

# The Hedge Fund Industry's Market Timing Ability and Role in Financial Contagion: Evidence from the Strategic Response to the 2008 Financial Crisis

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The organizational structure of hedge funds as limited partnerships allows managers to use proprietary strategies that are usually more aggressive. The common claim is that such aggressive proprietary strategies result in superior performance; however, it results in higher management fees. This paper investigates the ability of fund managers to anticipate market events and adopt appropriate strategies to capitalize on them. We attempt to find evidence of superior predictive ability of hedge fund managers by examining the performance of hedge funds prior to, during, and after the 2008 financial crisis. Our results show that there were some general structural and behavior changes made by hedge fund managers in response to the crisis. However, there was no convincing evidence that hedge fund managers are able to anticipate market events and implement superior strategies during the crisis. Return correlations to market indices strengthened after the crisis indicating some degree of adjustment and change in strategy after the crisis. Finally, while there is evidence of autocorrelation in returns before the crisis, there was none afterwards. We conclude that the ability of fund managers to anticipate and exploit catastrophic market events is not very strong.

*JEL classification:* G17, G19, G23

*Key words:* contagion, hedge funds, financial crisis

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## 1. Introduction

A hedge fund is an investment vehicle that is typically organized as a limited partnership with a relatively small number of investors who are limited partners and the sponsoring firm that acts as the general partner. Because the number of investors in the fund is restricted, there are often very high minimum investments. Those who invest in hedge funds tend to be wealthy individuals, professional investors, and financial institutions; in other words, entities that generally have the capacity to tolerate higher levels of risk and are considered sophisticated investors. As a limited partnership, the typical hedge fund is not subject to investment restrictions imposed by regulatory authorities in the U.S. securities markets, especially the those restrictions imposed by the Investment Company Act of 1940. This organization allows the managers of the fund to pursue much more aggressive strategies than would be permissible with the management of mutual fund which are heavily regulated by the Securities and Exchange Commission (SEC).

The hedge fund industry has grown phenomenally over the last quarter century. The industry had \$36 billion of assets under management (AUM) in the early 1990's. This increased to almost \$2 trillion prior to the onset of the global economic crisis in 2008. At the industry's peak, there were an estimated ten thousand hedge funds worldwide (White, 2014). Some attribute this growth to the industry's strong performance during the 1990's technology bubble (Brunnermeier & Nagel, 2004). Even though AUM decreased substantially during the crisis period (it was \$1449.76 billion at the end of 2018), it surpassed \$2 trillion level again by the end of March 2014 (Barclay Hedge). Hedge funds generally claim to implement proprietary investment strategies that result in superior performance and attract investors. Given the increasing popularity and presence of hedge funds across global markets, strategies, as well as any changes to strategies implemented by hedge funds could have measurable and significant effects on financial markets. One consequence of this is that hedge funds, while responding to events in one market, can act as a channel for communicating the effects of those events to other markets. In other words, hedge funds contribute to what is commonly recognized as contagion.

While the September 2008 Lehman Brothers bankruptcy filing is identified as a key event triggering the sharp declines in equity prices on global markets, the financial and economic crisis can trace its start to the Summer of 2007, when Bear Stearns' High-Grade Structured Credit Strategies Enhanced Leverage Fund and its High-Grade Structured Credit Fund had practically no equity remaining after their leverage bets on Credit Derivative Options (CDOs) that were collateralized by subprime mortgages suffered crippling losses. This triggered many so-called "quant" funds to also suffer sizeable losses, leading some to be liquidated. It had also brought widespread questions about the value of subprime loans by an increasingly wary market and within the general population. Additionally, while the financial crisis may have been initiated by events in U.S., the crisis was rapidly transmitted to Europe, Asia, and Latin America. The fact that the financial crisis spread to a number of countries at about the same time led to the widespread belief in contagion across the financial markets.

There is no uniform definition of what constitutes contagion. Contagion refers to the spread of market disturbances from one country to another country or a group of countries, a process observed through co-movements in exchange rates, stock prices, sovereign spreads and capital flows. Contagion can occur for different reasons and can conceptually be divided into two categories (Pritsker, 1997; Masson, 1998). The first emphasizes spillovers resulting from the normal interdependence among market economies. The interdependence will mean that shocks, whether of a global or local nature, will be transmitted across countries because of the countries' shared real and financial linkages. The second involves a financial crisis which cannot be linked to observed changes in macroeconomic or other fundamentals and is solely the result of the behavior of investors or other

financial agents. This type of contagion is often said to be caused by “irrational” phenomenon, such as herd behavior, increases in risk aversion, general loss of confidence, and ultimately, financial panic.

This paper provides some indirect evidence of hedge fund managers contributing to the spread of financial contagion. The paper finds some circumstantial evidence that the response of hedge fund managers to the financial crisis could have possible spillover effects to other markets. Some markets, such as China and India, were relatively insulated from the effects of the financial crisis due to the restrictions that were placed on these markets by their governments. Hedge funds that were investing in these markets; i.e., Asia focus funds (exclusive of Japan) and Global funds with a focus on these markets had positive results, even during the crisis. However, wherever there were no such protective restrictions, hedge funds were unable to achieve positive returns. This may be because they were unable to implement strategies to respond to the crisis without any regulatory restrictions, thus contributing to the spread of panic.

The general approach of this paper is a slight departure from the more traditional methods. Instead of focusing on market indices, this paper investigates whether hedge fund strategies were affected by the crisis and if fund managers recognized the changing risk environment and altered their asset allocation and their investment strategies prior to the crisis. More specifically, the paper will investigate whether hedge fund managers with significant investments in specific markets or an investment focus on specific markets, altered their allocation and strategies prior to the collapse becoming public knowledge; i.e., before information regarding the collapse had been propagated across markets. This would establish that these fund managers were able to predict the crash in developed markets and subsequently modify their actions in anticipation of the impending crisis. Such a response by them could have played a role in the spread of the crisis to other, relatively safer markets.

## **2. Literature Review**

Hedge funds differ from most other investment vehicles in a fundamental way. While all other types of investment firms allow individual investors to withdraw; i.e., an easy exit, hedge funds impose restrictions, or a lockup period. These restrictions result in lower liquidity for participating investors, who will thus demand an illiquidity premium. After the study by Amihud and Mendelson (1986) established the existence of an illiquidity premium in equity markets, there has been a great deal of effort in identifying various illiquidity measures. Most research focused on equity markets and finding proxies for illiquidity, such as bid-ask spreads and transaction costs. But, illiquidity can be explicitly observed in the partnership agreements of a hedge fund. In fact, the superior performance of hedge funds can be attributed to the existence of an illiquidity premium. Liang (1999) shows a correlation between the lockup period and return performance, while more

recently, Aragon (2007) shows more illiquid hedge funds have relatively superior returns. Schaub and Schmid (2013) study illiquidity premiums before and during crisis periods. They find that there is an illiquidity premium for funds in the non-crisis period that turns to an illiquidity discount during the crisis period.

Some literature has pointed to the market timing ability of hedge fund managers as the reason for higher performance. One of the principal focuses of this paper is to identify whether hedge fund managers exhibit superior market timing ability. Treynor and Mazuy (1966) was one of the first attempts to measure market timing ability of professional managers. Most subsequent studies have not found any compelling evidence for the timing ability of mutual funds. With the emergence of the large hedge fund industry, claims were made regarding the ability of these managers to produce relatively higher performance. Superior market timing is often claimed as one of the contributing factors, although there is evidence that this may be due more to an illiquidity premium (Liang, 1999; Aragon, 2007). Chen & Liang (2007) examined the market timing of hedge fund managers. They show that there is evidence of superior timing ability during bear periods. The market timing abilities of hedge fund managers during the 2008 financial crisis was studied by Aiken, Kilic & Reid (2016). Although their results show there was no timing ability overall, they did find evidence of some timing ability during and after the 2008 financial crisis among emerging markets-oriented funds.

This paper also attempts to study the contribution of hedge funds to the propagation of financial contagion, though in an indirect manner. An examination of contagion due to the 2008 financial crisis is important for portfolio investment strategies and justification of multilateral intervention. First, a critical tenet of an investment strategy is that most economic disturbances are country-specific, so stock markets in different countries should display relatively low correlations. International diversification should therefore substantially reduce portfolio risk and increase expected returns. If market correlations increase after a negative shock (contagion), this would undermine much of the rationale for international diversification. Second, policymakers worry that a negative shock to one country can reduce financial flows to another country, even if the fundamentals of the second country's economy are strong and there are few real linkages between two countries. Even if this effect is temporary, it could lead to a financial crisis in the second country; a crisis completely unwarranted by the country's fundamentals and policies. In the presence of contagion, multilateral intervention and contribution to bail-out funds can be justified.

A variety of econometric techniques have been used to test if contagion occurs during prior financial and currency crises. The transmission of shocks has been measured by simple cross-market correlation coefficients, GARCH models, cointegration techniques, and probit models. There are several studies that focus on the organizational characteristics and performance attributes of hedge funds (Ackermann, McEnally, & Ravenscraft, 1999; Liang, 1999; Agarwal & Naik, 2000a,

2000b, 2004; and Aragon, 2007). Despite research for both financial crises and contagion being fairly extensive, opinions vary widely on what constitutes contagion. This lack of consensus has led to a wide variety of testing methodologies and metrics that measure and differentiates contagion effects from normal co-movements across international markets. The most popular methods include changes in the correlation of asset returns, changes in the cointegration relationships, structural breaks or regime shifts across the crisis period, and application of extreme value theory. Each of these methods has its advantages as well as drawbacks. The primary aim of all methods is to differentiate between the effects – those caused by existing dependencies and those caused by abnormal behavior. In early correlation change studies, higher correlation indicated contagion (Bertero & Mayer, 1990; King & Wadhvani, 1990; Lee & Kim, 1993). However, Forbes & Rigobon (2002) show that covariance tests are biased towards accepting the alternative hypothesis. Kaplanis (1988) and Ratner (1992) show that international correlations over adjacent sub-periods are fairly constant. Moreover, although covariances may increase, correlations can be stable. Given these results, correlation tests can serve as adequate metrics of contagion. Longin & Solnik (1995) further refine these tests by explicitly modeling correlations on a conditional multivariate distribution. Phylaktis & Xia (2009) show that contagion effects are sector specific; i.e., the effects differ across different sectors of the market.

Several studies look at different aspects of the financial crisis and hedge fund performance. Ben-David, Franzoni & Moussawi (2012) found that during the 2008 financial crisis, hedge funds significantly reduced their equity holdings because of redemptions and margin calls. Schaub & Schmid (2011) found the performance prior to and after the 2008 financial crisis was linked to the liquidity restriction policies of various hedge funds. Billio, Getmansky & Pelizzon (2010), in their study of the collapse of Long Term Capital Management, found that strategies that are employed by hedge funds exhibit a high level of idiosyncratic risk. They attribute this risk to contagion among different hedge fund strategies. Boyson, Stahel & Stulz (2010) found that there is contagion, especially among the worst performing hedge funds, due to liquidity and adverse shocks.

### **3. Motivation and Hypothesis Development**

The existing literature on hedge funds has extensively examined hedge funds from the perspective of funds' superior performance due to superior strategies and active management as justification for the funds' fee structures. Generally, the results have been in favor of hedge funds in that there is evidence in support of superior performance of hedge fund managers, whether this is due to the existence of an illiquidity premium or not. This is in contrast to the mutual fund literature, where the risk-adjusted returns do not seem to justify the additional fees charged by these funds.

This paper does not attempt to uncover further evidence of superior hedge fund performance. Rather, using that as a premise, we ask whether market timing is one of the contributing factors to superior performance, and if there is evidence to support the existence of such market timing ability. The measurement of timing ability is difficult under most circumstances. In the case of hedge funds, it is further exacerbated by the fact that hedge funds are not regulated and thus not required to report any financial information. Under normal circumstances, the ability to time the market may take the form of rather small or minor changes to strategy, which renders the signal difficult to read. However, the response should be clear in cases of major market upheavals. We therefore chose the 2008 financial crisis to measure the anticipatory ability of the hedge fund industry to this catastrophic event.

If hedge fund managers are able to time the market, we should see a significant correlation between their return structure and the returns of the indices of the market on which the fund is focused. The reason is that, even if a fund does have a superior performance with respect to an index, there is no compelling reason for its returns to be correlated to the index returns, unless there is a connecting element. We attribute this connection, at least in part, to the fact that fund managers monitor their particular market and take appropriate action in anticipation of market movements. If this ability to time the market is consistent, then such correlations should persist during the crisis period also.

We also examine whether hedge funds were implementing their proven successful strategies consistently through all periods of market changes, either when markets are relatively stable and also during a crisis period. If hedge funds are implementing strategies consistently, we should see evidence of autocorrelation in their returns. If the strategies are not implemented with consistency, there should be no autocorrelation. What this means, in terms of a provable hypothesis, is that if hedge funds were able to anticipate market changes, even during the crisis period, we should see evidence of return autocorrelation during the crisis period as well. We use various methods such as measuring the strength of correlations, presence (or absence) of autocorrelation, and also the size effect of strategies by means of measuring the difference in the slope coefficient in the periods defined as before, during, and after the financial crisis.

Another inference that can be drawn from this investigation is that if hedge funds were anticipating and responding to market crises across the global markets, it can contribute to the spread of such crises; i.e., financial contagion. We believe that these two premises – evidence of the superior market timing ability and contribution to contagion are the significant contributions of this paper to existing literature.

#### **4. Data**

Since hedge funds are not regulated and consequently do not need to report performance to regulatory authorities, the data is sparse and does not lend itself to

a multi-dimensional analysis. It must be noted that, since performance figures are self-reported by the funds, they may have a reporting bias.

The data for this paper was collected from the Lipper Hedge Fund (TASS) database. We follow most prior studies in selecting the time period; e.g., Khandani & Lo (2011), Teo (2011), Sadka 2010, Agarwal & Naik (2009), Aragon (2007), who all start their studies in 1994. The time period our sample covers is mostly from 1994 through 2013. Some of the categories of funds started a little earlier and some a little later. Following Chen & Liang (2007), we divide our sample into three periods; a pre-crisis period from 1996 to 2006, a during-crisis period from early 2007 to the end of 2008, and after-crisis period from the beginning of 2009 to the end of 2013. Chen & Liang (2007) find that market timing hedge funds exhibit more timing skill in bear markets, perhaps due to managers receiving different signals in volatile periods.

As a part of their proprietary investment strategy, hedge funds may focus on a particular financial sector, or assets from a specific regional market, or may invest across the world markets. For the purpose of our analysis, we segregate the funds by the market focus of their investment strategy. These distinct market categories include,

- Emerging Markets Funds
- Funds investing in North America
- Asia, inclusive of Japan
- Funds focused exclusively on Japan
- Western Europe
- Global Funds
- No Focus Funds

The categorization may seem strictly geographic in nature. However, it must be noted, that the above categorization is not by the physical location of the fund. Rather, it is the investment focus or strategy of the fund that determines what category it falls into. For example, if a fund is included in the North American funds category, that fund invests primarily in assets that are traded in North American markets. The fund itself may be located anywhere in the world. Additionally, there are other funds which focus on Pan-Europe, Pan-America, Asia (exclusive of Japan), Northern Europe, and Eastern Europe. The data on these funds was insufficient to perform any robust analysis.

A further complication was introduced by the fact that hedge funds, by nature of their investment strategies, often have limited life and are dissolved. We find the number of funds in the sample varies considerably over time. This can raise the question of survivorship bias. That would constitute a major flaw in performance studies and would result in biasing the results in favor of superior performance. The primary focus of this investigation, is not fund performance, but presence or absence of market timing ability of hedge funds and their role in the propagation of

financial crises. As such, we do not think that survivorship bias would distort the results of this paper.

**Table 1 : Descriptive Statistics (monthly returns)**

<b>Panel A: Complete Sample</b>				
<b>Fund Focus</b>	<b>Period</b>	<b>Mean</b>	<b>Std Dev</b>	<b>Number of Funds</b>
Asia	1994-2013	0.87%	3.43%	189
Emerging Markets	1994-2013	0.75%	4.31%	932
Global	1991-2013	0.85%	1.97%	2735
Japan	1998-2013	0.55%	2.54%	213
North America	1984-2013	0.99%	2.43%	2361
No Focus	1991-2013	0.71%	1.79%	6365
Western Europe	1989-2013	0.94%	3.24%	465
<b>Panel B: Before (up to 2006)</b>				
<b>Fund Focus</b>	<b>Period</b>	<b>Mean</b>	<b>Std Dev</b>	<b>Number of Funds</b>
Asia	1994-2006	1.23%	3.90%	111
Emerging Markets	1994-2006	1.19%	4.64%	552
Global	1991-2006	1.20%	1.88%	1408
Japan	1998-2006	0.82%	2.54%	182
North America	1984-2006	1.21%	2.55%	1729
No Focus	1991-2006	1.06%	1.72%	6029
Western Europe	1989-2006	1.16%	2.51%	288
<b>Panel C: During (2007-2008)</b>				
<b>Fund</b>	<b>Period</b>	<b>Mean</b>	<b>Std Dev</b>	<b>Number of Funds</b>
Asia	2007-2008	0.30%	2.19%	163
Emerging Markets	2007-2008	-0.83%	4.78%	754
Global	2007-2008	0.17%	1.92%	1951
Japan	2007-2008	-0.41%	1.53%	197
North America	2007-2008	-0.11%	2.28%	1964
No Focus	2007-2008	-0.71%	2.58%	2176
Western Europe	2007-2008	-0.17%	2.01%	373
<b>Panel D: After (2009-2013)</b>				
<b>Fund</b>	<b>Period</b>	<b>Mean</b>	<b>Std Dev</b>	<b>Number of Funds</b>
Asia	2009-2013	0.13%	1.04%	137
Emerging Markets	2009-2013	0.28%	2.95%	698
Global	2009-2013	0.10%	1.27%	2069
Japan	2009-2013	0.45%	2.84%	96
North America	2009-2013	0.42%	1.40%	1357
No Focus	2009-2013	0.14%	1.09%	1294
Western Europe	2009-2013	0.32%	1.69%	344



The data itself, as mentioned earlier, is segregated by hedge fund investment focus and each of these categories are then divided into three periods, that is, *Before* the crisis, consisting of firm year return observations from 1994 to the end of 2006; *During*, which consists of return observations of 2007 to the end of 2008; and *After*, which consists of the rest of the sample; i.e., from 2009 through 2013. The descriptive statistics for the entire period as well as for the three sub-periods are provided in Table 1. The table is partitioned into four panels. The entire sample is covered in Panel A. The *Before* period (from the beginning of the sample up to 2006) is in Panel B, the *During* period (2007-2008) is in Panel C, and the *After* period (2009-2013) is in Panel D.

The Global focus funds seem to have the best risk-return ratio, followed by North American focus funds for the entire period of the sample. All the funds recovered after the crisis had passed, in the sense that all exhibit positive returns during the *After* sub-period. The North American funds seem to have posted the best recovery, with the highest risk-adjusted return. Surprisingly, two groups, the Asia focus and the Global focus funds, were able to post positive returns during the crisis period. Government policies and other insulating factors may have played a role in their being somewhat immune from the effects of the crisis. The number of funds during each period was counted. A very curious phenomenon emerges. The number of funds during the crisis had increased across almost every sector (with the No Focus sector being the exception). Given that the markets were in crisis, we would expect the number of funds to decrease. This increase may be a strategic response, whereby managers were seeking some accounting advantage by floating new funds and shifting assets. Once the crisis had passed, a significant portion of these funds seem to have been wound down. This may need to be investigated further.

## 5. Methodology

The paucity of data and the fact that the data is mostly self-reported places severe restrictions on the type of analysis we may employ. Our investigation is directed at the response of hedge funds to the 2008 financial crisis and determines whether the funds were able to change the strategies that they followed before the advent of the crisis. While the exact nature of the strategies cannot be identified, establishing that they were altered may be inferred.

A CUSUM test was applied on the return series to identify any possible break. Although we could not reject the null hypothesis of no structural break, there is evidence of a kink in the cumulative residuals which coincides roughly with the timing of the Lehman Brothers collapse; i.e., September 2008. The CUSUM statistic is computed as

$$W_t = \sum_{i=k+1}^T \frac{w_i}{s_i} \quad (1)$$

where  $w_t$  is the cumulative residual and  $s_t$  is the standard error of the regression. The upper and lower bounds are calculated as  $[k, \pm 0.948(T-k)^{1/2}]$  and  $[T, 3 \times \pm 0.948(T-k)^{1/2}]$ .

As previously described, the sample for each fund was broken into three sub-periods, *Before*, *During*, and *After* the financial crisis. Three methodologies were adopted to analyze the data – testing changes to the relationship to the market sector of the fund, testing changes in return correlations to the market sector of the fund, and an autoregression model.

### 5.1 Test for changes in relationship to the market sector

The hedge fund return performance is regressed on the index returns appropriate for the sector, for the *Before*, *During*, and *After* periods. A pooled regression is run on the pooled sample, including a dummy variable and an interaction term. The dummy takes the values of 0 for the *Before* period and 1 for the *After* period. The coefficient on the dummy measures changes to the intercept. These proxies for the effect of any changes caused by macroeconomic or structural factors. The interaction term is defined as the product of the dummy and the index returns. The coefficient of the interaction term measures the change in the coefficient of the returns; i.e., the size effect. This is the critical test of any change of the response of hedge funds due to the crisis. The individual regression models are as follows:

$$Fundperf_{i,b/d/a} = \beta_{0,b/d/a} + \beta_{i,b/d/a} Ind Ret_{i,b/d/a} + \varepsilon_{b/d/a} \quad (2)$$

where  $Fundperf_i$  is the  $i^{\text{th}}$  fund performance and  $Ind Ret_i$  is the index return for that sector. The suffixes  $b,d$  and  $a$  refer to the *Before*, *During*, and *After* periods.

The pooled regression is modeled as

$$Fundperf_{i,p} = \beta_{i,0} + \beta_{i,p} Ind Ret_{i,p} + \beta_{i,dum} DUM_i + \beta_{i,int} INT_i + \varepsilon_{i,p} \quad (3)$$

Where  $DUM_i$  is the Dummy for the *Before* and *After* periods and  $INT$  is the interaction term, defined as  $DUM \times \text{Index Return}$ .

### 5.2 Test for changes in correlations with the market sector

For this test, each fund's return correlations with the corresponding index are tested for changes in strength between the *Before* and *After* periods. The correlations between the fund and the index for each period are estimated. The change in strength of the relationship for the periods before and after the crisis are tested by transforming the correlations into their equivalent standard normal form, using the Fisher transformation,

$$Z_i = \frac{1}{2} \ln \frac{1 + \rho_i}{1 - \rho_i} \quad (4)$$

where  $\rho_i$  is the correlation between the returns of  $i^{\text{th}}$  firm and those of the appropriate index. The distribution of  $(Z_{i,pre} - Z_{i,post})$  is approximately normal with a zero mean and variance of

$$\sigma_i = \frac{1}{n_{i,pre} - 3} + \frac{1}{n_{i,post} - 3} \quad (5)$$

and where  $n_{i,pre}$  and  $n_{i,post}$  are the pre- and post-sample sizes.

### 5.3 Autoregressive Model Estimation

The time series of asset returns is very frequently modeled as an autoregressive process. In general, the autoregressive time series may be represented as

$$X_t = \mu(t) + \sum_{i=1}^n \varphi_i X_{t-i} + \varepsilon_t \quad (6)$$

where  $\mu(t)$  may be time-varying a mean or a constant, and  $X_{t-i}$  are the lagged values of the autoregressive variable  $X_t$ . The  $\varphi_i$ s are the coefficients of  $X_{t-i}$  and represent the strength of influence of past values of  $X_t$  upon its current value. If  $B$  is a backshift operator such that  $BX_t = X_{t-1}$  then the AR model can be written as

$$X_t = \mu(t) + \sum_{i=1}^n \varphi_i B^i X_t + \varepsilon_t. \quad (7)$$

Here we are considering an AR( $n$ ) model; i.e.,  $n$  terms from the past have an influence on the current value of  $X_t$ . A necessary condition for estimation is that time series must be stationary; i.e., the coefficients  $\varphi_i < 1$ . If not, the series is integrated. Most asset prices are integrated of order 1 and can be made stationary by differencing once. However this paper analyzes returns, which by definition are differences, and therefore the resulting series is stationary. If the roots of the

polynomial  $1 - \sum_{i=1}^n \varphi_i B^i$  are  $\gamma_i$ , then the autocorrelations can be estimated from the

autocorrelation function  $\rho(\tau) = \sum_{i=1}^n a_i \gamma_i^{-|\tau|}$ . The autocorrelation function is of

particular interest in this paper, since it allows us to make inferences about the behavior of hedge funds before and after the crisis. If hedge fund managers have superior anticipation of market events, we should see persistent autocorrelation in every sub-period. However, if they cannot anticipate shocks, we should see autocorrelations disappear during the periods where the managers were unable to predict market changes. The autocorrelation functions of the hedge fund performance were obtained with Yule-Walker estimations. We implemented a parsimonious model in the sense that we reduced the lookback periods, from large

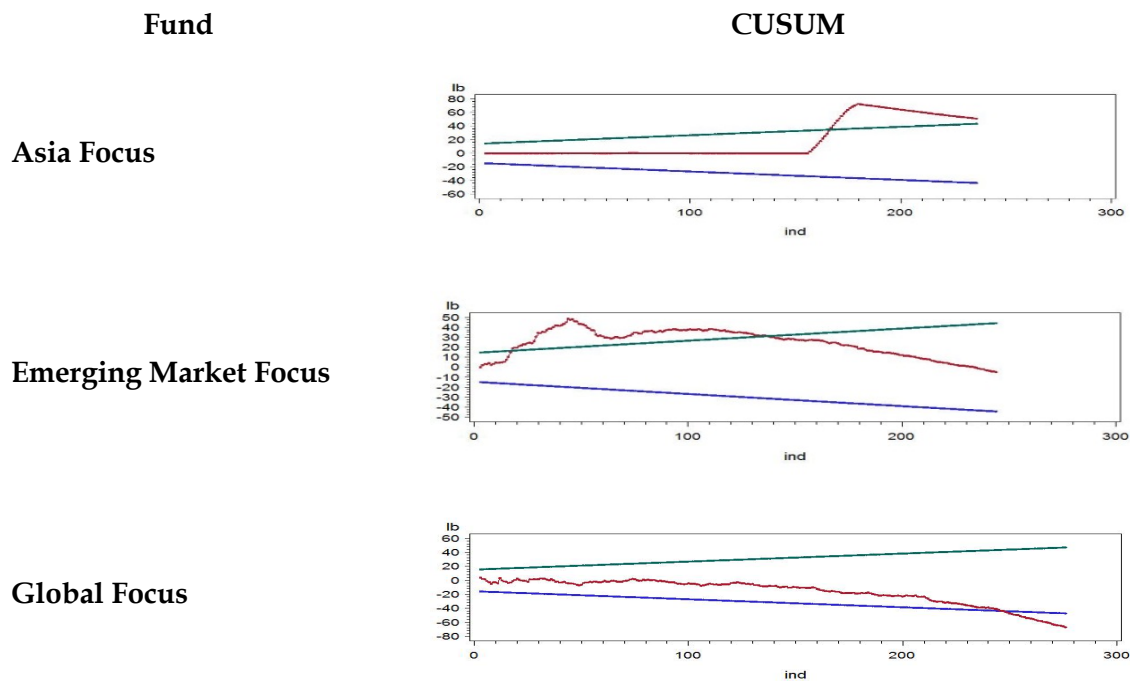
to small. Since the data is of monthly frequency, we look from 12-month to monthly lags.

This method also indicates whether the funds were implementing new strategies in response to the crisis. If managers are able to time the market, we should see autocorrelations in the period before the crisis. If there are no autocorrelations in this period, it would be evidence that the managers do not have superior predictive ability under all circumstances. If there are autocorrelations in the *Before* period, but none during the crisis period, then we may infer that the managers were unable to anticipate the crisis. The presence or absence of autocorrelations in the *After* period can have different interpretations. If managers were able to implement new strategies that are successful, then we should see significant autocorrelations. If there are none, it may be due to the fact that funds have not yet been able to discover successful strategies in the new environment. That is, the funds are experimenting with new strategies in the changed market environment and their performance will become a pure random walk.

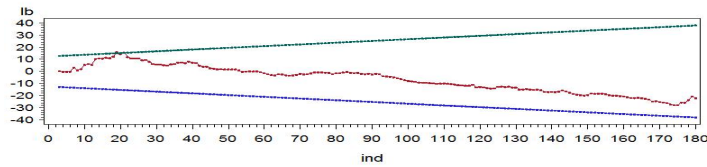
### 6. Results and Conclusion

The CUSUM test showed that all of the hedge fund performance series with the exception of the North American funds exhibit structural breaks. These results may be seen in Figure I.

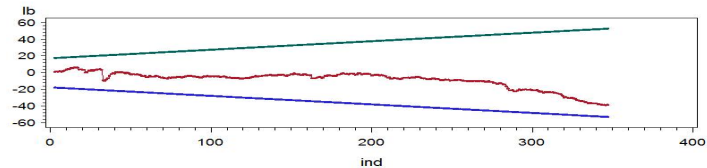
**Figure I. Illustrations of the CUSUM test results for identifying structural breaks over the entire sample (1994-2013).**



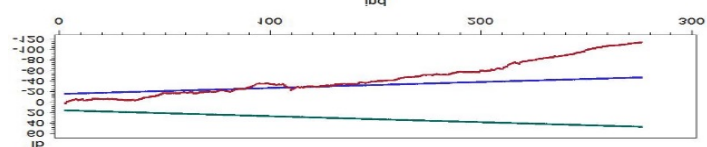
### Japan Focus



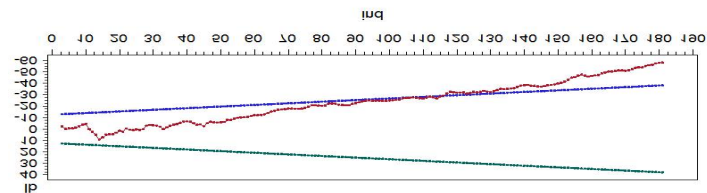
### North American Focus



### No Focus



### Western Europe Focus



The cumulative sums crossed the Upper or Lower bound prior to, or just after the crisis began in the third quarter of 2008. In particular, the various Emerging Market funds, as a group, showed a break very early in their series, indicating an early response or even some anticipation of the crisis.

We show regression results in Table 2. The betas of the respective indices are highly significant in explaining the funds' performances in each period. The pooled regression results show that there are no significant changes from any size effect, as shown by the coefficient of the interaction term, **INT**, which displayed no statistical significance to most of the funds. The only exceptions to this are the Japan Focus sector (significant at the 94% level) and the No Focus sector (significant at the 99% level). The coefficient of the Dummy is significant for all funds, an indication that there were structural changes and behavioral responses to the crisis by hedge fund managers.

The changes in correlation test results are shown in Table 3. All the hedge fund returns are highly correlated with their index results. There is a significant increase in the strength of the correlation with the market in the period after the crisis. This may indicate that the funds abandoned their previous strategies and moving closer to traditional strategies, while stabilizing themselves and investigating new

methods of generating superior returns. The notable exceptions here are the North America and No Focus sectors.

**Table 2: Regression Results**

<b>Fund</b>	<b>Before</b>	<b>During</b>	<b>After</b>	<b>Pooled</b>	<b>DUM</b>	<b>INT</b>
Asia Focus	21.869***	18.848***	22.175***	21.869***	-1.332***	0.305
Emerging Markets Focus	44.004***	54.111***	49.179***	54.111***	-1.097***	5.983
Global Focus	18.869***	13.116***	25.825***	13.12***	-1.217***	5.752
Japan Focus	42.662***	31.558***	20.032	31.558***	-0.542***	31.558*
North America Focus	-0.0069	7.268**	17.821**	7.268**	-0.727**	-7.275
No Focus	16.353***	26.525***	38.336***	26.525***	-0.906***	-10.172***
Western Europe Focus	29.854***	28.876***	29.788***	28.876***	-1.010***	0.977

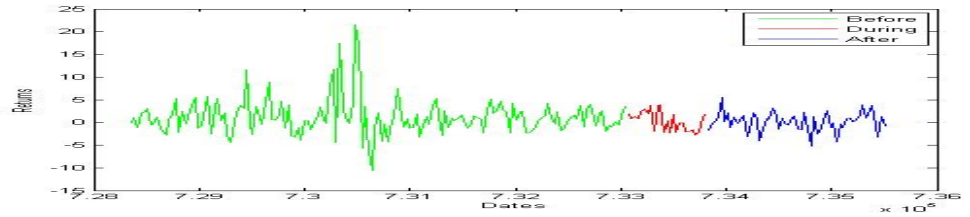
**Table 3**

<b>Fund</b>	<b>Rho (After)</b>	<b>Rho (During)</b>	<b>Rho (Before)</b>	<b>Z (After-Before)</b>
Asia Focus	0.7110	0.823	0.406	2.874***
Emerging Market Focus	0.9530	0.964	0.763	5.704***
Global Focus	0.7420	0.758	0.266	4.509***
Japan Focus	0.8630	0.868	0.602	3.532***
North America Focus	-0.0002	0.415	0.121	-0.839
No Focus	0.6920	0.789	0.610	0.937
Western Europe Focus	0.7470	0.757	0.515	2.357***

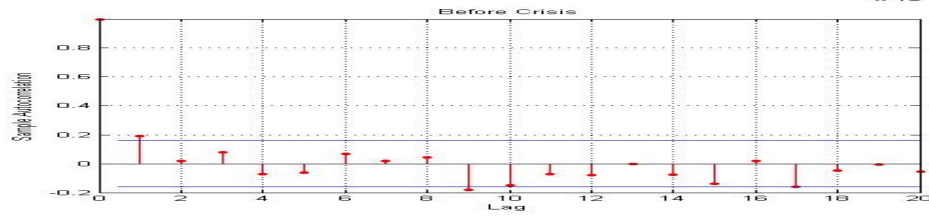
The autocorrelation functions from the estimation of the AR(n) model are shown in Figures II to VII. The fund performances show autocorrelation in the period before the crisis. This can be interpreted as evidence that fund managers do seem to have some significant market timing ability. This is expected since they would be implementing strategies that proved successful. All fund performances show no autocorrelations in the period after the crisis. In effect, they have become pure random walks in the period after the crisis.

Figure II: Asia Focus Funds Autocorrelations

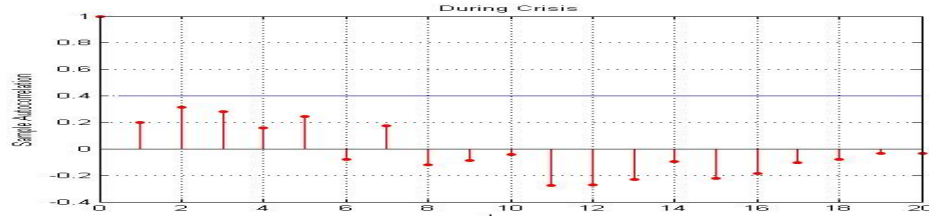
Performance



Autocorrelation Before Crisis



Autocorrelation During Crisis



Autocorrelation After Crisis

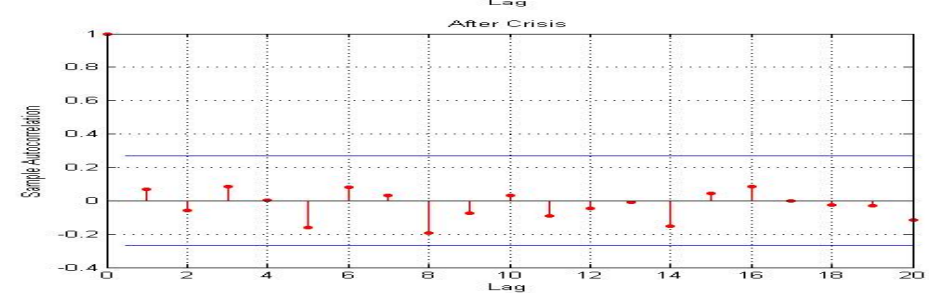


Figure III: Emerging Market Focus Funds Autocorrelations

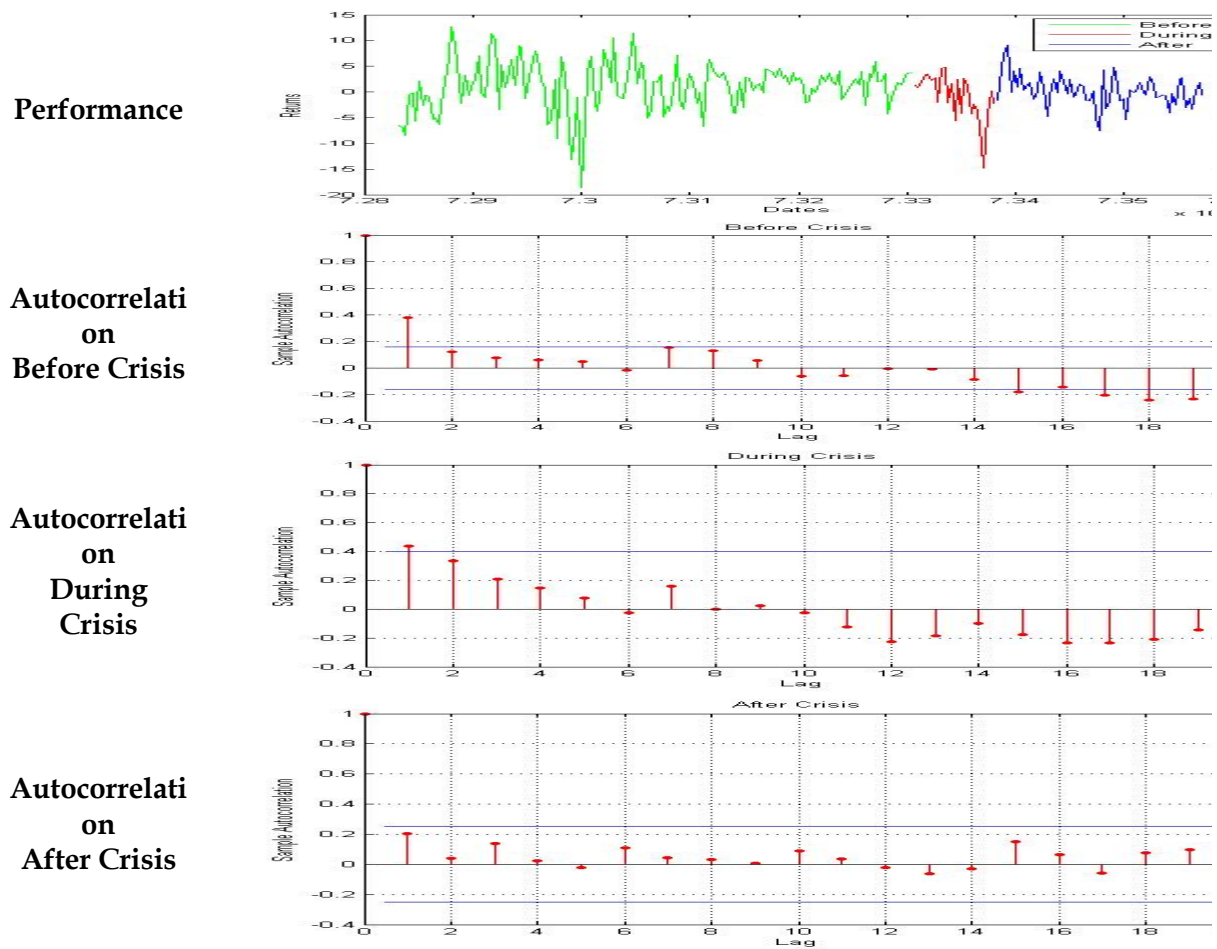
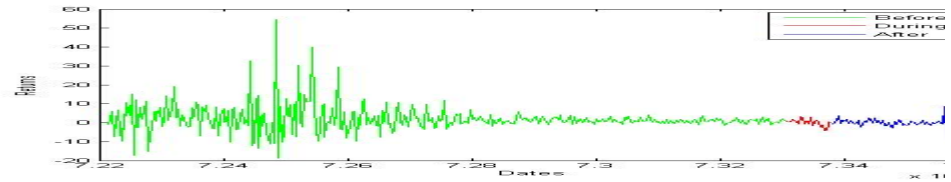


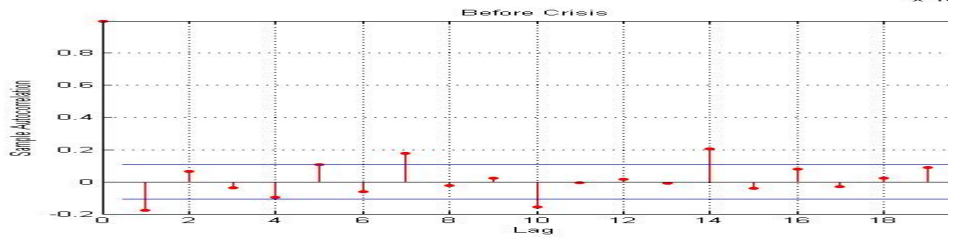


Figure IV: Global Focus Funds Autocorrelations

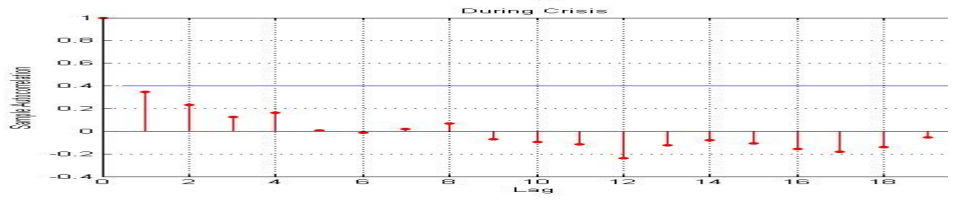
Performance



Autocorrelation on Before Crisis



Autocorrelation on During Crisis



Autocorrelation on After Crisis

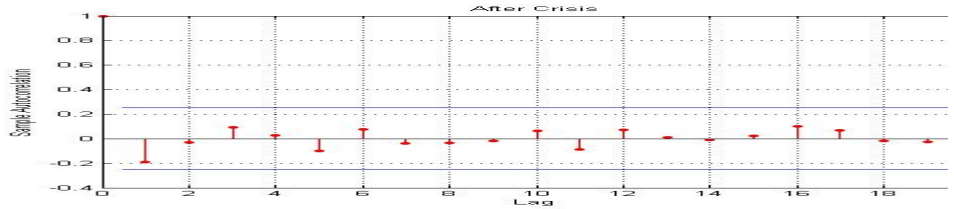
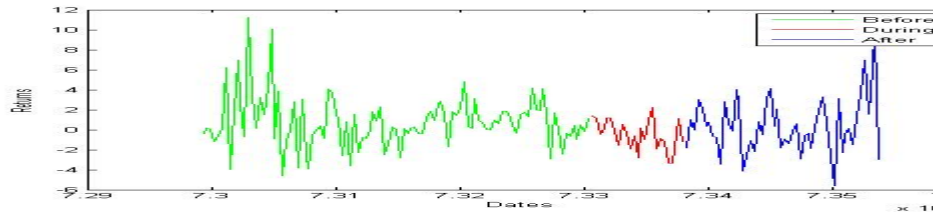
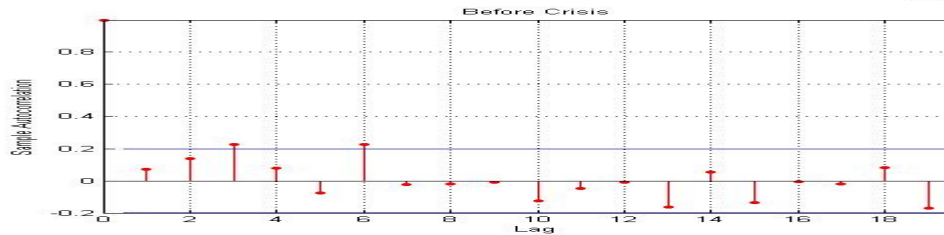


Figure V: Japan Focus Funds Autocorrelations

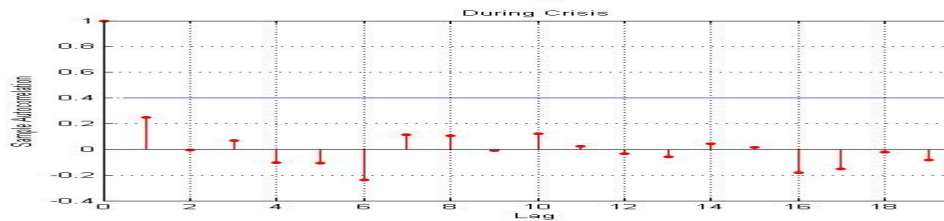
Performance



Autocorrelation on Before Crisis



Autocorrelation on During Crisis



Autocorrelation on After Crisis

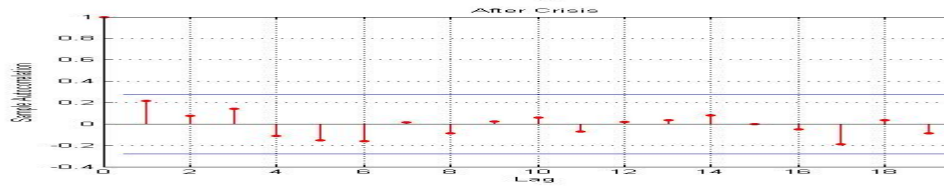
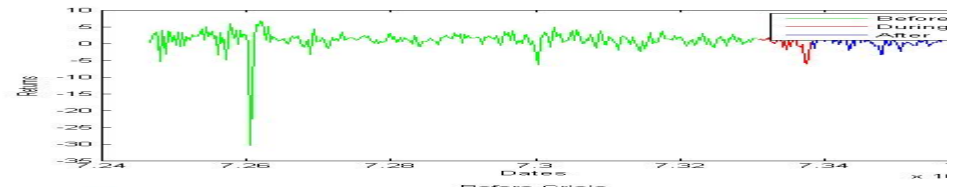
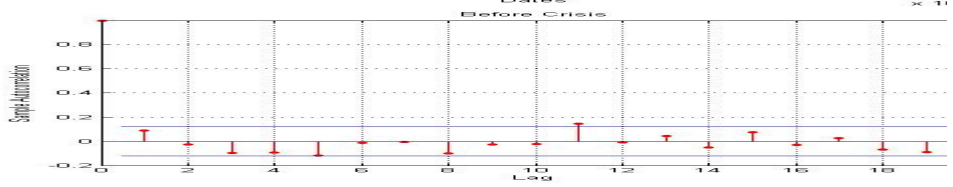


Figure VI: North America Focus Funds Autocorrelations

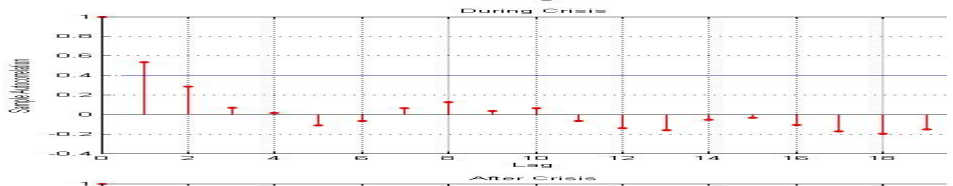
Performance



Autocorrelation on Before Crisis



Autocorrelation on During Crisis



Autocorrelation on After Crisis

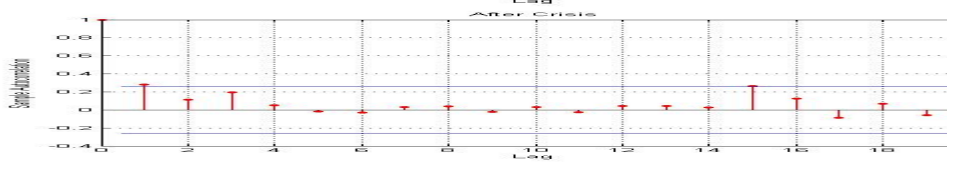
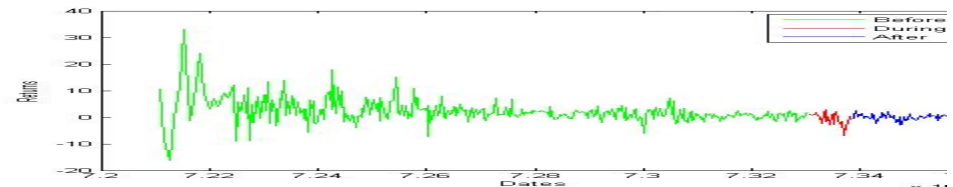
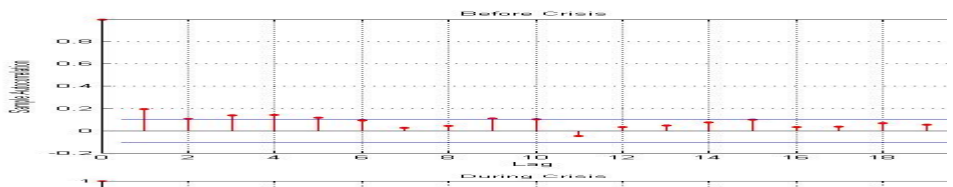


Figure VII: No Focus Funds Autocorrelations

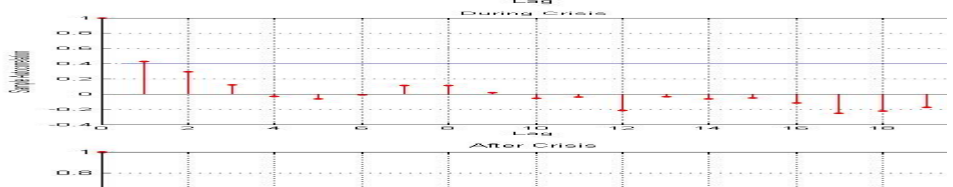
Performance



Autocorrelation on Before Crisis



Autocorrelation on During Crisis



Autocorrelation on After Crisis

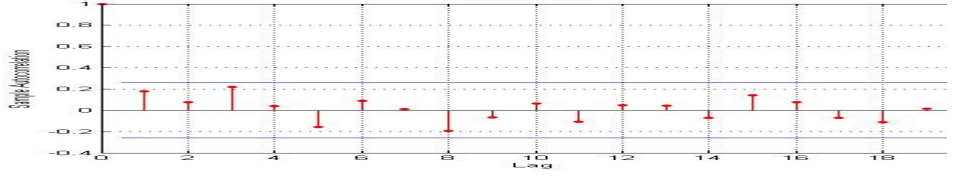
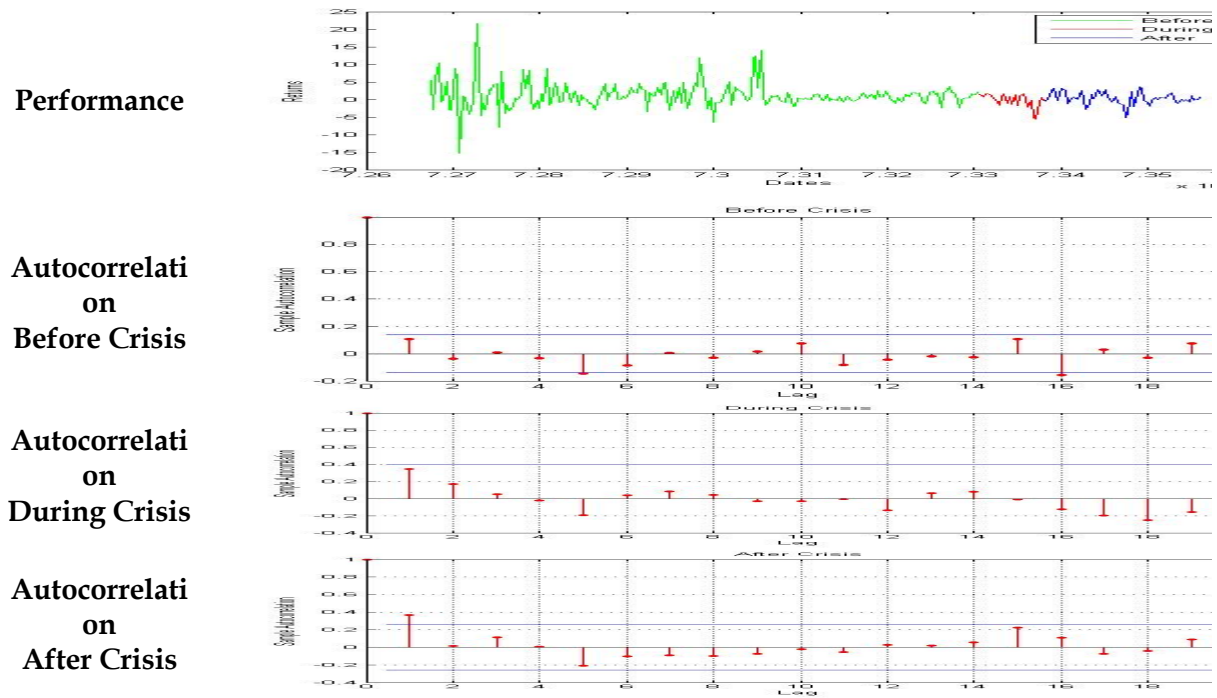


Figure VIII: Western Europe Focus Funds Autocorrelations



While the great financial crisis of 2008 may not have significantly altered the aggressive nature of the investments that hedge fund managers make, the events leading to the crisis as well as those highlighting the crisis resulted in significant breaks in the relationships between hedge fund returns and market index returns. Our test results indicate that hedge funds altered their pre-existing investment strategies, and adopted new strategies in response to the financial crisis. However, our tests do not provide any evidence of hedge funds' superior ability to predict the market crisis or an ability to respond to such a crisis in a timely fashion. The results of having no autocorrelations during the crisis period support this view.

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