

Forward Volatility Strategies

Long-dated USD volatility opportunities

Long-dated USD callable bond issuance into Germany and Taiwan is continual, but this year's unprecedented demand from Taiwan has driven lower right vols lower. The recent jump was driven by regulatory changes. As this was an unintended consequence of regulatory loosening, we expect the window to close and callable issuance to decrease to more normal levels. In this report, we present and compare five forward vol strategies which all benefit from this effect.

Large demand for USD callables

While demand for callables is common in Germany and Taiwan with accounting leeway given for the call, i.e., they can receive the higher coupon without accounting for the call itself, there are distinct differences in most of the types and formats.

German insurers tend to prefer longer bonds with infrequent calls (or single calls), e.g., 30YNC10Y10Y, or 20YNC10Y10Y (i.e., a single call). Germans prefer both MTN formats and the non-mark-to-market *Schuldscheine* (for which issuance data are not readily available).

Taiwanese insurers prefer frequent calls for their higher pick-up, e.g., 30YNC1Y1Y or 20YNC1Y1Y, and they have typically been prevented from doing more USD callables by regulators, aware that USD assets with TWD liabilities may result in mismatches. Formats have mostly included MTNs. But authorities in Taiwan wanting to resurrect a moribund Formosa bond market and attract foreign issuers, have relaxed rules on foreign investments. This has also had the unintended consequence of having TWD insurers load up on Formosa bonds (which do not count against a foreign asset limit) which are callable USD (and EUR) bonds issued by foreign companies.

Fig. 1: Total figures from callable Formosa and callable MTNs

Larger demand out of Taiwan

Sum of Size (mm)

Issue Month	Total
Jan-14	1,850.00
Feb-14	1,922.40
Mar-14	2,173.80
Apr-14	2,633.00
May-14	625
Jun-14	1,589.50
Jul-14	1,938.00
Aug-14	2,665.00
Sep-14	6,231.00
Oct-14	2,413.00
Nov-14	5,663.00
Dec-14	1,190.00
Grand Total	30,893.70

Source: GreTai, Nomura

The recent concentration of zero-callable issuance is due to regulation change prior to this summer. The new regulation encourages foreign firms to list foreign currency denominated corporate bonds (called Formosa bonds) in the onshore OTC market.

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Investment in those bonds won't be counted as a part of foreign investment for lifers. Taiwanese lifers have 45% cap on their AUM for overseas investment. However, the majority of the Formosa bond issuance since then has been zero callable, which is not quite what the regulator was hoping for. Market participants are not very clear how long the regulatory leeway will last. Therefore, there has been a rush to invest in zero-callable Formosa bonds. This window is likely to close soon.

The impact has been large, with long-dated vols especially in the lower right hand suffering significantly. We see the impact of Bermudan issuance in the vega profile (in the Appendix on Berm/Eur switch strategies) noting that 10y15y, 5y20y should all be under some downwards pressure from the recent glut in issuance. In particular, longer-dated forward vol (e.g., 2y and 5y forwards), especially the lower right corner of the vol surface, have show significant carry (see Figure 2 in the black boxes for those vols which are significantly below spot). It is the larger vol carry in this region we would like to benefit from.

Fig. 2: USD Forward volatility

Lower right corner of the vol surface shows decent carry.

Spot	1y	2y	3y	5y	7y	10y	15y	20y	30y
1y	49.0	69.0	78.4	81.8	80.2	77.1	73.1	72.3	69.5
2y	88.8	94.2	94.1	90.8	87.9	83.6	78.0	76.6	73.2
3y	102.3	99.7	97.5	92.9	89.8	85.4	79.1	77.0	73.3
5y	101.5	98.5	96.2	92.1	89.7	86.4	79.4	76.5	72.9
7y	97.3	94.9	92.9	89.1	86.9	83.7	76.3	73.0	69.8
10y	88.5	86.5	85.2	83.0	81.0	78.1	70.7	67.4	64.7
20y	64.3	61.8	61.0	60.1	59.6	58.8	53.2	51.6	48.3
30y	55.8	55.4	55.5	55.6	55.4	55.0	50.8	50.5	47.9

1y	1y	2y	3y	5y	7y	10y	15y	20y	30y
1y	86.4	93.1	93.4	91.8	90.3	86.3	79.9	78.6	74.8
2y	102.2	99.8	98.8	94.9	92.4	87.9	80.6	78.2	74.0
3y	104.3	101.8	99.6	95.3	92.8	88.7	80.9	78.0	73.8
5y	101.4	99.0	96.9	92.9	90.6	87.3	78.8	75.3	71.6
7y	96.5	94.3	92.5	88.9	86.7	83.2	74.9	71.2	67.9
10y	86.5	84.3	83.2	81.2	79.2	76.2	68.4	65.1	62.2
20y	63.1	60.5	59.8	59.0	58.5	57.9	52.1	50.5	47.1
30y	55.3	54.9	54.9	55.1	54.9	54.4	50.0	49.7	

1y change	1y	2y	3y	5y	7y	10y	15y	20y	30y
1y	37.4	24.1	15.0	10.0	10.1	9.2	6.8	6.3	5.3
2y	13.4	5.6	4.7	4.1	4.5	4.3	2.6	1.6	0.8
3y	2.0	2.1	2.1	2.4	3.0	3.3	1.8	1.0	0.5
5y	-0.1	0.5	0.7	0.8	0.9	0.9	-0.6	-1.2	-1.3
7y	-0.8	-0.6	-0.4	-0.2	-0.2	-0.5	-1.4	-1.8	-1.9
10y	-2.0	-2.2	-2.0	-1.8	-1.8	-1.9	-2.3	-2.3	-2.5
20y	-1.2	-1.3	-1.2	-1.1	-1.1	-0.9	-1.1	-1.1	-1.2
30y	-0.5	-0.5	-0.6	-0.5	-0.5	-0.6	-0.8	-0.8	

2y	1y	2y	3y	5y	7y	10y	15y	20y	30y
1y	102.4	100.5	98.6	95.5	93.2	89.0	80.6	77.3	72.4
2y	107.7	103.5	102.3	96.5	94.4	90.4	81.3	77.6	73.0
3y	105.9	103.3	100.3	95.6	93.8	90.5	81.0	77.1	72.7
5y	100.3	97.8	96.1	92.2	89.8	86.8	76.7	72.6	68.7
7y	94.2	92.3	90.7	87.5	85.5	81.8	72.4	68.3	64.9
10y	83.3	80.9	80.0	78.6	76.5	73.6	65.2	62.0	58.8
20y	61.5	59.1	58.4	57.6	57.2	57.0	50.9	49.3	45.6
30y	54.4	54.0	54.1	54.2	54.0	53.6	48.9	48.6	

2y change	1y	2y	3y	5y	7y	10y	15y	20y	30y
1y	53.4	31.5	20.2	13.7	13.0	11.9	7.5	5.0	2.9
2y	18.9	9.3	8.2	5.7	6.5	6.8	3.3	1.0	-0.2
3y	3.6	3.6	2.8	2.7	4.0	5.1	1.9	0.1	-0.6
5y	-1.2	-0.7	-0.1	0.1	0.1	0.4	-2.7	-3.9	-4.2
7y	-3.1	-2.6	-2.2	-1.6	-1.4	-1.9	-3.9	-4.7	-4.9
10y	-5.2	-5.6	-5.2	-4.4	-4.5	-4.5	-5.5	-5.4	-5.9
20y	-2.8	-2.7	-2.6	-2.5	-2.4	-1.8	-2.3	-2.3	-2.7
30y	-1.4	-1.4	-1.4	-1.4	-1.4	-1.4	-1.9	-1.9	

5y	1y	2y	3y	5y	7y	10y	15y	20y	30y
1y	112.8	106.4	103.3	95.4	92.2	90.2	78.5	72.8	67.8
2y	105.9	102.7	101.2	93.1	90.3	88.7	76.6	70.7	65.9
3y	101.4	99.7	96.2	90.2	87.6	86.5	74.4	68.7	64.1
5y	90.3	87.4	85.8	83.3	82.8	81.9	69.6	64.4	60.0
7y	82.0	78.9	77.9	78.1	78.1	75.7	64.6	60.5	55.9
10y	73.8	71.2	71.1	71.7	69.8	67.7	57.9	54.9	49.6
20y	57.0	55.3	55.0	55.7	55.8	55.6	48.2	46.4	41.7
30y	52.3	52.0	52.0	52.2	51.9	51.4	46.1	45.7	

5y change	1y	2y	3y	5y	7y	10y	15y	20y	30y
1y	63.8	37.4	24.9	13.6	12.0	13.1	5.4	0.5	-1.7
2y	17.1	8.5	7.1	2.3	2.4	5.1	-1.4	-5.9	-7.3
3y	-0.9	0.0	-1.3	-2.7	-2.2	1.1	-4.7	-8.3	-9.2
5y	-11.2	-11.1	-10.4	-8.8	-6.9	-4.5	-9.8	-12.1	-12.9
7y	-15.3	-16.0	-15.0	-11.0	-8.8	-8.0	-11.7	-12.5	-13.9
10y	-14.7	-15.3	-14.1	-11.3	-11.2	-10.4	-12.8	-12.5	-15.1
20y	-7.3	-6.5	-6.0	-4.4	-3.8	-3.2	-5.0	-5.2	-6.6
30y	-3.5	-3.4	-3.5	-3.4	-3.5	-3.6	-4.7	-4.8	

Source: Nomura Research

Comparing forward volatility strategies

There are several strategies we believe could capture depressed forward volatility.

These include:

- **Berm/Eur 25yNC5y5y**: long 25yNC5y5y straddles, short 5y20y straddles, both at 5y20y ATM
- **MCCS 5y5y20y**: Long 10y20y payers, short 5y5y20y payers, struck at 5y20y rates
- **Multi-strike MCCS 5y5y20y**: Long 10y20y payers, short 5y5y20y payers, three pairs - each struck at ATM-50bp, ATM and ATM+50bp

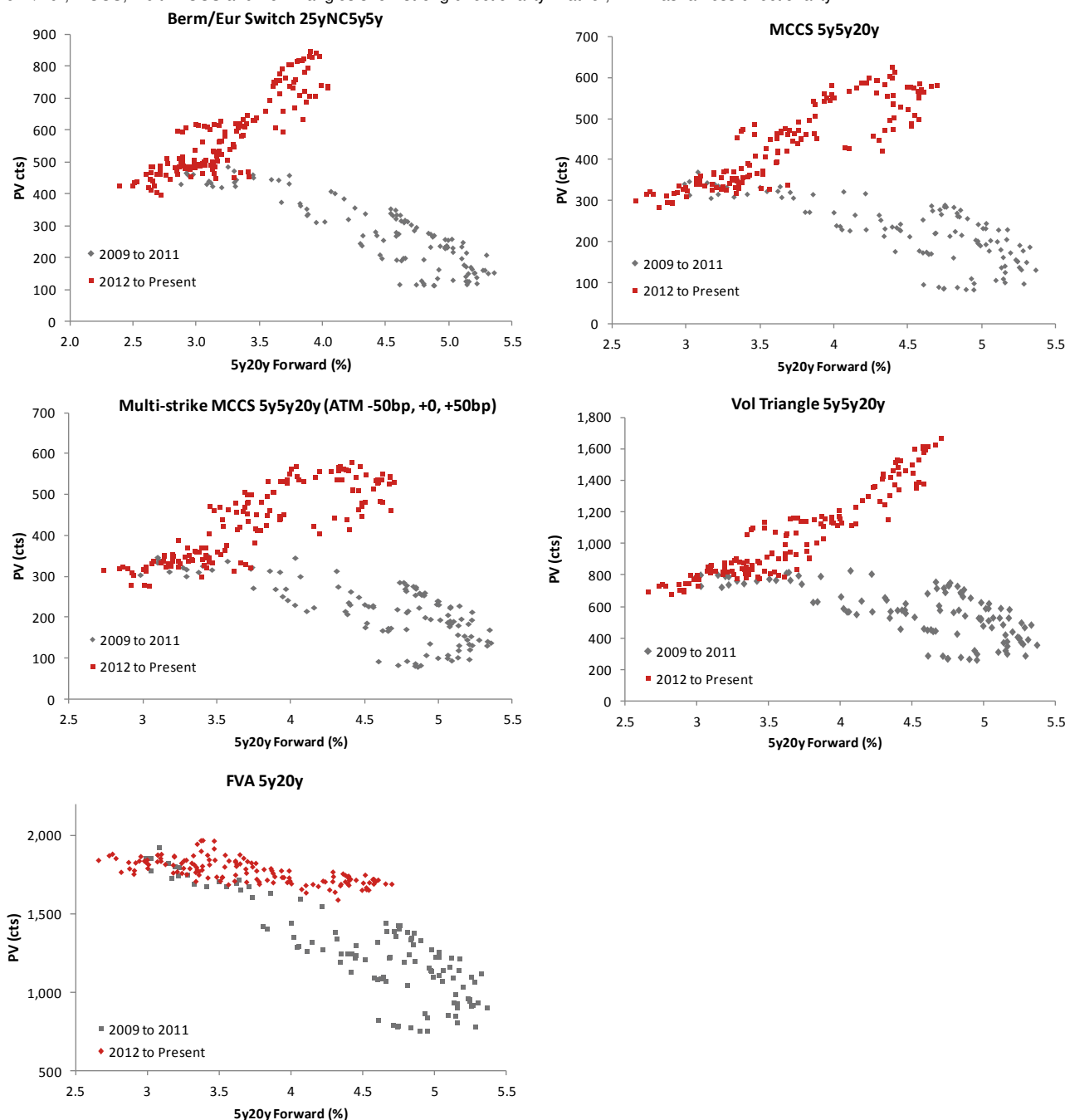
- **Long 5y5y20y vol triangles:** Long 5y5y straddles, short 5y25y straddles, long 10y20y straddles, all for equal notional and ATMF
- **Long FVA 5y5y20y:** Enter into 5y5y20y forward vol agreement. In five years' time, exchange forward price for spot-settled 5y20y ATMF straddle

We detail the pay-offs in five years' time and volatility dependence for each in the appendix, noting that many have quite similar pay-off profiles, with some crucial differences.

The strategies are all long forward volatility (i.e., although they may have small vega initially, $dVega/d\text{time} > 0$ and it grows over time, which we can see in the appendix, pay-offs have a large vol dependence). They have differing rates sensitivities, and differing rehedge needs. As we see in Figure 3, there is significant directionality to a number of these trades, making it almost impossible to compare like with like.

Fig. 3: Differing directionality – individual forward vol trades

Berm/Eur, MCCA, Multi-MCCA and Vol Triangles show strong directionality. Rather, FVA has far less directionality.



Source: Nomura Research

Figure 3 also shows that the directionality for specific trades changes over time. As the trade ages and the underlying rates approach or moves above the strike, we see an initially positive duration (from 2009 to 2011) changing to a negative duration (from 2012

to expiry). This is true for all except the forward volatility, which appears to have a positive duration throughout, perhaps partly due to volatility-rates correlations.

Figure 4 demonstrates the performance of these trades. It is not surprising that directional trades outperform in directional markets. MCCA, Multi-strike MCCA and FVA trades are better in terms of Calmar perhaps due to less dependence on rates.

Fig. 4: Performance of all these trades for the past five years

MCCA, Multi-MCCA and Berm/Eur switch appear to do best among them. But we are not comparing like with like.

	Berm/European Switch 25yNC5y5y	MCCA 5y5y20y	Multi-strike MCCA 5y5y20y	Vol Triangle 5y5y20y	FVA 5y5y20y
Max Gain	636%	566%	526%	486%	140%
Return to Term	295%	303%	320%	167%	131%
Return (p.a.)	35%	36%	37%	26%	20%
Std Dev (p.a.)	38.3%	37.4%	42.0%	35.4%	23.4%
Sharpe Ratio	0.91	0.95	0.89	0.75	0.85
Max drawdown	48.3%	39.5%	38.3%	54.4%	26.1%
Calmar Ratio	0.72	0.90	0.98	0.48	0.76

Source: Nomura Research

Reducing directionality and timing biases

We create unhedged indices (to reduce timing bias) and hedged indices (to subsequently reduce directionality). The indices are computed by entering into trades monthly for FVA, MCCA, Multi-strike MCCA and Vol Triangle Strategies, and holding for one year. The Berm/Eur switch involves quarterly transactions, held for one year as well.

The exotic trades have no transaction costs included. All revaluations of portfolios are done using weekly data. The delta-hedging is also done on a weekly basis following the method below:

- **Berm/Eur switch 25yNC5y5y** (vs 5y20y European) is hedged against 5y20y;
- **MCCA 5y5y20y** and **Multi-strike MCCA 5y5y20y** are hedged against 10y20y¹;
- **Vol Triangle 5y5y20y** is hedged against all three legs (i.e. 5y25y, 10y20y and 5y5y) for P&L stability in spite of maintenance challenges of hedging all three legs²;
- **FVA 5y5y20y** is hedged against 10y20y (in our study, FVA uses spot-settled swaptions which introduces delta from discounting and PV01).

Except for the triangle hedge, all hedges assume parallel shifts, and more sophisticated hedging strategies have not been considered. All transactions are spot settled and EONIA discounting. Hedging costs are assumed at 0.3bp running (i.e., Rehedge Notional*Pv01*0.3bp for each rehedg).

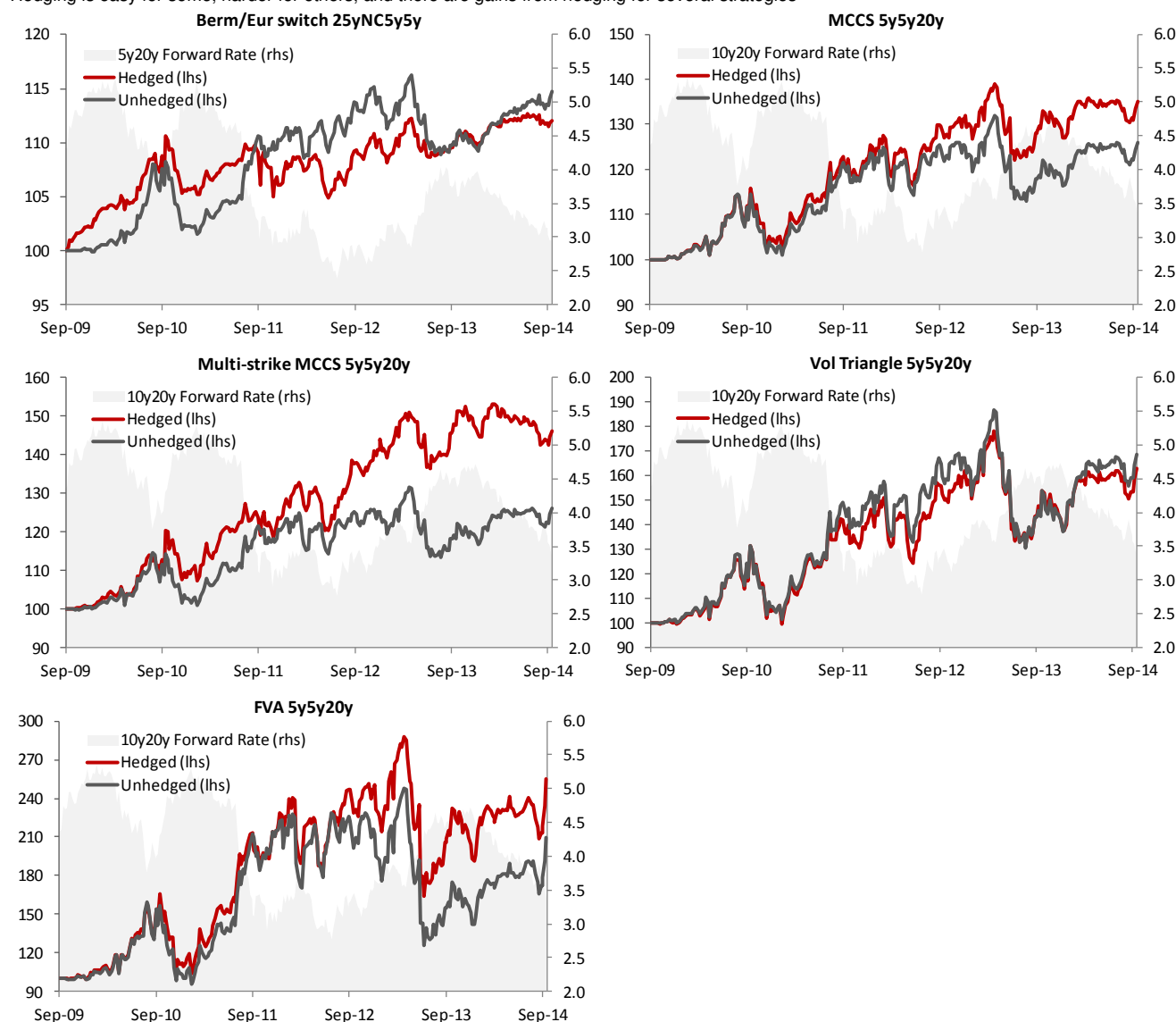
We see in Figure 5 that hedging improves the performance of MCCA, multi-strike MCCA and FVA trades. The Berm/Eur switch trade has a worse performance after hedging. The unhedged or hedged performance for the vol triangle is very similar.

¹ The trades were chosen to some extent to try to attempt hedging with the same or similar instrument. Berm/Eur switch does not have the 10y20y as an underlying. We believe this is a small matter given its relative similarity to 5y20y. Moreover, the only Berm/Eur trades which would have 10y20y underlying (e.g., 30YNC10Y5Y vs 10y20Y) have a natural maturity of 10 years rather than the 5-year maturity that is true of each of these trades.

² We also considered hedging the vol triangle against a single instrument (10y20y), which led to a much worse hedging performance. Hence we only compare the hedging against all three legs for vol triangle here.

Fig. 5: Comparing latent directionality of the five hedged and unhedged indices (1y holding)

Hedging is easy for some, harder for others, and there are gains from hedging for several strategies



Source: Nomura Research

We present the results for the hedged indices in Figure 6, highlighting Sharpe and Calmar ratios (since indices are not otherwise scaled to be easily compared).

- **Berm/Eur switch** is clearly very directional and hedging reduces Sharpe ratio (although it increases Calmar).
- The **Vol triangle** can have a very large delta. We initially hedged level alone but the performance of the “hedged” portfolio was so weak we decided against showing it. Our strategy of hedging all three legs appears to work reasonably.
- The **Single-Strike MCCS**, **Multi-strike MCCS** and **FVA** perform better after hedging with large improvements in Sharpe and Calmar ratios.
- The **hedged multi-strike MCCS** outperforms **hedged MCCS**, suggesting that the lower negative gamma makes it easier to hedge, with greater efficacy in hedging.
- In general, the **Multi-strike MCCS** and **FVA** appear to be the superior strategies, have the best Sharpe and the best Calmar, with lower transaction costs.

Fig. 6: Performance of unhedged and hedged forward volatility

	Unhedged Strategies					Hedged Strategies				
	B/E Switch 25yNC5y5y	MCCS 5y5y20y	Multi-strike MCCS 5y5y20y	Triangle 5y5y20y	FVA 5y5y20y	B/E Switch 25yNC5y5y	MCCS 5y5y20y	Multi-strike MCCS 5y5y20y	Triangle 5y5y20y	FVA 5y5y20y
Max Gain	16%	32%	32%	87%	148%	12%	39%	53%	78%	188%
Return to Term	15%	26%	26%	69%	109%	12%	35%	46%	63%	155%
Return (p.a.)	2.6%	4.8%	4.8%	11.9%	21.2%	2.2%	6.1%	7.6%	11.1%	23.2%
Std Dev (p.a.)	4.1%	10.3%	10.2%	21.2%	38.4%	3.8%	9.7%	10.0%	20.2%	34.0%
Sharpe Ratio	0.65	0.47	0.48	0.56	0.55	0.57	0.62	0.75	0.55	0.68
Max Drawdown	6%	14%	14%	30%	49%	5%	12%	11%	26%	43%
Calmar Ratio	0.42	0.33	0.35	0.40	0.43	0.42	0.50	0.69	0.43	0.54
Total Hedged per Trade	-	-	-	-	-	55.7%	20.6%	35.8%	244.2%	42.6%
Initial Hedged Ratio	-	-	-	-	-	15.0%	18.7%	40.4%	11.3%	49.9%

Source: Nomura Research

In Figure 6, we also look at the hedging needs for all these trades. Two measures are calculated:

- **Total Hedged per Trade:** the total hedged notional over the lifetime for each trade. The total hedged notional is calculated as the absolute value of initial hedged notional plus absolute value of subsequent notional change.
- **Initial Hedged Ratio:** the ratio of the absolute value of initial hedged notional to the total hedged notional over the lifetime.

We note the following points:

- In terms of total hedging requirement, **the Triangle trade** and **Berm/Eur Switch strategy** demand the most hedging amount for each trade. It appears the triangle hedging is not particularly good and it is more appropriate to consider hedging at least both level and slope in triangles.
- The average reheding in notional terms for **the Single-Strike** and **Multi-Strike MCCS trade** is around 20% to 40% of the notional of all legs for each trade, which is the least among all these trades. Also note that around 40% of total hedged notional for **Multi-Strike MCCS trade** can be done at the beginning of the trade.
- The **FVA trade** has a relatively reasonable total hedging amount (~43% in terms of notional) for each trade, but almost half of the hedging can be done at the beginning of this trade (i.e., this is basically a static hedge).

Conclusions

Recent Taiwanese callable issuance has led to depressed long dated volatility in USD (and to a lesser extent in EUR). We have investigated five forward vol strategies in this report: Berm/Eur Switch 25yNC5y5y, single-strike MCCS 5y5y20y, multi-strike MCCS 5y5y20y, Vol Triangles 5y5y20y and FVA 5y5y20y.

Clearly all strategies benefit from relatively depressed volatility in the lower right-hand side of the vol surface. All trades (including FVA) have an element of directionality. We have attempted to eliminate this.

In the end, two strategies stand out as the best performers: Multi-strike MCCS which has the best Sharpe, best Calmar, and among the lowest reheding costs, and FVA Strategy, which has low maintenance costs after the initial hedge and has a comparable Sharpe and Calmar. The performance of both hedged strategies exceeds that of any of the unhedged (but directional) strategies.

Appendix

Bermudan/European Switch

Bermudans/European is a strategy to go long forward volatility, with a good deal of directionality and some slope risk. Mostly regulatory and historical reasons lead investors in callables to choose differing tenors and call schedules. In general, the higher the call frequency, the larger the pick-up of callables to vanilla bonds.

German investors tend to favour longer calls with less frequency or even structures with a single call, while Taiwanese investors tend to favour higher pick-up and will even consider annual call frequencies. The depressing impact on vega can be similarly spread out by a given issuance profile. Figure 7 shows that the Berm/Eur trade has a high dependence on the diagonal. The risk is concentrated on the Lower Right area.

Fig. 7: 25yNC5y5y and 25yNC1y1y show varying degrees of risk spread across the diagonal

Lower right is the primary area of influence

NC5y5y	1Y	2Y	3Y	5Y	7Y	10Y	15Y	20Y	25Y	NC1y1y	1Y	2Y	3Y	5Y	7Y	10Y	15Y	20Y	25Y
6M	0	0	0	0	0	0	0	0	0	6M	0	0	0	0	0	0	0	0	0
1Y	0	0	0	0	0	0	0	0	0	1Y	0	0	0	0	0	0	0	110	434
2Y	0	0	0	0	0	0	0	0	0	2Y	0	0	0	0	0	0	0	567	755
3Y	0	0	0	0	0	0	0	0	0	3Y	0	0	0	0	0	0	0	600	233
5Y	0	0	0	0	0	0	0	5,308	0	5Y	0	0	0	0	0	0	3	1,243	137
7Y	0	0	0	0	0	0	0	0	0	7Y	0	0	0	0	0	0	931	2,234	0
10Y	0	0	0	0	0	0	3,985	0	0	10Y	0	0	0	0	0	0	2,116	0	0
12Y	0	0	0	0	0	0	0	0	0	12Y	0	0	0	0	0	582	854	0	0
15Y	0	0	0	0	0	3,007	0	0	0	15Y	0	0	0	0	420	2,228	0	0	0
20Y	0	0	0	1,578	0	0	0	0	0	20Y	21	102	162	180	766	0	0	0	0
25Y	0	0	0	0	0	0	0	0	0	25Y	185	100	106	20	0	0	0	0	0

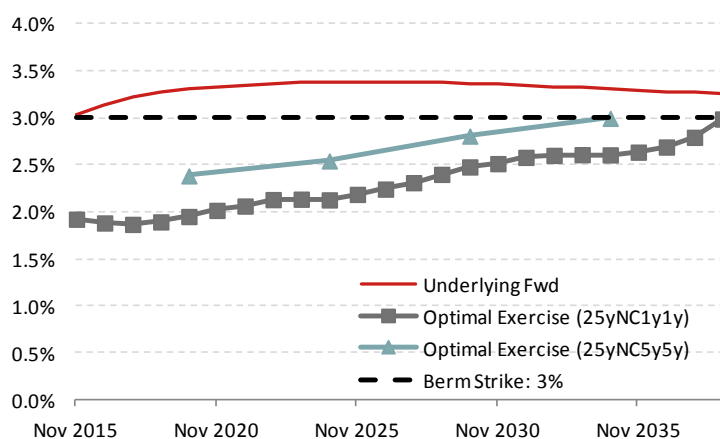
Source: Nomura Research. Both trades are receivers and struck at 3%.

Like American Options, the Bermudan Option optimal exercise boundary is derived by backward induction on a recombining tree. Figure 8 demonstrates the optimal exercise boundary for 25yNC1y1y and 25yNC5y5y. The underlying forward has same final maturity (e.g., at annual intervals the forwards are 1y24y, 2y23y, 3y22y, etc up to 24y1y and 25y spot). Berms with more optionality require far more “in-the-moneyness” before early exercise. Rather, Berms with less optionality will have optimal exercise strikes closer to the underlying strike (3% in the example on the right).

Unlike exercise boundaries in equities derivatives (e.g., for American Equity options), the choice of exercise vs continuation depends on the relative moneyness of a number of forwards on the curve, not just one underlying index. While Berms vs Europeans are a sort of forward vol trade, the slope dependence and vol slope dependence complicate the forward vol aspects.

Fig. 8: Optimal exercise boundary

Exercise boundary (shown for receivers) is far below strike initially, but converges at last exercise date



Source: Nomura Research

Figure 9 shows the payoff of a Bermudan/European Switch 25yNC5y5y trade, i.e. long \$100mm 25yNC5y5y ATMF payers and \$100mm 25yNC5y5y receivers vs short

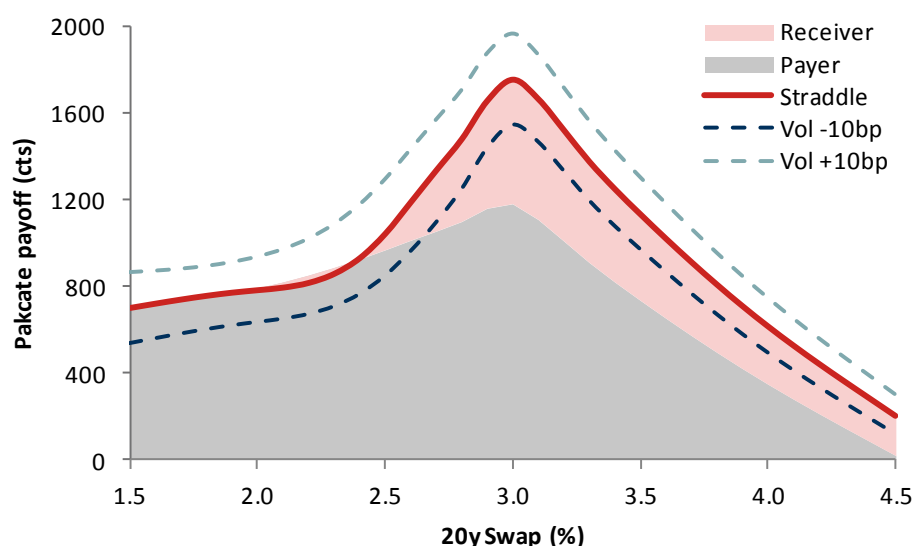
\$100mm 5y20y ATMF straddles. The strike is 3%. The pay-off can be divided into four regions:

- If 20y rates < 3%, 20y rates > Optimal Berm receiver exercise (~2.4%) then European receiver is exercised and investor is long Berm (20yNC5y5y) Receiver + Berm (20yNC5y5y) Payer + Payer Swap (@3%) position.
- If 20y rates < Optimal Berm receiver exercise (~2.4%) both Vanilla receiver and Berm receiver are exercised (where the pink shaded area decreases to zero). The investor is long only the Berm payer.
- If 20y rates > 3%, but 20y rates < Optimal Berm payer exercise (~4.5%) then European payer is exercised and investor is long Berm Receiver + Berm Payer + Receiver Swap (@3%) position.
- If 20y rate > Optimal Berm payer exercise (~4.5%) then both Vanilla payer and Berm payer are exercised (where the grey shaded area decreases to zero). The investor is long only the Berm receiver.

Figure 9 also shows a strong dependence of the Berm/Eur switch trade on forward volatility. Valuation depends on immediate call (i.e. 20y spot rate) but also on remaining forward calls and underlying vols (5y15y, 10y10y and 15y5y). There is also a dependence on slope and vol slope which leads to modest differences with other forward vol strategies in terms of hedging and performance.

Fig. 9: Aged 5y pay-off of Bermudan/European 25yNC5y5y

Forward vol exposure in 5y time



Source: Nomura Research

Mid-Curve Calendar Spread (MCCS)

Mid-Curve Calendar Spread (MCCS) is a strategy to go long forward vega, short gamma and long curve carry.

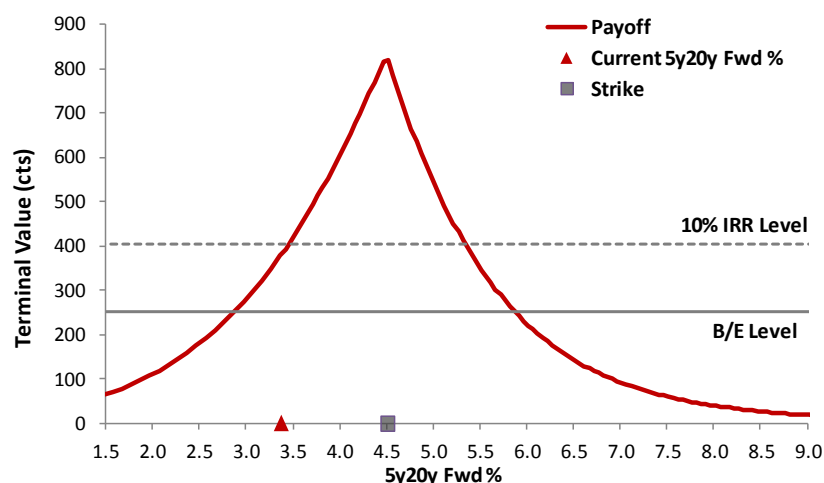
The pay-off of a USD 5y5y20y MCCS trade is shown in Figure 10, which is to go *long* \$100mm10y20y 4.5% receivers and *short* \$100mm 5y5y20y mid-curve 4.5% receivers. In five years' time, the pay-off can be divided into two sections:

- If the 5y20y rate > 4.5%, the Midcurve expires worthless and the resulting position, now 5y20y 4.5% Receivers remains.
- If the 5y20y rate < 4.5%, the Midcurve (physical settle) is exercised and becomes a Short Receiver Swap @ 4.5% (i.e., Long Payer Swap @ 4.5%). Using Put-Call Parity: Short 5y20y Receiver Swap @ 4.5% + Long 5y20y Receiver Swaption @ 4.5% = Long 5y20y Payer Swaption @ 4.5%.

The pay-off profile is thus Long 5y20y Payer Swaptions at low rates and Long 5y20y Receiver Swaptions at high rates. Put call parity means it made no difference if it was implemented with receiver swaptions or with payer swaptions.

Fig. 10: Aged 5y pay-off of USD 5y5y20y MCCS trade

10% IRR level upper and lower range: [3.46, 5.33] and B/E level upper and lower range: [2.88, 5.87]

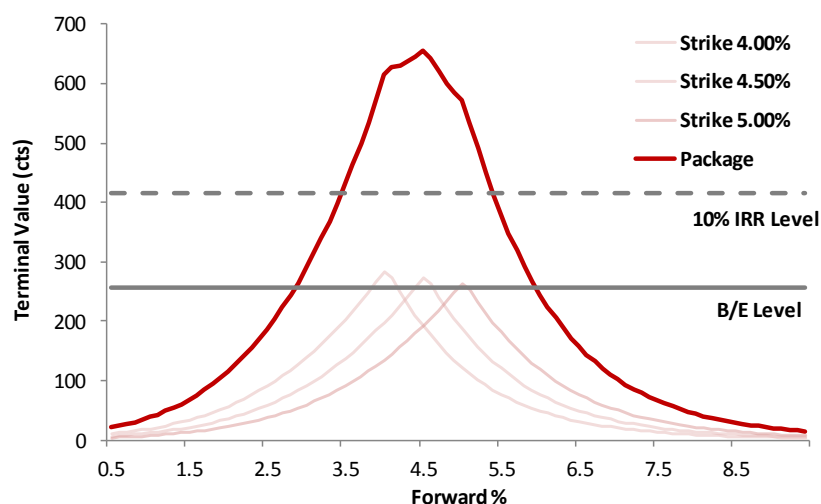


Source: Nomura Research

By combining the MCCS at several strikes, we widen the B/E range at the cost of some of the carry. In Figure 11, we show the payoff of Multi-Strike MCCS at 4%, 4.5% and 5% strikes for convenience.

Fig. 11: Aged 5y pay-off of USD 5y5y20y Multi-strike MCCS

10% IRR level upper and lower range: [3.42, 5.37] and B/E level upper and lower range: [2.83, 5.91]



Source: Nomura Research

Interestingly, the breakevens of the Multi-strike trade and the single strike trade are relatively similar. This is generally true at both higher and lower rates. This is part of the reason that the performance of the unhedged indices is similar, as we see in Figure 6. But the hedged indices perform quite differently and this can only be because hedging is effectively easier in the Multi-strike version, primarily because the gamma has been lowered considerably (we can see this primarily from the fact the pay-off has a flatter region rather than being peaked).

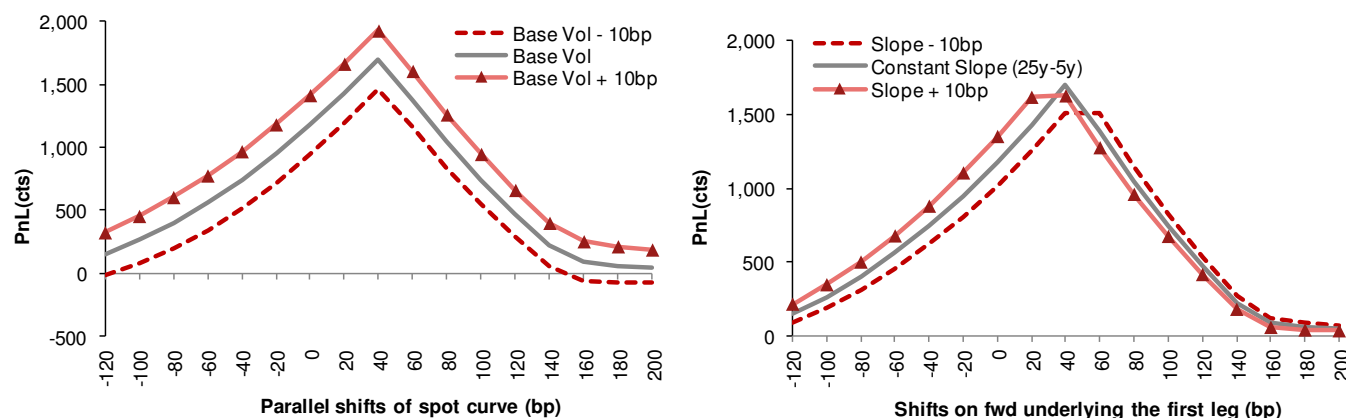
Volatility Triangle

A volatility triangle is another way to go long forward vega, short gamma and long curve carry, but with purely vanilla underlyings

As vanilla approximations of MCCS trades, volatility triangles show decent carry to term. Figure 12 is the 5y P&L of USD 5y5y20y triangles, which is to go long \$100mn 5y5y ATMF Straddles, long \$100mn 10y20y ATMF Straddles and short \$100mn 5y25y ATMF straddles for 548 cts (mid). The 5y P&L profile depends on both vol shifts and slope shifts. For USD 5y5y20y triangles, today's vega is 9ct/bp, which grows to approximately 20ct/bp at expiry. The sensitivity analysis on slopes shifts shows that it is a combined bull-steepener and bear-flattener.

Fig. 12: 5y P&L Profile of USD 5y5y20y Triangles

Pay-off shows dependence of vol shifts and slope shifts



Source: Nomura Research

While vol triangles are similar to MCCS (i.e., the 5y5y and 5y20y options together are similar to shorting a 5y5y20y midcurve), the pay-offs are in many ways much more diverse and depend on the different strikes and curve shape. We choose to only trade ATMF straddles in our vol triangles, only because this is more or less a market convention. But we can see many circumstances when, owing to changes in market correlation, butterflies will behave quite differently from an MCCS trade. Moreover, they have three separate underlying forward swaps and our experience shows we cannot use a single underlying to attempt a hedge.

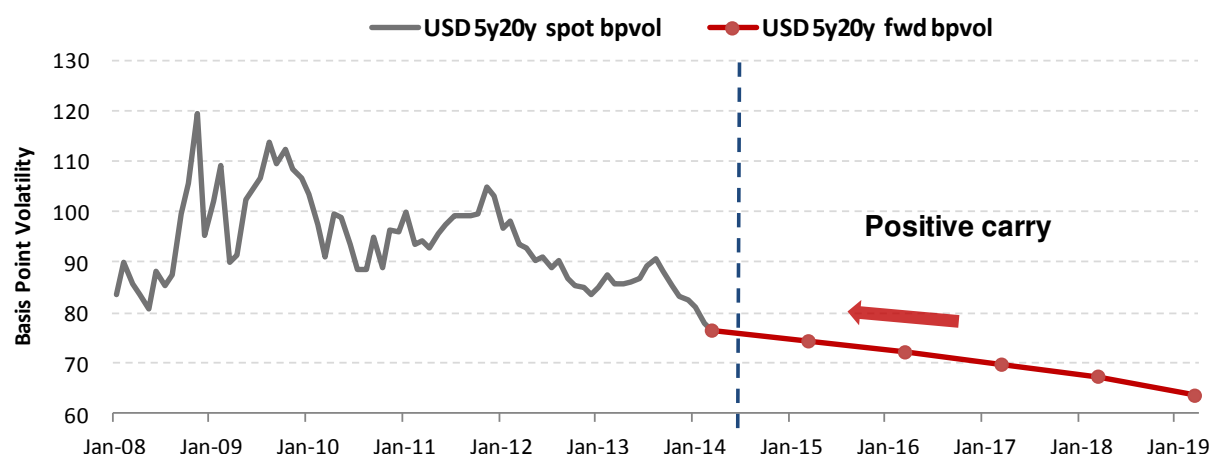
Forward Volatility Agreement (FVA)

Forward Volatility Agreement has the simplest form of pay-offs among all these trades. It is long vega only. We consider the 5y5y20y FVA, an agreement whereby two counterparties agree to a 5y forward price to a 5y20y ATMF straddle. At exercise, the premium is exchanged for a physical settle straddle. We choose to make the straddle spot premium rather than forward premium and this induces some delta (through the PV01).

The FVA trade provides a "pure" implied vol exposure. Forward vol exposure does not suffer time decay until the end of the forward period. It has no Black-Scholes delta nor gamma. Furthermore, a backwardised term-structure of forward vol yields positive carry.

Fig. 13: Term structure of forward vol has been backwardised

Forward vol position has positive carry.



Source: Nomura

Forward Volatility: What is it?

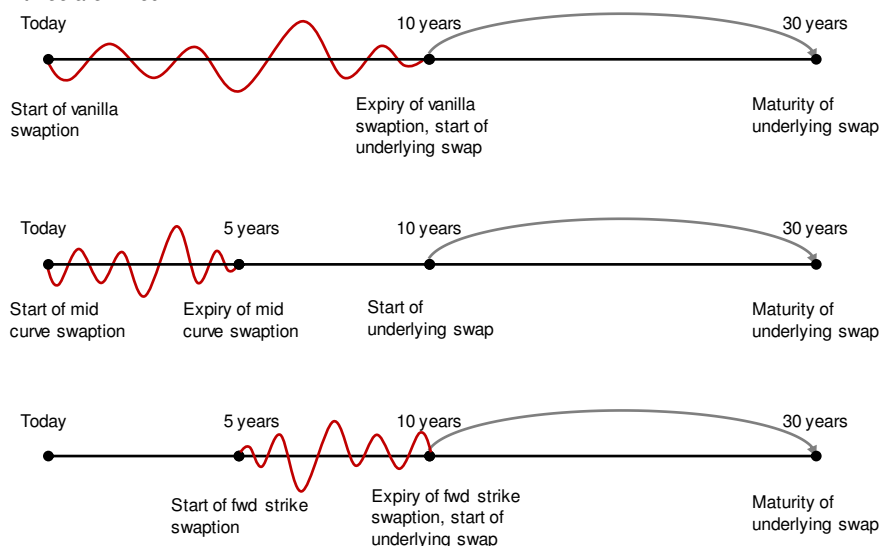
Forward volatility is, as one would expect, the exposure to an asset's volatility at some point in the future. This exposure can be synthesised in a number of ways and, as we

mentioned above, it seems clear that many of our proposed forward vol products have very small vega at trade start but vega grows considerably through time.

Forward vol itself can be synthesised through a combination of spot starting swaptions and midcurve swaptions of the same underlying at many different strikes. The intuition can be seen in Figure 14.

Fig. 14: Forward Vol, Vanilla Vol and Midcurve Vol

All three are linked



- **Plain Vanilla Swaption (10y20y):** Standard instrument where the strike is set at inception and the underlying swap starts on a spot basis from the option expiry date
- **Forward Starting Swaption (Mid-curve swaption, 5y5y20y):** The strike is set at inception but the underlying swap starts several years following the option expiry date
- **Forward Strike Swaption (Forward vol agreement, 5y5y20y):** The strike is only set after several years at the then ATM level, and the underlying swap starts on a spot basis from the option expiry date

Source: Nomura Research

Forward Volatility: Where does the carry come from?

Rates forward volatility, unlike its counterparts in equities (and sometimes in FX), is generally a source of decent positive carry. In FX and Equities, forward vol is typically larger than spot vol, and in other words, a forward vol strategy would have negative carry. This effectively implies a non-stationarity to equities and FX underlyings, in line with much of historical experience. In rates, forward vol is often below spot vol. In other words, short-term spikes which may impact spot vol are effectively shrugged off by the forward vol market as being temporal.

This is not true of all vols, since in the upper-left corner, the rates market prices in persistence or trending of short tenors and short forwards, and consequently the upper left (e.g., 1y, 2y tenors, 1y or 2y or shorter expiries) have negative carry. This is in line with historic experience where short rates are driven by trends in the economy and responsive policy rates, leading to, for all practical purposes, non-stationarity.

Long-dated rates forward vol has positive carry. This implies that longer forward of short tenors (e.g., 5y1y, 5y2y, 5y5y) and longer tenors (5y10y, 10y10y, 20y30y) have far more mean-reversion. In rates, much of the best forward vol carry is in long-tenor forward vol. Historically, long-tenor forwards (e.g., 5y20y, 10y10y) exhibit far more stability than other parts of the curve. The forward vol carry effectively prices in this historical phenomenon.

Appendix A-1

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