Global Market Report

Forty Years of Better Betas:

Using Barra Fundamental Factor Models to Assess Market Risk

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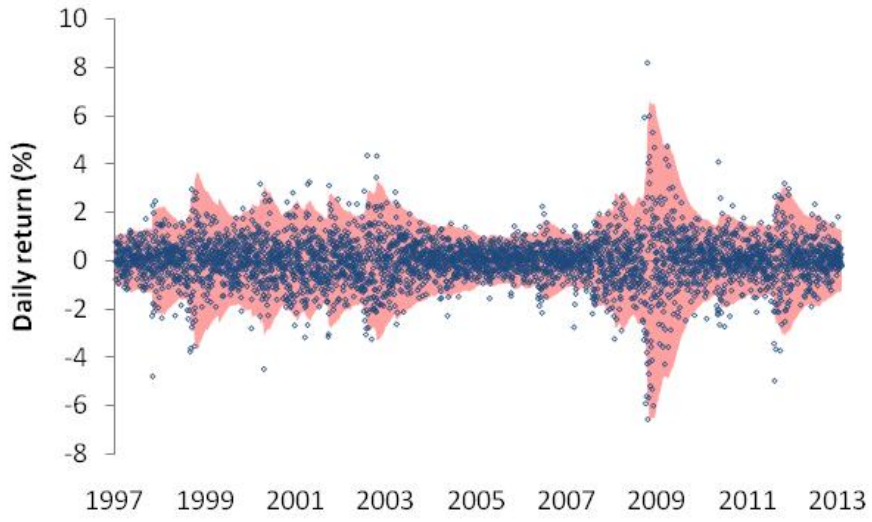
Recent Developments in Equity Market Risk

Since 1997, equity markets have experienced several periods of significant market turbulence. Figure 1 shows a time series of daily returns of the global equity markets from 1997 to early 2013. We observe a clear time variation in equity market volatility as well as a number of periods of extreme returns.

Figure 1: Daily Global Equity Market Returns, proxied by the Barra Global Equity Model (GEM3) World Factor.



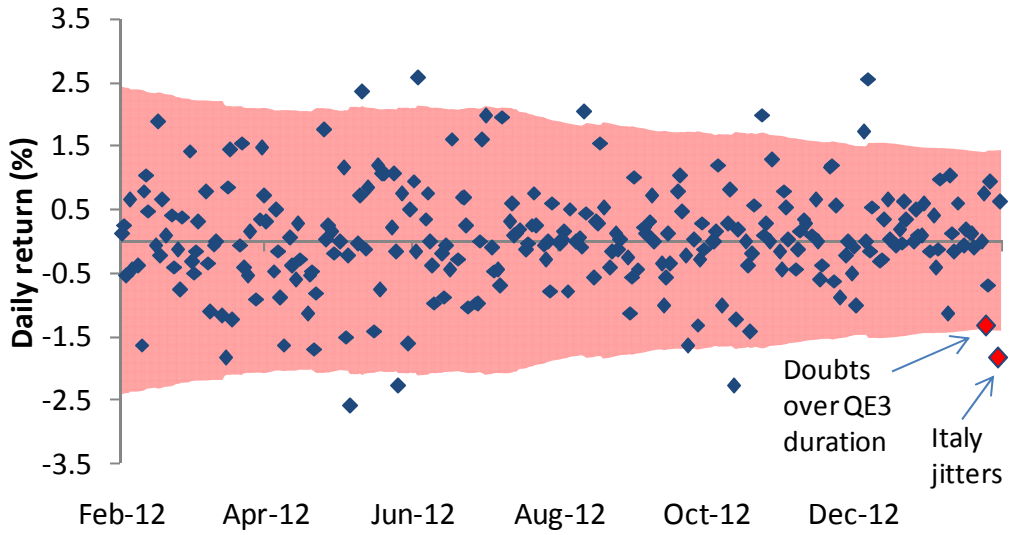
Note: the blue dots in the chart correspond to daily returns of the GEM3 World factor. The pink shaded areas are ± 2 forecast standard deviation bands for the World factor, using the GEM3S model forecast scaled to a daily horizon.

Figure 2 shows a similar plot, zooming in on events in the US equity markets during 2012. While this period saw falling levels of equity market risk and an increase in investor optimism and risk appetite, there remain challenges in the global economic climate and investor confidence can be fragile.

For example, February 20, 2013 saw a drop of 1.4 percent in the MSCI USA IMI Index on reported doubts over the duration of QE3.[1] This daily drop is a 1.9 standard deviation event using the risk forecast from the Barra Global Equity Model (GEM3S) scaled to daily horizon.

February 25, 2013 saw a drop of 1.8 percent in the MSCI USA IMI Index (a 2.6 standard deviation event using the GEM3S risk forecast scaled to daily horizon) on reported fears that a divided Italian parliament may get in the way of fiscal reforms and hamper EU stability.

Figure 2: Daily Returns of the MSCI United States IMI Index.



Note: the blue dots in the chart correspond to daily returns of the MSCI United States IMI Index. The pink shaded areas are ± 2 forecast standard deviation bands for the MSCI United States IMI Index, using the GEM3S model forecast scaled to a daily horizon.

These charts illustrate two points: significant crises in equity markets occur on a regular basis, and even periods of benign market conditions can be interrupted by significant negative market movements. When large market movements occur, risk and portfolio managers need to have conviction in the information that their portfolio and risk management tools are providing them. In this report, we look at the period between January 1997 and December 2012, and compare two methods of estimating the market risk of a portfolio and investigate the question: which estimation approach performed best during periods of market stress?

[1] See The Financial Times, Fed Doubts Grow Over Duration of QE3, February 21, 2013.

The Importance of Accurate Beta Estimation

A portfolio's beta is a key measure of market risk. Asset pricing models decompose the risk of any investment into two components: a firm-specific component, relating only to investment in a particular firm, and a market component, which contains risk affecting a large subset of all investments. Beta[2] is a way of separating risk and return into these two parts. Knowing a portfolio's beta allows institutional investors to break the expected return of that portfolio into two uncorrelated components: a market return and a residual return.

Many analysts estimate betas by regressing the returns of an asset against a stock index, with the slope of the regression being the beta of the asset. We refer to the result of this calculation as *historical beta*. These calculations can suffer from several well known shortcomings.[3] Rosenberg and McKibben (1973) proposed the use of fundamental factor models to overcome the shortcomings of brute force methods of estimating the covariances of asset returns. They illustrated that ex-ante measures of riskiness of returns of common stocks can be based on fundamental data for the firm, as well as the history of its stock prices. Fundamental factor models can offer a more robust estimate of covariances by focusing on a smaller set of common drivers of returns. We refer to betas calculated using this method as *fundamental betas*.

How can the performance of portfolios, constructed on the basis of these two methods, differ during periods of large market movements? We offer an empirical answer to this question in the next section.

Betas in Turbulent Markets

We constructed 20 portfolios by ranking the stocks in the estimation universe of the Barra Global Equity Model (GEM3) on the basis of their historical and predicted betas.[4] Specifically, we created the following portfolios:

- Ten equally weighted decile portfolios based on historical beta;
- Ten equally weighted decile portfolios based on predicted beta;

The portfolios were rebalanced monthly to reflect changing historical and predicted betas of assets over the period of January 1997 to December 2012.

Figure 3 shows the returns of the decile portfolios for the worst month during the sample period: October 2008. During this month, the World factor in the GEM3 model (which reflects the aggregate up and down movements of the global equity markets) posted a loss of 18.3 percent. Two things are striking about this plot. First, the loss of the lowest beta decile portfolio formed using predicted beta is approximately half that of the lowest beta decile portfolio formed using historical beta.[5] Moreover, the losses on the historical beta deciles did not increase monotonically with beta. In particular, the loss on the fifth and sixth historical beta deciles was lower than the loss on the fourth historical beta decile. This result clearly went against the outcome intended when creating these portfolios. The higher beta groups were expected to have a more negative return during this month relative to lower beta groups.

[2] Beta is measured by the covariance of the stock's return with the market portfolio divided by the variance of the market portfolio.

[3] For examples, see Damodaran (1999) or Gray et. al. (2005).

[4] The historical betas are estimated over the trailing 252 days of returns, using a regression half-life of 63 trading days.

[5] Note that the lowest beta decile portfolio formed on the basis of the historical beta actually loses more than the market. This is due to the decile portfolios being equally weighted.

Figure 3: Returns on historical and predicted beta deciles (equal weighted) in October 2008.

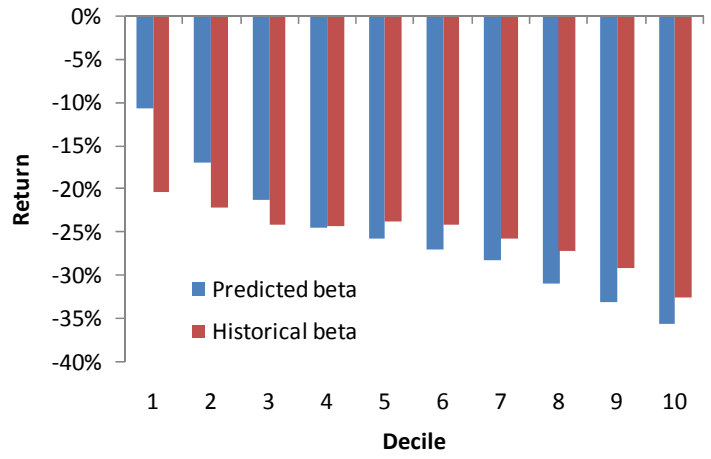
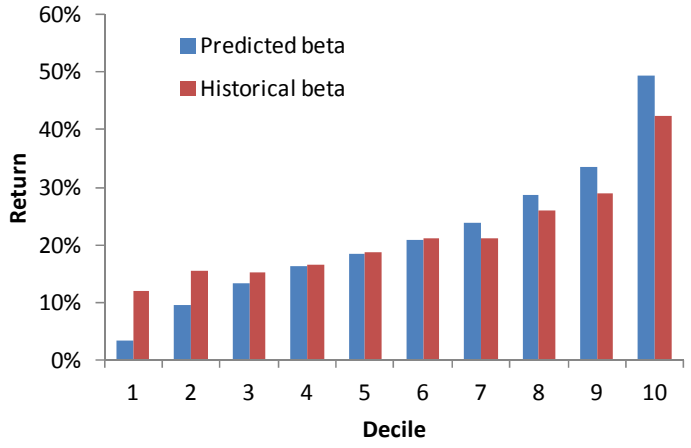


Figure 4 shows what happened during the best month of the sample period: April 2009. During this month the World factor posted a gain of 11.9 percent. The returns of the historical beta deciles did not increase monotonically with beta, which went against expectations. The dispersion between the highest decile portfolio return and the lowest decile portfolio return was also considerably smaller for the historical beta deciles relative to the predictive beta deciles.

Figure 4: Returns on historical and predicted beta deciles (equal weighted) in April 2009.



Finally, Table 1 gives a summary of the dispersion in decile performance on the months of largest market movements during our sample period. We observe that the return difference between the highest and the lowest predicted beta deciles was typically larger than the difference in return between the highest and lowest historical beta deciles. Moreover, during the most turbulent months in our sample, the return on the lowest beta decile was always lower for the predicted beta based portfolio than the historical beta based portfolio. This illustrates that between 1997 and 2012, during months of market turbulence, predicted beta was a more accurate gauge of the defensiveness of a portfolio than historical beta.

Table 1: Summary of the return dispersion between lowest and highest beta deciles, in months of largest market movements.

Month	Market return (%)	Absolute return difference: decile 10 - decile 1		Lowest beta decile return		Highest beta decile return	
		beta	pred beta	beta	pred beta	beta	pred beta
Oct 2008	-18.3	12.2	24.8	-20.4	-10.6	-32.6	-35.5
Aug 1998	-15.7	17.6	17.2	-9.1	-6.4	-26.7	-23.6
Sep 2008	-11.9	0.7	13.6	-13.9	-6.8	-14.7	-20.4
Sep 2001	-11.0	15.3	19.1	-9.5	-6.6	-24.8	-25.7
Sep 2002	-9.8	13.9	16.0	-3.8	-2.8	-17.6	-18.8
Apr 2003	7.7	15.5	17.4	4.8	4.4	20.3	21.8
Jul 2009	7.9	9.6	12.9	6.1	3.4	15.7	16.3
Dec 1999	8.7	13.7	17.6	1.4	0.9	15.1	18.4
Oct 2011	8.8	19.1	24.3	2.9	-3.0	22.0	21.4
Apr 2009	11.9	30.4	46.0	11.9	3.3	42.3	49.3
Average		14.8	20.9				

Conclusion

Forty years ago Rosenberg and McKibben suggested using fundamental multi-factor models to estimate the covariance matrix of security returns. Over the last 40 years, a number of studies have illustrated that fundamental betas tend to perform better on various measures relative to historical betas.[6]

In this report, we illustrate that during turbulent months between January 1997 and December 2012 fundamental betas proved better than historical betas for constructing portfolios with different levels of market exposure. The return difference between the highest and the lowest predicted beta deciles was almost always larger than the difference in return between the highest and lowest historical beta deciles. Moreover, we found that during turbulent months, the return on the lowest beta decile was always lower for the predicted beta based portfolio than the portfolio based on historical beta. Hence, during our sample period, predicted beta appears to be a more accurate gauge of the defensiveness or aggressiveness of a portfolio than historical beta.

[6] Rosenberg and McKibben (1973), Rosenberg (1985), Bender (2007) and Briner and Connor (2008).

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Appendix 1:
A More Formal Assessment of Performance

We also examined the fit for the security market lines formed using historical and predicted beta deciles.

As an example, let's consider the performance of the decile portfolio in September 2008. This month had the third lowest market return during our sample period, with the World factor posting a loss of 11.9 percent. Figures A1 and A2 examine the fit of the security market lines fitted to the historical and predicted beta deciles during this month. We observed almost no relationship between the returns of the historical beta decile portfolios and their betas. For the predicted beta decile portfolios, the fit of the security market line was considerably better.

Finally, Table A1 gives a summary of the performance of the two beta measures. Here we report the adjusted R^2 of the security market lines during the months with the most extreme returns during our sample period. We saw that, on average, the adjusted R^2 values for historical beta deciles were lower than the adjusted R^2 values for the predicted beta deciles, indicating better performance of predicted betas during months of extreme market movements.

Figure A1: Security market line for historical beta deciles (equal weighted) in September 2008.

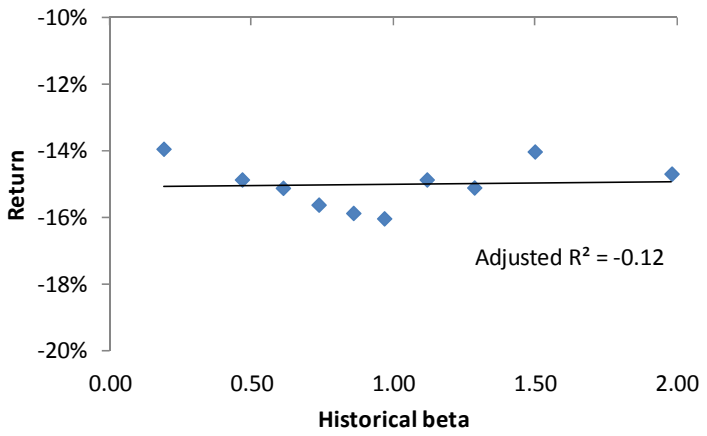

Figure A2: Security market line for predicted beta deciles (equal weighted) in September 2008.

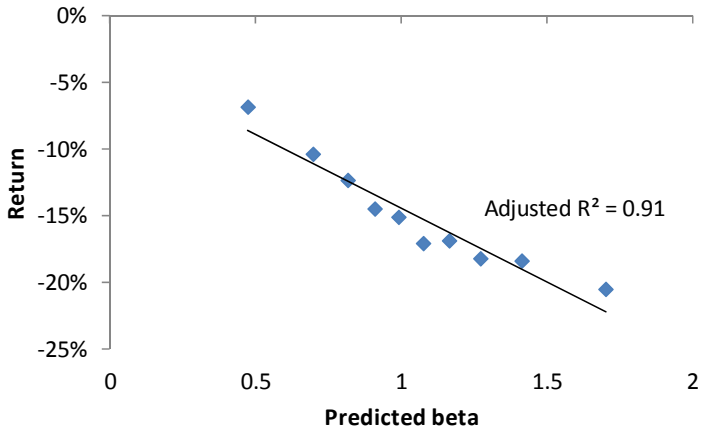

Table A1: Adjusted R squared of security market lines based on historical and predicted beta deciles.

Month	Market return (%)	Adjusted R squared			
		Equal weighted		Capitalization weighted	
		beta	pred beta	beta	pred beta
Oct 2008	-18.3	0.95	0.93	0.98	0.98
Aug 1998	-15.7	0.99	0.82	0.95	0.95
Sep 2008	-11.9	-0.12	0.91	0.32	0.84
Sep 2001	-11.0	0.97	0.99	0.92	0.87
Sep 2002	-9.8	0.91	0.99	0.84	0.90
Apr 2003	7.7	0.87	0.90	0.66	0.81
Jul 2009	7.9	0.93	0.96	0.89	0.92
Dec 1999	8.7	0.92	0.89	0.85	0.85
Oct 2011	8.8	0.99	0.97	0.98	0.90
Apr 2009	11.9	0.95	0.98	0.95	0.99
Average		0.84	0.93	0.83	0.90

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[1]As of March 31, 2012, as published by eVestment, Lipper and Bloomberg in September 2012

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