BARCLAYS

Quantitative Portfolio Strategy

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DTS Ratio as a Portfolio Risk Measure

Since we introduced DTS (Duration Times Spread) as a measure of credit risk ten years ago, it has continued to gain acceptance throughout the money management industry. Some mandates now use constraints on the overall DTS ratio of the portfolio to the benchmark in their investment policy. We explore the usefulness and limitations of the DTS ratio for controlling overall portfolio credit risk exposure.

- A DTS ratio has an advantage over DTS limits in that its imposition does not lead to selling as spreads widen as long as widening affects both the portfolio and the benchmark.
- A DTS ratio captures the portfolio risk vs. the benchmark well in times when relative spread changes across sectors are similar and highly correlated. At other times, relative spread volatilities of different sectors can diverge substantially and their correlations can decline. In such environments, the overall DTS ratio can be a less accurate predictor of portfolio risk.
- DTS ratio has served as a good measure of portfolio credit risk over the past couple of years. Nevertheless, as a precaution against sector-specific risk, we recommend that investors continue to monitor portfolio DTS exposures by sector as well.

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Is a Single Number Sufficient?

It has now been ten years since we introduced DTS (Duration Times Spread)[1] as a measure of credit risk exposure in 2005. In that time, we have explored applications of this measure to many aspects of credit portfolio management, including index replication, hedging, setting issuer constraints, and measuring the risk stemming from a portfolio's active sector weights relative to its benchmark.

Our research on DTS has shown that spread volatility tends to be proportional to spread, and that as a result, excess return volatility tends to be proportional to DTS. However, we have always been cognizant that DTS on its own does not provide any information about correlations. Therefore, when aggregating DTS across a broad credit portfolio, the most accurate risk estimate is obtained by summing DTS exposures across similar securities (e.g., within a particular sector or industry), and then using a risk model that considers correlations as well to evaluate the net effect of all sector-level exposures. This approach was used when incorporating DTS into the Barclays POINT Global Risk Model.[2]

In some credit mandates, one of the constraints imposed by the plan sponsor may be that the overall DTS of the portfolio may not deviate from that of the benchmark by more than a certain percentage. That is, the quantity constrained is the "DTS Ratio," or the ratio of portfolio DTS to that of the benchmark. This quantity does not take into account the effect of correlations on overall risk, and could allow for some distortion in portfolios with large active sector weights. To what extent does a DTS ratio close to 1 ensure that portfolio risk is similar to that of the benchmark? Does it work better in some market environments than others?

We address the use of the overall DTS ratio in the formulation of portfolio investment policy. First, we briefly discuss the distinction between constraining DTS contribution and DTS ratio. Next, we test the extent to which the overall portfolio DTS ratio can capture risk while ignoring correlations among sectors. For this, we use a very simple ad hoc DTS-based risk model to evaluate the risk of some simple active portfolios. We consider one group of portfolios that is credit-neutral by design, for which the DTS ratio is 1.0, and a second group of long-credit portfolios with a DTS ratio of 1.1. Do all portfolios in the overweight group always carry more risk than those in the credit-neutral group? We find that the answer depends on the level of sector correlations and the dispersion of relative spread volatilities in the credit market. In the current regime, with similar volatilities and high sector spread correlations, DTS ratio provides the desired differentiation with little ambiguity. In other time periods when sector correlations were lower and volatilities more dispersed, this would not have been the case.

Why DTS Ratio?

Even for those who have adopted DTS as a primary measure of credit risk, it may not be immediately clear why a plan sponsor might specify the allowed deviation from benchmark DTS in relative terms. A more precise way to keep the tracking error volatility (TEV) of the portfolio relative to the benchmark near a constant level would be to constrain the active DTS contribution to a constant absolute amount. However, this could effectively represent a spread stop-loss constraint that could negatively affect long-term portfolio performance. To illustrate this effect, consider the simple example shown in Figure 1. We assume that at the time the mandate is established, the benchmark is considered to have an average duration of 5 years and an average spread of 100bp, for a DTS of 5.0. The portfolio is allowed to deviate from this value by 10%, or by a DTS contribution of 0.5. In the base case, these two ways of expressing the allowed deviation are equivalent. However, consider what might

[1] See *A New Measure of Spread Exposure in Credit Portfolios*
[2] See *A Portfolio Manager's Guide to Multi-Factor Fixed Income Risk Models and Their Applications*

happen were spreads to double. Assuming that the wider-spread bonds in the portfolio would tend to widen by more than the benchmark (by the same proportion), the difference between portfolio and benchmark DTS would widen as well. The portfolio's DTS overweight would still be 10% of benchmark DTS, but in absolute terms it would have doubled from 0.5 to 1.0. Were the constraint expressed as a fixed limit on DTS overweight of 0.5, this would require a significant selloff of the portfolio position, locking in losses. With the constraint expressed as a percentage of benchmark DTS, the portfolio is allowed to absorb proportionally more risk as the market becomes more risky; this ensures that a portfolio that was permissible when established will not find itself in violation of investment policy solely due to a market-wide spread widening. (Note that if the portfolio OAS widens by proportionally more than the benchmark, there may indeed be a need to reduce risk; this is as it should be.) If the investor has a limited risk threshold, and would not be ready to tolerate the additional risk of continuing to hold the long-credit position in such a scenario, a fixed limit on DTS contribution may indeed be the appropriate policy. However, we have found that stop-loss constraints that force managers to liquidate positions after credit deterioration have been associated with poor through-the-cycle performance.[3] An investor with a longer return horizon and a somewhat greater tolerance for risk may prefer to give the manager the freedom to exercise judgement on whether to hold on to such positions, rather than force liquidations if spreads should rise. Constraining based on DTS ratio may give such freedom to the manager.

FIGURE 1
Effect of Spread Widening on Portfolio Active DTS

	Benchmark Characteristics			Portfolio Characteristics			
Scenario	OAS	OASD	DTS	OAS	OASD	DTS	DTS Overweight
Base Case	1.00	5.00	5.00	1.10	5.00	5.50	0.50
Spreads Double	2.00	5.00	10.00	2.20	5.00	11.00	1.00

Source: Barclays Research

Constructing Portfolios with Active Sector Weights

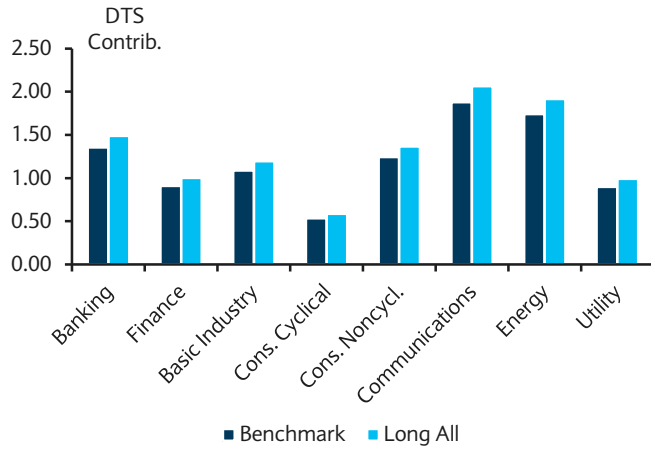
Does the overall DTS ratio give an accurate measure of whether the portfolio is more risky than the benchmark? To study this, we consider an eight-sector partition of the US Corporate Index, and construct stylized active portfolios by setting the weights assigned to these eight sectors over or under the benchmark weights. To express the ambiguity inherent in using a single DTS ratio to capture portfolio risk, we construct a family of long-credit portfolios that can all be characterized by the same DTS ratio of 1.1. We similarly construct a family of DTS-neutral portfolios, with DTS ratio 1.0. We then test whether all of the long-DTS portfolios indeed take on more credit risk than all of the DTS-neutral portfolios.

Figure 2 shows an active portfolio with a DTS ratio of 1.1 spread evenly across all sectors. When viewed in terms of DTS contributions, the portfolio is overweight by 10% of the benchmark DTS contribution to each sector.[4] This sector-neutral long-credit portfolio may be the most intuitive interpretation of a DTS ratio of 1.1. However, there are many other active portfolios that could result in precisely the same DTS ratio. In Figure 3, we show a

[3] See, for example, *Capturing Credit Spread Premium* and *Effect of Rating Stop-Loss Rules on Credit Portfolio Performance*.
[4] For our purposes, the precise implementation of these positions is not important. This position could be implemented by maintaining benchmark market weights by sector, but tilting the portfolio towards longer durations and/or wider spreads. Alternatively, the benchmark portfolio could simply be leveraged up by 10% across the board.

FIGURE 2

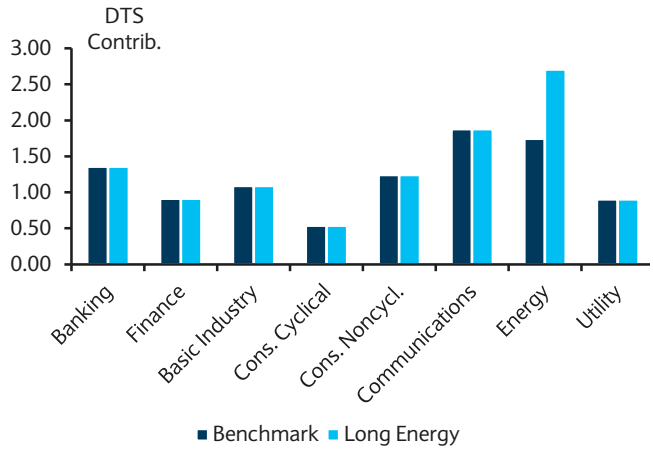
Active Portfolio with DTS Ratio 1.1 – Long All Sectors



Source: Barclays Research

FIGURE 3

Active Portfolio with DTS Ratio 1.1 – Long a Single Sector



Source: Barclays Research

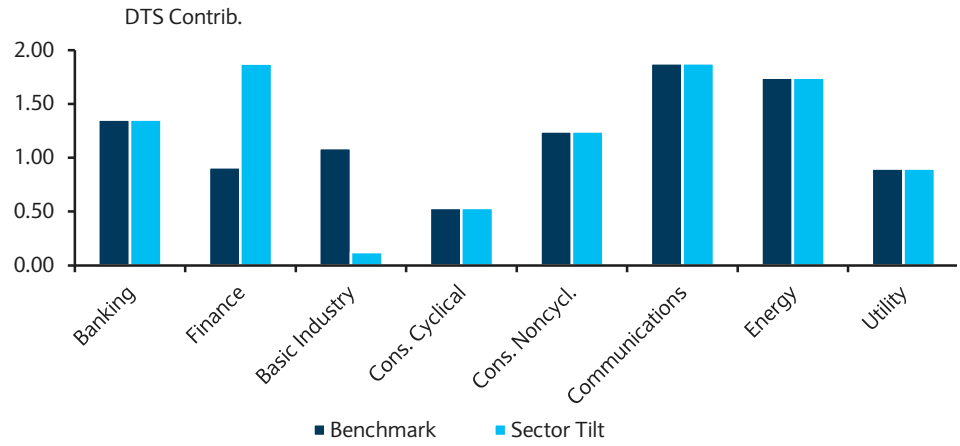
very different type of long-credit portfolio. In this single-sector implementation, the portfolio DTS is the same as that of the portfolio shown in Figure 2, with the same 10% DTS overweight relative to the benchmark. However, now this overweight is concentrated in a single sector. To achieve this, the DTS exposure to the energy sector is 55% higher than that of the benchmark, while those in all other sectors match the benchmark. While we have illustrated a portfolio that is long energy in particular, it is clear that we could just as well be long any of the other sectors in a similar fashion.

It should be safe to assume that any of the long-credit portfolios constructed in this way should have greater credit risk than the benchmark. However, depending on how relative spread volatilities and correlations vary from sector to sector, the various single-sector overweights may entail more or less risk than the "long all sectors" portfolio.

We now turn our attention to the DTS-neutral portfolios. A DTS ratio of 1.0 implies that the portfolio is neutral to the benchmark in terms of credit exposures; one might well imagine a portfolio that exactly matches the benchmark DTS exposures in all sectors. However, it is also possible for a portfolio to achieve overall DTS neutrality while containing a strong sector tilt: long one or more sectors against others. We will look at sector long-short portfolios with an overweight equal to 10% of benchmark DTS to one sector, and an equal and opposite underweight to another sector. A position of this type is illustrated in Figure 4, for a portfolio that is long finance and short basic industry. This recipe, when applied to all possible choices of which of our eight sectors to go long and short, can generate 56 different active portfolios. Once again, depending on volatilities and correlations, some of these portfolios are more risky than others.

FIGURE 4

Sample Active Portfolio with DTS Ratio 1.0 – Long Financials, Short Basic Industry



Source: Barclays Research

Comparing the Credit Risk Exposures of Long-DTS and DTS-Neutral Portfolios

To estimate the excess return volatility associated with each such portfolio, we need an estimated covariance matrix of relative spread changes.[5] For this exercise, we have chosen to compute this covariance matrix from the monthly relative spread changes in our eight sectors, using exponential weighting with a 1-year half-life to give greater weight to recent data.

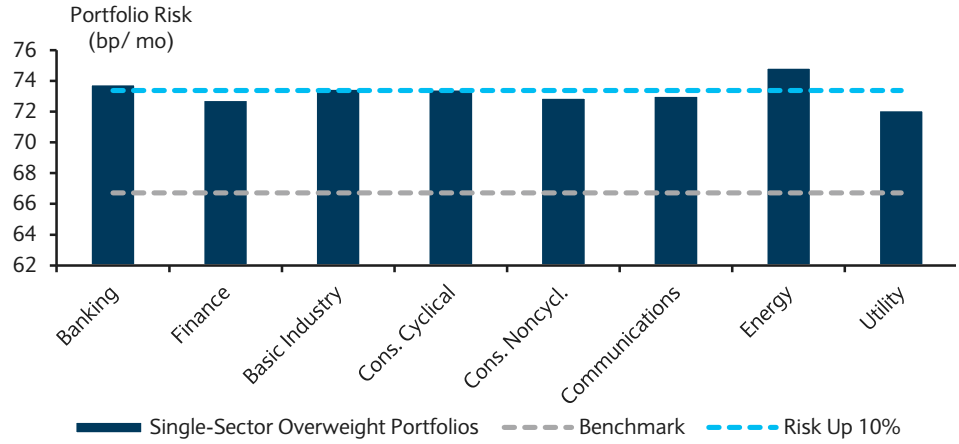
As of the end of May 2015, the relative spread volatilities observed in the market range from 6.2%/month for utilities to 9.0%/month for energy, and the pairwise correlations among sectors ranged from 0.74 for banking-utilities to a correlation of 0.97 between consumer cyclical and consumer non-cyclical.

Figure 5 shows the overall portfolio credit risk estimates obtained as of the end of May 2015 for our eight single-sector overweight portfolios. As demonstrated, the risk is largest when we are overweight the highest-volatility energy sector, and smallest when the DTS overweight is applied entirely in utilities, the lowest-volatility sector. Our long-DTS portfolios, while all corresponding to a DTS ratio of 1.1, carry risk ranging from 72.1bp/month to 74.9bp/month. These values span a range around the 73.4bp/m risk of the long-all-sectors portfolio, but are all comfortably larger than the estimated 66.7bp/month excess return volatility of the index.

[5] If we would assume constant relative spread volatility across all sectors and a uniform correlation structure, then all of the long-credit portfolios would have approximately the same volatility. However, we have found that relative spread volatilities do vary over time, even though they are far more stable than absolute spread volatilities. Correlation patterns change over time as well. Therefore, rather than impose assumptions of homogeneity and symmetry, we estimate volatilities and correlations from recent historical data.

FIGURE 5

Estimated excess return volatility of eight single-sector-overweight portfolios, 5/29/2015

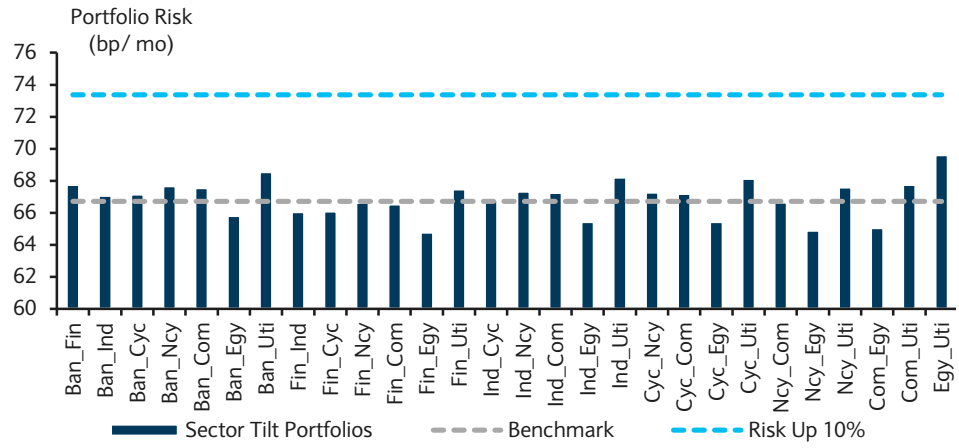


Source: Barclays Research

In Figure 6, we show the risks of our credit-neutral long-short portfolios.[6] These span a range from 64.8bp/month to 69.6bp/month – showing that they can diverge a fair amount from the 66.7bp/month risk of the benchmark – but well below a risk increase of 10 %.

FIGURE 6

Estimated excess return volatility of credit-neutral sector tilt portfolios, as of 5/29/2015



Source: Barclays Research

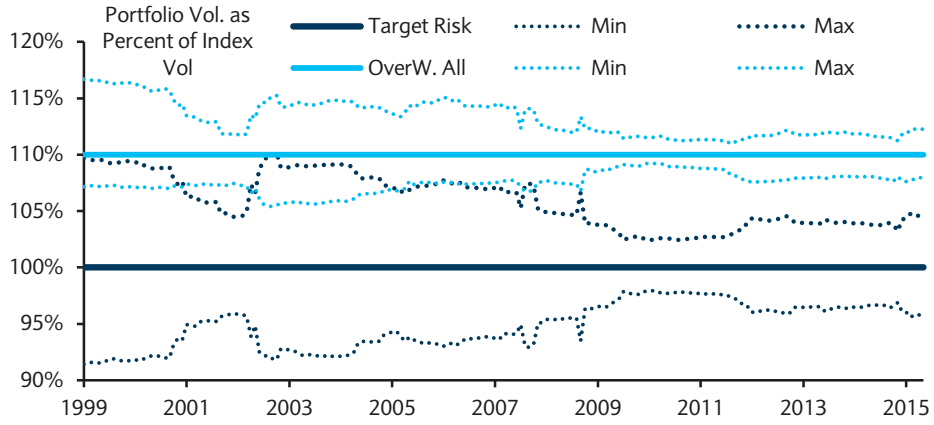
Might it be possible that one of our "credit-neutral" portfolios with DTS ratio 1.0 could have greater risk than one of our "long credit" portfolios with DTS ratio 1.1? This is theoretically possible, due to the variation among sector volatilities and correlations. However, as demonstrated in Figures 5 and 6, in the current environment even the least-risky of our long-credit portfolios has a greater risk (72.1bp/m) than the most risky of our credit-neutral long-short portfolios (69.6bp/m). This gives us confidence that staying within a given range of DTS ratios should keep the portfolio risk in the desired range.

[6] Actually, to improve legibility, we only show half of the possible pairs. For example, the rightmost portfolio in the figure, labeled as Egy_Uti, goes long energy and short utilities. As we are long the higher-volatility sector, and short the low-volatility one, this is the most risky portfolio shown. There is a complementary portfolio, not shown here, which is long utilities and short energy, with risk that is the lowest of all. Similarly, all of the pairs shown here have complementary portfolios in which the directions of the active positions are reversed.

Has this always been the case? To test this, we repeat this analysis each month from 1999 to the present, and keep track of the range spanned by the volatilities of the highest-risk and lowest-risk portfolios in each of our two groups as a percentage of benchmark risk. The results are shown in Figure 7. We find that over the past several years, the results are similar to those obtained in the current market environment. All of the long-credit portfolios fall within a small range around 110% of index risk, all of the credit-neutral portfolios have risk close to that of the benchmark, and there is no overlap between the two groups. However, if we look a little further back in time, we find that there were periods during which this differentiation broke down. For example, towards the end of 2002, there were some sector tilt portfolios with DTS equal to that of the index whose risk was 110% of the index level; at the same time, some of the "long-credit" portfolios with DTS ratio 1.1 had risk as low as 106% of the index level. In such a market environment, the DTS ratio alone does not seem to be sufficient to accurately characterize the level of portfolio risk; it would be important to include more detail about sector exposures.

FIGURE 7

Relative risk of "long credit" and "credit-neutral" portfolios implemented using different sector allocations, January 1999 – May 2015



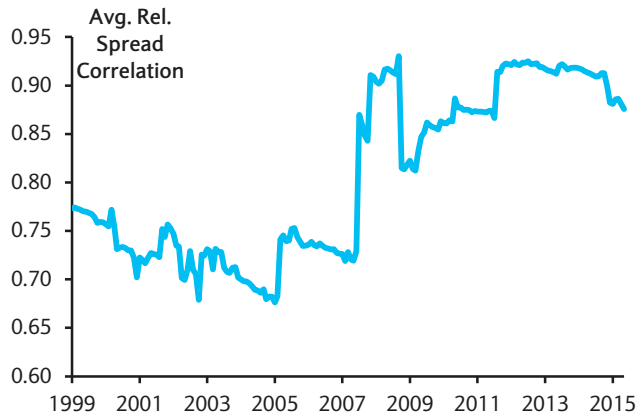
Source: Barclays Research

Why is the DTS ratio able to give a more precise estimate of portfolio risk in some market environments than in others? A combination of two effects is responsible: correlations among sector spread changes and the dispersion among sector spread volatilities. In the current market environment, not only have the spreads in different market sectors tended to move together, their relative spread volatilities have been very similar as well. Figure 8 shows how the average correlation among sectors has varied over time; over the past few years it has hovered near 90%, much higher than the norm prior to 2007. This is consistent with our recent finding[7] that the portion of excess returns explained by systematic risk factors has increased over the past several years. In addition, the range of risks spanned by our different active portfolios will depend on how much the relative spread volatilities vary from sector to sector. Figure 9 shows how the cross-sectional standard deviation of relative spread volatilities across sectors has changed over time; this is clear from the time series of relative spread volatilities by sector, shown in Figure 10. The tightest grouping of strategies in Figure 7 occurred in 2010-2011, which is characterized by a combination of high correlations among sectors and low dispersion in relative spread volatilities across sectors, as shown in Figure 8 and Figure 9.

[7] See *Time Dynamics of Credit Active Returns*, Barclays, 27 May 2014

FIGURE 8

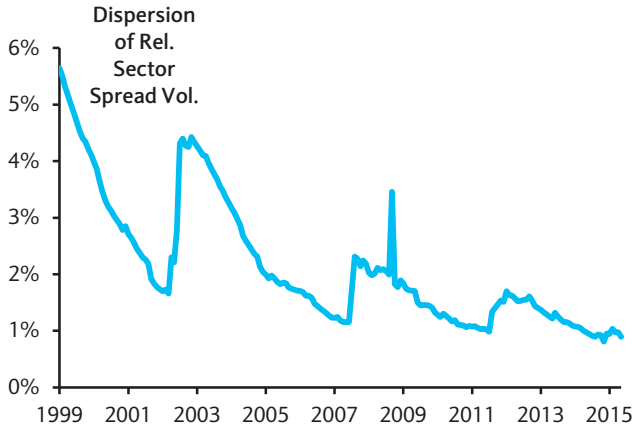
Average Correlation of Relative Spread Changes, January 1999 – May 2015



Note: At each point in time, correlations among our eight credit sectors are calculated using a trailing window of monthly data with a 12-month half-life; we show the average correlation across all possible pairs of sectors. Source: Barclays Research

FIGURE 9

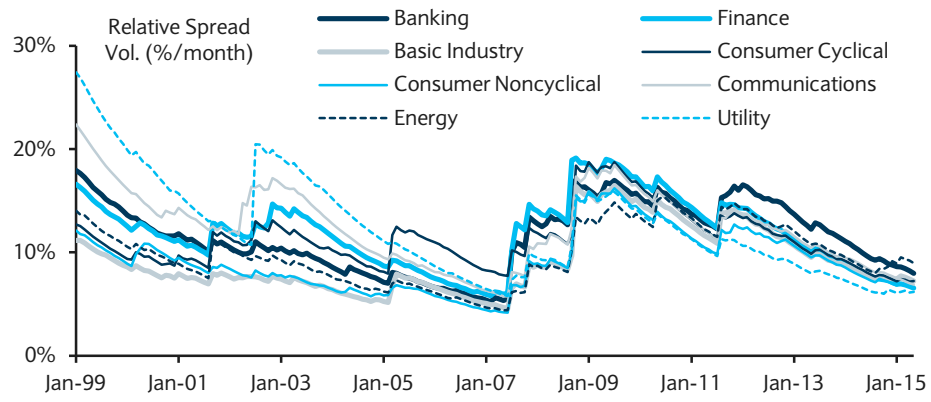
Dispersion of Relative Spread Volatilities, January 1999 – May 2015



Note: At each point in time, relative spread volatilities are calculated for each of our eight credit sectors using a trailing window of monthly data with a 12-month half-life; we show the standard deviation of these eight volatilities. Source: Barclays Research

FIGURE 10

Relative Spread Volatilities by Sector, 12-month half-life, January 1999-May 2015



Source: Barclays Research

When one sector has a much higher relative spread volatility than another, as in early 2003, then a portfolio that is overweight that sector by a given DTS contribution will be taking more credit risk than one that is overweight the same DTS contribution to a sector with lower relative spread volatility. Similarly, a DTS-neutral long-short position formed by matching the DTS contributions in the long and short ends of the trade could end up with an overall long or short net exposure to credit risk if the long sector has a much higher or lower relative spread volatility than the short one. The greater the imbalance in risk among different corporate sectors, the more important it is to keep track of sector-specific exposures as opposed to just a single overall number.[8]

[8] We have based the analysis throughout this short note on volatilities and correlations of relative spread changes computed with exponential weighting using a half-life of 12 months. As a historical record of how markets have moved, we find this useful for several reasons. Unlike growing-window calculations, it shows how market behavior changes over time; unlike trailing-window calculations, there is no artificial jump down in volatility when a risk spike falls off the end of the calculation window. However, it is not clear to us that this calibration, which gives the most weight to recent observations, gives the most balanced forward-looking risk estimates. In *DTS (Duration Times Spread) in the credit crunch: Did it live up to expectations?*, we found that using a flat 10%/month volatility estimate, consistent with our original study, did reasonably well at estimating credit risk through the global financial crisis. Even if it is desirable to periodically update this estimate as markets evolve, we would favor a slowly-changing estimate.

DTS Ratio Has Worked Well Recently; Sector Detail Advisable

DTS is an excellent measure of the amount of credit risk at any level of a credit portfolio, including exposures to specific issuers and sectors, and even at the level of the portfolio as a whole. If one needs to rely on a single simple metric to compare the credit exposure of the portfolio to that of the benchmark, the overall portfolio DTS certainly gives more information than spread duration, spread or credit quality alone. However, reliance on a single portfolio-level number such as DTS or DTS ratio can potentially mask significant differences in sector exposures. Over the past several years, a convergence of sector spread behavior characterized by tightly correlated spread changes and very similar relative spread volatilities across sectors has essentially created a credit market driven by a single systematic risk factor. In this environment, the DTS ratio has provided a very good estimate of portfolio beta; and it should continue to do so until this pattern changes. Just in case, though, it is advisable for managers to keep track of sector exposures as well; the next breakout of risk, like the last one, may be concentrated in a particular sector.

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