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PROFESSOR : **Paul Damien**

STUDENT : **Ting-Chun Chen**
Brett Cicinelli
Eddie Magnus
Jill Majerus
Ashely Marks

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Evaluating Firms- A Bayesian Approach

by

Ting-Chun Chen

(Joint with Brett Cicinelli, Eddie Magnus, Jill Majerus, Ashley Marks)

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Evaluating Firms- A Bayesian Approach

Ting-Chun Chen, Brett Cicinelli, Eddie Magnus, Jill Majerus, Ashley Marks

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Supervisor: Professor Paul Damien

University of Michigan Business School

Ann Arbor, MI. 48109 USA

Abstract

We hope to provide theoretical arguments why Beta, as it is currently used for investing purposes, is inaccurate. We will also explain a new way to apply Bayes Theorem to help better predict the risk of a stock for a year by projecting the returns of a specific stock and the S&P Index. In doing so, we will focus on economic and financial measures that we feel are important in assessing the value of a stock, and via Bayes Theorem, help quantify the different sources of uncertainty; conditioned on such analysis, a new - *Company Specific* - beta can then be ascertained.

Introduction

Beta

Beta's existence as a valid financial metric has been under ongoing debate. The usual response is, "it's not very good, but it's the best we have." To understand beta, consider the following equation:

$$\mathbf{Beta=Cov(r_i,r_m)Var(r_m),} \qquad \mathbf{(1)}$$

where $\mathbf{r_i}$ represents the return on a specific stock or portfolio, $\mathbf{r_m}$ is the return on the market, Var and Cov, respectively, are the variance and covariance functions.

One of the major problems with beta is that the formula is subject to different, often conflicting, interpretations. Example: How long do we match the return on a stock to that of a market? Most users of beta believe, the more data points, the better. For instance, "Valueline," from which we obtained all of our data, measures its beta using five years of weekly data. Numerous data points are used to delete all of the stochastic variables from the equation. This is effectively done with over 250 data points. But should the stochastic variables be deleted? No, these unsystematic risks determine a return for a specific investor, i.e., retorts a different school of thought; beta should try to capture these risks.

In the financial world, typically, beta is considered via the CAPM equation given by:

$$\mathbf{R_i=R_f+Beta(R_m-R_f),} \qquad (2)$$

where $\mathbf{R_f}$ is the risk-free rate, $\mathbf{R_m}$ is the return on the market and $\mathbf{R_i}$ is the predicted return of a stock based on its historical volatility. In other words, an investor who buys this stock deserves the return, R_i, in order to compensate for the amount of risk (measured by beta) for the stock.

Marginal Beta

The beta constructed by "Valueline," the weighted beta, uses weekly data points. However, very rarely will an investor hold a stock for one week; especially with the existence of a higher capital gains tax on stocks held for less than six months, investors generally avoid holding stocks for short-term periods. Therefore, we believe that a beta based on yearly data points would better capture the investor's mentality.

In trying to predict the stochastic variables, we have chosen to determine beta for a specific year, using its returns versus the market return for that year. We define this as a *marginal beta*—the difference between an investor's return and what a five-year beta had predicted.

As we discussed previously, the problem with the weighted beta is that it eliminates the random variables by using so many data points, five years of unnecessary data. The major question then becomes, what does one use as data to measure the marginal beta? The possibilities are numerous; but in order for a marginal beta to be an effective metric, it will have to accurately reflect the investor's mentality and measure a period in which the market can adjust to the risk of a company.

Assumptions/Guidelines

Accurately Reflect Investor's Mentality - In determining marginal beta, we have made one major assumption that the investor will not hold the stock for five years and evaluate it bi-weekly. (This is what the current weighted beta implies.) This is not a rule, rather we view it as an exception; also note that such exceptions are not necessarily useful when planning the return for an upcoming year. As a broker trying to sell a "hot" stock to an investor, we believe he/she should not use data five years back, while, at the same time, looking five years ahead using the weighted beta. The complexion of the company is going to change dramatically within those combined 10 years. Therefore, we assume that the investor is going to hold onto the stock for one year, with the knowledge that the marginal beta can be updated at the start of a new year using the same protocol.

Selecting Data Points - Investors are more concerned with quarterly and/or yearly results, so it is this that we are trying to predict. Companies report earnings once every quarter. By using quarterly results, we can see how the stock follows the S&P as the company announces its earnings. However, if we use quarterly results, our results will be skewed. For example, if one looks at Disney in 1989, it had a return of 42%, and during that time the S&P had a return of 25%. Using quarterly data points, the beta for the year 1989 is -1.09. This can be explained by the fact that the quarterly returns of Disney do not follow that of the S&P despite the fact that they both have positive returns over the year. Therefore, to truly capture the unsystematic risk and to have an accurate and useful marginal beta, it is critical that yearly data points are used.

Criticism of the Marginal Beta

The main criticism with using a marginal beta is that these yearly points do not just focus on the systematic risk of the market, they also include a company's unsystematic risk. While there is some validity to this position, it can be countered. The reason why people cancel the unsystematic risk out of the equation is because they *assume* that it cannot be predicted. We disagree. The unsystematic risk needs to be accounted for, not just eliminated; after all, the principal by which money is made on the stock market is the logic of uncertainty! In this paper, we attempt to establish a framework to predict this unsystematic risk.

The second criticism with trying to predict marginal beta for one year is that we are actually trying to predict the return for that year using risk. Would it not make more sense to use financial techniques to predict the return for the stock over a year as well as the return of the S&P over the year and then back out the risk? Not necessarily. After all, here again, *any* technique to *predict* stock returns by definition *cannot* avoid assumptions about risk.

Yet another criticism to marginal beta is that if investors already have a prediction for a stock price, why do they need beta in the first place? We counter this by noting that while we may know the return of the stock, we do not know the return on the market compared to the stock. Therefore, the projection of the return of the S&P is just as important to that of the stock.

Marginal Data/Calculations

We looked at 9 companies for the years 1987 to 1993 and found their marginal betas to those of the "Valueline" betas. To do this, we calculated the yearly returns of both the S&P and of the individual stocks. Then, we substituted our resulting beta into the formula (1) and found the marginal betas. Using these results, we ran a regression with weighted beta as the independent variable and marginal beta as the dependent variable. The R-Squared for the regression was only 3.2%. This means that weighted beta can predict just 3.2% of marginal beta. However, looking at Appendix A, the residual plot shows us that there are a number of outliers. Looking more closely at the data, we can see that of all the outliers occurred in the year 1988 when the market increased less than 1%. Therefore, any return, positive or negative, was intensely magnified. For example, consider the marginal betas of McDonald's for the year 1988 versus the remaining years.

Years	Valueline	Marginal
7/3/87	1.15	.42
7/1/88	1	-34.38
7/7/89	1	.66
7/6/90	1	.46
7/5/91	1	-.53
7/13/92	.95	.64
7/2/93	1.05	.88

The conclusion is that, in order for our model to be effective, the S&P must change at least 5%. In a given year, if the market yields a low return, the marginal betas for that year will be large; these large betas throw off any type of scale we could establish, as we will discuss below. It can be countered by entering a dummy variable into our equation if the return is less than 5%.

It is important to note the implications of this finding. Despite the lack of correlation between weighted beta and marginal beta, the weighted beta is (unintentionally) used to predict marginal beta. In other words, whenever a stock broker mentions the weighted beta to a client, he/she should instead be mentioning marginal beta!

To see this point more clearly, consider another regression, having eliminated the 1988 data (Appendix B). R-Squared actually drops from 3.2% to .2%, and the range of betas decline from (-34.38, 34.82), with 1988 data, to (-2.55, 3.71), without 1988 data. The residual plot without 1988 data shows that the marginal beta is almost absolutely random. Therefore, any attempt to accurately predict actual beta using any type of linear regression will likely be spurious. A potential way out of this dilemma is to possibly predict the marginal beta by applying Bayes Theorem.

Application of Bayes

In order to begin the construction of a formula to find marginal beta, it is important to understand how Bayes Theorem can help us construct a solution that is both mathematically simple and theoretically correct.

In every problem or decision, there is a likelihood and a prior, be it quantitative or qualitative (continuous or discrete) data. First, consider (binary) qualitative data; the data can be considered a success or a failure. As an example, consider a problem with 10 successes and 10 failures out of 20 trials (this is the likelihood) and a prior of 10 successes in 10 trials. The equation to determine whether the next data point will be a success or failure is:

$$\mathbf{s+a/(s+a+f+b)=(10+10)/(10+10+10+0)=66.6\ \%}, \qquad (3)$$

where s and f are the successes and failures in the likelihood, respectively, and a and b are the success and failures in the prior, respectively. Therefore, the probability that the next data point is a success is 66.6% or 33.33% that it is a failure. Note, that our new prior is now **a=20** and **b=10**. For each new point, the formula gets naturally updated. This continuous adjusting is the fundamental attraction of Bayes Theorem. Stated differently, we simply *learn from experience.*

Next consider a problem where the data is indeed quantitative. While, in principal, Bayes Theorem can be directly applied to such data, we propose to first discretize the data. There are a few steps that are needed before this can be done accurately.

First and foremost, we need to consider the likelihood. This is the essence to any problem; we need to take the quantitative data from the likelihood and determine whether it is a success or failure. How should one weight the variable defining the likelihood? In other words, we have to know how many success and failures we need to allocate to a particular likelihood function, that is fundamentally continuous. This is a critical part of the problem, and we refer to it as "scaling the likelihood."

Consider this illustration based on the work of Magnus.

A mutual fund manager's success, in most cases, is judged by his/her portfolio's return to that of the S&P 500's. In recent years, it has become increasingly evident to the average investor that the S&P has won this ongoing battle, and money has started pouring into index funds which try to mimic the return of the S&P. Now that Fidelity has closed investors to its Magellan Fund, it seems only a matter of time before the Vanguard Index Fund becomes the largest mutual fund in the world. It has already passed $40 billion in assets.

The goal for most mutual fund managers and brokers is to beat the S&P. Now some funds have been able to do this consistently over the last 20 years, albeit there are few of them. The goal is not necessarily to determine whether a particular stock will increase or decrease in value, although one could argue much of the data used will help determine the future value of a stock. However, one need not concern oneself with the economic environment to the extent that if investors were scared of the possibility of increased interest rates, my stock along with the rest of the market would be considered failures. Therefore, one must base success or failure strictly on whether the analyzed stock beat the S&P for the upcoming month.

My first problem was two-fold. I had to construct a prior belief, and then I needed to weight that prior in conjunction with the rest of the data I was going to collect. I chose a prior of 10 success to 15 failures, meaning simply, "I think that any stock picked in this market will fail to beat the S&P 15 out of 25 times." This was done for two reasons. First, while the average of the S&P may increase, that average is weighted so the breadth of the market may have decreased. So a dart thrown at the stock page in the *Wall Street Journal* would more likely strike stock that decreased rather than increased. It is possible that the opposite scenario is true, but I couldn't predict it for the upcoming month so I assumed the worst case scenario. Second, my argument becomes stronger if I am able to say, "with this initial bias of failure, the probability is still high that this stock will beat the S&P." I weighted my prior somewhat arbitrarily at 20% of the total amount of successes and failures.

The next step was to ask myself what constituted the likelihood. This is the true essence of the problem. Once I figured out what determined how a stock would do against the S&P, I was basically done. I knew that I would need some historical data on how the stock had performed versus the S&P before. I chose to use the last 12 months as my data, calculating the moving average of both the S&P and the stock I was analyzing. I then took the difference of each month's percentage increase (or decrease) from that of the S&P. I inputted the difference as a success if the number was positive or a failure if the stock had been outperformed by the S&P. Summing up the successes and failures, I weighted the percentage out of 50. For example, if a stock had beaten the S&P in 5 of the 12 months by 44 **percentage points,** but had lost in the other seven months by a total of 84 **percentage points,** then the stock would have accounted for 17 success ((44/(44+84))*50), and (50-17) 33 failures.

To use this simple analysis of a stock alone, the chartist's view, wouldn't indicate whether or not the stock would or would not outperform the S&P. Observing the stock market and how stocks were driven, I made a list of what I believed were the most critical issues on what drove a stock.

1. Wall Street Ratings - When brokers buy stocks, it is much easier to tell a client that the stock is rated a "buy" by 9 analysts. Furthermore, an upgrade, downgrade, or a reiterate of a previous belief of a stock from a certain analyst can move that stock as much as the report of great or poor earnings. This clearly needed to be captured in the analysis of any stock. I transferred this idea into Bayesian thinking by assigning a number to a belief (l=hold, .5=buy/hold, 0=anything else) and then summing and dividing by the total number of analysts with an opinion and weighting that percentage with a total of 10 successes or failures.

2. P/E/Value - The reason I included both P/E and Value is because in the investor's mind, they are often different. For example, Microsoft with a P/E of 30 is somewhat of a value for many, however, GTE with a P/E of 30 is way overvalued. To transfer a P/E value into a success or failure was somewhat arbitrary. I simply weighted the successes/failures at 8 and provided a map of what each P/E was in terms of successes and failures. A P/E of 20-25 constituted 4 success and 4 failures. These numbers were not entirely random. It is important to note that the average P/E of the S&P was right around 20 - 25 during this time. I constituted a lower P/E than the S&P average as an advantage and applied more successes than failures. When determining what number of successes and failures to apply to the value of a stock, I used a chart supplied by PaineWebber which I thought was very good at determining value by measuring among other things, the actual stock price and the potential of a company. This concept was also weighted with eight successes/failures. This conception of value is crucial to include because many times an analyst will simply degrade a stock on the fact that the stock price has become too high for either the company or the industry.

3. Growth of Earnings - What truly drives a stock prices? Any analyst will tell you, "its earnings." It is true that if a company is expected to reach 20% growth, and it only reaches 15%, the stock price will fall the day the company announces its earnings. But one need not be too concerned with that because this company should have increased its stock price by approximately 15%. (Often times it is a projected P/E that is fixed, causing a stock to rise or fall. The possibility of a stock continuously not making the number is also

captured with the analysis of the S&P vs. stock from the previous 12 months) I focused heavily on the projected growth rate of a company and assigned 20 successes and failures accordingly.

4. Articles about Future and General Feel for Company - Someone says "Intel," and you think "great company." Another says "ATT" and you become violently ill. How do you statistically account for this? Bayesian Analysis lets you take qualitative data and assign it a number. I weighted this idea with 5 successes or failures.

I realized that this formula or format would not give me an accurate probability on whether or not the stock would beat the S&P for the next month, but it was able to give me a number which I could compare to other stocks. I went about this next task by summing my prior and my likelihood (my prior is somewhat insignificant in that in the end I was comparing relative numbers rather than actual probabilities) and finding the relative probability that the stock would beat the S&P for the next month. I then took it a step further by solving for a Z-value that would tell me the chances of the stock having a 50% chance of beating the S&P for the next month (Appendix C). My final statement read, "There is a xxx relative probability that Company Y will have 50% chance or better beating the S&P for the next month."

I was fairly successful with this analysis for the month of June. The three companies that output the highest relative probability also were the most successful (Oracle, Medtronic and WorldCom) while my two lowest companies (West Marine and Red Brick Systems) proved to perform poorly.

As one can see, all data in the current news, qualitative and quantitative, is used and that is how Beta should be derived.

Creating an Equation

When trying to predict marginal beta, we first need to establish a prior on *all* the appropriate uncertain random quantities in order to predict the return on the stock. Our prior belief in this equation is going to be the stock price of the company. In other words, our prior belief is that the market is efficient in valuing a company based on the market's fundamentals. The stock price also gives us a real number to use in trying to find a future return.

$$R = \frac{[[[\text{stock price} + (\text{scale})X1 + (\text{scale})X2] * (\text{scale})X3] - \text{stock price}]}{\text{stock price}} \qquad (4)$$

The X variables in this equation are our likelihood. The scale in this equation is simply how important we feel each likelihood is to the prediction of R.

In this equation, our prior belief (stock price) is not effected by likelihood. This is a different application of Bayes. Our prior remains constant for each new stock and each new time period in order to find a real starting point in finding the return. Now the likelihood will make an impression on the prior, but it has to do it every time rather than moving the prior as one collects more likelihoods.

Finding a Likelihood—Individual Company

One of the major difficulties in answering this problem is that much of the data we need deals with the current perception of the company. This is extremely difficult to capture when looking back into history. In order to find an accurate likelihood, it is necessary to compile current data and perceptions and to put both the qualitative and quantitative data into a qualitative measure of successes and failures. To determine our likelihood, we used: (1) abnormal returns, (2) news about the company, and (3) past history of stock performance. Our new equation looks like this:

$$R = \frac{[[\text{stock price} + (\text{scale})\text{ abnormal returns} + (\text{scale})\text{ news}] * (\text{scale})\text{history}] - \text{stock price}]}{\text{stock price}} \quad (5)$$

To show how we would determine our likelihood, we will use the theme restaurant, Rainforest Cafe, as an example.

(1) Abnormal Returns - Discounting abnormal returns is a good start to finding a stock price. The equation is defined:

Discounted Abnormal Returns = **(ROE - r)/(r-g)** **(6)**

In this equation, the **ROE** is Return on Equity (Net Income/Beginning Shareholder Equity), **r** is cost of capital which is found using the **CAPM (r=rf+B(Market Return - rf), rf=risk free rate),** and **g** is the terminal growth rate. Of course the flaw in using this is that beta is being used to find r. In order to compensate for this, we will use current and future looking measures in addition to the discounted abnormal returns in the equation. Another possibility to finding a starting point would be to use discounted cash flows. However, by using abnormal returns we can better see our assumptions when valuing a company; see, for example, Palepu & Healy.

Ex: Rainforest Cafe - Rainforest Cafe went public in March of 1995. Since then, the stock soared to a high of $25,375 (the stock did a 3-for-2 split in January) and fell to $10.75. Prior to its fall in January of 1998, we completed a valuation of the company (See Appendix D). Using the Earnings Based Valuation Method, we calculated a value of $10.09 taking into account the 3-for-2 stock split. The stock price at the time of the valuation was around $25.

How should one weight abnormal returns, and use the actual weight? We suggest that one must subtract the stock price from abnormal returns. A negative value implies that the market is overvaluing the stock. In this case with Rainforest Cafe, $10.09- $25 =$-15.09. This number alone probably makes the most sense to use outright. However, it does not take into account that almost all of the stocks in the market, at the time, had stock prices higher than their fundamentals suggested. Therefore, we will weight the abnormal returns number by .5 in order to take into account the market's perception. Also, if the stock does fall to its projected level, it has the opportunity to turn itself around during the period of an entire year. Plugging these numbers into the equation, we have:

$$\mathbf{R = [(25 + (.5)\text{-}15.09) - 25] / 25 = (17.4 - 25) / 25 = -0.304 = -30.4\,\%} \quad \mathbf{(5)}$$

As one can see, we are already predicting a negative return for the upcoming year.

(2) News - P/E ratio, Wall Street ratings, and feel for the company are information that effect volatility. As discussed in the illustration given earlier, we can encapsulate this uncertainty, using Bayes Theorem.

P/E Ratios - Generally, the higher the number, the more volatile a stock is to a *negative* change in projected earnings. A stock with a currently high P/E ratio may have had a very low P/E ratio three or five years ago, yet the weighted beta is not using this current information. This is another reason why it is important to focus on current returns and back out the risk. (It comes as a surprise that the elementary concept of "regression to the mean effect" is often overlooked by analysts!)

In determining the likelihood, we can take into account this important information and weight it properly. Considering Rainforest Cafe, we found a very large P/E ratio relative to the market. In order to scale this, we took Rainforest's current P/E of 58 and subtracted it from the S&P P/E average of 25. We then have a number of 23, which represents how large the company's P/E is to that of the average P/E of the S&P. What does this mean? We established the following scale to help apply this number into our equation (7).

Range: Stock P/E-S&P P/E	Successes	Failures	Percentage	Number For Formula
Negative - Zero	4	0	100%	3
Zero - 5	3	1	75%	1.5
5-10	2	2	50%	0
10 - Infinity	0	4	0%	-2

We felt we should have a negative number with a P/E of at least 10 above the S&P because it would be difficult for the company's P/E to go much higher, but it would be easy for the company's P/E to fall. (In this case, we will use -2 in the equation.)

Wall Street Ratings - Currently, a stock price is based on perception in addition to its accounting fundamentals. In order to quantify this, we must take into account how the ratings of Wall Street's top analysts impact a company's current and future stock prices. Before Rainforest Cafe's stock price fell, it had a majority of "buy" recommendations. Here we have set up a scale such as the one before:

Range: Ratings	Success	Failures	Percentage	Number For Formula
100% Buys	**4**	**0**	**100%**	3
75%-100%Buys	3	1	**75%**	**1.5**
50%-75%Buys	**2**	2	**50%**	**0**
0 - 50% Buy	**0**	**4**	**0%**	-2

In Rainforest Cafe's case, more than 75% of the analysts recommended it as a "buy" in December of 1997. Therefore, we will assign 1.5 to the equation.

Feel About the Company - As implied earlier, this can be a very important factor in determining the return for a stock. If the company has hit a low and is restructuring, the feel is generally pretty "high." If a company is very successful and has the potential to expand, the feel is also very "high." One way to see if there is a negative feel about the company is to see if there is an increase in selling the stock short. This clearly was the case for Rainforest Cafe; however, the general feel about Rainforest Cafe was very "high" during this time. Following is the same scale as the previous one:

Range: Feel	Successes	Failures	Percentage	Number For Formula
Great	4	0	100%	3
Good	3	1	75%	1.5
Average	2	2	50%	0
Bad	0	4	0%	-2

Of course, this approach is subjective, but *any* assessment of stock is subjective. We can only base our decisions on how the stock has done before; therefore, we argue that the feel for Rainforest Cafe was "good" or 1.5.

Combining the three criteria for Rainforest Cafe, we have **(P/E)-2 + (WSR)1.5 + (FEEL)1.5 = 1.** However, this does not tell the whole story because saying a stock will move 1.5 points for a low stock price versus that of a high stock price, has different impacts on the return. Therefore, another scale is necessary:

Stock Price Range	Average Price	Best Scenario For Average Price	Worst Scenario For Average Price	Scale
0-5	2.5	12%	-8%	.03333
540	7.5	12%	-8%	.1
10-20	15	12%	-8%	.2
20-30	25	12%	-8%	.33333
30-50	40	12%	-8%	.53333
50-75	62.5	12%	-8%	.83333

75-100	87.5	12%	-8%	1.1667
100-150	125	12%	-8%	1.6667

We took a range from our best score of 9 (3+3+3) and from our worst score -6 (-2+(-2)+(-2)) and allocated percentage increases and decreases of 12 and 8%, respectively. We picked 12% because we thought that this would be the maximum amount of impact that news could have on a stock, on average. We chose -8% because, on average, we do not feel that news will impact the stock more than that. This scale is extremely arbitrary, but it is easy to present a range of credible "what if scenarios, from which, subjectively, one can choose the most "viable" one. For instance, "what if someone asks why 12% was chosen as the maximum percentage that news about the company could impact the price? A reasonable response would be, "Would you choose 70% as the maximum percentage?" The answer is obviously no; hence subjectivity plays a key role in determining a *proper* scale.

Applying the scale and data for Rainforest Cafe, we found that the stock price fell in the 30-50 range, and it had a score of 1. The scale, according to the chart, is .53333.

R = [[(stock price + (scale)**abnormal** returns + (scale)news) * (scale)history] - stock price]

stock price (5)

R = [[(25 + (.5)-15.09 + (.5333)1) * (scale)history] -25] / 25

R = (17.933 -25)/25= -28.3%, with (scale)history = 0

As shown, the news about the company increased Rainforest's expected return from -30.4% to -28.3%.

(3) History - The history of returns by a company is an important factor in determining how the company is going to do in the future. Every investment firm tells the public that past returns do not necessarily reflect future returns. But, past returns do give us a base to develop an idea on how that company will perform in the future. We are then able to make judgements on such things as the quality of management, the productivity of a company in using its assets, etc. These insights allow us to establish a base with which to gauge the company. For example, if you want to forecast the returns of Microsoft, it would not be prudent to disregard the fact that Microsoft has earned over 30% for the last five years. This is certainty relevant.

In forecasting, we came up with an average return over three years. Consider Rainforest Cafe shortly after its initial public offering (IPO); its price appreciated dramatically (509% over its first nine months). For the years 1996 and 1997, the returns were 14% and 19%, respectively. Because Rainforest's first return was an IPO and, therefore, extremely volatile for the first few months, we assumed that the first return was an outlier. To compensate we took an average of the years 1996 and 1997. The average return for this period was 16.5%. All we needed to do was add 16.5% to 1 and then multiply that answer by the sum of our stock price, abnormal returns, and news.

$$R = \frac{[[(\text{stock price} + (\text{scale})\text{abnormal returns} + (\text{scale})\text{news}) * (\text{scale})\text{history}] - \text{stock price}]}{\textbf{stock price}} \qquad \textbf{(5)}$$

R = [[(25 + (.5)-15.09 + (5333)1) * 1,165] -25] / 25

R = (17.933 * 1.165) -25)/25= -16.4%

We consider the first three variables—stock price, abnormal returns, and news—as a way to establish the current price, while the last variable—history—helps make a future projection.

Finding a Likelihood—S&P

Predicting the S&P Returns - Creating an equation for predicting the S&P returns is similar to creating an equation to predict an individual stock's return. Once again, we need a starting point—a prior belief. Our prior belief in this equation is going to be the current level of the S&P. In other words, our prior belief is that the market is efficient in valuing all of the companies in the index based on their fundamentals. The S&P level also gives us a real number to use in trying to find a future return.

$$\mathbf{R} = \frac{\mathbf{[[[S\&P + (scale)X1 + (scale)X2] * (scale)X3] - S\&P]}}{\mathbf{S\&P}} \qquad \mathbf{(7)}$$

The X variables in this equation are our likelihood. The **scale** in this equation is simply how important we feel each likelihood is to the prediction of **R**. Our prior is always the current S&P Level. Now the likelihood will make an impression on the prior, but it has to do it every time rather than moving the prior as one collects more likelihoods. This is the exact same methodology we used when using the stock price as our price when finding the expected return of the stock.

One of the major difficulties in answering this problem is that much of the data we need deals with the current perception of the market. Our likelihood will consist of: (1)

current market perception on the S&P value compared to its true value, (2) the Price to Earnings ratio of the S&P 500, and (3) the historic average return of the S&P 500. Our new equation looks like this:

$$R = \frac{[(S\&P + (scale)Market\ News + (scale)PTE) * (scale)history] - S\&P}{S\&P} \quad (8)$$

(1) Market News - Market news is a strong indicator of the direction the S&P is going. If perceptions are high, people are more likely to invest more money into stocks that will raise the level of the S&P. The perception of the market is based on indicators such as the state of the economy, fiscal policy, presidential stability, etc. In order to try and capture these indicators, we made another scale. However, we did not use numbers for our criteria, since presidential stability does not have a number. Instead, we assigned qualitative information to a scale. The following chart bases the S&P at 1000. It can easily be adjusted to find a new scale as the S&P changes.

Market News	Scale	Approximate Percentage Move
Excellent	80	8%
Great	70	7%
Good	50	5%
Average	25	2.5%
Bad	-25	-2.5%

With low inflation, high growth, and a general feel that the market is invincible, we chose to assess the market back in December of 1997 as "excellent" and assigned it 80 points.

At the time of the analysis, the S&P was around 970 points. Therefore, our equation looks like this:

$$\mathbf{R = \frac{[(970 + 80 + (scale)P/E)) * (scale)history] - S\&P}{S\&P}} \qquad \mathbf{(8)}$$

P/E Ratio- The P/E ratio is a strong measurement to gauge if the S&P is under- or overvalued. For example, the current P/E level of the S&P is 27. The historic average P/E of the S&P is between 10 and 20. Based on this information, one would say that the market is overvalued. But, how overvalued is it, and how much does this affect our expectations of futurr S&P returns? We created a chart similar to the one above to help determine this.

P/E Ratio	Scale	Approximate Percentage Move
>30	-100	-10%
20-30	-50	-5%
15-20	0	0%
10-15	50	5%
0-10	100	10%

As one can see, the higher the P/E ratio, the worse the effect it has on the projected return of the S&P. In the case of Rainforest Cafe, the S&P P/E ratio was around 24 at the time of the analysis, warranting a scale of-50. The new equation looks like this:

$$R = \frac{[(970 + 80 + -50)) * (scale)history] - S\&P}{S\&P} \quad (8)$$

Historical Returns - Using the same type of logic as we did with Rainforest Cafe's historical returns, we applied it to the S&P. It would be naive for us not to consider the S&P's recent historical trends in the equation. Simply taking the average return from 1995 to 1997 yields us 24%. Substituting into the appropriate equation:

25.25% = (((970 + 80 + -70)) * 1.24)-970)/970

Results

Now that we have a new projected return for both the S&P and Rainforest Cafe, we can find its anticipated marginal beta for the upcoming year. Using the same formula as before to find the variance, we find a projected marginal beta of -.34.

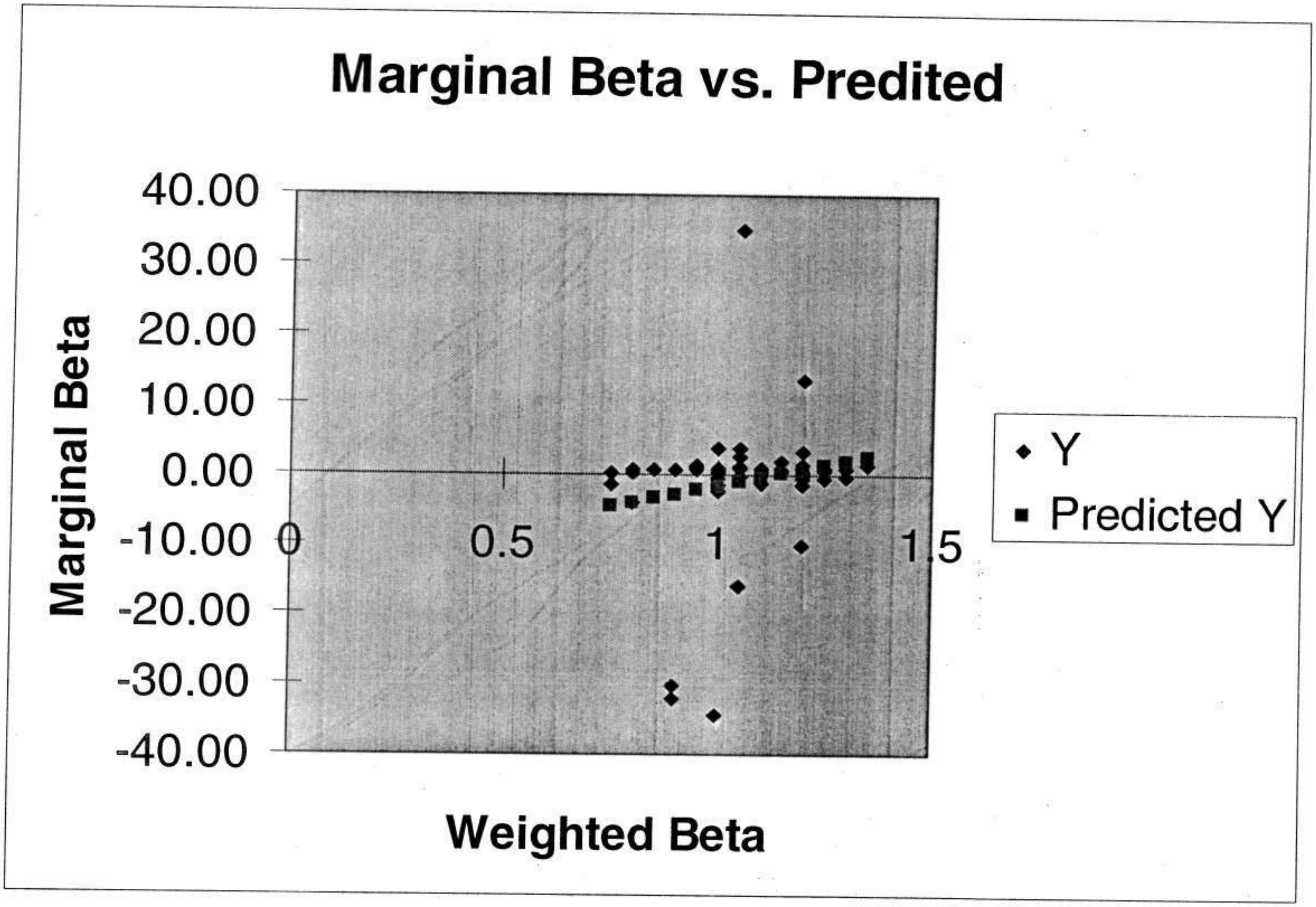
The actual beta will not be known until December of 1998; however, a four-month update is valuable and easily done via the Bayesian approach. The market has continued to boom, already appreciating 15% since December 1997. Rainforest Cafe took a large hit as its stock price fell from $25 to $10 in January after announcing poor earnings. The $10 price is the exact price we had valued the company at in December. The beta from December to April is -1.25. This is more volatile than we expected. However, notice the negative sign, which is impossible to predict using a weighted beta. Also realize that there are still eight more months left in the year. At this point in time we can update our beta for the next eight months. If the projected beta is -.34, and the current beta is -1.25, we can expect a positive .91 beta for the rest of the year. This is extremely valuable when determining the risk of a stock. It can continuously be updated, and the returns at certain points in the year will continuously change. This is one of the reasons why we did not scale our earnings-based valuation model too high. If we had, our beta would be more accurate now, but not for the entire year, which is what we are after. In other words, we expected the price of Rainforest Cafe to drop sometime this year, but we did not know when it would occur. To account for this, we give time for the company to correct itself and then move more smoothly with the market. This is another application of "regressions to the mean effect"—where there is movement back towards the mean after the stock price initially falls.

Conclusions

As we have begun to discuss, many implications of this paper exist. One important point to make is that we did not use the CAPM. We found the return of a stock by focusing on accounting numbers and forward projections, not on the risk-free rate and the market premium. So using beta in the CAPM is useless from the investor's point of view. What we can do is use it to help find the optimal portfolio based on projected risk. This is not to say that the CAPM is completely without value because when finding the *Cost of Capital* a five-year period is not out of the question, and the weighted beta makes some sense.

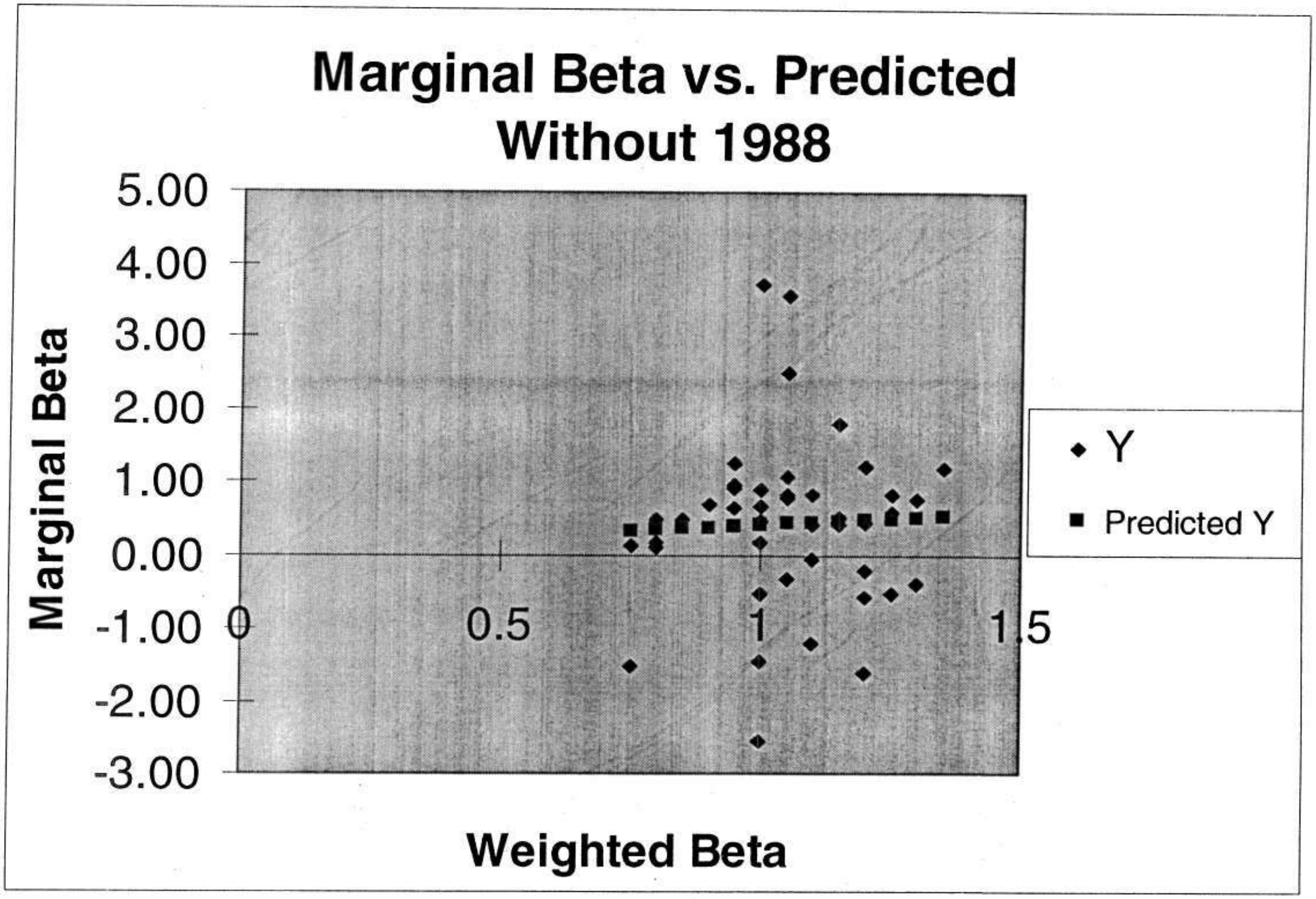
The main implication of this paper is that it offers an ongoing way of assessing a firm through the course of the year, by appropriately quantifying relevant sources of uncertainty. The result is a methodology that allows the data to be continuously updated throughout the year using the Bayesian methods that we discussed above.

Appendix A



Marginal Beta vs. Predited
40.00
30.00
20.00
10.00
0.00
-10.00
-20.00
-30.00
-40.00
0
0.5
1
1.5
Marginal Beta
Weighted Beta
Y
Predicted Y

Appendix B



Marginal Beta vs. Predicted
Without 1988
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Marginal Beta
0
0.5
1
1.5
Weighted Beta
Y
Predicted Y

Appendix C

date	S$P	% change	WMAR	%chang€	success	failure
6/1/96	668.72	0.00%	35.76	0.00%		
7/1/96	670.39	0.25%	35.76	0.00%		
8/1/96	640.23	-4.50%	33.15	-7.30%		
9/1/96	651.95	1.83%	38.72	16.80%	**14**	
10/1/96	687.15	5.40%	33.06	-14.62%		19
11/1/96	705.58	2.68%	35.24	6.59%		
12/1/96	756.58	7.23%	33.5	-4.94%		12
1/1/97	740.78	-2.09%	28.27	-15.61%		14
2/1/97	786.78	6.21%	32.28	14.18%		
3/1/97	791.07	0.55%	28.97	-10.25%		10
4/1/97	756.67	-4.35%	32.97	13.81%	**17**	
5/1/97	801.11	5.87%	26	-21.14%		27
				Total	**44**	84
6/1/97	838.44	**4.66%**	25	**-3.85%**		

Let my prior be (a, b)
Let my likelihood be (s,f)
Let r = (a+s)/(a+s+b+f)
Let r += (a+s+l)/(a+s+b+f+l)
Let t = (r(r+ - r))^.5

solve for Z, letting r+=.5
Z=(.5-r)/t
Use Normal Curve for prob.
Add or subtract value to .5

Likelihood			
One month moving average vs. S&P	**17**	**33**	Total % points difference ...50 weighted
Wall Street ratings	**8**	2	(buy=l), (buy/hold =.5), (anything else =-1)..10 weighted
PE	**1**	7	1-15(6.2), 15-19(5.3). 20-25(4.4). 25-30(3.5), 30-38(2.6), 38-48(1,7) <48(0,8)..8 weighted
Value	**4**	2	from chart ...6 weighted
Growth of earnings	**17**	3	1-5%(5,15),,5-9(7,13),9-13(9,11), 13-17(11,9),17-20(13,7), >20(17.3)..20 weighted
Articles about future and general feel for company	**2**	4	focus on expansion and cutting costs..6 weighted
Total	49	51	

	Successes	Failures
prior belief	10	**15**
likelihood	49	51
	59	**66**

r= 0.472
r+= 0.47619
t= 0.044474
z-value= 0.629586

r+= 0.5

The corresponding percent to the Z-Value is

-0.2324
<u>0.5</u>
26.76%

There is a 26.76% probability that **WMAR** will have 50% chance or better than beating the S&P for the month of June.

Appendix D

Base Case										
RainForest Cafe										
Earnings-Based Valuation Using Key Value Drivers										
Valuation based on eight-year forecast horizon										
Actual and Forecast:	1996	1997	1998	1999	2000	2001	**2002**	**2003**	**2004**	**2005**
Earnings	5924	13949								
Book Value	203954	216392								
ROE=(EPS/Beg book value)		0.068	0.098	0.128	0.158	0.188	0.200	0.200	**0.175**	**0.150**
Percentage growth in book value		0.061	0.100	0.100	0.250	0.100	0.100	0.100	0.100	0.040
Valuation Parameters:										
Estimated cost of capital	0.145									
ROE in 1997 ~	0.068									
Annual Increase in ROE	0.030									
Maximum ROE	0.200									
Decline in ROE after 2003~	0.015									
Minimum ROE after hitting peak	0.150									
Growth rate, 2000-2004_________	0.100									
Growth rate beyond 2004	0.040									
ROE - r ~		-0.077	-0.047	-0.017	0.013	0.043	0.055	0.055	0.030	0.005
growth in beg book, to date			1.000	1.100	1.210	1.513	1.664	1.830	2.013	2.214
(ROE-r)*growth to date			-0.047	-0.018	0.016	0.066	0.092	0.101	0.060	0.011
Discount factor________________			1.145	**1.311**	1.501	1.719	1.968	2.253	2.580	2.954
Discounted (ROE-r)*growth			**-0.041**	**-0.014**	0.011	0.038	0.046	0.045	0.023	0.004
Discounted Terminal value										0.041
			Valuation Computation							
Indicated price/book with T=5 yrs		1.150								
			Indicated market value					266841		
			Number of shares					17,446		
			Value per share					**$15.29**		

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