)^+}{C_t} - 1.$$

If $S_T > K$, then the call is exercised and the return is:

$$r^c_{t|T} = \frac{S_T - K}{C_t} - 1 >> r_{t|T}$$ most of the time.

If $S_T < K$, then the call is not exercised and the return is:

$$r^c_{t|T} = -100\%.$$

Contrary to McGuire & Tsatsaronis (2008), we will measure the two types of hedge funds leverage through the performance and not through the exposures of the factor model. Then, as the authors, we do not distinguish the two types of leverage but we do not focus on exposures of hedge funds to risk factors to avoid underestimation: exposures capture essentially on balance sheet leverage, even if some risk factors are option factors.

2. A new factor model to measure precisely alpha and leverage of hedge funds

Let us now enter into greater detail about the sources of hedge fund performance. In this paper, we will elaborate upon two innovative models in financial research: a factor-based model incorporating different systemic risk *proxies* and a measure of leverage impact on the performance of hedge funds, which is peculiar to them.

2.1. Alpha and risk factors. Are profits really the fruit of the manager's work and not of the systematic risk he takes and which may then backfire on

him: for example, the success of CDOs before 2007, which were very lucrative but concealed a disproportionate risk?

2.1.1. Measuring "abnormal" and "systematic" returns. Within a standard theoretical financial framework, having returns which are higher than the risk taken is an anomaly that is more or less quickly absorbed by the market participants. The consistent ability to capture market deficiencies over the long term would thus appear to reveal the presence of alpha. This is what hedge funds managers aim for through implementing complex strategies, the impact of which is increased tenfold by using leverage. Let us suppose that a manager who achieves a result of 3% per annum when the risk taken and observed by all agents on the market should let him earn 2%: this last figure incorporates the "normal" or "systematic" return. The 1% additional return noted here represents the manager's alpha and, therefore, the expression of his talent. Here, the difficulty lies in what will be included in the return stemming from "systematic" risk as it is necessary to neutralize this "normal" return so as to discover the "abnormal" return or alpha, which alone testifies to the "real" added-value of a manager. In fact, if one of the factors of "normal" returns to be neutralized is forgotten, alpha will turn out to be wrongly estimated.

There are numerous systematic risk factors which essentially stem from equity asset classes (OECD, Emerging Markets, Large versus Small Cap, Growth versus Value), bonds (Sovereign, Corporate and High-yield), commodities, money and foreign exchange. This means there are as many factors to be neutralized so as to measure alpha. As far as Jensen is concerned, a systematic return is summarized by a single factor: the benchmark share index of the market in question.

More complex models also capture alpha in the literature, as we show it in Table 1.

Table 1. Survey of the main alphas in literature

Authors	Model & data	Alpha & period
Agarwal & Naik (2001)	12 factors – Hedge Fund Research (HFR)	Between 0% and 1.21% per month according to the strategies used (1992/2000)
Edwards & Caglayan (2001)	6 factors – Managed Accounts Reports (MAR)	8.52% per annum for all the funds (1990/1998)
Capocci & Hübner (2002)	CAPM – MAR + HFR	0.36% per month for all the funds (1994/2000)
Capocci & Hübner (2002)	4 factors (Fama & French, 1993 + Carhart, 1997) – MAR + HFR	0.43% per month for all the funds (1994/2000)
Capocci & Hübner (2002)	11 factors – MAR + HFR	0.25% per month for all the funds (1994/2000)

2.1.2. Our risk factors. The numerous factor-based models studied in investment literature (Table 1) are very interesting but have not, for the most part, taken into account the new financial environment and particularly the impact of the crisis which we have experienced since 2007, as they were determined before the crisis. It has been our wish, in this issue, to offer an innovative model, incorporating traditional asset classes and other more alternative classes. In order to do this, we have defined variables capturing systemic risk, which has now become something that cannot be ignored in the creation of investment performance. The ultimate objective is to find out whether the alpha remaining after all the risk factors in respect of returns have been taken into account has persistence over time.

The model has two types of risk factors: traditional and alternative. The risk factors determined by indices are expressed as total return indices.

Table 2. Risk factors

Traditional risk factors	Equities	S&P 500
		NASDAQ
		MSCI BRIC
		MSCI US growth
		MSCI US value
	Rates	10-year US govies
		US 1-month interbank interest rate
	Foreign exchange	Euro-US Dollar
Alternative risk factors	Commodities	S&P Commodities
	Derivatives	VIX
	Systemic risk	3-year ITRAXX Europe (CDS)
		US corporate spread AAA/BAA
		US money supply trend (M2)

The model's innovation essentially lies in the incorporation of financial variables describing systemic risk within 3 segments of the economy:

1. Purely financial with European CDS premiums.
2. Industrial with corporate spreads of the US companies, with a Moody's rating of AAA and BAA, respectively.
3. Sovereign with the relative trend in liquidity within a State, determined in this instance by the monetary aggregate (M2) of the United States (notes, coins, short-term deposits and term deposits under 2 years).

2.2. The statistical model. Style regression is a very worthwhile technique for determining the allocation of a portfolio using only its returns, and without knowing the management policy which has been implemented.

2.2.1. Principle of Sharpe regression style. The article written by Sharpe (1992) in the *Journal of Portfolio Management* is fundamental when analyzing

the style of mutual funds and performance attribution in regard to them. In that article he defines a factor-based model made up of different asset classes. He uses 20 in all, ranging from short-term rates to share indices, according to different capitalizations, various geographic regions, and by using bond indices. He, therefore, covers the universe of traditional asset classes quite comprehensively. He finally defines dynamic and implicit portfolio exposure by imposing the following constraints: total exposure equal to 1 and each exposure being positive.

2.2.2. Estimation. The factor-based model is defined as follows:

$$r_t = \sum_{i=1}^{k} \beta_i F_{i,t} + \varepsilon_t ,$$

where r_t is the return on the portfolio determined on date t, β_i is the exposure to t factors $F_{i,t}$ and ε_t is the residual of the model.

We are adding exposure α to Sharpe's original model via a factor of 1 only.

We can also write this model as a matrix by considering the vector R as the total returns over the period under review:

$$R = F\beta + \varepsilon.$$

The Ordinary Least Squares (OLS) estimator comes from minimizing the sum of residuals in the squares:

$$\hat{\beta} = \arg\min \sum_{t=1}^{T} \varepsilon_t^2$$

which, from a matrix point of view, is equivalent to:

$$\hat{\beta} = \arg\min \varepsilon'\varepsilon = \arg\min \left(R - F\beta\right)' \left(R - F\beta\right).$$

This estimator has as its standard solution (and so without constraints):

$$\hat{\beta} = \left(F'F\right)^{-1} F'R.$$

However, when there is a wish for constraints to be added as in Sharpe's article (1992), we do not have any explicit solution. An optimi\ation program must, therefore, be decided which turns out to be a quadratic program.

In fact, the function to be minimized can also be written as:

$$\left(R - F\beta\right)' \left(R - F\beta\right) = R'R + \beta'F'F\beta - 2\beta'F'R$$

$$\propto \frac{1}{2}\beta'F'F\beta - \beta'F'R.$$

So now we do have a standard quadratic optimization program for determining $\hat{\beta}$ by adding the constraints $\beta_i > 0 \; \forall i$ and $\sum_{i=1}^{k} \beta_i = 1$.

To capture non-linearity of hedge funds performance, we can use piecewise regression. The equation we have to estimate, for two predefined pieces which are separated by the value 0, is:

$$R = F\beta_{bear} 1_{\{R<=0\}} + F\beta_{bull} 1_{\{R>0\}} + \varepsilon.$$

β_{bull} is determined when the market is bullish, i.e. the market increases, and on the contrary β_{bear} is determined when the market is bearish, i.e. the market decreases.

2.3. Estimation of performance due to leverage. *2.3.1. Where does alpha come from?* Using the previous example again, the manager outperforms by an additional 1%, while taking management fees, for three basic reasons:

1. His choice of financial securities was good: good *stock picking* is also talked about.
2. He went into or left certain market segments (asset classes, industrial sectors, geographic areas among others) at the right time: this is called *market timing*.
3. In the case of hedge funds his *leverage* policy essentially proved to be effective.

A comparison of the different alphas determined by literary articles that cannot be ignored testifies to significant differences according to the combinations of systematic risk factors used. But taken as a whole, the additional return of hedge funds seems established. It will be useful to observe the impact of the subprime crisis on these alphas – few studies still tackle this subject.

2.3.2. Leverage and alpha. Leverage is first and foremost a source of performance for hedge fund investors. However, the value of the leverage taken by a hedge fund is generally passed on by the fund without necessarily obtaining all its ins and outs. We are, therefore, going to develop a method to measure it quantitatively based solely on returns and so objectively. The idea of this measure is to use the previous model, to determine the classical alpha and to compare it with the alpha for the same model but without any leverage possibilities. This is reflected by the following constraints:

1. Risk factor exposure which is always positive: ban on selling risk factors.
2. Total exposure equal to 100%: no borrowing possibilities.

With these constraints, 2 main sources of hedge fund leverage are eliminated: short selling and investment leverage. In this instance we have taken inspiration from the style regression developed by Sharpe (1992) for determining the benchmarks and implicit allocations of mutual funds. By determining the difference between these 2 alphas, which we write down as $\alpha_{leverage} = \alpha_{without\ constraints} - \alpha_{with\ contraints}$, we will be able to obtain the source of outperformance or underperformance due to leverage. $\alpha_{with\ contraints}$ acts as a pure alpha based on selection (picking) and allocation (timing).

Two types of outcome are then possible:

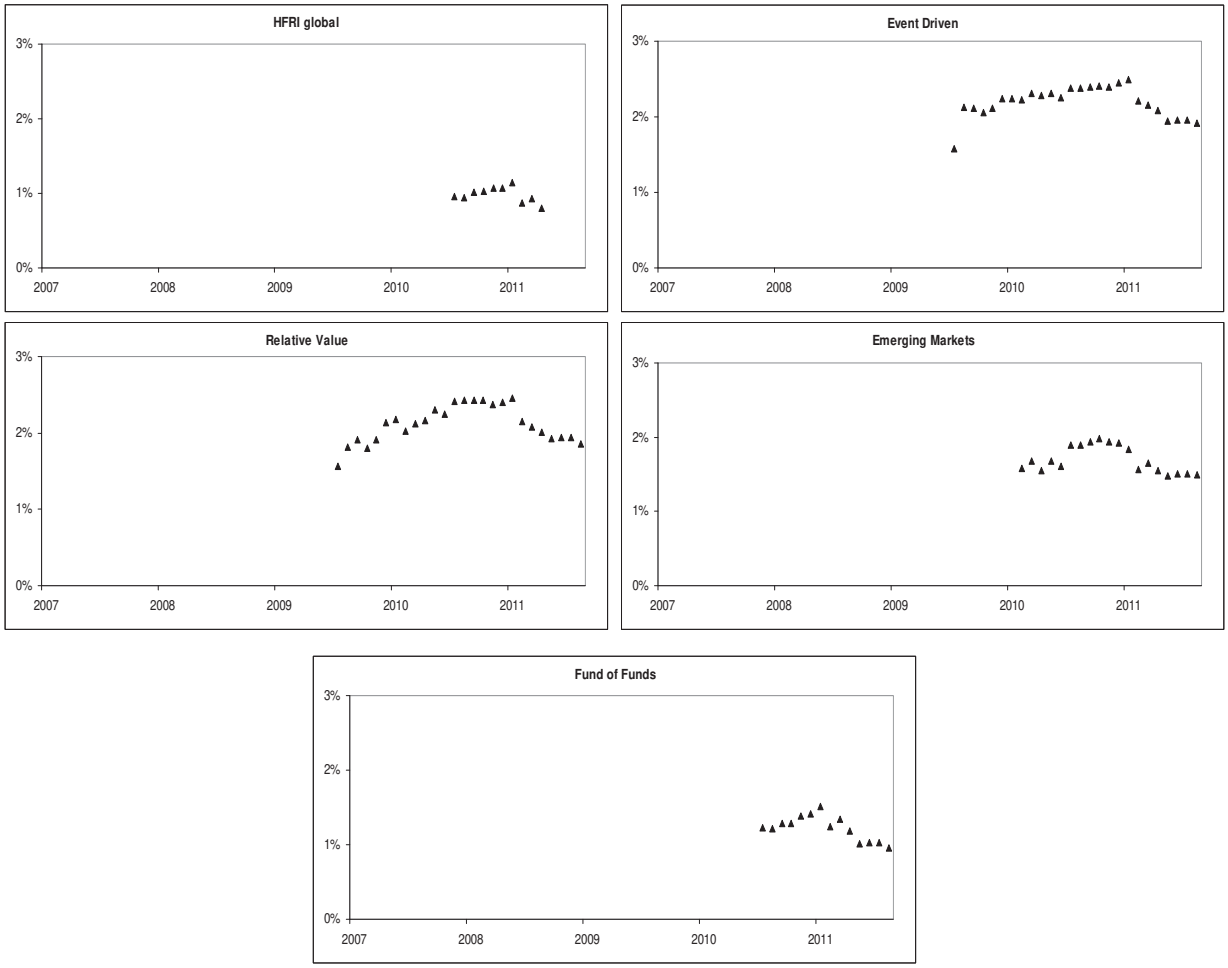
1. $\alpha_{leverage} > 0$, so leverage is beneficial and makes it possible to create investment performance for hedge funds;
2. $\alpha_{leverage} < 0$, so leverage is a source of risk and with no leverage, hedge funds may perform better. In other words, the performance of unleveraged hedge funds can be replicated, creating more alpha: it can then be considered that hedge funds will be tempted to use leverage less.

Contrary to McGuire & Tsatsaronis (2008), we will measure the two types of hedge funds leverage through the performance (alpha) and not through the exposures of the factor model.

3. Empirical results

3.1. Performance of hedge funds strategies. The period covered by our study is from March 31, 2005 to September 30, 2011. The data is monthly data. In order to carry out our linear regressions, a minimum data sample is required: therefore, we are not able to determine an alpha as from March 31, 2005, but we use the first 2 years (24 months) to introduce our estimators. We are, then, able to observe the alphas from the graphs below. The alphas on the graphs are the only significant ones at the 5% threshold.

The model here is determined without the constraints of Sharpe regression style.



Source: Datastream and author's own calculations.

Fig. 1. Monthly alphas for the different HFR indices

Interestingly, we observe the alphas in 2010 and 2011 for most strategies, after a learning period between 2007 and 2009 for all strategies, some of which again managed to find the road back to outperforming the market a bit before mid-2009 (Event Driven and Relative Value). With this model, the Equity Hedge

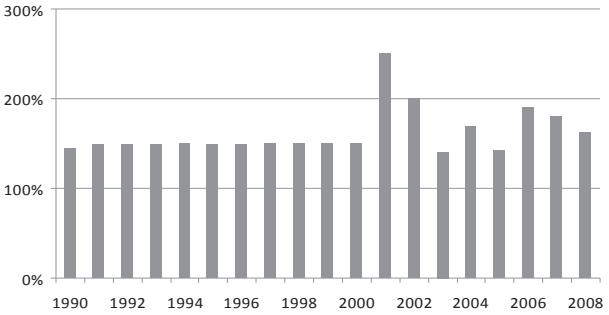
and Macro strategies do not show any significant alphas. This does not mean that these strategies have not create any investment performance over the period 2007-2011, but that this performance is only due to risk factors in the returns. Therefore, after times of scarcity lasting for 2 to 3 years hedge funds have again found sources of outperformance by adapting to the new financial environment.

When the risk factor weightings are looked at in detail, we can see (for the global HFRI index) several very interesting lessons:

1. Since January 2010, a negative weighting in US equities.
2. Disappearance of the positive weighting in short-term rates and in commodities since mid-2009.
3. Positive weighting in favor of value equities since summer 2010.
4. Diminishing systemic risk exposure which then disappears in 2011.

These reallocations have made it possible for hedge funds to again find the source of outperformmance, while greatly reducing the risk taken. However, another fundamental change has taken place: lower investment performance due to leverage.

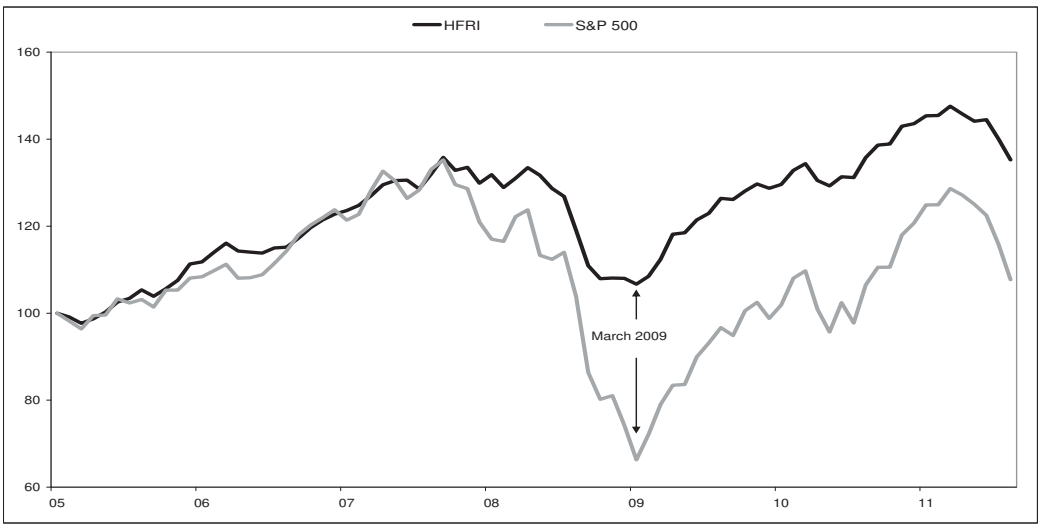
3.2. Leverage measurement. On the basis of estimated hedge funds' AUM and market exposures, we can quantify the investment leverage since 1990: the last 2 years inevitably show a decrease. Given that the leverage stemming from the use of derivatives is through off balance sheet OTC (other-the counter) transactions, it is simply not possible to quantify its level.



Source: Andrew W. Lo (2008) and authors' calculations.

Fig. 2. Evolution of the investment leverage

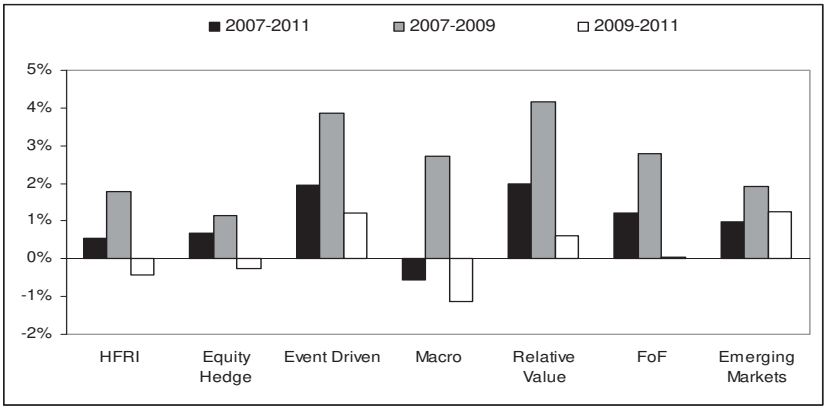
To precise leverage, we use our quantitative model and the measurement defined above. We split the sample into two sub-samples based on the market bullish trend since March 2009 (Figure 3).



Source: Datastream.

Fig. 3. Total return indexes (basis 100)

The figure below shows that leverage-based performance fell drastically between July 2007-March 2009 and March 2009-September 2011. A change of paradigm occurred most probably because of less use of leverage. Hedge funds have tightened their belts.



Source: Datastream and author's own calculations.
Note: FoF: Funds of Hedge Funds.

Fig. 4. Monthly $\alpha_{leverage}$ for the different HFR indices

Hedge funds have, therefore, changed tack in order to recover alpha by making more limited use of leverage, which was overused before 2009. It should be explained that this reduction in leverage is also due to the decrease in available liquidity compared to 2008, when the central banks had flooded the interbank market; furthermore, increased capital requirements have led to a reduction in prime brokerage activity; lastly, the ban on short selling has had the knock-on effect of reducing this leverage.

However, in spite of this, hedge funds have managed to find the road back to alpha.

For the distinction between bull and bear markets, we notice in Figure 5 that the directional strategies, as Macro, Fund of Funds (FoF), Emerging Markets, logically use leverage in bull markets to take advantage of increase and reduce it on bear markets; contrary to Equity Hedge and Relative Value strategies, whose performance due to alpha is more observed with bear markets (due certainly to short selling).

We have to precise that we have not data enough to study the leverage in the same precedent subperiods.

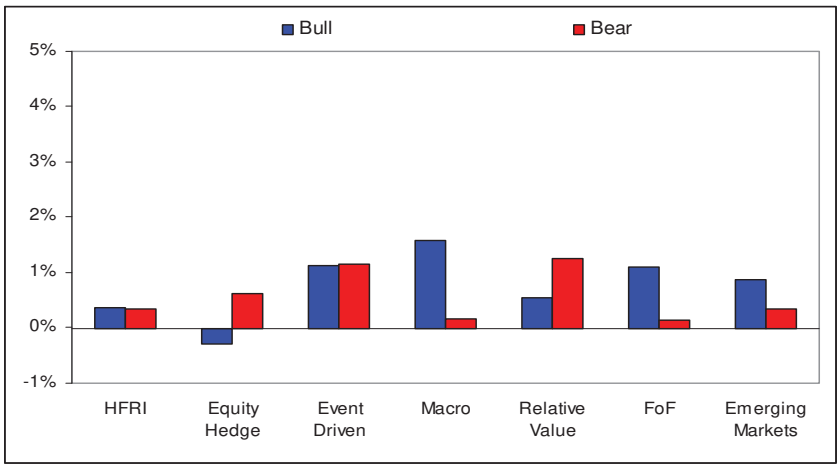


Fig. 5. Monthly $\alpha_{leverage}$ for the different HFR indices with distinction between bull and bear markets

Conclusion

To conclude, with no preconceived ideas at the outset, we must acknowledge the astonishing ability demonstrated by hedge funds to adapt to the new financial environment through attractive diversification between strategies, judicious reallocation and less use of leverage, amongst other things. The study is based only on the indices of the main hedge fund strategies defined by HFR and not the hedge funds directly. This in no way detracts from the truthfulness of the results, which make it possible to define a standard model which I hope will prove useful to anyone wishing to study hedge funds and their potential use of leverage.

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