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Drawdowns Looming? It's Not in the Numbers...

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A quick glance at a chart of predicted risk over the past 30 years suggests that risk in the past has typically risen in advance of major market declines. We set out to quantify the likelihood of a major drawdown in the near future based on current risk model readings. Data from our US risk model suggests a low likelihood of a major drawdown, at least in the near term.

1. Introduction

After 62 trading days from 4/17/14 to 7/16/14 without an absolute daily return greater than 100 basis points, the S&P 500 recently had four such returns over 19 days. With the market near all-time highs, these volatile returns have investors wondering if the market has peaked. Prognosticators have been weighing the relative influence of recent geopolitical news in Ukraine and the Middle East with generally upbeat economic and corporate data to try to explain recent and predict future market performance.

In this piece, we analyze the risk predictions of Axioma's Short Horizon, Fundamental US Equity Risk Model and compare those predictions with historical market downturns. We produce a simple logistic probability model for the likelihood of a drawdown of greater than a fixed percent over the following 20 days based on the risk predictions. The results show that since 2012, the likelihood of a 5% or 10% drawdown has steadily fallen. Currently, the likelihood of a 5% drawdown is about 10%, while the probability of a 10% drawdown is about 1%, both of which are close to all-time lows for such predictions.

A similar pattern of probabilities occurred twice previously: from 1991 to 1992, which was followed by 10 years of solid market performance; and from 2004 to 2005, which was followed by two or three years of solid market performance. And we all know what happened next. The 2008 crash was preceded, however, by a significant, steady increase in the probability of drawdowns for at least one and half years. If history repeats itself, then the data suggests that market will continue to do well until a similar increase in probabilities is observed.

2. Analysis

Axioma's US equity factor risk model provides detailed equity data on a daily basis going back to January 4, 1982. We use the largest (market cap) 500 stocks in Axioma's US risk model estimation universe for this model as a proxy for the market[1].

As explained in the Appendix, we construct daily time series of the cap-weighted portfolio returns, the risk predicted by Axioma's Short Horizon, Fundamental Factor Equity Risk Model (AXUS3-SH), and the maximum drawdown in the 20 days following each prediction. This data is shown in the first three charts of Figure 1.

The data shows four time windows of large drawdowns: (1) the market crash in late 1987, which caused predicted risk to increase suddenly from less than 20% to 45%; (2) July to October 1990, which corresponded to the eight month recession coinciding with the first Gulf War; (3) early 2000 to 2003, where the fallout from the Internet bubble led to a steady downturn until 2003; and (4) 2008, the great recession.

As noted in Axioma Quarterly Risk Review for the second quarter of 2014 (Axioma Insight, http://axioma.com/downloads/2Q14/Axioma_Q22014_RiskRev_US.pdf), market risk has been hovering near 10% for the last year and a half. Even longer periods of low risk occurred

[1] This allows us to avoid having to fill in any missing, daily position data for published benchmarks.

historically in the mid-1980s, 1992 to 1996, and again from 2004 to 2007. So the current relative calm of the markets is not an historical anomaly. There have been several similar periods.

Of course, the calm eventually ended. Was there any warning? Risk increased prior to the crashes in 1987 and 2008, and also rose before the market peak in 1990. Risk was up and down for several years preceding the peak in 2000, but it trended up from 1996 through the 1998 Russian debt crisis and then again through the dot-com bubble and prior to the mid- 2000 market peak. Similar trends may help investors take future precautions.

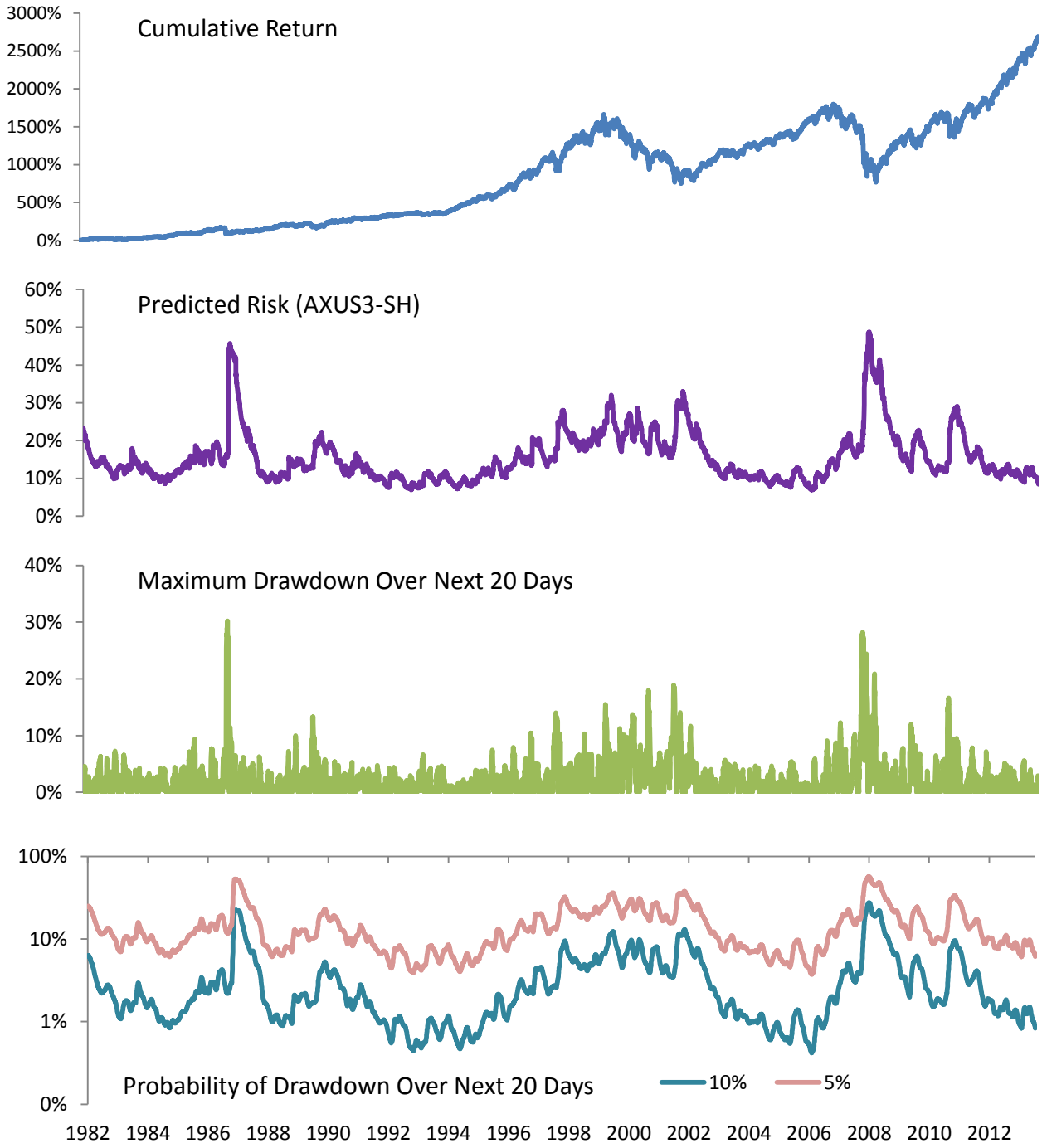
In order to quantify the ability of Axioma's predicted risk to caution investors about future drawdowns, we construct a simple logistic probability model that estimates the probability of observing a drawdown greater than a fixed target drawdown as a function of two parameters: the average predicted risk from 250 trading days prior to 21 days prior to the current time; and average predicted risk over the preceding 20 days. See the Appendix for further details.

The four charts below depict (1) the cumulative return of a cap-weighted portfolio comprising the largest 500 stocks in Axioma's risk model estimation universe (blue);(2) the predicted risk of that portfolio based on Axioma's short-horizon fundamental US3 model (purple); (3) the maximum drawdown for the portfolio in the 20 days following the risk prediction (green); and (4) the modelled probability of a 5% (pink) and 10% (turquoise) drawdown in the 20 days following the risk measurement as predicted by our simple probability model.

The expected drawdown over the next 20 days is estimated by the logistic probability models. One can see that these probabilities have cycled between high and low values over the previous three decades, and are currently both at relatively low levels, with levels having consistently trended downward for the past two years.

Perhaps the most encouraging take-away from these results is that all four major downturns were preceded by notable rises in the probability of a downturn (1986 – 1987; 1989 – 1990; 1996 – 2000; 2007 – 2008). If history is to repeat itself, we would expect a similar increase in the probability of a downturn before the market actually fell. Other than the fact that the market is at all-time highs, there is nothing evident in the current predictions to suggest that the market is ready to fall. The market will undoubtedly retreat eventually, but in the absence of an unforeseen crisis, the market appears to be healthy.

Figure 1. Cumulative Return, Predicted Risk, Maximum Drawdown and Probability of Drawdown, Biggest 500 US Stocks



Source: Axioma, Inc.

Appendix – Logistic Probability Model

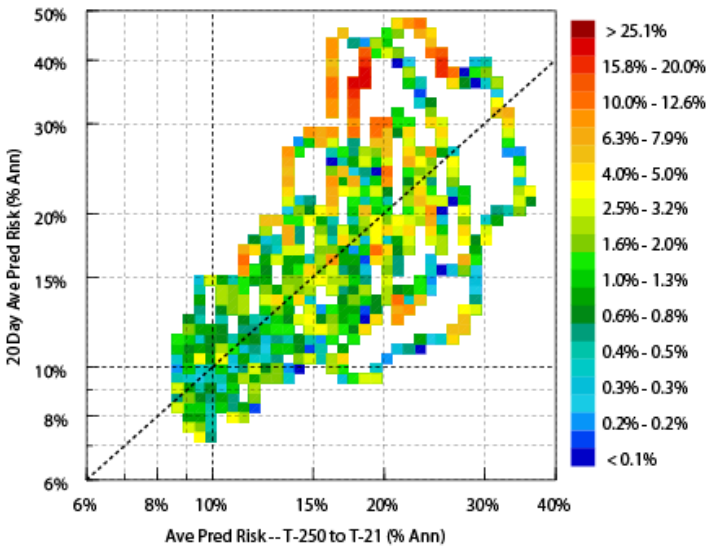
Using the largest 500 equities in Axioma's estimation universe, we construct two time series from 1/4/1982 to 8/8/2014: $r(t)$, the daily, cap-weighted portfolio returns, and $\sigma(t)$, the daily predicted risk for the cap-weighted portfolio.

From this data, we then construct three time series:

- $\sigma_{20}(t)$, the average predicted risk over the preceding 20 days;
- $\sigma_{250-21}(t)$, the average predicted risk from 250 trading days prior to *t* to 21 days prior to *t*; and,
- $d_{20}(t)$, the maximum drawdown over the 20 days following *t*.

Although these time series do not represent independent observations (e.g., the drawdown at *t* + 1 uses 19 of the same daily returns as the drawdown at *t*), for purposes of our simple probability model, we treat each of these observations as independent.

Figure 2: Contour Plot Of The Empirical Drawdown Data As A Function Of The Two Averaged Risk Predictions (Color Scale On The Right)



Note: This is a contour plot of the average observed 20-day drawdown (color scale on the right) as function the average predicted risk from 250 to 21 trading days prior (the slowly changing moving average – the horizontal axis) and the average predicted risk over the preceding 20 days (the vertical axis). Most of the data lies along the diagonal, dashed line where the horizontal and vertical axes are equal. In general, the drawdowns in the

lower left (mostly blue and green) are less than those in the upper right (mostly orange and red).

Source: Axioma, Inc.

We fit a logistic probability model for the probability of observing a drawdown greater than a fixed target drawdown:

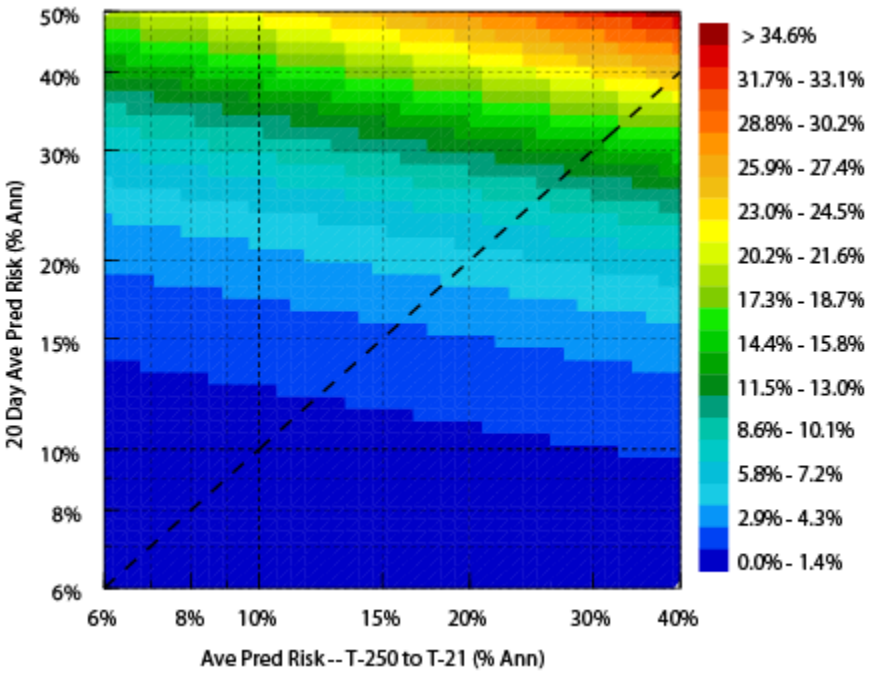
$$\mathrm{P}\left(d_{20} > x\right) = \frac{1}{1+\exp(c_0 + c_1 \log_{10}(\sigma_{250-21}) + c_2 \log_{10}(\sigma_{20})} \qquad \text{(xx)}$$

The coefficients, c_0, c_1, and c_2 are determined using iterative, re-weighted least squares to maximum the likelihood of the observed data. For *x* = 5%, we obtain c_0 = -1.26, c_1 = -0.43, and c_2 = -3.52. For *x* = 10%, we obtain c_0 = -0.41, c_1 = -0.41, and c_2 = -4.94.

Figure 3 shows the predicted probability of a 10% drawdown, according the logistic probability model. The probability is more sensitive to the 20-day average risk than the longer average risk. Although there is always a probability of a large drawdown, investors may be forewarned by a notable rise in predicted risk, as occurred before previous market downturns.

As shown in Figure 1, the modeled probability of a 5% decline over the following 20 days is approximately 10%, and the modeled probability of a 10% decline over the following 20 days is approximately 1%. These numbers can be translated into a time duration by asking how long one would have to wait until the probability of observing the drawdown reached 50%. That is, we solve for the number of periods, n, such that $(1-p)^n = 0.5$. For p = 10%, we get n = 6.6, and for p = 1%, we get n = 69. As posed here, each period is 20 days or one month of trading – where we fail to observe it (probability one minus p), and we need to fail to observe it for all 20 days. So, putting this together, we estimate that there is a 50% chance of observing a 5% drawdown every 6.6 months, and a 50% chance of observing a 10% drawdown every 69 months (5.7 years). These estimates seem reasonable.

Figure 3. Predicted Probability of A 10% Drawdown



Source: Axioma, Inc.