HAIGAZIAN UNIVERSITY

NEGATIVE RETURNS PRODUCE HIGHER CO-MOVEMENT AND HIGHER VARIANCE IN U.S. AND REGIONAL STOCK MARKETS

by

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A thesis
submitted in partial fulfillment of the requirements for the degree of
Masters of Business Administration
to the Faculty of Business Administration & Economics
at Haigazian University

Beirut, Lebanon
January 2010

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ACKNOWLEDGEMENTS

I would like to express my deepest gratitude and recognition to Dr. Samih A. Azar for his continuous support and guidance in this thesis.

I would also like to thank my big family at the *Spring of Life* Church for their prayers and continuous encouragement.

Abstract

The study of cross-border links in stock market returns is a key issue in specialized finance. The existing literature studies the effect of volatility on stock index co-movement, the relation between the tail returns of two financial assets and the stock index co-movement in post-crisis events, all of which lead to a higher correlation in stock returns. In this paper, we analyze the effects of *negative* returns of 18 US and 40 regional stock indexes on the magnitude of the co-movement of these stock indexes and on the magnitude of their total variances. We find empirical evidence that *negative* returns increase the co-movement of these stock indexes as well as the variance of returns. Then we relate this differential correlation of negative returns to behavioral finance, in particular to loss aversion, and specifically the disposition effect, in the sense that the fear of investors in realizing losses leads to a smaller volume of trading, which results in less liquidity and hence higher transaction risk on one hand, and more volatility and hence higher variance of returns on the other hand.

Introduction

In the past two decades, specialized research in finance has focused on cross-border links in stock market returns. Correlation, interdependence, co-movement, spillover, integration, contagion, co-volatility and similar keywords have emerged to dominate the universe of financial empirical research. If markets are more integrated, it is expected that their stock indexes display common trends. This is especially true after a contagious crisis happens. That is why most studies have dealt with post-crisis correlation of stock indexes compared with pre-crisis correlation. While this is not the purpose of this thesis, the literature on the subject is worth surveying because the patterns identified by this literature are directly relevant.

Events such as the 1992 European Monetary System crisis, the 1994 Mexican crisis, the 1997 Czech Republic and Asian crises, the 1998 Russian crisis, the 1999 Brazilian crisis, the 2001 Argentinean crisis, and the recent 2008 US crisis, along with the fear of a global financial system collapse, are driving researchers to be more interested in investigating cross-border links in stock market returns, since the negative consequences of these crises are not limited to the countries of origin, but are transmitted all over the world to several international markets.

A considerable amount of work has been devoted to investigating the degree of interdependence between stock markets. The evidence revealed in these studies suggests that the degree of correlations has increased substantially, especially in volatile periods. Several notable factors, such as expanding links between national economies, increased intra-regional trade, the trend of deregulations, cross-border investment, and the speed of international portfolio reallocations result in a world in which stock markets become more synchronized and hence more correlated.

The study of the transmission of shocks among international financial markets is important in its own right. This helps to assess the vulnerability of capital markets to international financial shocks (Forbes and Rigobon, 1999), to construct efficient portfolios (Ang and Bekaert, 2002) and to measure the potential for international diversification (Goetzmann *et al.*, 2005).

While approaches of standard finance, such as the portfolio principles of Markowitz (1952), the arbitrage principles of Miller and Modigliani (1958), the capital asset pricing theory of Sharpe (1964) and Lintner (1965) and the option pricing theory of Black and Scholes (1973) and Merton (1973), consider markets to be efficient and highly analytical, another branch of finance, behavioral finance, seeks to understand and predict systematic financial market implications of psychological decision processes.

A basic principle theory within behavioral finance is loss aversion. As the name indicates, loss aversion means that people are averse to losses – they tend to be more sensitive to decreases in their wealth than to increases. While selling winning stocks too early, investors, being loss averse, may tend to hold on to losing positions in the hope that prices will eventually recover.

Based on the above, this paper presents a significant contribution to the literature of financial integration for three important reasons. It analyses the effects of *negative* returns of 18 US and 40 regional stock indexes first on the magnitude of the co-movement of these stock indexes, and second on the magnitude of their total variances. Third, it relates this differential correlation of negative returns to behavioral finance, in particular to loss aversion, and specifically the disposition effect, in the sense that the fear of investors in realizing losses leads to a smaller volume of trading, which results in less liquidity and hence higher transaction risk on one hand, and more volatility and hence higher variance of returns on the other hand.

This paper is structured as follows. In the second section, a literature review of existing studies about international market movements, financial crises, contagion effects and loss aversion is carried out. Although this paper does not study crises, the main purpose of reviewing the literature on financial crises is that in such research one finds three relevant patterns. One is the effect of volatility on stock index co-movement. Two is the relation between the tail returns of two financial assets. And three is the stock index co-movement in post-crisis events. All these lead to a higher correlation in stock returns. The intuition that negative returns increase the correlation in stock returns is directly attributable to this literature because (1) contagion occurs usually with price declines more than with price advances, (2) higher correlation means higher volatility, and (3) the whole left tail distribution of returns is considered, instead of a small extreme left tail. In the third section, the data and the methodology used in this study are presented. In the fourth section, the empirical findings are summarized and discussed. Finally, the main conclusions and future research suggestions are provided.

Literature Review

First, we present a literature review of topics in volatility, tail behavior and post crisis effects. This survey is related to our project in the sense that in these topics we find studies on the co-movement of indexes. Then the literature is augmented by that on loss aversion and, specifically, the disposition effect. This is important in order to set the main hypothesis of this thesis which is that negative returns have a higher differential correlation.

Odier and Solnik (1993) found that correlations among US and international stock markets were higher when markets were most volatile, i.e. correlations are larger when market movements are large. Thus diversification seems to offer smaller benefits in periods of large movements in general and particularly in periods of large down movements, precisely when the benefits of diversification would have been most welcome.

Solnik, Boucrelle and Le Fur (1996) studied the correlation across bond markets, and across stock markets. They examined 37 years of monthly data for stocks and 36 years of monthly data for bonds. They observed that international correlations for stocks and bonds fluctuate widely over time. They also observed that volatility is contagious across markets. In addition, international correlation increases in periods of high market volatility. This is not good for investors because it is precisely during volatile moments in the market that low correlation is most desired.

Masih and Masih (1997) conducted a study of dynamic linkages of national stock prices of the stock markets of Taiwan, South Korea, Singapore and Hong Kong. They found that the established markets (i.e. Japan, USA, UK and Germany) play the leading role in driving the fluctuations in this group of stock markets. In other words, the established markets and Hong Kong were the initial receptors of exogenous shocks to the long-run equilibrium relationships, and the remaining markets, particularly the Singapore and Taiwan stock markets, had to bear most of the burden of adjustment to re-establish the long-run equilibrium relationship. The evidence highlighted the vulnerability of the Taiwan and Singapore stock markets to external shocks from the established markets.

Gelos and Sahay (2001) examined the effects of contagion in the economies of Central and Eastern Europe, Russia and the Baltic. They used a vector autoregressive VAR model and Granger causality tests to study stock markets, foreign exchange markets, debt markets and interest rates. They concluded that after the 1998 Russian crisis, the movements of the European emerging markets were similar to the movements that were observed in many Asian and Latin American markets during the Asian Crisis. In the sense of Granger's causality, which determines whether one time series is useful in forecasting another, the shocks originating from the Russian stock market caused the movements in the markets of the Czech Republic, Hungary and Poland. On the other hand, they rejected the null hypothesis that there was contagion originating from the markets of the Czech Republic, Asia and Russia, in the direction of the European financial markets.

Forbes and Rigobon (2002) studied the vulnerability of capital markets to international financial shocks. They showed that correlation coefficients depend on market volatility, and hence during a crisis when stock market volatility increases, cross-market correlations will be overestimated. They presented a method of correcting for heteroscedasticity and calculating unconditional cross-market correlation coefficients. They observed that there was virtually no contagion during the 1997 Asian crisis, 1994 Mexican devaluation and the 1987 US market crash. However, they observed that in all periods there was interdependence, i.e. high level of market co-movement.

Ang and Bekaert (2002) studied how to construct efficient portfolios. They investigated a US investor with Constant Relative Risk Aversion utility that maximizes end of period wealth and dynamically rebalances in response to regime switches. They modeled the state dependence of US, UK and German equity returns using a regime-switching model and found evidence for the existence of a high volatility regime, in which returns are more highly correlated and have lower means. They observed that there are always relatively large benefits to international diversification even with regime changes; moreover, currency hedging imparts further benefits. The costs of ignoring regime switching may be small or large depending on the presence of a conditionally risk-free asset. The inter-temporal hedging demands induced by time-varying correlations are negligible. Investors have little to lose by acting myopically instead of solving a more complex dynamic programming problem for horizons greater than one period.

Yang, Kolari and Min (2003) examined both short-run and long-run relationships between the US, Japanese and 10 Asian markets in the pre-crisis, crisis, and post-crisis periods. They concluded that both long-run co-integration relationships and short-run causal linkages among these markets were strengthened during the crisis and that these markets have generally been more integrated after the crisis than before the crisis. They also observed that the degree of integration among countries tends to change over time, especially around periods marked by financial crises.

Gerard, Thanyalakpark and Batten (2003) used an ICAPM approach and a bi-diagonal multivariate GARCH(1,1) process to examine the integration of East Asian stock markets with the US and other world markets. They found little or no evidence of either partial or total market segmentation for the Asian markets during the period 1985–1998. They also found that residual returns are significantly related to exchange rate variables. Local return shocks in emerging markets are found to have a differential impact on the return covariance between emerging markets but not on their covariance with developed markets. Hence, emerging markets display a lower level of interrelatedness with developed markets.

Goetzmann, Li and Rouwenhorst (2005) measured the potential of international diversifications. They collected data from 150 years of global equity market history in order to evaluate the stationarity of the equity correlation matrix through time. They showed that correlations were high during periods of economic and financial integration. Decomposing the benefits of international diversification into two parts – a component that measures variation of the average correlation across markets and a component that measures variation of the investment opportunity set – they found that half the benefits of diversification available to the international investor are due to the increasing number of world markets and half is due lower average correlation among the available markets.

Collins and Gavron (2005) used the vector autoregressive VAR method to measure the occurrence of contagion across 42 countries distributed over 6 blocs during nine financial events. According to the definition used in their paper, contagion represents an increase in co-movement between stock market returns. In other words, it is the significant increase in the correlation coefficient of the expected index returns between the crisis country and the tested countries from a 'stable' point prior to the event and a 'turmoil point' immediately following the event. They demonstrated that the 1999 Brazilian crisis and the 2001 Argentinean crisis are the most infectious crises, contaminating 14 countries. The 1997 Thai (Asian) crisis is found to be one of the lesser influential crises, infecting only 8% of the sample countries. On the other hand, they found no evidence of contagion from the Russian crisis to the Brazilian bond markets. Twelve countries showed no evidence of contagion during any of the events, and interestingly, the USA in not among them. Finally, according to the trade bloc co-membership, they find that the incidence of contagion appears to be more global than regional, with only very few incidences of contagion, primarily the 1997 Czech Crisis, to have regional impact.

Boyer, Kumagal and Yuan (2006) used the estimated correlations from a regime-switching model to find that stock market crises are spread through asset holdings of international investors. They estimated and compared the degree to which accessible (i.e. eligible for purchase by foreigners) and inaccessible (i.e. not eligible for purchase by foreigners) stock index returns co-move with the index return of the crisis country. The same estimation and comparison is also made after separating out the effects of exchange rate shocks. They suggested that if contagion is investor induced, either through portfolio rebalancing or wealth constraints, the co-movement of accessible stock returns with the crisis country stocks should increase more than the co-movement of inaccessible stock returns with the crisis country stocks during the period of turmoil. On the other hand, if contagion is fundamental based, the increase in co-movement should be similar for both accessible and inaccessible stocks. They had empirical evidence to prove that correlations with the crisis country increase during turmoil period, indicating that the crisis was transmitted through accessible stocks. They observe that this result is neither due to correlated exchange rates nor due to differences in cash flows. One of the tests they performed is worth mentioning here, since it provides empirical evidence on whether crises spread due to portfolio rebalancing or wealth constraints. If crises are transmitted due to investors' portfolio rebalancing needs, market co-movements should be symmetric in extreme market upturns and downturns. If crises are transmitted due to investor wealth constraints, market co-movements should be greater in extreme market downturns than extreme market upturns. They estimated the difference between the correlations in the negative and the positive tails at 1.5 standard deviations away from the mean for emerging and developed markets. Then they considered the number of countries with positive differences and performed a sign test. They found evidence that negative tail correlations are larger than positive tail correlations for emerging markets for both accessible and inaccessible returns. This led them to reject the null hypothesis and to conclude that higher correlations in the negative tail suggest that portfolio rebalancing is unlikely to be the channel through which crises spread among emerging markets. On the other hand, they found that the following null hypothesis cannot be rejected for developed countries: portfolio rebalancing can be a mechanism through which crises spread to developed countries.

Lin and Cheng (2008) used a multinomial logistic model to examine daily data for the period 1994–2004 in order to identify the economic determinants and to assess the co-movements across international stock markets. The results indicate that both volatility of stock market returns and the rate of change in the exchange rate affect the co-movement of those stock markets, regardless whether the time period is during or after financial crisis. Furthermore, they observe that interest rate differentials play an increasingly important role in the period after the financial crisis.

Leitao, Lobao and Armada (2008) used a complete set of tests – correlation tests, Kolmogorov-Smirnov tests, tests of extreme value (which identifies the part of the total observations that is located in the extreme percentiles of 5% and 95% of the probability distribution) and tests based on the estimation of Co-Integrated Vector Autoregressive CVAR models – to study the contagion effects between the financial markets of nine developed countries: Portugal, Spain, Ireland, Greece, France, United Kingdom, Germany, USA and Japan. The results revealed the importance of contagion effects on stock markets in developed countries during the crises in the 1990s. With these 9 developed countries, they detected one case of very strong contagion, the Asian crisis, two cases of strong contagion, the Russian crisis and the September 11 crisis, two cases with limited evidence, the Brazilian crisis and the Argentinean crisis, and one case with no significant contagion, the Mexican crisis.

Beirne, Caporale, Schulze-Ghattas and Spagnolo (2009) used a tri-variate VAR-GARCH-in-mean framework with the BEKK representation (i.e. a general multivariate GARCH model) to model and examine global and regional spillovers in means and variances of emerging market stock returns. They used a series of Wald tests involving restrictions on various spillover parameters to analyze the importance of different transmission channels. They tested a benchmark case of no spillovers in mean, no spillovers in variance and no GARCH-in-mean effects and 3 sets of hypotheses: tests of spillovers in mean, tests of spillovers in variance, and tests of GARCH-in-mean effects. They found empirical evidence to reject the benchmark case that rules out any spillovers from regional or global stock markets to local emerging markets, and hence they found that such spillovers are present in the majority of the emerging market economies analyzed. They also found that spillovers in mean returns are dominant in emerging Asia and Latin America, while spillovers in variance are observed to be dominant in emerging Europe. They also found some evidence of cross-market GARCH-in-mean effects. The relative importance of regional and global spillovers varies too, with global spillovers dominating in Asia, and regional spillovers in Latin America and the Middle East.

Next, a literature review of behavioral finance is presented, since the results will be directly related to behavioral finance, and specifically to the disposition effect.

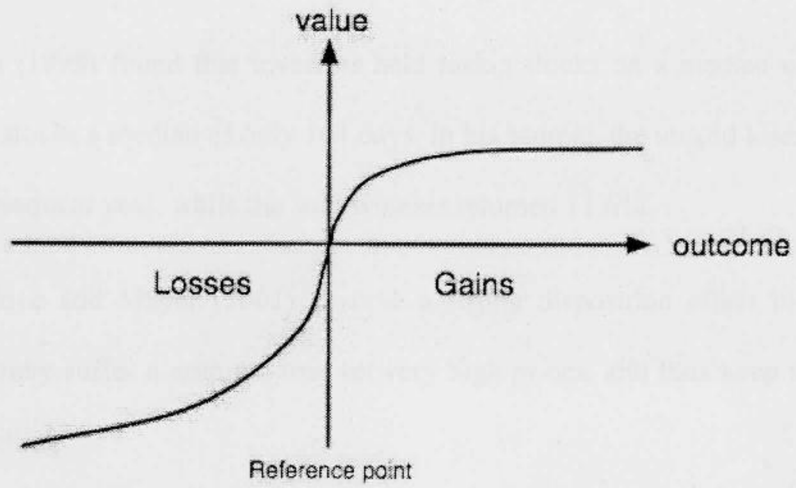
Prospect theory was developed by Daniel Kahneman and Amos Tversky in 1979 as a psychologically realistic alternative to expected utility theory. The expected utility theory offers a representation of truly rational behavior under uncertainty. This theory, however, has systematically failed to predict human behavior. Prospect theory, on the other hand, allows one to describe how people make choices in situations where they have to decide between alternatives that involve risk. Prospect theory in its most basic form suggests that assessments of the potential outcomes in a choice problem are a function of two judgmental operations. First, people tend to evaluate potential outcomes based on discernable changes in welfare relative to an easily accessible reference point rather than final states. Second, in the minds of most, losses loom larger than gains. As a result, decision makers are more likely to take additional risks to recover losses and return to their initial reference point as compared to individuals that have experienced the same relative level of gain.

According to prospect theory, decisions are based upon relative gains and losses (i.e. returns for instance) rather than upon the final wealth level (which is the key objective in conventional expected utility theory). Let W_t be the wealth of an investor at time t and let B_t be some appropriate benchmark wealth at time t relative to which an investor measures gains and losses. Gains are then measured as X_t, with $X_t = W_t - B_t$. The value function, V^S, is defined as

$$V^S = \begin{cases} X_t^{\alpha} & if\; X_t > 0 \\ -\lambda(-X_t)^{\beta} & if\; X_t < 0 \end{cases}$$

where the parameters α, β and λ are assumed positive. The two terms in the function are gains raised to the power α and losses raised to the power β multiplied by a relative loss aversion coefficient λ. α and β are estimated to be 0.88 and λ is estimated to be 2.25.

To explain loss aversion with prospect theory, Tversky and Kahneman (1991) suggest that there are three essential components that help explain how individuals make choices under uncertainty. First, gains and losses are examined relative to a reference point. Second, the value function is steeper for losses than for equivalently sized gains. Third, the marginal value of gains and losses diminishes with the size of the gain or the loss. The value function of the prospect theory is shown in the following figure:



Prospect theory is one of the most developed approaches in behavioral economics today. It has also been used to study a variety of situations in international security and comparative politics. Farhnam (1992, 1997) studied Roosevelt's changing reactions to the unfolding events in the Munich crisis. Weyland (1996, 2002) used risk acceptance and risk aversion to explain the pace and timing of domestic economic reforms in Latin American countries.

Shefrin and Statman (1985) have built on prospect theory and predicted that since people dislike incurring losses much more than they like incurring gains and are, hence, willing to gamble in the domain of losses, they will hold on to stocks that have lost value too long and will be eager to sell stocks that have risen in value. This is known as the disposition effect. The disposition effect is atypical because the purchase price of a stock should not matter much for whether one decides to sell.

Weber and Camerer (1998) found disposition effects in their experiments, where people whose shares were automatically sold every period did not buy back the shares of losers more than winners. This result shows that they are not optimistic about the losers but simply reluctant to sell them and lock in a realized loss.

Odean (1998) found that investors held losing stocks on a median of 124 days and held winning stocks a median of only 104 days. In his sample, the unsold losers returned only 5% in the subsequent year, while the sold winners returned 11.6%.

Genesove and Mayer (2001) observe a strong disposition effect in housing sales. Owners who may suffer a nominal loss set very high prices, and thus keep their houses too long before selling.

This literature survey is intended to introduce the main thesis of this study, which is that negative returns have a differential impact relative to positive returns. This is well supported if there is a crisis, if there is higher volatility, and if the tails of the return distributions are compared. Based on loss aversion and the disposition effect in behavioral finance, the hypothesis is therefore well-grounded empirically and theoretically. Moreover the hypothesis is maintained for periods of crisis and for very long periods where crises occur sporadically.

Data and Methodology

Data

Data required to test our hypothesis is obtained from *MSCI Barra* and includes daily gross prices of 18 US stock indexes and 40 regional standard core stock indexes. All indexes are defined in Appendix A. In addition daily data on the Dow Jones Industrial Average and the S&P 500 are obtained from Yahoo! Finance.

The sample period of our data is from 29 May 1992 to 19 October 2009, i.e. 4536 observations for each of the US stock indexes, from 19 October 2004 to 19 October 2009, i.e. 1304 observations for each of the regional stock indexes, and from 3 January 1950 to 28 December 2009, i.e. 15094 observations for the last sample of DJIA and S&P 500 stock indexes.

We first compute the log returns of the stock indexes as follows:

$$X_t = Ln(P_t) - Ln(P_{t-1})$$

where X is the continuously compounded percentage change in the stock index, P is the price of the stock index in local currency, t denotes the period and Ln is the natural logarithm function.

Methodology

The research methodology presented aims at analyzing the effect of the negative returns on the magnitude of co-movement between indexes and the magnitude of the ensuing variances.

Data used in our analysis, being a time series, suffers from serial correlation and heteroscedasticity. The existence of serial correlation means that the error residuals are correlated with their own lagged values. This is a violation to the standard assumption of regression theory that disturbances are not correlated with each other. The problem with serial correlation is that regression analysis is not efficient and the computed standard errors are not correct and are generally understated. This problem is fixed using the AR (autoregressive) and the MA (moving average) terms. According to Alexander (2008, p. 331), negative serial correlations in high frequency data are due to the bid-ask bounce effect. The presence of the AR and the MA terms in the regressions implies that returns are predictable from past returns. This may be due to the fact that daily data are non-synchronous, prices being recorded at discrete intervals. This is only apparently against the Efficient Market Hypothesis (EMH) developed by Professor Eugene Fama (1965, 1970, 1991). EMH asserts that financial markets are "informationally efficient", or that prices on traded assets (*e.g.,* stocks, bonds, or property) already reflect all known information, and instantly adjust to reflect new information.

The presence of heteroscedasticity means that the variance of the error terms is not constant. The standard warning is that in the presence of heteroscedasticity, the ordinary least squares regression coefficients are still unbiased, but the standard errors and confidence intervals estimated by conventional procedures will be too narrow, giving a false sense of precision. ARCH (Autoregressive Conditional Heteroscedasticity) models which were introduced by Engle (1982) and generalized as GARCH (Generalized ARCH) by Bollerslev (1986) treat heteroscedasticity as a variance to be modeled. As a result, not only are the deficiencies of least squares corrected, but a prediction is computed for the conditional variance.

On the other hand, it is important to notice that the sample sizes of the US, the regional, and the long run US stock indexes are fairly large and hence there is no need to look carefully to conditional heteroscedasticity and serial correlation because in a very large sample OLS is robust to departures from normality.

We use the ML – ARCH (Marquardt) – Normal Distribution method of the EViews statistical package to estimate the regressions on the log returns of the dependent variable (Y) of the log returns of the independent variable (X).

The null hypothesis of the first t-test states that the differential coefficient of negative returns is less than or equal to zero (negative returns do not produce higher correlation between indexes), $\alpha_3 \leq 0$. In contrast, the alternative hypothesis of this test states that the differential coefficient is significantly positive (negative returns produce higher correlation between indexes), i.e. $\alpha_3 > 0$. The test is performed at a threshold of 2 in the t-statistics. The second test examines the magnitude of the variances produced by negative returns. Other tests are also investigated, like a t-test, a normality test and a sign test.

To examine the effect of the negative returns on the co-movement of the stock indexes, dummy variables are included in the regressions. The dummy variables are defined in the following manner:

$$\begin{cases} NEG_i = 0 & if\, X_t > 0 \\ NEG_i = 1 & if\, X_t \leq 0 \end{cases}$$

.

The regressions will be divided in four groups.

Regression group 1: Regressions on the log returns of major US stock indexes (Y) of the log returns of the US Investable Market 2500 Index (X). The independent variable is selected because it is the most comprehensive of all stock indexes, and, hence, is a natural candidate for a benchmark. For this group, which includes 17 regressions, the dummy variable is defined as:

$$\begin{cases} NEG = 0 & if\, X_t > 0 \\ NEG = 1 & if\, X_t \leq 0 \end{cases}$$

The regression is defined as:

$$Y_t = \alpha_0 + \alpha_1 * NEG + \alpha_2 * X_t + \alpha_3 * NEG * X_t + \alpha_4 * AR(1) + \alpha_5 * MA(1) + \varepsilon_t$$

Where $\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4$ and α_5 are estimated by the model, the $AR(1)$ and $MA(1)$ are the autoregressive and the moving average terms respectively, the error terms $\varepsilon_t \sim iid(0, \sigma_t^2)$ are independent and identically distributed with mean zero and conditional variance given by:

$$\sigma_t^2 = \beta_0 + \beta_1 * \varepsilon_{t-1}^2 + \beta_2 * \varepsilon_{t-2}^2 + \beta_3 * \sigma_{t-1}^2 + \beta_4 * \sigma_{t-2}^2$$

Where $\beta_0, \beta_1, \beta_2, \beta_3$ and β_4 are also estimated by the model, the ARCH terms ε_{t-1}^2 and ε_{t-2}^2 represent volatility from previous periods and the GARCH terms σ_{t-1}^2 and σ_{t-2}^2 represent the variance of previous terms.

Regression group 2: Regressions on the log returns of the US Investable Market 2500 Index (Y) of the log returns of 7 US stock indexes (X). The regressions are reversed with the computation of the reverse dummy, i.e. a dummy on the new independent variable X, which was a dependent variable Y previously. For this group, which includes 7 regressions, the following dummy variables are defined:

$$\begin{cases} NEG_i = 0 & if\ X_t > 0 \\ NEG_i = 1 & if\ X_t \leq 0 \end{cases}$$

Where i=3,4,5,6,7,8,9 for the independent variable (X) being respectively the US Investable Market Growth, the US Prime Market 750 Index, the US Prime Market Value, the US Prime Market Growth, the US Large Cap 300 Index, the US Large Cap Value and the US Large Cap Growth respectively.

The regression is defined as:

$$Y_t = \alpha_0 + \alpha_1 * NEG_i + \alpha_2 * X_t + \alpha_3 * NEG_i * X_t + \alpha_4 * MA(1) + \varepsilon_t$$

Where $\alpha_0, \alpha_1, \alpha_2, \alpha_3$ and α_4 are estimated by the model, the $MA(1)$ is the moving average term, the error terms $\varepsilon_t \sim iid(0, \sigma_t^2)$ are independent and identically distributed with mean zero and conditional variance given by:

$$\sigma_t^2 = \beta_0 + \beta_1 * \varepsilon_{t-1}^2 + \beta_2 * \varepsilon_{t-2}^2 + \beta_3 * \sigma_{t-1}^2 + \beta_4 * \sigma_{t-2}^2$$

Where $\beta_0, \beta_1, \beta_2, \beta_3$ and β_4 are also estimated by the model, the ARCH terms ε_{t-1}^2 and ε_{t-2}^2 represent volatility from previous periods and the GARCH terms σ_{t-1}^2 and σ_{t-2}^2 represent the variance of previous terms.

Regression group 3: This group of regressions is further divided into 2 subgroups. The first subgroup contains regressions on the log returns of major regional stock indexes (Y) of the log returns of North America Standard Core (X). The choice of the log returns of the North America Standard Core as the independent variable is dictated by the fact that it corresponds to the most liquid and internationally critical stock index. For this subgroup, which includes 39 regressions, the dummy variable is defined by:

$$\begin{cases} NEG_{17} = 0 & if\, X_t > 0 \\ NEG_{17} = 1 & if\, X_t \le 0 \end{cases}$$

The regression is defined as:

$$Y_t = \alpha_0 + \alpha_1 * NEG_{17} + \alpha_2 * X_t + \alpha_3 * NEG_{17} * X_t + \alpha_4 * MA(1) + \varepsilon_t$$

Where $\alpha_0, \alpha_1, \alpha_2, \alpha_3$ and α_4 are estimated by the model, the $MA(1)$ is the moving average term, the error terms $\varepsilon_t \sim iid(0, \sigma_t^2)$ are independent and identically distributed with mean zero and conditional variance given by:

$$\sigma_t^2 = \beta_0 + \beta_1 * \varepsilon_{t-1}^2 + \beta_2 * \varepsilon_{t-2}^2 + \beta_3 * \varepsilon_{t-3}^2 + \beta_4 * \sigma_{t-1}^2$$

Where $\beta_0, \beta_1, \beta_2, \beta_3$ and β_4 are also estimated by the model, the ARCH terms ε_{t-1}^2 , ε_{t-2}^2 and ε_{t-3}^2 represent volatility from previous periods and the GARCH term σ_{t-1}^2 represents the variance of the previous term.

The second subgroup contains regressions on the log returns of major regional stock indexes (Y) of the log returns of EM Europe Standard Core (X). The EM Europe Standard Core is chosen because it is the most comprehensive ex-North-America stock index, and is expected to be a benchmark for regional stock markets. For this subgroup, which includes 8 regressions, the dummy variable is defined by:

$$\begin{cases} NEG_{36} = 0 & if\, X_t > 0 \\ NEG_{36} = 1 & if\, X_t \leq 0 \end{cases}$$

The regression is defined as:

$$Y_t = \alpha_0 + \alpha_1 * NEG_{36} + \alpha_2 * X_t + \alpha_3 * NEG_{36} * X_t + \alpha_4 * AR(1) + \alpha_5 * MA(1) + \varepsilon_t$$

Where $\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4$ and α_5 are estimated by the model, the $AR(1)$ and $MA(1)$ are the autoregressive and the moving average terms respectively, the error terms $\varepsilon_t \sim iid(0, \sigma_t^2)$ are independent and identically distributed with mean zero and conditional variance given by:

$$\sigma_t^2 = \beta_0 + \beta_1 * \varepsilon_{t-1}^2 + \beta_2 * \sigma_{t-1}^2$$

Where β_0, β_1 and β_3 are also estimated by the model, the ARCH term ε_{t-1}^2 represents volatility from the previous period and the GARCH term σ_{t-1}^2 represents the variance of the previous term.

Regression group 4: This is a regression on the log returns of the S&P 500 as the dependent variable (Y) of the log returns of the DJIA (X), including a dummy (DUM) that takes the following values:

$$\begin{cases} DUM = 0 & if\, X_t > 0 \\ DUM = 1 & if\, X_t \leq 0 \end{cases}$$

The regression is defined as:

$$Y_t = \alpha_0 + \alpha_1 * DUM + \alpha_2 * X_t + \alpha_3 * DUM * X_t + \alpha_4 * MA(1) + \varepsilon_t$$

Where $\alpha_0, \alpha_1, \alpha_2, \alpha_3, and\ \alpha_4$ are estimated by the model, the $MA(1)$ is the moving average term, the error terms $\varepsilon_t \sim iid(0, \sigma_t^2)$ are independent and identically distributed with mean zero and conditional variance given by:

$$\sigma_t^2 = \beta_0 + \beta_1 * \varepsilon_{t-1}^2 + \beta_2 * \varepsilon_{t-2}^2 + \beta_3 * \sigma_{t-1}^2 + \beta_4 * \sigma_{t-2}^2$$

Where β_0, β_1, β_2, β_3 and β_4 are also estimated by the model, the ARCH terms ε_{t-1}^2 and ε_{t-2}^2 represents volatility from the previous period and the GARCH terms $\sigma_{t-1}^2 and$ σ_{t-2}^2 represents the variance of the previous terms.

Results

I. The Effect of the Negative Returns on the Co-movement of the Indexes

Based on the above data set and methodology, tables II, III, IV and V show the differential impacts of the negative returns on the co-movement between the log returns of the stock indexes. The coefficients estimated in the tables will be considered significant if the absolute value of their *t*-statistic is greater or equal to two.

In the discussion, α_1 is the coefficient of the dummy variable and it represents the shift in the regression (the change in the y-intercept) caused by the negative returns, α_3 is the coefficient of the interaction of the dummy variable with the independent variable and it represents the change in the slope of the regression line caused by the negative returns. In other words, this coefficient represents the differential magnitude of the co-movement of the indexes caused by the negative returns. The total effect $(\alpha_2 + \alpha_3)$ represents the extent to which the dependent and the negative independent variable vary together. The effect α_2 represents the extent to which the dependent and the positive independent variable vary together.

Discussion 1

The results of the 17 regressions on the log returns of major US stock indexes (Y) of the log returns of the US Investable Market 2500 Index (X) are considered.

Please insert Table II here

In the 17 regressions, the estimated values of α_3 are significantly positive for 10 cases, insignificant for 1 case and negative for the remaining 6 cases, of which one is insignificant. This means that for 10 out of the 17 regressions, the negative returns result in a higher co-movement between the stock indexes. On the other hand, the total effect of negative returns $(\alpha_2 + \alpha_3)$ is approximately equal to one for the 14 out of the 17 regressions, showing that in 14 cases the benchmark and the portfolio vary together proportionately.

The adjusted R-squares show that for 8 cases more than 90% of the fraction of the variance of the dependent variable is explained by the independent variable, for 8 cases around 80% and for 1 case about 70%.

Discussion 2

Next, the 7 cases that did not result in a significantly positive coefficient of the interactive term between the dummy variable and the independent variable, i.e. whenever α_3 was not significantly positive, are considered. For these 7 cases, the dependent and the independent variables are interchanged, the dummy redefined, and hence the results consider the 7 regressions on the log returns of the US Investable Market 2500 Index (Y) of the log returns of the 7 US indexes (X) that are discussed above.

Please insert Table III here

In the 7 regressions, the estimated values of α_3 are significantly positive for 6 cases, and insignificant for only 1 case. It is noticed that the 6 regressions that resulted in negative (only one insignificant) α_3 coefficients in the previous discussion result in significantly positive α_3 coefficients here. On the other hand, the regression that resulted in an insignificant α_3 in the previous regression also results in an insignificant α_3 here. This is the case of the regression between the US Investable Market 2500 Index and US Prime Market Growth. On the other hand, the total effect of negative returns of $(\alpha_2 + \alpha_3)$ is approximately equal to one for 4 out of the 7 regressions, showing that in 4 cases the benchmark and the portfolio vary together proportionately.

The adjusted R-squares show that for 5 cases more than 90% of the fraction of the variance of the dependent variable is explained by the independent variable and for 2 cases around 80%.

Discussion 3

In this section, the 39 regressions on the log returns of major regional stock indexes (Y) of the log returns of North America Standard Core (X) are considered.

Please insert Table IVa here

In the 39 regressions, the estimated values of α_3 are significantly positive for 31 cases and insignificant for 8 cases, of which 4 cases of insignificantly negative α_3. This means that for 31 out of the 39 regressions, the negative returns result in a higher co-movement between the indexes. It is also noticed, that in one case, α_2, the coefficient on the non-interactive independent variable is insignificant. On the other hand, the total effect of negative returns of $(\alpha_2 + \alpha_3)$ is never approximately equal to one, rather it is approximately between 0.5 and 0.8 in most of the cases showing moderate co-movement between the benchmark and the portfolio. It is also observed that in the 8 cases which resulted in insignificant α_3 coefficients the dependent variables (Y) are all stock indexes of Emerging Markets.

The adjusted R-squares show that for 8 cases more than 80% of the fraction of the variance of the dependent variable is explained by the independent variable, while in some other cases the adjusted R-squares are very low.

Discussion 4

Now the 8 cases that did not result in a significantly positive α_3 and the case that resulted in insignificant α_2 are considered. For these 9 stock indexes, which are all stock indexes of Emerging Markets, the 8 regressions on the log returns of 8 regional stock indexes of these Emerging Markets (Y) of the log returns of EM Europe Standard Core (X) are considered.

Please insert Table IVb here

In the 8 regressions, the estimated values of α_3 are significantly positive for 7 cases, and insignificantly negative for only 1 case. On the other hand, the total effect of negative returns of $(\alpha_2 + \alpha_3)$ is again approximately between 0.5 and 0.8 for most of the cases, showing moderate dependence between the benchmark and the portfolio.

The adjusted R-squares show that for 3 cases more than 90% of the fraction of the variance of the dependent variable is explained by the independent variable, 2 cases around 60-80% and 3 cases of lower adjusted R-squares.

Discussion 5:

The last regression is between the log returns of the S&P 500 and the log returns of the DJIA. The assumption is that shocks come from the DJIA and impact the S&P 500. The coefficient α_3 on the interactive dummy is highly significant, with a t-statistic of 7.441, and has the expected positive sign. Moreover the coefficient on the dummy shift intercept α_2 is also positive and highly significant. The adjusted R-square is 0.916, which means that 91.6% of the variability in the S&P 500 log returns is explained by the independent variables. This last regression which encompasses more than 60 years of daily data shows forcefully that the hypothesis of this thesis is strongly verified and validated, and does not depend on the sample size or sample period.

Please insert Table V here

The Regressions Diagnostics

The Standardized Residuals

The standardized residuals are calculated as $\frac{\varepsilon_t}{\sigma_t}$. Then in order to test for higher-order serial correlation of order k, the Ljung-Box Q-statistic on the standardized residuals for lag order k, is calculated. Next, to test for higher-order conditional heteroscedasticity of order k, the Ljung-Box Q-statistic on the squares of the standardized residuals for lag order k is calculated. Since our analysis employs daily data, we consider 3 values for k: 5, 10 and 15 for lag periods of approximately 1, 2 and 3 weeks respectively. For a significance level of 1%, it is observed that there is no further serial correlation and no further conditional heteroscedasticity except for few cases which are not worrisome because the sample sizes of both the US and the regional stock indexes are fairly large and OLS is robust to departures from normality.

The Adjusted R-Squares

The 16 US regressions and the 37 regional regressions that resulted in significant α_2 coefficients and significantly positive α_3 coefficients are considered, and the averages of the adjusted R-squares are computed. For the 16 US regressions, the average $\overline{R}^2 = 0.8884$, showing that on average 89% of the fraction of the variance of the dependent variable is explained by the independent variable for the US stock indexes. For the 37 regional regressions, the average $\overline{R}^2 = 0.4691$, showing that on average 47% of the fraction of the variance of the dependent variable is explained by the independent variable for the regional stock indexes. Therefore regional stock indexes carry more idiosyncratic risk. For the total of 53 regressions, the average $\overline{R}^2 = 0.5957$, showing that on average 60% of the fraction of the variance of the dependent variable is explained by the independent variable.

Skewness and Excess Kurtosis

Table I shows the skewness and the excess kurtosis of the stock indexes.

Insert Table I here

It is observed that 47 significant values of skewness and 60 significant values of excess kurtosis occur. This observation can be done by easily computing the t-statistics by the ratio of the skewness and excess kurtosis to their respective standard errors. A value is considered significant if the absolute value of its t-statistic is greater or equal to two.

Jarque-Bera Normality Test

Next, the Jarque-Bera test, which is a goodness-of-fit measure of departure from normality, based on the sample skewness and kurtosis, is calculated. The test statistic JB is defined as:

$$JB = \frac{N}{6}(S^2 + K^2/4)$$

Where S is the sample skewness, K is the sample excess kurtosis, i.e. kurtosis minus 3, and N is the sample size. The JB statistic is distributed under the null as an asymptotic chi-square distribution with two degrees of freedom and can be used to test the null hypothesis that the data are from a normal distribution. The upper tail *p*-values of the JB statistics are all less than 0.00001. Thus all the log returns of the 60 stock indexes considered in our analysis are non-normal.

Based on these results, it is concluded that Table I presents non-normal characteristics. However, the fact that the regression residuals are independent and identically distributed, as evidenced by the Ljung-Box Q-statistics on the standardized residuals and the squares of the standardized residuals, enables us to assume asymptotic normality because the sample is very large. The Central Limit Theorem states that the addition of random independent variables is approximately normal as the sample size increases.

The Sign Tests

Table VI shows the summary of the regressions that resulted in significant α_2 and significantly positive α_3 coefficients.

Insert Table VI here

A sign test is performed with a hypothesized value of 0 on α_1 and it is found that the *p*-value of the lower tail test is 0.6082, while the *p*-value of the upper tail test is 0.3918. Thus, there is not enough evidence for the significance of the shift dummy, and hence it is equal statistically to zero on average. A sign test is also performed with a hypothesized value of 0 on $1\text{-}\alpha_2\text{-}\alpha_3$, to test the total effect of (α_2+α_3). The *p*-value of the lower tail test is close to 1, while the *p*-

value of the upper tail test is 1.96E-08, due to the fact that the total effect is significant, and is statistically on average less than one.

The Stationary Test

Next, it is checked whether the conditional variances of the log returns of the stock indexes are stationary after the transformation. A stationary series means that the mean and the auto-co-variances of the series do not depend on time. This test is important because standard inference procedures do not apply to non-stationary series. The sum $\sum_{k=1} \beta_k$ is computed, i.e. the sum of the coefficients of the ARCH and GARCH terms from the equations of the conditional variance. It is observed that this sum is less than 1 for each regression, and hence stationary is verified.

II. The Effect of the Negative Returns on the Variance and the Standard Deviation

The percentages by which the negative returns affect the variance and the standard deviation are calculated. The calculation is made on an average basis.

First, in table VI, the averages $\overline{\alpha_2}$ and $\overline{\alpha_3}$ of the two coefficients α_2 and α_3 respectively of the regressions that resulted in significant α_2 and significantly positive α_3 coefficients, where α_2 is the coefficient of the independent variable, and α_3 is the coefficient of the interaction between the dummy variable and the independent variable, are calculated.

The effect of the negative returns on the variance is calculated as follows:

$$\frac{\overline{\alpha_3}^2 * E[\sigma^2(NEG * X)]}{\overline{\alpha_2}^2 * \sigma^2(X)} = \frac{\overline{\alpha_3}^2 * \frac{1}{2}\sigma^2(X)}{\overline{\alpha_2}^2 * \sigma^2(X)} = \frac{\overline{\alpha_3}^2}{2\overline{\alpha_2}^2}$$

Note that $E[\sigma^2(NEG * X)] = \frac{1}{2}\sigma^2(X)$ because almost 50% of the log returns is negative and their averages are close to zero. The effect of the negative returns on the standard deviation is: $\sqrt{\frac{\overline{\alpha_3}^2}{2\overline{\alpha_2}^2}}$.

For the 16 regressions of the US stock indexes

The additional effect of the negative returns on the variance is $\frac{\overline{\alpha_3}^2}{2\overline{\alpha_2}^2} = \frac{0.0597^2}{2*0.9140^2} = 0.002133$. The additional effect of the negative returns on the standard deviation is: $\sqrt{0.002133} = 0.0462$. Therefore, the negative returns increase the standard deviation approximately by 4.6%.

For the 37 regressions of the regional stock indexes

The additional effect of the negative returns on the variance is $\frac{\overline{\alpha_3}^2}{2\overline{\alpha_2}^2} = \frac{0.1407^2}{2*0.5451^2} = 0.033296$. The additional effect of the negative returns on the standard deviation is: $\sqrt{0.033296} = 0.1825$. Therefore, the negative returns increase the standard deviation approximately by 18.25%, much larger than in the previous case, and much larger than what would be expected.

For the total number of 53 regressions

The additional effect of the negative returns on the variance is $\frac{\overline{\alpha_3}^2}{2\overline{\alpha_2}^2} = \frac{0.1162^2}{2*0.6564^2} = 0.015672$. The additional effect of the negative returns on the standard deviation is: $\sqrt{0.015672} = 0.1252$. Therefore, the negative returns increase the total standard deviation approximately by 12.5%, which is in between the above two values, but is still relatively high.

For the last regression

The effect on the variance is as follows for the secular regression:

$$\frac{\overline{\alpha_3}^2}{2\overline{\alpha_2}^2} = \frac{0.03497^2}{2 * 0.92869^2} = 0.00070896$$

Which corresponds to an increase in standard deviation of $\sqrt{0.00070896} = 0.0266 = 2.66\%$.

All these findings support the maintained hypothesis of this thesis that negative returns have a differential impact, relative to positive returns. The regressions have converted variables found with high skewness and kurtosis into *i.i.d.* distributed residuals. The results are so supportive that it is anybody's guess why the differential impact of negative returns has not been discovered previously.

In order to present more evidence that the disposition effect of negative returns is according to the precepts of behavioral finance and loss aversion, one last regression is carried out to show that negative returns also produce lower volume of trading. Yahoo! Finance provides data on volume of trading for the last secular data. The dummy (DUM) is defined to be 0 if the log returns of the DJIA are positive and 1 otherwise. This dummy enters as a shift parameter and as an interactive parameter with the DJIA log returns (X). Then a regression is tested with a GARCH(2,1) specification of the conditional variance. The change in logs of the volume of trading (Y) is regressed on a constant, the dummy shift parameter (DUM), the log returns of the DJIA (X), and the interactive dummy variable with the log returns of the DJIA (X*DUM). The results with t-statistics in parenthesis are:

$$
\begin{aligned}
Y = &-0.02132 - 0.0297DUM + 5.2440X - 10.0405X * DUM + \varepsilon \\
&\quad (\text{-}9.018) \quad\; (\text{-}9.343) \qquad\; (23.769) \quad (\text{-}40.296) \\
N &= 15093 \;\; s.e. = 0.2078 \;\; \bar{R}^2 = 0.0398
\end{aligned}
$$

This regression suffers from serial correlation but no further conditional heteroscedasticity. Nonetheless the estimates are unbiased. The results speak for themselves: negative returns coexist with lower trading volume. The differential impact is -10.0405, and the total impact is -4.7965. This is evidence that negative returns produce illiquidity (because of a lower trading volume) and thus higher volatility in log returns. The concept of loss aversion and the disposition effect are equally supported.

Conclusion

As we review the literature on financial crises, we observe three patterns: First, the effect of volatility on stock index co-movement; second, the relation between the tail returns of two financial assets; third, the stock index co-movement in post-crisis events – these three patterns lead to a higher correlation in stock returns. Our intuition that negative returns increase the correlation in stock returns is directly attributable to this literature because (1) contagion occurs usually with price declines more than with price advances, (2) higher correlation means higher volatility, and (3) the whole left tail distribution of returns is considered, instead of a small extreme left tail.

Our research methodology aims at analyzing the effect of the negative returns on the magnitude of co-movement between indexes and the magnitude of the ensuing variances. For our regressions, we use the log returns of 4536 observations for each of the 18 US stock indexes, 1304 observations for each of the 40 regional stock indexes, and 15094 observations for each of the S&P500 and the DJIA. For most of the cases, the problem of serial correlation is fixed using the AR and the MA terms, while the problem of conditional heteroscedasticity is fixed by the GARCH model.

First, out of the 17 regressions of the log returns of major US stock indexes (Y) on the log returns of the US Investable Market 2500 Index (X), 10 cases show that the negative returns result in a higher co-movement between the stocks.

Second, after interchanging the dependent and the independent variables, out of the 7 regressions of the log returns of the US Investable Market 2500 Index (Y) on the log returns of major US stock indexes (X), 6 cases show that negative returns result in a higher co-movement between the stock indexes.

Third, out of the 39 regressions of major regional stock indexes (Y) on the log returns of North America Standard Core (X), 31 cases show that the negative returns result in a higher co-movement between the stock indexes.

Fourth, out of the 8 regressions on log returns of major regional stock indexes (Y) of the log returns of EM Europe Standard Core (X), 7 cases show that the negative returns result in a higher co-movement between the stock indexes.

Fifth, the regression of the log returns of the S&P500 (Y) of the log returns of the DJIA (X) shows that the negative returns result in a higher co-movement between the stock indexes. This last regression which encompasses more than 60 years of daily data shows forcefully that the hypothesis of this thesis is strongly verified and validated, and does not depend on the sample size or sample period.

Sixth, we observe that the negative returns increase the standard deviation of the US regressions by 4.6%, of the regional regressions by 18.25%, for the total regressions by 12.5%, and for the regression between the log returns of S&P500 & DJIA by 2.66%.

Finally, the regression of the change in logs of the volume of trading (Y) the log returns of the DJIA shows that negative returns coexist with lower trading volume – evidence that negative returns produce illiquidity and thus higher volatility in log returns. Consequently, the concept of loss aversion and the disposition effect are equally supported.

Now that we have enough evidence to support the assumption that negative returns produce a higher co-movement between stock indexes, the same hypothesis can also be tested in other markets.

The negative returns are unpleasant and their consequence is even more unfavorable. It would be challenging to do research in order to discover a well-diversified portfolio that might beat this unfavorable outcome of the negative returns.

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Table Ia

Descriptive statistics and normality test of the log returns of major US indexes and of the dummy variables

Variable	N	Minimum	Maximum	Range	Mean (Std. Error)	Median	Std. Deviation	Skewness (S.E.=0.036358)	Excess Kurtosis (S.E.=0.072699)	P(JB)
US INVESTABLE MARKET 2500 INDEX	4536	-0.096971	0.107999	0.204970	0.000301 (0.000177)	0.000443	0.011901	-0.266990	9.457743	< 0.00001
US INVESTABLE MARKET VALUE	4536	-0.107953	0.103957	0.211910	0.000335 (0.000169)	0.000424	0.011414	-0.401187	13.140586	< 0.00001
US INVESTABLE MARKET GROWTH	4536	-0.096952	0.111999	0.208950	0.000258 (0.000199)	0.000476	0.013396	-0.108600	6.928886	< 0.00001
US PRIME MARKET 750 INDEX	4536	-0.094813	0.110293	0.205105	0.000295 (0.000177)	0.000370	0.011934	-0.226280	9.507608	< 0.00001
US PRIME MARKET VALUE	4536	-0.104978	0.106899	0.211877	0.000329 (0.000171)	0.000398	0.011515	-0.362099	12.808599	< 0.00001
US PRIME MARKET GROWTH	4536	-0.096214	0.113618	0.209832	0.000252 (0.000199)	0.000447	0.013417	-0.062570	7.112925	< 0.00001
US LARGE CAP 300 INDEX	4536	-0.092659	0.109987	0.202646	0.000281 (0.000177)	0.000330	0.011938	-0.172609	9.250503	< 0.00001
US LARGE CAP VALUE	4536	-0.103424	0.108715	0.212139	0.000314 (0.000173)	0.000238	0.011665	-0.324980	12.330442	< 0.00001
US LARGE CAP GROWTH	4536	-0.092188	0.111196	0.203384	0.000242 (0.000198)	0.000350	0.013319	0.002194	7.064731	< 0.00001
US SMALL + MID CAP 2200 INDEX	4536	-0.113199	0.102010	0.215209	0.000374 (0.000187)	0.000837	0.012594	-0.465960	8.905661	< 0.00001
US SMALL + MID CAP 2200 INDEX VALUE	4536	-0.123333	0.090745	0.214078	0.000413 (0.000171)	0.000692	0.011509	-0.548559	13.858735	< 0.00001
US SMALL + MID CAP 2200 INDEX GROWTH	4536	-0.112628	0.114627	0.227256	0.000305 (0.000219)	0.000857	0.014748	-0.369993	6.267672	< 0.00001
US MID CAP 450 INDEX	4536	-0.107551	0.111932	0.219483	0.000372 (0.000188)	0.000624	0.012652	-0.456480	9.580133	< 0.00001
US MID CAP VALUE	4536	-0.114077	0.098051	0.212128	0.000420 (0.000170)	0.000638	0.011434	-0.500605	13.581697	< 0.00001

Table Ia – continued

Descriptive statistics and normality test of the log returns of major US indexes and of the dummy variables

Variable	N	Minimum	Maximum	Range	Mean (Std. Error)	Median	Std. Deviation	Skewness (S.E.=0.036358)	Excess Kurtosis (S.E.=0.072699)	P(JB)
US MID CAP GROWTH	4536	-0.120129	0.128019	0.248148	0.000292 (0.000225)	0.000716	0.015161	-0.380093	7.419014	< 0.00001
US SMALL CAP 1750 INDEX	4536	-0.120874	0.089336	0.210210	0.000379 (0.000190)	0.000880	0.012814	-0.437524	8.062178	< 0.00001
US SMALL CAP VALUE	4536	-0.136108	0.087110	0.223217	0.000406 (0.000178)	0.000760	0.011963	-0.537208	13.692178	< 0.00001
US SMALL CAP GROWTH	4536	-0.105982	0.098209	0.204190	0.000326 (0.000216)	0.000827	0.014573	-0.335510	4.938497	< 0.00001
NEG	4536	0	1	1	0.476631 (0.007417)	-	-	-	-	-
NEG_3	4536	0	1	1	0.477513 (0.007417)	-	-	-	-	-
NEG_4	4536	0	1	1	0.479277 (0.007418)	-	-	-	-	-
NEG_5	4536	0	1	1	0.479277 (0.007418)	-	-	-	-	-
NEG_6	4536	0	1	1	0.480159 (0.007419)	-	-	-	-	-
NEG_7	4536	0	1	1	0.484788 (0.007421)	-	-	-	-	-
NEG_8	4536	0	1	1	0.485670 (0.007422)	-	-	-	-	-
NEG_9	4536	0	1	1	0.483245 (0.007421)	-	-	-	-	-

Table Ib

Descriptive statistics and normality test of the log returns of major regional indexes and of the dummy variables

Variable	N	Minimum	Maximum	Range	Mean (Std. Error)	Median	Std. Deviation	Skewness (S.E.=0.067754)	Excess Kurtosis (S.E.=0.135406)	P(JB)
EAFE + CANADA	1304	-0.088629	0.082910	0.171539	0.000274 (0.000376)	0.000874	0.013580	-0.403995	8.626582	< 0.00001
EAFE ex UK	1304	-0.083531	0.071247	0.154777	0.000285 (0.000368)	0.000947	0.013283	-0.468587	7.423197	< 0.00001
EASEA INDEX	1304	-0.101184	0.099475	0.200658	0.000311 (0.000431)	0.000850	0.015559	-0.204521	9.570443	< 0.00001
EMU	1304	-0.104424	0.109922	0.214347	0.000326 (0.000461)	0.000926	0.016643	-0.099515	8.626270	< 0.00001
EMU ex GERMANY	1304	-0.107169	0.114657	0.221825	0.000302 (0.000464)	0.000745	0.016744	0.000960	9.553009	< 0.00001
EU	1304	-0.105044	0.111350	0.216394	0.000268 (0.000458)	0.000836	0.016552	-0.068382	9.414046	< 0.00001
EURO	1304	-0.103727	0.113724	0.217451	0.000328 (0.000468)	0.000933	0.016883	-0.059854	8.795137	< 0.00001
EUROPE	1304	-0.101778	0.107605	0.209383	0.000279 (0.000446)	0.000851	0.016112	-0.060833	9.255084	< 0.00001
EUROPE GDP	1304	-0.104149	0.108669	0.212819	0.000308 (0.000456)	0.000941	0.016451	-0.112573	8.907441	< 0.00001
EUROPE ex EMU	1304	-0.099083	0.109375	0.208458	0.000233 (0.000441)	0.000672	0.015941	-0.041808	9.578703	< 0.00001
EUROPE ex SWITZERLAND	1304	-0.105393	0.111740	0.217134	0.000268 (0.000460)	0.000804	0.016598	-0.078685	9.355599	< 0.00001
EUROPE ex UK	1304	-0.100585	0.105328	0.205913	0.000340 (0.000446)	0.000712	0.016115	-0.074389	8.362226	< 0.00001
FAR EAST	1304	-0.089450	0.103805	0.193255	0.000110 (0.000416)	0.000439	0.015014	-0.189119	5.332256	< 0.00001

Table Ib – continued

Descriptive statistics and normality test of the log returns of major regional indexes and of the dummy variables

Variable	N	Minimum	Maximum	Range	Mean (Std. Error)	Median	Std. Deviation	Skewness (S.E.=0.067754)	Excess Kurtosis (S.E.=0.135406)	P(JB)
G7 INDEX	1304	-0.076922	0.091179	0.168101	0.000138 (0.000343)	0.000766	0.012369	-0.475941	10.466149	< 0.00001
KOKUSAI INDEX	1304	-0.083182	0.102396	0.185578	0.000193 (0.000368)	0.000718	0.013281	-0.436061	10.862782	< 0.00001
NORDIC COUNTRIES	1304	-0.115382	0.118593	0.233974	0.000354 (0.000538)	0.000772	0.019411	-0.060829	6.126241	< 0.00001
NORTH AMERICA	1304	-0.094963	0.104276	0.199239	0.000114 (0.000407)	0.000590	0.014687	-0.389684	10.701961	< 0.00001
PACIFIC	1304	-0.091820	0.098313	0.190133	0.000206 (0.000412)	0.000803	0.014882	-0.373823	5.703149	< 0.00001
PACIFIC ex JAPAN	1304	-0.131620	0.083236	0.214856	0.000533 (0.000472)	0.001004	0.017060	-0.884358	8.153635	< 0.00001
PAN-EURO	1304	-0.101741	0.110520	0.212261	0.000276 (0.000449)	0.000654	0.016215	-0.027290	9.575170	< 0.00001
THE WORLD INDEX	1304	-0.073169	0.090975	0.164143	0.000179 (0.000339)	0.000804	0.012247	-0.483047	10.191682	< 0.00001
WORLD ex AUSTRALIA	1304	-0.074458	0.091054	0.165512	0.000167 (0.000340)	0.000774	0.012294	-0.481075	10.181810	< 0.00001
WORLD ex EMU	1304	-0.074287	0.088321	0.162609	0.000152 (0.000333)	0.000830	0.012021	-0.531292	10.545426	< 0.00001
WORLD ex EUROPE	1304	-0.074297	0.086170	0.160467	0.000132 (0.000338)	0.000764	0.012205	-0.434658	10.543887	< 0.00001
WORLD ex UK	1304	-0.072611	0.089880	0.162492	0.000180 (0.000335)	0.000795	0.012106	-0.480257	10.141798	< 0.00001

Table Ib – continued

Descriptive statistics and normality test of the log returns of major regional indexes and of the dummy variables

Variable	N	Minimum	Maximum	Range	Mean (Std. Error)	Median	Std. Deviation	Skewness (S.E.=0.067754)	Excess Kurtosis (S.E.=0.135406)	P(JB)
WORLD ex USA	1304	-0.088629	0.082910	0.171539	0.000274 (0.000376)	0.000874	0.013580	-0.403994	8.626591	< 0.00001
EAFE FREE	1304	-0.088009	0.082365	0.170374	0.000256 (0.000378)	0.000887	0.013643	-0.399796	8.488590	< 0.00001
FAR EAST FREE	1304	-0.089448	0.103811	0.193259	0.000110 (0.000416)	0.000439	0.015015	-0.189021	5.332371	< 0.00001
PACIFIC FREE	1304	-0.091816	0.098317	0.190133	0.000206 (0.000412)	0.000801	0.014882	-0.373764	5.702963	< 0.00001
PACIFIC FREE ex JAPAN	1304	-0.131620	0.083235	0.214855	0.000533 (0.000472)	0.001004	0.017060	-0.884361	8.153588	< 0.00001
THE WORLD INDEX FREE	1304	-0.073169	0.090975	0.164144	0.000179 (0.000339)	0.000804	0.012247	-0.483046	10.191730	< 0.00001
EM	1304	-0.099639	0.100736	0.200375	0.000666 (0.000438)	0.001884	0.015815	-0.536690	7.725390	< 0.00001
EM ASIA	1304	-0.086112	0.126531	0.212643	0.000598 (0.000454)	0.001461	0.016399	-0.317282	6.803995	< 0.00001
EM EASTERN EUROPE	1304	-0.207764	0.191444	0.399208	0.000434 (0.000703)	0.002028	0.025386	-0.448387	11.672646	< 0.00001
EM EMEA	1304	-0.154142	0.128635	0.282776	0.000513 (0.000533)	0.001707	0.019238	-0.597990	8.409676	< 0.00001
EM EUROPE	1304	-0.199264	0.186234	0.385498	0.000458 (0.000680)	0.002138	0.024549	-0.451272	10.888275	< 0.00001
EM EUROPE & MIDDLE EAST	1304	-0.177198	0.154748	0.331945	0.000455 (0.000569)	0.002121	0.020530	-0.624553	10.883407	< 0.00001

Table Ib – continued

Descriptive statistics and normality test of the log returns of major regional indexes and of the dummy variables

Variable	N	Minimum	Maximum	Range	Mean (Std. Error)	Median	Std. Deviation	Skewness (S.E.=0.067754)	Excess Kurtosis (S.E.=0.135406)	P(JB)
EM FAR EAST	1304	-0.094333	0.144893	0.239226	0.000565 (0.000467)	0.001433	0.016861	-0.198238	8.388420	< 0.00001
EM LATIN AMERICA	1304	-0.150601	0.153640	0.304241	0.001042 (0.000629)	0.002438	0.022708	-0.453574	8.367901	< 0.00001
EM ex ASIA	1304	-0.135447	0.113266	0.248713	0.000750 (0.000533)	0.001765	0.019256	-0.614282	7.986613	< 0.00001
NEG_{17}	1304	0	1	1	0.453221 (0.013791)	-	-	-	-	-
NEG_{36}	1304	0	1	1	0.440184 (0.013752)	-	-	-	-	-

Notes:

P(JB) is the upper tail probability of the Jarque-Bera statistic which is distributed asymptotically as a chi-square distribution with two degrees of freedom. The Jarque-Bera statistic is calculated as follows: $JB = \frac{N}{6}(S^2 + K^2/4)$, where S is skewness and K is excess kurtosis.

Data source: MSCI Barra

Table Ic

Descriptive statistics and normality test of the log returns of the DJIA and S&P 500, and of the dummy variable (DUM).

Variable	N	Minimum	Maximum	Range	Mean (Std. Error)	Median	Std. Deviation	Skewness (S.E.=0.01994)	Excess Kurtosis (S.E.=0.03987)	P(JB)
DJIA	15093	-0.256315	0.105083	0.361398	0.000263 (0.000078687)	0.000417	0.009667	-1.31532	40.6820	< 0.00001
S&P 500	15093	-0.228997	0.109572	0.338569	0.000279 (0.000078891)	0.000457	0.009692	-1.08044	29.9144	< 0.00001
DUM	15093	0	1	1	0.478699 (0.0040663)	-	-	-	-	-

Notes:
P(JB) is the upper tail probability of the Jarque-Bera statistic which is distributed asymptotically as a chi-square distribution with two degrees of freedom. The Jarque-Bera statistic is calculated as follows: $JB = \frac{N}{6}(S^2 + K^2/4)$, where S is skewness and K is excess kurtosis.

Data source: Yahoo! Finance

Table II

Regressions on the log returns of major US stock indexes (Y) of the log returns of the US Investable Market 2500 Index (X), incorporating a shift dummy and an interactive dummy with the latter variable (NEG), that takes the value 0 if X>0, and one otherwise.

Y_t	α_0	α_1	α_2	α_3	α_4	α_5	β_0	β_1	β_2	β_3	β_4	$\overline{R}^2$	F	P(F)	Marginal Significance Level					
															Q(5)	Q(10)	Q(15)	$Q^2(5)$	$Q^2(10)$	$Q^2(15)$
US INVESTABLE MARKET VALUE	6.46E-06 (0.114)	-2.37E-04 (-3.066)	0.9198 (150)	0.0210 (3.023)	-	0.0850 (5.247)	2.52E-09 (2.214)	0.1025 (11.39)	-0.0956 (-11.55)	1.7523 (35.60)	-0.7594 (-16.22)	0.9029	4686	<0.0001	0.792	0.274	0.461	0.644	0.156	0.370
US INVESTABLE MARKET GROWTH	-7.26E-06 (0.127)	-2.47E-04 (-3.187)	1.0780 (176)	-0.0197 (-2.903)	-	0.0844 (5.194)	2.15E-09 (2.404)	0.1042 (11.91)	-0.0987 (-12.06)	1.7712 (46.47)	-0.7770 (-21.35)	0.9350	7252	<0.0001	0.766	0.245	0.407	0.651	0.152	0.349
US PRIME MARKET 750 INDEX	-6.60E-05 (-4.091)	2.88E-05 (1.297)	1.0076 (734)	-0.0109 (-5.792)	-	0.0288 (1.900)	4.93E-09 (4.671)	0.0548 (10.52)	-	0.9327 (140)	-	0.9973	235679	<0.0001	0.678	0.028	0.054	0.446	0.478	0.389
US PRIME MARKET VALUE	-7.19E-05 (-1.139)	3.15E-04 (3.620)	0.9397 (141)	0.0093 (1.150)	-	0.0829 (5.109)	3-05E-09 (1.997)	0.0881 (10.04)	-0.0826 (-10.16)	1.7881 (34.92)	-0.7940 (-16.28)	0.8956	4324	<0.0001	0.952	0.176	0.391	0.804	0.313	0.564
US PRIME MARKET GROWTH	-7.22E-05 (-1.22)	-2.20E-04 (-2.73)	1.0827 (167)	-0.0424 (-6.087)	-	0.0499 (3.077)	2.66E-09 (2.089)	0.1034 (11.02)	-0.0965 (-11.28)	1.7614 (36.52)	-0.7685 (-16.81)	0.9284	6533	<0.0001	0.486	0.179	0.234	0.376	0.180	0.373
US LARGE CAP 300 INDEX	-1.51E-04 (-4.442)	5.44E-05 (1.176)	1.0139 (345)	-0.0257 (-6.700)	0.0580 (3.579)	-	1.55E-08 (4.268)	0.0973 (5.668)	-0.0499 (-2.949)	0.9435 (146)	-	0.9885	48501	<0.0001	0.590	0.069	0.042	0.800	0.930	0.842
US LARGE CAP VALUE	-1.37E-04 (-1.857)	3.13E-04 (3.152)	0.9585 (124)	-0.0072 (-0.785)	-	0.0730 (4.700)	5.61E-08 (4.344)	0.0635 (12.43)	-	0.9321 (170)	-	0.8852	4997	<0.0001	0.826	0.117	0.230	0.328	0.213	0.231
US LARGE CAP GROWTH	-1.72E-04 (-2.449)	-1.76E-04 (-1.811)	1.0778 (148)	-0.0683 (-8.816)	0.0392 (2.417)	-	4.33E-08 (4.292)	0.1122 (8.029)	-0.0498 (-3.492)	0.9352 (192)	-	0.9161	6187	<0.0001	0.240	0.217	0.167	0.269	0.406	0.394
US SMALL + MID CAP 2200 INDEX	3.79E-04 (4.450)	-1.19E-04 (-0.998)	0.9562 (116)	0.0794 (7.506)	-0.5532 (-3.483)	0.5938 (3.891)	5.93E-08 (3.645)	0.0969 (5.709)	-0.0507 (-3.013)	0.9497 (179)	-	0.9152	5438	<0.0001	0.054	0.008	0.004	0.837	0.884	0.766
US SMALL + MID CAP 2200 INDEX VALUE	2.98E-04 (3.285)	2.75E-04 (2.309)	0.7663 (84.97)	0.0953 (9.868)	0.6602 (4.879)	-0.6149 (-4.272)	4.53E-08 (4.167)	0.1328 (9.199)	-0.0786 (-5.238)	0.9446 (184)	-	0.8319	2493	<0.0001	0.104	0.107	0.015	0.205	0.640	0.799
US SMALL + MID CAP 2200 INDEX GROWTH	5.84E-04 (4.930)	-5.66E-04 (-3.486)	1.0491 (81.777)	0.0772 (4.770)	-0.3346 (-2.400)	0.4215 (3.145)	9.83E-09 (1.533)	0.0879 (8.525)	-0.0826 (-8.975)	1.8106 (31.72)	-0.8161 (-15.14)	0.8540	2653	<0.0001	0.094	0.003	0.017	0.771	0.410	0.612
US MID CAP 450 INDEX	3.29E-04 (4.551)	-8.02E-05 (-0.773)	0.9648 (125)	0.0721 (7.243)	-0.1534 (-3.353)	0.5564 (3.761)	3.98E-08 (3.582)	0.0443 (10.41)	-	0.9521 (199)	-	0.9322	7789	<0.0001	0.096	0.010	0.004	0.336	0.057	0.113
US MID CAP VALUE	2.05E-04 (2.611)	2.74E-04 (2.503)	0.8244 (97.71)	0.0701 (8.075)	0.0162 (4.275)	-	4.20E-08 (3.901)	0.1304 (9.176)	-0.0770 (-5.178)	0.9449 (178)	-	0.8469	3135	<0.0001	0.074	0.040	0.033	0.138	0.380	0.664
US MID CAP GROWTH	5.08E-04 (4.525)	-4.78E-04 (-3.050)	1.0616 (84.81)	0.0691 (4.354)	-0.4313 (-2.644)	0.4944 (3.143)	9.63E-09 (1.319)	0.0771 (7.740)	-0.0718 (-8.245)	1.8194 (25.01)	-0.8251 (-12.01)	0.8472	2515	<0.0001	0.131	0.011	0.065	0.677	0.197	0.471

Table II – continued

Regressions on the log returns of major US stock indexes (Y) of the log returns of the US Investable Market 2500 Index (X), incorporating a shift dummy and an interactive dummy with the latter variable (NEG), that takes the value 0 if X>0, and one otherwise.

Y_t	α_0	α_1	α_2	α_3	α_4	α_5	β_0	β_1	β_2	β_3	β_4	$\overline{R}^2$	F	P(F)	Marginal Significance Level					
															Q(5)	Q(10)	Q(15)	$Q^2(5)$	$Q^2(10)$	$Q^2(15)$
US SMALL CAP 1750 INDEX	4.50E-04 (3.792)	-1.06E-04 (-0.655)	0.9307 (86.14)	0.0991 (6.844)	0.0322 (2.048)	-	1.75E-07 (4.303)	0.0852 (5.215)	-0.0300 (-1.849)	0.9376 (151)	-	0.8529	3285	<0.0001	0.670	0.020	0.038	0.841	0.450	0.345
US SMALL CAP VALUE	3.56E-04 (3.213)	4.26E-04 (2.798)	0.6971 (61.31)	0.1269 (10.01)	-	-	6.84E-08 (4.401)	0.1087 (6.926)	-0.0582 (-3.607)	0.9483 (204)	-	0.7627	2082	<0.0001	0.079	0.037	0.001	0.847	0.987	0.882
US SMALL CAP GROWTH	6.48E-04 (4.443)	-6.81E-04 (-3.477)	1.0425 (72.26)	0.0794 (4.290)	-0.5203 (-4.142)	0.5878 (4.958)	8.60E-09 (1.499)	0.0901 (9.609)	-0.0875 (-9.887)	1.8416 (58.87)	-0.8444 (-28.31)	0.8187	2047	<0.0001	0.015	0.000	0.001	0.399	0.861	0.848

Notes:

$Y_t = \alpha_0 + \alpha_1 * NEG + \alpha_2 * X_t + \alpha_3 * NEG * X_t + \alpha_4 * AR(1) + \alpha_5 * MA(1) + \varepsilon_t$; $\varepsilon_t \sim iid(0, \sigma_t^2)$; $\sigma_t^2 = \beta_0 + \beta_1 * \varepsilon_{t-1}^2 + \beta_2 * \varepsilon_{t-2}^2 + \beta_3 * \sigma_{t-1}^2 + \beta_4 * \sigma_{t-2}^2$; $NEG = 0\ if\ X_t > 0$; $NEG = 1\ if\ X_t \leq 0$. The numbers in parentheses represent the values of t-statistics. Sample size : 4536 observations. Sample period : 6/01/1992 – 10/19/2009. P(F) is the actual p-value of the F-statistic on the whole regression. The standardized residuals are computed as $\frac{\varepsilon_t}{\sigma_t}$. The Q(k) is the Ljung-Box Q-statistic on the standardized residuals for lag order k. It tests for higher-order serial correlation where the order is k. The $Q^2(k)$ is the Ljung-Box Q-statistic on the squares of the standardized residuals for lag order k. It tests for higher-order conditional heteroscedasticity where the order is k.

Data source: MSCI Barra

Table III

Regressions on the log returns of the US Investable Market 2500 Index (Y) of the daily log returns of major US stock indexes (X), incorporating a shift dummy and an interactive dummy with the latter variable (NEG_i) $for\ 3 \le i \le 9$, that takes the value 0 if the corresponding X>0, and one otherwise.

X_t	α_0	α_1	α_2	α_3	α_4	β_0	β_1	β_2	β_3	β_4	$\overline{R}^2$	F	P(F)	Marginal Significance Level					
														Q(5)	Q(10)	Q(15)	$Q^2(5)$	$Q^2(10)$	$Q^2(15)$
US INVESTABLE MARKET GROWTH	1.07E-04 (2.103)	9.07E-05 (1.306)	0.8599 (179)	0.0164 (2.752)	0.0773 (4.796)	1.46E-09 (1.859)	0.0941 (9.912)	-0.0897 (-10.27)	1.8157 (45.84)	-0.8202 (-21.81)	0.9345	7193	<0.0001	0.762	0.070	0.199	0.875	0.131	0.373
US PRIME MARKET 750 INDEX	6.10E-05 (3.798)	-7.11E-06 (-0.318)	0.9881 (729)	0.0118 (6.314)	0.0402 (2.543)	4.93E-09 (4.543)	0.0830 (5.143)	-0.0305 (-1.905)	0.9347 (133)	-	0.9973	206387	<0.0001	0.674	0.042	0.062	0.742	0.753	0.626
US PRIME MARKET VALUE	1.27E-04 (2.002)	-1.68E-04 (-1.943)	0.9642 (142)	0.0108 (1.356)	0.1005 (6.105)	3.30E-08 (3.996)	0.0949 (9.520)	-0.0357 (-3.194)	0.9381 (175)	-	0.8960	4883	<0.0001	0.862	0.278	0.463	0.391	0.369	0.473
US PRIME MARKET GROWTH	2.20E-04 (4.188)	-2.64E-05 (-0.363)	0.8405 (176)	0.0334 (5.294)	0.0646 (4.029)	2.33E-08 (4.219)	0.0897 (6.016)	-0.0243 (-1.539)	0.9327 (182)	-	0.9282	7324	<0.0001	0.536	0.077	0.122	0.128	0.073	0.172
US LARGE CAP 300 INDEX	1.26E-04 (3.721)	2.91E-05 (0.635)	0.9690 (347)	0.0281 (7.500)	0.0845 (5.227)	1.88E-08 (4.391)	0.1053 (6.183)	-0.0546 (-3.193)	0.9377 (130)	-	0.9884	485000	<0.0001	0.590	0.134	0.072	0.590	0.736	0.685
US LARGE CAP VALUE	8.17E-05 (1.116)	6.72E-05 (0.683)	0.9453 (124)	0.0256 (2.744)	0.1044 (6.629)	5.39E-08 (4.312)	0.0641 (13.52)	-	0.9320 (184)	-	0.8859	5029	<0.0001	0.671	0.260	0.471	0.321	0.349	0.410
US LARGE CAP GROWTH	3.77E-04 (5.879)	-1.90E-04 (-2.153)	0.8079 (145)	0.0502 (7.020)	0.0751 (4.695)	4.36E-08 (4.505)	0.0988 (5.954)	-0.0322 (-1.888)	0.9296 (173)	-	0.9156	6148	<0.0001	0.498	0.222	0.087	0.093	0.079	0.170

Notes:

$Y_t = \alpha_0 + \alpha_1 * NEG_i + \alpha_2 * X_t + \alpha_3 * NEG_i * X_t + \alpha_4 * MA(1) + \varepsilon_t$; $\varepsilon_t \sim iid(0, \sigma_t^2)$; $\sigma_t^2 = \beta_0 + \beta_1 * \varepsilon_{t-1}^2 + \beta_2 * \varepsilon_{t-2}^2 + \beta_3 * \sigma_{t-1}^2 + \beta_4 * \sigma_{t-2}^2$; $NEG_i = 0\ if\ X_t > 0$; $NEG_i = 1\ if\ X_t \le 0; for\ 3 \le i \le 9$; Where i=3 if X= US INVESTABLE MARKET GROWTH; i=4 if X=US PRIME MARKET 750 INDEX; i=5 if X= US PRIME MARKET VALUE; i=6 if X= US PRIME MARKET GROWTH; i=7 if X= US LARGE CAP 300 INDEX; i=8 if X= US LARGE CAP VALUE; i=9 if X= US LARGE CAP GROWTH. The numbers in parentheses represent the values of t-statistics. Sample size : 4536 observations. Sample period : 6/01/1992 – 10/19/2009. P(F) is the actual p-value of the F-statistic on the whole regression. The standardized residuals are computed as $\frac{\varepsilon_t}{\sigma_t}$. The Q(k) is the Ljung-Box Q-statistic on the standardized residuals for lag order k. It tests for higher-order serial correlation where the order is k. The $Q^2(k)$ is the Ljung-Box Q-statistic on the squares of the standardized residuals for lag order k. It tests for higher-order conditional heteroscedasticity where the order is k.

Data source: MSCI Barra

Table IVa

Regressions on the log returns of major regional stock indexes (Y) of the log returns of North America Standard Core (X), incorporating a shift dummy and an interactive dummy with the latter variable (NEG17), that takes the value 0 if X>0, and one otherwise.

Y_t	α_0	α_1	α_2	α_3	α_4	β_0	β_1	β_2	β_3	β_4	$\overline{R}^2$	F	P(F)	Marginal Significance Level					
														Q(5)	Q(10)	Q(15)	$Q^2(5)$	$Q^2(10)$	$Q^2(15)$
EAFE + CANADA	1.02E-03 (3.060)	2.11E-05 (0.038)	0.4845 (12.66)	0.1784 (3.481)	-0.2157 (-7.205)	1.19E-06 (3.367)	0.0994 (7.870)	-	-	0.8918 (65.44)	0.3120	84.9	<0.0001	0.889	0.618	0.799	0.031	0.024	0.036
EAFE ex UK	1.25E-03 (3.333)	-3.64E-04 (-0.597)	0.3786 (9.260)	0.1755 (3.123)	-0.1786 (-5.865)	1.36E-06 (3.146)	0.0894 (7.397)	-	-	0.9003 (66.14)	0.2179	52.4	<0.0001	0.882	0.677	0.862	0.028	0.016	0.029
EASEA INDEX	7.32E-04 (2.156)	7.38E-04 (1.282)	0.6331 (15.56)	0.1825 (3.557)	-0.3119 (-10.72)	1.36E-06 (4.119)	0.1016 (8.069)	-	-	0.8907 (67.06)	0.3713	110	<0.0001	0.854	0.352	0.387	0.115	0.307	0.318
EMU	7.44E-04 (1.931)	6.63E-04 (1.056)	0.7095 (16.49)	0.1607 (3.051)	-0.3104 (-10.36)	1.36E-06 (3.405)	0.0914 (8.151)	-	-	0.9022 (75.42)	0.3943	121	<0.0001	0.882	0.266	0.198	0.186	0.620	0.704
EMU ex GERMANY	6.81E-04 (1.807)	6.87E-04 (1.117)	0.7019 (16.54)	0.1499 (2.792)	-0.3070 (-10.35)	1.38E-06 (3.587)	0.0944 (8.359)	-	-	0.8991 (75.13)	0.3789	114	<0.0001	0.845	0.257	0.180	0.225	0.599	0.701
EU	5.59E-04 (1.581)	9.99E-04 (1.665)	0.7047 (16.99)	0.1811 (3.553)	-0.3393 (-11.84)	1.47E-06 (4.425)	0.1006 (8.116)	-	-	0.8913 (68.59)	0.4055	127	<0.0001	0.834	0.198	0.194	0.145	0.390	0.382
EURO	6.91E-04 (1.753)	6.62E-04 (1.036)	0.7313 (16.89)	0.1522 (2.918)	-0.3209 (-10.76)	1.39E-06 (3.397)	0.0897 (8.024)	-	-	0.9038 (76.60)	0.3988	124	<0.0001	0.884	0.228	0.204	0.165	0.611	0.735
EUROPE	5.86E-04 (1.685)	8.68E-04 (1.471)	0.6847 (16.89)	0.1701 (3.380)	-0.3375 (-11.77)	1.39E-06 (4.140)	0.0979 (7.871)	-	-	0.8941 (67.52)	0.4036	126	<0.0001	0.803	0.189	0.228	0.197	0.499	0.485
EUROPE GDP	7.31E-04 (1.993)	7.22E-04 (1.187)	0.6875 (16.22)	0.1698 (3.241)	-0.3139 (-10.58)	1.35E-06 (3.801)	0.0946 (8.089)	-	-	0.8986 (72.28)	0.3951	122	<0.0001	0.873	0.283	0.273	0.175	0.561	0.567
EUROPE ex EMU	4.45E-04 (1.304)	9.97E-04 (1.685)	0.6413 (15.80)	0.1702 (3.225)	-0.3211 (-11.42)	1.45E-06 (4.102)	0.0983 (7.570)	-	-	0.8926 (64.42)	0.3872	118	<0.0001	0.497	0.151	0.312	0.293	0.411	0.375
EUROPE ex SWITZERLAND	5.64E-04 (1.596)	9.91E-04 (1.651)	0.7054 (16.99)	0.1805 (3.533)	-0.3391 (-11.87)	1.46E-06 (4.412)	0.1001 (8.102)	-	-	0.8919 (68.34)	0.4062	127	<0.0001	0.819	0.198	0.202	0.166	0.426	0.398
EUROPE ex UK	7.67E-04 (2.065)	5.61E-04 (0.915)	0.6757 (16.27)	0.1526 (2.937)	-0.3079 (-10.35)	1.32E-06 (3.314)	0.0888 (7.806)	-	-	0.9042 (72.73)	0.3875	118	<0.0001	0.873	0.273	0.303	0.270	0.700	0.722
FAR EAST	1.92E-03 (3.631)	-1.59E-03 (-1.898)	-0.1032 (-1.886)	0.2413 (3.497)	-0.1215 (-3.905)	3.16E-06 (3.335)	0.0952 (7.442)	-	-	0.8898 (61.63)	0.0194	4.25	1.2E-04	0.579	0.259	0.650	0.009	0.004	0.017
G7 INDEX	3.76E-04 (2.885)	-6.60E-05 (-0.304)	0.7860 (53.08)	0.0676 (3.417)	-0.2111 (-7.048)	1.64E-07 (3.223)	0.0934 (7.618)	-	-	0.8979 (67.76)	0.8809	1377	<0.0001	0.810	0.698	0.909	0.040	0.061	0.082
KOKUSAI INDEX	2.89E-04 (2.146)	2.90E-04 (1.272)	0.8533 (51.97)	0.0711 (3.442)	-0.3121 (-10.78)	1.94E-07 (4.060)	0.0991 (7.938)	-	-	0.8949 (68.91)	0.8626	1169	<0.0001	0.869	0.389	0.412	0.134	0.351	0.343
NORDIC COUNTRIES	6.34E-04 (1.379)	1.21E-03 (1.584)	0.6999 (13.58)	0.1734 (2.377)	-0.2174 (-8.048)	1.88E-06 (3.464)	0.0745 (7.620)	-	-	0.9176 (84.45)	0.3163	86.6	<0.0001	0.565	0.480	0.664	0.615	0.742	0.619

Table IVa – continued

Regressions on the log returns of major regional stock indexes (Y) of the log returns of North America Standard Core (X), incorporating a shift dummy and an interactive dummy with the latter variable (NEG17), that takes the value 0 if X>0, and one otherwise.

Y_t	α_0	α_1	α_2	α_3	α_4	β_0	β_1	β_2	β_3	β_4	$\bar{R}^2$	F	P(F)	Marginal Significance Level					
														Q(5)	Q(10)	Q(15)	$Q^2(5)$	$Q^2(10)$	$Q^2(15)$
PACIFIC	1.93E-03 (3.810)	-1.34E-03 (-1.701)	-0.0367 (-0.676)	0.2481 (3.572)	-0.1158 (-3.752)	3.01E-06 (3.519)	0.1020 (7.322)	-	-	0.8834 (59.24)	0.0250	5.34	<0.0001	0.780	0.378	0.767	0.004	0.001	0.006
PACIFIC ex JAPAN	1.56E-03 (3.161)	-1.45E-04 (-0.189)	0.2185 (3.729)	0.2318 (2.918)	-0.1331 (-4.210)	2.46E-06 (4.509)	0.0892 (7.865)	-	-	0.8997 (74.48)	0.0894	18.8	<0.0001	0.967	0.973	0.975	0.002	0.003	0.027
PAN-EURO	5.36E-04 (1.529)	8.56E-04 (1.444)	0.6958 (17.16)	0.1585 (3.196)	-0.3474 (-12.18)	1.39E-06 (4.155)	0.0974 (7.984)	-	-	0.8948 (68.46)	0.4092	129	<0.0001	0.835	0.166	0.234	0.174	0.502	0.534
THE WORLD INDEX	4.75E-04 (2.989)	-2.75E-06 (-0.010)	0.7486 (40.42)	0.0823 (3.365)	-0.2308 (-7.776)	2.54E-07 (3.382)	0.0976 (7.687)	-	-	0.8947 (66.12)	0.8058	772	<0.0001	0.865	0.689	0.852	0.045	0.048	0.056
WORLD ex AUSTRALIA	4.31E-04 (2.825)	8.26E-06 (0.032)	0.7645 (43.56)	0.0770 (3.327)	-0.2419 (-8.147)	2.36E-07 (3.392)	0.0973 (7.706)	-	-	0.8947 (65.87)	0.8267	888	<0.0001	0.888	0.681	0.851	0.055	0.094	0.098
WORLD ex EMU	4.17E-04 (3.123)	-1.19E-04 (-0.551)	0.7480 (48.98)	0.0658 (3.148)	-0.1626 (-5.347)	1.62E-07 (3.069)	0.0948 (7.296)	-	-	0.8966 (66.19)	0.8729	1278	<0.0001	0.562	0.571	0.850	0.025	0.007	0.006
WORLD ex EUROPE	4.38E-04 (4.119)	-3.63E-04 (-2.186)	0.7734 (65.95)	0.0505 (3.410)	-0.1194 (-3.936)	1.05E-07 (3.332)	0.1010 (7.598)	-	-	0.8897 (65.56)	0.9300	2475	<0.0001	0.785	0.341	0.736	0.010	0.003	0.014
WORLD ex UK	5.03E-04 (3.436)	-1.73E-04 (-0.723)	0.7507 (45.71)	0.0676 (3.017)	-0.1799 (-5.979)	1.86E-07 (3.041)	0.0892 (7.371)	-	-	0.9030 (68.27)	0.8472	1032	<0.0001	0.879	0.685	0.869	0.039	0.020	0.031
WORLD ex USA	1.02E-03 (3.060)	2.11E-05 (0.038)	0.4845 (12.66)	0.1784 (3.481)	-0.2157 (-7.205)	1.19E-06 (3.367)	0.0994 (7.870)	-	-	0.8918 (65.44)	0.3120	84.9	<0.0001	0.889	0.618	0.799	0.031	0.024	0.036
EAFE FREE	1.03E-03 (2.971)	7.87E-06 (0.013)	0.4581 (11.49)	0.1824 (3.452)	-0.2304 (-7.712)	1.29E-06 (3.431)	0.0984 (7.732)	-	-	0.8924 (65.13)	0.2712	69.8	<0.0001	0.867	0.678	0.847	0.036	0.039	0.051
FAR EAST FREE	1.88E-03 (3.553)	-1.66E-03 (-1.988)	-0.1060 (-1.898)	0.2156 (2.955)	-0.1114 (-4.116)	4.79E-06 (3.567)	0.0143 (0.540)	0.1149 (3.534)	-	0.8481 (40.97)	0.0178	3.44	6.2E-04	0.663	0.342	0.729	0.217	0.074	0.216
PACIFIC FREE	1.92E-03 (3.762)	-1.46E-03 (-1.859)	-0.0401 (-0.719)	0.2144 (2.982)	-0.1045 (-3.862)	4.61E-06 (3.732)	0.0245 (1.023)	0.1152 (3.510)	-	0.8381 (37.79)	0.0232	4.37	<0.0001	0.818	0.458	0.813	0.069	0.026	0.102
PACIFIC FREE ex JAPAN	1.56E-03 (3.161)	-1.45E-04 (-0.189)	0.2185 (3.729)	0.2318 (2.918)	-0.1331 (-4.210)	2.46E-06 (4.509)	0.0892 (7.865)	-	-	0.8997 (74.48)	0.0894	18.8	<0.0001	0.967	0.973	0.975	0.001	0.003	0.027
THE WORLD INDEX FREE	4.75E-04 (2.989)	-2.77E-06 (-0.010)	0.7486 (40.42)	0.0823 (3.365)	-0.2308 (-7.775)	2.54E-07 (3.381)	0.0976 (7.687)	-	-	0.8947 (66.12)	0.8058	772	<0.0001	0.865	0.689	0.852	0.045	0.048	0.056
EM	1.55E-03 (3.345)	-2.61E-04 (-0.382)	0.4532 (9.053)	0.0493 (0.756)	-	2.60E-06 (3.921)	0.1334 (9.201)	-	-	0.8563 (62.91)	0.2436	70.4	<0.0001	0.935	0.793	0.599	0.019	0.098	0.305
EM ASIA	1.73E-03 (3.492)	-2.45E-04 (-0.326)	0.1365 (2.504)	0.1443 (1.875)	-	2.55E-06 (3.306)	0.0427 (2.274)	0.0762 (3.213)	-	0.8727 (61.66)	0.0596	12.2	<0.0001	0.627	0.419	0.294	0.004	0.006	0.022

Table IVa – continued

Regressions on the log returns of major regional stock indexes (Y) of the log returns of North America Standard Core (X), incorporating a shift dummy and an interactive dummy with the latter variable (NEG17), that takes the value 0 if X>0, and one otherwise.

Y_t	α_0	α_1	α_2	α_3	α_4	β_0	β_1	β_2	β_3	β_4	$\bar{R}^2$	F	P(F)	Marginal Significance Level					
														Q(5)	Q(10)	Q(15)	$Q^2(5)$	$Q^2(10)$	$Q^2(15)$
EM EASTERN EUROPE	7.46E-04 (1.005)	5.33E-04 (0.466)	0.6077 (7.720)	-0.0553 (-0.521)	-	1.06E-05 (6.881)	0.0471 (2.230)	0.0838 (3.491)	-	0.8451 (58.89)	0.1673	37.8	<0.0001	0.459	0.756	0.855	0.006	0.056	0.088
EM EMEA	9.15E-04 (1.499)	7.87E-04 (0.871)	0.5948 (9.485)	-0.0023 (-0.026)	-0.0743 (-2.376)	6.24E-06 (6.656)	0.1292 (8.123)	-	-	0.8512 (59.70)	0.1930	45.0	<0.0001	0.633	0.731	0.902	0.080	0.376	0.437
EM EUROPE	9.63E-04 (1.328)	4.59E-04 (0.424)	0.6633 (8.669)	-0.0214 (-0.208)	-0.0581 (-2.014)	1.26E-05 (7.762)	0.0513 (2.279)	0.0082 (0.231)	0.1042 (3.390)	0.8093 (52.36)	0.1845	33.2	<0.0001	0.262	0.537	0.728	0.020	0.130	0.182
EM EUROPE & MIDDLE EAST	9.85E-04 (1.622)	3.98E-04 (0.448)	0.5879 (8.974)	0.0141 (0.162)	-0.0779 (-2.727)	8.05E-06 (7.007)	0.0546 (2.094)	0.0150 (0.388)	0.0989 (3.270)	0.8104 (56.75)	0.1932	35.1	<0.0001	0.443	0.803	0.830	0.034	0.165	0.280
EM FAR EAST	1.87E-03 (3.680)	-6.88E-04 (-0.872)	0.0922 (1.643)	0.1602 (2.017)	-	2.40E-06 (3.142)	0.0272 (1.258)	0.0822 (3.256)	-	0.8830 (69.30)	0.0466	9.52	<0.0001	0.763	0.576	0.381	0.034	0.058	0.101
EM LATIN AMERICA	1.94E-03 (3.822)	-1.05E-03 (-1.343)	1.1425 (23.62)	0.0197 (0.335)	-	8.89E-06 (4.970)	0.2033 (8.260)	-	-	0.7674 (29.94)	0.5229	238	<0.0001	0.774	0.805	0.911	0.914	0.026	0.058
EM ex ASIA	1.32E-03 (2.505)	-1.05E-04 (-0.134)	0.8314 (15.598)	-0.0179 (-0.248)	-	5.25E-06 (4.951)	0.1377 (8.926)	-	-	0.8400 (51.76)	0.3964	143	<0.0001	0.921	0.872	0.923	0.374	0.528	0.698

Notes:
$Y_t = \alpha_0 + \alpha_1 * NEG17 + \alpha_2 * X_t + \alpha_3 * NEG17 * X_t + \alpha_4 * MA(1) + \varepsilon_t$; $\varepsilon_t \sim iid(0, \sigma_t^2)$; $\sigma_t^2 = \beta_0 + \beta_1 * \varepsilon_{t-1}^2 + \beta_2 * \varepsilon_{t-2}^2 + \beta_3 * \varepsilon_{t-3}^2 + \beta_4 * \sigma_{t-1}^2$; $NEG17 = 0\ if\ X_t > 0$; $NEG17 = 1\ if\ X_t \leq 0$. The numbers in parentheses represent the values of t-statistics. Sample size: 1304 observations. Sample period: 10/20/2004 – 10/19/2009. P(F) is the actual p-value of the F-statistic on the whole regression. The standardized residuals are computed as $\frac{\varepsilon_t}{\sigma_t}$. The Q(k) is the Ljung-Box Q-statistic on the standardized residuals for lag order k. It tests for higher-order serial correlation where the order is k. The $Q^2(k)$ is the Ljung-Box Q-statistic on the squares of the standardized residuals for lag order k. It tests for higher-order conditional heteroscedasticity where the order is k.
Data source: MSCI Barra

Table IVb

Regressions on the log returns of major regional stock indexes (Y) of the log returns of EM Europe Standard Core (X), incorporating a shift dummy and an interactive dummy with the latter variable (NEG36), that takes the value 0 if X>0, and one otherwise.

Y_t	α_0	α_1	α_2	α_3	α_4	α_5	β_0	β_1	β_2	$\overline{R}^2$	F	P(F)	Marginal Significance Level					
													Q(5)	Q(10)	Q(15)	$Q^2(5)$	$Q^2(10)$	$Q^2(15)$
EM	1.44E-03 (4.380)	-7.76E-05 (-0.158)	0.4349 (24.04)	0.1011 (4.400)	-	-	1.04E-06 (3.4300	0.1038 (8.115)	0.8850 (61.44)	0.6726	446	<0.0001	0.085	0.163	0.336	0.223	0.182	0.291
EM ASIA	1.51E-03 (3.383)	8.95E-05 (0.127)	0.2787 (10.52)	0.1214 (3.844)	-	-	1.05E-06 (2.633)	0.0786 (7.057)	0.9173 (82.13)	0.3448	114	<0.0001	0.173	0.137	0.174	0.119	0.285	0.253
EM EASTERN EUROPE	-4.68E-04 (-3.793)	8.95E-04 (4.863)	1.0315 (171)	-0.0033 (-0.468)	-	-	8.44E-08 (2.547)	0.0643 (5.409)	0.9263 (73.87)	0.9875	17206	<0.0001	0.136	0.499	0.197	0.815	0.849	0.913
EM EMEA	9.14E-04 (3.578)	-1.04E-03 (-2.910)	0.7261 (54.96)	0.0371 (2.309)	-	-	3.75E-07 (2.280)	0.0576 (5.365)	0.9299 (70.09)	0.9149	2336	<0.0001	0.065	0.115	0.162	0.776	0.770	0.175
EM EUROPE & MIDDLE EAST	4.68E-04 (5.321)	-5.73E-04 (-4.633)	0.8419 (207)	0.0169 (3.675)	-	-	3.69E-08 (3.347)	0.0754 (8.760)	0.9196 (105)	0.9852	14433	<0.0001	0.784	0.924	0.931	0.667	0.353	0.262
EM FAR EAST	1.50E-03 (3.231)	-6.13E-05 (-0.081)	0.2708 (9.932)	0.1243 (3.805)	-	-	9.43E-07 (2.450)	0.0689 (7.081)	0.9277 (95.50)	0.3170	101	<0.0001	0.066	0.094	0.137	0.151	0.502	0.326
EM LATIN AMERICA	1.23E-03 (2.086)	6.98E-04 (0.728)	0.5704 (15.57)	0.0802 (1.976)	0.6747 (9.184)	-0.8072 (-14.34)	3.62E-06 (3.637)	0.0733 (6.457)	0.9105 (70.80)	0.4804	151	<0.0001	0.841	0.456	0.760	0.700	0.421	0.473
EM ex ASIA	1.04E-03 (2.778)	-1.76E-04 (-0.320)	0.6438 (28.51)	0.0598 (2.360)	0.7350 (8.675)	-0.8197 (-11.67)	9.53E-07 (3.319)	0.0617 (6.975)	0.9243 (89.13)	0.7792	574	<0.0001	0.472	0.590	0.761	0.565	0.273	0.488

Notes:

$Y_t = \alpha_0 + \alpha_1 * NEG36 + \alpha_2 * X_t + \alpha_3 * NEG36 * X_t + \alpha_4 * AR(1) + \alpha_5 * MA(1) + \varepsilon_t$; $\varepsilon_t \sim iid(0, \sigma_t^2)$; $\sigma_t^2 = \beta_0 + \beta_1 * \varepsilon_{t-1}^2 + \beta_2 * \sigma_{t-1}^2$; $NEG36 = 0 \; if \; X_t > 0$; $NEG36 = 1 \; if \; X_t \leq 0$. The numbers in parentheses represent the values of t-statistics. Sample size: 1304 observations. Sample period : 10/20/2004 – 10/19/2009. P(F) is the actual p-value of the F-statistic on the whole regression. The standardized residuals are computed as $\frac{\varepsilon_t}{\sigma_t}$. The Q(k) is the Ljung-Box Q-statistic on the standardized residuals for lag order k. It tests for higher-order serial correlation where the order is k. The $Q^2(k)$ is the Ljung-Box Q-statistic on the squares of the standardized residuals for lag order k. It tests for higher-order conditional heteroscedasticity where the order is k.

Data source: MSCI Barra

Table V

Regressions on the log returns of S&P500 (Y) of the daily log returns of DJIA (X), incorporating a shift dummy and an interactive dummy with the latter variable (DUM), that takes the value 0 if X>0, and one otherwise.

X_t	α_0	α_1	α_2	α_3	α_4	β_0	β_1	β_2	β_3	β_4	$\bar{R}^2$	F	P(F)	Marginal Significance Level					
														Q(5)	Q(10)	Q(15)	$Q^2(5)$	$Q^2(10)$	$Q^2(15)$
Dow Jones Industrial Average	1.17E-06 (0.031)	3.5E-04 (7.265)	0.9287 (225)	0.0350 (7.441)	0.0440 (4.986)	4.67E-08 (10.11)	0.1907 (26.82)	-0.1704 (-27.24)	1.1930 (34.35)	-0.2201 (-6.698)	0.9157	18220	<0.0001	0.825	0.755	0.893	0.046	0.155	0.428

Notes:
$Y_t = \alpha_0 + \alpha_1 * DUM + \alpha_2 * X_t + \alpha_3 * DUM * X_t + \alpha_4 * MA(1) + \varepsilon_t$; $\varepsilon_t \sim iid(0, \sigma_t^2)$; $\sigma_t^2 = \beta_0 + \beta_1 * \varepsilon_{t-1}^2 + \beta_2 * \varepsilon_{t-2}^2 + \beta_3 * \sigma_{t-1}^2 + \beta_4 * \sigma_{t-2}^2$; $DUM = 0 \; if \; X_t > 0$; $DUM = 1 \; if \; X_t \leq 0$. The numbers in parentheses represent the values of t-statistics. Sample size: 15093 observations. Sample period : 01/03/1950 – 12/28/2009. P(F) is the actual p-value of the F-statistic on the whole regression. The standardized residuals are computed as $\frac{\varepsilon_t}{\sigma_t}$. The Q(k) is the Ljung-Box Q-statistic on the standardized residuals for lag order k. It tests for higher-order serial correlation where the order is k. The $Q^2(k)$ is the Ljung-Box Q-statistic on the squares of the standardized residuals for lag order k. It tests for higher-order conditional heteroscedasticity where the order is k.

Data source: Yahoo! Finance

Table VI

The sign tests of α_1 and 1- α_2-α_3 and the stationary test for the 53 regressions which resulted in significant α_2 and significantly positive α_3.

Dependent Variable	Independent Variable	α_1 Sign	α_1 Sig.	α_1	α_2	α_3	$\alpha_2+\alpha_3$	1- α_2-α_3	$\sum_{k=1}$ β
US INVESTABLE MARKET VALUE	US INVESTABLE MARKET 2500 INDEX	<0	Sig	-2.37E-04	0.9198	0.0210	0.9408	0.0592	0.99
US SMALL + MID CAP 2200 INDEX		<0	Insig	-1.19E-04	0.9562	0.0794	1.0356	-0.0356	0.99
US SMALL + MID CAP 2200 INDEX VALUE		>0	Sig	2.75E-04	0.7663	0.0953	0.8616	0.1384	0.99
US SMALL + MID CAP 2200 INDEX GROWTH		<0	Sig	-5.66E-04	1.0491	0.0772	1.1263	-0.1263	0.99
US MID CAP 450 INDEX		<0	Insig	-8.02E-05	0.9648	0.0721	1.0369	-0.0369	0.99
US MID CAP VALUE		>0	Sig	2.74E-04	0.8244	0.0701	0.8945	0.1055	0.99
US MID CAP GROWTH		<0	Sig	-4.78E-04	1.0616	0.0691	1.1307	-0.1307	0.99
US SMALL CAP 1750 INDEX		<0	Insig	-1.06E-04	0.9307	0.0991	1.0298	-0.0298	0.99
US SMALL CAP VALUE		>0	Sig	4.26E-04	0.6971	0.1269	0.8240	0.1760	0.99
US SMALL CAP GROWTH		<0	Sig	-6.81E-04	1.0425	0.0794	1.1219	-0.1219	0.99
US INVESTABLE MARKet 2500 Index	US INV. MARKET GROWTH	>0	Insig	9.07E-05	0.8599	0.0164	0.8763	0.1237	0.99
US INVESTABLE MARKet 2500 Index	US PRIME MARKET 750 INDEX	<0	Insig	-7.11E-06	0.9881	0.0118	0.9999	1E-04	0.98
US INVESTABLE MARKet 2500 Index	US PRIME MARKET GROWTH	<0	Insig	-2.64E-05	0.8405	0.0334	0.8739	0.1261	0.99
US INVESTABLE MARKet 2500 Index	US LARGE CAP 300 INDEX	>0	Insig	2.91E-05	0.9690	0.0281	0.9971	0.0029	0.98
US INVESTABLE MARKet 2500 Index	US LARGE CAP VALUE	>0	Insig	6.72E-05	0.9453	0.0256	0.9709	0.0291	0.99
US INVESTABLE MARKet 2500 Index	US LARGE CAP GROWTH	<0	Sig	-1.90E-04	0.8079	0.0502	0.8581	0.1419	0.99
EAFE + CANADA	NORTH AMERICA	>0	Insig	2.11E-05	0.4845	0.1784	0.6629	0.3371	0.99
EAFE ex UK		<0	Insig	-3.64E-04	0.3786	0.1755	0.5541	0.4459	0.98
EASEA INDEX		>0	Insig	7.38E-04	0.6331	0.1825	0.8156	0.1844	0.99
EMU		>0	Insig	6.63E-04	0.7095	0.1607	0.8702	0.1298	0.99
EMU ex GERMANY		>0	Insig	6.87E-04	0.7019	0.1499	0.8518	0.1482	0.99
EU		>0	Insig	9.99E-04	0.7047	0.1811	0.8858	0.1142	0.99
EURO		>0	Insig	6.62E-04	0.7313	0.1522	0.8835	0.1165	0.99
EUROPE		>0	Insig	8.68E-04	0.6847	0.1701	0.8548	0.1452	0.99
EUROPE GDP		>0	Insig	7.22E-04	0.6875	0.1698	0.8573	0.1427	0.99
EUROPE ex EMU		>0	Insig	9.97E-04	0.6413	0.1702	0.8115	0.1885	0.99
EUROPE ex SWITZERLAND		>0	Insig	9.91E-04	0.7054	0.1805	0.8859	0.1141	0.99
EUROPE ex UK		>0	Insig	5.61E-04	0.6757	0.1526	0.8283	0.1717	0.99
FAR EAST		<0	Insig	-1.59E-03	-0.1032	0.2413	0.1381	0.8619	0.98
G7 INDEX		<0	Insig	-6.60E-05	0.786	0.0676	0.8536	0.1464	0.99
KOKUSAI INDEX		>0	Insig	2.90E-04	0.8533	0.0711	0.9244	0.0756	0.99
NORDIC COUNTRIES		>0	Insig	1.21E-03	0.6999	0.1734	0.8733	0.1267	0.99
PACIFIC		<0	Insig	-1.34E-03	-0.0367	0.2481	0.2114	0.7886	0.98
PACIFIC ex JAPAN		<0	Insig	-1.45E-04	0.2185	0.2318	0.4503	0.5497	0.98
PAN-EURO		>0	Insig	8.56E-04	0.6958	0.1585	0.8543	0.1457	0.99
THE WORLD INDEX		<0	Insig	-2.75E-06	0.7486	0.0823	0.8309	0.1691	0.99
WORLD ex AUSTRALIA		>0	Insig	8.26E-06	0.7645	0.077	0.8415	0.1585	0.99
WORLD ex EMU		<0	Insig	-1.19E-04	0.7480	0.0658	0.8138	0.1862	0.99
WORLD ex EUROPE		<0	Sig	-3.63E-04	0.7734	0.0505	0.8239	0.1761	0.99
WORLD ex UK		<0	Insig	-1.73E-04	0.7507	0.0676	0.8183	0.1817	0.99
WORLD ex USA		>0	Insig	2.11E-05	0.4845	0.1784	0.6629	0.3371	0.99
EAFE FREE		>0	Insig	7.87E-06	0.4581	0.1824	0.6405	0.3595	0.99
FAR EAST FREE		<0	Insig	-1.66E-03	-0.1060	0.2156	0.1096	0.8904	0.97
PACIFIC FREE		<0	Insig	-1.46E-03	-0.0401	0.2144	0.1743	0.8257	0.97
PACIFIC FREE ex JAPAN		<0	Insig	-1.45E-04	0.2185	0.2318	0.4503	0.5497	0.98
THE WORLD INDEX FREE		<0	Insig	-2.77E-06	0.7486	0.0823	0.8309	0.1691	0.99
EM	EM EUROPE	<0	Insig	-7.76E-05	0.4349	0.1011	0.5360	0.464	0.98
EM ASIA		>0	Insig	8.95E-05	0.2787	0.1214	0.4001	0.5999	0.99
EM EMEA		<0	Sig	-1.04E-03	0.7261	0.0371	0.7632	0.2368	0.98
EM EUROPE & MIDDLE EAST		<0	Sig	-5.73E-04	0.8419	0.0169	0.8588	0.1412	0.99
EM FAR EAST		<0	Insig	-6.13E-05	0.2708	0.1243	0.3951	0.6049	0.99
EM LATIN AMERICA		>0	Insig	6.98E-04	0.5704	0.0802	0.6506	0.3494	0.98
EM ex ASIA		<0	Insig	-1.76E-04	0.6438	0.0598	0.7036	0.2964	0.98
Maximum					**1.0616**	**0.2481**	**1.1307**		
Minimum					**-0.1060**	**0.0118**	**0.1096**		
Range					**1.1676**	**0.2363**	**1.0211**		
Average (Us regressions)					**0.9140**	**0.0597**	**0.9736**		
Average (Regional regressions)					**0.5451**	**0.1407**	**0.6857**		
Average (All regressions)					**0.6564**	**0.1162**	**0.7726**		
Sign test (p-value (one tailed, lower))				**0.6082**				**1.0000**	
Sign Test (p-value (one tailed, upper))				**0.3918**				**1.96E-08**	

Data souce: MSCI Barra

Appendix A: Index Definitions

US Index Definitions:

The **MSCI US Investable Market 2500 Index** represents the investable universe of companies in the US equity market. This index targets for inclusion 2,500 companies and represents, as of October 29, 2004, approximately 98% of the capitalization of the US equity market. The MSCI US Investable Market 2500 Index is the aggregation of the MSCI US Large Cap 300, Mid Cap 450 and Small Cap 1750 Indices.

The **MSCI US Investable Market Value Index** represents the value companies of the MSCI US Investable Market 2500 Index. The MSCI US Investable Market Value Index is a subset of the MSCI US Investable Market 2500 Index.

The **MSCI US Investable Market Growth Index** represents the growth companies of the MSCI US Investable Market 2500 Index. The MSCI US Investable Market Growth Index is a subset of the MSCI US Investable Market 2500 Index.

The **MSCI US Prime Market 750 Index** represents the universe of large and medium capitalization companies in the US equity market. This index targets for inclusion 750 companies and represents, as of October 29, 2004, approximately 86% of the capitalization of the US equity market. The MSCI US Prime Market 750 Index is the aggregation of the MSCI US Large Cap 300 and Mid Cap 450 Indices.

The **MSCI US Prime Market Value Index** represents the value companies of the MSCI US Prime Market 750 Index. The MSCI US Prime Market Value Index is a subset of the MSCI US Prime Market 750 Index.

The **MSCI US Prime Market Growth Index** represents the growth companies of the MSCI US Prime Market 750 Index. The MSCI US Prime Market Growth Index is a subset of the MSCI US Prime Market 750 Index.

The **MSCI US Large Cap 300 Index** represents the universe of large capitalization companies in the US equity market. This index targets for inclusion 300 companies and represents, as of October 29, 2004, approximately 71% of the capitalization of the US equity market.

The **MSCI US Large Cap Value Index** represents the value companies of the MSCI US Large Cap 300 Index. The MSCI US Large Cap Value Index is a subset of the MSCI US Large Cap 300 Index.

The **MSCI US Large Cap Growth Index** represents the growth companies of the MSCI US Large Cap 300 Index. The MSCI US Large Cap Growth Index is a subset of the MSCI US Large Cap 300 Index.

The **MSCI US Small + Mid Cap 2200 Index** represents the universe of small and medium capitalization companies in the US equity market. This index targets for inclusion 2200 companies and represents, as of October 29, 2004, approximately 27% of the capitalization of the US equity market. The MSCI Small + Mid Cap 2200 Index is the aggregation of the MSCI US Small Cap 1750 and Mid Cap 450 Indices.

The **MSCI US Small + Mid Cap Value Index** represents the value companies of the MSCI US Small + Mid Cap 2200 Index. The MSCI US Small + Mid Cap Value Index is a subset of the MSCI US Small + Mid Cap 2200 Index.

The **MSCI US Small + Mid Cap Growth Index** represents the growth companies of the MSCI US Small + Mid Cap 2200 Index. The MSCI US Small + Mid Cap Growth Index is a subset of the MSCI US Small + Mid Cap 2200 Index.

The **MSCI US Mid Cap 450 Index** represents the universe of medium capitalization companies in the US equity market. This index targets for inclusion 450 companies and represents, as of October 29, 2004, approximately 15% of the capitalization of the US equity market.

The **MSCI US Mid Cap Value Index** represents the value companies of the MSCI US Mid Cap 450 Index. The MSCI US Mid Cap Value Index is a subset of the MSCI US Mid Cap 450 Index.

The **MSCI US Mid Cap Growth Index** represents the growth companies of the MSCI US Mid Cap 450 Index. The MSCI US Mid Cap Growth Index is a subset of the MSCI US Mid Cap 450 Index.

The **MSCI US Small Cap 1750 Index** represents the universe of small capitalization companies in the US equity market. This index targets for inclusion 1,750 companies and represents, as of October 29, 2004, approximately 12% of the capitalization of the US equity market.

The **MSCI US Small Cap Value Index** represents the value companies of the MSCI US Small Cap 1750 Index. The MSCI US Small Cap Value Index is a subset of the MSCI US Small Cap 1750 Index.

The **MSCI US Small Cap Growth Index** represents the growth companies of the MSCI US Small Cap 1750 Index. The MSCI US Small Cap Growth Index is a subset of the MSCI US Small Cap 1750 Index.

Regional Index Definitions:

(The **MSCI EAFE Index (Europe, Australasia, Far East)** is a free float-adjusted market capitalization index that is designed to measure the equity market performance of developed markets, excluding the US & Canada. As of June 2007 the MSCI EAFE Index consisted of the following 21 developed market country indices: Australia, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, and the United Kingdom.)

The **MSCI EAFE + CANADA Index** is a free float-adjusted market capitalization index that is designed to measure the equity market performance of countries within EAFE and Canada.

The **MSCI EAFE ex UK Index** is a free float-adjusted market capitalization index that is designed to measure the equity market performance of countries within EAFE except United Kingdom.

The **MSCI EASEA (EAFE ex Japan) Index** is a free float-adjusted market capitalization index that is designed to measure the equity market performance of countries within EAFE except Japan.

The **MSCI EMU (European Economic and Monetary Union) Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of countries within EMU. As of June 2007 the MSCI EMU Index consisted of the following 11 developed market country indices: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain.

The **MSCI EMU ex Germany Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of countries within EMU except Germany.

The **MSCI EU Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of 17 countries within the European Union: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Spain, Sweden and United Kingdom.

The **MSCI Euro Index** is a subset of the Standard broad benchmarks for Europe, comprising the largest and most liquid securities. It is the narrower version of the MSCI EMU Index. It captures 90% of its broad benchmark counterparts' market cap, with significantly less constituents.

The **MSCI Europe Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the developed markets in Europe. As of June 2007, the MSCI Europe Index consisted of the following 16 developed market country indices: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

The **MSCI Europe GDP Index** is the GDP-weighted indices for Europe.

The **MSCI Europe ex EMU Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the developed markets in Europe except the countries within EMU.

The **MSCI Europe ex Switzerland Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the developed markets in Europe except for Switzerland.

The **MSCI Europe ex UK Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the developed markets in Europe except United Kingdom.

The **MSCI Far East** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the Far East. It is consisted of following 3 developed country indices: Hong Kong, Japan and Singapore.

The **MSCI G7 Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the following 7 developed country indices: Canada, France, Germany, Italy, Japan, United Kingdom and USA.

The **MSCI KOKUSAI (World ex Japan) Index** is a free float-adjusted market capitalization index that is designed to measure the equity market performance of developed markets excluding Japan. As of June 2007 the MSCI KOKUSAI Index consisted of the following 22 developed market country indices: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

The **MSCI NORDIC COUNTRIES Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the following 4 developed country indices: Denmark, Finland, Norway and Sweden.

The **MSCI NORTH AMERICA Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the following 2 developed country indices: Canada and USA.

The **MSCI Pacific Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the developed markets in the Pacific region. As of June 2007, the MSCI Pacific Index consisted of the following 5 Developed Market countries: Australia, Hong Kong, Japan, New Zealand, and Singapore.

The **MSCI Pacific ex Japan Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of the developed markets in the Pacific region except Japan.

The **MSCI Pan-Euro Index** is a subset of the Standard broad benchmarks for Europe, comprising the largest and most liquid securities. The MSCI Pan-Euro Index is the narrower version of the MSCI Europe Index. It captures 90% of its broad benchmark counterparts' market cap, with significantly less constituents.

The **MSCI World Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets. As of June 2007 the MSCI World Index consisted of the following 23 developed market country indices: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, and the United States.

The **MSCI World ex Australia Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets except Australia.

The **MSCI World ex EMU Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets except the countries in EMU region.

The **MSCI World ex Europe Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets except the countries in Europe.

The **MSCI World ex UK** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets except United Kingdom.

The **MSCI World ex USA** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets except USA.

The continued "Free" branding for the following 5 Developed Market Indices recognizes that these indices have histories different from the similar index that does not have the suffix "Free". Otherwise, these indices have the same current constituents and current performance. For example, the MSCI EAFE and EAFE Free Indices now have exactly the same constituents and performance. However, due to investment restrictions on foreign investors in the past, in Singapore, Switzerland, Sweden, Norway and Finland, which were recognized in EAFE Free, but not in EAFE, the history of the two indices is different. Historically, the MSCI Free indices reflected investable opportunities for global investors by taking into account local market restrictions on share ownership by foreigners. These restrictions may have assumed several forms: (1) specific classes of shares excluded from foreign investment; (2) specific securities or classes of shares for an individual company may have had limits for foreign investors; (3) the combination of regulations governing qualifications for investment, repatriation of capital and income, and low foreign ownership limits may have created a difficult investment environment for the foreign investor; and (4) specific industries, or classes of shares within a specific industry, may have been restricted to foreign investors.

The **MSCI EAFE Index Free**

The **MSCI Far East Index Free**

The **MSCI Pacific Index Free**

The **MSCI Pacific Free ex Japan Index**

The **MSCI World Index Free**

The **MSCI Emerging Markets Index** is a free float-adjusted market capitalization index that is designed to measure equity market performance of emerging markets. As of June 2009 the MSCI Emerging Markets Index consisted of the following 22 emerging market country indices: Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Korea, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Russia, South Africa, Taiwan, Thailand, and Turkey.

The **MSCI EM Asia Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of emerging markets in Asia. It consists of the following 8 emerging market country indices: China, India, Indonesia, Korea, Malaysia, Philippines, Taiwan and Thailand.

The **MSCI EM Eastern Europe Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of emerging markets in Eastern Europe. It consists of the following 4 emerging market country indices: Czech Republic, Hungary, Poland and Russia.

The **MSCI EMEA Asia Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of emerging markets in the EMEA Region. It consists of the following 9 emerging market country indices: Czech Republic, Egypt, Hungary, Israel, Morocco, Poland, Russia, South Arica, and Turkey.

The **MSCI EM Europe Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of emerging markets in Europe. It consists of the following 5 emerging market country indices: Czech Republic, Hungary, Poland, Russia and Turkey.

The **MSCI EM Europe and Middle East Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of emerging markets in Europe and the Middle East. It consists of the following 6 emerging market country indices: Czech Republic, Hungary, Israel, Poland, Russia and Turkey.

The **MSCI EM Far East Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of emerging markets in the Far East. It consists of the following 7 emerging market country indices: China, Indonesia, Korea, Malaysia, Philippines, Taiwan and Thailand.

The **MSCI EM Latin America Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of emerging markets in Latin America. As of June 2007 the MSCI EM Latin America Index consisted of the following 5 emerging market country indices: Brazil, Chile, Colombia, Mexico, and Peru.

The **MSCI EM ex Asia Index** is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of all emerging markets except in Asia. It consists of the following 14 emerging market country indices: Brazil, Chile, Colombia, Czech Republic, Egypt, Hungary, Israel, Mexico, Morocco, Peru, Poland, Russia, South Africa and Turkey.