The Information Content of Implied Beta

Stephen P. Huffman and Cliff R. Moll

Abstract

Motivated by the conflict between capital market theory and empirical results related to the pricing of systematic and nonsystematic risk, we develop, estimate (using option pricing data), and test a measure of *ex-ante* systematic risk. In our cross-sectional analysis, we find that our measure of implied beta is significant in explaining the future returns for a sample of 2,864 optionable firms examined during the 1999-2010 sample period. Although we fail to find a significant relationship between a traditional measure of systematic risk, beta, and future stock returns, we do provide evidence of a significant positive relationship between future stock returns and our implied beta measure. However, our robustness tests indicate that the implied beta measure is significant only for smaller firms and for firms with higher ratios of book-to-market equity.

I. Introduction

We investigate the relationship between an *ex-ante* measure of systematic risk, implied beta, and future returns using cross-sectional analysis of 2,864 optionable firms over the 1999-2010 sample period. Similar to numerous other researchers, we fail to find a significant relationship between a traditional measure of systematic risk, beta, and future stock returns; however, we do find a significant positive relationship between our measure of implied beta and future stock returns, which is consistent with the findings of Buss and Vilkov (2012). Our sample and methodology is different from that of Buss and Vilkov (2012), as they estimate an implied beta using options with one-year until expiration, while we estimate an implied beta using standardized 30-day options data from OptionMetrics. Further, we investigate the impact of firm size and each firm's ratio book-to-market equity on our findings.

Although traditional capital market theory (e.g., Sharpe, 1964) predicts a positive risk-return relationship, empirical evidence of this relationship is mixed for various measures of risk (i.e., beta, implied volatility and idiosyncratic volatility). Complicating matters even more, empirical findings indicate the existence of a size premium and a value premium, which is estimated in the three-factor Fama-French model by Fama and French (1993).

When we partition our sample by firm size and by the ratio of book value of equity to market value of equity (book-to-market equity), we find that only the smallest firms display a significant relationship between our measure of implied beta and future stock returns, and only

Stephen P. Huffman is Professor of Finance, College of Business, University of Wisconsin Oshkosh; huffman@uwosh.edu
Cliff R. Moll is an Associate Professor of Finance, College of Business, University of Wisconsin Oshkosh; mollc@uwosh.edu

the firms with higher ratios of book-to-market equity have a significant relationship between future stock returns and our measure of implied beta.

Our findings have implications with respect to the findings in prior studies. For example, Fama and French (1992) report that the traditional measure of systematic risk, beta, is not significant in explaining future returns. Although Pettengill, Sundaram, and Mathur (1995) argue that the traditional capital asset pricing model is based on expected returns rather than realized returns, Pettengill et al. (1995) use a conditional approach, based on up markets and down markets; they find a "consistent and highly significant relationship between beta and cross sectional portfolio returns" (p. 101). That is, Pettengill et al. (1995) find a positive relationship between beta and realized returns in periods when excess returns were positive, and a negative relationship between beta and realized returns in periods when excess returns were negative. Pettengill et al. (1995) conjecture that their conditional results may explain the findings of: (1) a weak relationship between beta and returns (e.g., Fama and French, 1992; Lakonishok and Shapiro, 1986) and (2) time varying betas (e.g., Reinganum, 1981; Tinic and West, 1984).

The findings of more recent studies are also problematic for the traditional capital asset pricing model. Specifically, numerous studies have found a strong relationship between idiosyncratic volatility measures and future returns. For example, the finding of an indirect relationship between idiosyncratic volatility and future returns reported by Ang, Hodrick, Xing, and Zhang (2006) has prompted researchers to conduct additional investigations of the risk-return relationship. Banerjee, Doran, and Peterson (2007), Diavatopoulos, Doran, and Peterson (2008), Amann, Süss, and Verhofen (2009), Bali, Cakici, Yan, and Zhang (2005), Malkiel and Xu (2006), Dennis, Mayhew, and Stivers (2006),) and Fu (2009) are examples of recent research that examines various relationships between risk measures and stock returns.

Motivated by the findings of these studies, we investigate the information contained in the implied systematic volatility of 2,864 optionable firms during the January 1999-October 2010 sample period. Although this paper uses a methodology that is similar to Banerjee, Doran, and Peterson (2007), we focus on estimating each firm's implied beta (rather than implied total market volatility). Our paper is unique because we examine the implied beta for individual firms, rather than just the implied volatility for the market. Because traditional capital market theory asserts that only systematic risk matters, we estimate the implied betas of individual firms in our sample and determine their information content, with respect to future firm returns.

Our study bridges several strands of literature and is motivated by the theory presented in these studies, their findings, and insights from their methodologies. The first strand of literature examines the relationship between risk and return. The capital asset pricing model, developed by Sharpe (1964) and Lintner (1965), predicts a positive relationship between systematic risk and stock returns. As the theory evolved, financial economists decomposed the total risk of an asset into two distinct components: (1) systematic risk, and (2) idiosyncratic (nonsystematic) risk. Theoretically, investors are compensated only for bearing systematic risk because idiosyncratic

risk is eliminated via portfolio diversification. However, Ang, Hodrick, Xing, and Zhang (2006) refute findings of traditional asset pricing literature, documenting a negative relationship between idiosyncratic volatility and future stock returns.

A second strand of literature explores the relative information content of both historical and implied measures of idiosyncratic volatility as predictors of future stock returns. Using implied market volatility and each firm's beta, Diavatopoulos, Doran, and Peterson (2008) calculate a monthly measure of each firm's implied idiosyncratic volatility. Conceptually, this measure of implied idiosyncratic volatility provides an estimate of investors' expectations of idiosyncratic volatility for the firm over the coming month. The authors document a positive relationship between implied idiosyncratic volatility and future stock returns. They conclude that implied idiosyncratic volatility, calculated using option prices, provides for both a better measure of the market's anticipated idiosyncratic volatility and a better way to examine the risk-return relationship than historical idiosyncratic volatility. We expand upon this methodology when developing and estimating our measure of implied beta.

Other studies have investigated the possible reasons for the mixed results for the relationship between idiosyncratic volatility and returns. Ang, Hodrick, Xing, and Zhang (2006) report a negative relationship, while Fu (2009) reports a positive relationship. Fu (2009) claims that the negative relationship found by Ang, Hodrick, Xing, and Zhang (2006) is due to their use of a lagged measure of idiosyncratic volatility. Fu (2009) uses a predicted idiosyncratic volatility measure and finds a positive relationship. In both studies, the estimate of volatility is based upon prior returns. However, we use a forecasted measure of idiosyncratic volatility, estimated by using option pricing data. Like Diavatopoulos, Doran, and Peterson (2008) and Dennis, Mayhew, and Stivers (2006), our conditional measure of volatility is based on option traders' expectations of risk over the coming month. Because implied volatility is a forward-looking (i.e., an *ex-ante*) measure based on investor expectations, we expect it to be positively related to future stock returns.

The use of options to estimate implied volatility is an alternative to relying on historical returns. French, Groth, and Kolari (1983) develop a hybrid beta by assuming that the historical correlation is constant, and use the implied variances of options on individual stocks and an index to estimate beta. Other papers, such as Chang, Christoffersen, Jacobs, and Vainberg (2011), investigate the ability of implied measures of betas using model-free beta estimates to predict realized betas. Meanwhile, Buss and Vilkov (2012) compute implied beta using OptionMetrics Black-Scholes implied volatility estimates for options with one year maturities, and then compare their implied beta estimates to historical betas, French et al. (1983) betas, and the model-free implied betas, and find that their implied beta estimates perform better. Buss and Vilkov (2012) conclude that the Chang et al. (2011) betas "deliver a risk-return picture that is too flat, resulting in an expected market excess return close to zero" (page 3126). Our paper investigates the information content of our implied beta and is more similar to the Buss and Vilkov (2012) investigation of implied beta; however, we use options that are less likely to be

subject to liquidity concerns, and we investigate the impact of firm size and ratio of book value of equity to market value of equity on our results. Buss and Vilkov (2012) estimate an implied beta for one year, compared to our 30-day estimates.

Our sample contains 2,864 firms over the January 1999-October 2010 sample period, which includes a greater number of firms over a longer sample period than most previous studies. We use this sample to investigate the information content of implied beta using cross-sectional analysis. The main contributions of our paper are: (1) the development of a measure of implied beta (an *ex ante* measure of systematic risk), (2) the comparison of the results of predicting future returns using a traditional measure of beta (an *ex post* measure of systematic risk) and an implied measure of beta, and (3) robustness tests of findings when the sample is partitioned by firm size and by book-to-market equity ratios.

First, we describe the construction of our data set and the development of our measure of implied beta. Next, we explain and present the results from our cross-sectional analysis. Finally, we summarize our findings and conclusions.

II. Data

We employ daily implied volatility data from January 1999 through October 2010, collected from OptionMetrics and implied market volatility (VIX) data for option contracts on the Standard and Poor's 500 (S&P 500) index from the CBOE website (www.cboe.com). Firm price, return, and number of shares outstanding data are from CRSP. Book value of equity data is from Compustat. All common stocks (with share codes 10 and 11) are included in our sample.

Our options sample requires each firm's underlying stock to have at least four years of prior return data available from CRSP. Prior stock return data is needed to estimate the beta and implied volatility variables for each sample firm. We calculate the historical beta by regressing monthly firm returns on market returns, using 48 to 60 months of prior return data, as available:

$$r_{i,t} = \alpha_i + \beta_i r_{m,t} + \varepsilon_{i,t} \quad (1)$$

where $r_{i,t}$ is the return for firm i on day t, and $r_{m,t}$ is the return on the CRSP value-weighted index on day t. Each month, the sample is updated and equation (1) is re-estimated, giving a rolling estimate of beta (e.g., historical beta) for each firm.

Using options data for each firm, OptionMetrics calculates implied volatilities, expressed as standard deviations, by using American or European models where appropriate. Two implied volatilities are reported, one based on calls and one based on puts. Because there is a variety of strike prices and maturities for each firm on any given day, a standardized implied volatility is calculated by using the greatest weight on implied volatilities of at-the-money options closest to 30 days to maturity. Averaging across all options reduces the measurement error associated with inverting option prices to obtain implied volatilities (see Hentschel (2003) for details). An

average standardized implied volatility is calculated for each firm by averaging the call and put standardized implied volatility values each day. On the last trading day of each month, we obtain the 30-day standardized forward implied volatility as the measure of implied volatility over the next month. For example, we use the September 30th standardized 30-day implied volatility as a measure of the implied volatility for the month of October. The VIX measure is calculated in a similar manner.

An alternative methodology to using the estimated implied volatility measure from OptionMetrics is to use model-free measure, as investigated by Bakshi, Kapadia, and Madan (2003). Bakshi et al. (2003) conclude that individual stocks are less skewed than the market, which may indicate that only the systematic skew is priced. Because we are estimating the implied betas using one-month options of individual firms to examine the information content, the impact of skewness on our estimates should be minimal. Further, Buss and Vilkov (2012) estimate an implied beta using a one-year option. However, their measure may be subject to liquidity concerns.

III. Methodology

We use cross-sectional analysis to examine the information content of risk measures for future returns over our sample period for 2,864 firms. Similar to that calculated by Dennis, Mayhew, and Stivers (2006) and Diavatopoulos, Doran, and Peterson (2008), implied idiosyncratic volatility is calculated as:

$$\sigma^2_{IV,i,t} = \beta^2_{i,t}\sigma^2_{VIX,t} + \sigma^2_{IIV,i,t} \quad (2)$$

where $\sigma^2_{IV,i,t}$ is the implied variance for firm *i*, observed at the end of month *t*, $\beta_{i,t}$ is the beta for firm *i*, observed at the end of month *t*, $\sigma^2_{VIX,t}$ is the implied market variance from VIX, observed at the end of month *t*, and $\sigma^2_{IIV,i,t}$ is the implied idiosyncratic variance for firm *i*, observed at the end of month *t*. The implied variance values (both firm-specific and market) are observed at the end of each month and provide the market's forecast of the implied variance expected in the coming month.

Using equation (2), we solve for the idiosyncratic portion of the implied variance, $\sigma^2_{IIV,i,t}$, as: $\sigma^2_{IV,i,t} - \beta^2_{i,t}\sigma^2_{VIX,t}$. The measure of implied idiosyncratic volatility is calculated as the square root of the idiosyncratic portion of the implied variance. Theoretically, this value is bounded below by zero; however, negative values are empirically possible. Consistent with Diavatopoulos, Doran, and Peterson (2008), we set all negative implied idiosyncratic volatility values equal to zero.

We solve for the systematic portion of the implied variance. That is, we calculate beta as follows: $\beta^2_{i,t}\sigma^2_{VIX,t} = \sigma^2_{IV,i,t} - \sigma^2_{IV,i,t}$, which simplifies to: $\beta^2_{i,t} = \frac{\sigma^2_{IV,i,t} - \sigma^2_{IIV,i,t}}{\sigma^2_{VIX,t}}$ and to

$\beta_{i,t} = \sqrt{\frac{\sigma^2_{V,i,t} - \sigma^2_{IIV,i,t}}{\sigma^2_{VIX,t}}}$. The value $\beta_{i,t}$ is the same as the estimated historical beta using OLS regression and stock returns.

If the implied idiosyncratic is assumed to be constant from the previous month, then the implied variance from the option and the variance of the VIX can be used to estimate an implied beta, such that an implied beta, $I\beta_{i,t}$, is calculated as:

$$I\beta_{i,t} = \sqrt{\frac{\sigma^2_{V,i,t} - \sigma^2_{IIV,i,t-1}}{\sigma^2_{VIX,t}}} \quad (3)$$

where $\sigma^2_{IIV,i,t-1}$ is the estimated implied idiosyncratic variance from $t - 1$. When the implied variance is less than the implied idiosyncratic variance from the prior day, the numerator in equation (3) is set to zero. As a robustness check, we delete all negative implied idiosyncratic volatility observations and re-estimate all of our primary models, and find that our results are qualitatively similar to those obtained when negative implied idiosyncratic volatility values are set equal to zero.

As we present in Table 1, the 2,864 sample firms' mean (median) for a traditional measure of historical beta; i.e., equation (1), is 1.20 (1.06). In Panel A of Table 1, we report the mean, median, 25th percentile, 75th percentile and standard deviation of firm characteristics within the 143-month period from January 1999 through October 2010. We calculate descriptive statistics by first finding the average of each variable for each of the 2,864 firms across time and then averaging across all sample firms. All available monthly data for each firm is used. The variables used in the analysis include: σ_{IIV} is the implied idiosyncratic volatility as defined in equation (2), β is a historical beta, which is measure of systematic risk, as defined in equation (1) using regression analysis, $I\beta$ is a measure of implied beta as defined in equation (3), *SIZE* is defined as the natural log of market value of equity, where market value of equity is defined as share price multiplied by the number of shares outstanding, and *BM* is defined as the natural log of the ratio of book-to-market equity. Because optionable firms usually have more volatility, higher values of systematic risk are expected. The implied beta, i.e., equation (3), mean (median) of 1.14 (1.04) is similar to the historical beta estimates using regression analysis. Descriptive statistics for firm size, SIZE, the natural log of the ratio of book value of equity to market value of equity, BM, and implied idiosyncratic risk, σ^2_{IIV}, also are presented in Table 1.

Table 1: Descriptive Statistics for the January 1999 through October 2010 Sample

Panel A: Full Sample Descriptive Statistics by Firm

Variable	Mean	Std Dev	25th Pctl	Median	75th Pctl
Implied IIV	0.1506	0.3069	0.0318	0.0778	0.1663
Historical Beta	1.1967	0.7875	0.6459	1.0553	1.5865
Implied Beta	1.1401	0.9692	0.4477	1.0465	1.6343
SIZE	21.0376	1.5516	19.9420	20.9491	22.0038
BM	–0.7773	1.0005	–1.2955	–0.7971	–0.3230

Variable		Smallest Tercile	Middle Tercile	Largest Tercile	Largest Minus Smallest
Implied Beta at month t		0.2259	1.0035	2.1387	1.9128***
					(64.79)
Return in month t + 1		0.0065	0.0088	0.0143	0.0078*
					(1.75)
Panel C: Historical Beta Terciles Means					
Historical Beta		0.4625	1.026	2.026	1.5635***
					(62.13)
Return in month t + 1		0.0075	0.0102	0.012	0.0045
					(0.78)

The *t* -statistics are reported in parentheses.

*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively

IV. Results

We examine the relationship between returns and measures of systematic volatility. First, each month, we partition firms into terciles based on their time t (1) historical beta and (2) implied beta. The firms in the top third (largest historical beta) are placed in the largest historical beta tercile. The firms in the bottom third (smallest historical beta) are placed in the smallest historical beta tercile. The remaining firms are placed in the middle historical beta tercile. The same partitioning procedure is done using implied beta whereby firms are placed into the largest, middle and smallest implied beta terciles. Next, mean one-month-ahead returns (betas) are calculated for each historical beta and implied beta tercile. Finally, we subtract the mean return (beta) for the smallest implied beta tercile from the mean return (beta) for the largest implied beta tercile and determine statistical differences using *t*-tests.

Results of the implied beta and historical beta tercile sorts are presented in Table 1 Panels B and C, respectively. As presented in Panel B of Table 1, the mean returns increase as implied beta increases. Specifically, the mean monthly returns increase from 0.65% for the smallest implied beta tercile, to 0.88% for the middle implied beta tercile, to 1.43% for the largest implied beta tercile. The last column of Panel B gives the results of a *t*-test, whereby we test whether the difference in means between the smallest and largest implied beta terciles is statistically

significant. As expected, the implied betas increase from the smallest to the largest implied beta terciles. As documented in the last column of Panel B, the returns for the largest implied beta tercile are significantly larger than the returns for the smallest implied beta tercile.

As presented in Panel C of Table 1, the mean returns increase as historical beta increases. Specifically, the mean monthly returns increase from 0.75% for the smallest historical beta tercile, to 1.02% for the middle historical beta tercile, to 1.20% for the largest historical beta tercile. The last column of Panel C gives the results of a *t*-test for differences in means between the smallest and largest implied beta terciles. As expected, the historical betas increase from the smallest to the largest implied beta terciles. However, as shown in the last column of Panel C, the returns for the largest historical beta tercile are not significantly larger than the returns for the smallest historical beta tercile.

Taken together, the results presented in Panels B and C of Table 1 indicate that a positive relationship exists between implied beta and future returns. However, the same cannot be said for historical beta. Thus, our preliminary findings suggest that although historical beta may be "dead," our measure of beta (implied beta) is not. We use these preliminary findings to motive our subsequent cross-sectional analysis.

We examine the cross-sectional relationship between returns and measures of systematic volatility. Each month, we estimate the following model:

$$R_{i,t+1} = \alpha + \delta_1 Systematic\ Volatility_{i,t} + \delta_2 SIZE_{i,t} + \delta_3 BM_{i,t} + \varepsilon_{i,t} \quad (4)$$

where $SIZE_i$ is the natural log of market value of equity for firm *i*, and BM_i is the natural log of the ratio of the book value of equity to the market value of equity; and the measure of systematic volatility is defined as firm *i*'s beta, β_i, or implied beta, $I\beta_i$, as defined in equation (1) and equation (3), respectively. All of the measures of systematic risk, SIZE, and BM are estimated at the end of month *t* (i.e., one month prior to the returns).

Using the cross-sectional results from equation (4), we employ a Fama and MacBeth (1973) methodology, where *t*-statistics are formed from the time-series distribution of the cross-sectional coefficients. If any of the measures of systematic volatility are a relevant risk factor, then the coefficient for systematic volatility, δ_1, will be statistically significant. Because of the numerous studies that find that beta is a poor predictor of future returns, we expect the traditional measure of historical beta to be insignificant. However, because implied beta is a measure of expected volatility, a significant coefficient indicates that our alternative estimation of implied (expected) systematic risk is related to future returns.

We examine the cross-sectional relationship between systematic risk measures and future firm returns as modeled in equation (4). Coefficients are estimated using the Fama and MacBeth (1973) methodology of averaging the cross-sectional coefficient estimates of the model. The models are estimated for 2,864 firms for 143 months, beginning in January 1999. Our cross-sectional results are reported in Table 2. In model 1, we are unable to find a significant

relationship between the traditional market model (historical) beta and future stock returns, which is consistent with most previous studies (e.g., Fama and French, 1992).

Table 2: Cross-Sectional Relationship between Risk Measures and Future Monthly Stock Returns

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	0.0050	0.0037	0.0471***	0.0392*
	(1.21)	(0.89)	(2.48)	(1.86)
Historical Beta	0.0041		0.0026	
	(0.93)		(0.69)	
Implied Beta		0.0051*		0.0040*
		(1.83)		(1.70)
SIZE			–0.0019***	–0.0016**
			(–2.26)	(–1.75)
BM			0.0004	0.0009
			(0.26)	(0.54)
Mean Adj. R^2	0.0469	0.0287	0.0669	0.0511

The *t* -statistics are reported in parentheses.
*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively

In model 3, the coefficient for the traditional historical beta measure remains insignificant when the control variables for firm size and the book-to-market equity ratios are included in the model. Consistent with prior studies, the negative coefficient for the SIZE variable indicates the existence of a size effect.

Our most interesting results from Table 2 are for model 2 and model 4. Specifically, we find a positive significant relationship between our measure of implied beta and future stock returns. Our results for model 4 indicate the coefficient for implied beta remains significant, when control variables for firm size and the ratio of book-to-market equity are included in the model. Further, the coefficient for SIZE is negative and significant. That is, our measure of implied beta and firm size both appear to predict future stock returns. Our main findings for the historical beta and the implied beta are consistent with the findings reported by Buss and Vilkov (2012). However, we also control for size and book-to-market equity ratios in our robustness tests.

In Table 3 and Table 4, we report the results of robustness tests, where we partition the sample into terciles based on: (1) firm size, and (2) the ratio of book-to-market equity. When we partition the sample into size (i.e., market value) terciles, we find that our main results do not change for the smallest firm size tercile of optionable firms. That is, as reported in Table 3, the coefficients for implied beta, $I\beta_t$, for the smallest firms in the sample remain positive and significant. However, the implied beta coefficients for the firms in the middle and largest market value terciles are not statistically significant. These findings may be useful in explaining the size premium and/or the negative relationship between firm size and future returns.

Table 3: Cross-Sectional Relationship between Implied Beta and Future Monthly Stock Returns: by SIZE Terciles

Panel A: Single Variable Model with Implied Beta as independent variable

Variable	Smallest Tercile of Market Value	Middle Tercile of Market Value	Largest Tercile of Market Value
Intercept	0.0065	0.0053	0.0019
	(1.16)	(1.36)	(0.49)
Implied Beta	0.0055**	0.0036	0.0033
	(2.03)	(1.37)	(1.07)

Panel B Multivariate Model with Implied Beta, *SIZE* and *BM* as independent variables

Variable	Smallest Tercile of Market Value	Middle Tercile of Market Value	Largest Tercile of Market Value
Intercept	–0.0007	–0.0117	0.0419**
	(–0.02)	(–0.32)	(2.50)
Implied Beta	0.0050**	0.0035	0.0032
	(2.16)	(1.39)	(1.12)
SIZE	0.0004	0.0008	–0.0017***
	(0.18)	(0.50)	(–2.66)
BM	0.0011	0.0010	0.0007
	(0.49)	(0.67)	(0.49)
Mean Adj. R^2	0.0332	0.0487	0.069

The *t* -statistics are reported in parentheses.

*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively

As we report in Table 4 (using the same methodology as in Table 3), when we partition the sample into terciles using the ratio of book-to-market equity, we find that our main results do not change for the firms in the highest book-to-market equity ratio tercile. However, the coefficients for implied beta for the samples in the other two terciles are not significant. That is, firms in the sample with the highest book-to-market equity ratios (e.g. value firms) have positive and significant coefficients for implied beta in both the single variable model and the model with control variables; however, the level of significance increases to 1%. This relationship may be useful in explaining the value premium.

Table 4: Cross-Sectional Relationship between Implied Beta and Future Monthly Stock Returns: by BM Terciles

Panel A: Single Variable Model with Implied Beta as independent variable

Variable	Lowest *BM* Tercile	Middle *BM* Tercile	Highest BM Tercile
Intercept	0.0021	0.0048	0.0062
	(0.56)	(1.18)	(1.09)
Implied Beta	0.0038	0.0045	0.0049*
	(1.22)	(1.65)	(1.90)
Mean Adj. R^2	0.0324	0.029	0.0257

Panel B Multivariate Model with Implied Beta, *SIZE* and *BM* as independent variables

Variable	Lowest *BM* Tercile	Middle *BM* Tercile	Highest BM Tercile
Intercept	0.0380*	0.0345	0.0456*
	(1.86)	(1.65)	(1.69)
Implied Beta	0.0031	0.0042	0.0041*
	(1.06)	(1.62)	(1.76)
SIZE	–0.0015*	–0.0012	–0.0019*
	(–1.66)	(–1.28)	(–1.66)
BM	0.0004	0.0031	–0.0013
	(0.23)	(0.87)	(–0.84)
Mean Adj. R^2	0.0500	0.0434	0.0443

The *t* -statistics are reported in parentheses.

*, **, and *** indicate significance at the 0.10, 0.05, and 0.01 levels, respectively

Taken together, the results presented in Tables 3 and 4 suggest that there is a statistically significant relationship between our implied beta measure and future returns. However, the relationship does not seem to be consistent across firm size and firm book-to-market. Specifically, it seems to be primarily prevalent for small firms and for value firms.

V. Conclusion

We employ cross-sectional analysis to examine the relationship between our measure of implied beta and future stock returns for optionable firms. Prior research has focused on examining the relationship between returns and various measures of risk (e.g., beta, implied total volatility, idiosyncratic volatility, implied idiosyncratic volatility, etc.). Given the mixed results

of previous research, we examine the relationship between implied beta and future stock returns in order to better understand the information contained in beta and implied risk measures.

Most prior studies use *ex post* data to estimate the betas of individual firms; however, if the relationship between the returns of the market and the stock returns of individual firms changes between the estimation period and the test period, then finding a significant relationship would be difficult. Our implied beta measure reduces the dependence on historical stock return data to estimate a measure of *ex-ante* systematic risk (beta). Our findings suggest that although historical beta may be "dead," our analysis of implied beta indicates the existence of a positive relationship between implied beta and future returns. Overall, our results provide evidence of a significant measure of systematic risk (a result that has eluded many prior researchers). Specifically, using a sample of optionable firms, we find a positive and statistically significant relationship between our measure of implied beta and future stock returns.

Our paper's main contribution to the literature is that we develop and test a measure of *ex-ante* systematic risk, and we are able to find empirical evidence that our measure of implied beta contains information that is useful in predicting future stock returns. However, our robustness tests indicate that the implied beta measure is significant only for smaller firms and for firms with higher book-to-market equity ratios. One potential avenue for future research would be a closer examination of these firms, aimed at explaining what makes the risk-return relationship hold for these firms and not for others.

References

Amann, M., Süss, S., and Verhofen, M. (2009). Do implied volatilities predict stock returns? *Journal of Asset Management,* 10, 222-234.

Ang, A., Hodrick, R.J., Xing, Y., and Zhang, X. (2006). The cross-section of volatility and expected returns. *The Journal of Finance,* 61, 259-299.

Bakshi, G., Kapadia, N., and Madan, D. (2003). Stock return characteristics, skew laws, and the differential pricing of individual equity options. *Review of Financial Studies,* 16, 101-143.

Bali, T., Cakici, N., Yan, X., and Zhang, Z. (2005). Does idiosyncratic risk really matter? *Journal of Finance,* 60, 905–929.

Banerjee, P., Doran, S., and Peterson, D. (2007). Implied volatility and future portfolio returns. *Journal of Banking and Finance,* 31, 3183-3199.

Bekaert, G., Hodrick, R., and Zhang, X. (2012). Aggregate idiosyncratic volatility. *Journal of Financial and Quantitative Analysis,* 47, 1155-1185.

Buss, A., and Vilkov, G. (2012). Measuring equity risk with option-implied correlations. *Review of Financial Studies,* 25, 3113-3140.

Chang, B., Christoffersen, P., Jacobs, K., and Vainberg, G. (2011). Option-implied measures of equity risk. *Review of Finance,* 16, 385-428.

Dennis, P., Mayhew, S., and Stivers, C. (2006). Stock returns, implied volatility innovations, and the asymmetric volatility phenomenon. *Journal of Financial and Quantitative Analysis,* 41, 381-406.

Diavatopoulos, D., Doran, J., and Peterson, D. (2008). The information content in implied idiosyncratic volatility and the cross-section of stock returns: Evidence from the options market. *Journal of Futures Markets,* 28, 1013-1039.

Fama, E., and French, K. (1992). The cross-sectional of expected stock returns. *Journal of Financial*, 47, 427-465.

Fama, E., and French, K. (1993). Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics,* 33, 3-56.

Fama, E., and MacBeth, J. (1973). Risk, return, and equilibrium: Empirical tests. *The Journal of Political Economy,* 607-636.

French, D. W., Groth, J. C., and Kolari, J. W. (1983). Current investor expectations and better betas. *The Journal of Portfolio Management*, 10, 12–17.

Fu, F. (2009). Idiosyncratic risk and the cross-section of expected stock returns. *Journal of Financial Economics,* 91, 24-37.

Hentschel, L. (2003). Errors in implied volatility estimation. *Journal of Financial and Quantitative Analysis,* 38, 779-810.

Lakonishok, J., and Shapiro, A. (1986). Systematic risk, total risk and size as determinates of stock market returns. *Journal of Banking and Finance*, 10, 115-132.

Lintner, J. (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics,* 47, 18-87.

Malkiel, B., and Xu, Y. (2006). Idiosyncratic risk and security returns. Working Paper, Princeton University.

Moll, C., and Huffman, S. (2016). The incremental information content of innovations in implied idiosyncratic volatility. *Review of Financial Economics*, 30, 33-44.

Pettengill, G., Sundaram, S., and Mathur, I. (1995). The conditional relation between beta and returns. *Journal of Financial and Quantitative Analysis*, 30, 101-116.

Reinganum, M. (1981). A New Empirical Perspective on the CAPM. *Journal of Financial and Quantitative Analysis*, 16, 439-462.
Sharpe, W. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance,* 19, 425-442.
Tinic, S., and West, R. (1984). Risk and return: January vs. the rest of the year. *Journal of Financial Economics*, 13, 561-574.