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Using Multiple Risk Models for Superior Portfolio Management…

A Practice Not Just For Quants

Melissa Brown, CFA
Chris Canova, CFA

The focus on risk management is today unprecedented. We believe the use of daily multiple risk models – both short and longer horizon, and both fundamental and statistical – can help managers to predict portfolio risk more accurately. Multiple risk estimates provide a more comprehensive view of portfolio risks, and the daily data that underlies these models can help managers to react faster and with more confidence. Indeed, for growing numbers of Axioma's clients the use of multiple daily risk models is already becoming best practice. The case study presented here highlights the benefits of looking at portfolios through the lenses of multiple daily risk models.

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Overview

The focus on risk management is today unprecedented. We believe the use of daily multiple risk models – both short and longer horizon, and both fundamental and statistical – can help managers to predict portfolio risk more accurately. Multiple risk estimates provide a more comprehensive view of portfolio risks, and the daily data that underlies these models can help managers to react faster and with more confidence. Indeed, for growing numbers of Axioma's clients the use of multiple daily risk models is already becoming best practice. The case study presented here highlights the benefits of looking at portfolios through the lenses of multiple daily risk models.

Case Study

In this case study, we review a US Large Cap Core manager benchmarked to the Russell 1000 Index1. We will attempt to:

- Outline the clear benefits of daily updates to all risk model components
- Show the general structure and differences between fundamental and statistical factor models
- Highlight the pros and cons of each model type and demonstrate the complementary nature of the two approaches
- Introduce a new set of analytics – "Risk Model Spreads" –that can help quickly and intuitively to explain the sources of deviation in estimates between model approaches
- Illustrate how using these new analytics can improve client reporting, increase portfolio manager confidence in digesting risk analytics, and most importantly, improve decision making in portfolio construction.

Note that our case study portfolio is one run by a fundamental manager. The benefits we highlight below can accrue to both fundamental and quantitative managers who desire to effectively manage the risks in their portfolios.

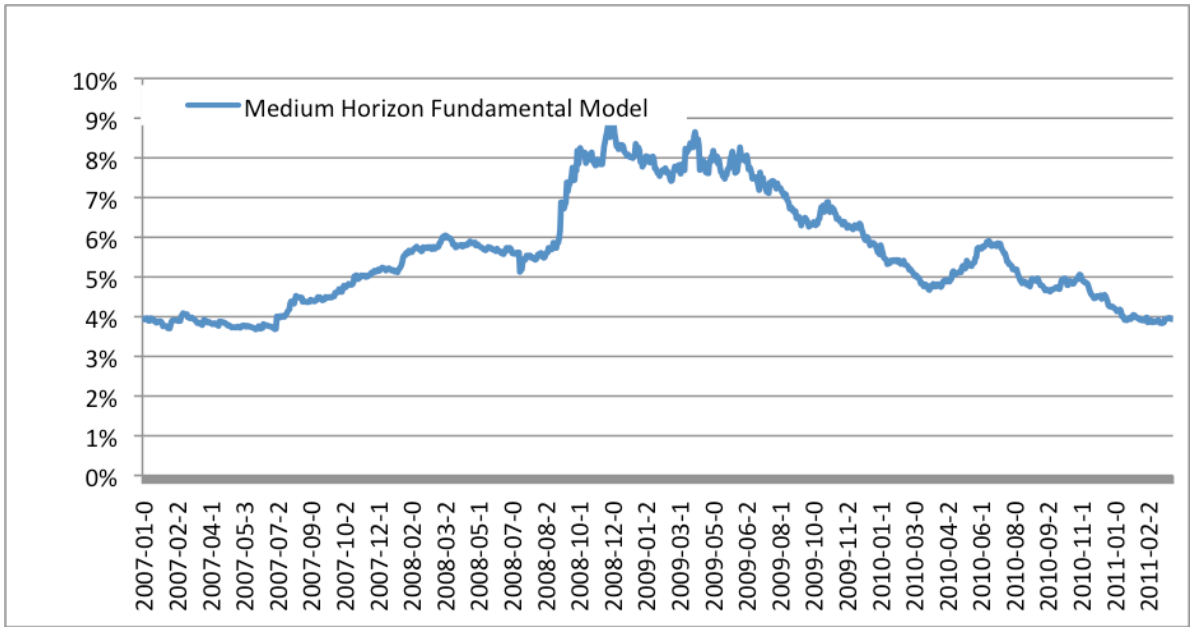
We will use the quarterly holdings of a fundamentally-oriented portfolio from early 2007 through February 2011 to illustrate our points. The financial crisis and its aftermath clearly resulted in variations in predicted risk. Our goal is to show that using more than one model would have helped to identify risk changes during the financial crisis sooner than a single monthly model, and to locate the source(s) of

[1] Source: Evestment Alliance

changing risk, while maintaining the manager's ability to identify risks and attribute returns. In this study we hope to highlight a consistent, intuitive, and repeatable framework to improve on these historically common approaches. In doing so, we will illustrate the value of providing more timely and actionable analytics, increasing the context and basis for interpreting these numbers, and highlighting methods for incorporating these insights into an improved portfolio construction process.

Figure 1 illustrates a common time-series chart of predicted active risk, using our case study portfolio holdings and the medium-horizon fundamental factor risk model – what the user of a single model might see.

Figure 1. Predicted Active Risk



When discussing use and types of risk models, we are often asked the following questions:

- Why is using daily data important?
- Are fundamental or statistical models more accurate?
- Which of these models performs best for portfolio construction?
- Should I use a short or medium-horizon model?
- How important is the risk model and alpha horizon alignment?

The benefits of using daily data have been explored in prior research papers2. To summarize, more data points in a shorter period of time improve a model's accuracy. Because risk updates are made available as events occur, trading can be done using the most up-to-date risk information. One also avoids the beginning-of-month crowding associated with monthly model updates. While the different closing times of various markets worldwide could present potential issues for multi-country models, Axioma uses returns timing adjustment to deal with asynchronicity across such markets.

[2] See, for example "Risk Model Reliability: Daily vs. Monthly Estimates", Anthony Renshaw, PhD, Axioma Research Paper number 6.

Reporting is key to a manager's understanding of a portfolio's risks and the ability to react to those risks. Using stale data, especially when underlying risks are changing rapidly, can lead a manager to under- or over-react. There also are times when an unusual source of risk may emerge that has previously been undiscovered but may have significant impact on a portfolio's returns. Note that the ability to look at daily reports using daily data updates, rather than using stale month-end data, is already a significant step in the right direction, and we will address this issue again in the discussion below.

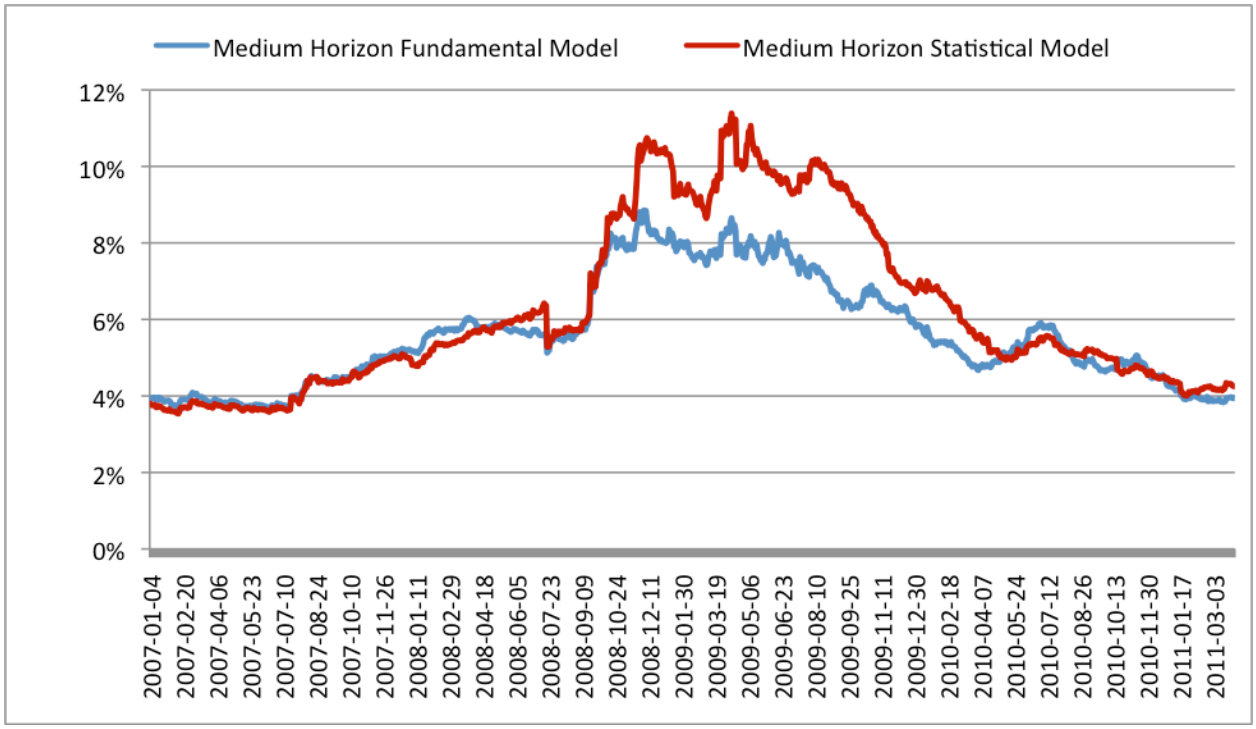
As for the fundamental versus statistical model debate, in our experience there is no one answer for every portfolio. Each approach to risk modeling has its own benefits. Fundamental models provide a consistent and explainable framework for risk decomposition, portfolio construction and performance attribution. They typically do a good job of forecasting risk, and can explain the factors currently driving risk exposures, both historically and intuitively. However, fundamental models may not contain "all of the factors" relevant to practitioners, such as short-term temporary factors. Statistical models, in contrast, have no preconceived notions about what the factors should be; factors emerge as part of the estimation process. Statistical models are better able to capture short-term phenomena and in general do well in providing unbiased risk estimates. However, there may be a lack of intuition in explaining factor exposures and returns, which makes statistical models difficult to use for performance attribution and risk decomposition. Regarding the model's investment horizon, a short-term trader may prefer a short-term model, especially when volatility is changing rapidly. A longer term investor may prefer a medium-horizon model during "normal" periods, as a shorter term model may lead to unnecessary trading.

However, when risks are changing, even a manager usually focused on a longer horizon may want to use a shorter-term model. The medium-term model, which uses a longer history, may under- or overestimate risk. An underestimate of risk may lead to undesirably high realized risk, whereas overestimating may lead a manager to leave return opportunities on the table. For all these reasons, we believe portfolio managers should not restrict themselves to using a single risk model, as their ability to manage portfolio risk can be enhanced with multiple models. As noted, while each type of model has benefits and pitfalls, together they work synergistically.

One note of caution: We believe that it is important to use just one vendor for multiple risk models. If the models come from different sources, the model providers might use different methods for estimating factor return frequency – e.g. a fundamental model may use monthly data while a statistical model uses weekly data. In this case, it is difficult to distinguish if the differences in risk estimates are associated with the assumptions of the model estimation process, or due to the modeling approach. Using models estimated with different approaches by the same vendor ensure the data sets, estimation universe, frequency of data, half-life assumptions (i.e. deciding how much history should be used in determining current risk estimates) , and approach to calculating specific risk are aligned, allowing for improved accuracy of distinguishing the differences using the methods outlined in this case study. Further, the ease of integration of analysis is greatly improved by a platform which automatically integrates the various risk model estimates.

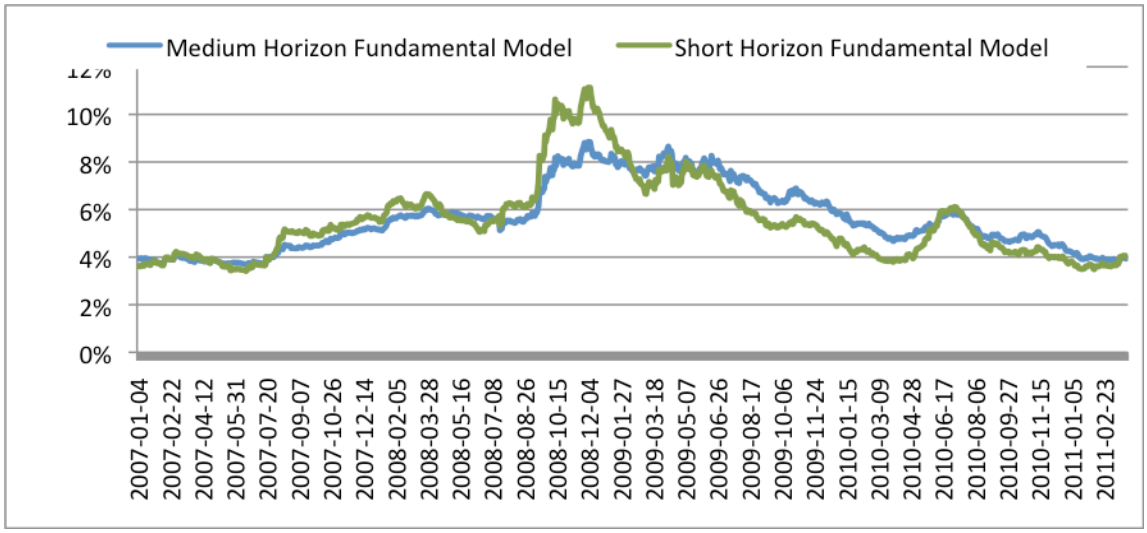
Let's review our case study portfolio from the perspective of all four of Axioma's US Risk Models. How would our views of risk levels change if we added additional risk models to the plot?
As shown in Figure 2, when the medium-horizon statistical model is compared with the medium-horizon fundamental model, we see a substantial divergence in risk estimates for about a year and a half, with the statistical model predicting higher risk than the fundamental model for the entire period. In the "more normal" periods included in this study, the two models produced essentially the same risk estimates. A statistical model, however, may do a better job than a fundamental model at picking up unusual sources of risk. As mentioned, one potential downside is that it may be difficult to explain what that statistical factor is, and this lack of intuition may make managers reluctant to use a statistical model. Yet statistical models can provide an extremely important validation of whether the level of portfolio risk is truly close to its target.

Figure 2. Predicted Active Risk Comparison, Fundamental Vs. Statistical



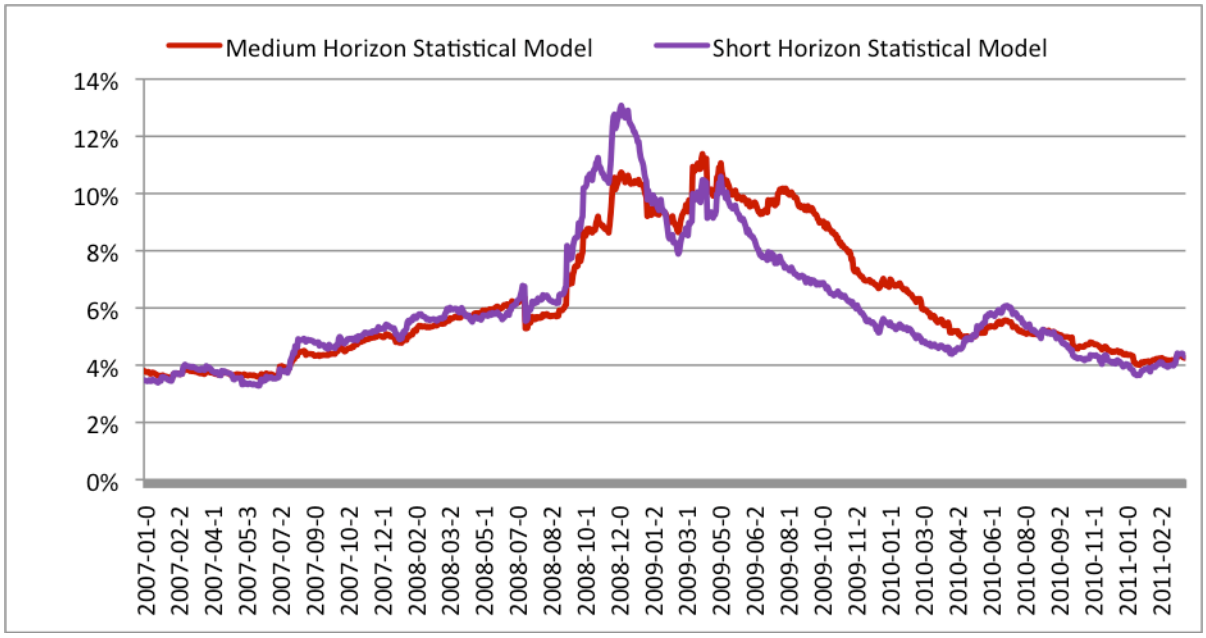
Now we turn to the short horizon versus medium horizon comparison for the fundamental models. Figure 3 shows that the short-horizon model reacted much more quickly to the sudden change in risk in September 2008 (in fact, the medium horizon model never really caught up). In addition, as risk settled down in mid-2009 the short-horizon model again reacted more quickly. A manager using both models might have been able to refrain from rebalancing a portfolio that seemed to have too much active risk from a medium-horizon perspective, knowing that the predicted risk would come down.

Figure 3. Predicted Active Risk Comparison, Medium Vs. Short Horizon, Fundamental



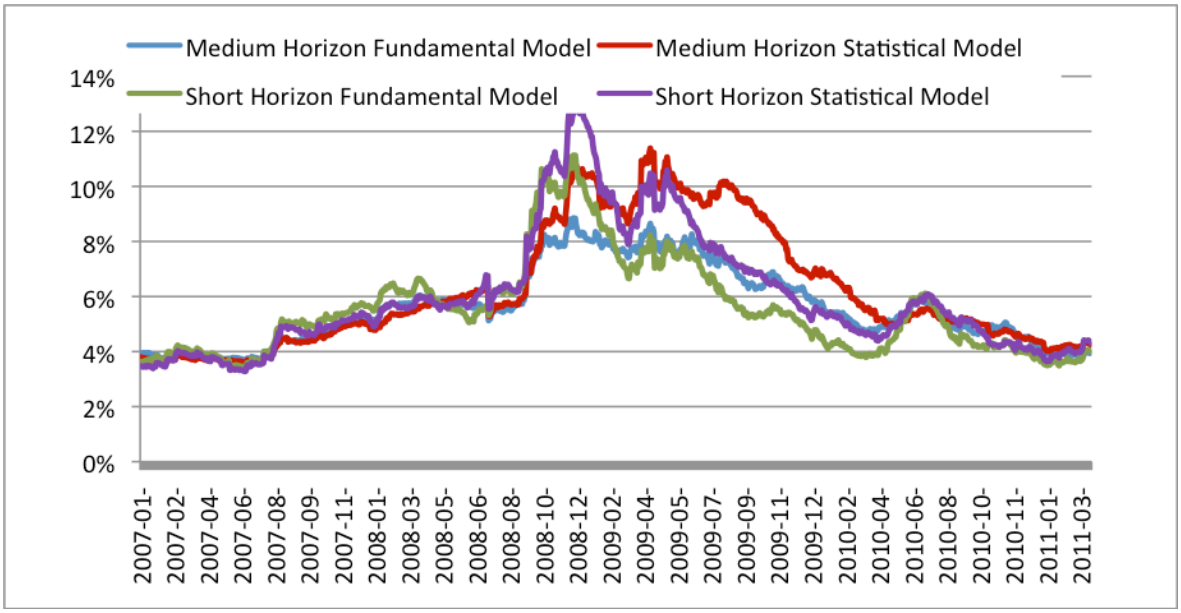
Similarly, as shown in Figure 4, the short-horizon statistical model led the medium-horizon model.

Figure 4. Predicted Active Risk Comparison, Medium Vs. Short Horizon, Statistical



Viewed together in Figure 5, we see that the different levels of predicted risks during the crisis eventually converged when the market settled down. Each offered its own insight, and a manager looking at all four could have obtained a better handle on the risks being taken.

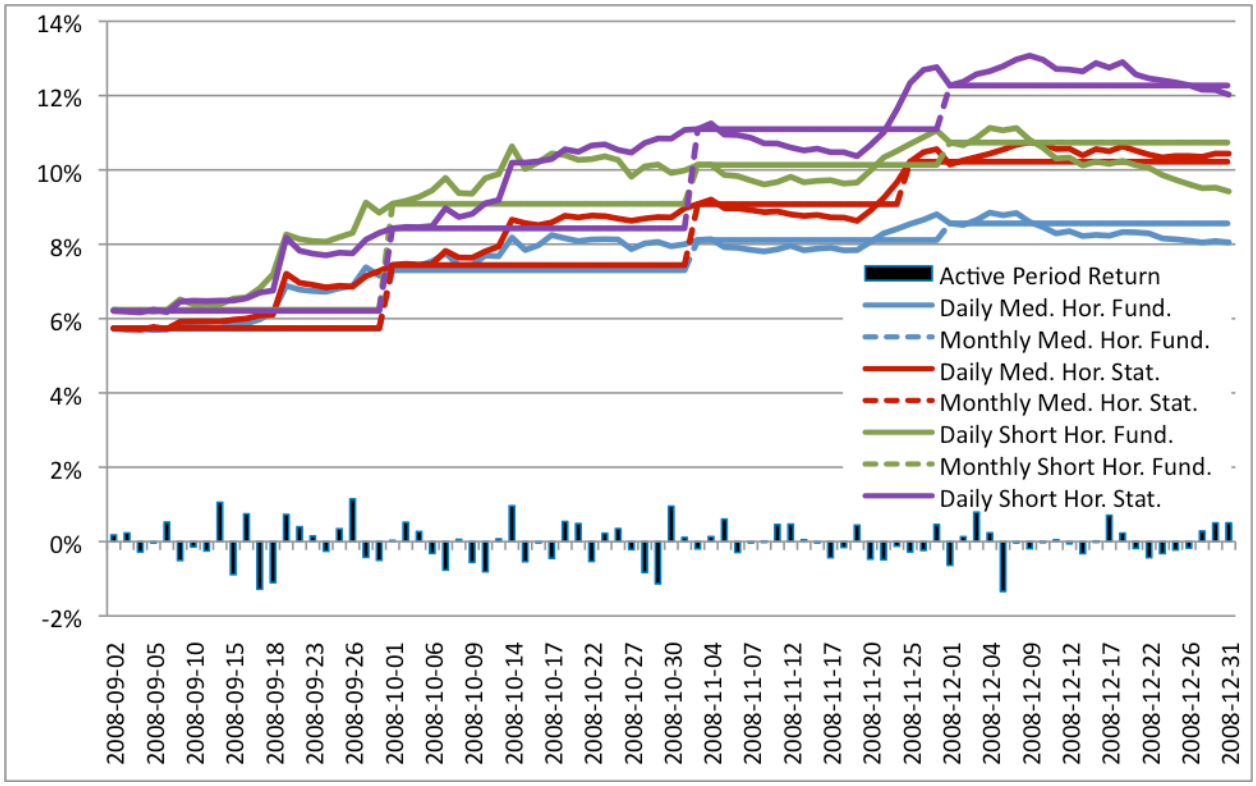
Figure 5. Comparison of All Four Models



In summary, we observed a time of stable volatility in the beginning of 2007, when risk models were in sync with respect to the predicted risk of the portfolio, regardless of horizon or approach. In mid 2007, volatility began to increase and the risk estimates diverged. With the financial crisis in 2008, dramatic changes occurred. The shorter horizon models highlighted the magnitude of the volatility increase much more rapidly than the medium-horizon models. By design, with shorter half-lives (again, relying more on recent history), this was to be expected. We also saw that the statistical models estimated greater risk vs. their fundamental counterparts.

Upon closer inspection, we can identify the benefits and insights that could have been seen using daily updates of risk during this period. In Figure 6, the dashed lines represent the "once a month" risk model update process. These estimates jumped significantly at the end of each month. The crowding effect of multiple managers rebalancing with this new information, and the drastic attempts to reduce risk during this period, had profound implications for asset trading and portfolio rebalancing during this period. Daily information highlighted the increases in volatility much earlier during each month. Armed with this information, portfolio managers could have better adapted and potentially understood what was occurring, rather than moving blindly through the month waiting for their risk model to update. Of course, we do not mean to suggest that daily risk model updates make daily rebalancing appropriate. The value of daily risk models is that they provide portfolio managers with better and more timely estimates of risk, as well as the flexibility to rebalance as they see fit at any time during the month, incorporating their views of return opportunities balanced with the most up to date risk profile for their portfolio and assets.

Figure 6. Comparison of Daily Vs. Monthly Updates, All Models



The data at the x-axis of the graph shows a simple plot of the daily active returns of this portfolio. We see a clear pattern of increased dispersion of daily active returns during the first two weeks of September 2008, with daily returns approaching and exceeding 1% swings per day3. The active risk of the portfolio quickly responds, with the short-term models jumping from just over 6% to almost 8% in a matter of weeks. The medium-horizon model responds more gradually.

The graph highlights the fact that—with a model that is only updated monthly—much of the increase in volatility is not captured until the last day of the month. However, with daily risk model updates, we can identify and incorporate these changes in risk into the portfolio profile as the month unfolds. When mid-month volatility occurs, daily models will clearly add value to reporting and risk management. A manager mandated to keep active risk under a certain level would have been able to recognize this and react more quickly.

In Figure 7, we rely on some of the analytics underlying the risk model to illustrate how using different types of models along with daily updates can help a manager identify what is changing in a portfolio's risk profile.

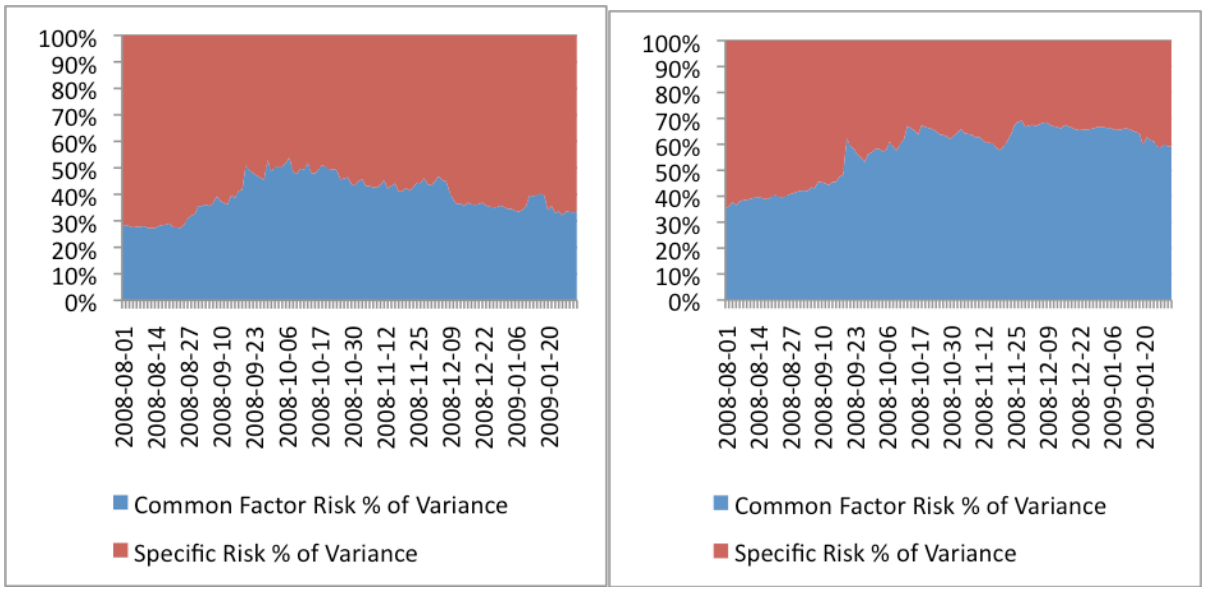
Sources of Risk

Let's look at the decomposition of factor vs. specific risk using Axioma's Medium Horizon Fundamental and Statistical models. In the charts below, we show the percentage of active risk coming

[3] At a targeted active risk level of 6%, we would expect the portfolio's returns to be within about 75 basis points of the index 2/3 of the days.

from Common Factor vs. Specific Risk. The chart on the left represents the decomposition using the fundamental model, the chart on the right represents the decomposition using the statistical model. The statistical model suggests that the increase in risk is largely due to an increase in "market" risk, while the fundamental model suggests that the increase in risk is "stock specific" (indicating a potential missing factor in the fundamental model during this period).

Figure 7. Components of Variance, Fundamental (Left) Versus Statistical (Right) Models



In Figure 7, the statistical model shows that common factor risk increased, but what factor was at play? Perhaps a counterparty or solvency risk factor? Many ideas have been put forward to explain this risk profile increase. Regardless of the cause of these market shocks, the point is that a portfolio manager needs to have a good understanding of how the portfolio's risk decomposition may be affected by regime shifts in volatility by using two, three or even four risk model types. The statistical model was able to capture and report this due to the free form of the estimation process. Because this factor was not one of the pre-defined factors used by fundamental risk models, the increase was not captured as factor risk, and was pushed into specific risk.

This is not to say that all fundamental factor risks did not change over this period. In fact, for a few factors, we observed a significant increase in risk (see Figure 8). The risk of a tilt on volatility or size increased significantly near the end of 2008, and only gradually decreased over the subsequent period. A manager might have reined in even a small bet on one of these factors during this time.

On the other hand, the risk – from a fundamental model perspective – changed little on a number of other risk factors (as shown in Figure 9), and a manager might have wanted to use the turnover budget to change other bets.

Figure 8. Factor Volatilities

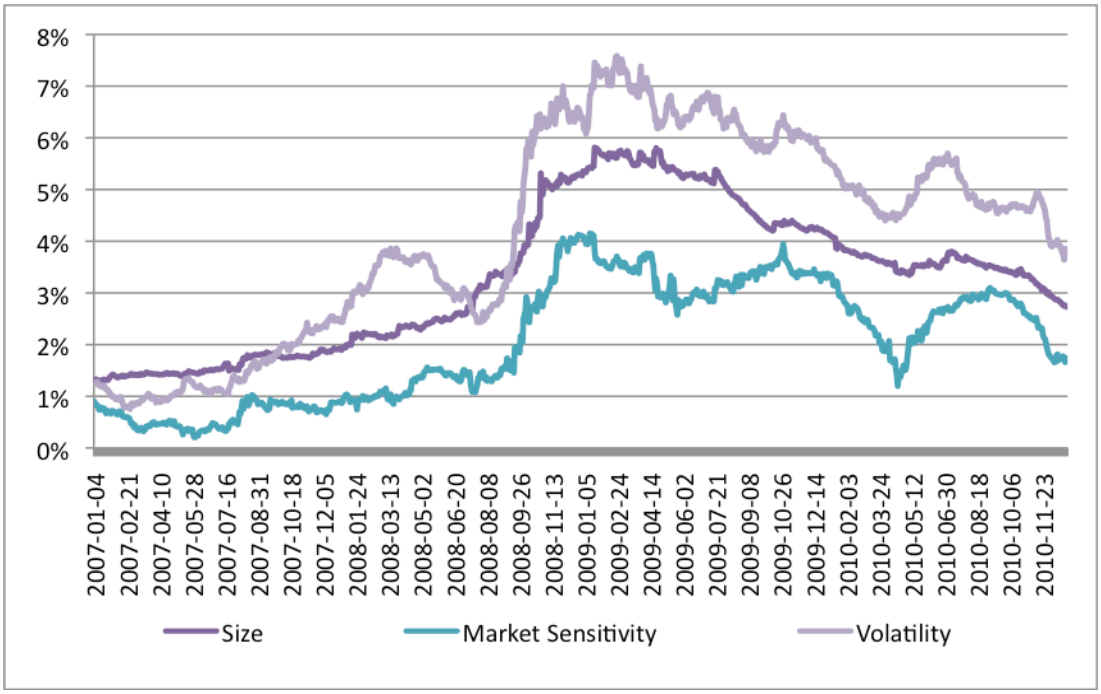
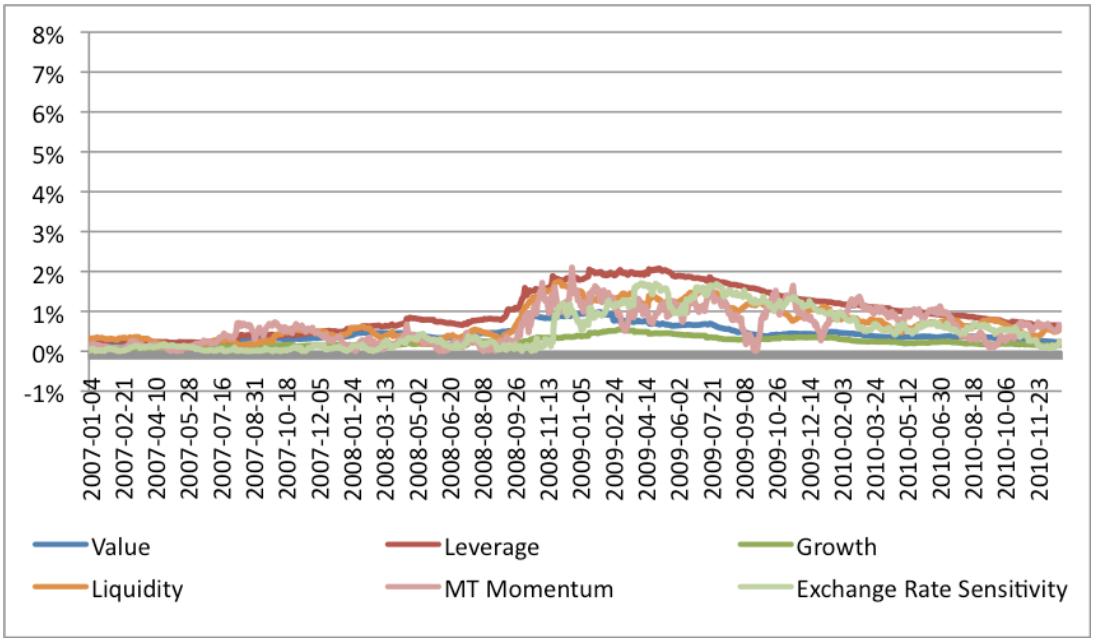
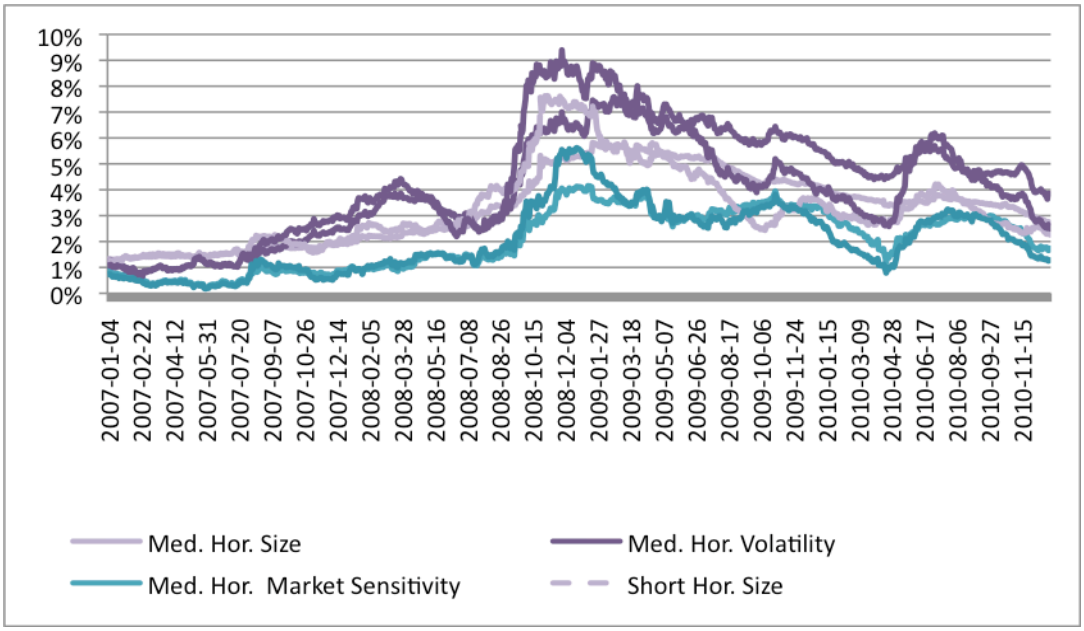


Figure 9. Factor Volatilities, Continued



A comparison of the risk changes in the short-horizon versus the medium-horizon models provides additional insights. Figure 10 shows that near the end of 2008, the risk of size, volatility and market sensitivity shot up much more quickly in the short-horizon models than in the medium-horizon models. The short-horizon models also declined more quickly for size and volatility as risk settled down. However, the short-horizon version of market sensitivity did not drop off any more quickly than the medium-horizon version.

Figure 10. Comparison of Select Factor Volatilities, Medium Vs. Short Horizon



The sources of the risk differences have significant implications for stock pickers and quant managers alike. For portfolios that seek to be neutral to factors, using only a fundamental model may lead to a misestimation of true risk. And a single focus on a medium-horizon model may cause a manager to react too slowly to big changes in risk. For those managers who aim to tilt on certain factors, the change in risk may actually reduce their exposure to those factors as "stock-specific" risk increases. A fundamental manager may also want to know when the risk in individual stocks is changing, and scale his or her bets accordingly.

Introducing Risk Model Spreads

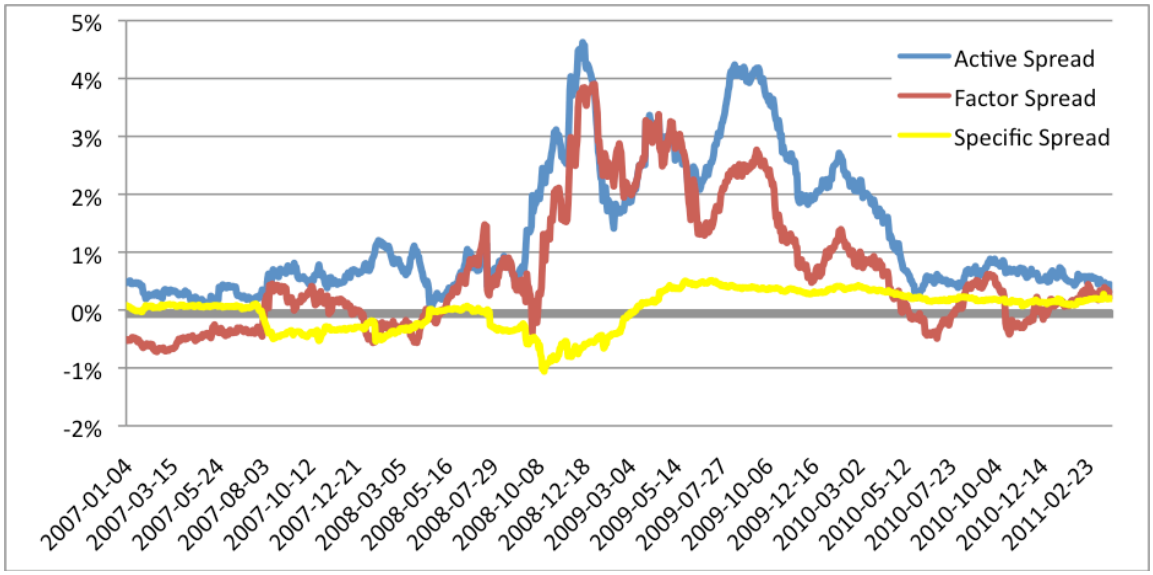
Identifying when and how models diverge does not need to be a needle in a haystack exercise. A simple and intuitive set of analytics produced daily can help distinguish the causes of differences in risk model estimates very clearly. We introduce the concept of risk model spreads, in various categories defined below, that seek to provide just this information:

- Active Spread = Largest Risk Estimate – Smallest Risk Estimate
- Common Factor (CF) Spread = Stat Model CF Risk – Fund Model CF Risk
- Specific Risk Spread = Stat Model Spec Risk – Fund Model Spec Risk
- Stat/Fund Spread = Stat Model Risk – Fund Model Risk
- Short /Medium Spread = Short Model Risk – Medium Model Risk

By definition, the Active Spread will always be positive, and it is the magnitude that is most important, whereas the direction of the other spreads will contain additional information. These daily analytics supply early indications of risk model divergence, leading to increased ability to incorporate this information into portfolio management. Most importantly, users can see why the models are diverging, and make appropriate decisions as to whether or not they should act on this information.

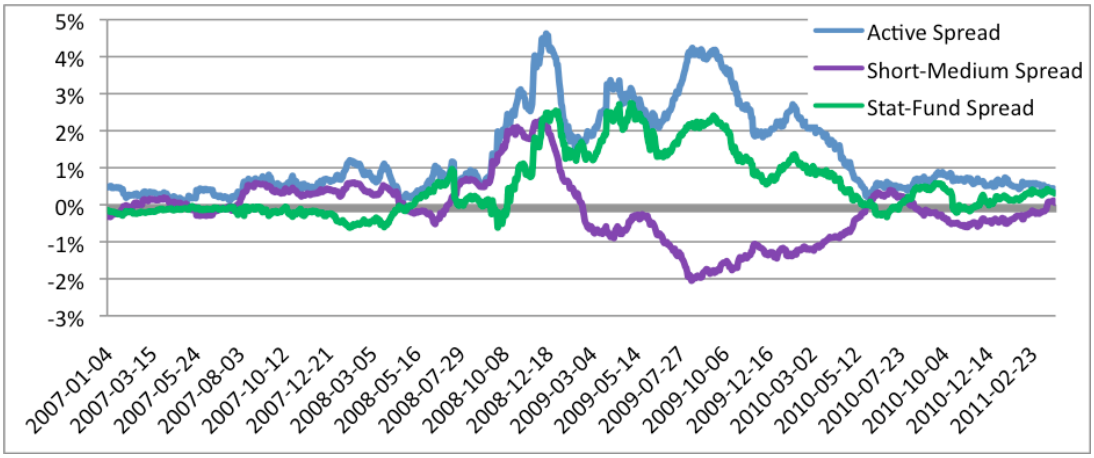
Figure 11 shows a time series chart of the Active Spread, Factor Spread, and Specific Spread. What we see is that as the volatility increase over 2007 and 2008 occurred – and the active spread grew -, the differences in estimates were largely due to the factor structure of fundamental and statistical risk models using different methodologies.

Figure 11. Active, Factor and Specific Spreads



Next, let's examine the differences in trends in risk associated with the horizon of the model, as well as the type of risk model. By definition, when the Short-Medium spread is above 0%, the short-horizon model predicts higher risk than the medium-horizon counterparts. As we see in Figure 12, starting in April 2009, the short-horizon model started predicting lower risk than the medium-horizon models as volatility subsided. At that time, some models may have been significantly overpredicting risk. While every risk model is subject to some degree of lag, Axioma's methodology of Dynamic Volatility Adjustment helps users adjust much more quickly to these changes in risk.4

Figure 12. Active, Short/Medium and Stat/Fundamental Spreads



[4] Please contact your sales representative to see "Dynamic Volatility Adjustment Overview", Axioma Research Paper, May 2009.

We believe by using these model spreads, a manager can identify sources of changing risk, and can do so earlier than by using just one model. Some implications of these spreads include:

- Shorter-term models will move more quickly, and may signal to a manager that it is time to rein in or loosen up risk, because the longer-term model will eventually catch up
- If the common factor spread and the specific risk spreads are in opposite directions, this indicates a shift in the distribution of risk, not necessarily a change in overall risk
- If both spreads are positive, then the statistical model may be picking up something not yet seen by the fundamental model – perhaps a new temporary factor is driving risk.

One can, of course, extend this analysis to fundamental model components to examine changes in the underlying common factors.

Conclusion

Using a sample portfolio's risk characteristics during a time of high market stress, we have attempted to illustrate a number of different points related to a manager's ability to quantify and subsequently manage risk. We've shown that a risk model using daily data will recognize changes in risk much more quickly than one that relies on monthly data updates. By using both statistical and fundamental models in our analysis, we have shown how a manager might dig down to identify sources of changing risk, and thus rebalance the portfolio accordingly. We have also demonstrated that using short-horizon and statistical models can alert a manager to changing levels of risk earlier than using a medium-horizon fundamental model by itself, even if those variations of the models are not used for portfolio construction.

We believe that risk-management approaches using only one type of risk model and/or monthly data updates are essentially obsolete. Further, using multiple models that are developed with different approaches and assumptions can be problematic for truly identifying the sources of the differences. More detailed and second-opinion checks on risk analytics can improve a manager's ability to recognize a changing risk environment and problematic assumptions, and therefore manage risk more effectively. Finally, one does not need to be a quantitative manager to benefit from recognizing and understanding the changing risk landscape. The ability to effectively manage portfolio risk is a universal necessity.