Derivatives Strategy
Chicago/New York
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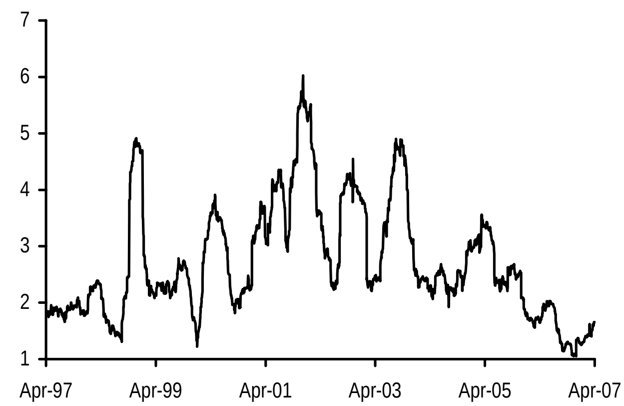
Research Note

Fixed income correlation trading using swaptions

- **As the Fed comes back into play in the eyes of the market, realized curve volatility is likely to trend higher …**
- **… leading to lower *realized* correlations between different points on the yield curve going forward**
- **Isolating exposure to yield curve correlations in an arbitrage-free framework is typically difficult and model-dependent at best, and requires the use of many instruments such as caps and swaptions**
- **Structuring short term trades with exposure to *realized* correlations (as opposed to changes in implied correlations) is harder still**
- **We present a framework to construct short-horizon trades that reasonably isolate exposure to future realized correlations, using only a small number of liquid short-expiry swaptions**

Chart 1: One hallmark of the recent Fed pause period has been low realized curve volatility
Rolling 3-month realized volatility of the 2s/10s swap yield curve; bp/day



Overview

One defining characteristic of US Fixed Income markets since the Fed went on hold has been the steady decline in realized curve volatility. For instance, 3-month realized volatility of the 2s/10s swap yield curve in the period between mid-August and mid-November period was barely 1bp/day, which is the lowest it has been in 10-years (Chart 1). This low curve volatility in late 2006 was intuitively understandable – with stable Fed expectations and the yield curve at very flat levels, the yield curve became essentially sticky.

One consequence of low realized curve volatility is that fewer random factors were needed to explain yield curve movements. Chart 2 shows the fraction of total variance explained by the first principal components, in recent months. It is notable that the first factor alone explained an astounding 95% of total variance for between September and February. Put differently, yield movements across the yield curve were essentially driven by one single random factor, causing yields across various points to become highly correlated.

This decline in yield curve volatility (and the accompanying rise in correlation) was eminently foreseeable, being a case of history repeating itself; the second half of 2000 saw a similar decline in curve volatility, and long-correlation trades were generally profitable in that period (we defer the discussion of how to construct such trades until later in this paper).

More recently, the changing macroeconomic environment is now supportive of higher curve volatility and lower correlation on the yield curve going forward. A key component of our economic outlook going forward is that potential GDP is slowing, causing the inflation/growth trade-off to deteriorate. Recent data support this view, with unemployment falling and core inflation rising even though the economy has delivered subpar growth over the last year. One consequence of a deteriorating inflation/growth trade-off is declining correlations on the yield curve. In an environment in which growth is weak but inflation is high, Fed easing or expectations of Fed easing can cause short-term rates to

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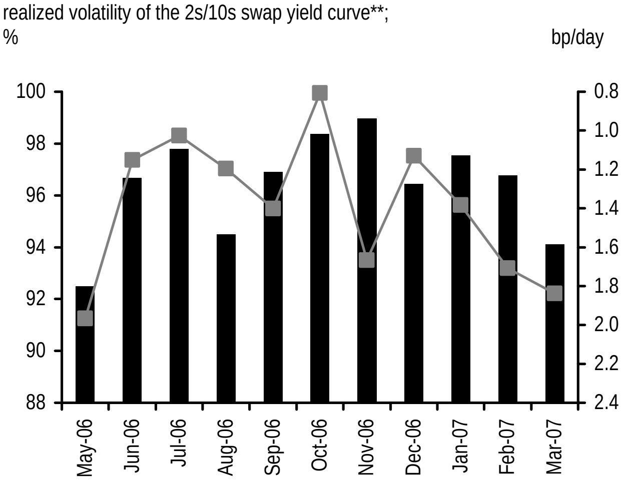
Chart 2: The first principal component explained over 95% of the total variance in yields in late 2006 as curve volatility reached historic lows, causing yields to behave in a highly correlated fashion

Percent of total variation explained by the 1st principal component*, versus the realized volatility of the 2s/10s swap yield curve**;



* PCA done at 1-month intervals, using that month's history of daily yield changes. ** Curve volatility estimated as standard deviation of daily changes in the 2s/10s swap curve over that month.

Chart 3: The implied volatility spreads between Libor caps and swaptions is pricing in lower realized correlations going forward

1x6 Libor cap correlation spread*; % points of correlation

* The JPMorgan correlation spread measure is a metric that collapses the difference between implied correlation matrix (calculated from swaption and caplet implied vols) and the backward looking 6M historical correlation matrix into a single scalar.

fall but long-term rates to rise as the market expects rate cuts to be inflationary. We believe this partly explains the curve reaction to last week's FOMC statement. Similarly, Fed tightening to offset inflation in the face of weak growth can cause short-term rates to rise with no effect on long-term rates as the market prices in recession. With the Fed now handicapped to some extent by an undesirable growth/inflation trade-off, we view the macroeconomic environment as supportive of lower correlations and higher curve volatility.

Thus, we view declining correlations as a structural characteristic of the late-stage Fed pause period, and recommend that investors position options portfolios to benefit from this. However, trading fixed income market correlations is model-dependent at best, and rather tricky – as a general rule, isolating exposure to correlations requires several instruments, such as trading caps versus swaptions (note that each caplet must be separately delta-hedged to isolate exposure to correlations). Also, these trades typically contain exposure to forward volatilities that can be difficult to hedge using liquid instruments. In addition, a typical correlation trade constructed using caps and swaptions tends to have greater vega exposure – i.e., such trades require a repricing of implied correlations, rather than monetizing the spread between implied and realized correlations. These repricings may take much longer to materialize, given the greater proportion of one-sided flows in the cap market. Finally, in the current environment, the spread between swaption and Libor cap volatilities appears to have priced in declining correlations going forward (Chart 3) – thus, valuations do not appear favorable to construct correlation trades using Libor cap and swaption volatility instruments.

It is thus desirable to have a framework to structure correlation trades in the current environment, with the following key characteristics. First, each trade must utilize as few instruments as possible. Second, only highly liquid instruments should be used. Third, trades must be short-dated in nature, and effectively isolate exposure to the spread between implied and subsequent realized correlation. Fourth, such a framework must produce a sufficiently rich set of trades whose valuations are currently attractive. Finally, given that correlations in fixed income markets (as opposed to, say, equities) are generally much higher and trade in relatively tight ranges, these trades must be adequately levered with respect to declines in correlation to make them attractive net of trading frictions.

In this note, we present an empirical framework for constructing correlation trades, which we believe possesses all of these characteristics. Each trade will be constructed using exactly 3 short-dated swaptions, thus satisfying the first two conditions. Further, the use of short expiries, and the fact that all legs of a given trade will have the same expiry (as will be seen) effectively create exposure to realized correlation, rather than depend on repricings of implied volatilities. Trades stemming from this framework are sufficiently levered (with respect to the potentially small realized correlation declines) to make them worthwhile, and several such opportunities appear to exist in the market currently.

An empirical framework

Consider any three points on the yield curve – say, the 2-, 10- and 30-year maturity points on the swap curve. In light of the rather well-accepted fact that the US yield curve is roughly two-dimensional (i.e., largely explained by two independent stochastic factors), we may approximately view yield changes in the 30-year sector as being determined by yield changes in the other two points. Thus, we may write:

Eqn 1: $\Delta y_{30} = \beta_2 \Delta y_2 + \beta_{10} \Delta y_{10} + \varepsilon$

where y (with the appropriate subscript) is used to denote yields, and ε denotes the standard error of the regression. In practice, we may estimate the betas using a regression over recent history. We assume that these betas are stable over the trade horizon – this is not unreasonable, as we will be constructing short term trades with short expiry swaptions. It then follows that:

Eqn 2: $\sigma^2_{30} = \beta^2_2 \ \sigma^2_2 + \beta^2_{10} \ \sigma^2_{10} + 2 \ \beta_2 \ \beta_{10} \ c_{2,10} \ \sigma_2 \ \sigma_{10} \ + \sigma_\varepsilon^2$

Where the σs are used to denote volatilities, and $c_{2,10}$ denotes the correlation coefficient between yield changes in the 2- and 10-year sectors. (We assume yield changes to be normally distributed, and the volatilities are expressed in basis points per day). Thus, the volatility of the 30-year point on the curve is determined by volatilities in the 2- and 10-year tail sectors, and the correlation between those two points.

Alternatively, we may recast equation 2 to infer the implied correlation between 2- and 10-year yield changes, given implied volatilities of all 3 points on the curve. I.e.,

Eqn 3: $c_{2,10}^I = (\sigma^2_{30} - \beta^2_2 \, \sigma^2_2 - \beta^2_{10} \, \sigma^2_{10} - \sigma_\varepsilon^2 \,) \,/\, 2 \ \beta_2 \ \beta_{10} \ \sigma_2 \ \sigma_{10}$

Equation 3 forms the basis for constructing correlation trades. Note that nothing in equation 3 prevents the implied correlation from exceeding 1. For given volatilities in 2- and 10-year tails, a sufficiently high implied volatility in the 30-year sector will cause the implied correlation as defined above to exceed 1. It is thus not to be confused with implied correlations obtainable from an arbitrage-free framework; nonetheless, it is a useful proxy which is more than adequate, as we will demonstrate.

Estimating risk weights

With three instruments to structure a trade with, we may choose vega-risk weights that immunize the weighted volatility spread against changes in implied volatility in the 2- and 10-year legs. For instance, assuming a weight of 1 on the 30-year leg and weights of w_2 and w_{10} on the 2- and 10-year legs, we define the weighted volatility spread to be:

Eqn 4: $V(\sigma_{2,} \, \sigma_{10,} \, c_{2,10}^I) \equiv \sigma_{30} + w_2\sigma_2 + w_{10}\sigma_{10}$

where σ_{30} is in turn defined by equation 2, and we choose the risk weights w_2 and w_{10} that satisfy

Eqn 5: $\partial V/\partial\sigma_2 \ = \ \partial V/\partial\sigma_{10} = 0.$

Equation 5 may be solved using either an analytical approximation, or using a solver such as Microsoft Excel's built in solver – in our example, for instance, we currently estimate $w_2 = 0.2$ and $w_{10} = -1.14$ solves Equation 5, where we have estimated the betas in Equation 1 over 3-months history.

Thus, the weighted volatility spread is designed to be hedged against moves in the volatility of 2- and 10-year tails, but remains exposed to the realized correlation between the two.

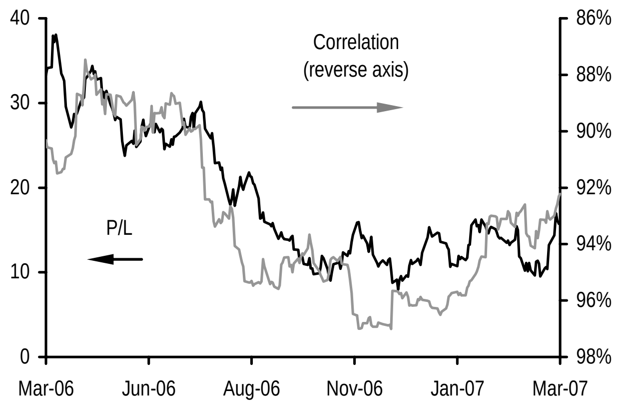
Effectiveness in trading correlation

As seen so far, this is a rather simple strategy, using only liquid swaption instruments and relying on empirical relationships between points on the curve, to structure short term trades that are exposed to correlation. It remains to be seen how effective such a strategy really is with respect to correlation exposure – i.e., do P/Ls from this strategy indeed track future realized correlations?

Currently, under our framework, we estimate that an investor can isolate exposure to 2s/10s correlation by selling \$100mn 6Mx10Y swaption straddles versus buying \$71mn 6Mx2Y swaption straddles and buying \$46mn 6Mx30Y swaption straddles (translating into 17:88 risk weights on the wings versus 100 in the belly). To test the effectiveness of this trade in monetizing realized correlation, we look at rolling 3-month delta-hedged P/Ls from this trade, versus the 3-month realized correlation between 2- and 10-year yield changes (each leg is delta hedged daily in our analysis).

Chart 4: Selling 6Mx10Y swaption straddles versus a weighted amount of 6Mx2Y and 6Mx30Y swaption straddles is an effective way to position for lower correlation between 2- and 10-year swap yields

Rolling 3-month delta hedged returns from selling $100mn 6Mx10Y straddles versus buying $71mn 6Mx2Y and $46mn 6Mx30Y swaption straddles versus rolling 3-month realized correlation between 2- and 10-year swap yield changes;
Bp of notional on 10-year leg %



As seen in Chart 4, rolling 3-month P/Ls from such a trade has closely tracked realized correlation over the past year. However, on a mark-to-market basis, another source of risk is any change in the weighted implied volatility spread itself – or, put differently, changes in implied correlation over the life of the trade. For our framework to be a valid means of trading correlation, we would need to verify the following. First, these two sources of risk must explain a significant portion of the returns on the trading strategy. Second, given our objective, realized correlation must be the dominant driver of returns. Table 1 presents statistics from regressing rolling P/Ls versus (i) subsequent realized correlation and (ii) changes in implied correlation. As can be seen from this

Table 1: Explaining rolling quarterly P/Ls from our trading strategy

Statistics from regressing rolling 3-month P/Ls from selling $100mn 6M10Y straddles versus buying $71mn 6M2Y straddles and buying $46mn 6M30Y straddles, against 3-month realized correlation between 2- and 10-year yield changes and the 3-month change in implied correlation between 2- and 10-year yields.

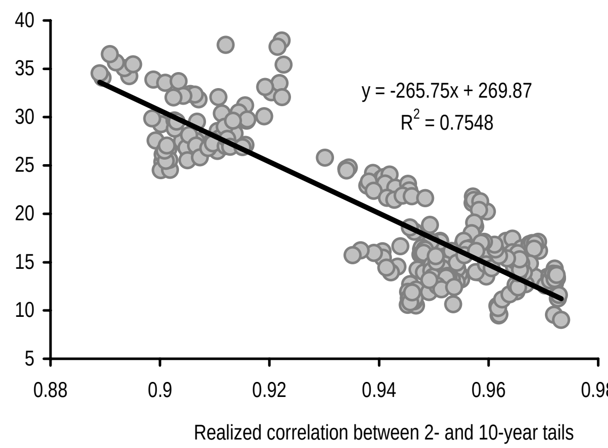
	Coefficient	T-statistic
Realized correlation	-265.8	-27.6
Chg in implied correlation	-51.1	-5.7
Intercept	269.9	29.9

	Value
R^2	76%
Standard error	3.63

* Based on 1-year history of rolling P/Ls

Chart 5: Realized correlation is the dominant driver of returns from our trading strategy …

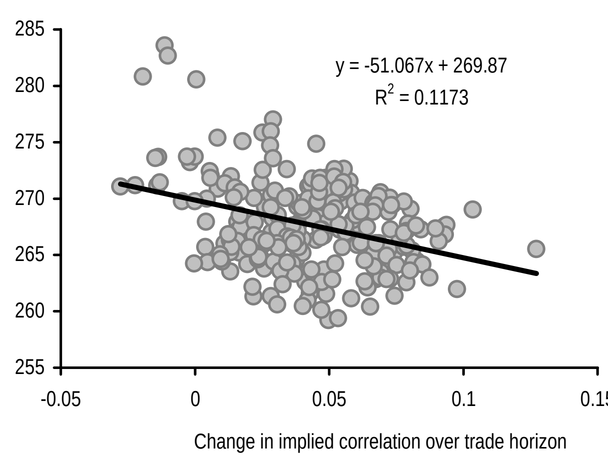
Rolling 3-month P/Ls from selling $100mn 6M10Y straddles versus $71mn 6Mx2Y and $46mn 6Mx30Y straddles*, adjusted for change in implied correlation over the 3-month period** versus realized correlation; bp of 6M10Y notional



* Assumes daily delta hedging and no transaction costs. ** Defined as 3M P/L minus 51*change in implied correlation.

Chart 6: … with changes in implied correlation being a secondary factor

Rolling 3-month P/Ls from selling $100mn 6M10Y straddles versus $71mn 6Mx2Y and $46mn 6Mx30Y straddles*, adjusted for realized correlation over the 3-month period** versus change in implied correlation; bp of 6M10Y notional



* Assumes daily delta hedging and no transaction costs. ** Defined as 3M P/L minus 51*change in implied correlation.

table, as well as in charts 5 and 6, realized correlation is the dominant driver of returns (both in terms of statistical significance as well as the magnitude of the coefficient). Further, the magnitude of the coefficient demonstrates that this trade has sufficient leverage with respect to realized correlation to make the strategy worthwhile – less than 0.1 moves in correlation are needed to make the trade sufficiently attractive. Finally, these two factors alone explain over 76% of the variability in returns over the past year – we note here that this test holds current hedge ratios constant through time, and more careful trade construction using updated hedge ratios is only likely to improve this further. In any case, an R^2 of 76% suggests that realized and implied correlations are the two most important sources of risk in our trading strategy. As a final point, since we use relatively short expiry swaptions, if the investor has the intent and ability to delta hedge the options through to expiry, exposure to implied correlation can be "eliminated" by pricing and delta-hedging the swaptions using constant implied correlation (equal to the levels at inception). In other words, for daily delta hedging purposes, the investor can observe daily implied volatility on 2- and 10-year tails in our example, but would impute an implied volatility to 30-year tails based on the implied correlation at inception. Delta hedges would then be calculated according to these implied volatilities. Such an approach results in a strategy that isolates exposure to realized correlation on a terminal basis, but remains exposed to changes in implied correlations on a daily mark-to-market basis.

Conclusions

With the Fed now potentially being back in play, and with growth and inflation concerns emerging as two separate drivers of yield levels across the curve, we expect curve volatility to increase and correlations to decline across the curve. As a consequence, we believe portfolio managers should add exposure to declining *realized* correlations, as a core risk going forward. However, trading correlation has been difficult without the use of exotic instruments and complex models.

In this note, we believe we have enabled the construction of trades that isolate exposure to realized correlation. Our framework uses only short-dated swaptions (and only three per trade), and amounts to merely a novel weighting scheme for swaption straddle butterflies. As such, these trades are liquid, easy to execute, and tactical in nature. Most of all, this weighting framework allows an investor to completely isolate exposure to realized correlations (on a terminal basis) by using fixed implied correlations to calculate delta-hedges once a trade has been initiated – this is not unreasonable since the strategy uses short-expiry swaptions and an investor could decide to hold the trade to expiry, but does result in mark-to-market exposure to implied correlations.

JPMorgan is introducing a new report that presents a daily list of attractive correlation trades.

Trade recommendation

- **Position for declining correlations via plain vanilla swaption straddle butterflies**
  – Sell $100mn notional 6Mx10Y swaption straddles versus buying $71mn notional 6Mx2Y swaption straddles and buying $46mn notional 6Mx30Y swaption straddles This trade requires delta hedging.

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Long Correlation Trades

Trade Wing1/Body/Wing2	Risk* Wt1	Risk Wt2	Notional Wing1	Notional Body	Notional Wing2	Imp. Corr	3M Rlzd. Correlation	Vol Spread** Mispricing
1Y1Y/1Y2Y/1Y5Y	-0.309	-0.747	-32.115	100.0	-60.178	0.915	0.991	0.302
6M1Y/6M2Y/6M5Y	-0.262	-0.812	-34.900	100.0	-50.879	0.875	0.989	0.290
3M1Y/3M2Y/3M5Y	-0.280	-0.801	-34.437	100.0	-54.363	0.879	0.981	0.286
6M1Y/6M2Y/6M3Y	-0.148	-0.880	-60.161	100.0	-28.850	0.831	0.989	0.188
9M1Y/9M2Y/9M5Y	-0.379	-0.681	-29.231	100.0	-73.793	0.957	0.994	0.161
3M1Y/3M2Y/3M3Y	-0.166	-0.867	-59.205	100.0	-32.263	0.878	0.981	0.125
3M1Y/3M3Y/3M5Y	-0.234	-0.813	-51.182	100.0	-66.553	0.903	0.965	0.121
1Y2Y/1Y3Y/1Y5Y	-0.146	-0.887	-55.833	100.0	-21.338	0.904	0.982	0.103
1Y2Y/1Y5Y/1Y7Y	-0.047	-0.984	-73.745	100.0	-10.967	0.722	0.968	0.097
3M2Y/3M3Y/3M5Y	-0.449	-0.564	-35.495	100.0	-65.735	0.983	0.992	0.089

Short Correlation Trades

Trade Wing1/Body/Wing2	Risk Wt1	Risk Wt2	Notional Wing1	Notional Body	Notional Wing2	Imp. Corr	3M Rlzd Correlation	Vol Spread Mispricing
6M2Y/6M10Y/6M30Y	0.177	0.872	45.539	-100.0	73.085	1.146	0.933	-0.240
1Y2Y/1Y10Y/1Y30Y	0.157	0.896	46.821	-100.0	64.768	1.216	0.941	-0.240
9M2Y/9M10Y/9M30Y	0.167	0.884	46.192	-100.0	69.021	1.172	0.935	-0.236
3M2Y/3M10Y/3M30Y	0.179	0.872	45.522	-100.0	74.032	1.126	0.918	-0.231
1Y3Y/1Y7Y/1Y10Y	0.263	0.756	56.951	-100.0	55.760	1.071	0.984	-0.202
3M5Y/3M10Y/3M30Y	0.360	0.660	34.476	-100.0	63.934	1.021	0.982	-0.201
9M5Y/9M10Y/9M30Y	0.351	0.674	35.229	-100.0	62.229	1.028	0.984	-0.198
1Y5Y/1Y10Y/1Y30Y	0.348	0.678	35.458	-100.0	61.731	1.030	0.985	-0.193
6M5Y/6M10Y/6M30Y	0.353	0.670	35.011	-100.0	62.651	1.023	0.983	-0.191
6M1Y/6M5Y/6M10Y	0.227	0.854	48.164	-100.0	102.753	1.049	0.948	-0.176

Notes:
*Vega risk weights are determined to immunize the trade from changes in the weighted vol spread while benefitting from changes in correlations. For details, see JP Morgan's Derivative Trade Note, April 4, 2004, titleld "Fixed income correlation trading using swapitons," P.3
**Mispricing is Implied vol - Fair Value Implied vol spread. Fair Value is derived from recent realized correlation.

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