

# Adaptive Risk Management Strategy (ARMS)

*ARMS is a quantitative volatility-focused approach to investing. The strategy generates superior risk-mitigating returns by segregating asset classes, based on their historical volatility range, into two portfolios, each alternatively deployed based on market-implied volatility signals.*

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## Abstract

Modern Portfolio Theory's (MPT), in its traditional form and its current variation of using multiple asset classes beyond cash, equities and bonds, has, in recent years, failed to deliver on its goals of achieving higher returns and lower volatility.

Since 1920, the U.S equity market (as measured by the S&P 500) has averaged a return of 9.8% annualized with a standard deviation of 18%, while bonds have averaged a 7% return about a 9% standard deviation. However, in the past two decades, volatility, especially in equities, has dramatically increased with some historic spikes in market volatility. Additionally, the double digit equity market returns of the 90's have shrunk to low single digits. Investors have had to endure long periods for U.S equity market returns to revert to the long term mean. They have shown less patience with traditional long term strategy promises, especially since the financial crisis in 2008. During the recent crisis, extreme market volatility tested the risk tolerances of investors and pushed many long term investors out of equities into very conservative strategies. All these tectonic shifts in market behavior coupled with a challenging macroeconomic and political environment have tested long held beliefs and investment managers' skills. In the last twelve years, many well known managers, both in public and private funds have thrown in the towel because they couldn't adapt to the current secular bear market environment. Many die hard buy-and-hold investors have had to accept active management strategies.

The current market environment that managers face is something few have ever experienced before. The challenges include high unemployment, anemic economic growth, inflation uncertainty, unprecedented intervention by central banks, and potential looming major political and economic catalysts - from political convulsions in Middle East countries revolution to the seemingly intractable European debt crisis - that could precipitate a major market crisis. Baby

boomers, which make up the largest demographic group of the U.S population, are moving into their retirement years and are naturally not willing to bear the current market volatility.

All these factors have repeatedly sent shock waves through the market during this secular bear environment and look set to continue to roil the markets for the foreseeable future. Active management strategies are an increasingly utilized trend among investors seeking to navigate market volatility.

A principal weakness of MPT is the change in correlation amount asset classes during extreme market crises periods. The change in correlations violates a foundational assumption of the strategy and so fails to deliver on MPT's promise of lower volatility at a time of its greatest need. There is also the behavioral science aspect: many managers, like investors, have a difficult time rebalancing portfolios and cutting allocations to rising asset classes and buying falling assets classes.

In this paper I will present a quantitative, risk management-based approach to investing called Adaptive Risk Management Strategy (ARMS). ARMS will guide investors, using multiple asset classes, to construct a tactically managed ARMS portfolio.

The ARMS system use a single signal to switch between two portfolios during period of rising and falling markets.

With today's broad range of asset class and sector ETFs, it is easier to utilize these vehicles to gain exposure to an asset class. In outlining the methodology, ETFs will be utilized as the proxy for the asset class.

The ARMS is methodology consists of two major components:

**Component 1: "Asset Class Volatility Range Ranking System"** The methodology uses a volatility range screen on the universe of asset classes. First, from an ETFs database screen for

ETFs that fit each asset class in broad universe of asset classes (in our example we have chosen five ETFs in each asset class), calculate the volatility range for these potential ETF candidates and rank all the ETFs by volatility range. Section the ETFs in volatility range ranking system into two volatility categories, and then create two portfolio alternatives that form the “**ARMS ETFs Portfolio**”. The portfolio consists of a low volatility asset classes portfolio (P1) and a high volatility asset classes portfolio (P2) that help investors to control portfolio risk better and adapt to changing market trends.

**Component 2: “Market Implied Volatility System”** alerts investors with market reversal (exits and entries) signals to adapt ARMS ETFs Portfolio to new market trends. This system uses market implied volatility augmented with simple rules.

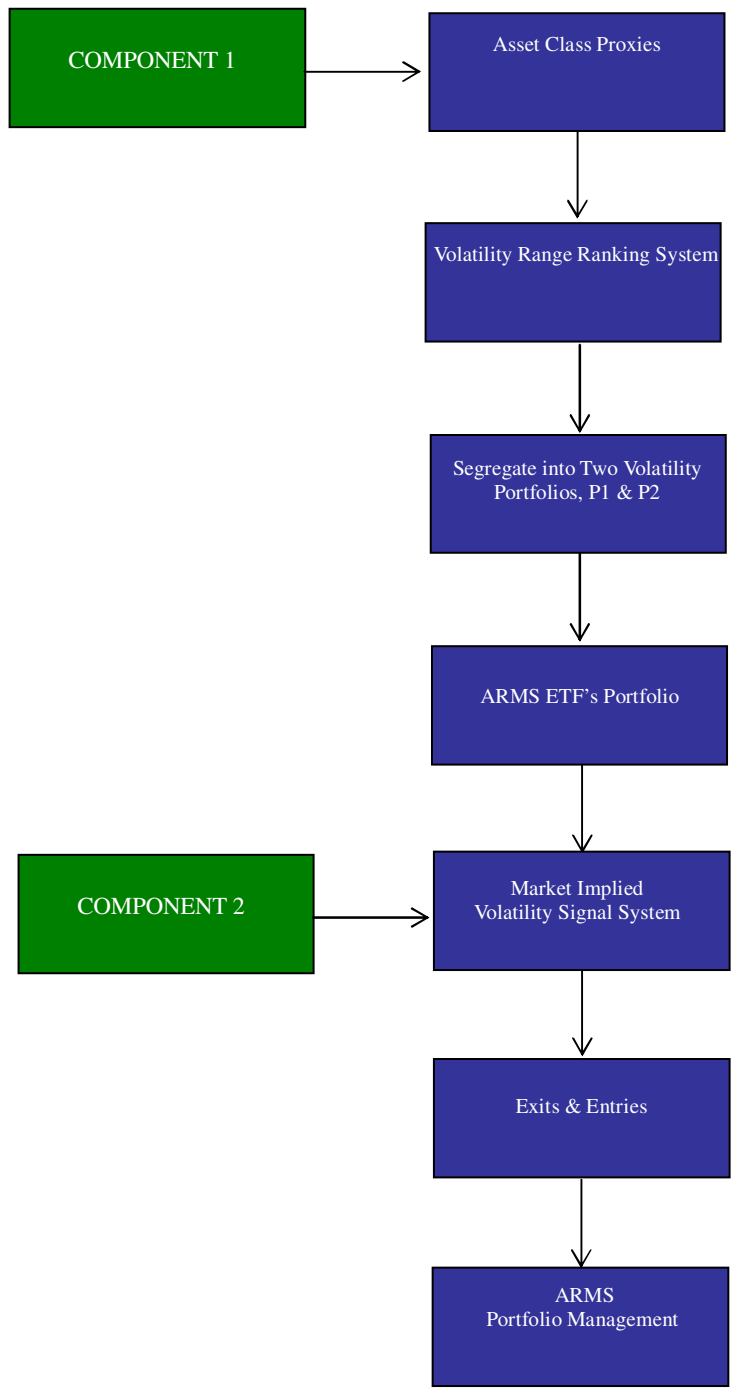
I will discuss how to use ARMS methodology to:

- 1- Select from a universe of low correlation asset classes to create a new easy to manage asset allocation.
- 2- Construct an ARMS ETFs portfolio
- 3- Identify exits and entries
- 4- Tactically manage the ARMS ETFs portfolio against market volatility.

In our illustration process we will use the universe of broad asset class ETFs - selected because they have a low correlation to the S&P 500 and to each other - to construct the ARMS ETFs portfolio. The strategy is designed to be fully invested during both down and up market trends using ARMS ETFs portfolio components portfolio 1 and portfolio 2.

We will show the strategy’s back-testing results and provide portfolio statistics to support its long term out-performance over the S&P 500.

The ARMS process is summarized in the following flow chart:



*Figure 1 shows ARMS Strategy steps*

The strategy back-testing has shown very promising results. For example, in the full period of back testing ARMS has beaten 99.53% of all US equity managers. For comparison, the S&P 500 has beaten 52.89% of those managers, over the same time period. Additionally, the strategy was profitable and out-performed S&P 500 significantly on a risk adjusted returns basis. The back testing process of ARMS was performed in an Excel spreadsheet using market data and the ARMS market implied volatility signal system to switch between the portfolios. The overview of the back testing results is summarized in pages 22 through 30.

# ***Adaptive Risk Management Strategy (ARMS)***

## **Overview**

The Strategy consists of two major steps:

- **ARMS Volatility Range Filter**

A quantitative methodology is used to modify an MPT-like extended asset class portfolio to a new tactical asset allocation. The new allocation allows investors to build a successful tactical portfolio that is adaptive to the current market environment.

The system is a simple quantitative ranking volatility filter that guides investors to select and rank investments by volatility range and then group and segregate these investments by volatility range into the two components of the ARMS portfolio strategy for deployment in a successful tactical management system.

- **ARMS Market Implied Volatility System**

ARMS market implied volatility system is a methodology to identify entries and exits for ARMS ETFs portfolio. It is based primarily on the S&P 500 implied volatility (VIX) with augmented other simple criteria.

## **Part 1: ARMS Volatility Range Filter**

### **1- Overview**

First we screen for ETF proxies of MPT-like extended asset allocation model, and then rank ETFs in ascending order by volatility range.

Once we determine volatility range for each ETF, we group them by volatility categories, and then to two components. Component 1 assigned to portfolio 1 (P1) to capitalize on the downside

momentum and component 2 is assigned to portfolio 2 (P2) to capitalize on the upside momentum. These two components of the portfolio play different roles in portfolio management.

The process will be explained in detail in this paper.

## **2- ETFs Proxies' Volatility Range**

The MPT-like extended asset allocation consists of the following asset classes:

- Money Market
- US Fixed Income
- International Fixed Income
- US Equity
- International Equity
- High Yield
- Real Estate
- Natural Resources
- Multi-Strategy
- Venture

MPT extended asset classes was based on the correlation between asset classes, volatility of asset classes, and historical returns. The strategy has worked well since the 1980's and was popular among institutional investors but in the most recent decade became dysfunctional when the correlation between asset classes has increased significantly.

In the following step I am going to calculate volatility range for each ETF:

Choose as many ETFs as desired per asset class from an ETF database. There are over 1200 ETFs available today but 98% of the daily ETF trading volume is represented by about 500 ETFs.

For illustration purposes I will screen for five ETFs per asset class, a total of 50 ETFs universe.



Calculate the volatility for each proxy by simply using [www.ETFReplay.com](http://www.ETFReplay.com) to display all ETFs volatility table at once, using excel and the volatility range formulas: Max ( $\sigma$ )-Min ( $\sigma$ ) calculates all ETFs volatility range where:

Max ( $\sigma$ ): maximum volatility

Min ( $\sigma$ ): minimum volatility

The calculation is summarized in table 1.

**Note 1:** Volatility is the annualized standard deviation of daily returns. i.e. 20- days' volatility is the standard deviation of the past 20-1 day returns multiplied by SQRT (252) from February 07, 2011 through February 07, 2013.

**Note 2:** The selected period has to include a stressed market period with high implied volatility and a stable market with low implied volatility.

| Asset Class                | Symbol | Min Vol | Max Vol | Vol Range |
|----------------------------|--------|---------|---------|-----------|
| <b>Money Market</b>        | SHV    | 0.1     | 0.4     | 0.3       |
|                            | CYB    | 0.8     | 5.9     | 5.1       |
|                            | SHY    | 0.2     | 1.5     | 1.3       |
|                            | GSY    | 2.5     | 5.9     | 3.4       |
|                            | MINT   | 0.4     | 1.58    | 1.18      |
| <b>US Fixed Income</b>     | TIP    | 2.3     | 15.8    | 13.5      |
|                            | GVI    | 1       | 5.5     | 4.5       |
|                            | AGG    | 1.2     | 7.7     | 6.5       |
|                            | UUP    | 3.4     | 13.7    | 10.3      |
|                            | IEF    | 2.6     | 13.6    | 11        |
| <b>International Fixed</b> | EMB    | 1.8     | 16      | 14.2      |
|                            | BWX    | 3.6     | 13.2    | 9.6       |
|                            | IGOV   | 4.1     | 14.9    | 10.8      |
|                            | ISHG   | 3.6     | 14.6    | 11        |
|                            | PCY    | 2.1     | 13.1    | 11        |
| <b>High Yield</b>          | HYG    | 3.1     | 26.7    | 23.6      |
|                            | LQD    | 2.3     | 14.1    | 11.8      |
|                            | JNK    | 2.8     | 25.9    | 23.1      |
|                            | HYD    | 1.4     | 26.2    | 24.8      |
|                            | BKLN   | 1.8     | 19.3    | 17.5      |

|                             |      |      |      |      |
|-----------------------------|------|------|------|------|
| <b>US Equity</b>            | SPY  | 5.5  | 49.4 | 43.9 |
|                             | MDY  | 7.1  | 60.5 | 53.4 |
|                             | QQQ  | 7.7  | 50.2 | 42.5 |
|                             | IWM  | 8.1  | 65.4 | 57.3 |
|                             | DIA  | 5.5  | 43.7 | 38.2 |
| <b>International Equity</b> | EFA  | 6.1  | 60.6 | 54.5 |
|                             | EEM  | 7.7  | 58.8 | 51.1 |
|                             | EWG  | 7.8  | 72.1 | 64.3 |
|                             | DLS  | 7.3  | 55.9 | 48.6 |
|                             | EWC  | 6.6  | 44.7 | 38.1 |
| <b>Multi-Strategy</b>       | QAI  | 1.9  | 23.5 | 21.6 |
|                             | DEF  | 4.4  | 35.4 | 31   |
|                             | AOM  | 2.7  | 17.3 | 14.6 |
|                             | DEF  | 4.4  | 35.4 | 31   |
|                             | ALT  | 2.3  | 19.6 | 17.3 |
| <b>Real Estate</b>          | IYR  | 4.6  | 61   | 56.4 |
|                             | XHB  | 9.9  | 62   | 52.1 |
|                             | ITB  | 9.7  | 62.1 | 52.4 |
|                             | ICF  | 5.8  | 64.8 | 59   |
|                             | RWO  | 5.3  | 62.9 | 57.6 |
| <b>Natural Resources</b>    | DBC  | 6.4  | 34.6 | 28.2 |
|                             | GUNR | 14.5 | 82.8 | 68.3 |
|                             | OIH  | 13.7 | 72.7 | 59   |
|                             | XLE  | 9.4  | 60.6 | 51.2 |
|                             | GLD  | 7.4  | 36.3 | 28.9 |
| <b>Venture</b>              | IWC  | 8.6  | 63.8 | 55.2 |
|                             | PSP  | 6.6  | 66   | 59.4 |
|                             | IJS  | 8.2  | 63.3 | 55.1 |
|                             | FDM  | 10.4 | 70.7 | 60.3 |
|                             | DGS  | 6.5  | 53.4 | 46.9 |

*Table 1 shows ETFs proxies listed by volatility range within the MPT-like asset classes.*

In the following step I am going to reclassify the extended MPT-like asset classes to two volatility asset class categories in order to better control portfolio risk.

Let's rank volatility range in ascending order for all the 50 ETFs from the above table using the following volatility range ranking system:

a. **Low volatility: (0-15)%**

b. **High volatility: 16% and greater**

It is unlikely to find high volatility ETFs with low volatility range in a period that includes a stressed market and stable market.

### 3- Modifying Asset Classes Classification

| Asset Class volatility Category | Symbol | Min Vol | Max Vol | Vol Range          |
|---------------------------------|--------|---------|---------|--------------------|
| Low Volatility                  |        |         |         | 0 =<Vol Range)<15% |
|                                 | SHV    | 0.1     | 0.4     | 0.3                |
|                                 | MINT   | 0.4     | 1.58    | 1.18               |
|                                 | SHY    | 0.2     | 1.5     | 1.3                |
|                                 | GSY    | 2.5     | 5.9     | 3.4                |
|                                 | GVI    | 1       | 5.5     | 4.5                |
|                                 | CYB    | 0.8     | 5.9     | 5.1                |
|                                 | AGG    | 1.2     | 7.7     | 6.5                |
|                                 | BWX    | 3.6     | 13.2    | 9.6                |
|                                 | UUP    | 3.4     | 13.7    | 10.3               |
|                                 | IGOV   | 4.1     | 14.9    | 10.8               |
|                                 | IEF    | 2.6     | 13.6    | 11                 |
|                                 | ISHG   | 3.6     | 14.6    | 11                 |
|                                 | PCY    | 2.1     | 13.1    | 11                 |
|                                 | LQD    | 2.3     | 14.1    | 11.8               |
|                                 | TIP    | 2.3     | 15.8    | 13.5               |
|                                 | EMB    | 1.8     | 16      | 14.2               |
|                                 | AOM    | 2.7     | 17.3    | 14.6               |
| High Volatility                 |        |         |         | Vol Range >= 16%   |
|                                 | ALT    | 2.3     | 19.6    | 17.3               |
|                                 | BKLN   | 1.8     | 19.3    | 17.5               |
|                                 | QAI    | 1.9     | 23.5    | 21.6               |
|                                 | JNK    | 2.8     | 25.9    | 23.1               |
|                                 | HYG    | 3.1     | 26.7    | 23.6               |
|                                 | HYD    | 1.4     | 26.2    | 24.8               |
|                                 | DBC    | 6.4     | 34.6    | 28.2               |
|                                 | GLD    | 7.4     | 36.3    | 28.9               |
|                                 | DEF    | 4.4     | 35.4    | 31                 |
|                                 | DEF    | 4.4     | 35.4    | 31                 |
|                                 | EWC    | 6.6     | 44.7    | 38.1               |

|  |      |      |      |      |
|--|------|------|------|------|
|  | DIA  | 5.5  | 43.7 | 38.2 |
|  | QQQ  | 7.7  | 50.2 | 42.5 |
|  | SPY  | 5.5  | 49.4 | 43.9 |
|  | DGS  | 6.5  | 53.4 | 46.9 |
|  | DLS  | 7.3  | 55.9 | 48.6 |
|  | EEM  | 7.7  | 58.8 | 51.1 |
|  | XLE  | 9.4  | 60.6 | 51.2 |
|  | XHB  | 9.9  | 62   | 52.1 |
|  | ITB  | 9.7  | 62.1 | 52.4 |
|  | MDY  | 7.1  | 60.5 | 53.4 |
|  | EFA  | 6.1  | 60.6 | 54.5 |
|  | IJS  | 8.2  | 63.3 | 55.1 |
|  | IWC  | 8.6  | 63.8 | 55.2 |
|  | IYR  | 4.6  | 61   | 56.4 |
|  | IWM  | 8.1  | 65.4 | 57.3 |
|  | RWO  | 5.3  | 62.9 | 57.6 |
|  | ICF  | 5.8  | 64.8 | 59   |
|  | OIH  | 13.7 | 72.7 | 59   |
|  | PSP  | 6.6  | 66   | 59.4 |
|  | FDM  | 10.4 | 70.7 | 60.3 |
|  | EWG  | 7.8  | 72.1 | 64.3 |
|  | GUNR | 14.5 | 82.8 | 68.3 |

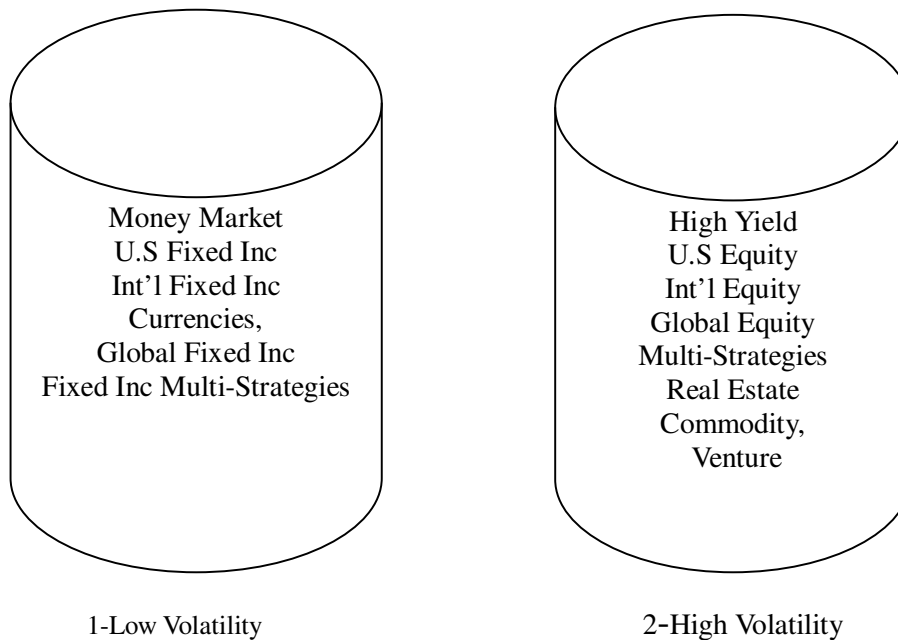
*Table 2 shows the 50 ETFs from previous MPT-like extended asset classes re-classified and grouped to two asset class categorized by volatility range.*

The new allocation consists of two volatility asset classes' categories:

The first asset class is less risky than the second asset class.

From the above table using the volatility range ranking system, all 50 ETFs are ranked in ascending order and separated into two volatility categories.

I have also reclassified MPT-like asset classes and expanded the list to more asset classes:



*Figure 2 shows MPT-like extended asset classes grouped to two asset class volatility categories.*

- **Low Volatility**

- 1- Money Market
- 2- U.S Fixed Income
- 3- International Fixed Income
- 4- Currencies.
- 5- Market Neutral
- 6- Global Fixed Income
- 7- Fixed Inc Multi-Strategies

- **High Volatility**

- 8- High Yield
- 9- US Equity
- 10- International Equity
- 11- Equity Multi-strategies

12- Real Estate

13- Commodity

14- Venture

#### 4-ARMS Portfolio Construction

Let's reduce the list of 50 ETFs in table 2 to 13 ETFs to simplify the back-testing process.

We could add more non fixed income ETFs to low volatility category but several of these ETFs strategies don't have enough historical data for back testing.

| Asset Class volatility Category     |        | Period: Feb 07, 2011-Feb 08,2013 |      |                    |
|-------------------------------------|--------|----------------------------------|------|--------------------|
| Low Volatility                      | Symbol | Min                              | Max  | 0=<Vol Range =<15% |
| Ishares Intermediate US Gov Bond    | GVI    | 1                                | 5.5  | 4.5                |
| Ishares Barclays Aggregate Bond     | AGG    | 1.2                              | 7.7  | 6.5                |
| Ishares Barclays 7-10 year Treasury | IEF    | 2.6                              | 13.6 | 11                 |
| Powershares DB US \$ Bullish        | UUP    | 3.4                              | 13.7 | 10.3               |
| Ishares Treasury Barclays Tips      | TIP    | 2.3                              | 15.8 | 13.5               |
| High Volatility                     |        |                                  |      | Vol Range >= 16%   |
| Ishares Iboxx High Yield Corp Bond  | HYG    | 3.1                              | 26.7 | 23.6               |
| Proshares DB Commodity Index        | DBC    | 6.4                              | 34.6 | 28.2               |
| SPDR S&P 400                        | MDY    | 7.5                              | 60.5 | 53                 |
| Ishares MSCI EFA index              | EFA    | 6.1                              | 60.6 | 54.5               |
| Ishares MSCI Emerging Markets       | EEM    | 7.7                              | 58.8 | 51.1               |
| Ishares DJ US Real Estate           | IYR    | 4.6                              | 61   | 56.4               |
| Ishares Russell Microcap            | IWC    | 8.6                              | 63.8 | 55.2               |
| S&P 500 Implied Volatility Index    | VIX    | 12.4                             | 48   | 35.6               |

*Table 3* shows the new asset class volatility categories with selected ETFs list for back testing.

As shown above we have constructed portfolio 1 and portfolio 2. Portfolio 1 is composed of 5 low volatility ETFs. Portfolio 2 is composed of 7 high volatility ETFs.

We could include more or less ETFs in the portfolio1 and the portfolio 2 as desired.

Portfolio 1 and portfolio 2 components:

| Asset Class volatility Category     |               | Period: Feb 07, 2011-Feb 08,2013 |            |                               | ARMS ETFs Portfolio | Asset Allocation    |
|-------------------------------------|---------------|----------------------------------|------------|-------------------------------|---------------------|---------------------|
| <b>Low Volatility</b>               | <b>Symbol</b> | <b>Min</b>                       | <b>Max</b> | <b>0&lt;Vol Range&lt;=15%</b> | <b>Portfolio 1</b>  | <b>Equal Weight</b> |
| Ishares Intermediate US Gov Bond    | GVI           | 1                                | 5.5        | 4.5                           | P1                  | 20%                 |
| Ishares Barclays Aggregate Bond     | AGG           | 1.2                              | 7.7        | 6.5                           |                     | 20%                 |
| Ishares Barclays 7-10 year Treasury | IEF           | 2.6                              | 13.6       | 11                            |                     | 20%                 |
| Powershares DB US \$ Bullish        | UUP           | 3.4                              | 13.7       | 10.3                          |                     | 20%                 |
| Ishares Treasury Barclays Tips      | TIP           | 2.3                              | 15.8       | 13.5                          |                     | 20%                 |
| <b>High Volatility</b>              |               |                                  |            | <b>Vol Range &gt;= 16%</b>    | <b>Portfolio 2</b>  | <b>Equal Weight</b> |
| Ishares Iboxx High Yield Corp Bond  | HYG           | 3.1                              | 26.7       | 23.6                          | P2                  | 14.28%              |
| Proshares DB Commodity Index        | DBC           | 6.4                              | 34.6       | 28.2                          |                     | 14.28%              |
| SPDR S&P 400                        | MDY           | 7.5                              | 60.5       | 53                            |                     | 14.28%              |
| Ishares MSCI EFA index              | EFA           | 6.1                              | 60.6       | 54.5                          |                     | 14.28%              |
| Ishares MSCI Emerging Markets       | EEM           | 7.7                              | 58.8       | 51.1                          |                     | 14.28%              |
| Ishares DJ US Real Estate           | IYR           | 4.6                              | 61         | 56.4                          |                     | 14.28%              |
| Ishares Russell Microcap            | IWC           | 8.6                              | 63.8       | 55.2                          |                     | 14.28%              |
| S&P 500 Implied Volatility Index    | VIX           | 12.4                             | 48         | 35.6                          |                     |                     |
| <b>TOTAL</b>                        |               |                                  |            |                               | <b>P=P1+ P2</b>     | <b>100.00%</b>      |

*Table 4 shows ARMS portfolio components P1 & P2.*

P1: Portfolio 1 consists of low volatility asset classes.

P2: Portfolio 2 consists of high volatility asset classes.

ARMS ETFs portfolio (P) adapts to P1 or P2 based on market implied volatility system alert signals.

P1 holdings: GVI, AGG, IEF, UUP, TIP

P2 holdings: HYG, MDY, EFA, EEM, IYR, DBC, IWC.

ARMS uses portfolio P2 when a new buy signal is registered and a new uptrend has started.

When a new sell signal is registered and a new downtrend has started P2 is sold and the proceeds invested in P1. In a narrow trading range, the ARMS signals will alert investors whether to adapt to P1 or P2.

Portfolio 1 could be more diversified than just fixed income or currency ETFs. I have included only fixed income and currency ETFs in portfolio 1 for back testing because of shorter history data availability of some alternative low volatility ETF asset classes including market neutral, conservative multi-strategies ETFs, and global fixed income.

## **Part 2 Market Implied Volatility System**

### **2.1 Overview**

Since the secular bear began in 2000 we have seen two bear markets (greater than 40% drops) and multiple corrections. We are still expecting more to come. Investor's psychology has become more averse to market volatility and they are increasingly embracing active strategies with integrated active risk control models.

In this part I am going to discuss market implied volatility system. This system alerts investors to major reversal points of the market and removes damaging human behavioral bias from investments decisions.

VIX is a forward looking indicator and predictive especially when it is integrated properly in a comprehensive system.

VIX is a volatility index created by the Chicago Board of Exchange and measures the implied volatility of the S&P 500 option index and its expected 30 day volatility. The VIX formula and clarification is beyond the scope of this paper. It is also known as the "fear index" or market psychology gauge. However, due to its randomness in the short term, I have decided to use weekly closing values to smooth and remove market implied volatility noise. The system is a simple mathematical formula composed of 30 week and 12 week exponential moving average of market implied volatility combined with other simple rules.



## ***2.2 Market Implied Volatility system:***

Let's calculate EMA (30) and EMA (12) weeks of VIX weekly closing values.

Using the formula  $D_i = \text{EMAI}(30) - \text{EMAI}(12)$ ;  $i=1 \dots N$ , calculate  $D_i$  (see back testing table).

Where:  $D_i$  is the distance between  $\text{EMAI}(30)$  and  $\text{EMAI}(12)$  at value  $i$ .

ARMS volatility exits and entries system is summarized as follow:

(1)  $\left\{ \begin{array}{l} \text{Sell signal subject to:} \\ \mathbf{D_i < 0} \end{array} \right.$

(2)  $\left\{ \begin{array}{l} \text{Buy Signal subject to:} \\ \mathbf{D_i > 0} \end{array} \right.$

- A buy signal is valid when  $D_i > 0$
- A sell signal is valid when  $D_i < 0$

Market corrections and rallies respectively from peaks and the lows without the above conditions are invalid and the market fluctuation is considered within the normal market trend volatility range, any attempt to sell or buy outside those rules is risky and fall under active trading, not active management.

If  $D_i > 0$  indicates it is time to adapt to portfolio 2.

If  $D_i < 0$  indicates it is time to adapt to portfolio 1

## ***Part 3 Back testing***

### **3.1 Overview**

In the ARMS ETFs portfolio, there are two components, P1 and P2, as described in table 4.

When a buy signal is issued according to the ARMS volatility system, we buy ETFs that are within P2 or within the high volatility asset class category. This portfolio stays invested as long as  $D > 0$  to benefit from upside market momentum.

When a sell signal is issued we sell P2 holdings and buy P1 ETFs. This portfolio stays invested as long as  $D < 0$  to benefit from the downside momentum. If the market is in a trading range, the ARMS signal will determine the portfolio P1 or P2.

Based on the ARMS back testing strategy, entry and exit frequencies are about two to three times a year.

The ARMS strategy goal is to outperform the S&P 500 on a risk adjusted returns basis.

Due to the limited availability of market price history for some of the ETFs that we have included in ARMS ETFs portfolio, I have selected a back testing period from April 2007 to December 31<sup>st</sup>, 2012. This period includes a major bear market and a major bull market. No commissions or slippage was factored in this back testing.

The buys and the sales were executed at the end of the week in which a signal was triggered. Part or all of the back testing process could be automated in major platforms.

The back-testing results are summarized below.

### **3.2 Back-Testing Statistics**

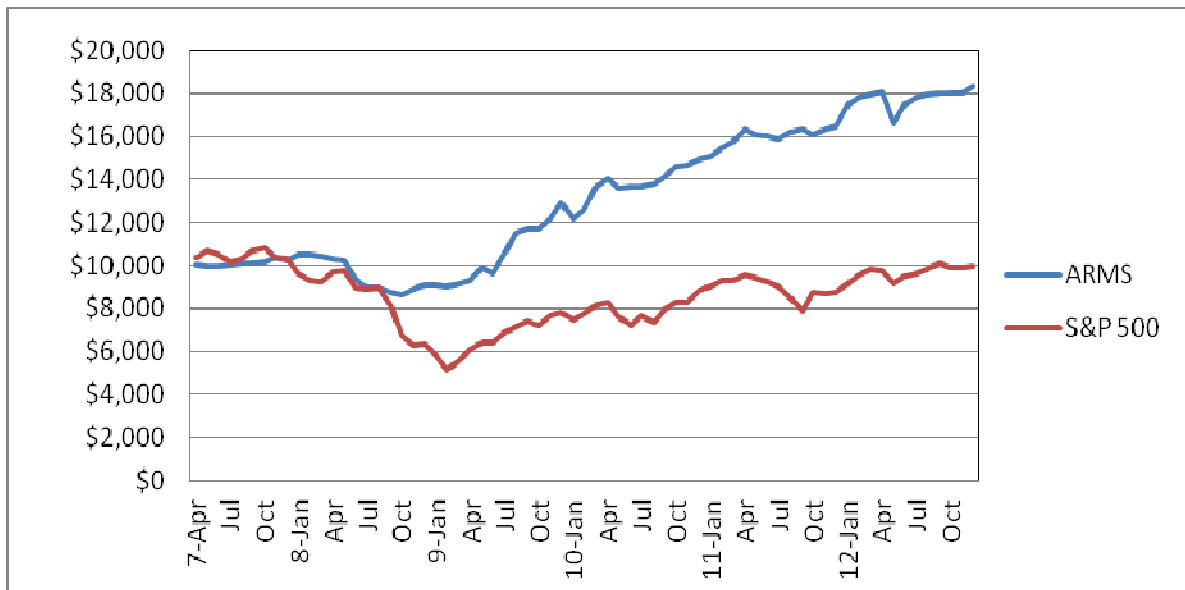
The following table is a comparison of the average annual historical returns of the ARMS portfolio vs. MPT-like asset class buy and hold portfolio and S&P 500.

| Historical Returns |      |        |       |       |        |       |       |
|--------------------|------|--------|-------|-------|--------|-------|-------|
|                    | 2007 | 2008   | 2009  | 2010  | 2011   | 2012  | AVG   |
| ARMS               | 2.6  | -11.6  | 36.6  | 15.11 | 10.16% | 11.63 | 9.074 |
| Buy & Hold         | 6.38 | -18.13 | 19.02 | 13.26 | 1.07%  | 9.99  | 5.088 |
| S&P 500            | 3.93 | -37    | 23.58 | 13.81 | 1.12%  | 11.39 | 2.81  |

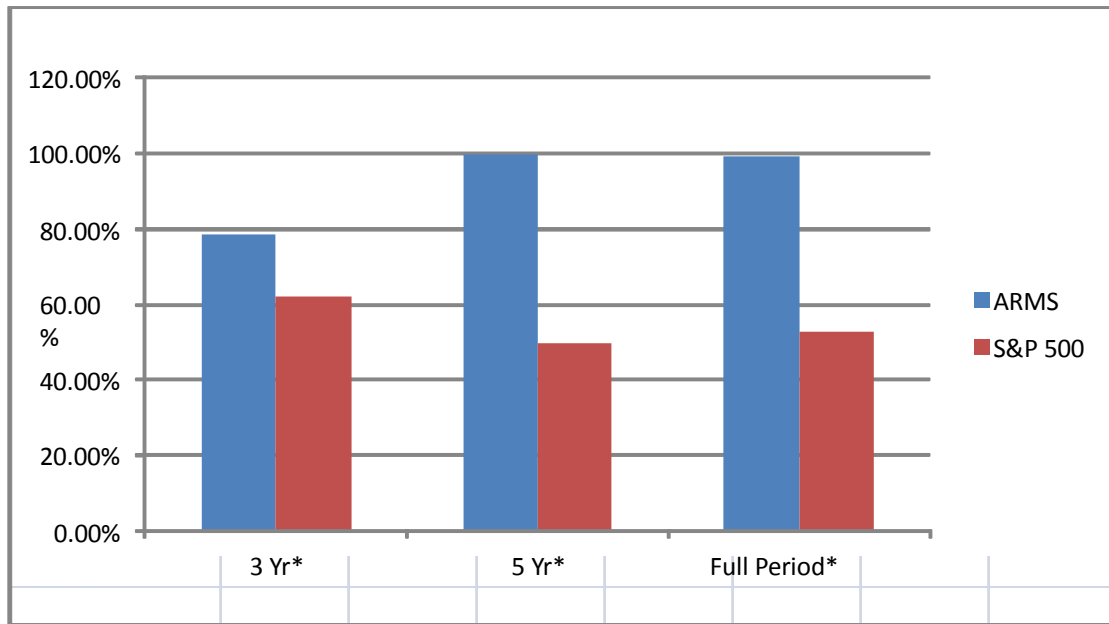
**Table 5** shows the average annual historical returns of ARMS, buy and hold portfolio, and the S&P 500 index.

| Risk Statistics             |         |        |
|-----------------------------|---------|--------|
| Since Apr 2007              | ARMS    | S&P500 |
| Number of Up Months         | 47      | 39     |
| Number of Down Months       | 22      | 29     |
| Up Months (%)               | 68%     | 57%    |
| Down Months (%)             | 31%     | 43%    |
| Upside capture ratio        | 76.17%  |        |
| Downside capture ratio      | 31.02%  |        |
| Average Annual Return       | 10.75%  | 2.81%  |
| Standard Deviation          | 9.63%   | 16.48% |
| Sharpe Ratio                | 1.12    | 0.16   |
| Max annual drawdown         | -19.18  | -53.3  |
| 2008 year result            | -11.6   | -37    |
| AVG ARMS signals per a year | Apprx 3 |        |

**Table 6** shows ARMS portfolio and S&P 500 risk statistics.



**Chart 1** shows the growth of a hypothetical \$ 10000 from April 2007 through December 2012.



**Chart 2** shows ARMS and SP 500 out-performances percentages of all US domestic equity funds.

3 yr\*: Total US domestic equity funds was 2399

5 Yr\*: Total US domestic equity funds was 2241

Full period\*: Total US domestic equity funds was 2156

In 3 years, ARMS out-performed 78.74% of all U.S domestic equity funds while the S&P 500 out-performed 61.97% funds.

In 5 years, ARMS out-performed 99.70% of all U.S domestic equity funds while the S&P 500 out-performed 49.72% of those funds.

In the full period of back testing, ARMS out-performed 99.53% of all U.S domestic funds while the S&P 500 out-performed 52.89% of those funds.

### 3.3 Evaluation

The result of back testing shows the ARMS portfolio has out-performed the S&P 500 from April 2007 through December 2012; the portfolio was tactically managed and fully invested. The downside capture ratio is only 31% with a standard deviation of 9.63% and average return of

10.75% vs. the S&P 500 average return of 2.81% and standard deviation of 16.48%. ARMS outperformed not only the S&P 500 on risk adjusted returns basis but also the diversified buy and hold portfolio. The ARMS portfolio strategy outperformed the S&P 500 on all risk statistics.

## **Conclusion**

This paper has shown how the Adaptive Risk Management Strategy can be used to improve multi-asset class allocation's risk adjusted returns and the returns from holding the S&P 500. The risk statistics data showed a favorable comparison of ARMS against the S&P 500 and all US equity managers.

The ARMS portfolio was fully invested throughout the back testing period by investing either in portfolio 1 ETFs or portfolio 2 ETFs, rather than a risk on risk off strategy. In this manner the portfolio can capitalize on the uptrend momentum as well as the downside momentum. The strategy can accommodate conservative investors by adjusting the volatility range ranking system filter of the high volatility asset class investments range from Vol range  $\geq 16$  to

$16 \leq$  Vol range  $\leq 25$  and expanding the investment choices within low risk asset class investments such as international and emerging market debt, global equity & income ETFs, and low volatility multi-strategies.

## Appendix A

| Month | ARMS Returns | S&P 500 Returns |        |       |       |
|-------|--------------|-----------------|--------|-------|-------|
|       |              |                 | 10-Jan | -5.62 | -3.7  |
| 7-Apr | 0.38         | 3.7             | Feb    | 3.3   | 2.85  |
| May   | -0.92        | 3.26            | Mar    | 8.54  | 5.88  |
| Jun   | -0.04        | -1.78           | Apr    | 2.86  | 1.48  |
| Jul   | 0.74         | -3.2            | May    | -3.3  | -8.2  |
| Aug   | 1.15         | 1.29            | Jun    | 0.23  | -5.39 |
| Sep   | -0.33        | 3.58            | Jul    | 0.12  | 6.88  |
| Oct   | 0.69         | 1.48            | Aug    | 0.96  | -4.74 |
| Nov   | 1.87         | -4.4            | Sep    | 2.42  | 8.76  |
| Dec   | -0.94        | -0.86           | Oct    | 3.25  | 3.69  |
| 8-Jan | 2.3          | -6.12           | Nov    | 0.68  | -0.23 |
| Feb   | 0.08         | -3.48           | Dec    | 1.67  | 6.53  |
| Mar   | -0.56        | -0.6            | 11-Jan | 1.24  | 2.26  |
| Apr   | -1.25        | 4.75            | Feb    | 2.71  | 3.2   |
| May   | -0.73        | 1.07            | Mar    | 1.43  | -0.11 |
| Jun   | -8.84        | -8.6            | Apr    | 3.93  | 2.85  |
| Jul   | -3.64        | -0.99           | May    | -1.73 | -1.35 |
| Aug   | -0.14        | 1.22            | Jun    | -0.42 | -1.83 |
| Sep   | -2.15        | -9.08           | Jul    | -0.81 | -2.15 |
| Oct   | -1.87        | -16.94          | Aug    | 2.31  | -5.68 |
| Nov   | 2.98         | -7.49           | Sep    | 0.75  | -7.18 |
| Dec   | 2.22         | 0.78            | Oct    | -1.56 | 10.77 |
| 9-Jan | 0.37         | -8.57           | Nov    | 1.44  | -0.51 |
| Feb   | -0.72        | -10.99          | Dec    | 0.87  | 0.85  |
| Mar   | 1            | 8.54            | 12-Jan | 6     | 4.36  |
| Apr   | 2.05         | 9.39            | Feb    | 1.96  | 4.06  |
| May   | 5.96         | 5.31            | Mar    | 0.9   | 3.13  |
| Jun   | -2.69        | 0.02            | Apr    | 0.7   | -0.75 |
| Jul   | 10.31        | 7.41            | May    | -8    | -6.27 |
| Aug   | 8.32         | 3.36            | Jun    | 5.26  | 3.96  |
| Sep   | 2.08         | 3.57            | Jul    | 1.78  | 1.26  |
| Oct   | 0.04         | -1.98           | Aug    | 0.85  | 1.98  |
| Nov   | 3.73         | 5.74            | Sep    | 0.38  | 2.42  |
| Dec   | 6.15         | 1.78            | Oct    | -0.1  | -1.98 |
|       |              |                 | Nov    | 0.07  | 0.28  |
|       |              |                 | Dec    | 1.83  | 0.71  |

**Table 7** shows ARMS back testing results from Apr 2007 through Dec 2012.

## Appendix B

| Date       | SP 500<br>VIX | EMA(30) | EMA(12) | EMA(30)-<br>EMA(12) | A.R.M.S Signals | Monthly<br>Rt P1 | Monthly<br>Rt P2 | ARMS<br>Monthly Rt |
|------------|---------------|---------|---------|---------------------|-----------------|------------------|------------------|--------------------|
| 3/2/2007   | 18.61         | 11.92   | 12.00   | -0.07               | Initial signal* |                  |                  |                    |
| 3/9/2007   | 14.09         | 12.06   | 12.32   | -0.26               |                 |                  |                  |                    |
| 3/16/2007  | 16.79         | 12.37   | 13.01   | -0.64               |                 |                  |                  |                    |
| 3/23/2007  | 12.95         | 12.41   | 13.00   | -0.59               |                 |                  |                  |                    |
| 3/30/2007  | 14.64         | 12.55   | 13.25   | -0.70               |                 |                  |                  |                    |
| 4/6/2007   | 13.23         | 12.59   | 13.25   | -0.65               |                 |                  |                  |                    |
| 4/13/2007  | 12.2          | 12.57   | 13.09   | -0.52               | First entry     |                  |                  |                    |
| 4/20/2007  | 12.07         | 12.54   | 12.93   | -0.39               |                 |                  |                  |                    |
| 4/27/2007  | 12.45         | 12.53   | 12.86   | -0.32               |                 | 1.91             |                  | 1.91               |
| 5/4/2007   | 12.91         | 12.56   | 12.86   | -0.31               |                 |                  |                  |                    |
| 5/11/2007  | 12.95         | 12.58   | 12.88   | -0.30               |                 |                  |                  |                    |
| 5/18/2007  | 12.76         | 12.59   | 12.86   | -0.27               |                 |                  |                  |                    |
| 5/25/2007  | 13.34         | 12.64   | 12.93   | -0.29               |                 |                  |                  |                    |
| 6/1/2007   | 12.78         | 12.65   | 12.91   | -0.26               |                 | -4.6             |                  | -4.6               |
| 6/8/2007   | 14.84         | 12.79   | 13.21   | -0.42               |                 |                  |                  |                    |
| 6/15/2007  | 13.94         | 12.87   | 13.32   | -0.45               |                 |                  |                  |                    |
| 6/22/2007  | 15.75         | 13.05   | 13.69   | -0.64               |                 |                  |                  |                    |
| 6/29/2007  | 16.23         | 13.26   | 14.08   | -0.83               |                 | -0.22            |                  | -0.22              |
| 7/6/2007   | 14.72         | 13.35   | 14.18   | -0.83               |                 |                  |                  |                    |
| 7/13/2007  | 15.15         | 13.47   | 14.33   | -0.86               |                 |                  |                  |                    |
| 7/20/2007  | 16.95         | 13.69   | 14.73   | -1.04               |                 |                  |                  |                    |
| 7/27/2007  | 24.17         | 14.37   | 16.19   | -1.82               |                 | 3.72             |                  | 3.72               |
| 8/3/2007   | 25.16         | 15.06   | 17.57   | -2.50               |                 |                  |                  |                    |
| 8/10/2007  | 28.3          | 15.92   | 19.22   | -3.30               |                 |                  |                  |                    |
| 8/17/2007  | 29.99         | 16.83   | 20.87   | -4.05               |                 |                  |                  |                    |
| 8/24/2007  | 20.72         | 17.08   | 20.85   | -3.77               |                 |                  |                  |                    |
| 8/31/2007  | 23.38         | 17.48   | 21.24   | -3.76               |                 | 5.75             |                  | 5.75               |
| 9/7/2007   | 26.23         | 18.05   | 22.01   | -3.96               |                 |                  |                  |                    |
| 9/14/2007  | 24.92         | 18.49   | 22.46   | -3.96               |                 |                  |                  |                    |
| 9/21/2007  | 19            | 18.52   | 21.92   | -3.40               |                 |                  |                  |                    |
| 9/28/2007  | 18            | 18.49   | 21.32   | -2.83               |                 | -1.65            |                  | -1.65              |
| 10/5/2007  | 16.91         | 18.39   | 20.64   | -2.25               |                 |                  |                  |                    |
| 10/12/2007 | 17.73         | 18.35   | 20.19   | -1.85               |                 |                  |                  |                    |
| 10/19/2007 | 22.96         | 18.64   | 20.62   | -1.98               |                 |                  |                  |                    |
| 10/26/2007 | 19.56         | 18.70   | 20.46   | -1.75               |                 |                  |                  |                    |
| 11/2/2007  | 23.01         | 18.98   | 20.85   | -1.87               |                 | 3.46             |                  | 3.46               |

|            |       |       |       |       |   |       |        |        |
|------------|-------|-------|-------|-------|---|-------|--------|--------|
| 11/9/2007  | 28.5  | 19.59 | 22.03 | -2.43 |   |       |        |        |
| 11/16/2007 | 25.49 | 19.98 | 22.56 | -2.58 |   |       |        |        |
| 11/23/2007 | 25.61 | 20.34 | 23.03 | -2.69 |   |       |        |        |
| 11/30/2007 | 22.87 | 20.50 | 23.00 | -2.50 |   | 9.36  |        | 9.36   |
| 12/7/2007  | 20.85 | 20.52 | 22.67 | -2.15 |   |       |        |        |
| 12/14/2007 | 23.27 | 20.70 | 22.76 | -2.06 |   |       |        |        |
| 12/21/2007 | 18.47 | 20.56 | 22.10 | -1.55 |   |       |        |        |
| 12/28/2007 | 20.74 | 20.57 | 21.89 | -1.32 |   | -4.68 |        | -4.68  |
| 1/4/2008   | 23.94 | 20.79 | 22.21 | -1.42 |   |       |        |        |
| 1/11/2008  | 23.68 | 20.97 | 22.44 | -1.46 |   |       |        |        |
| 1/18/2008  | 27.18 | 21.37 | 23.17 | -1.79 |   |       |        |        |
| 1/25/2008  | 29.08 | 21.87 | 24.08 | -2.20 |   |       |        |        |
| 2/1/2008   | 24.02 | 22.01 | 24.07 | -2.06 |   | 11.49 |        | 11.49  |
| 2/8/2008   | 28.01 | 22.40 | 24.67 | -2.28 |   |       |        |        |
| 2/15/2008  | 25.02 | 22.57 | 24.73 | -2.16 |   |       |        |        |
| 2/22/2008  | 24.06 | 22.66 | 24.62 | -1.96 |   |       |        |        |
| 2/29/2008  | 26.54 | 22.91 | 24.92 | -2.01 |   | 0.42  |        | 0.42   |
| 3/7/2008   | 27.49 | 23.21 | 25.31 | -2.11 |   |       |        |        |
| 3/14/2008  | 31.16 | 23.72 | 26.21 | -2.49 |   |       |        |        |
| 3/21/2008  | 26.62 | 23.91 | 26.28 | -2.37 |   |       |        |        |
| 3/28/2008  | 25.71 | 24.02 | 26.19 | -2.16 |   | -2.81 |        | -2.81  |
| 4/4/2008   | 22.45 | 23.92 | 25.61 | -1.69 |   |       |        |        |
| 4/11/2008  | 23.46 | 23.89 | 25.28 | -1.39 |   |       |        |        |
| 4/18/2008  | 20.13 | 23.65 | 24.49 | -0.84 |   |       |        |        |
| 4/25/2008  | 19.59 | 23.39 | 23.74 | -0.35 |   |       |        |        |
| 5/2/2008   | 18.18 | 23.05 | 22.88 | 0.17  | B | -6.28 |        | -6.28  |
| 5/9/2008   | 19.41 | 22.82 | 22.35 | 0.47  |   |       |        |        |
| 5/16/2008  | 16.47 | 22.41 | 21.44 | 0.96  |   |       |        |        |
| 5/23/2008  | 19.55 | 22.22 | 21.15 | 1.07  |   |       |        |        |
| 5/30/2008  | 17.83 | 21.94 | 20.64 | 1.30  |   |       | -5.14  | -5.14  |
| 6/6/2008   | 23.56 | 22.04 | 21.09 | 0.95  |   |       |        |        |
| 6/13/2008  | 21.22 | 21.99 | 21.11 | 0.88  |   |       |        |        |
| 6/20/2008  | 22.97 | 22.05 | 21.40 | 0.66  |   |       |        |        |
| 6/27/2008  | 23.44 | 22.14 | 21.71 | 0.43  |   |       | -61.9  | -61.9  |
| 7/4/2008   | 24.8  | 22.32 | 22.19 | 0.13  |   |       |        |        |
| 7/11/2008  | 27.49 | 22.65 | 23.00 | -0.35 | S |       | -26.35 | -26.35 |
| 7/18/2008  | 24.05 | 22.74 | 23.16 | -0.42 |   |       |        |        |
| 7/25/2008  | 22.91 | 22.75 | 23.12 | -0.37 |   |       |        |        |
| 8/1/2008   | 22.57 | 22.74 | 23.04 | -0.30 |   | 0.62  |        | 0.62   |
| 8/8/2008   | 20.66 | 22.60 | 22.67 | -0.07 |   |       |        |        |
| 8/15/2008  | 19.58 | 22.41 | 22.20 | 0.21  | B | 6.97  |        | 6.97   |



|            |       |       |       |        |   |       |        |        |
|------------|-------|-------|-------|--------|---|-------|--------|--------|
| 8/22/2008  | 18.81 | 22.18 | 21.68 | 0.50   |   |       |        |        |
| 8/29/2008  | 20.65 | 22.08 | 21.52 | 0.56   |   |       | -10.69 | -10.69 |
| 9/5/2008   | 23.06 | 22.14 | 21.76 | 0.39   |   |       |        |        |
| 9/12/2008  | 25.66 | 22.37 | 22.36 | 0.01   |   |       |        |        |
| 9/19/2008  | 32.07 | 22.99 | 23.85 | -0.86  | S |       | -7.38  | -7.38  |
| 9/26/2008  | 34.74 | 23.75 | 25.53 | -1.77  |   |       |        |        |
| 10/3/2008  | 45.14 | 25.13 | 28.54 | -3.41  |   | -5.5  |        | -5.5   |
| 10/10/2008 | 69.95 | 28.02 | 34.91 | -6.89  |   |       |        |        |
| 10/17/2008 | 70.33 | 30.75 | 40.36 | -9.61  |   |       |        |        |
| 10/24/2008 | 79.13 | 33.87 | 46.33 | -12.45 |   |       |        |        |
| 10/31/2008 | 59.89 | 35.55 | 48.41 | -12.86 |   | -9.34 |        | -9.34  |
| 11/7/2008  | 56.1  | 36.88 | 49.60 | -12.72 |   |       |        |        |
| 11/14/2008 | 66.31 | 38.78 | 52.17 | -13.39 |   |       |        |        |
| 11/21/2008 | 72.67 | 40.96 | 55.32 | -14.36 |   |       |        |        |
| 11/28/2008 | 55.28 | 41.89 | 55.32 | -13.43 |   | 14.89 |        | 14.89  |
| 12/5/2008  | 59.93 | 43.05 | 56.03 | -12.97 |   |       |        |        |
| 12/12/2008 | 54.28 | 43.78 | 55.76 | -11.98 |   |       |        |        |
| 12/19/2008 | 44.93 | 43.85 | 54.09 | -10.24 |   |       |        |        |
| 12/26/2008 | 43.38 | 43.82 | 52.44 | -8.62  |   |       |        |        |
| 1/2/2009   | 39.19 | 43.52 | 50.40 | -6.88  |   | 11.08 |        | 11.08  |
| 1/9/2009   | 42.82 | 43.48 | 49.24 | -5.76  |   |       |        |        |
| 1/16/2009  | 46.11 | 43.65 | 48.76 | -5.11  |   |       |        |        |
| 1/23/2009  | 47.27 | 43.88 | 48.53 | -4.65  |   |       |        |        |
| 1/30/2009  | 44.82 | 43.94 | 47.96 | -4.02  |   | 1.85  |        | 1.85   |
| 2/6/2009   | 43.37 | 43.90 | 47.25 | -3.35  |   |       |        |        |
| 2/13/2009  | 42.98 | 43.84 | 46.59 | -2.75  |   |       |        |        |
| 2/20/2009  | 49.3  | 44.20 | 47.01 | -2.81  |   |       |        |        |
| 2/27/2009  | 46.35 | 44.34 | 46.91 | -2.57  |   | -3.59 |        | -3.59  |
| 3/6/2009   | 49.33 | 44.66 | 47.28 | -2.62  |   |       |        |        |
| 3/13/2009  | 42.36 | 44.51 | 46.52 | -2.02  |   |       |        |        |
| 3/20/2009  | 45.89 | 44.60 | 46.43 | -1.83  |   |       |        |        |
| 3/27/2009  | 41.04 | 44.37 | 45.60 | -1.23  |   | 5.01  |        | 5.01   |
| 4/3/2009   | 39.7  | 44.07 | 44.69 | -0.62  |   |       |        |        |
| 4/10/2009  | 36.53 | 43.58 | 43.44 | 0.15   | B | -2.33 |        | -2.33  |
| 4/17/2009  | 33.94 | 42.96 | 41.97 | 0.98   |   |       |        |        |
| 4/24/2009  | 36.82 | 42.56 | 41.18 | 1.38   |   |       |        |        |
| 5/1/2009   | 35.3  | 42.09 | 40.28 | 1.82   |   |       | 17.55  | 17.55  |
| 5/8/2009   | 32.05 | 41.45 | 39.01 | 2.44   |   |       |        |        |
| 5/15/2009  | 33.12 | 40.91 | 38.10 | 2.80   |   |       |        |        |
| 5/22/2009  | 32.63 | 40.38 | 37.26 | 3.11   |   |       |        |        |
| 5/29/2009  | 28.92 | 39.64 | 35.98 | 3.66   |   |       | 41.75  | 41.75  |

|            |       |       |       |      |  |  |        |        |
|------------|-------|-------|-------|------|--|--|--------|--------|
| 6/5/2009   | 29.62 | 38.99 | 35.00 | 3.99 |  |  |        |        |
| 6/12/2009  | 28.15 | 38.29 | 33.95 | 4.34 |  |  |        |        |
| 6/19/2009  | 27.99 | 37.63 | 33.03 | 4.60 |  |  |        |        |
| 6/26/2009  | 25.93 | 36.87 | 31.94 | 4.93 |  |  | -18.87 | -18.87 |
| 7/3/2009   | 27.95 | 36.30 | 31.32 | 4.97 |  |  |        |        |
| 7/10/2009  | 29.02 | 35.83 | 30.97 | 4.86 |  |  |        |        |
| 7/17/2009  | 24.34 | 35.09 | 29.95 | 5.14 |  |  |        |        |
| 7/24/2009  | 23.09 | 34.31 | 28.89 | 5.42 |  |  |        |        |
| 7/31/2009  | 25.92 | 33.77 | 28.44 | 5.33 |  |  | 72.21  | 72.21  |
| 8/7/2009   | 24.76 | 33.19 | 27.87 | 5.32 |  |  |        |        |
| 8/14/2009  | 24.27 | 32.61 | 27.32 | 5.30 |  |  |        |        |
| 8/21/2009  | 25.01 | 32.12 | 26.96 | 5.16 |  |  |        |        |
| 8/28/2009  | 24.76 | 31.65 | 26.62 | 5.02 |  |  | 58.22  | 58.22  |
| 9/4/2009   | 25.26 | 31.24 | 26.41 | 4.82 |  |  |        |        |
| 9/11/2009  | 24.15 | 30.78 | 26.07 | 4.71 |  |  |        |        |
| 9/18/2009  | 23.92 | 30.34 | 25.74 | 4.60 |  |  |        |        |
| 9/25/2009  | 25.61 | 30.03 | 25.72 | 4.32 |  |  |        |        |
| 10/2/2009  | 28.68 | 29.94 | 26.17 | 3.77 |  |  | 14.56  | 14.56  |
| 10/9/2009  | 23.12 | 29.50 | 25.70 | 3.80 |  |  |        |        |
| 10/16/2009 | 21.43 | 28.98 | 25.05 | 3.94 |  |  |        |        |
| 10/23/2009 | 22.27 | 28.55 | 24.62 | 3.93 |  |  |        |        |
| 10/30/2009 | 30.69 | 28.69 | 25.55 | 3.14 |  |  | 0.27   | 0.27   |
| 11/6/2009  | 24.19 | 28.40 | 25.34 | 3.05 |  |  |        |        |
| 11/13/2009 | 23.36 | 28.07 | 25.04 | 3.03 |  |  |        |        |
| 11/20/2009 | 22.19 | 27.69 | 24.60 | 3.09 |  |  |        |        |
| 11/27/2009 | 24.74 | 27.50 | 24.62 | 2.88 |  |  | 26.11  | 26.11  |
| 12/4/2009  | 21.25 | 27.10 | 24.10 | 3.00 |  |  |        |        |
| 12/11/2009 | 21.59 | 26.74 | 23.72 | 3.03 |  |  |        |        |
| 12/18/2009 | 21.68 | 26.42 | 23.40 | 3.01 |  |  |        |        |
| 12/25/2009 | 19.47 | 25.97 | 22.80 | 3.17 |  |  |        |        |
| 1/1/2010   | 21.68 | 25.69 | 22.63 | 3.07 |  |  | 43.04  | 43.04  |
| 1/8/2010   | 18.13 | 25.20 | 21.93 | 3.27 |  |  |        |        |
| 1/15/2010  | 17.91 | 24.73 | 21.32 | 3.42 |  |  |        |        |
| 1/22/2010  | 27.31 | 24.90 | 22.24 | 2.66 |  |  |        |        |
| 1/29/2010  | 24.62 | 24.88 | 22.60 | 2.28 |  |  | -39.41 | -39.41 |
| 2/5/2010   | 26.11 | 24.96 | 23.14 | 1.82 |  |  |        |        |
| 2/12/2010  | 22.73 | 24.82 | 23.08 | 1.74 |  |  |        |        |
| 2/19/2010  | 20.02 | 24.51 | 22.61 | 1.90 |  |  |        |        |
| 2/26/2010  | 19.5  | 24.18 | 22.13 | 2.05 |  |  | 23.09  | 23.09  |
| 3/5/2010   | 17.42 | 23.75 | 21.41 | 2.34 |  |  |        |        |
| 3/12/2010  | 17.58 | 23.35 | 20.82 | 2.53 |  |  |        |        |

|            |       |       |       |       |   |       |        |        |
|------------|-------|-------|-------|-------|---|-------|--------|--------|
| 3/19/2010  | 16.97 | 22.94 | 20.23 | 2.71  |   |       |        |        |
| 3/26/2010  | 17.77 | 22.61 | 19.85 | 2.76  |   |       |        |        |
| 4/2/2010   | 17.47 | 22.27 | 19.48 | 2.79  |   |       | 59.75  | 59.75  |
| 4/9/2010   | 16.14 | 21.88 | 18.97 | 2.91  |   |       |        |        |
| 4/16/2010  | 18.36 | 21.65 | 18.87 | 2.78  |   |       |        |        |
| 4/23/2010  | 16.62 | 21.33 | 18.53 | 2.80  |   |       |        |        |
| 4/30/2010  | 22.05 | 21.37 | 19.07 | 2.30  |   |       | 20     | 20     |
| 5/7/2010   | 40.95 | 22.64 | 22.44 | 0.20  |   |       |        |        |
| 5/14/2010  | 31.24 | 23.19 | 23.79 | -0.60 | S |       | -26.45 | -26.45 |
| 5/21/2010  | 40.1  | 24.28 | 26.30 | -2.02 |   |       |        |        |
| 5/28/2010  | 32.07 | 24.78 | 27.19 | -2.40 |   | 2.33  |        | 2.33   |
| 6/4/2010   | 35.48 | 25.47 | 28.46 | -2.99 |   |       |        |        |
| 6/11/2010  | 28.79 | 25.69 | 28.51 | -2.82 |   |       |        |        |
| 6/18/2010  | 23.95 | 25.58 | 27.81 | -2.23 |   |       |        |        |
| 6/25/2010  | 28.53 | 25.77 | 27.92 | -2.15 |   |       |        |        |
| 7/2/2010   | 30.12 | 26.05 | 28.26 | -2.21 |   | 1.15  |        | 1.15   |
| 7/9/2010   | 24.98 | 25.98 | 27.76 | -1.78 |   |       |        |        |
| 7/16/2010  | 26.25 | 26.00 | 27.52 | -1.53 |   |       |        |        |
| 7/23/2010  | 23.47 | 25.83 | 26.90 | -1.07 |   |       |        |        |
| 7/30/2010  | 23.5  | 25.68 | 26.38 | -0.69 |   | 0.62  |        | 0.62   |
| 8/6/2010   | 21.74 | 25.43 | 25.66 | -0.24 |   |       |        |        |
| 8/13/2010  | 26.24 | 25.48 | 25.75 | -0.27 |   |       |        |        |
| 8/20/2010  | 25.49 | 25.48 | 25.71 | -0.23 |   |       |        |        |
| 8/27/2010  | 24.45 | 25.41 | 25.52 | -0.10 |   | 4.79  |        | 4.79   |
| 9/3/2010   | 21.31 | 25.15 | 24.87 | 0.28  | B | -2.45 |        | -2.45  |
| 9/10/2010  | 21.99 | 24.95 | 24.43 | 0.52  |   |       |        |        |
| 9/17/2010  | 22.01 | 24.76 | 24.06 | 0.70  |   |       |        |        |
| 9/24/2010  | 21.71 | 24.56 | 23.69 | 0.87  |   |       |        |        |
| 10/1/2010  | 22.5  | 24.43 | 23.51 | 0.92  |   |       | 20.38  | 20.38  |
| 10/8/2010  | 20.71 | 24.19 | 23.08 | 1.11  |   |       |        |        |
| 10/15/2010 | 19.03 | 23.85 | 22.46 | 1.40  |   |       |        |        |
| 10/22/2010 | 18.78 | 23.53 | 21.89 | 1.64  |   |       |        |        |
| 10/29/2010 | 21.2  | 23.38 | 21.78 | 1.59  |   |       | 22.76  | 22.76  |
| 11/5/2010  | 18.26 | 23.05 | 21.24 | 1.80  |   |       |        |        |
| 11/12/2010 | 20.61 | 22.89 | 21.15 | 1.74  |   |       |        |        |
| 11/19/2010 | 18.04 | 22.58 | 20.67 | 1.91  |   |       |        |        |
| 11/26/2010 | 22.22 | 22.55 | 20.91 | 1.65  |   |       |        |        |
| 12/3/2010  | 18.01 | 22.26 | 20.46 | 1.80  |   |       | 4.76   | 4.76   |
| 12/10/2010 | 17.61 | 21.96 | 20.02 | 1.94  |   |       |        |        |
| 12/17/2010 | 16.11 | 21.58 | 19.42 | 2.16  |   |       |        |        |
| 12/24/2010 | 16.47 | 21.25 | 18.97 | 2.29  |   |       |        |        |

|            |       |       |       |       |   |       |        |        |
|------------|-------|-------|-------|-------|---|-------|--------|--------|
| 12/31/2010 | 17.75 | 21.03 | 18.78 | 2.25  |   |       | 11.66  | 11.66  |
| 1/7/2011   | 17.14 | 20.78 | 18.53 | 2.25  |   |       |        |        |
| 1/14/2011  | 15.46 | 20.43 | 18.06 | 2.38  |   |       |        |        |
| 1/21/2011  | 18.47 | 20.31 | 18.12 | 2.19  |   |       |        |        |
| 1/28/2011  | 20.04 | 20.29 | 18.41 | 1.88  |   |       | 8.7    | 8.7    |
| 2/4/2011   | 15.93 | 20.01 | 18.03 | 1.98  |   |       |        |        |
| 2/11/2011  | 15.69 | 19.73 | 17.67 | 2.06  |   |       |        |        |
| 2/18/2011  | 16.43 | 19.52 | 17.48 | 2.04  |   |       |        |        |
| 2/25/2011  | 19.22 | 19.50 | 17.75 | 1.75  |   |       | 18.98  | 18.98  |
| 3/4/2011   | 19.06 | 19.47 | 17.95 | 1.52  |   |       |        |        |
| 3/11/2011  | 20.08 | 19.51 | 18.28 | 1.23  |   |       |        |        |
| 3/18/2011  | 24.44 | 19.83 | 19.23 | 0.60  |   |       |        |        |
| 3/25/2011  | 17.91 | 19.70 | 19.02 | 0.68  |   |       |        |        |
| 4/1/2011   | 17.4  | 19.55 | 18.77 | 0.78  |   |       | 10     | 10     |
| 4/8/2011   | 17.87 | 19.45 | 18.63 | 0.81  |   |       |        |        |
| 4/15/2011  | 15.32 | 19.18 | 18.12 | 1.06  |   |       |        |        |
| 4/22/2011  | 14.69 | 18.89 | 17.60 | 1.29  |   |       |        |        |
| 4/29/2011  | 14.75 | 18.62 | 17.16 | 1.46  |   |       | 27.54  | 27.54  |
| 5/6/2011   | 18.4  | 18.61 | 17.35 | 1.26  |   |       |        |        |
| 5/13/2011  | 17.07 | 18.51 | 17.31 | 1.20  |   |       |        |        |
| 5/20/2011  | 17.43 | 18.44 | 17.33 | 1.11  |   |       |        |        |
| 5/27/2011  | 15.98 | 18.28 | 17.12 | 1.16  |   |       | -12.11 | -12.11 |
| 6/3/2011   | 17.95 | 18.26 | 17.25 | 1.01  |   |       |        |        |
| 6/10/2011  | 18.86 | 18.30 | 17.49 | 0.80  |   |       |        |        |
| 6/17/2011  | 21.85 | 18.53 | 18.16 | 0.36  |   |       |        |        |
| 6/24/2011  | 21.1  | 18.69 | 18.62 | 0.08  |   |       |        |        |
| 7/1/2011   | 15.87 | 18.51 | 18.19 | 0.32  |   |       | -2.94  | -2.94  |
| 7/8/2011   | 15.95 | 18.35 | 17.85 | 0.50  |   |       |        |        |
| 7/15/2011  | 19.53 | 18.42 | 18.11 | 0.32  |   |       |        |        |
| 7/22/2011  | 17.52 | 18.36 | 18.02 | 0.35  |   |       |        |        |
| 7/29/2011  | 25.25 | 18.81 | 19.13 | -0.32 | S |       | -5.66  | -5.66  |
| 8/5/2011   | 32    | 19.66 | 21.11 | -1.45 |   |       |        |        |
| 8/12/2011  | 36.36 | 20.74 | 23.46 | -2.72 |   |       |        |        |
| 8/19/2011  | 43.05 | 22.18 | 26.47 | -4.29 |   |       |        |        |
| 8/26/2011  | 35.59 | 23.04 | 27.87 | -4.83 |   |       |        |        |
| 9/2/2011   | 33.92 | 23.74 | 28.80 | -5.06 |   | 11.57 |        | 11.57  |
| 9/9/2011   | 38.52 | 24.70 | 30.30 | -5.60 |   |       |        |        |
| 9/16/2011  | 30.98 | 25.10 | 30.40 | -5.30 |   |       |        |        |
| 9/23/2011  | 41.25 | 26.14 | 32.07 | -5.93 |   |       |        |        |
| 9/30/2011  | 42.96 | 27.23 | 33.75 | -6.52 |   | 3.75  |        | 3.75   |
| 10/7/2011  | 36.2  | 27.81 | 34.12 | -6.32 |   |       |        |        |

|            |       |       |       |       |   |      |        |        |
|------------|-------|-------|-------|-------|---|------|--------|--------|
| 10/14/2011 | 28.24 | 27.84 | 33.22 | -5.38 |   |      |        |        |
| 10/21/2011 | 31.32 | 28.06 | 32.93 | -4.87 |   |      |        |        |
| 10/28/2011 | 24.53 | 27.83 | 31.64 | -3.80 |   | -7.8 |        | -7.8   |
| 11/4/2011  | 30.16 | 27.98 | 31.41 | -3.43 |   |      |        |        |
| 11/11/2011 | 30.04 | 28.12 | 31.20 | -3.08 |   |      |        |        |
| 11/18/2011 | 32    | 28.37 | 31.32 | -2.95 |   |      |        |        |
| 11/25/2011 | 34.47 | 28.76 | 31.81 | -3.05 |   |      |        |        |
| 12/2/2011  | 27.52 | 28.68 | 31.15 | -2.47 |   | 7.2  |        | 7.2    |
| 12/9/2011  | 26.38 | 28.53 | 30.41 | -1.88 |   |      |        |        |
| 12/16/2011 | 24.29 | 28.26 | 29.47 | -1.21 |   |      |        |        |
| 12/23/2011 | 20.73 | 27.77 | 28.13 | -0.35 |   |      |        |        |
| 12/30/2011 | 23.4  | 27.49 | 27.40 | 0.09  | B | 4.43 |        | 4.43   |
| 1/6/2012   | 20.63 | 27.05 | 26.36 | 0.69  |   |      |        |        |
| 1/13/2012  | 20.91 | 26.65 | 25.52 | 1.13  |   |      |        |        |
| 1/20/2012  | 18.28 | 26.11 | 24.41 | 1.71  |   |      |        |        |
| 1/27/2012  | 18.53 | 25.62 | 23.50 | 2.12  |   |      | 41.98  | 41.98  |
| 2/3/2012   | 17.1  | 25.07 | 22.52 | 2.56  |   |      |        |        |
| 2/10/2012  | 20.79 | 24.80 | 22.25 | 2.55  |   |      |        |        |
| 2/17/2012  | 17.78 | 24.34 | 21.56 | 2.78  |   |      |        |        |
| 2/24/2012  | 17.31 | 23.89 | 20.91 | 2.98  |   |      |        |        |
| 3/2/2012   | 17.29 | 23.46 | 20.35 | 3.11  |   |      | 13.74  | 13.74  |
| 3/9/2012   | 17.11 | 23.05 | 19.85 | 3.20  |   |      |        |        |
| 3/16/2012  | 14.47 | 22.50 | 19.03 | 3.48  |   |      |        |        |
| 3/23/2012  | 14.82 | 22.00 | 18.38 | 3.63  |   |      |        |        |
| 3/30/2012  | 15.5  | 21.59 | 17.94 | 3.65  |   |      | 6.29   | 6.29   |
| 4/6/2012   | 16.7  | 21.27 | 17.75 | 3.52  |   |      |        |        |
| 4/13/2012  | 19.55 | 21.16 | 18.02 | 3.14  |   |      |        |        |
| 4/20/2012  | 17.44 | 20.92 | 17.93 | 2.99  |   |      |        |        |
| 4/27/2012  | 16.32 | 20.62 | 17.69 | 2.94  |   |      | 4.91   | 4.91   |
| 5/4/2012   | 19.16 | 20.53 | 17.91 | 2.62  |   |      |        |        |
| 5/11/2012  | 19.89 | 20.49 | 18.22 | 2.27  |   |      |        |        |
| 5/18/2012  | 25.1  | 20.78 | 19.28 | 1.51  |   |      |        |        |
| 5/25/2012  | 21.76 | 20.85 | 19.66 | 1.19  |   |      |        |        |
| 6/1/2012   | 26.66 | 21.22 | 20.73 | 0.49  |   |      | -56.03 | -56.03 |
| 6/8/2012   | 21.23 | 21.22 | 20.81 | 0.41  |   |      |        |        |
| 6/15/2012  | 21.11 | 21.22 | 20.86 | 0.36  |   |      |        |        |
| 6/22/2012  | 18.11 | 21.02 | 20.43 | 0.58  |   |      |        |        |
| 6/29/2012  | 17.07 | 20.76 | 19.92 | 0.84  |   |      | 36.8   | 36.8   |
| 7/6/2012   | 17.1  | 20.52 | 19.48 | 1.04  |   |      |        |        |
| 7/13/2012  | 16.73 | 20.28 | 19.06 | 1.22  |   |      |        |        |
| 7/20/2012  | 16.27 | 20.02 | 18.63 | 1.39  |   |      |        |        |

|            |       |       |       |       |   |  |       |       |
|------------|-------|-------|-------|-------|---|--|-------|-------|
| 7/27/2012  | 16.7  | 19.81 | 18.33 | 1.47  |   |  | 12.44 | 12.44 |
| 8/3/2012   | 15.64 | 19.54 | 17.92 | 1.62  |   |  |       |       |
| 8/10/2012  | 14.74 | 19.23 | 17.43 | 1.80  |   |  |       |       |
| 8/17/2012  | 13.45 | 18.86 | 16.82 | 2.04  |   |  |       |       |
| 8/24/2012  | 15.18 | 18.62 | 16.57 | 2.05  |   |  |       |       |
| 8/31/2012  | 17.47 | 18.54 | 16.70 | 1.84  |   |  | 5.95  | 5.95  |
| 9/7/2012   | 14.38 | 18.28 | 16.35 | 1.93  |   |  |       |       |
| 9/14/2012  | 14.51 | 18.03 | 16.06 | 1.97  |   |  |       |       |
| 9/21/2012  | 13.98 | 17.77 | 15.74 | 2.03  |   |  |       |       |
| 9/28/2012  | 15.73 | 17.64 | 15.74 | 1.90  |   |  | 2.69  | 2.69  |
| 10/5/2012  | 14.33 | 17.43 | 15.52 | 1.90  |   |  |       |       |
| 10/12/2012 | 16.14 | 17.34 | 15.62 | 1.72  |   |  |       |       |
| 10/19/2012 | 17.05 | 17.32 | 15.84 | 1.48  |   |  |       |       |
| 10/26/2012 | 17.8  | 17.35 | 16.14 | 1.21  |   |  |       |       |
| 11/2/2012  | 17.59 | 17.37 | 16.36 | 1.01  |   |  | -0.68 | -0.68 |
| 11/9/2012  | 18.61 | 17.45 | 16.71 | 0.74  |   |  |       |       |
| 11/16/2012 | 16.41 | 17.38 | 16.66 | 0.72  |   |  |       |       |
| 11/23/2012 | 15.14 | 17.24 | 16.43 | 0.81  |   |  |       |       |
| 11/30/2012 | 15.87 | 17.15 | 16.34 | 0.81  |   |  | 0.51  | 0.51  |
| 12/7/2012  | 15.9  | 17.07 | 16.27 | 0.79  |   |  |       |       |
| 12/14/2012 | 17    | 17.06 | 16.39 | 0.68  |   |  |       |       |
| 12/21/2012 | 17.84 | 17.11 | 16.61 | 0.50  |   |  |       |       |
| 12/28/2012 | 22.72 | 17.48 | 17.55 | -0.07 | S |  | 12.84 | 12.84 |

*Table 8 shows back testing results.*

Initial signal\*: the initial sell signal was on March 2<sup>nd</sup>, 2007 but the beginning of the back testing period was on April 13,2007.

## Glossary

### *Steps to calculate EMA (30) and EMA (12):*

- 1- Calculating the weighting multiplier:  $k = 2/n+1$ ,  $n=30$ ,  $12$  weeks
- 2- Derive the initial “EMA1 (30) and EMA1 (12)” which can be simple moving average of previous 30 weeks VIX and 12 weeks VIX values respectively.

$$\text{SMA (12)} = \sum_{i=1}^n \text{VIX}_i/n ; \quad n=12$$

$$\text{SMA (30)} = \sum_{i=1}^n \text{VIX}_i/n ; \quad n=30$$

After the first EMA1 (30) and EMA1 (12) calculation then:

- 3- Calculate the exponential moving rolling average of 30 and 12 VIX weekly closing values respectively **EMA (30) and EMA (12)**.

The formula is:

$$\text{EMA}_{i+1}(30) = \text{EMA}_i(30) * k + \text{EMA}_{i-1}(30) * (1-k), \quad i \geq 13 \text{ or } I \geq 31$$

Where the mathematical terms:

$k$ = Multiplier

SMA: Simple Moving Average of the initial period.

EMA: Exponential Moving Average. EMA is a moving average that is weighted more on recent volatility.