Option-Implied Betas: Positive Bias and Term Structure

Steven Chen and Joon Young Yoon

Advisor: Mark Witte

1 Introduction

Accurate measurement of CAPM beta is important in both theoretical and practical application. Beta captures the covariation of the return on a stock with the return on the market portfolio, usually approximated with an index. Beta is used in many applications including portfolio management, cost of capital estimation, portfolio evaluation, and detection of abnormal returns.

Common methods to estimate beta involve regressions using historical data. The most well-known method is to use historical data and run an OLS regression to estimate the covariance between the market and the stock. These methods are limited because they rely on the assumption that the future will be sufficiently similar to the past to justify a simple extrapolation of current or lagged betas. It is widely agreed that betas are time-varying, and historical methods allow for this variation through the use of a rolling window of historical returns. Other approaches model the time variation of beta in a more sophisticated fashion. However these methods are all highly dependent on the stability of historical patterns.

A better approach to measuring beta would be to use derivatives with embedded forward looking information. Options contain forward-looking information, and thus they incorporate information about future betas rather than relying on an extrapolation from a lagged beta. Due to the fact that the option-implied betas are risk-neutral betas and not true physical betas, we hypothesize that these option-implied betas will have a positive bias. To test this hypothesis and to determine the predictive power of option-implied betas, we estimate the beta using information from prices of equity and index options. We then conduct an out-of-sample test comparing the option-implied beta with the traditional OLS estimates, and a residual error correlation test with systematic factors to test how well the option-implied beta is capturing systematic risk.

The strength of using options is that the option-implied beta can be computed using closing prices of multiple options with different maturities on a single day. This allows us to examine the term structure of betas, a research area that has not been studied before. We hypothesize that there exists a term structure in the betas, and compare the differences in beta estimates of different maturities to determine the presence and characteristics of the term structure.

1.1 Literature Review

There has been prior research on the methodology of extracting market beta from options. The standard estimates of beta from historical return on the market and on individual equity estimates beta is:

$$\beta_i = \frac{COV_{i,m}}{VAR_m} = CORR_{i,m}\left(\frac{VAR_i}{VAR_m}\right)^{1/2} \tag{1}$$

where the moments are computed from time series of historical returns. Any method which estimates forward looking volatility or correlation can theoretically be used to estimate a forward looking beta.

French, Groth and Kolari (1983) introduce option information by using the variances for the market and individual equity implied by option information in expression (1). They use a hybrid estimation method because the correlation between the equity and market return, $CORR_{i,m}$, is estimated from historical returns. Their estimate of beta can be written as:

$$\beta_i^{FGK} = CORR_{i,m}\left(\frac{VAR_i^{FL}}{VAR_m^{FL}}\right)^{1/2}$$

where VAR_i^{FL} and VAR_m^{FL} represent the forward looking estimates of variance derived from the prices of the individual equity and index options.

The use of historical correlation to approximate future correlation introduces a few problems. If there is little or no history available for a specific firm, the historical correlation cannot be derived and this estimation method cannot be used. Another problem is that when a firm undergoes a major change such as a merger or reorganization, the correlation and the firm is likely to change. In addition, if the macroeconomic environment significantly changes, historical correlations are no longer useful. These problems can be seen in real life during the recent financial crisis as global financial and macroeconomic conditions changed and historical correlations were thrown off. McNulty et al (2002) cite the sensitivity of correlation estimates from historical data as a key detractor for corporate practitioners when using the CAPM for cost of capital computations.

Siegel (1995) bypasses the need to calculate historical correlations by assuming the existence of an option to exchange shares in firm *i* for units of the market index. Using the accounting identity dollars per share = (dollars per index unit) times (index units per share), he derives the beta of firm *i* as:

$$\beta_i^S = \frac{VAR_i^{FL} + VAR_m^{FL} - VAR_X^{FL}}{2VAR_m^{FL}}$$

where VAR_X^{FL} is the forward-looking variance implied from the option to exchange index units for equity shares. Unfortunately, since exchange options are not traded, this method cannot be used to calculate betas in practice.

Using the conventional estimate of beta given by equation (1), it seems intuitive that beta can be related to the moments of the underlying stock distribution. Although we cannot readily see the moments of the underlying stock distribution, option prices allow us to back out the risk-neutral probability distribution, and thus the risk-neutral moments. The most basic method models the options prices using a parametric model, the most common being the Black-Scholes model. While using these models is quick and convenient, the parametric approach lacks the flexibility of nonparametric models by predefining the underlying risk-neutral probability density. These models are limited in their ability to use observed prices in estimating the moments.

Jackwerth and Rubinstein (1996) use a nonparametric model to use observed option prices to back out a risk-neutral probability. Using observed bid and ask prices on a set of discrete option prices, they assume a prior density function and then find the density function that is closest to the prior in the least squares sense while satisfying the restrictions based on the bids and asks and other common restrictions. While this method is conceptually simple, the use of a least squares optimization does not have a theoretical basis and thus seems a little arbitrary. In addition, while this method may work to back out a single risk-neutral probability density, the optimization procedure can be computationally intensive and is not feasible to implement on a large scale.

In a complete market, there are either as many securities traded as there are states of the world, or there are a sufficient number of intermediate trading times so that there are as many dynamically rebalanced portfolios feasible as there are states of the world. In such a complete market, Ross (1976) shows that one can recover the risk-neutral probability distribution from a set of European option prices. Breeden and Litzenberger (1978) give the exact formula for the risk-neutral distribution:

$$\frac{\partial^2 C}{\partial K^2} = \pi_{S=K}$$

(2)

where $\pi_{S=K}$ gives the risk neutral probability that the stock will be at strike K at expiration. However, this approach needs a continuum of option prices while only a discrete set of strikes are observable. An approximation for this second derivative is the butterfly position:

$$C(K+1) + C(K-1) - 2C(K) \approx \pi_{S=K}$$

(3)

where C(K) denotes the call price at observed strike K. The butterfly can be intuitively interpreted as the difference between the call verticals, where the call verticals are the differences between adjacent calls. Thus the butterfly is the difference of the differences, or an approximation for the second derivative. This method will give extremely rough and noisy estimates of the risk neutral probability however. Equation (2) and (3) suggest two approaches to estimate the risk-neutral distribution. The first is to use the butterfly contracts to get a rough distribution, and then use optimization and smoothing techniques to fit a curve to the distribution. The second is to use the observed option prices and use cubic splines to get a continuum of option prices.

Bakshi, Kapadia and Madan (2003) provide a methodology to estimate the moments of the risk-neutral probability distribution of a stock given a continuum of options prices. They present the formulas for deriving the mean, variance, skewness and kurtosis of the risk-neutral distribution using a continuum of OTM (out-of-the-money) option prices. The correlation needed in equation (1) is still not easily estimated from the option prices however. Christoffersen, Jacobs, and Vainberg (2007) build upon these results by deriving beta as:

$$\beta_i^{CJV} = \left(\frac{SKEW_i}{SKEW_m}\right)^{1/3} \left(\frac{VAR_i}{VAR_m}\right)^{1/2} \tag{4}$$

where the moments are calculated using the methods of Bakshi, Kapadia and Madan (2003).

We use the methods of Christoffersen, Jacobs, and Vainberg (2007) and Bakshi, Kapadia, and Madan (2003) to estimate beta using the risk-neutral moments. We use a dataset that includes the most recent financial crisis in order to study how the option derived betas perform in periods of extremely high volatility. We also expand on prior research by specifically analyzing the bias of option-implied betas, introducing new tests, and studying the term structure of the betas.

2 Methodology

2.1 Estimation of Market Betas from Moments

Similar to Bakshi, Kapadia, and Madan (2003) we assume that the log-return on stock *i* follows a single factor model of the form:

$$R_i = \alpha_i + \beta_i R_m + \varepsilon_i \tag{5}$$

where the market return R_m has mean μ_m. The idiosyncratic shock ε_i has zero mean and is assumed to be independent of the market return R_m. While we did not include the time scripts t and the maturity dates m for simplicity, there will theoretically be a different beta at each point in time and for each maturity length. Expression (4) gives the formula for beta derived by Christoffersen, Jacobs, and Vainberg (2007). Intuitively, expression (4) is relating the third moment of the market to the third moment of the stock. To formalize the concept of this method of estimation, consider the definition of the third central moment of *i*:

$$\mu_{i,3} = E[(R_i - E[R_i])^3]$$

Using the single factor return structure with an independent idiosyncratic term we can write the third moment of R_i as:

$$\begin{aligned}
\mu_{i,3} &= E[(\alpha_i + \beta_i R_m + \varepsilon_i - E[\alpha_i + \beta_i R_m + \varepsilon_i])^3] \\
&= E[(\alpha_i + \beta_i R_m + \varepsilon_i - E[\alpha_i] - E[\beta_i R_m] - E[\varepsilon_i])^3] \\
&= E[(\beta_i(R_m - E[R_m]) + \ \varepsilon_i)^3] \\
&= E\left[\beta_i{}^3(R_m - E[R_m])^3 + 3\beta_i{}^2(R_m - E[R_m])^2\varepsilon_i + 3\beta_i\left(R_m - E[R_m]\right)\varepsilon_i{}^2 + \varepsilon_i{}^3\right] \\
&= \beta_i{}^3 E[(R_m - E[R_m])^3] + E[\varepsilon_i{}^3] \\
&= \beta_i{}^3 \mu_{m,3} + \mu_{\varepsilon_i,3}
\end{aligned}$$

We can thus derive beta as:

$$\beta_i = \left[\left(\frac{\mu_{i,3}}{\mu_{m,3}}\right) - \left(\frac{\mu_{\varepsilon_i,3}}{\mu_{m,3}}\right)\right]^{\frac{1}{3}}$$

(6)

In deriving expression (5), we used the assumption that the idiosyncratic risk ε_i is independent of R_m, $E[\varepsilon_i] = 0$, and the fact that $E(R_m - E[R_m]) = 0$. In order to be able to implement the estimator using only the third moments of R_i and R_m we now make the identifying assumption that the third moment of the idiosyncratic shock is zero, $\mu_{\varepsilon_i,3} = 0$. Note that this assumption follows if we assume that the idiosyncratic risk is normally distributed. The reasonability of this assumption will not be discussed here, but Christoffersen, Jacobs, and Vainberg (2007) provide a discussion. We can then solve for the market beta of stock i to be

$$\beta_i = \left(\frac{\mu_{i,3}}{\mu_{m,3}}\right)^{1/3}$$

(7)

The beta of an individual equity is the ratio between the third central moment of the equity to the third central moment of the index to the third root. Expression (7) indicates that the third moment of the market return has to be non-zero for the market beta to be well-defined. Expression (7) is the same as expression (4):

$$\beta_i = \left(\frac{SKEW_i}{SKEW_m}\right)^{1/3} \left(\frac{VAR_i}{VAR_m}\right)^{1/2} = \left(\frac{\mu_{i,3}}{\mu_{m,3}}\right)^{1/3} \left(\left(\frac{VAR_m}{VAR_i}\right)^{3/2}\right)^{1/3} \left(\frac{VAR_i}{VAR_m}\right)^{1/2} = \left(\frac{\mu_{i,3}}{\mu_{m,3}}\right)^{1/3}$$

From now on, we will refer to expression (4) as the formula of beta since these moments can be calculated using the methods of Bakshi, Kapadia, and Madan (2003).

2.2 Estimation of Risk-Neutral Moments from Option Prices

We employ the methods of Carr and Madan (2001) as used in Bakshi, Kapadia, and Madan (2003) to estimate the skewness and variance. The key result is that any twice differentiable payoff function can be spanned by a position in bonds, stocks and out-of-the-money options. They create new contracts termed *Quad* and *Cubic* defined as contracts that have a payoff function equal to the squared return and cubed return respectively, for a given time horizon τ. These contracts can then be used to determine skewness and variance.

Let q denote the probability distribution function under the risk-neutral measure. The variance and skewness under the risk neutral measure are defined as

$$SKEW \equiv \frac{E^q[(R - E^q[R])^3]}{VAR^{3/2}}$$

$$VAR \equiv E^q[(R - E^q[R])^2]$$

Using the uncentered moments, these can be rewritten as

$$SKEW = \frac{E^q[R^3 - 3R^2E^q[R] + 3RE^q[R]^2 - E^q[R]^3]}{VAR^{3/2}}$$

$$= \frac{E^q[R^3] - 3E^q[R]E^q[R^2] + 2E^q[R^3]}{VAR^{3/2}}$$

$$VAR = E^q[R^2 - 2RE^q[R] + E^q[R]^2]$$

$$= E^q[R^2] - E^q[R]^2$$

(8)

Using annualized interest returns r (i.e. if interest rates are 3%, r = 1.03-- this convention will be used throughout the paper), we get the fair value of these contracts as

$$Quad = r^{-\tau}E^{q}[R^{2}]$$

$$Cubic = r^{-\tau}E^{q}[R^{3}]$$

Substitution these expressions into the formulas given by (8), we get

$$SKEW = \frac{r^{\tau}Cubic - 3E^{q}[R]r^{\tau}Quad + 2E^{q}[R^{3}]}{VAR^{3/2}} \tag{9}$$

$$VAR = r^{\tau}Quad - E^{q}[R]^{2} \tag{10}$$

Bakshi, Kapadia, and Madan (2003) show that under all martingale pricing measures, the *Quad* and *Cubic* contracts can be recovered from the market prices of OTM European calls C(τ,*K*) and puts P(τ,*K*) where τ denotes time to maturity and *K* denotes the strike price.

The price of the *Quad* contract is

$$Quad = \int_{S}^{\infty} \frac{2\left(1 - ln\left[\frac{K}{S}\right]\right)}{K^{2}} C(\tau, K)\, dK + \int_{0}^{S} \frac{2\left(1 + ln\left[\frac{S}{K}\right]\right)}{K^{2}} P(\tau, K)\, dK \tag{11}$$

where S is the price of the underlying stock. The price of the *Cubic* contract is

$$Cubic = \int_{S}^{\infty} \frac{6ln\left(\frac{K}{S}\right) - 3ln\left(\frac{K}{S}\right)^2}{K^2} C(\tau, K)dK - \int_{0}^{S} \frac{6ln\left(\frac{S}{K}\right) + 3ln\left(\frac{S}{K}\right)^2}{K^2} P(\tau, K)\, dK$$

(12)

In addition, Bakshi, Kapadia and Madan (2003) show that the risk-neutral log-return mean can be approximated by

$$E^q[R] = e^{r\tau} - 1 - \frac{e^{r\tau}}{2} Quad - \frac{e^{r\tau}}{6} Cubic$$

(13)

By finding the price of the *Cubic* and *Quad* contracts, we can find the resulting forward looking moments of skewness and variance, and thus get the option-implied beta.

2.3 Relationship Between Risk-Neutral Beta and Physical Beta

It is important to realize that the statistical beta that we are calculating is a risk-neutral beta and not a physical beta. In other words, the skewness and variance that we calculate using option prices is the skewness and variance of the risk-neutral probability density function, not the physical probability function. A risk-neutral probability assigns higher probability to bad states of the world, and lower probability to good states of the world because the risk-neutral probabilities incorporate the risk premium that is otherwise included in the discount rate under the physical measure, measure P.

Risk-averse investors demand a higher rate of return on risky assets as opposed to risk-free assets. Under the physical probability measure P, the following should hold:

$$S_o < {r_f}^{-1} E^P[S_1]$$

(14)

where S_o is the price of a risky asset today, S_1 is the uncertain payoff on the asset in one year and r_f is the risk-free rate. The above holds because the discount rate under the actual probability measure is comprised of *r* the risk-free rate plus an additional risk premium since investors are risk-averse. Under a risk-neutral probability measure, measure Q, the following will hold:

$$S_o = {r_f}^{-1} E^Q[S_1]$$

(15)

The probabilities under the risk-neutral measure Q incorporate this risk premium, and thus $E^Q[S_1] = S_o r_f$, or the expectation of the asset under Q should equal to the risk-free rate of return.

By directly comparing $E^Q[S_1]$ and $E^P[S_1]$, the following holds:

$$\frac{E^Q[S_1]}{r_f} = \frac{E^P[S_1]}{r_i}$$

Since $r_i = r_f + risk\ premium$, it follows that $E^Q[S_1] < E^P[S_1]$. Since the payoffs S_1 are the same, the probability measure Q increases the probability of bad states and decreases the probability of good states. The risk-neutral probabilities will exhibit more negative skew the higher the level of risk aversion.

CAPM beta can be different under a risk-neutral measure due to this tilting of the risk-neutral probability. Traditional models of CAPM assume that beta is a constant. However many studies have examined models conditional on market movements. The most common method to capture market movements is to define up and down markets based on arbitrarily chosen threshold values. Chen (1982) allows beta to be nonstationary in examining the risk-return relationship in up and down markets and concludes that investors seek compensation for assuming downside risk, and that down market betas are more appropriate measures of portfolio risks than single beta. Pettengill, Sundaram and Mathur (1995) postulate a positive (negative) relation between the beta and returns during an up (down) market. Their study of US stocks over the period 1926-1990 reported the existence of a systematic conditional relation between the beta and the return. Galagedera and Faff (2004) expand these conditional models by modeling beta risk-return relationships depending on market volatility regimes. They find that betas in low, neutral, and high volatility regimes are positive and significant, but in most industry sectors the betas were not found to be significantly different in the three regimes.

Assuming that beta is conditional on market movements or volatility, the risk-neutral model should bias beta towards the level of beta seen in down states of the world. For example, if we assume that beta is higher in a down market because stocks and the index have higher co-movement in downward markets, then the risk-neutral beta should overestimate the true beta since risk neutral distributions overweight the negative states of the world. To formalize this, we can express beta in a functional form as

$$\beta_t = g(x_t)$$

where x_t represents different market regimes such as up and down markets, or levels of market volatility. At time t = 0, β_o can then be expressed as

$$\beta_o = E[\beta_t] = \int g(x_t) f(x_t)\, dx_t$$

where $f(x_t)$ denotes the probability density function of the different market regimes at time t. Since the risk-neutral probability density function $f^Q(x_t)$ is tilted more towards bad states of the world than the physical probability density function $f^P(x_t)$, the betas in the bad states of the world (down markets) will be more heavily weighted under the risk-neutral measure. As a result, given our assumption that bad states of the world have a higher beta, the risk-neutral beta at time t = 0 will overestimate the true beta. We thus present the following hypotheses:

Hypothesis 1. *The risk-neutral beta will have a positive bias compared to the true physical beta.*

Hypothesis 2. *The risk-neutral betas will exhibit a term structure which reflects investor perceptions of the future. A positively sloped term structure will imply that investors expect market conditions to deteriorate, while a negatively sloped term structure will imply that investors expect market conditions to improve.*

These hypotheses are based on the assumption that betas are higher in down markets as opposed to up markets due to increased covariance between securities in bear markets. Hypothesis 1 follows from the intuition that since risk-neutral distributions overemphasize down conditions, risk-neutral betas will have higher betas. Hypothesis 2 follows from the intuition that if beta has an increasing term structure, investors are requiring a higher market premium in the longer run, thus implying that they expect that markets will be worsening. If the betas exhibit a decreasing term structure, investors are requiring a lower market premium in the longer run, thus implying that they think markets will be improving. Having outlined the big picture, we now pursue our empirical objectives to evaluate these hypotheses.

3 Data and Implementation Procedure

3.1 Data Description

We present the empirical results for twenty-nine stocks. Our choice of companies closely mimics the companies analyzed in Christoffersen, Jacobs, and Vainberg (2007). We obtain options data from Option Metrics from WRDS (Wharton Research Data Services). We extract the date, expiration date, call or put identifier, strike price, best bid and best offer from the option price file. We focus on the quotes from the period January 1, 2002 to December 31, 2011. Our horizon of analysis differs from previous research by using more recent data, specifically adding the period of the recent financial crisis in order to analyze how these option-implied betas perform under times of extremely high volatility and large bid-ask spreads.

We acquire European options for the S&P500 options, but the equity options are American style options. Since our moment estimations are calculated using European options values, we have to justify our use of American options since American options have an extra early exercise premium. There are two reasons why we believe that American options can be used to calculate the moments. First, OTM (out-of-the-money) options have negligible early exercise premiums because they can only be exercised if they are ITM (in-the-money). Second, even if early exercise premiums are not negligible, i.e. OTM options that are close to the ATM (at-the-money) strike, the portfolio weightings given by equations (11) and (12) are small by construction. Thus we believe that the early exercise premium in American options will not greatly affect our moment estimations.

Interest rates are taken from the Option Metrics Zero Coupon Yield Curve. Security prices are taken from COMPUSTAT and Option Metrics, and dividends are taken from COMPUSTAT. Similar to Bakshi, Cao and Chen (1997), Bakshi, Kapadia and Madan (2003), and Jiang and Tian(2005), we use the midpoint of the bid-ask spread for each option contract. We screened the data to eliminate all ITM option prices, zero bids, arbitrage violations, and options with maturities shorter than 20 days. We eliminated sets of options with only one data point. In addition, in order to remove outliers, we omitted data points where the estimated beta jumped by either an absolute value of 1 or by 200% compared with the median of the four nearest-dated beta estimates. In some cases, these restrictions eliminated many of our data points. For example, when we eliminated zero bids for INTC, we eliminated about a quarter of our options. As a result, there are many frequent gaps in the beta calculations for INTC and thus our results for INTC are not as reliable. Figure 2 displays the variance and skewness of the index S&P500. Figures 3-5 display the skewness, variance and betas of the companies with gaps indicating data that was omitted for the previous reasons.

3.2 Implementing the Estimation of Moments and Betas

We use daily data and multiple maturities for each date to calculate multiple daily betas for each equity that represents the systematic risk over different maturity lengths. This approach differs from Christoffersen, Jacobs and Vainberg (2007) since they calculate a single beta for each day by only looking at maturities around 120 days. The benefit of calculating different maturity betas is that we can analyze the term structure of beta to see if longer maturity betas capture more systematic risk.

In order to calculate the *Quad* and *Cubic* contracts, we need a continuum of option prices across all strikes. However, market-data only provides a discrete set of option strikes. We follow the methods of Shimko (1993), Aït-Sahalia and Lo (1998), Carr and Wu (2004) and Jiang and Tan (2005) to span the option prices to derive a continuum of option prices given a discrete set.

We first limit ourselves to OTM options. Theoretically, we could estimate the moments using an entire span of only call-data or only put-data, but we use only OTM options because ITM options are not traded frequently and their prices are not as informative.

For each maturity, we use the collection of OTM options to back out the implied volatilities using the Black-Scholes formula. We interpolate a continuum of implied volatilities using a cubic spline across every cent increment between the lowest observed strike and the highest observed strike. These increments can also be interpreted as moneyness levels (K/S). The cubic spline can only be used to derive volatilities for strikes in between the lowest and highest observed strikes, so for the moneyness levels below (above) the available moneyness level in the market, we use the implied volatility of the lowest (highest) available strike price. The minimum moneyness level should be as close to 0 as possible, and we chose our minimum to be $.01. The maximum moneyness level should be chosen at a point where the derived call prices reached a value of 0 so that the resulting trapezoidal integrations that approximate the first term in expressions (11) and (12) do not leave out any terms which have positive call values. We chose our maximum to be 150% of the highest available strike. We originally followed Christoffersen, Jacobs and Vainberg (2007) in using a maximum moneyness level of 300% of the stock price, but we encountered scenarios where the highest available strike was higher than 300% of the stock price (i.e. when stock price is low).

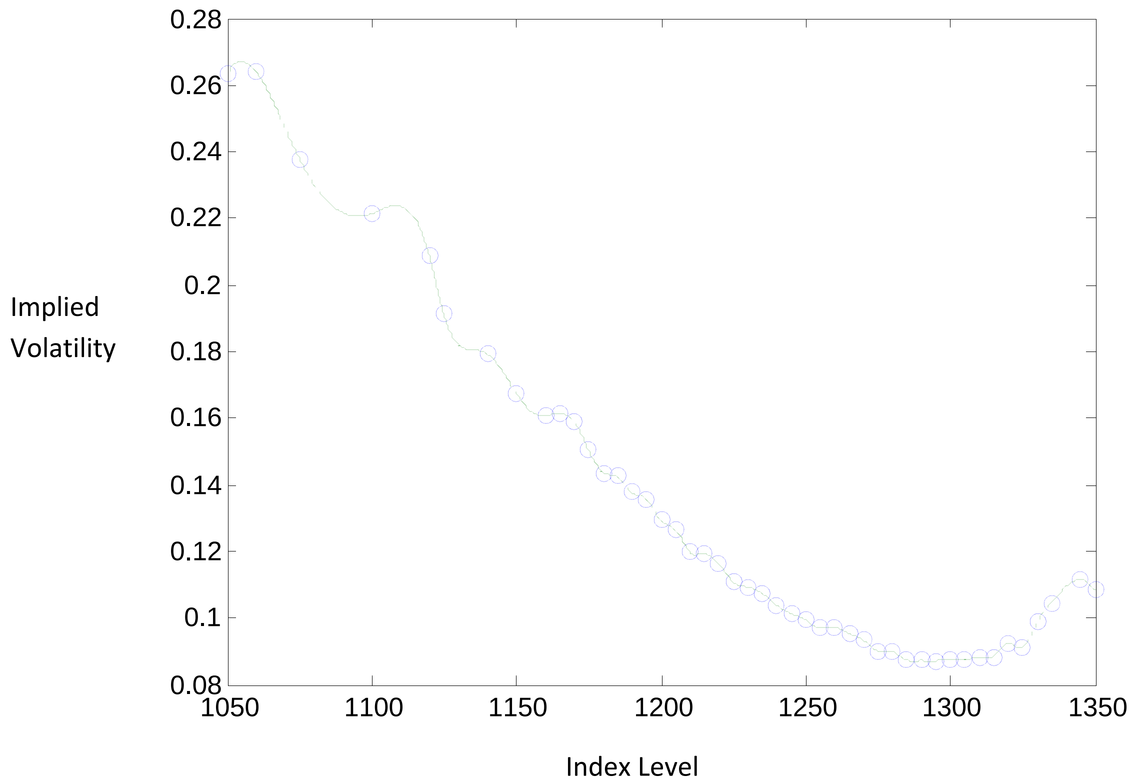


Figure 1. Splined implied volatility curve between lowest and highest available strikes for S&P500 Index. This is the implied volatility curve we estimated for S&P500 Index Options on December 28, 2005 with an expiration on January 21, 2006. The index level at this point was around 1258.2. The circles represent the implied volatilities of known strike prices, and the line is the cubic spline. The shape of this implied volatility curve matches what we expect from a volatility smile. Volatilities for strikes outside of this range were assumed to equal the closest available known strike volatility.

We then use the Black-Scholes formula to take this continuum of implied volatilities and convert them into call and put prices. Implied volatilities that were below the stock price were used to calculate OTM put prices, and volatilities that were above the stock price were used to calculate OTM call prices. With this grid of option prices, we used trapezoidal numerical integration to calculate the prices of the *Quad* and *Cubic* contracts according to expressions (11) and (12), and then used expressions (9) and (10) to calculate an estimate of skewness, variance, and mean for each maturity.

Using our estimates of skewness and variance of the stock for a given maturity and traded date, in order to estimate stock beta, we then match them to the skewness and variance of the S&P Index that was derived from options with the same trading date, and with a maturity closest to the maturity of the equity. We then removed the beta estimates that did not have matching stock and index maturities. It is important that these maturities match up closely because different maturity lengths will have different levels of skewness and variance.

It is important to note that the use of the Black-Scholes model does not assume that Black-Scholes correctly prices options. This formula is only used as a map to convert prices into implied volatilities and back. The reason why a cubic spline is not used directly on option prices is because splining on prices is generally noisy and does not yield smooth results. This approach is still non-parametric in that it uses market prices to derive the implied volatility curve, and thus the unobserved option prices, as opposed to a parametric approach which would impose a structure on the prices of the options.

4 Empirical Results

4.1 Estimates of Moments and Betas

We now present empirical results for the stocks we analyzed. Figure 2 presents the option-implied variance and skewness of the S&P500 Index. Figures 3 and 4 present the option-implied variance and skewness of each of the companies. Figure 5 presents the option-implied beta for each of the companies. Each of these graphs presents the averaged moment or beta for each date rather than the moments or beta separated by maturity date in order to make to graphs more easily readable. Table 4 summarizes the average estimates of the moments and beta.

These findings indicate that on average, individual stock risk-neutral distributions are less negatively skewed than the market. In addition, the individual risk-neutral distributions are more volatile than the index. These characteristics confirm the findings of Bakshi, Kapadia, and Madan (2003). The intuition as to why the skewness of an individual risk-neutral distribution will be less negative than the skewness of the market is that the skewness of an individual stock is derived as a linear combination of the skewness of the market and the skewness of the idiosyncratic risk, where the weights on each skewness component are less than 1 and greater than 0. Given that the idiosyncratic risk is symmetric around zero—thus having a skewness of 0—or has a distribution that is positively skewed, the skewness of the individual stock will be less negative than the skewness of the market. Our empirical findings confirm that on average, the idiosyncratic risk component is less negatively skewed than the market, thus leading to a less negative skew in the individual stock return.

Higher volatility for the individual stock returns follows by observing that the variance of the individual stock is a linear combination of the variance of the market returns and the variance of the idiosyncratic risk, where the weight on the market return variance is the square of the beta and the weight on the idiosyncratic risk variance is 1. Thus the individual stock returns are inherently more volatile than the market returns.

There are generally two spikes in option-implied variance for each of the companies. The first spike is smaller and occurs around the 2002-2003 period, which corresponds to the recession and market crashes in the early 2000s. The second spike is much larger and occurs during the 2008-2010 period, which corresponds to the recent financial crisis. The spike in variance is much more pronounced for AIG, JPM, and C, which suggests different industry reactions to these crises.

The risk-neutral skewness shows a trend of stability prior to 2008, and then a rapid drop after 2010. As we have mentioned before, a large negative risk-neutral skewness reflects a higher level of risk aversion. Thus it is not surprising that the risk-neutral skewness drops greatly after 2010 since it reflects the greater uncertainty and risk aversion due to the financial crisis. While the index skewness also dropped, in general it did not drop as much as the individual stock skewness dropped. It is important to note that these graphs do not imply that the physical distribution also changed after the financial crisis, only that investor perceptions towards risk had changed.

The risk-neutral betas show mixed reactions during the 2008-2010 financial crisis. Most of the companies exhibited a stable trend throughout this period, however a certain few—AA, AXP, AIG, JPM, and C—had betas that exploded between 2008-2010 and settled back down after 2010. These companies were the same companies that exhibited a huge increase in volatility during the 2008-2010 period. Under the estimation method of beta given by expression (4), given that the skewness of the companies trended similarly to the skewness of the market index, the ratio between their skewness would have remained stable. Thus it is not surprising that the patterns in individual betas mimic the patterns in variance since the changes in betas would have been the result of changing variance ratios.

This observation is interesting because it shows that although risk-aversion and volatility increased and resulted in market-wide drops in risk-neutral skewness and increases in risk-neutral variance, investors only demanded a higher risk-premium for companies for which they had a higher level of risk aversion than they did compared to the market, or which exhibited volatility higher than the market. This observation shows that increasing beta in down states occurs not simply because the state is bad, but because there is a higher level of covariance between the stock and the index indicated by the more pronounced changes in stock skewness and variance versus the market. If there is not this higher level of covariance, as seen in the mirroring changes in skewness and variance between the stocks with unchanging betas, then the beta will remain constant. A central assumption behind our hypotheses is that down markets exhibit higher betas, and these observations provide some reasoning as to why those betas would increase in down markets.

4.2 Forecasting Performance of the Beta Estimates

We conducted three types of analysis on our beta estimations in order to identify their forecasting performance and characteristics. For all of our tests, we were trying to identify how well our estimated betas were capturing systematic risk, whether the betas were systematically biased upwards, and whether there was a presence of a term structure. The three types of analyses we performed were out-of-sample comparison tests against traditionally-calculated OLS beta estimates, residual correlations with systematic factors, and tests to detect a systematic term structure.

We grouped our betas into four categories based on maturity length. The first category was an average of betas of all maturities lengths. The second category was short-term betas, which we defined as the averaged betas calculated from options with maturities less than 60 days. The third category was medium-term betas, which had maturities between 60 and 150 days. The fourth category was long-term betas, which had maturities between 150 and 260 days. Thus for each category, we generated one beta for each day where option prices were available for the given category. In addition, we analyzed each beta in four different time periods defined as the entire time period (2002-2012), pre-financial crisis (2002-2008), crisis (2008-2010), and post-crisis (2010-2012). The following sections present these tests and our results in more detail.

4.3 Out-Of-Sample Comparison Test Between Option-Implied and OLS Betas

We constructed a standard out-of-sample forecasting test. A typical forecasting regression regresses the ex-post observed variable to be forecasted on the forecasting variables. In our case, we do not directly observe the ex-post variable. We thus measure the ex-post beta using the realized betas proposed by Andersen et al. (2006). We compute the ratio of the squared covariance and the squared variance of the market return for the next 180 daily return data as the realized beta. To compute the OLS betas, we compute the ratio of the squared covariance and the squared variance of the market return on the past 180 daily returns data. To compute the option-implied beta, we take the average of the different maturity option-implied betas calculated for each date and average those over the past 40 days in order to reduce noise. We thus calculate a daily option-implied, OLS, and realized beta over the entire time span. Tables 5-8 present the correlation, the Mean Squared Error, and the Bias of the option-implied and OLS versus the realized beta.

For each stock and each time frame, the predictor with the highest correlation is indicated in bold. The option-implied beta outperforms the OLS beta in all of the time frames analyzed. Higher correlation with the realized beta is a signal of a better predictor for market movement. In addition, for most cases when our option-implied beta outperforms the OLS beta, both predictors are highly correlated with the realized beta. However, in many cases when the OLS beta outperforms the option-implied beta, both predictors are not correlated or negatively correlated with the realized beta. This observation implies that when both predictors are correlated with the realized returns, the option-implied beta is a better predictor, but there are also occasions where idiosyncratic effects make both predictors bad.

The option-implied beta had low to negative correlations with the realized beta for CAT, KO, GE, HD, INTC, MMM, PFE, and PG. We do not have an all-encompassing explanation of why the option-implied betas performed poorly for these companies, but we would like to note that some of these companies overlap with the companies that performed poorly in our other tests and in the tests performed by Christoffersen, Jacobs and Vainberg (2007). We provide some potential ideas that may partially explain why the option-implied betas for these companies consistently perform poorly in the following sections.

The OLS beta generally has a lower mean squared error than the option–implied beta. More interestingly however, is that the bias of the option-implied beta is consistently positive, meaning that our option-implied beta is overestimating the beta. This positive bias is consistent for almost all of the stocks throughout all of the time periods analyzed. The evidence of positive bias provides strong evidence supporting Hypothesis 1 that risk-neutral betas will be higher than the true physical beta. From 2002-2012, out of the 29 stocks that we tested, 28 of them showed consistent positive bias. Only CAT showed a consistent negative bias. Figure 6 presents graphs of the option-implied beta, OLS beta, and realized beta for all of the stocks. The trend of positive bias can also be seen from these graphs.

4.4 Correlation of Residual Errors with Systematic Factors

We performed a test to see how well our betas were capturing systematic risks. Using our daily betas, we calculated the error term:

$$\varepsilon_{i,t} = R_{i,t} - \beta_{i,t} R_{m,t}$$

where $R_{i,t}$denotes the return of stock *i* at time *t*, $\beta_{i,t}$ denotes the beta of stock *i* at time *t*, and $R_{m,t}$ denotes the return of the index at time *t*. We then calculated the correlation of these residual errors with different systematic factors. If our beta was capturing all of the systematic risk, the error terms should theoretically have zero correlation with other systematic factors because they would be noise. The systematic factors that we compared our errors to were the daily returns on the Dow Jones Industrial Average (DIA) and the daily returns on the CBOE Volatility S&P500 (VIX). We calculated a correlation for each of our beta categories. In addition, we separated our time periods into four different categories in order to see how our betas were performing before, during, and after the 2008 financial crisis, as well as over the entire time period we analyzed. As a result, for each systematic factor and stock, we calculated 16 different correlations. Tables 9-16 summarize our results.

We found that the absolute value of error correlations were similar when comparing against the DIA and the VIX. However, the error terms were generally negatively correlated with the DIA and positively correlated with the VIX. These findings provide further evidence supporting Hypothesis 1. We hypothesized that risk-neutral betas would be higher than true physical betas due to the nature of risk-neutral densities overestimating bad states of the world where people demand a higher risk premium. The true beta should result in error terms with zero correlation to the market factor since it correctly identifies the level of risk premium. A beta that is biased higher overemphasizes the systematic risk and thus subtracts a higher market risk premium than it is supposed to, thus resulting in negatively correlated error terms with the market factor. These negative correlations with the DIA confirm our hypothesis that our option implied betas would systematically estimate betas higher than the true beta.

On the other hand, the positive correlation of the error terms with the VIX is in-line with a negative correlation with the DIA. We calculated the correlation of the returns on the VIX and the DIA over our sample time period to be -0.7290. This finding is consistent with literature that finds that increased realized volatility coincides with downward market moves [French, Schwert, and Stambaugh (1987) and Glosten, Jagannathan and Runkle (1993)]. Thus error terms which are positively correlated with the DIA should be negatively correlated with the VIX. These two findings both suggest that our option-implied beta is consistently overestimating the market beta.

In general, the errors generated using the short term betas had lower correlation with the systematic factors than all of the other beta categories. We believe that this is likely due to the result that the short term betas were much more liquid than the other beta categories, and thus their prices were probably more informative. In addition, traders have better information over the near future rather than the far future, and the option prices would better reflect this information, which would in turn lead to more accurate betas. The medium term betas had about the same levels of correlation with the systematic factors as the long term betas did for both the VIX and the DIA.

Looking over the four different time periods of pre-financial crisis, we found that our pre-crisis betas generally had the lowest error correlations, and our crisis and post-crisis betas had error correlations that varied greatly. The amount of error correlation during these two time periods seemed to be company or industry dependent as opposed to a macro phenomenon. For example, using averaged betas, GE had an error correlation to DIA of -0.29 during the crisis, and a DIA of -0.82 after the crisis. On the other hand JPM had an error correlation to DIA of -0.42 during the crisis, and -0.04 after the crisis. Another reason for these widely varying numbers is that our option-implied betas were volatile during the crisis period. Figure 6 shows that most betas increased during this period, but were still not as volatile as our option-implied betas. These widely varying beta estimations may not be as reliable as the stable beta estimations calculated in the pre-crisis period. In addition, these time periods were much smaller than the other time periods, and as a result there could be a lot more noise.

A few of our stocks had residual terms which were consistently uncorrelated with the systematic factors, while others had residual terms which were consistently correlated with the systematic factors. These findings suggest that the effectiveness of option-derived betas may be dependent on underlying company characteristics and matches the results from our out-of-sample test. One reason why our betas may be performing poorly in certain situations is because the underlying risk-neutral distribution is very different than the actual physical distribution for the stock. For example, our betas performed poorly for the pharmaceutical companies Merck, Pfizer, Johnson & Johnson, and Procter & Gamble. These results mimic the findings of Christoffersen, Jacobs, and Vainberg (2007) who also found that their forward-looking betas performed poorly for these companies. They indicated that the forward-looking beta does poorly in a few cases where the average realized beta is either very low or very high.

We believe that the shape of the underlying distribution has an effect on how effective the forward-looking betas perform. The success of pharmaceutical companies is highly dependent on the success of a few products. Many years and money are put into the research of a few drugs where success could provide a huge revenue stream for many years and failure could result in huge costs. Thus it is likely that their true physical distributions take on bimodal shapes. There are two potential reasons why bimodal shapes could affect the beta performance. First, the risk-neutral distributions might not be able to capture these bimodal shapes as well as other distribution shapes. Detecting the bumps in bimodal distributions require a finer grid of option strikes than may be available. Second, our option betas are derived as the ratio of the third moment of the stock to the third moment of the index. Bimodal distributions have distributions where the fourth moment plays a more dominant role in determining the shape of the underlying, and just comparing the risk-neutral third moments might not fully capture the co-movement between the index and the company. As a result, the risk-neutral beta would differ from the true beta and would perform poorly under the correlation test. Our results are interesting because they confirm Christoffersen, Jacobs, and Vainberg's (2007) findings with a different type of test, and suggest that further research be done on the characteristics of the underlying distribution which may affect the accuracy of the option-implied betas. There are likely to be many other factors besides bimodality affecting the effectiveness of option-implied betas, since we also discovered other companies such as GE, WMT, and VZ who also performed poorly but who are not likely candidates for bimodal distributions.

4.5 Term Structure of Betas

We looked at the differences between the betas computed on the same date with different maturities in order to determine whether there was a systematic difference between their values. A systematic difference, for example 180 day maturity betas being consistently higher than 60 day betas, would imply a term structure in the betas. This approach of analyzing beta is novel and the property of beta term structures has not been previously studied.

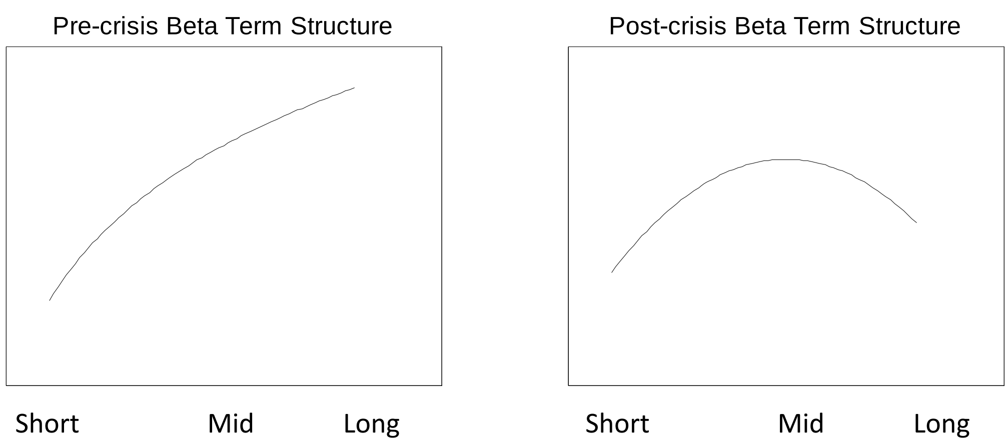
We found strong evidence suggesting a term structure in the betas. Tables 17-24 detail our findings. Figures 7 and 8 show the graphs of the mean differences of each of the stocks. Throughout the time period of 2002-2012, the mid maturity betas were determined with statistical significance to be higher than the short maturity betas for every single stock. The long maturity betas were also consistently different than the short maturity betas, however, some of them were actually lower than the short term betas. This finding is compelling because it suggests a curvature in the term structure. According to these observations, betas do not necessarily always increase, but rather can also initially increase and then decrease with longer maturity. To further analyze these results, we looked at the mid-short and long-short differences within the pre-crisis, crisis, and post-crisis period to determine whether there was a change in the term structure.

Within the period of 2002-2008, the mid-short beta mean differences were positive and statistically significant. The long-short beta mean differences were varied, but were positive for most of the companies except for AIG, BA, CAT, HPQ, and UTX. In general, the mid-short differences were higher than the long-short differences, thus suggesting an increasing slope in the short to mid portion of the beta term structure, and a flat or negative slope from the mid to long portion of the beta term structure.

However during the period of 2008-2010, both the mid-short and long-short beta mean differences had many more negatives numbers. For the mid-short, AIG, JPM, and GE had negative means, implying that the mid-maturity betas for those companies were lower than the short-maturity betas. All of these differences were statistically significant. For the long-short betas during this time period, more companies exhibited a negative mean difference. In addition to the companies which had negative means from 2002-2008, JPM, C, KO, GE, and HD, also showed negative mean differences. All companies except for KO and UTX had differences which were statistically significant at the 99% level. An interesting note is that during this period, the mean difference between the long-short was generally higher than the mean difference between the mid-short, a flip from the period of 2002-2008.

During the period of 2010-2012, the mid-short had only one negative mean difference for all of the 29 stocks. The long-short, on the other hand, had 14 stocks with negative differences, 13 of which were statistically significant. For the stocks with positive mean differences, the differences were approximately the same between mid-short and long-short.

These findings are interesting because they suggest that the term structure of beta flipped after the financial crisis. The long-short differences had many more negative differences at each progressive time-period, thus indicating that the long betas were initially higher than the short betas, but eventually became lower after the financial crisis. The mid-short differences were in general consistently positive, indicating that the mid betas were higher than the short betas throughout the period. For clarity, the following rough graphs illustrate what the data implies about the term structures:



These tests provide strong evidence supporting Hypothesis 2. We find that there is a very clear term structure in the betas, and more interestingly, there was a change in the term structure after the financial crisis. A positively sloped term structure would mean that investors are demanding a higher risk premium farther in the future, whereas a negatively sloped term structure would mean that investors are demanding a lower risk premium farther in the future.

Thus the beta term structure could be used to interpret market perceptions of the future path of the economy. Perhaps the increasing beta term structure prior to the financial crisis implied that the markets were going to be down in the future, and the decreasing beta term structure post-crisis implies that the investors believe that the markets will improve. These are interesting questions to ask, and we leave them to be answered in further research. We do however conclude that there is a significant difference between the betas of different term maturities.

4.5 Conclusion

Market betas are one of the most important concepts in finance. Currently market-betas are obtained using regression techniques on historical data. Some applications use a rolling window of historical data, while others use more sophisticated estimates that allow for time-varying betas. However, all historical betas implicitly assume that the future will be similar to the past.

This paper builds upon a new approach on estimating betas using option information which has not been researched much before. We found that option-implied betas had a consistent positive bias versus physical betas. Our out-of-sample test showed that the option-implied betas had a consistent positive bias versus the realized beta. In addition, our error correlation test showed that the residual errors using the option-implied betas were all negatively correlated with the market factor, thus suggesting that the option-implied beta was too high.

We also found that there exists a significant term structure in the betas. No one has tried to identify the term structure of betas, and using option data was especially convenient because traded options having different maturity dates, allowing us to compute betas corresponding to different maturities. We speculated on the implications and interpretations of the term structures, but this question still remains open to further research.

Our research presents many new avenues of research in deriving betas using option data. More research can be done on studying what causes the positive bias in the risk-neutral betas, as well as methodologies to try to correct for this bias. The idea of beta term structures is interesting, and more research can be done to see how these structures can be used as a forecast for the future. Option-implied betas are a relatively new research field, and much more work can be done.

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Table 1

Descriptive Statistics for Option Data

Short (20 to 60 Days)

	Call				Put			
Ticker	Number of Quotes	Number of Exclusions	Remaining	Mean	Number of Quotes	Number of Exclusions	Remaining	Mean
AA	38149	26713	11436	0.36	38152	27745	10407	0.38
AXP	42606	32249	10357	0.67	42607	26412	16195	0.60
AIG	43074	31242	11832	0.68	43074	30247	12827	0.75
BA	40632	30877	9755	0.74	40632	26286	14346	0.66
CAT	39836	27390	12446	0.85	39837	23551	16286	0.82
JPM	48924	35415	13509	0.58	48922	31042	17880	0.56
C	47726	36385	11341	0.38	47729	35391	12338	0.45
KO	35567	28638	6929	0.46	35567	24759	10808	0.40
DIS	35544	27293	8251	0.39	35544	24851	10693	0.39
DD	36063	27841	8222	0.52	36062	23384	12678	0.49
XOM	41551	31752	9799	0.60	41551	26816	14735	0.56
GE	37393	29801	7592	0.24	37394	28464	8930	0.27
WMT	40496	32417	8079	0.49	40496	27067	13429	0.42
HPQ	33249	23628	9621	0.49	33249	21894	11355	0.50
HD	39847	30886	8961	0.41	39847	27477	12370	0.38
HON	38555	29284	9271	0.57	38555	24351	14204	0.53
INTC	22880	16588	6292	0.24	22880	17738	5142	0.29
IBM	59136	46723	12413	0.96	59155	39919	19236	0.84
JNJ	34126	28328	5798	0.44	34126	24561	9565	0.40
MCD	37084	29460	7624	0.53	37084	24338	12746	0.46
MRK	37307	29053	8254	0.44	37307	25497	11810	0.43
MSFT	37954	26941	11013	0.31	37954	28457	9497	0.33
MMM	28954	22426	6528	1.01	28954	18360	10594	0.89
PFE	40018	32328	7690	0.24	40018	29914	10104	0.24
MO	37641	29644	7997	0.43	37641	23276	14365	0.37
PG	38895	32260	6635	0.61	38895	27215	11680	0.53
T	36620	30361	6259	0.31	36622	26175	10447	0.34
UTX	36919	29072	7847	0.75	36919	24848	12071	0.66
VZ	36872	27815	9057	0.34	36872	23068	13804	0.35
Index	1140879			24.25	1141252			21.38

Notes to Table: The sample contains call and put prices for the S&P500 and the stocks analyzed during the period January 1, 2002 to December 31, 2011. We removed options prices that violated arbitrage conditions, had bids of 0, and were in-the-money, and had maturity dates less than 20 days. Prices were extracted from Option Metrics.

Table 2

Descriptive Statistics for Option Data

Mid (60 to 150 Days)

	Call				Put			
Ticker	Number of Quotes	Number of Exclusions	Remaining	Mean	Number of Quotes	Number of Exclusions	Remaining	Mean
AA	33793	19856	13937	0.58	33795	22155	11640	0.61
AXP	39193	27609	11584	1.13	39193	20964	18229	0.99
AIG	50170	32367	17803	1.06	50171	32458	17713	1.25
BA	46696	31781	14915	1.25	46696	26671	20025	1.18
CAT	47804	28998	18806	1.42	47804	24892	22912	1.53
JPM	59842	37989	21853	0.98	59846	32686	27160	1.00
C	56939	36068	20871	0.64	56942	37082	19860	0.79
KO	40320	29577	10743	0.74	40320	22334	17986	0.63
DIS	32803	22834	9969	0.62	32803	20145	12658	0.61
DD	32998	23314	9684	0.83	32998	18293	14705	0.80
XOM	39985	27500	12485	0.96	39985	21336	18649	0.87
GE	44030	29241	14789	0.34	44030	28951	15079	0.43
WMT	46357	33936	12421	0.81	46357	24823	21534	0.67
HPQ	38222	23120	15102	7.44	38222	22969	15253	0.92
HD	44027	29682	14345	0.67	44027	26782	17245	0.66
HON	44358	30799	13559	0.94	44358	23623	20735	0.92
INTC	27768	16266	11502	0.36	27769	19884	7885	0.48
IBM	49335	33633	15702	1.58	49335	27453	21882	1.46
JNJ	31031	23341	7690	0.68	31031	18014	13017	0.64
MCD	42689	31820	10869	0.89	42689	21406	21283	0.77
MRK	35533	25541	9992	0.69	35533	21536	13997	0.71
MSFT	38293	22757	15536	0.50	38293	26269	12024	0.55
MMM	27022	20384	6638	1.87	27022	14438	12584	1.44
PFE	46144	32206	13938	0.36	46144	29116	17028	0.38
MO	40437	28206	12231	0.68	40437	20121	20316	0.67
PG	35369	27289	8080	0.97	35369	19600	15769	0.80
T	36395	27837	8558	0.47	36395	21610	14785	0.60
UTX	41320	28626	12694	1.23	41320	22640	18680	1.14
VZ	40436	27316	13120	0.53	40437	20969	19468	0.60
Index	1140879			24.25	1141252			21.38

Notes to Table: The sample contains call and put prices for the S&P500 and the stocks analyzed during the period January 1, 2002 to December 31, 2011. We removed options prices that violated arbitrage conditions, had bids of 0, and were in-the-money, and had maturity dates less than 20 days. Prices were extracted from Option Metrics.

Table 3

Descriptive Statistics for Option Data

Long (150 to 260 Days)

	Call				Put			
Ticker	Number of Quotes	Number of Exclusions	Remaining	Mean	Number of Quotes	Number of Exclusions	Remaining	Mean
AA	30807	16140	14667	0.94	30810	17792	13018	0.92
AXP	35317	22512	12805	1.77	35317	16703	18614	1.57
AIG	41965	23086	18879	1.77	41964	23791	18173	2.03
BA	40826	23997	16829	2.00	40827	20486	20341	1.94
CAT	40877	22206	18671	2.41	40877	20354	20523	2.57
JPM	45953	26206	19747	1.50	45954	24090	21864	1.58
C	45573	25773	19800	1.01	45575	26507	19068	1.17
KO	37446	24422	13024	1.06	37446	18467	18979	1.03
DIS	30621	18987	11634	0.98	30621	17133	13488	0.95
DD	30230	19071	11159	1.28	30230	15042	15188	1.34
XOM	38467	23255	15212	1.50	38467	18657	19810	1.45
GE	34368	20095	14273	0.58	34368	20470	13898	0.68
WMT	38953	24995	13958	1.21	38953	18684	20269	1.12
HPQ	33443	16996	16447	1.31	33443	19364	14079	1.57
HD	40043	23116	16927	0.99	40044	22136	17908	1.04
HON	34798	21084	13714	1.49	34798	16717	18081	1.49
INTC	22292	10297	11995	0.59	22292	16619	5673	0.88
IBM	49705	29376	20329	2.36	49705	25480	24225	2.40
JNJ	30737	20707	10030	1.01	30740	15765	14975	1.01
MCD	36234	23643	12591	1.27	36234	16156	20078	1.28
MRK	32319	20567	11752	1.08	32319	17793	14526	1.19
MSFT	32529	16460	16069	0.81	32528	22884	9644	1.00
MMM	25794	18364	7430	2.96	25794	12457	13337	2.26
PFE	36899	22688	14211	0.54	36898	21089	15809	0.62
MO	34095	20348	13747	0.94	34095	16162	17933	1.18
PG	34220	23790	10430	1.44	34220	16772	17448	1.28
T	30998	22580	8418	0.75	30999	17419	13580	1.06
UTX	36829	21930	14899	1.80	36831	18485	18346	1.82
VZ	32925	19986	12939	0.85	32925	16472	16453	1.08
Index	1140879			24.25	1141252			21.38

Notes to Table: The sample contains call and put prices for the S&P500 and the stocks analyzed during the period January 1, 2002 to December 31, 2011. We removed options prices that violated arbitrage conditions, had bids of 0, and were in-the-money, and had maturity dates less than 20 days. Prices were extracted from Option Metrics.

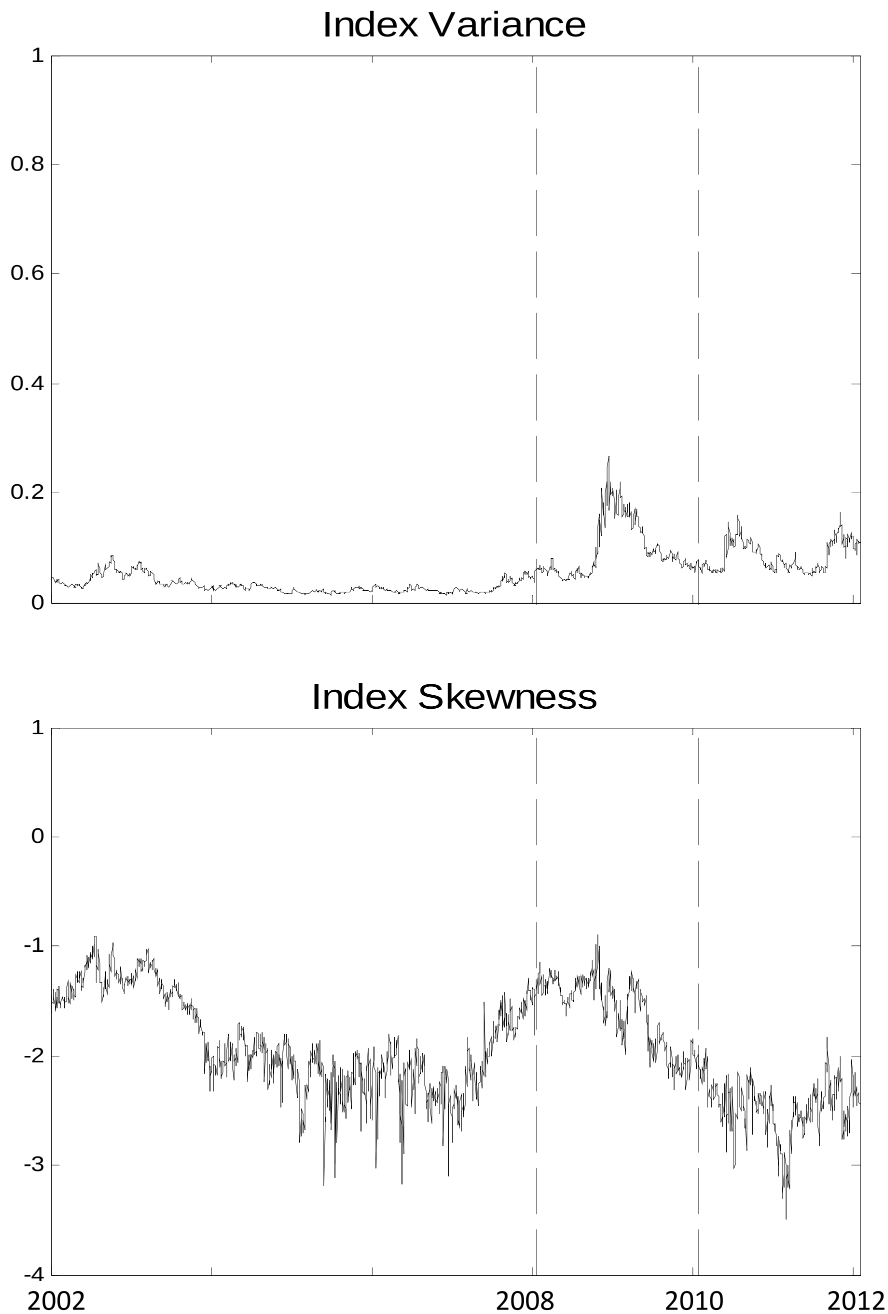
Table 4

Descriptive Statistics for Beta and Moments

Ticker	Variance	Skewness	Option Implied Beta	Number of Eliminations	Number Remaining
AA	0.0695	-0.7386	1.4107	52	8327
AXP	0.0670	-1.1854	1.4419	19	7757
AIG	0.0738	-1.1690	1.4833	173	7997
BA	0.0392	-1.0117	1.1775	14	8815
CAT	0.0393	-0.8886	1.1797	21	8943
JPM	0.0569	-1.4578	1.4861	35	9401
C	0.1038	-1.3144	1.5245	220	9527
KO	0.0172	-1.3076	0.7997	9	9425
DIS	0.0364	-0.9694	1.1741	18	8008
DD	0.0300	-1.1541	1.1542	15	7566
XOM	0.0243	-1.2595	1.0699	11	8351
GE	0.0316	-1.3505	1.1384	10	7995
WMT	0.0223	-1.3011	0.9379	9	9320
HPQ	0.0399	-0.9277	1.0854	12	6124
HD	0.0420	-1.1485	1.2317	14	8701
HON	0.0388	-1.0453	1.1640	15	8775
INTC	0.0352	-1.0136	1.0967	9	3810
IBM	0.0256	-1.2609	1.0881	11	8379
JNJ	0.0160	-1.4805	0.9241	10	8277
MCD	0.0262	-1.3099	1.0377	15	9255
MRK	0.0293	-1.2508	1.2533	16	7500
MSFT	0.0250	-0.8543	0.9576	9	7743
MMM	0.0263	-1.2241	1.0517	18	6297
PFE	0.0305	-1.2759	1.1114	21	9645
MO	0.0284	-1.6388	1.2428	26	9298
PG	0.0165	-1.4400	0.9166	9	8081
T	0.0389	-1.6544	1.2706	21	6087
UTX	0.0298	-1.1817	1.0451	9	9480
VZ	0.0297	-1.4727	1.1952	11	8756

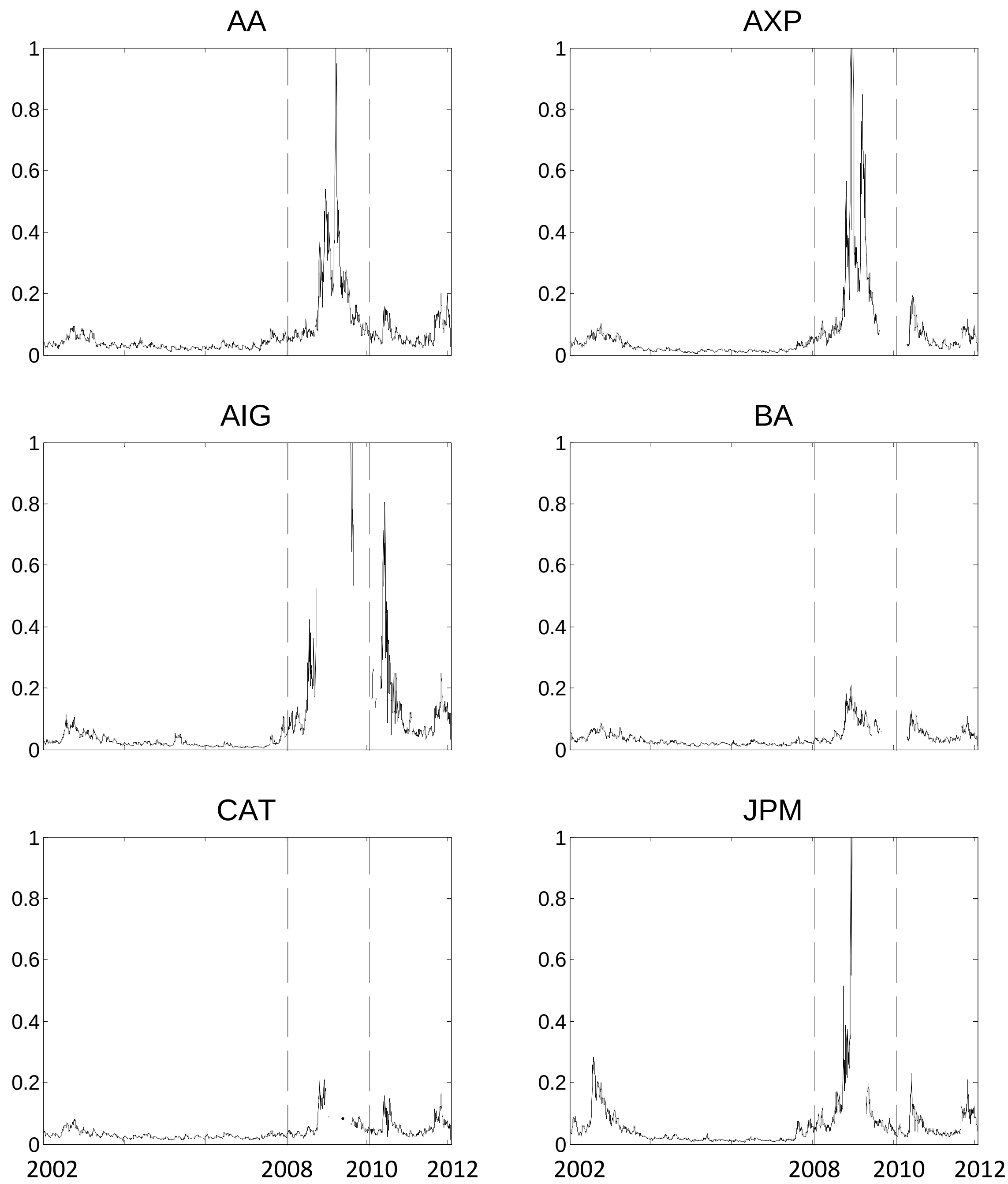
Notes to Table: We present the average of the moments and beta calculated for each stock during the period January 1, 2002 to December 31, 2011. In order to remove outliers, we omitted data points where the estimated beta jumped by either an absolute value of 1 or by 200% compared with the median of the four nearest-dated beta estimates.

Figure 2. Averaged Forward-Looking Variance and Skewness for Index



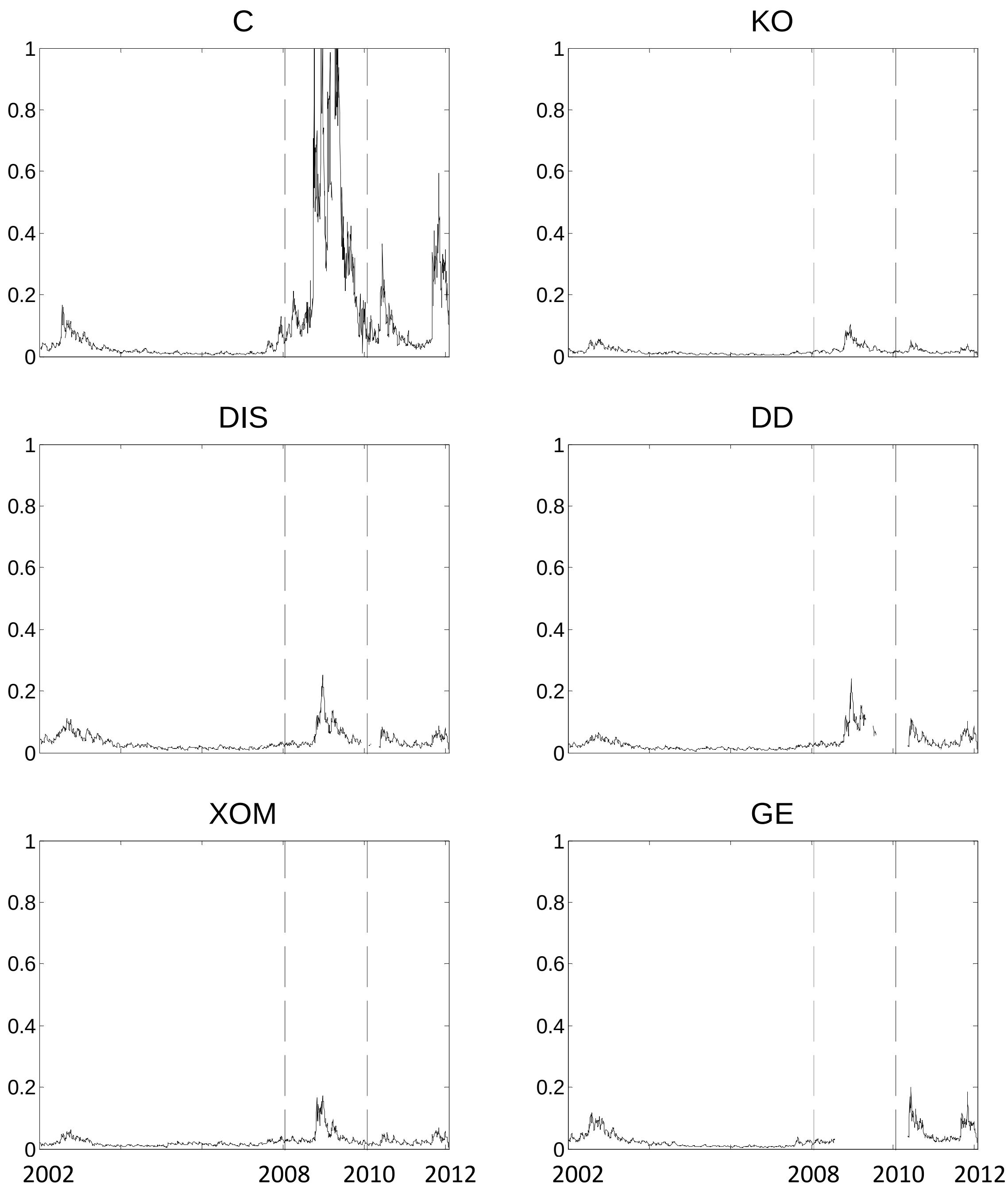
Notes to Figures: We present the Option-Implied Variance and Skewness for the S&P500. The Option-Implied Moments for each date were calculated by taking the average of all of the available moments for the date. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 3. Averaged Option-Implied Variance for Companies



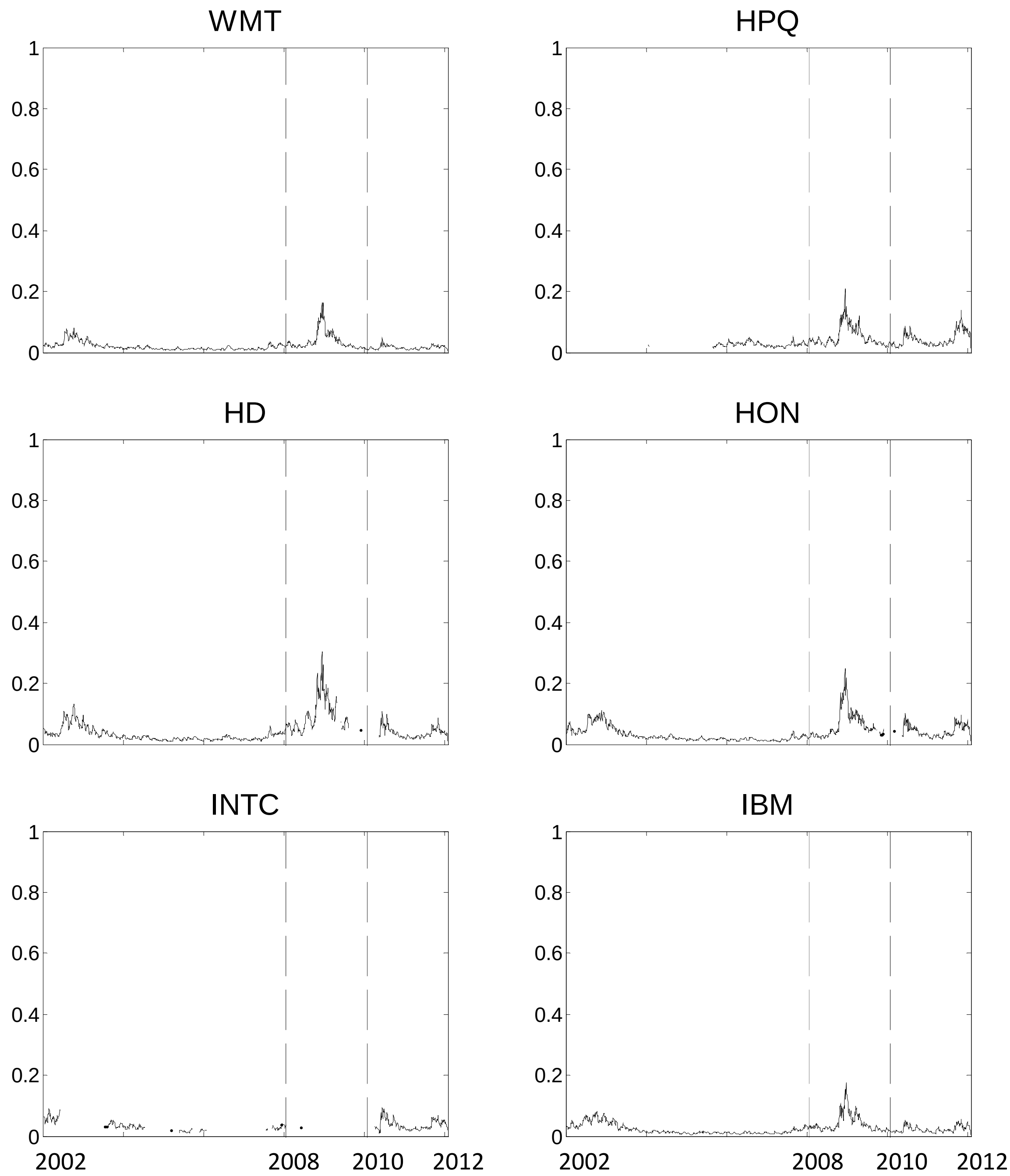
Notes to Figures: We present the Option-Implied Variance for each company analyzed. The Option-Implied Variance for each date was calculated by taking the average of all available variances for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 3 continued. Averaged Option-Implied Variance for Companies



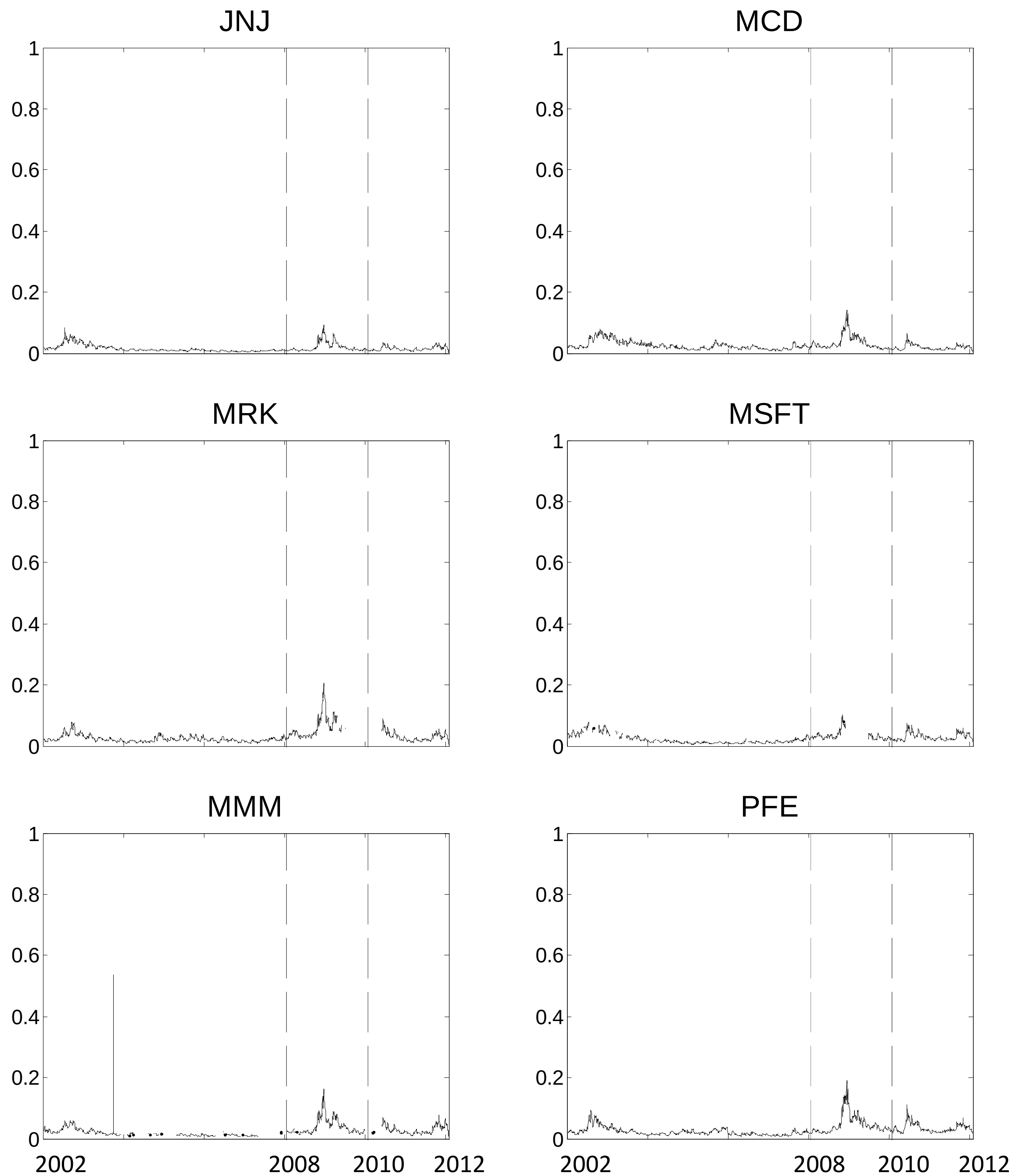
Notes to Figures: We present the Option-Implied Variance for each company analyzed. The Option-Implied Variance for each date was calculated by taking the average of all available variances for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 3 continued. Averaged Option-Implied Variance for Companies



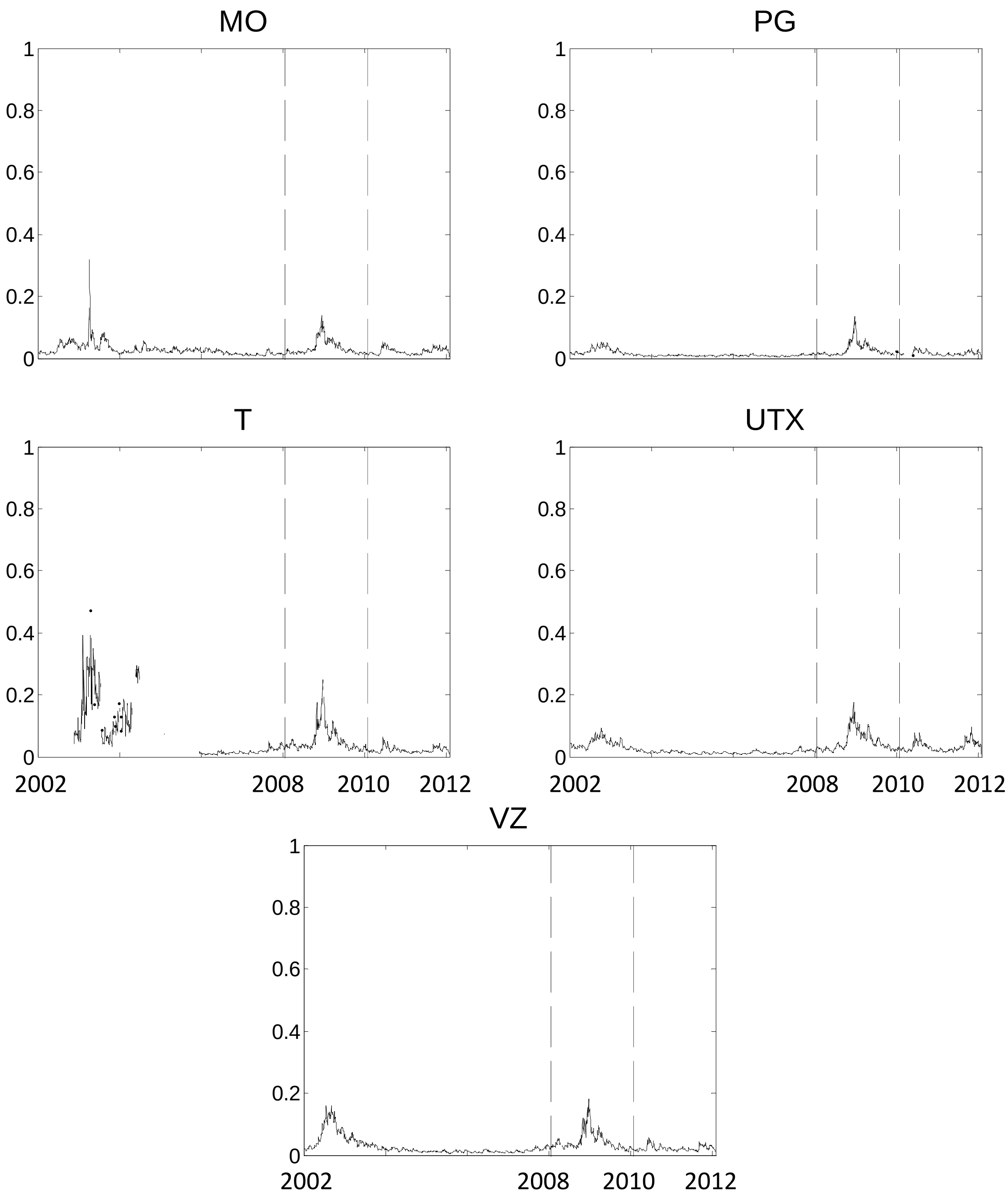
Notes to Figures: We present the Option-Implied Variance for each company analyzed. The Option-Implied Variance for each date was calculated by taking the average of all available variances for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 3 continued. Averaged Option-Implied Variance for Companies



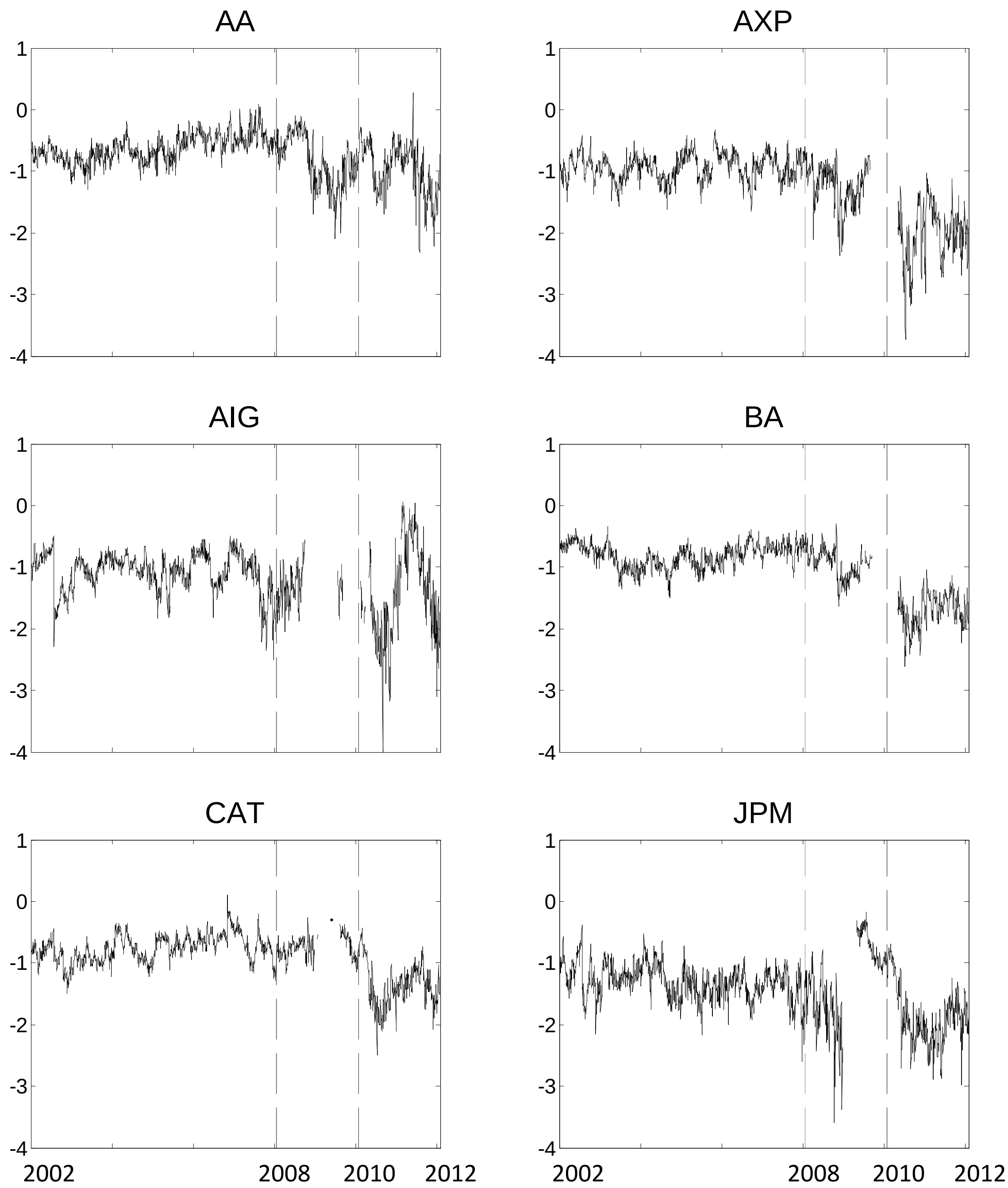
Notes to Figures: We present the Option-Implied Variance for each company analyzed. The Option-Implied Variance for each date was calculated by taking the average of all available variances for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 3 continued. Averaged Option-Implied Variance for Companies



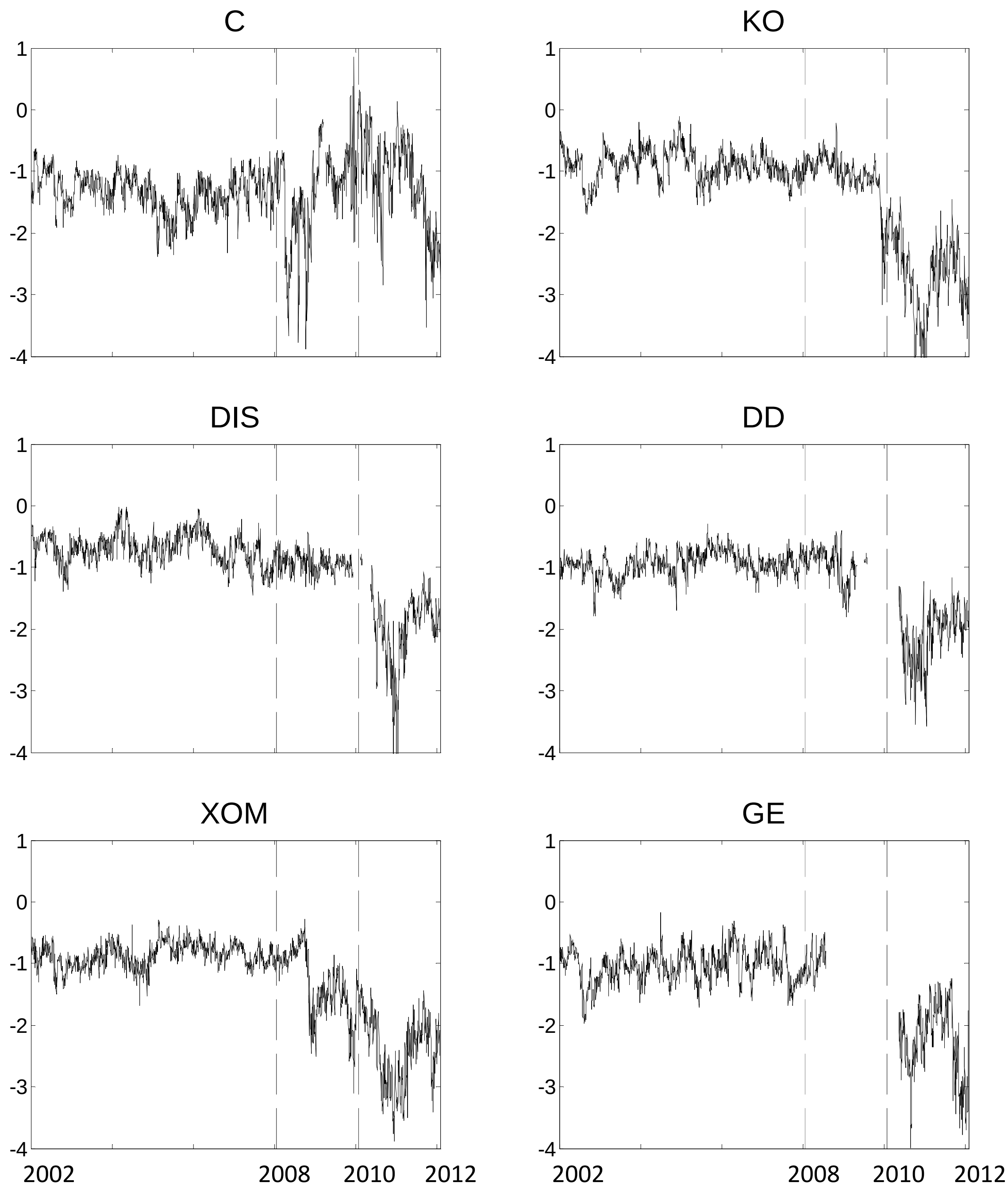
Notes to Figures: We present the Option-Implied Variance for each company analyzed. The Option-Implied Variance for each date was calculated by taking the average of all available variances for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 4 continued. Averaged Option-Implied Skewness for Companies



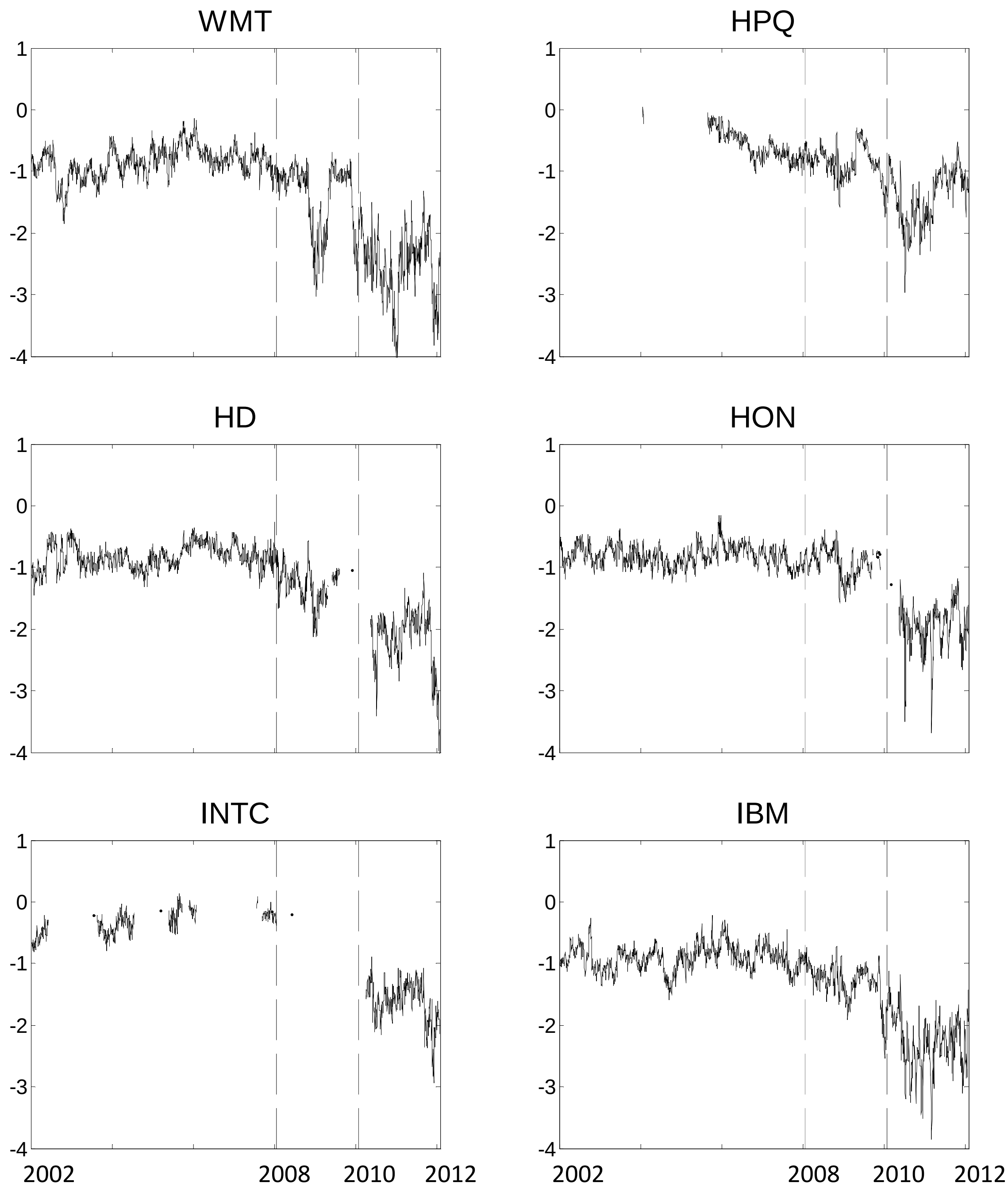
Notes to Figures: We present the Option-Implied Skewness for each company analyzed. The Option-Implied Skewness for each date was calculated by taking the average of all available skewness for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 4 continued. Averaged Option-Implied Skewness for Companies



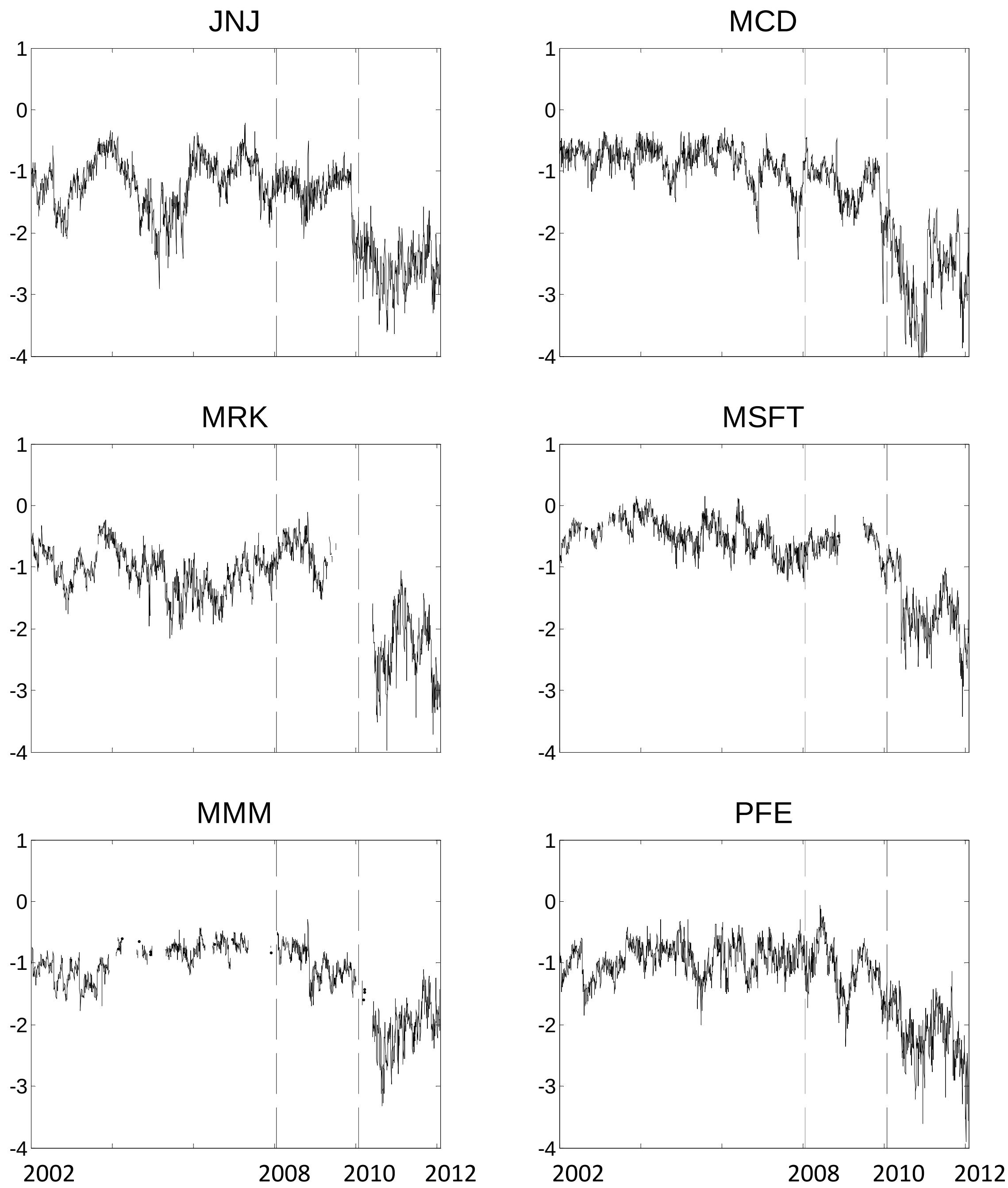
Notes to Figures: We present the Option-Implied Skewness for each company analyzed. The Option-Implied Skewness for each date was calculated by taking the average of all available skewness for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 4 continued. Averaged Option-Implied Skewness for Companies



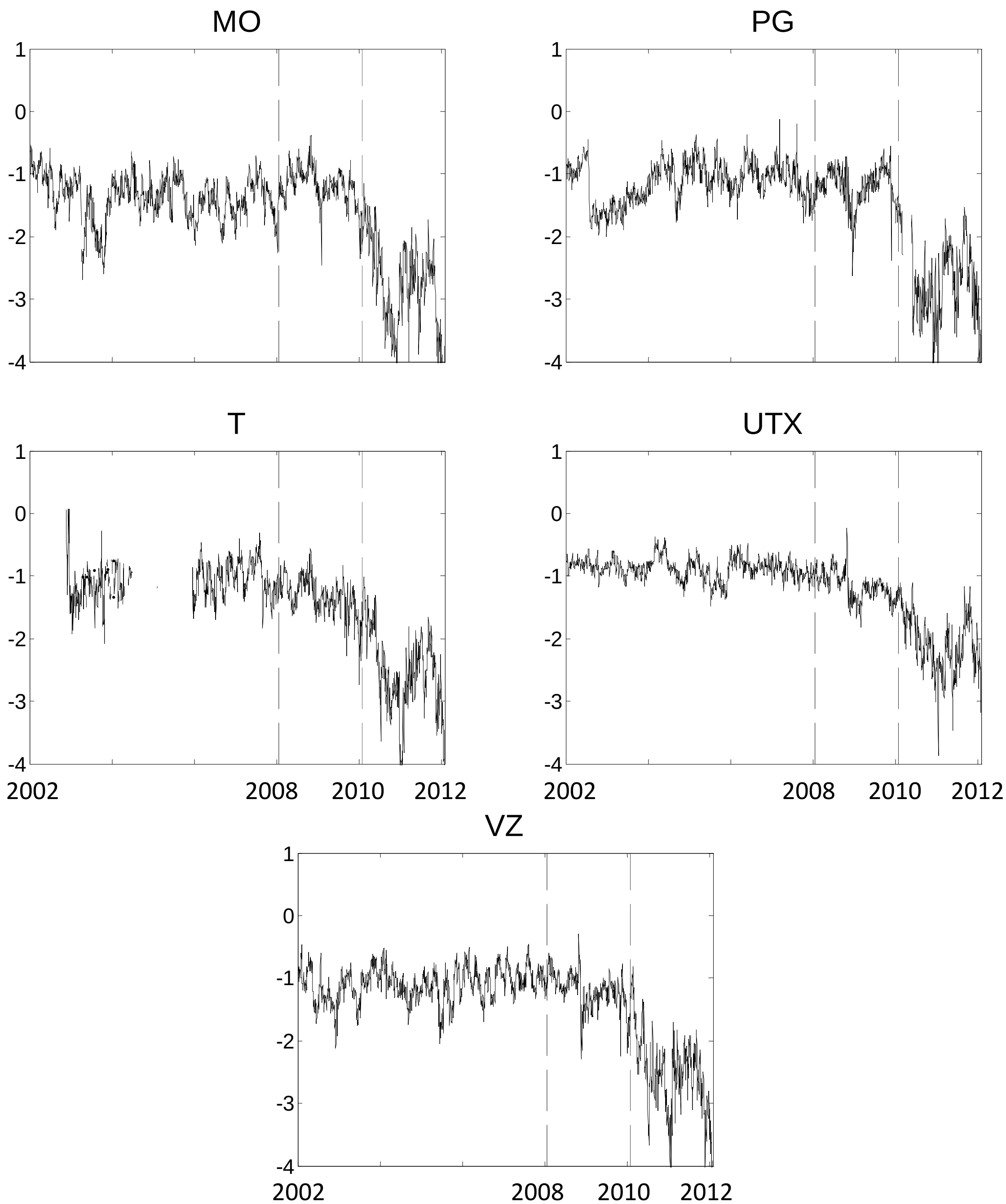
Notes to Figures: We present the Option-Implied Skewness for each company analyzed. The Option-Implied Skewness for each date was calculated by taking the average of all available skewness for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 4 continued. Averaged Option-Implied Skewness for Companies



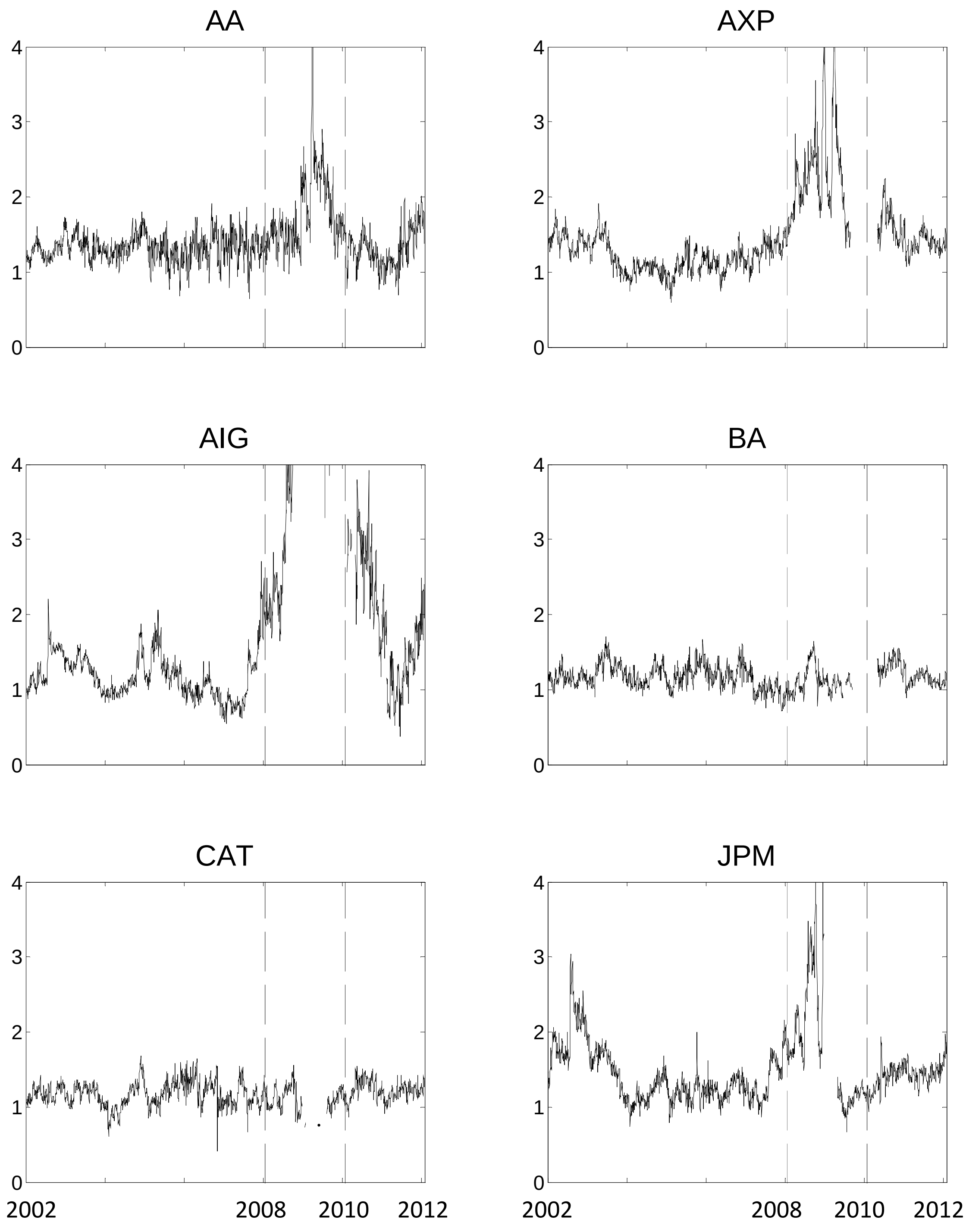
Notes to Figures: We present the Option-Implied Skewness for each company analyzed. The Option-Implied Skewness for each date was calculated by taking the average of all available skewness for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 4 continued. Averaged Option-Implied Skewness for Companies



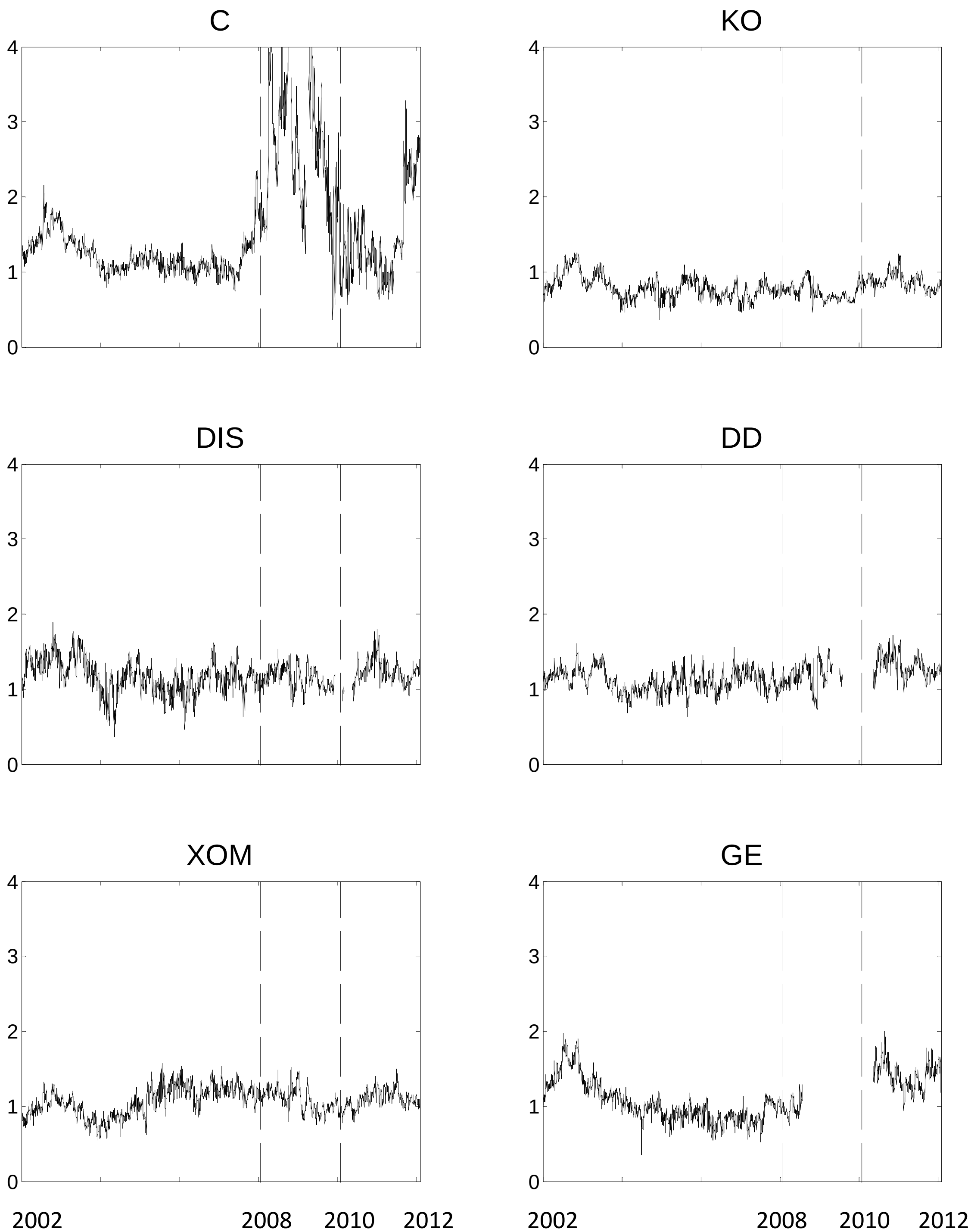
Notes to Figures: We present the Option-Implied Skewness for each company analyzed. The Option-Implied Skewness for each date was calculated by taking the average of all available skewness for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 5. Averaged Forward-Looking Betas for Companies



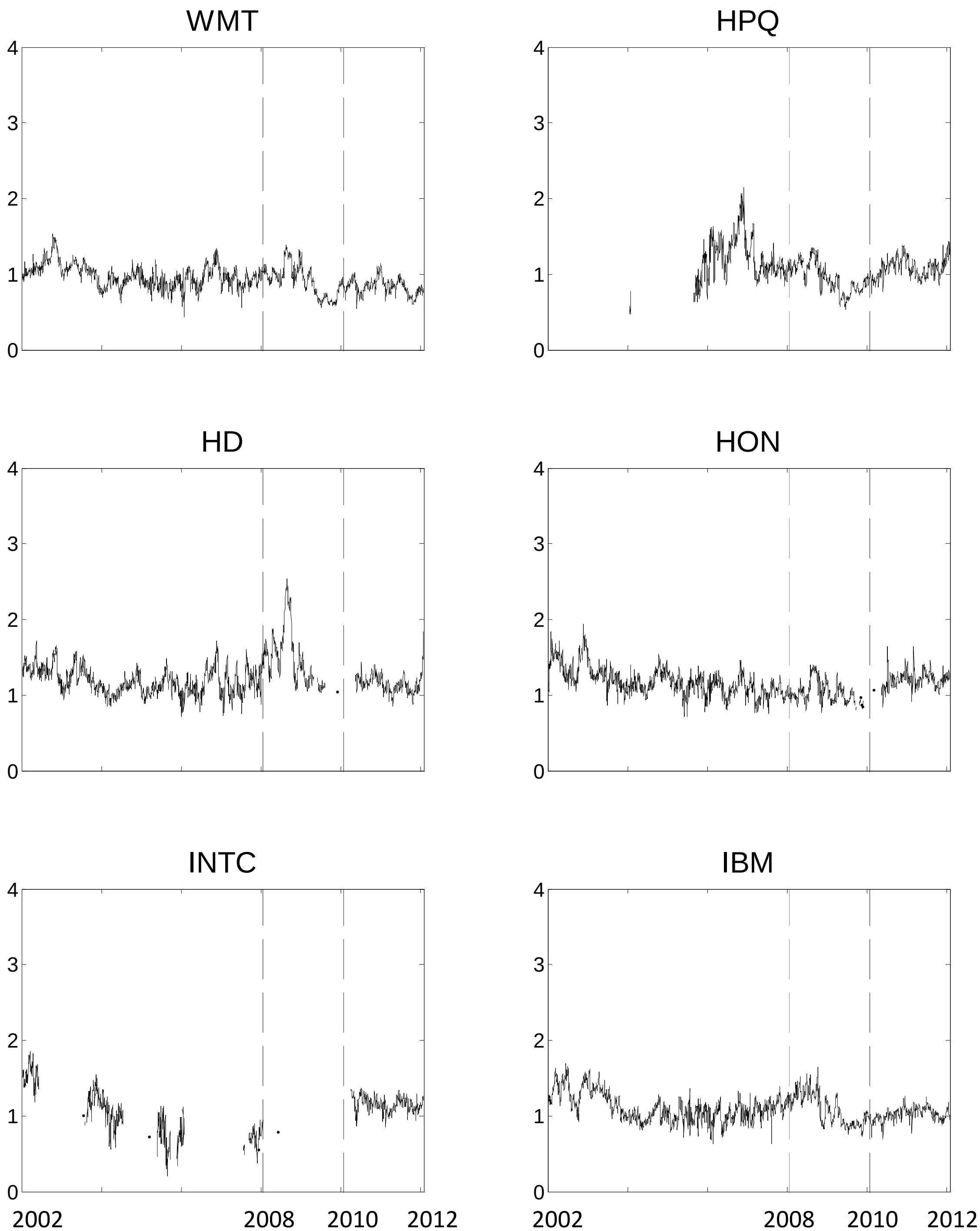
Notes to Figures: We present the Option-Implied Beta for each company analyzed. The Option-Implied Betas for each date were calculated by taking the average of all available betas for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 5 continued. Averaged Forward-Looking Betas for Companies



Notes to Figures: We present the Option-Implied Beta for each company analyzed. The Option-Implied Betas for each date were calculated by taking the average of all available betas for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 5 continued. Averaged Forward-Looking Betas for Companies



Notes to Figures: We present the Option-Implied Beta for each company analyzed. The Option-Implied Betas for each date were calculated by taking the average of all available betas for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 5 continued. Averaged Forward-Looking Betas for Companies

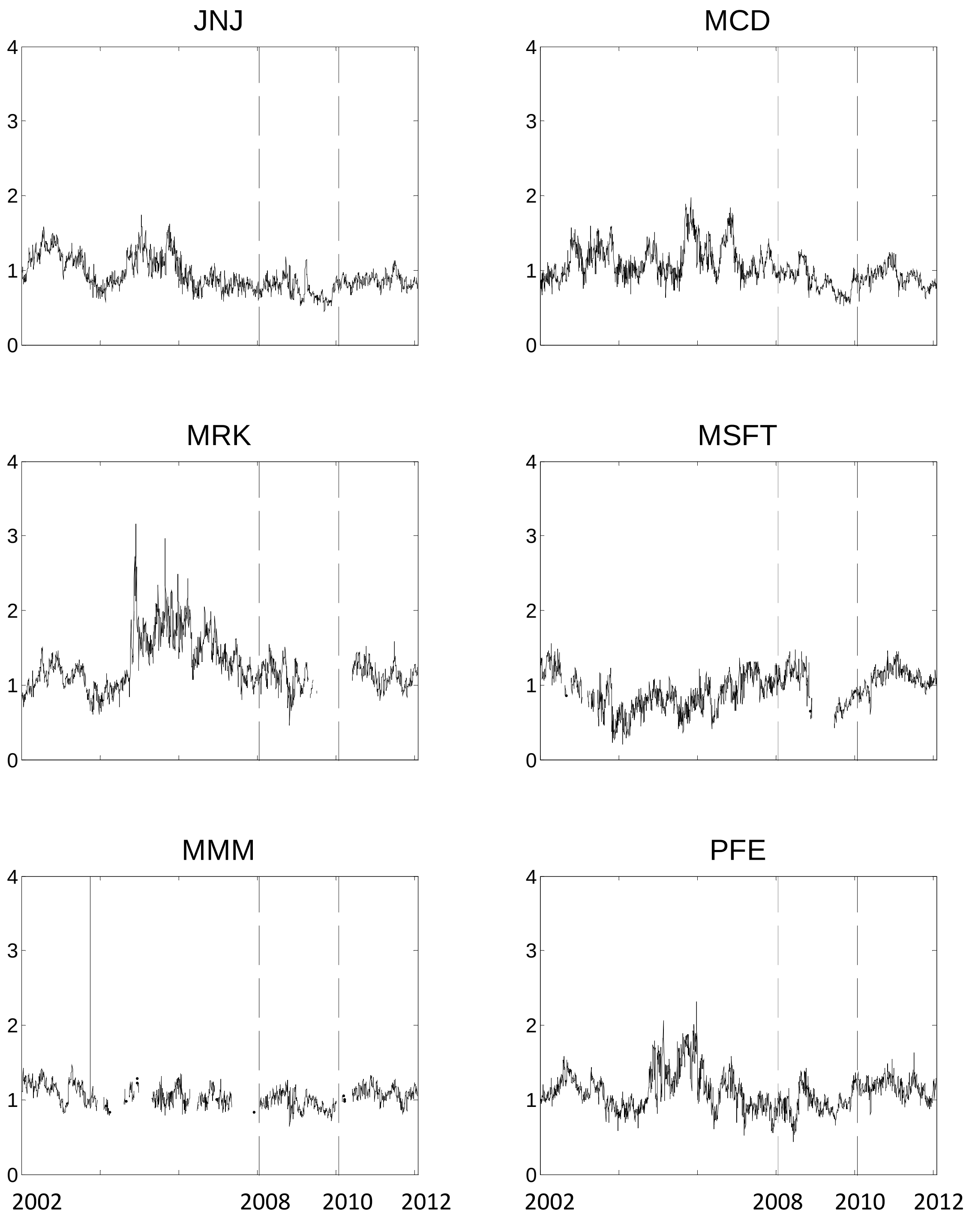


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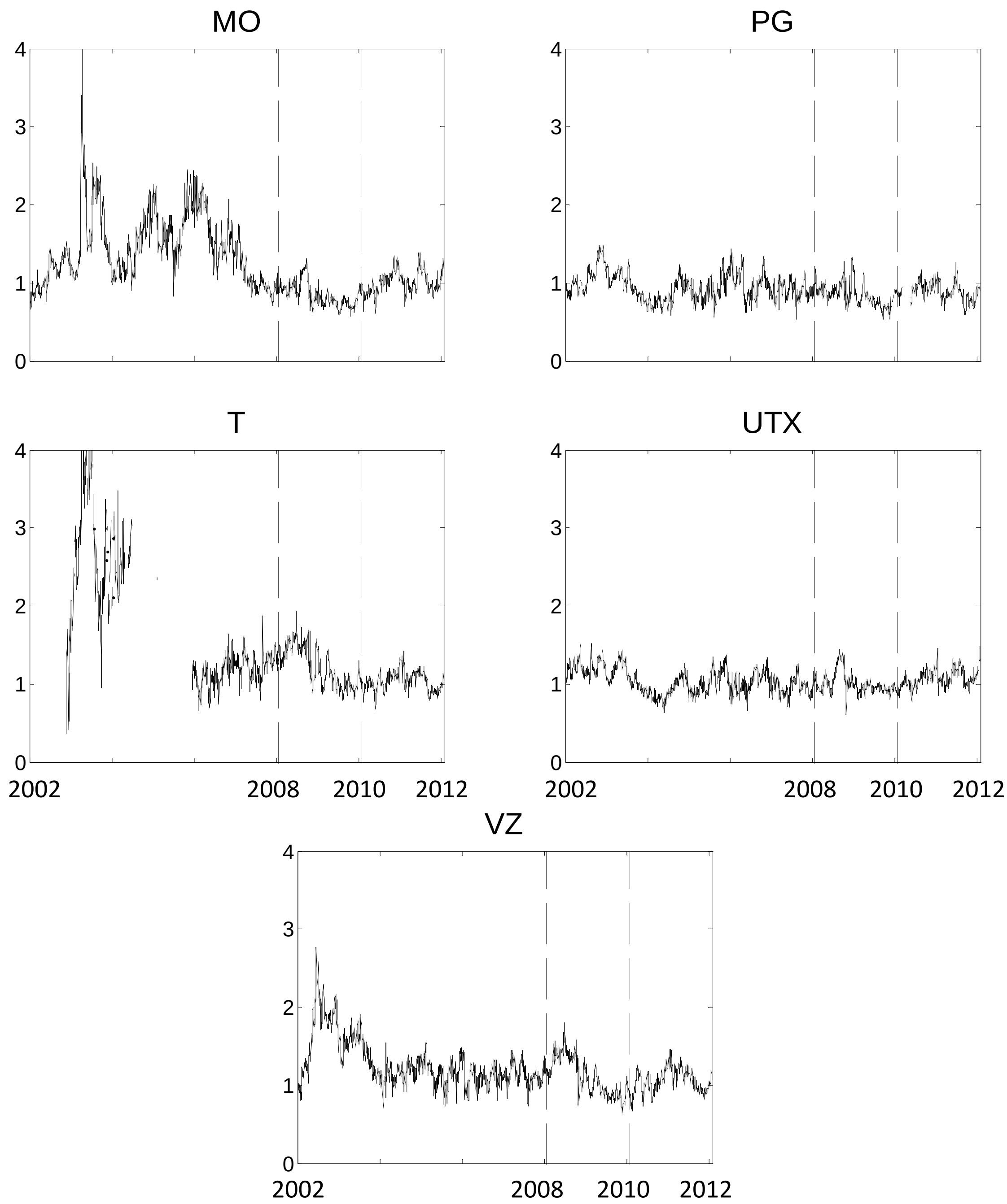
Figure 5 continued. Averaged Forward-Looking Betas for Companies



Notes to Figures: We present the Option-Implied Beta for each company analyzed. The Option-Implied Betas for each date were calculated by taking the average of all available betas for the date. Gaps represent that data for that date was either not available, or was filtered out. The sample period is January 1st, 2002 to December 31st, 2011.

Table 5

Out-Of-Sample Comparison Test between Option-Implied and OLS Beta (2002-2012)

	Option-Implied Beta			Rolling OLS Beta			
Tickers	**Correlation with Realized Beta**	**MSE**	**Bias**	**Correlation with Realized Beta**	**MSE**	**Bias**	**Number of Observations**
AA	**0.557**	0.102	0.095	0.531	0.113	0.026	2319
AXP	**0.739**	0.131	0.149	0.566	0.093	-0.016	2138
AIG	**0.543**	0.423	0.180	0.478	0.199	-0.114	1949
BA	**0.376**	0.060	0.175	0.183	0.057	0.014	2128
CAT	0.208	0.053	-0.064	**0.432**	0.060	0.008	2154
JPM	**0.614**	0.129	0.113	0.449	0.113	0.053	2222
C	**0.630**	0.322	0.106	0.599	0.207	-0.016	2300
KO	-0.071	0.078	0.224	**0.035**	0.021	-0.010	2319
DIS	**0.534**	0.044	0.116	0.490	0.042	0.017	2202
DD	**0.251**	0.038	0.101	0.091	0.031	-0.027	2066
XOM	**0.301**	0.060	0.116	0.119	0.078	-0.010	2319
GE	-0.211	0.235	0.335	**0.649**	0.023	0.015	1859
WMT	0.487	0.111	0.268	**0.751**	0.025	0.032	2319
HPQ	**-0.054**	0.085	0.134	-0.264	0.046	-0.005	1413
HD	-0.274	0.107	0.159	**0.119**	0.039	0.023	2096
HON	0.414	0.025	0.029	**0.477**	0.023	0.010	2159
INTC	0.115	0.192	-0.165	**0.787**	0.061	0.096	776
IBM	**0.451**	0.100	0.270	0.326	0.038	0.025	2319
JNJ	**0.544**	0.199	0.412	-0.112	0.036	-0.004	2319
MCD	**0.460**	0.172	0.353	0.404	0.053	-0.000	2319
MRK	**0.315**	0.358	0.523	-0.267	0.048	-0.014	2049
MSFT	0.291	0.050	0.002	**0.579**	0.033	0.041	2025
MMM	-0.149	0.086	0.228	**0.023**	0.030	0.008	1652
PFE	0.169	0.339	0.520	**0.213**	0.066	-0.019	2319
MO	**0.302**	0.631	0.679	0.213	0.066	-0.019	2316
PG	-0.248	0.174	0.363	**0.424**	0.019	-0.002	2247
T	0.315	0.832	0.658	**0.557**	0.030	0.048	1662
UTX	**0.452**	0.093	0.258	0.415	0.039	0.017	2319
VZ	**0.580**	0.244	0.442	0.415	0.039	0.017	2316

Notes to Table: We present the Correlation, Mean Squared Error (MSE) and Bias of the Option-Implied Beta and the OLS Beta with the Realized Beta for the time period 2002-2012. The beta with the higher correlation with realized beta is bolded. The right column also provides the number of observations of each beta used to calculate these summary statistics. In 2002-2012, the option-implied beta had a higher correlation in **17** of the 29 stocks that we analyzed.

Table 6

Out-Of-Sample Comparison Test between Option-Implied and OLS Beta

(2002-2008)

	Option-Implied Beta			Rolling OLS Beta			
Tickers	**Correlation with Realized Beta**	**MSE**	**Bias**	**Correlation with Realized Beta**	**MSE**	**Bias**	**Number of Observations**
AA	0.014	0.101	0.127	**0.541**	0.060	-0.033	1470
AXP	**0.615**	0.047	0.008	0.541	0.060	-0.033	1469
AIG	**0.411**	0.097	0.050	0.093	0.134	-0.079	1470
BA	**0.401**	0.072	0.206	-0.056	0.071	0.049	1470
CAT	**0.300**	0.046	-0.028	0.202	0.074	-0.000	1470
JPM	**0.653**	0.082	0.119	0.536	0.065	-0.000	1470
C	0.418	0.111	0.045	**0.525**	0.100	-0.047	1469
KO	-0.291	0.077	0.201	**-0.002**	0.025	-0.004	1470
DIS	**0.625**	0.047	0.115	0.574	0.048	0.058	1469
DD	**-0.178**	0.041	0.123	-0.603	0.031	0.004	1470
XOM	**0.307**	0.067	0.069	0.092	0.108	-0.015	1470
GE	**0.245**	0.114	0.221	-0.003	0.026	0.019	1470
WMT	**0.517**	0.038	0.155	-0.003	0.026	0.019	1470
HPQ	**-0.421**	0.134	0.199	-0.513	0.074	-0.010	565
HD	-0.247	0.047	0.052	**-0.102**	0.044	-0.001	1470
HON	**0.515**	0.025	0.060	0.449	0.025	0.049	1470
INTC	**0.768**	0.240	-0.449	0.693	0.057	0.030	488
IBM	**0.570**	0.079	0.237	0.178	0.054	0.036	1470
JNJ	**0.596**	0.264	0.487	-0.086	0.044	0.022	1470
MCD	**0.165**	0.177	0.339	0.109	0.073	-0.011	1470
MRK	**0.332**	0.435	0.577	-0.197	0.055	-0.004	1469
MSFT	0.384	0.050	-0.074	**0.600**	0.043	0.075	1333
MMM	**-0.103**	0.130	0.321	-0.174	0.037	0.062	939
PFE	0.133	0.337	0.503	**0.251**	0.079	-0.031	1470
MO	0.107	0.885	0.836	**0.251**	0.079	-0.030	1468
PG	-0.362	0.193	0.372	**0.432**	0.024	-0.000	1469
T	-0.200	1.449	0.848	**0.041**	0.042	0.035	818
UTX	**0.528**	0.052	0.182	0.031	0.050	-0.002	1470
VZ	**0.418**	0.252	0.428	0.031	0.050	-0.002	1469

Notes to Table: We present the Correlation, Mean Squared Error (MSE) and Bias of the Option-Implied Beta and the OLS Beta with the Realized Beta for the time period 2002-2008. The beta with the higher correlation with realized beta is bolded. The right column also provides the number of observations of each beta used to calculate these summary statistics. In 2002-2008, the option-implied beta had a higher correlation in **20** of the 29 stocks that we analyzed.

Table 7

Out-Of-Sample Comparison Test between Option-Implied and OLS Beta (2008-2010)

	Option-Implied Beta			Rolling OLS Beta			
Tickers	**Correlation with Realized Beta**	**MSE**	**Bias**	**Correlation with Realized Beta**	**MSE**	**Bias**	**Number of Observations**
AA	**0.395**	0.154	0.038	-0.575	0.281	0.027	505
AXP	**0.565**	0.388	0.492	-0.695	0.209	-0.156	401
AIG	**-0.618**	1.860	0.416	-0.692	0.846	-0.726	198
BA	0.027	0.045	0.126	**0.777**	0.033	-0.166	390
CAT	-0.275	0.087	-0.095	**0.809**	0.027	-0.058	340
JPM	**0.498**	0.390	0.151	-0.526	0.349	0.220	408
C	**0.300**	0.974	0.622	-0.424	0.594	0.110	488
KO	**0.584**	0.051	0.213	-0.664	0.019	-0.003	505
DIS	**0.322**	0.012	0.044	0.157	0.039	-0.107	472
DD	0.236	0.034	-0.017	**0.677**	0.055	-0.189	338
XOM	**0.449**	0.062	0.215	-0.023	0.037	0.056	505
GE	-0.362	0.140	0.369	**0.712**	0.016	0.121	131
WMT	0.465	0.271	0.493	**0.687**	0.034	0.141	505
HPQ	-0.658	0.053	0.056	**-0.391**	0.016	0.001	504
HD	**0.043**	0.378	0.531	-0.002	0.039	0.128	368
HON	-0.245	0.033	-0.032	**0.556**	0.027	-0.124	431
INTC	N/A	N/A	N/A	N/A	N/A	N/A	1
IBM	**0.072**	0.186	0.392	-0.306	0.012	0.035	505
JNJ	**0.426**	0.076	0.258	-0.741	0.036	-0.043	505
MCD	**0.409**	0.134	0.339	-0.290	0.018	0.030	505
MRK	**0.551**	0.137	0.354	-0.755	0.052	-0.053	332
MSFT	**0.861**	0.031	0.080	-0.249	0.015	-0.005	348
MMM	-0.403	0.034	0.109	**-0.236**	0.024	-0.046	457
PFE	**-0.116**	0.250	0.456	-0.549	0.065	-0.008	505
MO	**0.286**	0.155	0.359	-0.550	0.065	-0.007	504
PG	**0.472**	0.079	0.268	-0.303	0.013	-0.038	497
T	**0.869**	0.261	0.499	0.603	0.030	0.124	500
UTX	0.446	0.142	0.353	**0.669**	0.028	0.129	505
VZ	**0.869**	0.228	0.464	0.669	0.028	0.129	504

Notes to Table: We present the Correlation, Mean Squared Error (MSE) and Bias of the Option-Implied Beta and the OLS Beta with the Realized Beta for the time period 2008-2010. The beta with the higher correlation with realized beta is bolded. The right column also provides the number of observations of each beta used to calculate these summary statistics. In 2008-2010, the option-implied beta had a higher correlation in **19** of the 29 stocks that we analyzed.

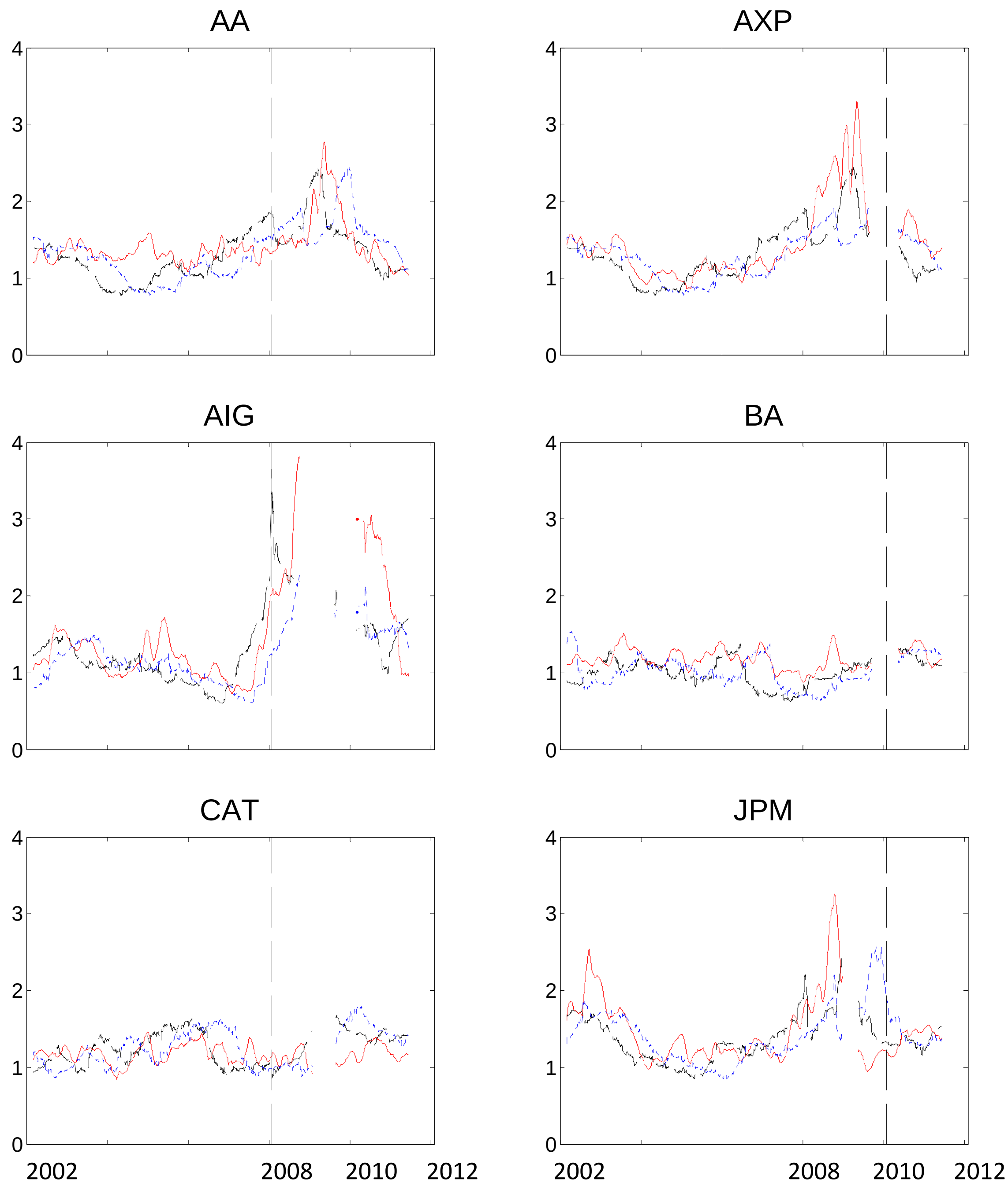
Table 8

Out-Of-Sample Comparison Test between Option-Implied and OLS Beta (2010-2012)

	Option-Implied Beta			Rolling OLS Beta			
Tickers	**Correlation with Realized Beta**	**MSE**	**Bias**	**Correlation with Realized Beta**	**MSE**	**Bias**	**Number of Observations**
AA	0.501	0.025	0.046	**0.701**	0.096	0.278	344
AXP	0.164	0.205	0.405	**0.422**	0.101	0.286	268
AIG	-0.203	1.113	0.699	**0.031**	0.079	0.135	281
BA	**0.335**	0.019	0.077	-0.576	0.018	0.087	268
CAT	-0.293	0.053	-0.188	**0.091**	0.034	0.108	344
JPM	**0.111**	0.023	0.045	-0.121	0.039	0.080	344
C	-0.744	0.298	-0.363	**-0.536**	0.116	-0.063	343
KO	**0.282**	0.119	0.339	0.035	0.006	-0.046	344
DIS	**-0.076**	0.086	0.252	-0.682	0.011	0.008	261
DD	**0.307**	0.026	0.130	-0.320	0.003	0.012	258
XOM	**0.831**	0.031	0.167	0.472	0.010	-0.085	344
GE	-0.729	0.968	0.968	**0.328**	0.005	-0.058	258
WMT	0.356	0.184	0.424	**0.653**	0.006	-0.069	344
HPQ	**-0.226**	0.049	0.139	-0.934	0.043	-0.007	344
HD	**0.725**	0.060	0.240	-0.597	0.011	0.008	258
HON	**-0.223**	0.009	-0.044	-0.459	0.004	0.010	258
INTC	**0.349**	0.109	0.319	0.002	0.067	0.209	287
IBM	**0.050**	0.058	0.232	-0.120	0.006	-0.035	344
JNJ	**0.535**	0.103	0.318	0.533	0.005	-0.059	344
MCD	**-0.650**	0.207	0.434	-0.806	0.021	0.001	344
MRK	**-0.555**	0.201	0.426	-0.750	0.006	-0.018	248
MSFT	**-0.162**	0.070	0.217	-0.289	0.010	-0.041	344
MMM	-0.358	0.017	0.100	**0.567**	0.011	-0.092	256
PFE	**0.080**	0.479	0.688	-0.579	0.011	0.014	344
MO	**-0.359**	0.243	0.475	-0.579	0.011	0.014	344
PG	-0.669	0.239	0.483	**0.119**	0.006	0.049	281
T	**0.161**	0.197	0.436	-0.041	0.004	-0.029	344
UTX	**0.795**	0.198	0.443	0.117	0.011	-0.070	344
VZ	**0.161**	0.236	0.469	0.117	0.011	-0.070	343

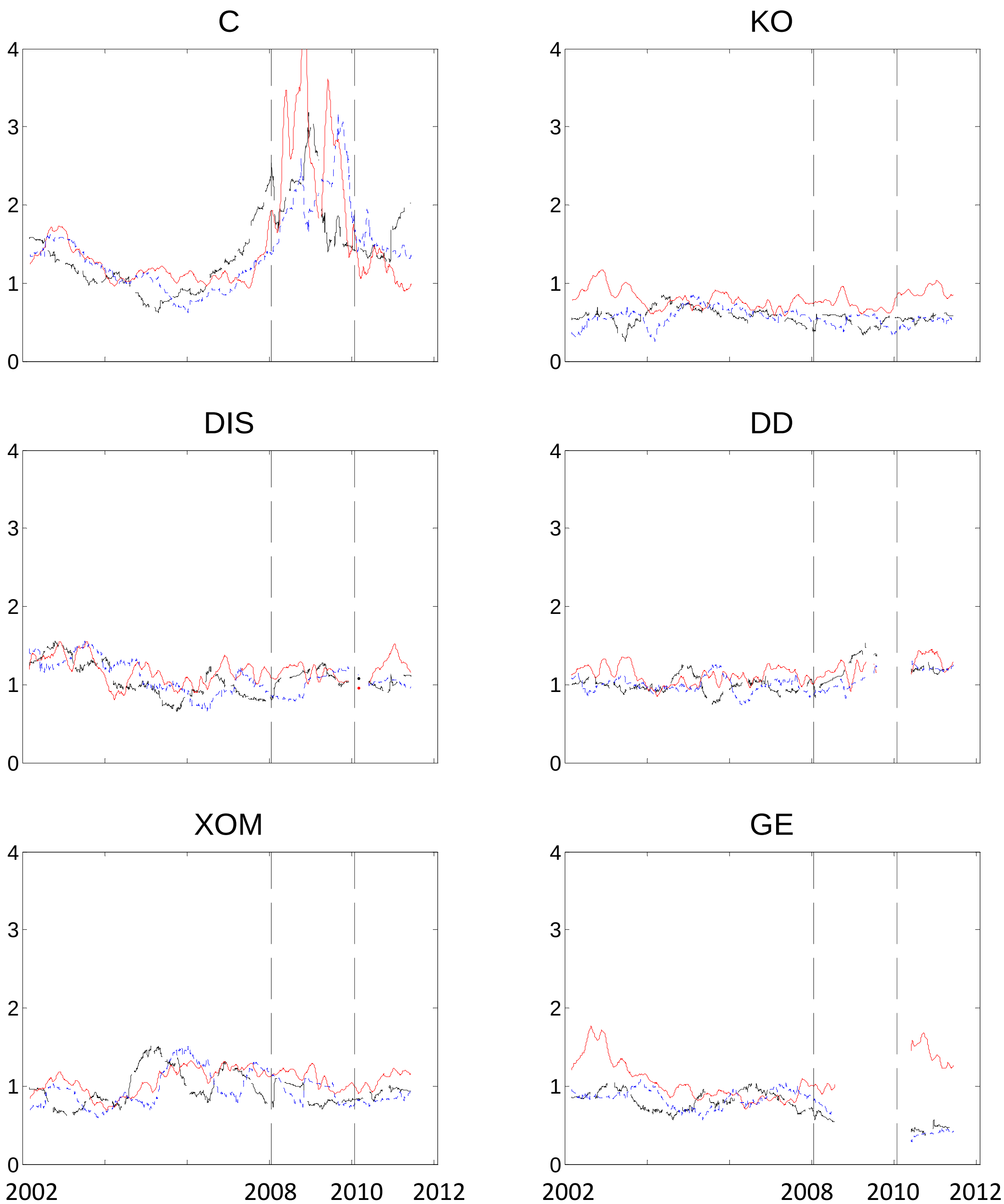
Notes to Table: We present the Correlation, Mean Squared Error (MSE) and Bias of the Option-Implied Beta and the OLS Beta with the Realized Beta for the time period 2010-2012. The beta with the higher correlation with realized beta is bolded. The right column also provides the number of observations of each beta used to calculate these summary statistics. In 2010-2012, the option-implied beta had a higher correlation in **20** of the 29 stocks that we analyzed.

Figure 6. Graphs of Option-Implied Beta, Rolling OLS Beta, Realized Beta



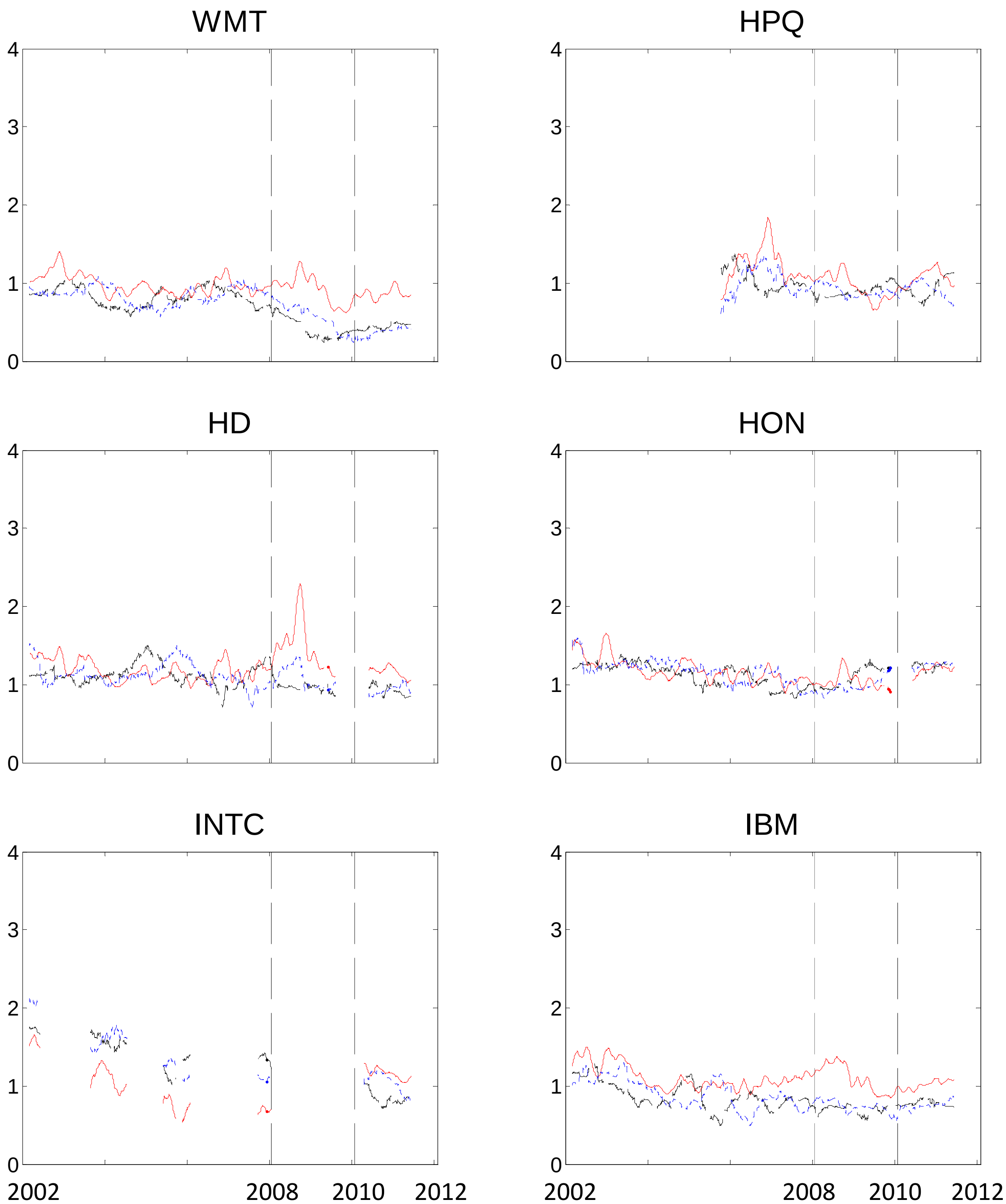
Notes to Figures: We present the Option-Implied Beta in the solid red line, the Realized Beta in the dashed black line, and the Rolling OLS Beta in the dotted blue line. The Option-Implied Betas for each date were calculated in a two-step process in order to reduce noise. First we averaged all of the different maturity betas that resulted from options traded for the day. With these averaged betas, we then calculated an average over the previous two months and used that average as our Option-Implied Beta. The OLS Betas at each date were calculated using a rolling regression of the past 180 day returns. The Realized Betas at each date were calculated using a regression of the future 180 day returns. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 6 continued. Graphs of Option-Implied Beta, Rolling OLS Beta, Realized Beta



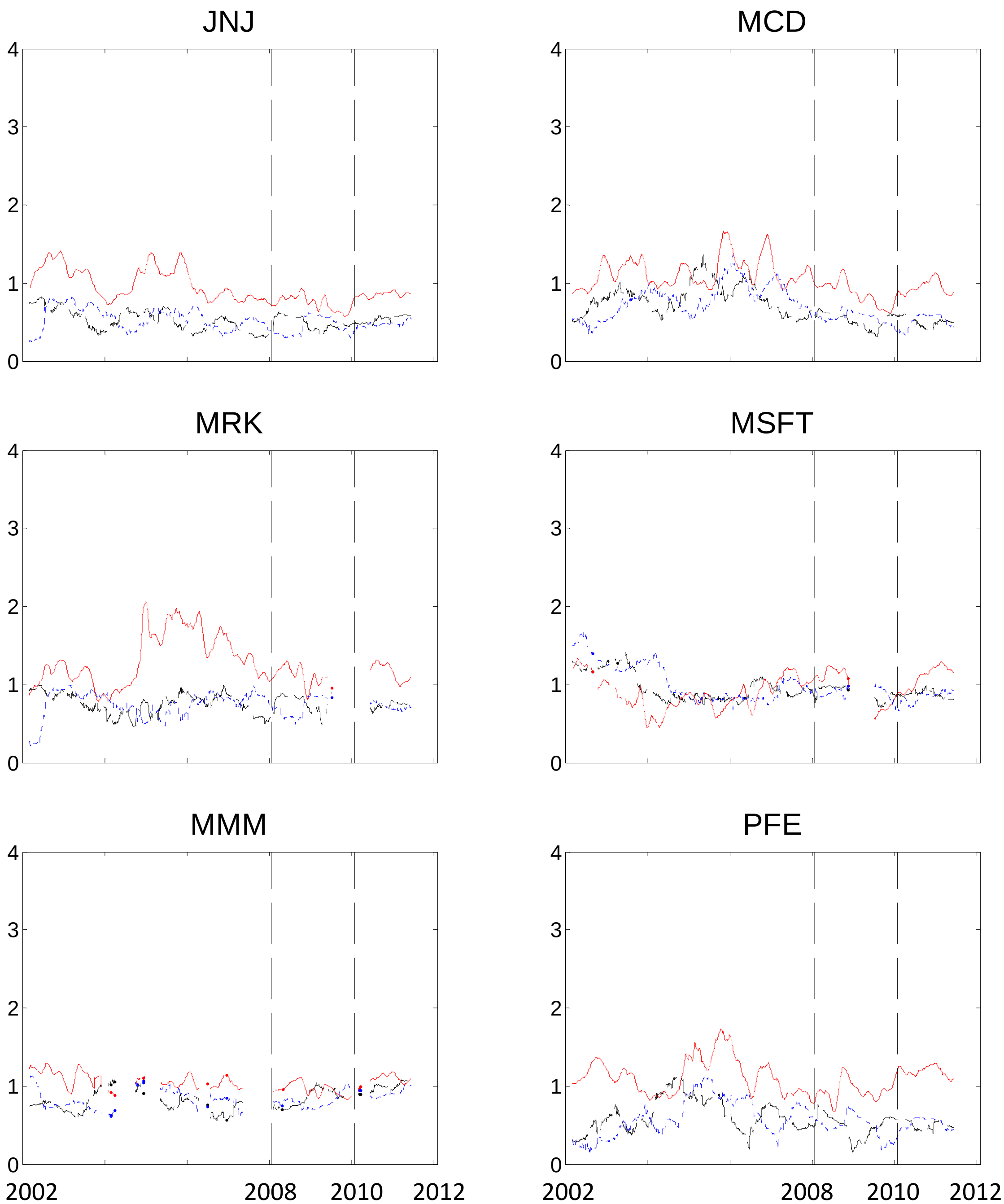
Notes to Figures: We present the Option-Implied Beta in the solid red line, the Realized Beta in the dashed black line, and the Rolling OLS Beta in the dotted blue line. The Option-Implied Betas for each date were calculated in a two-step process in order to reduce noise. First we averaged all of the different maturity betas that resulted from options traded for the day. With these averaged betas, we then calculated an average over the previous two months and used that average as our Option-Implied Beta. The OLS Betas at each date were calculated using a rolling regression of the past 180 day returns. The Realized Betas at each date were calculated using a regression of the future 180 day returns. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 6 continued. Graphs of Option-Implied Beta, Rolling OLS Beta, Realized Beta



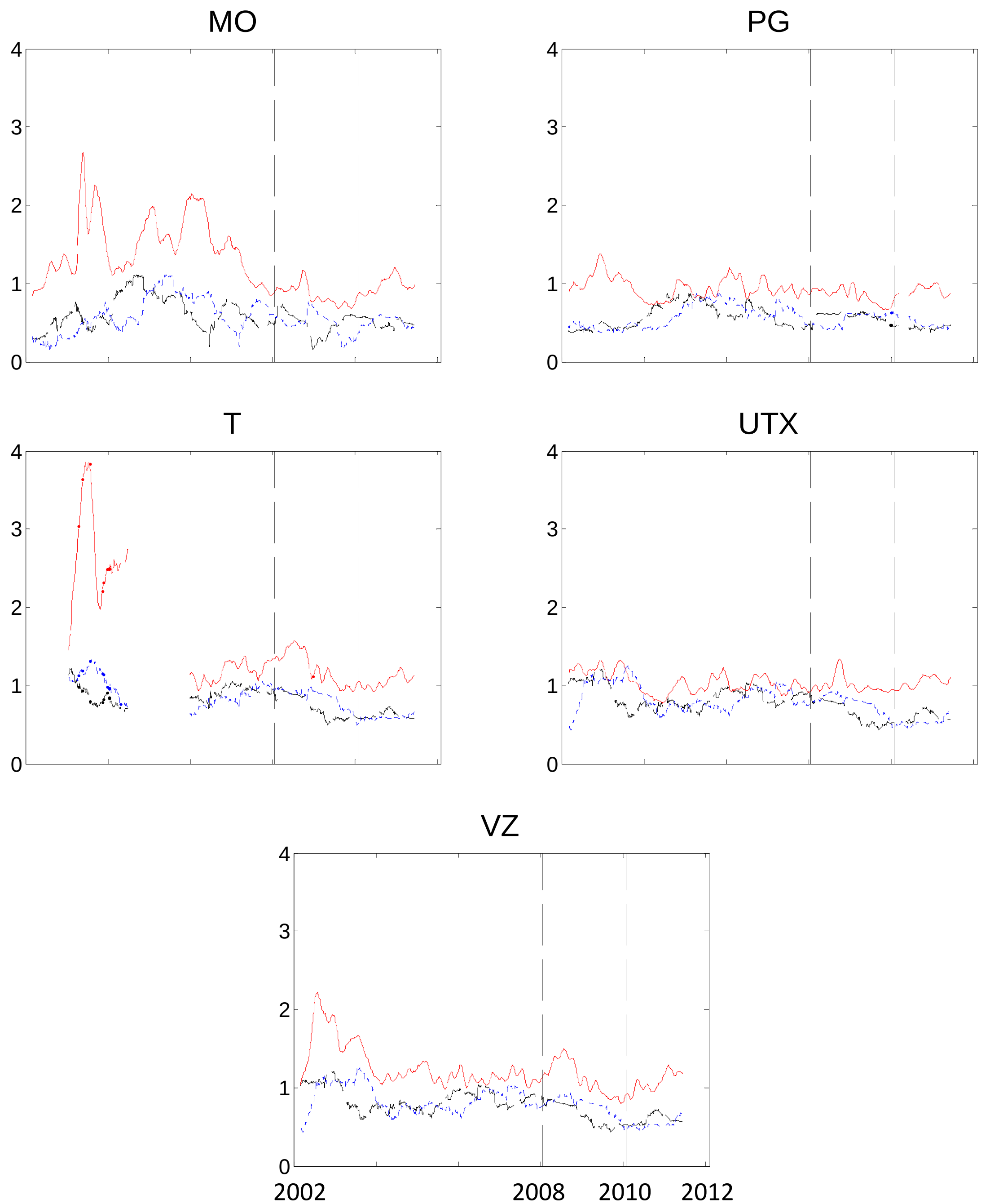
Notes to Figures: We present the Option-Implied Beta in the solid red line, the Realized Beta in the dashed black line, and the Rolling OLS Beta in the dotted blue line. The Option-Implied Betas for each date were calculated in a two-step process in order to reduce noise. First we averaged all of the different maturity betas that resulted from options traded for the day. With these averaged betas, we then calculated an average over the previous two months and used that average as our Option-Implied Beta. The OLS Betas at each date were calculated using a rolling regression of the past 180 day returns. The Realized Betas at each date were calculated using a regression of the future 180 day returns. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 6. Graphs of Option-Implied Beta, Rolling OLS Beta, Realized Beta



Notes to Figures: We present the Option-Implied Beta in the solid red line, the Realized Beta in the dashed black line, and the Rolling OLS Beta in the dotted blue line. The Option-Implied Betas for each date were calculated in a two-step process in order to reduce noise. First we averaged all of the different maturity betas that resulted from options traded for the day. With these averaged betas, we then calculated an average over the previous two months and used that average as our Option-Implied Beta. The OLS Betas at each date were calculated using a rolling regression of the past 180 day returns. The Realized Betas at each date were calculated using a regression of the future 180 day returns. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 6. Graphs of Option-Implied Beta, Rolling OLS Beta, Realized Beta



Notes to Figures: We present the Option-Implied Beta in the solid red line, the Realized Beta in the dashed black line, and the Rolling OLS Beta in the dotted blue line. The Option-Implied Betas for each date were calculated in a two-step process in order to reduce noise. First we averaged all of the different maturity betas that resulted from options traded for the day. With these averaged betas, we then calculated an average over the previous two months and used that average as our Option-Implied Beta. The OLS betas at each date were calculated using a rolling regression of the past 180 day returns. The Realized Betas at each date were calculated using a regression of the future 180 day returns. The sample period is January 1st, 2002 to December 31st, 2011.

Table 9

Correlation Between Errors and Systematic Factor Using Averaged Betas

DIA

Tickers	2002-2012		2002-2008		2008-2010		2010-2012	
AA	**-0.08**	-3.53	**0.01**	0.54	**-0.10**	-2.08	**-0.16**	-3.13
AXP	**-0.34**	-12.39	**0.01**	0.47	**-0.53**	-6.92	**-0.25**	-4.17
AIG	**-0.12**	-5.13	**-0.11**	-3.72	**-0.17**	-2.10	**-0.18**	-3.29
BA	**-0.10**	-4.38	**-0.08**	-2.94	**-0.18**	-3.03	**0.07**	1.65
CAT	**0.05**	2.44	**0.03**	1.17	**-0.03**	-0.53	**0.26**	7.72
JPM	**-0.29**	-11.21	**-0.20**	-6.37	**-0.42**	-6.05	**-0.04**	-0.95
C	**-0.25**	-9.95	**-0.09**	-3.06	**-0.35**	-5.74	**-0.08**	-1.58
KO	**-0.22**	-9.13	**-0.25**	-7.72	**-0.18**	-3.46	**-0.31**	-5.27
DIS	**-0.01**	-0.49	**-0.03**	-0.95	**0.02**	0.37	**-0.04**	-0.75
DD	**-0.05**	-2.15	**-0.09**	-3.11	**-0.01**	-0.14	**-0.04**	-0.87
XOM	**-0.17**	-7.35	**-0.10**	-3.60	**-0.24**	-4.27	**-0.21**	-3.92
GE	**-0.48**	-14.77	**-0.33**	-9.65	**-0.29**	-2.54	**-0.82**	-9.30
WMT	**-0.36**	-13.40	**-0.16**	-5.47	**-0.53**	-7.76	**-0.41**	-6.53
HPQ	**-0.04**	-1.52	**-0.02**	-0.51	**-0.08**	-1.75	**0.03**	0.78
HD	**-0.23**	-9.11	**-0.09**	-3.31	**-0.39**	-5.36	**-0.25**	-4.13
HON	**0.02**	0.85	**0.02**	0.85	**-0.04**	-0.71	**0.18**	4.57
INTC	**0.04**	1.26	**0.28**	9.03	**N/A**	N/A	**-0.22**	-3.83
IBM	**-0.27**	-10.77	**-0.11**	-3.82	**-0.45**	-6.96	**-0.28**	-4.89
JNJ	**-0.38**	-13.79	**-0.40**	-11.05	**-0.39**	-6.31	**-0.43**	-6.76
MCD	**-0.29**	-11.13	**-0.22**	-7.06	**-0.38**	-6.12	**-0.45**	-6.98
MRK	**-0.19**	-7.69	**-0.22**	-6.96	**-0.12**	-1.92	**-0.44**	-6.21
MSFT	**-0.01**	-0.36	**0.12**	4.83	**-0.03**	-0.48	**-0.26**	-4.63
MMM	**-0.20**	-7.18	**-0.25**	-6.42	**-0.23**	-4.06	**0.04**	0.82
PFE	**-0.43**	-15.18	**-0.34**	-9.85	**-0.52**	-7.69	**-0.67**	-9.02
MO	**-0.38**	-13.72	**-0.42**	-11.48	**-0.33**	-5.55	**-0.57**	-8.11
PG	**-0.41**	-14.28	**-0.42**	-11.52	**-0.38**	-6.07	**-0.53**	-7.28
T	**-0.39**	-12.03	**-0.44**	-8.98	**-0.39**	-6.21	**-0.51**	-7.59
UTX	**-0.23**	-9.23	**-0.10**	-3.51	**-0.26**	-4.69	**-0.55**	-7.93
VZ	**-0.38**	-13.74	**-0.37**	-10.50	**-0.38**	-6.13	**-0.51**	-7.53

Notes to Table: For each of the firms analyzed, we present the correlation between the residual terms and the systematic factor. The residual terms were calculated using available daily betas and the corresponding return on the index and stock. The betas were split into four categories: average of all betas, average of short term betas, average of medium term betas, and average of long term betas corresponding to each date. The bolded number in the chart represents the correlation, and the second number in smaller font represents the t-statistic. The sample period is January 1st, 2002 to December 31st, 2011.

Table 10

Correlation Between Errors and Systematic Factor Using Short Betas

DIA

Tickers	2002-2012		2002-2008		2008-2010		2010-2012	
AA	**0.07**	3.78	**0.11**	4.89	**0.06**	1.55	**0.00**	0.09
AXP	**-0.16**	-6.76	**0.11**	4.89	**-0.32**	-4.88	**-0.06**	-1.26
AIG	**-0.12**	-4.82	**-0.11**	-3.96	**-0.21**	-2.44	**-0.09**	-1.79
BA	**-0.07**	-3.21	**-0.08**	-2.78	**-0.12**	-2.05	**0.07**	1.58
CAT	**0.08**	4.18	**0.04**	1.78	**0.04**	0.69	**0.28**	8.50
JPM	**-0.24**	-9.39	**-0.18**	-5.86	**-0.31**	-4.76	**-0.13**	-2.63
C	**-0.21**	-8.71	**-0.10**	-3.51	**-0.32**	-5.21	**0.04**	0.98
KO	**-0.17**	-7.37	**-0.21**	-6.81	**-0.14**	-2.71	**-0.18**	-3.43
DIS	**0.14**	8.09	**0.06**	2.51	**0.26**	7.80	**0.13**	3.01
DD	**0.17**	9.75	**0.04**	1.45	**0.32**	8.56	**0.20**	5.06
XOM	**-0.04**	-2.09	**-0.01**	-0.42	**-0.07**	-1.56	**-0.06**	-1.19
GE	**-0.45**	-14.13	**-0.29**	-8.59	**-0.32**	-2.73	**-0.81**	-9.21
WMT	**-0.29**	-11.28	**-0.13**	-4.34	**-0.42**	-6.60	**-0.37**	-6.03
HPQ	**0.00**	0.07	**0.03**	0.72	**-0.01**	-0.28	**0.02**	0.34
HD	**-0.22**	-8.59	**-0.09**	-3.19	**-0.37**	-5.21	**-0.20**	-3.41
HON	**0.06**	2.88	**0.04**	1.69	**0.04**	0.95	**0.18**	4.41
INTC	**0.11**	4.07	**0.31**	10.55	**N/A**	N/A	**-0.10**	-1.87
IBM	**-0.18**	-7.70	**-0.06**	-2.05	**-0.32**	-5.48	**-0.19**	-3.62
JNJ	**-0.25**	-9.87	**-0.32**	-9.42	**-0.17**	-3.28	**-0.28**	-4.89
MCD	**-0.21**	-8.55	**-0.18**	-5.74	**-0.23**	-4.19	**-0.41**	-6.50
MRK	**-0.08**	-3.68	**-0.14**	-4.76	**0.05**	0.94	**-0.37**	-5.49
MSFT	**0.08**	4.18	**0.20**	8.98	**0.09**	1.94	**-0.20**	-3.74
MMM	**-0.06**	-2.27	**-0.15**	-4.22	**-0.05**	-1.11	**0.21**	5.31
PFE	**-0.38**	-13.79	**-0.30**	-8.94	**-0.43**	-6.79	**-0.67**	-8.99
MO	**-0.32**	-12.26	**-0.39**	-10.88	**-0.22**	-3.96	**-0.56**	-8.03
PG	**-0.26**	-10.16	**-0.33**	-9.54	**-0.16**	-3.11	**-0.39**	-5.89
T	**-0.15**	-5.39	**-0.18**	-3.76	**-0.07**	-1.51	**-0.43**	-6.70
UTX	**-0.18**	-7.80	**-0.09**	-3.09	**-0.19**	-3.64	**-0.49**	-7.34
VZ	**-0.23**	-9.30	**-0.23**	-7.28	**-0.18**	-3.39	**-0.42**	-6.61

Notes to Table: For each of the firms analyzed, we present the correlation between the residual terms and the systematic factor. The residual terms were calculated using available daily betas and the corresponding return on the index and stock. The betas were split into four categories: average of all betas, average of short term betas, average of medium term betas, and average of long term betas corresponding to each date. The bolded number in the chart represents the correlation, and the second number in smaller font represents the t-statistic. The sample period is January 1st, 2002 to December 31st, 2011.

Table 11

Correlation Between Errors and Systematic Factor Using Medium Betas

DIA

Tickers	2002-2012		2002-2008		2008-2010		2010-2012	
AA	**-0.15**	-6.34	**-0.03**	-1.25	**-0.21**	-3.79	**-0.15**	-2.87
AXP	**-0.43**	-14.35	**-0.08**	-2.75	**-0.62**	-7.54	**-0.23**	-3.88
AIG	**-0.17**	-6.59	**-0.17**	-5.68	**-0.16**	-1.99	**-0.28**	-4.58
BA	**-0.14**	-5.97	**-0.11**	-3.82	**-0.24**	-3.73	**0.01**	0.19
CAT	**0.00**	-0.09	**-0.02**	-0.63	**-0.09**	-1.48	**0.21**	5.89
JPM	**-0.32**	-11.88	**-0.26**	-7.87	**-0.45**	-6.25	**0.00**	-0.10
C	**-0.26**	-10.33	**-0.09**	-3.15	**-0.38**	-5.87	**-0.07**	-1.44
KO	**-0.27**	-10.70	**-0.29**	-8.62	**-0.23**	-4.17	**-0.40**	-6.34
DIS	**-0.08**	-3.59	**-0.08**	-2.77	**-0.09**	-1.78	**-0.08**	-1.44
DD	**-0.13**	-5.40	**-0.15**	-5.13	**-0.12**	-1.95	**-0.10**	-1.79
XOM	**-0.25**	-9.81	**-0.15**	-5.08	**-0.34**	-5.59	**-0.28**	-4.79
GE	**-0.49**	-14.78	**-0.34**	-9.85	**-0.23**	-2.13	**-0.82**	-9.28
WMT	**-0.41**	-14.50	**-0.17**	-5.54	**-0.59**	-8.31	**-0.48**	-7.16
HPQ	**-0.09**	-3.27	**-0.07**	-1.58	**-0.15**	-2.85	**0.00**	-0.02
HD	**-0.28**	-10.39	**-0.12**	-4.05	**-0.44**	-5.72	**-0.34**	-5.13
HON	**-0.02**	-1.04	**0.00**	-0.16	**-0.10**	-1.84	**0.15**	3.59
INTC	**0.04**	1.43	**0.26**	8.24	**N/A**	N/A	**-0.19**	-3.36
IBM	**-0.31**	-11.78	**-0.15**	-4.92	**-0.49**	-7.32	**-0.27**	-4.72
JNJ	**-0.43**	-14.93	**-0.44**	-11.64	**-0.47**	-7.06	**-0.48**	-7.11
MCD	**-0.32**	-11.99	**-0.22**	-7.02	**-0.45**	-6.87	**-0.47**	-7.13
MRK	**-0.24**	-8.94	**-0.27**	-8.05	**-0.17**	-2.60	**-0.45**	-6.17
MSFT	**0.00**	-0.16	**0.09**	3.45	**0.01**	0.13	**-0.23**	-4.19
MMM	**-0.25**	-8.57	**-0.33**	-7.86	**-0.26**	-4.39	**-0.01**	-0.24
PFE	**-0.44**	-15.12	**-0.34**	-9.85	**-0.51**	-7.58	**-0.67**	-8.95
MO	**-0.39**	-14.02	**-0.42**	-11.40	**-0.36**	-5.95	**-0.58**	-8.16
PG	**-0.47**	-15.62	**-0.47**	-12.26	**-0.47**	-7.04	**-0.56**	-7.42
T	**-0.43**	-12.54	**-0.40**	-7.70	**-0.49**	-7.24	**-0.50**	-7.45
UTX	**-0.28**	-10.89	**-0.15**	-4.98	**-0.32**	-5.40	**-0.61**	-8.40
VZ	**-0.43**	-14.95	**-0.45**	-11.85	**-0.43**	-6.72	**-0.50**	-7.41

Notes to Table: For each of the firms analyzed, we present the correlation between the residual terms and the systematic factor. The residual terms were calculated using available daily betas and the corresponding return on the index and stock. The betas were split into four categories: average of all betas, average of short term betas, average of medium term betas, and average of long term betas corresponding to each date. The bolded number in the chart represents the correlation, and the second number in smaller font represents the t-statistic. The sample period is January 1st, 2002 to December 31st, 2011.

Table 12

Correlation Between Errors and Systematic Factor Using Long Betas

DIA

Tickers	2002-2012		2002-2008		2008-2010		2010-2012	
AA	**-0.16**	-6.83	**-0.05**	-2.00	**-0.17**	-3.25	**-0.33**	-5.53
AXP	**-0.36**	-12.75	**-0.02**	-0.91	**-0.53**	-6.86	**-0.41**	-5.96
AIG	**-0.06**	-2.71	**-0.01**	-0.28	**-0.12**	-1.51	**-0.12**	-2.07
BA	**-0.06**	-2.77	**-0.03**	-1.18	**-0.18**	-2.96	**0.18**	4.58
CAT	**0.09**	4.57	**0.08**	3.32	**-0.02**	-0.37	**0.32**	10.37
JPM	**-0.27**	-10.39	**-0.15**	-4.92	**-0.44**	-6.17	**0.05**	1.08
C	**-0.23**	-9.10	**-0.06**	-2.12	**-0.31**	-5.04	**-0.18**	-3.39
KO	**-0.20**	-8.25	**-0.23**	-7.14	**-0.17**	-3.18	**-0.24**	-4.35
DIS	**-0.12**	-5.42	**-0.07**	-2.44	**-0.19**	-3.46	**-0.16**	-2.85
DD	**-0.22**	-8.62	**-0.16**	-5.22	**-0.30**	-4.16	**-0.25**	-4.10
XOM	**-0.25**	-9.97	**-0.15**	-5.16	**-0.33**	-5.49	**-0.33**	-5.50
GE	**-0.49**	-14.93	**-0.35**	-9.99	**-0.29**	-2.54	**-0.82**	-9.25
WMT	**-0.35**	-12.92	**-0.18**	-5.93	**-0.50**	-7.44	**-0.36**	-5.89
HPQ	**-0.01**	-0.27	**0.00**	0.11	**-0.07**	-1.48	**0.11**	2.84
HD	**-0.17**	-6.82	**-0.07**	-2.36	**-0.30**	-4.39	**-0.13**	-2.43
HON	**0.04**	1.76	**0.03**	1.26	**-0.02**	-0.48	**0.26**	7.33
INTC	**-0.05**	-1.59	**0.25**	7.70	**N/A**	N/A	**-0.36**	-5.58
IBM	**-0.31**	-11.86	**-0.13**	-4.55	**-0.50**	-7.35	**-0.36**	-5.91
JNJ	**-0.46**	-15.64	**-0.44**	-11.77	**-0.51**	-7.45	**-0.52**	-7.60
MCD	**-0.30**	-11.54	**-0.25**	-7.76	**-0.39**	-6.27	**-0.43**	-6.73
MRK	**-0.28**	-10.22	**-0.26**	-8.03	**-0.25**	-3.62	**-0.49**	-6.63
MSFT	**-0.12**	-5.08	**0.05**	1.80	**-0.20**	-3.13	**-0.36**	-5.88
MMM	**-0.30**	-9.88	**-0.27**	-6.66	**-0.39**	-5.97	**-0.10**	-1.90
PFE	**-0.48**	-16.23	**-0.37**	-10.41	**-0.61**	-8.51	**-0.64**	-8.72
MO	**-0.38**	-13.73	**-0.42**	-11.43	**-0.37**	-6.04	**-0.48**	-7.20
PG	**-0.48**	-15.92	**-0.47**	-12.35	**-0.47**	-7.02	**-0.60**	-7.84
T	**-0.50**	-14.02	**-0.43**	-8.38	**-0.55**	-7.82	**-0.60**	-8.32
UTX	**-0.18**	-7.76	**-0.04**	-1.60	**-0.26**	-4.54	**-0.47**	-7.17
VZ	**-0.47**	-15.88	**-0.43**	-11.62	**-0.51**	-7.44	**-0.58**	-8.22

Notes to Table: For each of the firms analyzed, we present the correlation between the residual terms and the systematic factor. The residual terms were calculated using available daily betas and the corresponding return on the index and stock. The betas were split into four categories: average of all betas, average of short term betas, average of medium term betas, and average of long term betas corresponding to each date. The bolded number in the chart represents the correlation, and the second number in smaller font represents the t-statistic. The sample period is January 1st, 2002 to December 31st, 2011.

Table 13

Correlation Between Errors and Systematic Factor Using Averaged Betas

VIX

Tickers	2002-2012		2002-2008		2008-2010		2010-2012	
AA	**0.03**	1.72	**0.02**	0.91	**0.02**	0.40	**0.10**	2.41
AXP	**0.18**	10.65	**-0.01**	-0.47	**0.40**	13.17	**0.22**	5.86
AIG	**0.09**	4.88	**0.11**	4.93	**0.09**	1.36	**0.17**	4.19
BA	**0.09**	5.02	**0.08**	3.53	**0.23**	5.99	**-0.06**	-1.15
CAT	**-0.04**	-1.86	**-0.01**	-0.51	**0.04**	0.78	**-0.19**	-3.52
JPM	**0.17**	10.11	**0.12**	5.54	**0.33**	10.24	**0.04**	1.00
C	**0.12**	6.90	**0.06**	2.28	**0.26**	7.71	**0.00**	0.04
KO	**0.20**	12.64	**0.17**	7.70	**0.23**	6.52	**0.31**	9.90
DIS	**0.04**	2.06	**0.00**	0.15	**0.12**	2.83	**0.06**	1.25
DD	**0.06**	3.13	**0.06**	2.46	**0.10**	1.98	**0.03**	0.63
XOM	**0.10**	5.68	**0.00**	-0.16	**0.23**	6.71	**0.23**	6.53
GE	**0.37**	26.86	**0.19**	8.95	**0.31**	5.06	**0.71**	50.12
WMT	**0.27**	18.48	**0.11**	4.77	**0.48**	21.06	**0.38**	13.83
HPQ	**0.05**	1.99	**0.03**	0.74	**0.10**	2.51	**0.01**	0.32
HD	**0.18**	10.86	**0.09**	3.66	**0.40**	12.82	**0.20**	5.18
HON	**0.01**	0.38	**0.02**	0.79	**0.07**	1.45	**-0.13**	-2.39
INTC	**-0.01**	-0.20	**-0.24**	-4.58	**N/A**	N/A	**0.23**	6.53
IBM	**0.23**	15.21	**0.12**	5.22	**0.43**	17.01	**0.30**	9.38
JNJ	**0.33**	25.08	**0.30**	16.45	**0.41**	15.56	**0.42**	16.11
MCD	**0.25**	16.31	**0.18**	8.41	**0.37**	12.93	**0.40**	14.74
MRK	**0.20**	11.72	**0.18**	8.78	**0.17**	3.68	**0.37**	11.98
MSFT	**0.04**	1.73	**-0.07**	-2.28	**0.08**	1.68	**0.23**	6.62
MMM	**0.18**	9.60	**0.21**	8.18	**0.26**	7.64	**0.03**	0.58
PFE	**0.33**	24.87	**0.24**	12.13	**0.44**	17.37	**0.56**	28.13
MO	**0.32**	23.67	**0.32**	18.09	**0.31**	9.88	**0.46**	18.81
PG	**0.34**	25.17	**0.27**	14.44	**0.39**	14.16	**0.51**	21.69
T	**0.33**	21.21	**0.26**	10.50	**0.42**	16.07	**0.47**	19.49
UTX	**0.20**	12.52	**0.08**	3.40	**0.26**	7.79	**0.47**	19.55
VZ	**0.29**	20.77	**0.23**	11.46	**0.36**	12.56	**0.45**	18.33

Notes to Table: For each of the firms analyzed, we present the correlation between the residual terms and the systematic factor. The residual terms were calculated using available daily betas and the corresponding return on the index and stock. The betas were split into four categories: average of all betas, average of short term betas, average of medium term betas, and average of long term betas corresponding to each date. The bolded number in the chart represents the correlation, and the second number in smaller font represents the t-statistic. The sample period is January 1st, 2002 to December 31st, 2011.

Table 14

Correlation Between Errors and Systematic Factor Using Short Betas

VIX

Tickers	2002-2012		2002-2008		2008-2010		2010-2012	
AA	**-0.09**	-4.26	**-0.09**	-3.26	**-0.13**	-2.64	**-0.06**	-1.21
AXP	**0.05**	2.42	**-0.11**	-3.70	**0.22**	5.48	**0.03**	0.74
AIG	**0.07**	3.57	**0.11**	4.71	**0.13**	2.02	**0.04**	0.93
BA	**0.07**	3.50	**0.07**	2.96	**0.18**	4.28	**-0.09**	-1.70
CAT	**-0.07**	-3.18	**-0.03**	-1.26	**-0.01**	-0.27	**-0.22**	-4.06
JPM	**0.14**	8.13	**0.09**	4.01	**0.25**	6.88	**0.11**	2.84
C	**0.08**	4.23	**0.05**	2.03	**0.21**	5.77	**-0.12**	-2.34
KO	**0.14**	8.32	**0.12**	5.32	**0.18**	4.76	**0.18**	4.97
DIS	**-0.09**	-4.19	**-0.09**	-3.16	**-0.11**	-2.11	**-0.10**	-1.91
DD	**-0.11**	-4.82	**-0.05**	-1.77	**-0.19**	-2.94	**-0.21**	-3.60
XOM	**-0.01**	-0.70	**-0.09**	-3.34	**0.08**	1.89	**0.07**	1.71
GE	**0.35**	23.97	**0.15**	6.67	**0.34**	5.81	**0.69**	46.83
WMT	**0.22**	14.24	**0.07**	3.04	**0.40**	15.02	**0.36**	12.32
HPQ	**0.01**	0.55	**-0.02**	-0.47	**0.05**	1.07	**0.01**	0.30
HD	**0.15**	8.70	**0.06**	2.61	**0.38**	11.59	**0.13**	3.16
HON	**-0.03**	-1.24	**-0.01**	-0.19	**0.00**	-0.10	**-0.14**	-2.59
INTC	**-0.09**	-2.59	**-0.29**	-5.21	**N/A**	N/A	**0.11**	2.62
IBM	**0.14**	8.37	**0.05**	1.97	**0.30**	9.74	**0.20**	5.76
JNJ	**0.22**	14.08	**0.22**	10.59	**0.23**	6.73	**0.27**	8.41
MCD	**0.19**	11.54	**0.14**	6.06	**0.25**	7.39	**0.35**	12.29
MRK	**0.10**	5.13	**0.10**	4.49	**-0.01**	-0.15	**0.29**	8.34
MSFT	**-0.05**	-2.18	**-0.15**	-4.74	**-0.03**	-0.51	**0.16**	4.16
MMM	**0.06**	2.82	**0.13**	4.57	**0.10**	2.50	**-0.14**	-2.49
PFE	**0.29**	20.24	**0.20**	9.67	**0.34**	11.62	**0.55**	27.15
MO	**0.29**	20.76	**0.30**	16.69	**0.22**	6.29	**0.45**	18.59
PG	**0.22**	13.67	**0.18**	8.59	**0.21**	5.96	**0.37**	12.21
T	**0.17**	8.36	**0.10**	2.66	**0.14**	3.71	**0.38**	13.52
UTX	**0.16**	9.29	**0.06**	2.28	**0.19**	5.33	**0.39**	14.59
VZ	**0.17**	10.31	**0.11**	4.99	**0.18**	5.00	**0.35**	11.93

Notes to Table: For each of the firms analyzed, we present the correlation between the residual terms and the systematic factor. The residual terms were calculated using available daily betas and the corresponding return on the index and stock. The betas were split into four categories: average of all betas, average of short term betas, average of medium term betas, and average of long term betas corresponding to each date. The bolded number in the chart represents the correlation, and the second number in smaller font represents the t-statistic. The sample period is January 1st, 2002 to December 31st, 2011.

Table 15

Correlation Between Errors and Systematic Factor Using Medium Betas

VIX

Tickers	2002-2012		2002-2008		2008-2010		2010-2012	
AA	**0.08**	4.27	**0.07**	2.99	**0.11**	2.72	**0.07**	1.73
AXP	**0.23**	14.29	**0.05**	2.13	**0.47**	17.41	**0.23**	6.20
AIG	**0.14**	7.21	**0.16**	7.41	**0.10**	1.54	**0.24**	6.69
BA	**0.13**	7.41	**0.11**	4.97	**0.28**	7.50	**0.01**	0.31
CAT	**0.00**	0.16	**0.03**	1.13	**0.09**	1.76	**-0.14**	-2.76
JPM	**0.19**	11.43	**0.16**	7.37	**0.37**	11.84	**0.01**	0.28
C	**0.14**	7.77	**0.06**	2.52	**0.30**	9.08	**0.01**	0.11
KO	**0.24**	15.96	**0.19**	9.02	**0.27**	8.19	**0.39**	14.42
DIS	**0.09**	4.80	**0.04**	1.76	**0.19**	5.16	**0.10**	2.21
DD	**0.13**	6.85	**0.11**	4.90	**0.19**	4.25	**0.10**	2.30
XOM	**0.16**	9.30	**0.04**	1.39	**0.31**	10.06	**0.30**	9.34
GE	**0.37**	26.40	**0.19**	8.99	**0.22**	3.22	**0.71**	49.72
WMT	**0.29**	20.72	**0.11**	4.64	**0.52**	24.46	**0.44**	17.45
HPQ	**0.09**	3.87	**0.07**	1.75	**0.15**	3.95	**0.05**	1.24
HD	**0.23**	14.14	**0.11**	4.78	**0.46**	16.21	**0.28**	8.10
HON	**0.04**	1.84	**0.03**	1.38	**0.13**	3.06	**-0.09**	-1.76
INTC	**-0.01**	-0.21	**-0.23**	-4.30	**N/A**	N/A	**0.22**	5.89
IBM	**0.26**	17.58	**0.15**	6.86	**0.47**	19.36	**0.30**	9.48
JNJ	**0.37**	29.35	**0.33**	18.69	**0.46**	18.97	**0.47**	19.62
MCD	**0.27**	17.98	**0.18**	8.34	**0.43**	16.64	**0.42**	15.81
MRK	**0.23**	14.26	**0.23**	11.16	**0.21**	4.82	**0.38**	12.41
MSFT	**0.05**	2.25	**-0.04**	-1.34	**0.08**	1.61	**0.21**	6.04
MMM	**0.22**	12.19	**0.26**	10.79	**0.29**	8.49	**0.08**	1.68
PFE	**0.33**	24.85	**0.24**	12.04	**0.44**	17.33	**0.56**	27.88
MO	**0.33**	24.27	**0.32**	17.93	**0.33**	10.88	**0.46**	18.98
PG	**0.38**	29.81	**0.31**	16.97	**0.45**	18.09	**0.54**	24.42
T	**0.37**	24.11	**0.27**	10.01	**0.50**	21.71	**0.47**	19.89
UTX	**0.25**	16.61	**0.12**	5.38	**0.31**	10.00	**0.53**	24.91
VZ	**0.33**	24.53	**0.27**	14.35	**0.42**	16.18	**0.46**	18.63

Notes to Table: For each of the firms analyzed, we present the correlation between the residual terms and the systematic factor. The residual terms were calculated using available daily betas and the corresponding return on the index and stock. The betas were split into four categories: average of all betas, average of short term betas, average of medium term betas, and average of long term betas corresponding to each date. The bolded number in the chart represents the correlation, and the second number in smaller font represents the t-statistic. The sample period is January 1st, 2002 to December 31st, 2011.

Table 16

Correlation Between Errors and Systematic Factor Using Long Betas

VIX

Tickers	2002-2012		2002-2008		2008-2010		2010-2012	
AA	**0.13**	7.20	**0.11**	4.67	**0.09**	2.17	**0.27**	8.33
AXP	**0.22**	13.67	**0.03**	1.36	**0.41**	13.73	**0.35**	11.36
AIG	**0.07**	3.24	**0.05**	2.01	**0.04**	0.52	**0.17**	4.05
BA	**0.06**	2.96	**0.05**	1.85	**0.23**	5.82	**-0.14**	-2.48
CAT	**-0.08**	-3.45	**-0.05**	-1.94	**0.02**	0.34	**-0.23**	-4.15
JPM	**0.15**	8.86	**0.11**	4.87	**0.34**	10.46	**-0.03**	-0.71
C	**0.12**	6.72	**0.05**	2.05	**0.22**	6.18	**0.10**	2.51
KO	**0.19**	11.58	**0.17**	7.78	**0.21**	5.78	**0.26**	7.78
DIS	**0.14**	7.87	**0.07**	2.87	**0.29**	8.76	**0.16**	4.01
DD	**0.19**	11.14	**0.12**	5.51	**0.33**	9.03	**0.22**	5.67
XOM	**0.18**	10.60	**0.06**	2.35	**0.31**	10.05	**0.33**	11.16
GE	**0.39**	28.95	**0.22**	10.58	**0.31**	5.02	**0.71**	49.40
WMT	**0.26**	17.75	**0.14**	6.10	**0.46**	18.92	**0.32**	10.57
HPQ	**0.01**	0.46	**0.01**	0.36	**0.07**	1.65	**-0.04**	-0.96
HD	**0.14**	7.75	**0.07**	2.88	**0.33**	9.21	**0.12**	2.78
HON	**-0.01**	-0.28	**0.02**	0.79	**0.05**	1.04	**-0.20**	-3.35
INTC	**0.08**	2.86	**-0.20**	-3.88	**N/A**	N/A	**0.36**	11.82
IBM	**0.29**	20.13	**0.16**	7.61	**0.50**	21.82	**0.37**	13.09
JNJ	**0.40**	33.67	**0.35**	20.91	**0.51**	22.70	**0.49**	21.66
MCD	**0.25**	16.94	**0.20**	9.67	**0.37**	12.92	**0.37**	13.25
MRK	**0.27**	17.59	**0.24**	12.23	**0.30**	7.76	**0.43**	15.18
MSFT	**0.12**	6.52	**0.00**	0.13	**0.21**	4.99	**0.31**	10.11
MMM	**0.26**	14.98	**0.23**	9.20	**0.39**	13.54	**0.16**	3.74
PFE	**0.36**	27.99	**0.27**	14.42	**0.49**	21.91	**0.53**	25.51
MO	**0.31**	22.39	**0.31**	17.47	**0.33**	11.10	**0.39**	13.92
PG	**0.40**	33.28	**0.33**	18.73	**0.47**	19.77	**0.57**	28.30
T	**0.41**	29.64	**0.29**	11.52	**0.55**	27.11	**0.53**	24.99
UTX	**0.17**	10.08	**0.05**	2.06	**0.25**	7.28	**0.41**	15.75
VZ	**0.37**	29.16	**0.29**	16.06	**0.47**	19.26	**0.53**	24.73

Notes to Table: For each of the firms analyzed, we present the correlation between the residual terms and the systematic factor. The residual terms were calculated using available daily betas and the corresponding return on the index and stock. The betas were split into four categories: average of all betas, average of short term betas, average of medium term betas, and average of long term betas corresponding to each date. The bolded number in the chart represents the correlation, and the second number in smaller font represents the t-statistic. The sample period is January 1st, 2002 to December 31st, 2011.

Table 17

Term Structure of Different Maturity Betas

Mid –Short (2002-2012)

Tickers	Mean Difference	SE	t-value	p-value	CI		Number of Observations
AA	0.285	0.382	36.824	0.000	0.265	0.305	2444
AXP	0.272	0.343	37.853	0.000	0.254	0.291	2270
AIG	0.120	0.509	10.773	0.000	0.091	0.149	2093
BA	0.061	0.270	10.808	0.000	0.046	0.076	2288
CAT	0.063	0.287	10.643	0.000	0.048	0.079	2321
JPM	0.026	0.284	4.555	0.000	0.011	0.041	2389
C	0.088	0.472	9.127	0.000	0.063	0.113	2401
KO	0.103	0.198	25.662	0.000	0.092	0.113	2454
DIS	0.240	0.303	38.424	0.000	0.224	0.256	2357
DD	0.209	0.248	39.770	0.000	0.196	0.223	2216
XOM	0.180	0.195	45.665	0.000	0.170	0.191	2447
GE	0.083	0.224	16.685	0.000	0.070	0.096	2029
WMT	0.074	0.172	21.455	0.000	0.065	0.083	2475
HPQ	0.087	0.278	12.373	0.000	0.069	0.105	1580
HD	0.108	0.267	19.243	0.000	0.094	0.123	2260
HON	0.084	0.203	19.958	0.000	0.073	0.095	2324
INTC	0.064	0.222	9.134	0.000	0.046	0.083	988
IBM	0.155	0.183	41.935	0.000	0.145	0.164	2457
JNJ	0.176	0.191	45.447	0.000	0.166	0.186	2438
MCD	0.128	0.246	25.787	0.000	0.115	0.141	2439
MRK	0.247	0.316	36.559	0.000	0.229	0.264	2197
MSFT	0.115	0.244	21.837	0.000	0.102	0.129	2143
MMM	0.156	0.424	15.783	0.000	0.130	0.181	1841
PFE	0.087	0.272	15.941	0.000	0.073	0.102	2461
MO	0.075	0.287	12.975	0.000	0.060	0.090	2467
PG	0.182	0.194	45.595	0.000	0.172	0.192	2368
T	0.231	0.303	30.343	0.000	0.211	0.251	1589
UTX	0.098	0.229	21.232	0.000	0.086	0.110	2470
VZ	0.248	0.259	47.390	0.000	0.235	0.262	2450

Notes to Table: For each of the firms analyzed, we present the term structure between different maturity betas. This table provides the summary statistics for the Mid-Short Term Betas for the period 2002-2012. Included are the Mean of the Differences, the Standard Error, the t-value, the p-value, the Confidence Interval, and the Number of Observations. Betas were terms as short if they were estimated from options with maturities less than 60 days. They were termed as mid if their options had maturities between 60 and 150 days, and they were termed as long if their options had maturities between 150 and 260 days. For each available date, the betas that fell into each time category were averaged together, and the average was used to represent the beta of that time category for that date. The mean difference was then calculated as the mean of the daily differences of these averaged betas over the time period analyzed.

Table 18

Term Structure of Different Maturity Betas

Mid -Short (2002-2008)

Tickers	Mean Difference	SE	t-value	p-value	CI		Number of Observations
AA	0.285	0.362	30.149	0.000	0.260	0.309	1467
AXP	0.248	0.208	45.480	0.000	0.234	0.262	1458
AIG	0.100	0.279	13.768	0.000	0.082	0.119	1466
BA	0.073	0.294	9.561	0.000	0.053	0.093	1484
CAT	0.085	0.313	10.423	0.000	0.064	0.106	1483
JPM	0.096	0.230	16.040	0.000	0.080	0.111	1480
C	0.062	0.204	11.761	0.000	0.049	0.076	1479
KO	0.104	0.176	22.724	0.000	0.093	0.116	1470
DIS	0.255	0.300	32.638	0.000	0.235	0.276	1472
DD	0.208	0.218	36.787	0.000	0.194	0.223	1474
XOM	0.196	0.191	39.156	0.000	0.183	0.209	1465
GE	0.111	0.205	20.845	0.000	0.098	0.125	1475
WMT	0.057	0.158	13.945	0.000	0.047	0.068	1480
HPQ	0.176	0.341	12.606	0.000	0.140	0.212	595
HD	0.104	0.258	15.563	0.000	0.087	0.121	1486
HON	0.093	0.210	17.063	0.000	0.079	0.107	1478
INTC	0.083	0.250	7.673	0.000	0.055	0.110	538
IBM	0.172	0.183	36.258	0.000	0.160	0.185	1475
JNJ	0.201	0.210	36.418	0.000	0.187	0.215	1457
MCD	0.134	0.270	18.910	0.000	0.116	0.153	1444
MRK	0.282	0.336	32.246	0.000	0.259	0.305	1471
MSFT	0.159	0.255	22.417	0.000	0.140	0.177	1300
MMM	0.178	0.555	10.076	0.000	0.133	0.224	981
PFE	0.107	0.299	13.669	0.000	0.087	0.127	1462
MO	0.096	0.331	11.176	0.000	0.074	0.118	1475
PG	0.201	0.177	43.281	0.000	0.189	0.213	1447
T	0.302	0.349	21.282	0.000	0.265	0.339	605
UTX	0.108	0.244	16.988	0.000	0.091	0.124	1484
VZ	0.313	0.257	46.558	0.000	0.296	0.330	1460

Notes to Table: For each of the firms analyzed, we present the term structure between different maturity betas. This table provides the summary statistics for the Mid-Short Term Betas for the period 2002-2008. Included are the Mean of the Differences, the Standard Error, the t-value, the p-value, the Confidence Interval, and the Number of Observations. Betas were terms as short if they were estimated from options with maturities less than 60 days. They were termed as mid if their options had maturities between 60 and 150 days, and they were termed as long if their options had maturities between 150 and 260 days. For each available date, the betas that fell into each time category were averaged together, and the average was used to represent the beta of that time category for that date. The mean difference was then calculated as the mean of the daily differences of these averaged betas over the time period analyzed.

Table 19

Term Structure of Different Maturity Betas

Mid -Short (2008-2010)

Tickers	Mean Difference	SE	t-value	p-value	CI		Number of Observations
AA	0.362	0.478	16.785	0.000	0.306	0.417	491
AXP	0.524	0.575	18.066	0.000	0.449	0.599	392
AIG	-0.252	0.923	-3.759	0.000	-0.426	-0.077	189
BA	0.072	0.163	8.597	0.000	0.051	0.094	373
CAT	0.054	0.175	5.711	0.000	0.029	0.078	341
JPM	-0.063	0.404	-3.156	0.002	-0.115	-0.011	408
C	0.094	0.930	2.108	0.036	-0.021	0.208	438
KO	0.059	0.133	9.731	0.000	0.043	0.074	487
DIS	0.222	0.255	18.755	0.000	0.192	0.253	463
DD	0.216	0.281	14.071	0.000	0.177	0.256	334
XOM	0.151	0.183	18.444	0.000	0.130	0.172	496
GE	-0.068	0.149	-5.182	0.000	-0.102	-0.034	128
WMT	0.066	0.161	9.143	0.000	0.047	0.085	498
HPQ	0.049	0.161	6.653	0.000	0.030	0.067	488
HD	0.149	0.252	11.105	0.000	0.114	0.184	353
HON	0.054	0.150	7.357	0.000	0.035	0.073	423
INTC	N/A	N/A	N/A	N/A	N/A	N/A	1
IBM	0.169	0.205	18.349	0.000	0.145	0.192	496
JNJ	0.153	0.147	23.149	0.000	0.136	0.170	495
MCD	0.113	0.125	20.072	0.000	0.098	0.127	498
MRK	0.240	0.251	17.303	0.000	0.204	0.276	326
MSFT	0.057	0.198	5.410	0.000	0.030	0.085	347
MMM	0.115	0.169	14.483	0.000	0.095	0.136	452
PFE	0.103	0.247	9.315	0.000	0.074	0.131	498
MO	0.059	0.137	9.678	0.000	0.044	0.075	495
PG	0.135	0.173	17.349	0.000	0.115	0.156	488
T	0.295	0.226	28.797	0.000	0.268	0.321	488
UTX	0.081	0.140	12.702	0.000	0.064	0.097	489
VZ	0.212	0.193	24.441	0.000	0.190	0.235	495

Notes to Table: For each of the firms analyzed, we present the term structure between different maturity betas. This table provides the summary statistics for the Mid-Short Term Betas for the period 2008-2010. Included are the Mean of the Differences, the Standard Error, the t-value, the p-value, the Confidence Interval, and the Number of Observations. Betas were terms as short if they were estimated from options with maturities less than 60 days. They were termed as mid if their options had maturities between 60 and 150 days, and they were termed as long if their options had maturities between 150 and 260 days. For each available date, the betas that fell into each time category were averaged together, and the average was used to represent the beta of that time category for that date. The mean difference was then calculated as the mean of the daily differences of these averaged betas over the time period analyzed.

Table 20

Term Structure of Different Maturity Betas
Mid -Short (2010-2012)

Tickers	Mean Difference	SE	t-value	p-value	CI		Number of Observations
AA	0.206	0.311	14.591	0.000	0.170	0.243	484
AXP	0.121	0.302	8.192	0.000	0.083	0.159	418
AIG	0.347	0.707	10.250	0.000	0.259	0.434	436
BA	0.010	0.251	0.799	0.425	-0.022	0.041	429
CAT	0.006	0.260	0.543	0.587	-0.024	0.036	495
JPM	-0.106	0.242	-9.764	0.000	-0.133	-0.078	499
C	0.161	0.436	8.113	0.000	0.110	0.212	482
KO	0.140	0.285	10.942	0.000	0.107	0.173	495
DIS	0.205	0.354	11.881	0.000	0.161	0.250	420
DD	0.206	0.313	13.307	0.000	0.166	0.246	406
XOM	0.164	0.215	16.801	0.000	0.139	0.189	484
GE	0.029	0.271	2.231	0.026	-0.005	0.063	424
WMT	0.133	0.206	14.314	0.000	0.109	0.156	495
HPQ	0.017	0.256	1.434	0.152	-0.013	0.046	495
HD	0.088	0.306	5.890	0.000	0.049	0.126	419
HON	0.083	0.222	7.677	0.000	0.055	0.111	421
INTC	0.042	0.180	4.969	0.000	0.020	0.064	447
IBM	0.086	0.138	13.745	0.000	0.070	0.102	484
JNJ	0.126	0.156	17.847	0.000	0.108	0.145	484
MCD	0.126	0.261	10.739	0.000	0.096	0.156	495
MRK	0.122	0.255	9.585	0.000	0.089	0.155	398
MSFT	0.041	0.216	4.245	0.000	0.016	0.066	494
MMM	0.146	0.184	15.985	0.000	0.122	0.170	406
PFE	0.016	0.191	1.813	0.070	-0.007	0.038	499
MO	0.028	0.251	2.452	0.015	-0.002	0.057	495
PG	0.171	0.255	13.951	0.000	0.139	0.203	431
T	0.081	0.252	7.149	0.000	0.052	0.110	494
UTX	0.086	0.251	7.602	0.000	0.057	0.115	495
VZ	0.093	0.251	8.205	0.000	0.063	0.122	493

Notes to Table: For each of the firms analyzed, we present the term structure between different maturity betas. This table provides the summary statistics for the Mid-Short Term Betas for the period 2010-2012. Included are the Mean of the Differences, the Standard Error, the t-value, the p-value, the Confidence Interval, and the Number of Observations. Betas were terms as short if they were estimated from options with maturities less than 60 days. They were termed as mid if their options had maturities between 60 and 150 days, and they were termed as long if their options had maturities between 150 and 260 days. For each available date, the betas that fell into each time category were averaged together, and the average was used to represent the beta of that time category for that date. The mean difference was then calculated as the mean of the daily differences of these averaged betas over the time period analyzed.

Table 21

Term Structure of Different Maturity Betas

Long -Short (2002-2012)

Tickers	Mean Difference	SE	t-value	p-value	CI		Number of Observations
AA	0.318	0.439	35.938	0.000	0.295	0.341	2462
AXP	0.259	0.374	33.175	0.000	0.239	0.279	2296
AIG	-0.099	0.517	-8.708	0.000	-0.128	-0.070	2072
BA	-0.100	0.250	-19.318	0.000	-0.114	-0.087	2312
CAT	-0.116	0.253	-22.117	0.000	-0.129	-0.102	2339
JPM	-0.068	0.367	-9.147	0.000	-0.088	-0.049	2405
C	0.055	0.596	4.512	0.000	0.023	0.086	2407
KO	0.023	0.225	5.065	0.000	0.011	0.035	2480
DIS	0.261	0.351	36.397	0.000	0.243	0.280	2382
DD	0.240	0.270	42.266	0.000	0.226	0.255	2243
XOM	0.188	0.216	43.319	0.000	0.177	0.200	2470
GE	0.079	0.251	14.162	0.000	0.064	0.093	2040
WMT	0.030	0.197	7.515	0.000	0.019	0.040	2490
HPQ	-0.092	0.287	-12.872	0.000	-0.111	-0.074	1597
HD	-0.033	0.284	-5.579	0.000	-0.048	-0.018	2284
HON	0.030	0.258	5.591	0.000	0.016	0.044	2336
INTC	0.112	0.284	12.462	0.000	0.089	0.135	1000
IBM	0.169	0.228	37.020	0.000	0.158	0.181	2477
JNJ	0.188	0.228	41.009	0.000	0.177	0.200	2460
MCD	0.088	0.281	15.566	0.000	0.074	0.103	2453
MRK	0.227	0.332	32.341	0.000	0.209	0.246	2223
MSFT	0.170	0.254	31.044	0.000	0.156	0.184	2166
MMM	0.152	0.446	14.728	0.000	0.126	0.179	1861
PFE	0.082	0.318	12.759	0.000	0.065	0.098	2478
MO	-0.012	0.361	-1.602	0.109	-0.030	0.007	2482
PG	0.205	0.214	46.784	0.000	0.193	0.216	2393
T	0.297	0.366	32.314	0.000	0.273	0.321	1580
UTX	-0.046	0.227	-10.096	0.000	-0.057	-0.034	2497
VZ	0.275	0.327	41.770	0.000	0.258	0.292	2466

Notes to Table: For each of the firms analyzed, we present the term structure between different maturity betas. This table provides the summary statistics for the Long-Short Term Betas for the period 2002-2012. Included are the Mean of the Differences, the Standard Error, the t-value, the p-value, the Confidence Interval, and the Number of Observations. Betas were terms as short if they were estimated from options with maturities less than 60 days. They were termed as mid if their options had maturities between 60 and 150 days, and they were termed as long if their options had maturities between 150 and 260 days. For each available date, the betas that fell into each time category were averaged together, and the average was used to represent the beta of that time category for that date. The mean difference was then calculated as the mean of the daily differences of these averaged betas over the time period analyzed.

Table 22

Term Structure of Different Maturity Betas

Long -Short (2002-2008)

Tickers	Mean Difference	SE	t-value	p-value	CI		Number of Observations
AA	0.290	0.416	26.873	0.000	0.262	0.318	1484
AXP	0.189	0.246	29.483	0.000	0.172	0.205	1476
AIG	-0.056	0.300	-7.178	0.000	-0.076	-0.036	1476
BA	-0.092	0.248	-14.390	0.000	-0.109	-0.076	1494
CAT	-0.101	0.249	-15.658	0.000	-0.118	-0.084	1492
JPM	0.028	0.291	3.702	0.000	0.008	0.047	1489
C	0.044	0.238	7.103	0.000	0.028	0.060	1487
KO	0.069	0.193	13.721	0.000	0.056	0.082	1480
DIS	0.274	0.355	29.787	0.000	0.250	0.297	1490
DD	0.215	0.230	36.158	0.000	0.200	0.231	1492
XOM	0.205	0.209	37.851	0.000	0.191	0.219	1486
GE	0.136	0.212	24.622	0.000	0.121	0.150	1484
WMT	0.056	0.182	11.824	0.000	0.043	0.068	1489
HPQ	-0.015	0.328	-1.137	0.256	-0.050	0.019	596
HD	0.015	0.236	2.449	0.014	-0.001	0.031	1496
HON	0.066	0.247	10.309	0.000	0.050	0.083	1486
INTC	0.091	0.291	7.290	0.000	0.058	0.123	547
IBM	0.167	0.227	28.389	0.000	0.151	0.182	1493
JNJ	0.196	0.239	31.458	0.000	0.180	0.212	1475
MCD	0.132	0.296	16.970	0.000	0.112	0.152	1452
MRK	0.239	0.338	27.261	0.000	0.216	0.261	1489
MSFT	0.211	0.253	30.342	0.000	0.193	0.229	1321
MMM	0.132	0.573	7.285	0.000	0.085	0.179	993
PFE	0.129	0.321	15.425	0.000	0.108	0.151	1471
MO	0.018	0.404	1.678	0.094	-0.009	0.045	1484
PG	0.214	0.210	39.109	0.000	0.200	0.229	1466
T	0.346	0.408	20.724	0.000	0.302	0.389	597
UTX	-0.022	0.215	-3.960	0.000	-0.036	-0.008	1495
VZ	0.318	0.353	34.617	0.000	0.294	0.342	1477

Notes to Table: For each of the firms analyzed, we present the term structure between different maturity betas. This table provides the summary statistics for the Long-Short Term Betas for the period 2002-2008. Included are the Mean of the Differences, the Standard Error, the t-value, the p-value, the Confidence Interval, and the Number of Observations. Betas were terms as short if they were estimated from options with maturities less than 60 days. They were termed as mid if their options had maturities between 60 and 150 days, and they were termed as long if their options had maturities between 150 and 260 days. For each available date, the betas that fell into each time category were averaged together, and the average was used to represent the beta of that time category for that date. The mean difference was then calculated as the mean of the daily differences of these averaged betas over the time period analyzed.

Table 23

Term Structure of Different Maturity Betas
Long -Short (2008-2010)

Tickers	Mean Difference	SE	t-value	p-value	CI		Number of Observations
AA	0.403	0.538	16.525	0.000	0.340	0.466	486
AXP	0.608	0.440	27.305	0.000	0.550	0.666	390
AIG	-0.548	0.741	-10.288	0.000	-0.686	-0.409	193
BA	-0.016	0.155	-1.996	0.047	-0.036	0.005	382
CAT	-0.087	0.240	-6.734	0.000	-0.120	-0.053	347
JPM	-0.175	0.459	-7.766	0.000	-0.234	-0.117	413
C	-0.211	1.120	-3.932	0.000	-0.349	-0.072	436
KO	-0.005	0.169	-0.615	0.539	-0.024	0.015	497
DIS	0.356	0.228	33.558	0.000	0.329	0.384	460
DD	0.441	0.238	33.853	0.000	0.408	0.475	332
XOM	0.216	0.225	21.281	0.000	0.190	0.243	490
GE	-0.062	0.191	-3.743	0.000	-0.106	-0.019	130
WMT	0.020	0.159	2.896	0.004	0.002	0.039	504
HPQ	-0.066	0.178	-8.276	0.000	-0.086	-0.045	498
HD	-0.052	0.193	-5.137	0.000	-0.078	-0.026	362
HON	0.012	0.160	1.501	0.134	-0.008	0.032	429
INTC	N/A	N/A	N/A	N/A	N/A	N/A	1
IBM	0.275	0.243	25.018	0.000	0.246	0.303	490
JNJ	0.235	0.196	26.595	0.000	0.213	0.258	491
MCD	0.096	0.143	15.063	0.000	0.080	0.113	504
MRK	0.406	0.244	30.032	0.000	0.371	0.441	324
MSFT	0.176	0.210	15.566	0.000	0.147	0.205	345
MMM	0.233	0.161	30.803	0.000	0.214	0.253	450
PFE	0.127	0.287	9.898	0.000	0.094	0.160	504
MO	0.063	0.145	9.789	0.000	0.047	0.080	501
PG	0.233	0.174	29.630	0.000	0.213	0.254	484
T	0.460	0.297	33.999	0.000	0.425	0.494	483
UTX	0.000	0.138	-0.053	0.958	-0.016	0.016	499
VZ	0.320	0.225	31.581	0.000	0.294	0.346	490

Notes to Table: For each of the firms analyzed, we present the term structure between different maturity betas. This table provides the summary statistics for the Long-Short Term Betas for the period 2008-2010. Included are the Mean of the Differences, the Standard Error, the t-value, the p-value, the Confidence Interval, and the Number of Observations. Betas were terms as short if they were estimated from options with maturities less than 60 days. They were termed as mid if their options had maturities between 60 and 150 days, and they were termed as long if their options had maturities between 150 and 260 days. For each available date, the betas that fell into each time category were averaged together, and the average was used to represent the beta of that time category for that date. The mean difference was then calculated as the mean of the daily differences of these averaged betas over the time period analyzed.

Table 24

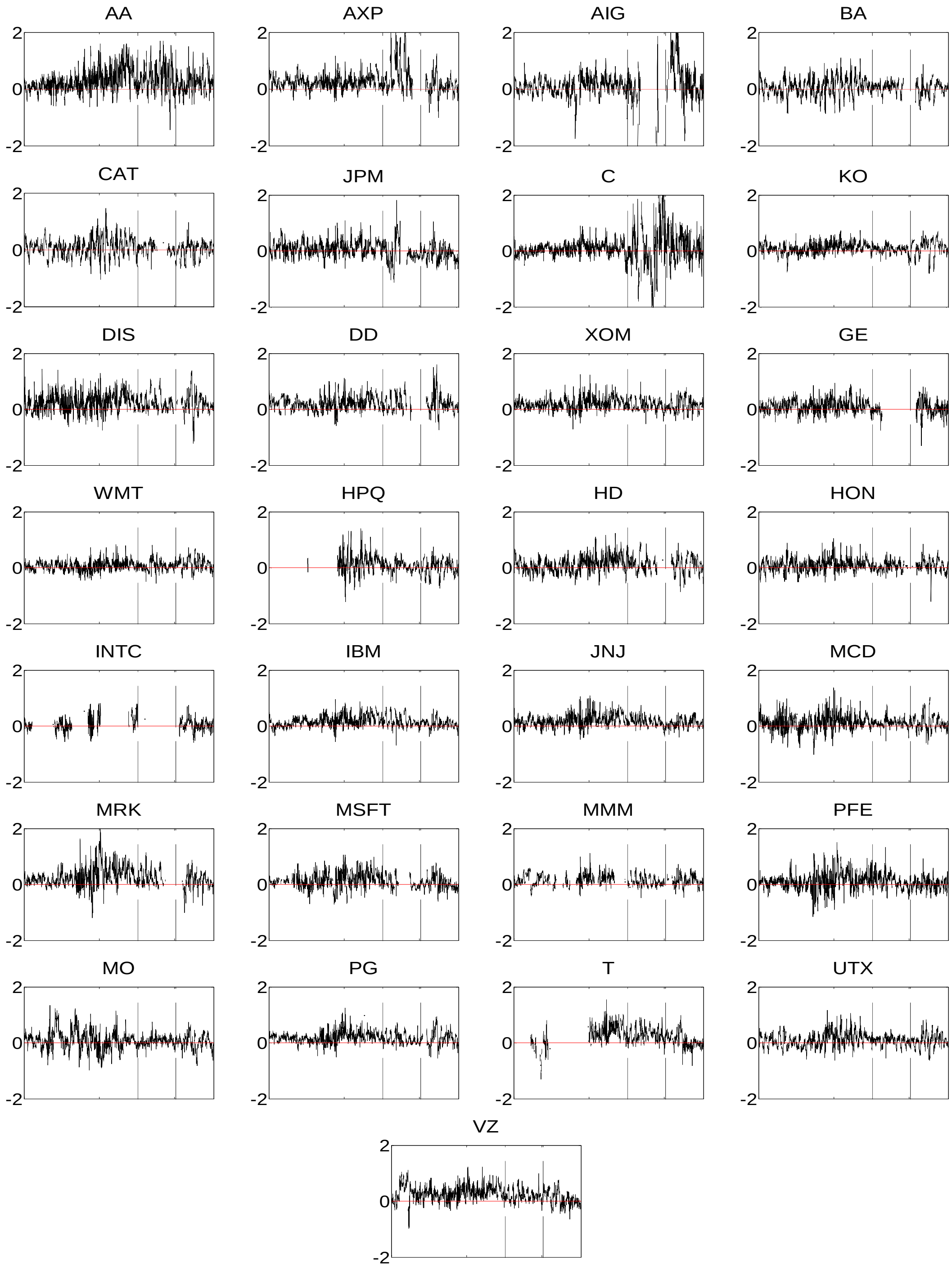
Term Structure of Different Maturity Betas

Long -Short (2010-2012)

Tickers	Mean Difference	SE	t-value	p-value	CI		Number of Observations
AA	0.317	0.384	18.327	0.000	0.272	0.362	490
AXP	0.182	0.480	7.836	0.000	0.122	0.242	428
AIG	-0.039	0.822	-0.962	0.337	-0.146	0.067	401
BA	-0.203	0.289	-14.664	0.000	-0.239	-0.168	434
CAT	-0.180	0.262	-15.292	0.000	-0.210	-0.149	498
JPM	-0.266	0.382	-15.629	0.000	-0.310	-0.222	501
C	0.329	0.567	12.736	0.000	0.262	0.396	482
KO	-0.085	0.307	-6.188	0.000	-0.120	-0.049	501
DIS	0.117	0.397	6.113	0.000	0.067	0.166	430
DD	0.170	0.342	10.184	0.000	0.127	0.213	417
XOM	0.109	0.210	11.584	0.000	0.085	0.134	492
GE	-0.076	0.305	-5.151	0.000	-0.115	-0.038	424
WMT	-0.039	0.252	-3.438	0.001	-0.068	-0.010	495
HPQ	-0.211	0.286	-16.537	0.000	-0.244	-0.178	501
HD	-0.186	0.417	-9.225	0.000	-0.239	-0.134	424
HON	-0.080	0.333	-4.923	0.000	-0.122	-0.038	419
INTC	0.137	0.274	10.598	0.000	0.103	0.170	450
IBM	0.073	0.160	10.107	0.000	0.054	0.091	492
JNJ	0.119	0.207	12.829	0.000	0.095	0.144	492
MCD	-0.047	0.299	-3.499	0.001	-0.082	-0.012	495
MRK	0.045	0.276	3.282	0.001	0.009	0.080	408
MSFT	0.055	0.251	4.888	0.000	0.026	0.084	498
MMM	0.112	0.262	8.710	0.000	0.079	0.145	416
PFE	-0.103	0.267	-8.679	0.000	-0.134	-0.073	501
MO	-0.175	0.332	-11.734	0.000	-0.213	-0.136	495
PG	0.141	0.253	11.745	0.000	0.110	0.173	441
T	0.081	0.253	7.200	0.000	0.052	0.111	498
UTX	-0.162	0.286	-12.690	0.000	-0.195	-0.129	501
VZ	0.104	0.274	8.524	0.000	0.073	0.136	497

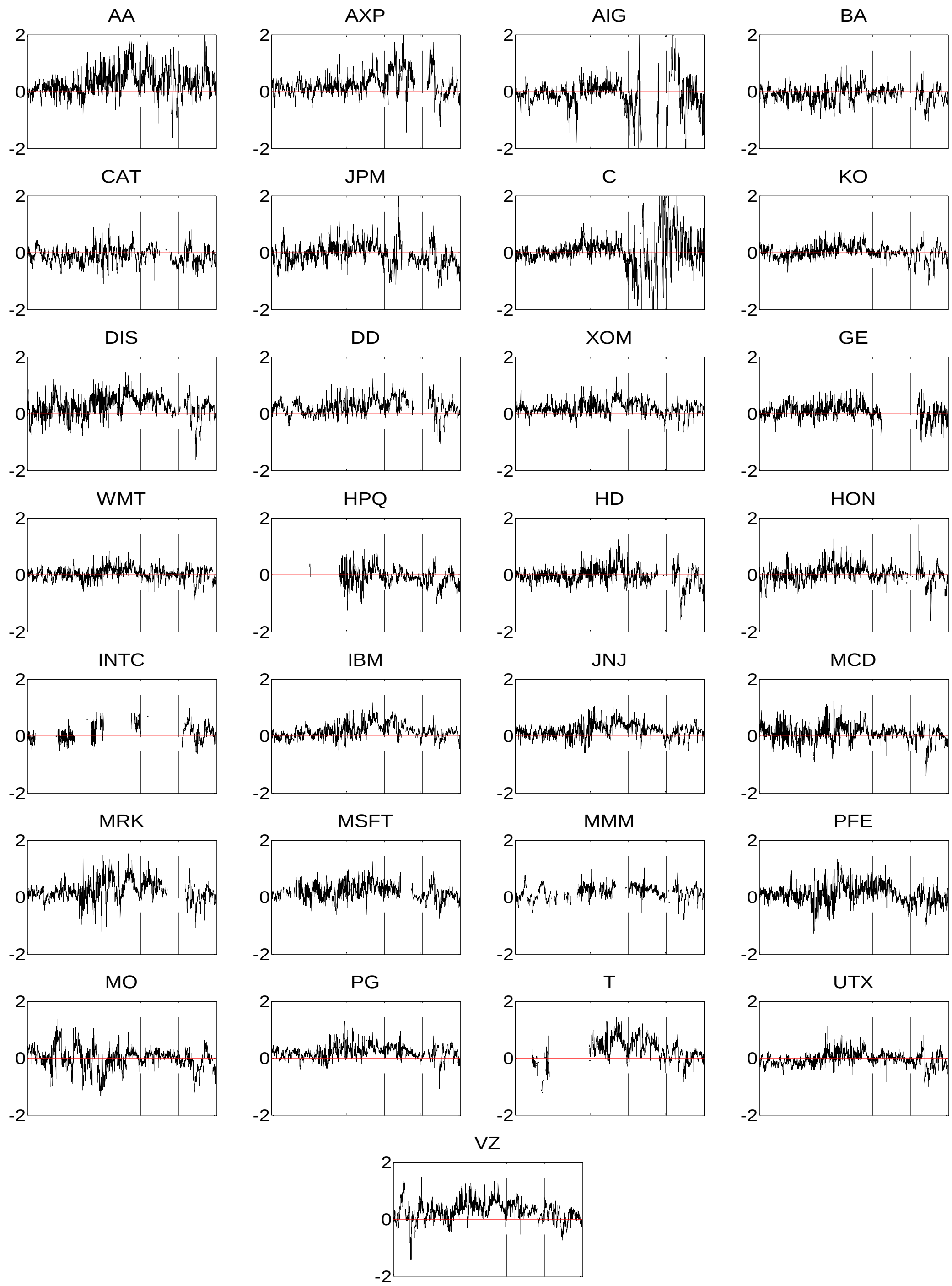
Notes to Table: For each of the firms analyzed, we present the term structure between different maturity betas. This table provides the summary statistics for the Long-Short Term Betas for the period 2010-2012. Included are the Mean of the Differences, the Standard Error, the t-value, the p-value, the Confidence Interval, and the Number of Observations. Betas were terms as short if they were estimated from options with maturities less than 60 days. They were termed as mid if their options had maturities between 60 and 150 days, and they were termed as long if their options had maturities between 150 and 260 days. For each available date, the betas that fell into each time category were averaged together, and the average was used to represent the beta of that time category for that date. The mean difference was then calculated as the mean of the daily differences of these averaged betas over the time period analyzed.

Figure 7. Mid-Short Term Beta Differences



Notes to Figures: We present the Difference between the Mid – Short Term Maturity Betas in the solid black line. The solid red line represents no difference. Betas were terms as short if they were estimated from options with maturities less than 60 days. They were termed as mid if their options had maturities between 60 and 150 days, and they were termed as long if their options had maturities between 150 and 260 days. For each available date, the betas that fell into each time category were averaged together, and the average was used to represent the beta of that time category for that date. The mean difference was then calculated as the mean of the daily differences of these averaged betas. The sample period is January 1st, 2002 to December 31st, 2011.

Figure 8. Long-Short Term Beta Differences



Notes to Figures: We present the Difference between the Long – Short Term Maturity Betas in the solid black line. The solid red line represents no difference. Betas were terms as short if they were estimated from options with maturities less than 60 days. They were termed as mid if their options had maturities between 60 and 150 days, and they were termed as long if their options had maturities between 150 and 260 days. For each available date, the betas that fell into each time category were averaged together, and the average was used to represent the beta of that time category for that date. The mean difference was then calculated as the mean of the daily differences of these averaged betas. The sample period is January 1st, 2002 to December 31st, 2011.