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G10 Rates Investment and Hedging Opportunities

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Interest Rate Outlook

Whilst policy remains far from 'normalised', central bankers will remain crucial for market moves, grappling with lowflation and the painstaking removal of quantitative easing.

- With Jay Powell becoming the Fed Chair effective in February 2018, market expects stronger deregulation motive in banking sector and a sympathy towards a potential fiscal stimulus.
- The outcome serves to solidify continuity of the current monetary policy regime implying the gradual pace of tightening will not materially change with the market pricing the terminal rate (3y1m OIS) in line with our expectations near 1.9%.
- Market now pricing 95% likelihood of a December Fed hike, with a terminal rate at 1.90%.

- Draghi says there will not be any 'sudden stop' on QE so we have to raise the odds that the Asset Purchase Program lasts until September 2018, in one form or another. Combined with the 'well past' language it means that the Jul19 timing for the first hike now looks fair rather than the limit for markets. The ECB set market expectations of €30bn for 9-months and then delivered, with a few nuances.

- We see no outright hawks in the current BoJ. Kataoka has become even more dovish, moving one step to the left – elsewhere, the landscape remains the same.
- After PM Shinzo Abe's decisive election victory, we would expect long-time ally Kuroda to be reappointed at the helm of the BoJ, but see Deputy Governor Nakaso or Columbia Professor Ito as potential successors, should Kuroda not be reappointed. Nevertheless, BOJ will continue to persist with "powerful monetary easing" to boost inflation, even if Kuroda leaves.

BOJ to persist with monetary easing to boost inflation: Kuroda https://www.reuters.com/article/us-boj-policy-kuroda/boj-to-persist-with-monetary-easing-to-boost-inflation-kuroda-idUSKBN1DD28T

Interest Rate Outlook - USD

With market shifting its focus from Fed balance sheet reduction to Trump's tax reform, we changed our view from curve steepening to neutral/ slightly flattening, depending on the interplay between Treasury supply and the Fed.

- **Tax reform comes to the forefront**
  - Fiscal stimulus mechanically boosts growth, not number of hikes
  - Based on our deficit assumption of $1.5tn over 10yr, risks remain to the upside in yields**,** with only 30%~40% currently priced in
  - e.g. **5y5y** rate a further **+20bp**
- **Net Supply to increase by more than x2 in CY2018**
  - 2018 net marketable borrowing needs expected to be around $1.3tn vs $580bn for 2017.
  - We expect much of the issuance at the **front-end** (bills & <5y coupons) starting from next Feb, with pressures to build around Feb-April.
  - **Weak foreign demand in 10y** refunding auctions have been disappointing this year. Another potential factor for 10y rate to move further up.
  - We expect a Treasury **coupon hike in February** due to tax reform, debt ceiling and Fed normalization.+
- **Fed balance sheet reduction**
  - The $50 billion per month **taper would begin in October**, with a gradually raising cap. The balance sheet would drop below $3 tn in 2020.
  - pre-QE3 levels of reserves by the end of next year.
  - Overlaying expectation on foreign reserves, some **widening in XCCY basis spread** (~10bp for 3M JPYUSD).
  - simply shifting Fed Treasury reinvestments, for instance from 30y bonds to 3m T-bills, does not steepen the yield curve

Citi's Interest Rate Forecasts (as of Nov 27 2017)

IR Forecasts (%)	1Q 18F	2Q 18F	3Q 18F	4Q 18F	1Q 19F	2Q 19F
Fed Funds	1.75	2.00	2.25	2.25	2.50	2.75
3m $ Libor	1.90	2.15	2.40	2.40	2.65	2.90
UST 2y	1.85	1.95	2.00	2.15	2.20	2.15
UST 5y	2.05	2.10	2.15	2.30	2.45	2.50
UST 10y	2.50	2.50	2.55	2.70	2.80	2.85
UST 30Y	3.00	3.00	3.00	3.00	3.05	3.10
Swap 10y	2.47	2.48	2.55	2.70	2.80	2.85
Economics Forecasts (%)	**1Q 18F**	**2Q 18F**	**3Q 18F**	**4Q 18F**	**1Q 19F**	**2Q 19F**
GDP SAAR	2.4	2.3	2.7	2.9	2.6	2.3
PCE Deflator YoY	1.5	1.9	1.8	1.8	1.9	2.0
Unemployment Rate	4.0	4.0	3.9	3.8	3.8	3.7
Long Term Forecasts (%)	**2017F**	**2018F**	**2019F**	**2020F**	**2021F**	**2022F**
Central Bank Rate	1.13	1.94	2.60	2.75	2.75	2.75
10y Government Yield	2.45	2.75	2.90	3.05	3.10	3.15

Source: Citi Research

- **Front end cheapening to continue (2Y)**
  - Cheapening of Treasuries to OIS as GC rates have moved higher
  - Indicate a combination of dealer balance sheet issues into yearend and selling of front end Treasuries by investors.
- **November CPI report to set pace of 2018 rate hikes**
  - Strong core CPI (0.22% MoM): A December hike is now very likely. A March '18 hike (**and three total in 2018**) is our base case but remains dependent on stronger core inflation.
  - Fed hikes premised on inflation pickup imply less flattening; longer-term yields may price higher inflation rates as the Fed continues hiking, rather than front-end yields moving higher alone.

Short-End Notes - To Live and Die in QE https://www.citivelocity.com/t/eppublic/1Ciu9
US Rates Weekly - Tax cuts and the next act https://www.citivelocity.com/t/eppublic/1CcRM
Global Economic Outlook and Strategy - November 2017 https://www.citivelocity.com/t/eppublic/1DL0H

Short-End Notes - 2018 UST Supply Outlook https://www.citivelocity.com/t/eppublic/1CiQn
US Rates Weekly - Let's Get Fiscal https://www.citivelocity.com/t/eppublic/1CgGP
US Rates Weekly – Curveball https://www.citivelocity.com/t/eppublic/1Ck38

USD Rates – Effect of Tax Reform on Rates Curve

US Tax Cut on Rates Curve

How does fiscal policy affect the curve?

- Expectations of higher Treasury supply bring long-term rates higher
- Temporary boost to growth causes tighter monetary policy

What do past discretionary fiscal shocks tell us?

- Looking at past US legislations that changed fiscal policies for reasons other than ongoing economic developments

Changes of rates from 1m before to 1w after law signed

date law signed	9/3/82	4/20/83	7/18/84	10/22/86	12/22/87	11/5/90	8/10/93	8/5/97	6/7/01	5/28/03
net decline in revenues as % of GDP	-0.8	-1.1	-0.2	0.2	-0.2	-0.6	-0.6	-0.02	0.8	0.6

rate/curve	2y	5y	10y	5y5y	10y10y	2s10s	5s30s
beta, bp/% deficit/GDP	36.2	35.2	35.8	36.3	39.1	-0.3	0.6
t-stat	1.75	1.83	1.96	2.20	2.44	-0.07	0.08

Source: Citi Research

- 1% increase in deficit/GDP => 36bp increase in the 10y rate
- But not much effect on 2s10s and 5s30s

US Rates Weekly - Let's Get Fiscal https://www.citivelocity.com/t/eppublic/1CgGP

US Tax Cut on Rates Curve

The curve has been highly directional with deficits – but deficits are by definition not independent of rates.

Current tax reform should be compared to previous discretionary fiscal shocks.

Source: Citi Research

US Tax Cut on Rates Curve

Regression of structural fiscal policy on (1) long-dated forwards and (2) real neutral rate

- Citi's regression analysis shows that **structural deficits/GDP** is a highly statistically significant determinant of **long-dated forwards**.
  - The 5y5y rate tends to increase by about **30bp with a 1% increase in deficit/GDP**.
  - On the other hand it did not have a strong correlation with either **trend growth** or the long-run **neutral real rate**

➢ Long-dated forwards largely independent of the Fed's response
➢ Expectation of about **$1.5tn** decline in revenues => 5y5y rate to rise by another +**20bp** when fully priced in.

	Rate	const %	Inflation target %	Trend GDP %	% Foreign purchases / GDP	% per % increase in 5y-ahead deficit/GDP	R^2 %
Long-term Forwards	**5y5y**	1.57	1.31	0.47	-0.45	0.30	87
	10y10y	1.31	1.14	0.83	-0.36	0.34	88
Real neutral rate	**r* (real)**	2.95	-	-	-0.29	0.01	6
	r* (real)	0.91	-	0.71	-0.25	0.01	42

Source: Citi Research, CBO, Philadelphia Fed, Haver

- Citi's expectation of changes in rates following tax reform implementation in different rate hike scenarios

	# additional hikes priced in		chg in rates and curve, bp							
	1st year	2nd year	2y	5y5y	10y10y	5y	10y	30y	2s10s	5s30s
Scenario A	0.5	0.5	8.3	20.0	24.0	13.4	16.1	19.2	7.8	5.8
Scenario B	1	1	16.5	20.0	24.0	18.8	19.1	20.6	2.6	1.8
Scenario C	1.5	1.5	24.7	20.0	24.0	24.2	22.1	22.1	-2.7	-2.1

Source: Citi Research

US Rates Weekly - Let's Get Fiscal https://www.citivelocity.com/t/eppublic/1CgGP
Inflation target is the 10y-ahead CPI inflation forecast the Survey of Professional Forecasters. Trend GDP and 5y-ahead deficits/GDP are estimated by CBO. The r* is an estimate of real neutral rate by Laubach and Williams. Newey-West serially-adjusted t-stats are reported in parentheses. Sample: 1980-2008.

USD 5y5y Seagull - Low Cost Swaption Strategy

Details/ references on this page are indicative and are for illustrative and discussion purposes only and not a recommendation to buy or sell into any specific transaction.

Seagull structure can be used to position for rising rates at low cost and positive carry

- *Table:* Shows the key characteristics and trade details of the Seagull
  - Buy $100mm 5y5y ATM Payer
  - Sell $100mm 5y5y a-70bps Receiver
  - Sell $100mm 5y5y a+100bps Payer

Low net delta and convexity

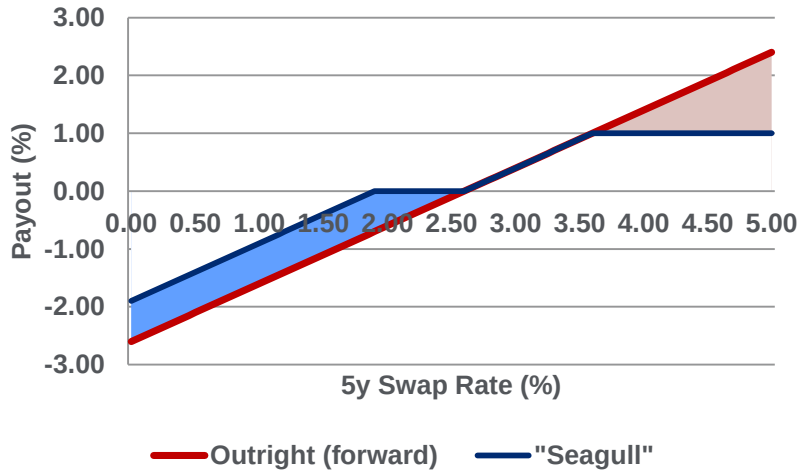
Vega spread risk

Positive carry

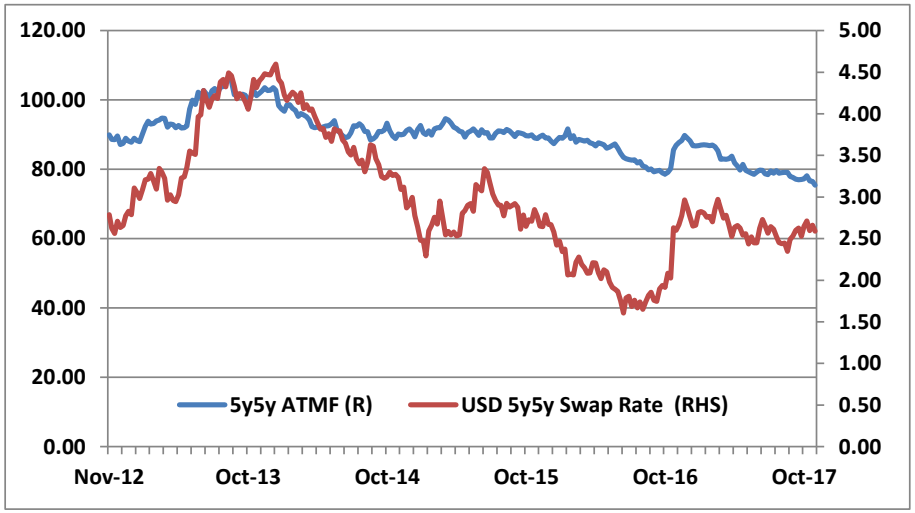
Positive carry contributions

CCY	Type	Notional	Expiry	Tail	Strike	ATM Spread	Spot Premium	Delta[1]	Gamma[2]	Vega[3]	1y Theta[4]	1y Roll[5]	1y Roll Breakdown Swap	1y Roll Breakdown Theta[4]	1y Roll Breakdown Vega
USD 5y5y Seagull															
USD	p	$ 100mm	5y	5y	2.601%	a+0	2,900k	19k	98	38k	-299k	-424k	-84k	-299k	-41k
USD	r	$ -100mm	5y	5y	1.901%	a-70	-1,600k	15k	-131	-33k	273k	202k	-116k	273k	44k
USD	p	$ -100mm	5y	5y	3.601%	a+100	-1,300k	-9k	-75	-33k	260k	315k	41k	260k	14k
						Total	**0.00k**	**25k**	**-108**	**-28k**	**234k**	**93k**	**-158k**	**234k**	**17k**

Payoff Structure (Seagull vs. Outright forward)



USD 5y5y Swap Rate and ATM Vol



***Source**: Citi*
***Notes**: These values are estimates only.*
Past performance is not an indicator of future performance

(1) Delta = Change in PV for a +1bp parallel rise in rates, using Sabr volatility surface. (2) *Gamma = Change in Delta for a +1bp parallel rise in rates* , using Sabr volatility surface
(3) Vega = Change in PV for a +1bp parallel rise in normalised volatility. (4) 12m Theta = Change in option time-value by reducing the expiry by 12-months, keeping the forward and normalised volatility constant
(5) 12m Roll = Change in PV over 12-months, assuming positions roll-down the curve and volatility surface (i.e. forwards are not realised)

USD Rates Volatility – Formosa Bonds on long-end Vol

USD Rates Vol Market Driver – Taiwanese Formosa Callable Bonds

A Formosa bond – a bond issued in a foreign currency (often in USD) for the Taiwanese investors and listed on the local Taipei Exchange.

Regulation Change in 2014:

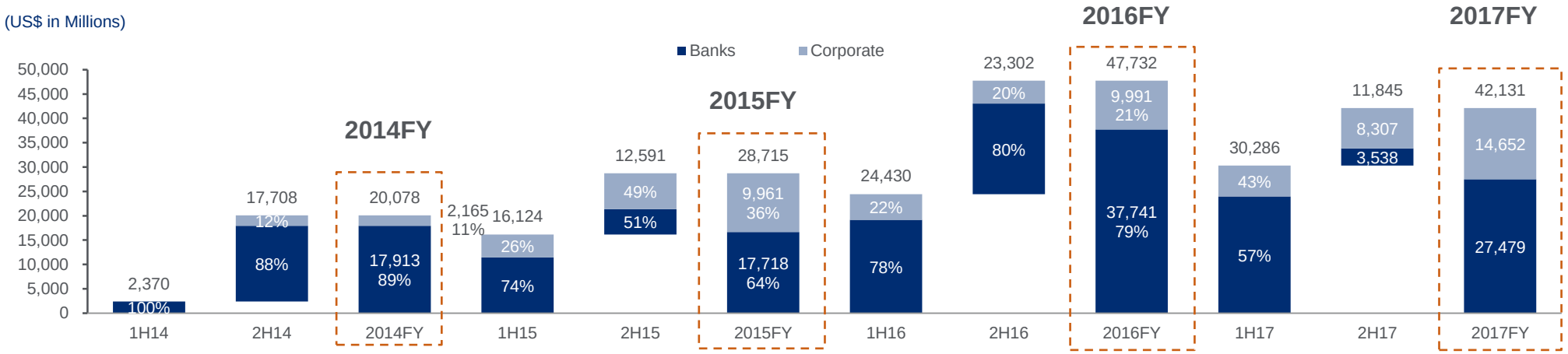
- Previously 'foreign investments' subject to maximum of 45%
- In 2014, the regulation updated to allow those on the Taipei Exchange to be excluded from this limit

Structure:

- Financial and high-grade corporate issuers
- Majority Bermudan Callable format, zero-coupon and bullet
- 30Y maturities, with initial calls between 1Y-5Y

Total market size:

- $20bn (2014) / $28bn (2015) / $47bn (2016) / $42bn (2017 YTD)
- Citi is amongst top 3 bank issuers ($4.8bn)



Source: Bloomberg, Dealogic as of Nov 2017.

USD Rates Vol Market Driver

Callable bond supply outlook

In 1H17 an influx of Formosas were issued before the anticipated regulation change of minimum non-call period (5y)

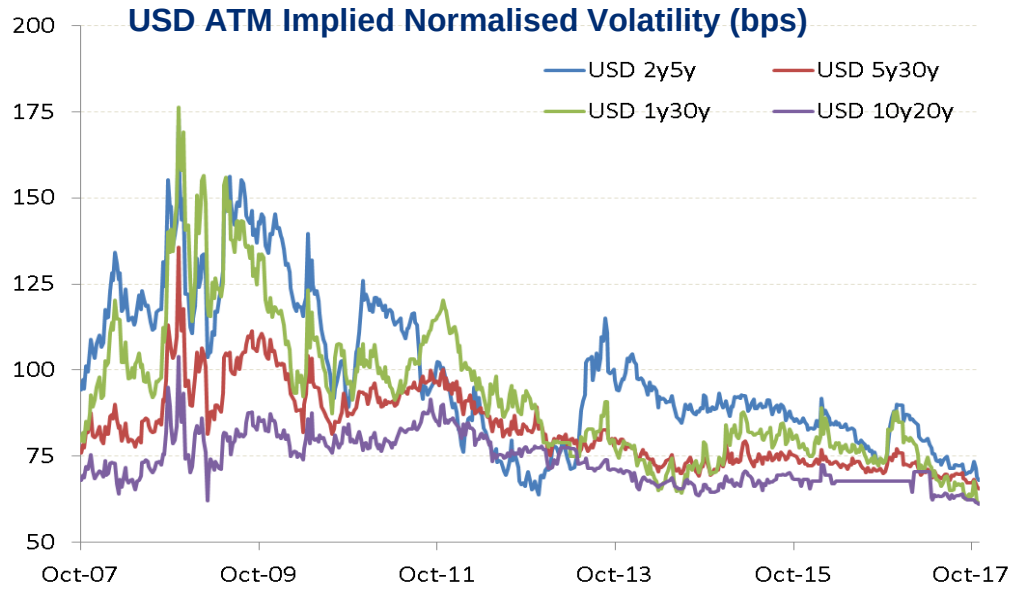
- Material slow down in the recent few months
  1. Less attractive yields
     - 30y USD swap rates & low vol & longer NC period
  2. Higher FX hedging costs
     - Around 40% of foreign assets (USD) are hedged back to TWD
     - Market now implies 2% drop between spot and 1y forward USDTWD
     - Yield (IRR) net FX hedging costs is currently at lowest level since 2013
  3. Low growth of policy sales
  4. Regulation scrutiny

Source: Citi Research. US bank CDS index as proxy for credit spread

- We expect supply of callables to remain weak through the rest of the year
- Supply may pick up in January but smaller than in previous years (vs 1Q17 $21bn)

Callable bond supply keeps long-end vol down

Typical structure: 30yNC5y, then every year callable by the issuer



Source: Citi

Tenor

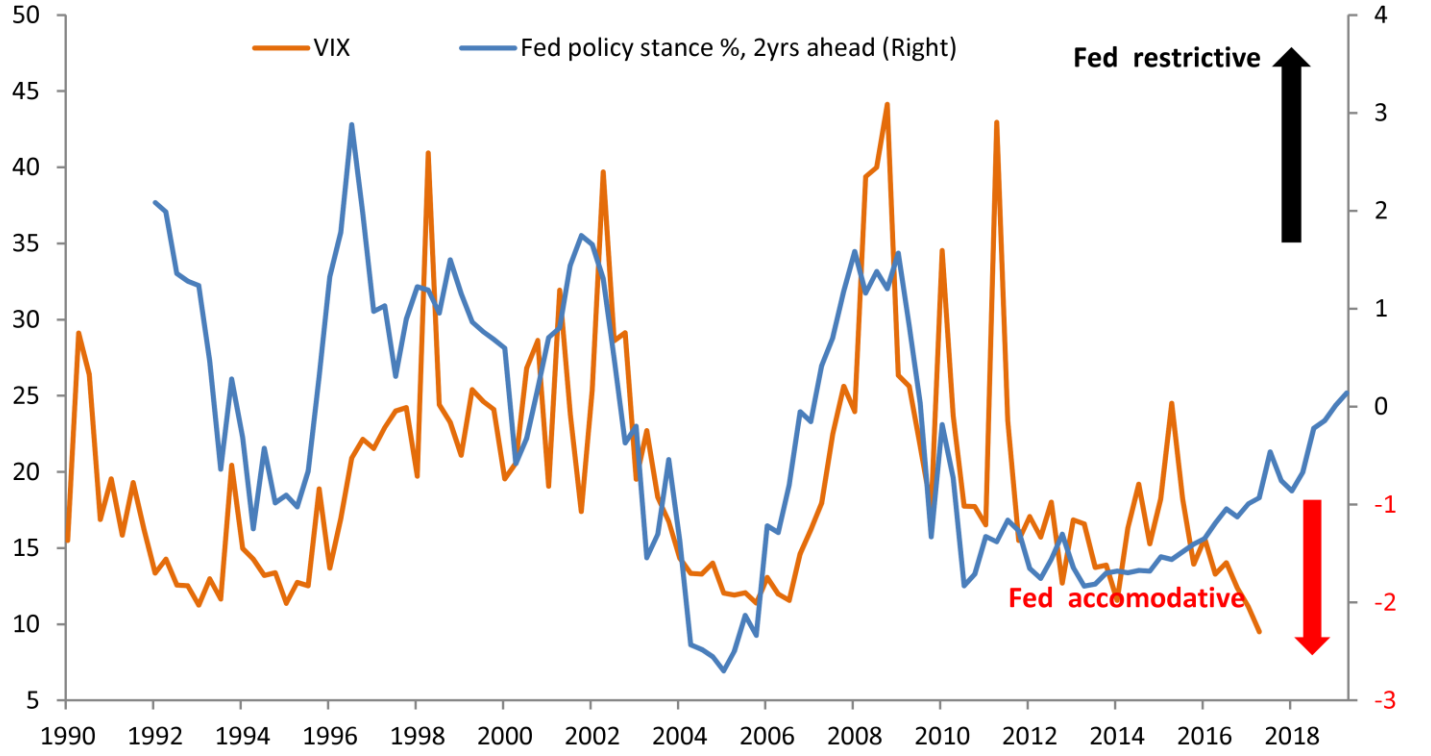
Expiry / Spot	2Y	5Y	10Y	15Y	20Y	30Y
1Y	51.5	62.2	65.1	63.8	62.8	61.7
2Y	62.5	68.4	69.8	67.7	65.9	64.8
3Y	69.6	72.0	71.9	69.0	66.9	65.5
4Y	73.6	74.2	72.9	69.3	66.9	65.6
5Y	76.2	75.4	73.2	69.3	66.7	65.5
7Y	76.5	75.2	72.2	67.8	64.9	63.5
10Y	73.6	72.1	68.7	63.7	61.1	59.9
15Y	64.2	62.9	59.9	55.9	54.2	53.5
20Y	56.5	55.5	53.1	50.3	49.1	48.6

Source: Citi

Volatility Regime Shift?

- In recent weeks equity volatility spiked – is it temporary or an early warning of a regime shift?
- We find that monetary policy stance is a good leading indicator for the volatility regime
- Volatility may rise as a lagged impact of the tightening in the policy stance. We think investors should be more mindful of risk asset volatility as the Fed moves past neutral - which is not that far away at roughly 1.5%.

The Fed policy stance leads the VIX by around 2 years

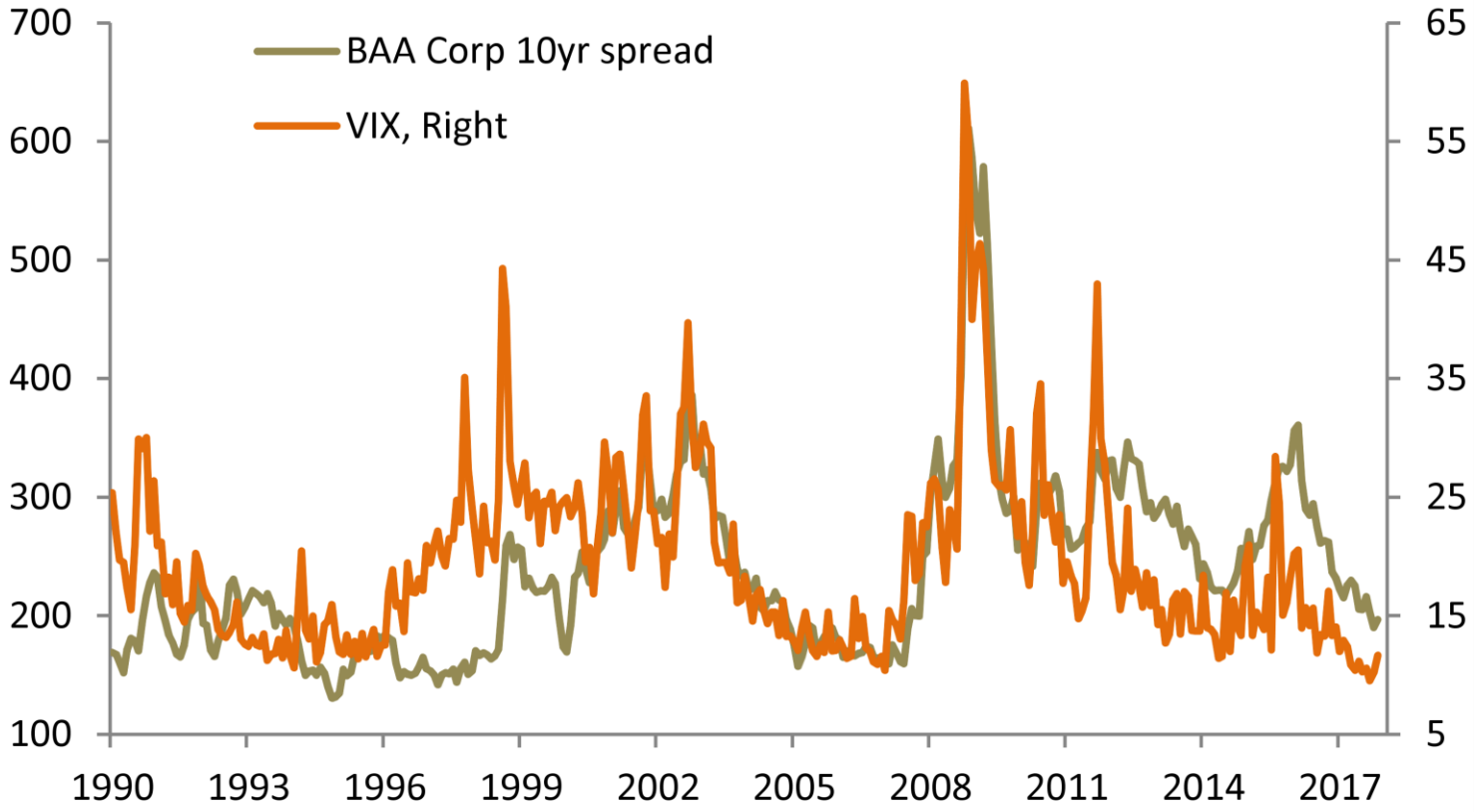


Source: Citi Research, FRBSF, Bloomberg

Fed policy stance defined as the 2y yield gap to time-varying nominal neutral Fed rate (see European Rates Weekly When will volatility regime shift? https://www.citivelocity.com/t/eppublic/1DHDW)

How to Hedge Against a High Vol, Wide Credit Environment

High historical correlation between VIX and credit spread

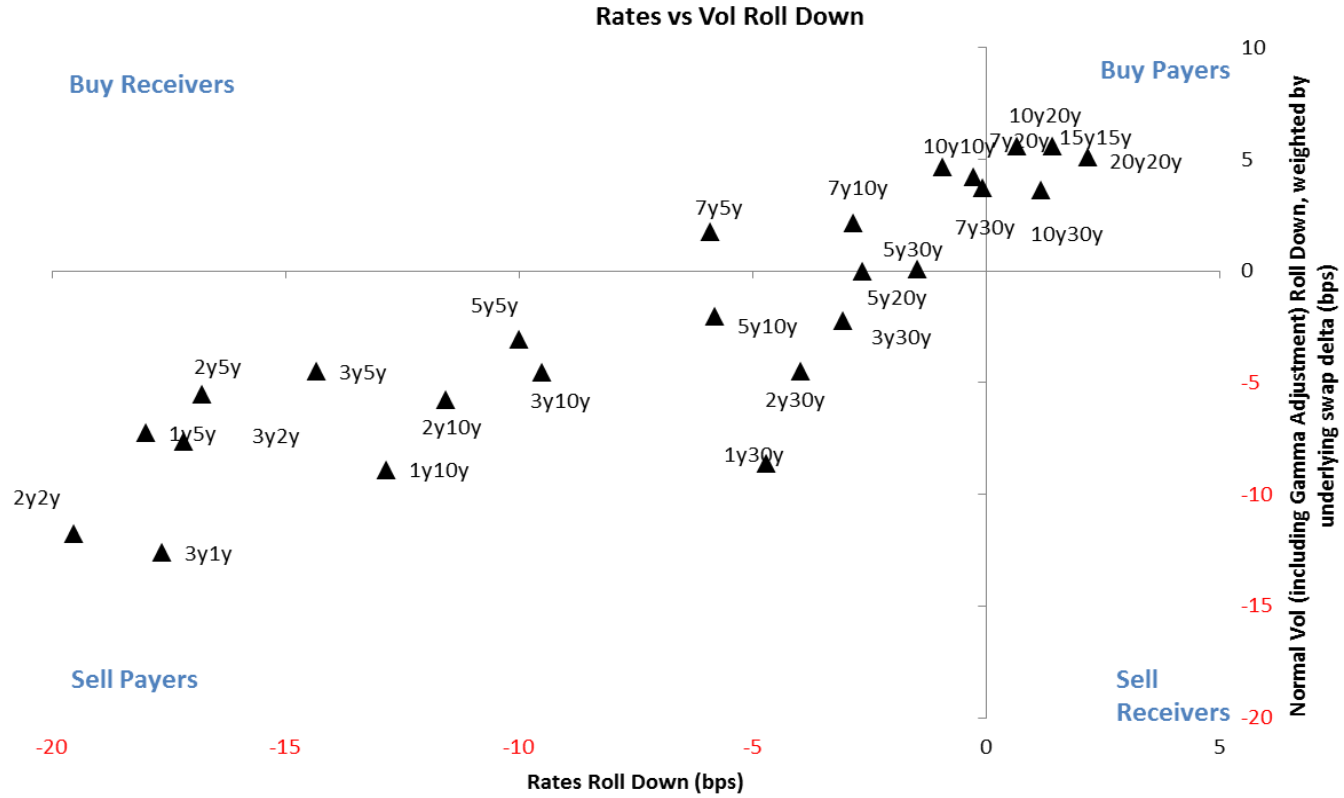


Source: Citi Research, Bloomberg

USD Swaption Vol & Rates (with 1Y positive roll-down)

- Long volatility structures should make sense given (1) the potential reduced lack of supply from the Formosa market and (2) volatility to finally pick up following Fed hikes.

Long-dated payer swaptions offer a positive roll-down
- because of the shapes of the rates curve and the vol surface.



	CCY	Type	Notional	Expiry	Tail	Strike	ATM Spread	Spot Premium	Delta	Gamma	Vega	1y Theta	1y Roll	1y Roll Breakdown Swap	Theta	Vega
(1)	USD	p	$ 100mm	**15y**	**15y**	2.67%	a+0	7,786k	29k	94	141k	-258k	**164k**	238k	-258k	184k
(2)	USD	p	$ 100mm	**20y**	**20y**	2.54%	a+0	8,946k	27k	82	184k	-220k	**272k**	317k	-220k	176k

***Source**: Citi **Note**: Past performance is not an indicator of future performance. - These values are estimates only.*

(Rates roll is based on change in underlying swap rate. The vol roll is the expected change in implied normal vol of an ATM option, adjusted for gamma vs. theta P&L expectations, adjusted by the vega/swap delta ratio.)

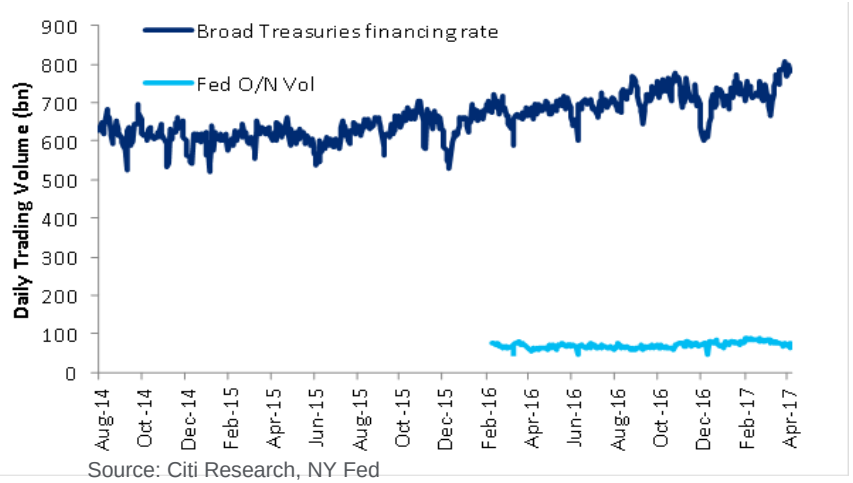
Regulations – Libor Reform & Margin Rules

The end of LIBOR? Not so fast

LIBOR is deeply entrenched in the financial system. We believe ARAC timeline is too optimistic and that USD LIBOR will likely remain quoted after 2021.

- In June, the Alternative Reference Rates Committee (ARRC) chose the "**Secured Overnight Financing Rate (SOFR)**" to be the benchmark replacement for USD LIBOR. Previously named BTFR, SOFR is a volume-weighted **Treasury GC overnight repo rate**, expected to be published in 1H18.
  - Unlike the other currencies, the repo index was chosen over overnight bank funding rate because:
    - ➢ Stronger volumes in GC relative to Fed Funds
    - ➢ LCR and NSFR incentivize banks to fund via secured channels
    - ➢ The risk of a decline in Fed Funds and ED deposit volumes in a scenario where the Fed balance sheet continues to expand

SOFR volume vs Fed Funds volume



Source: Citi Research, NY Fed

- The SOFR presents challenges to corporate hedges because it is an overnight rate. The market may eventually have to come up with a **3m SOFR rate**.
- ISDA has converged to the idea of using **SOFR + spread model** as a fallback rate for permanent LIBOR discontinuation
- We expect **regulators** will eventually impose economic penalties on contracts linked to LIBOR, perhaps in the form of capital charges. This may be especially easy to implement for LIBOR-linked derivatives by setting higher minimum initial margin requirements with a gradual phase-in schedule. We would expect this to affect only new derivative contracts

North America Rates View - The end of LIBOR? Not so fast https://www.citivelocity.com/t/eppublic/178A6
US Rates Weekly - Repeal and replace LIBOR https://www.citivelocity.com/t/eppublic/1Csl0
Short-End Notes - All Hail GC https://www.citivelocity.com/t/eppublic/1Csl5 / North America Rates View LIBOR: Killing it softly with Baily's Song

The end of LIBOR? Not so fast

Given uncertainty about the future of LIBOR but no liquid market for the SOFR-linked derivatives, we would expect more active usage of OIS swaps in the next few years.

North America Rates View - The end of LIBOR? Not so fast https://www.citivelocity.com/t/eppublic/178A6
US Rates Weekly - Repeal and replace LIBOR https://www.citivelocity.com/t/eppublic/1Csl0
Short-End Notes - All Hail GC https://www.citivelocity.com/t/eppublic/1Csl5

Roll-off of Libor-linked contracts

Challenging transition plan on potential hold off on legacy contracts

USD LIBOR Market Footprint by Asset Class		% roll off after x years							
	Years:	1y	2y	3y	5y	7y	10y	20y	30y
Loans	Syndicated Loans	19%	36%	62%	90%	96%	97%	98%	99%
Bonds	Floating/ Variable Rate	29%	47%	62%	73%	74%	76%	80%	81%
Securitization	Residential MBS	0%	1%	2%	3%	5%	6%	18%	86%
	CMBS	1%	6%	8%	12%	23%	65%	80%	89%
	ABS	3%	6%	9%	15%	20%	25%	39%	88%
OTC Derivatives	IRS	18%	31%	42%	65%	75%	83%	96%	99%
	FRA	94%	99%	100%	100%	100%	100%	100%	100%
	Interest Rate Options	45%	59%	66%	74%	77%	79%	81%	81%
	Cross Currency Swaps	29%	46%	60%	76%	83%	88%	95%	99%
Exchange Traded Derivatives	Interest Rate Options	77%	94%	100%	100%	100%	100%	100%	100%
	Interest Rate Futures	33%	67%	88%	99%	100%	100%	100%	100%

Source: Citi Research, NY Fed
Note: the data is as of 2014. We assume the roll-off schedule has not changed much since then.

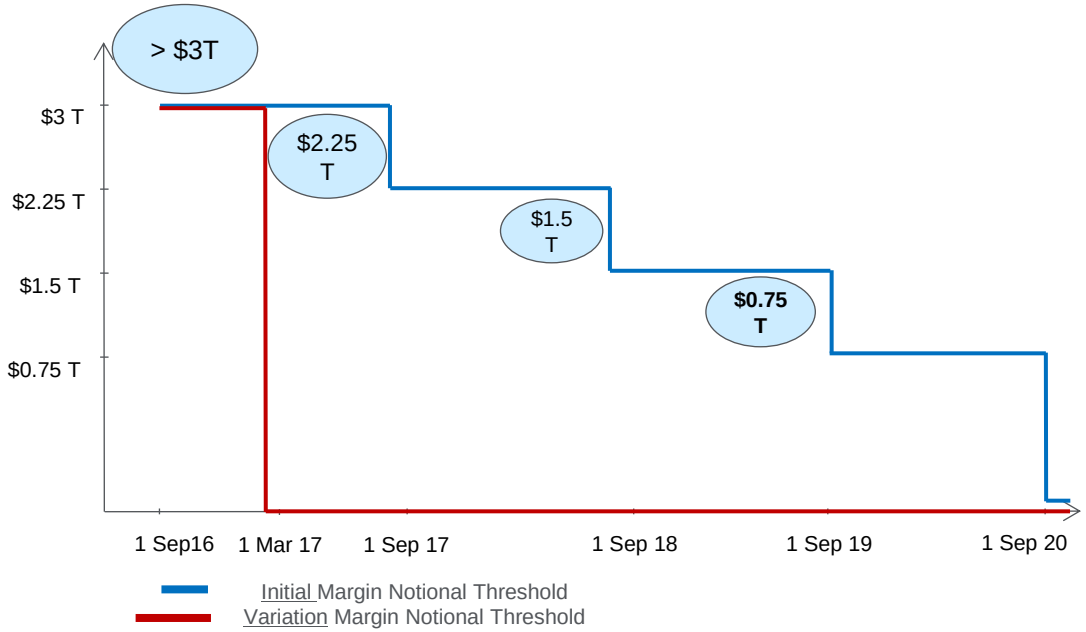
Margin Requirement for Non-Centrally Cleared Derivatives

Margin on Uncleared Swaps became effective from Sept 2016 by the US and from Feb 2017 by the EU.

- **Variation margin** (VM) requirements through mandatory two-way posting of variation margin, zero thresholds and a minimum transfer amount on all new trades executed from the relevant implementation date.

- **Initial margin** (IM) requirements through mandatory two-way initial margin exchange. Initial margin will be subject to segregation requirements at a third party, with no rehypothecation.

US Margin Rule Timeline based on Notional Amount



- Non-Financial End Users are exempt from the margin requirements
- Financial End Users with less than $8B of Material Swap Exposure are exempt from IM requirements

Alternative to Margined Asset Swaps – Repack Notes

Illustration - Repack of a JGB 5Y Bond into USD Fixed Rate Note

Key Features:

- No liquidity requirements vs trading the derivative (see graph below)
- Repack can be on more than one collateral
- Cashflows can be customised to meet client's liabilities
- Benefits of SPIRE platform
- 2-way CSA, daily margined
- Citi has senior claim on the underlying bond in the SPV

Example Costs and Pricing Adjustments:

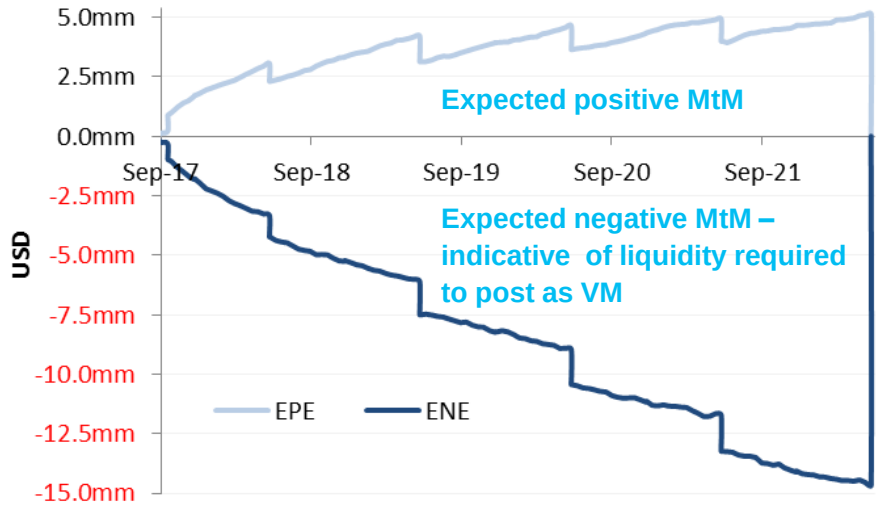
- Setup and maintenance costs: Fixed costs from legal, listing and setup – this is normally independent of size but varies with complexity of structure. Running fees for ongoing maintenance costs eg. custody fees.
- Swap market risk
- Credit Risk (CVA): Can be reduced with trigger levels, although some residual exposure remains.
- Funding Value Asset (FVA): Funding cost to Citi for converting bonds into cash to post on the hedge swap when the mark-to-market of the swap is positive
- Funding Value Liability (FVL): Funding benefit to Citi on collateral received when the mark-to-market of the swap is negative

Source: Citi
Note: These values are estimates only.

Transaction Overview

- SPIRE Issued Note:
  - Notional: USD 100mm
  - Coupon: 2.45% (for comparison, 5Y UST yield 2.05%)
  - Maturity: 20 Sept 2022
- Underlying Bond: JGB 0.1 20/09/22 #133
- The Hedge: Cross-currency swap where SPIRE pays JPY bond cash-flows to Citi and receives USD cash-flows for the Note

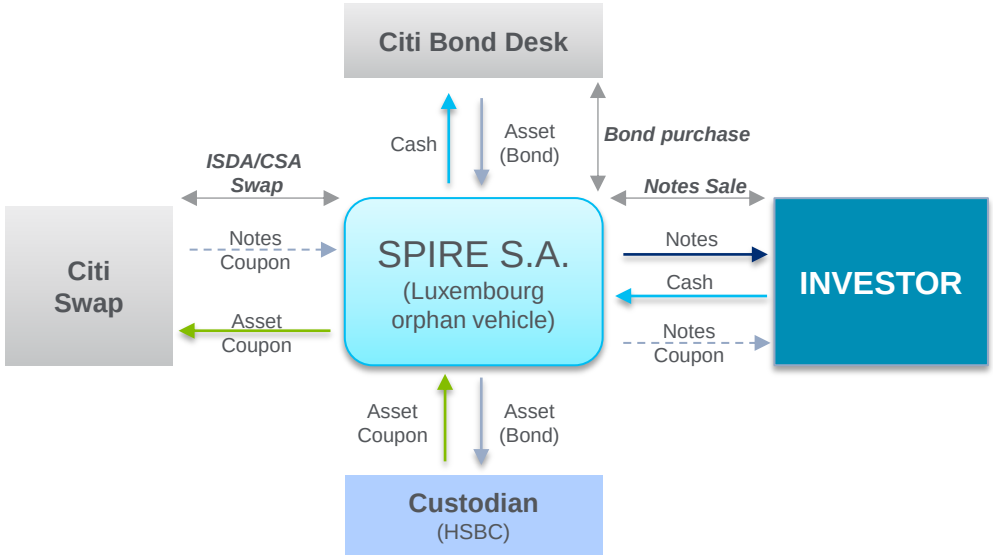
Expected Profile of the Swap (Investor's view)



SPIRE: a new multi-dealer platform

Citi with other dealers established a new repack platform which promotes standardization and liquidity.

Transaction Overview



Rationale for SPIRE

- SPIRE gives investors three key benefits not available from traditional single dealer platforms: (i) **a multi-dealer platform with standard documentation**; (ii) **secondary market liquidity from multiple dealers** *(subject to certain conditions);* and (iii) **if the original swap counterparty defaults, a process for replacement of that swap counterparty exists** *(subject to certain conditions)*
- SPIRE is the only multi-dealer repack platform in the market. From now on, investors will be able to use this unique platform as their repack vehicle of choice and will choose their dealer from one of the four founding investment banks on the platform (BNPP, Citi, CS and JPM)

Summary

- SPIRE is a Luxembourg-based repackaging vehicle. SPIRE stands for "Single Platform Investment Repackaging Entity"
- SPIRE is a new single issuance platform for notes arranged by the participating dealers (initially, BNPP, Citi, CS and JPM)
- Product types are rates, credit and equity (including non-proprietary indices).
- Clients only have to on-board a single vehicle to get access to equal terms from all participating dealers
- New dealers are in the process of being added to the platform to use SPIRE for their repack issuance
- SPIRE has a single set of documents, with no flexibility for an individual dealer to adjust the issuance programme
- All issuances use the same Trustee, Paying Agent and Custodian ensuring full transferability of terms and pricing transparency
- All dealers are "plugged" into the platform from day 1 with a view to facilitating a secondary market and replacement of a defaulted swap counterparty

* Existing clients only

- US tax reform – further 20bp rise in 5y5y when fully priced in
- Formosa callables – suppressing swaption vols
- Regulations to watch – LIBOR & margin rules

Appendix

Forecasts

Citi's Forecast on Treasury Issuance in 2018

	FRN	Nominal Treasuries						TIPS			Gross	Total Redemption			Fed	Net Supply
2018	2y	2yr	3yr	5yr	7yr	10yr	30yr	5y	10y	30y	Supply	Nominals	TIPS	FRNs	Maturity	to Pvt
Jan-18	15	26	24	34	28	20	12	0	13	0	172	115	19	41	30	27
Feb-18	15	28	26	35	29	24	16	0	0	7	180	163			49	65
Mar-18	15	30	28	35	29	21	13	0	11	0	182	121			31	92
Apr-18	17	32	30	35	29	21	13	16	0	0	193	123	52	45	35	8
May-18	15	32	30	35	29	24	16	0	11	0	192	158			55	89
Jun-18	15	32	30	35	29	21	13	0	0	5	180	119			30	92
Jul-18	17	32	30	35	29	21	13	0	13	0	190	117	17	43	30	44
Aug-18	15	32	30	35	29	24	16	14	0	0	195	154			44	85
Sep-18	15	32	30	35	29	21	13	0	11	0	186	116			17	87
Oct-18	17	32	30	35	29	21	13	0	0	5	182	117		42	23	46
Nov-18	15	32	30	35	29	24	16	0	11	0	192	176			62	78
Dec-18	15	32	30	35	29	21	13	14	0	0	189	118			17	88
Total	186	372	348	419	347	263	167	44	70	17	2,233	1597	88	171	424	801

Source: Citi Research

Market Forecast:

Unconditional probability of a 25bp hike at each month from Fed Funds Futures:

Meeting Date	Nov-17	Dec-17	Jan-18	Mar-18	May-18	Jun-18	Jul-18	Sep-18
Probability of a hike	0%	95%	93%	147%	152%	188%	193%	193%

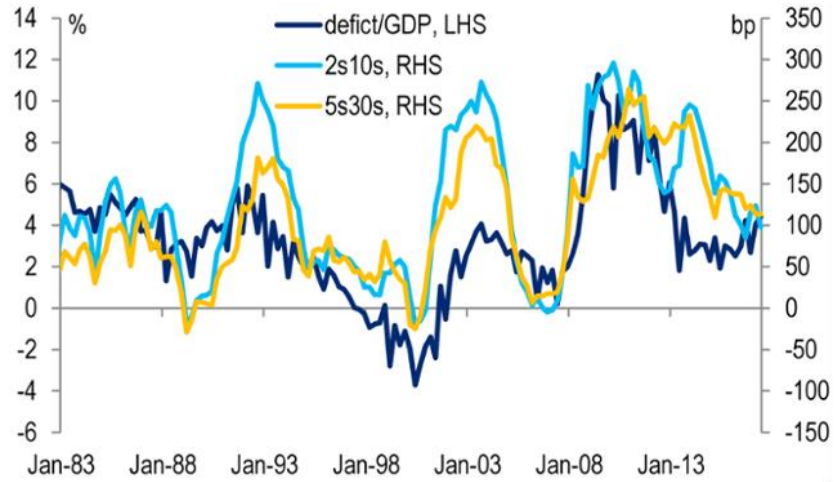
Source: Citi Research (as of 17Nov17). Note: probability is calculated assuming 25bp per hike. Negative indicates a cut.

Market implied terminal rate from Fed Funds Futures:

Source: Bloomberg, Citi

US Deficits vs Rates Curve

The curve has been highly directional with deficits – but deficits are by definition not independent of rates. Current tax reform should be compared to previous discretionary fiscal policies.



Source: Citi Research

Citi's regression for expectations of long-term trend growth, inflation target, and price-insensitive demand for Treasuries from reserve mangers using pre-2008 samples.

rate	const	inflation target, %	trend GDP,%	5y-ahead deficit/GDP, %	foreign purchases/ GDP, %	R2, %
5y5y	1.57 (1.84)	1.31 (6.17)	0.47 (1.10)	**0.30 (3.23)**	-0.45 (-2.59)	87
10y10y	1.31 (1.40)	1.14 (5.64)	0.83 (1.74)	**0.34 (4.04)**	-0.36 (-2.37)	88
r* (real)	2.95 (15.78)			**0.01 (0.14)**	-0.29 (-2.84)	6
r* (real)	0.91 (1.52)		0.71 (3.91)	**0.01 (0.39)**	-0.25 (-3.41)	42

Source: Citi Research, CBO, Philadelphia Fed, Haver

Inflation target is the 10y-ahead CPI inflation forecast the Survey of Professional Forecasters. Trend GDP and 5y-ahead deficits/GDP are estimated by CBO. The r* is an estimate of real neutral rate by Laubach and Williams. Newey-West serially-adjusted t-stats are reported in parentheses. Sample: 1980-2008.

US Rates Weekly - Let's Get Fiscal https://www.citivelocity.com/t/eppublic/1CgGP

T. Laubach, "New Evidence on the Interest Rate Effects of Budge Deficits and Debt", The Journal of the European Economic Association, June 2009

A Look at the Forward Vol Surfaces

We have selected the 1Y, 2Y and 5Y forward vol surfaces for 3 different option tails

Implied USD Implied Normalised Volatility Surfaces (bps):

Spot USD ATM Straddles

		<-- Tails -->			
	Spot	**5Y**	**10Y**	**20Y**	**30Y**
<-- Expiry -->	**1Y**	62	65	63	62
	2Y	68	70	66	65
	3Y	72	72	67	65
	4Y	74	73	67	66
	5Y	75	73	67	65
	7Y	75	72	65	63
	10Y	72	69	61	60

The spot volatility surface above is the market implied volatilities from vanilla ATM straddle swaptions.

Change in 1Y forward vols vs. spot:

1Y	**5Y**	**10Y**	**20Y**	**30Y**
1Y	3	5	4	4
2Y	3	3	2	2
3Y	2	2	1	1
4Y	2	2	1	1
5Y	1	1	0	0
7Y	0	0	0	-1
10Y	-1	-1	-1	-2

The table above show how the 1Y forward volatility surface differs vs. the spot volatility surface.

The formula described earlier in this presentation has been used in the model, along with realised correlations from the last 12-months.

The model implied forward volatility is relatively flat for the 20Y & 30Y tails.

Change in 2Y forward vols vs. spot:

2Y	**5Y**	**10Y**	**20Y**	**30Y**
1Y	10	8	5	4
2Y	7	5	1	1
3Y	5	3	0	0
4Y	2	2	0	-1
5Y	1	1	-2	-2
7Y	-1	-1	-2	-3
10Y	-3	-3	-3	-4

The table above show how the 2Y forward volatility surface differs vs. the spot volatility surface.

Change in 5Y forward vols vs. spot:

5Y	**5Y**	**10Y**	**20Y**	**30Y**
1Y	14	11	4	2
2Y	10	6	-2	-2
3Y	4	3	-3	-3
4Y	1	0	-6	-6
5Y	-3	-2	-8	-7
7Y	-6	-7	-9	-9
10Y	-8	-8	-11	-8

The table above show how the 5Y forward volatility surface differs vs. the spot volatility surface.

The larges drop in forward volatility can be found on the 5Y forward 5Y-expiry swaptions, such as the **5y5y20y** and **5y5y30y**

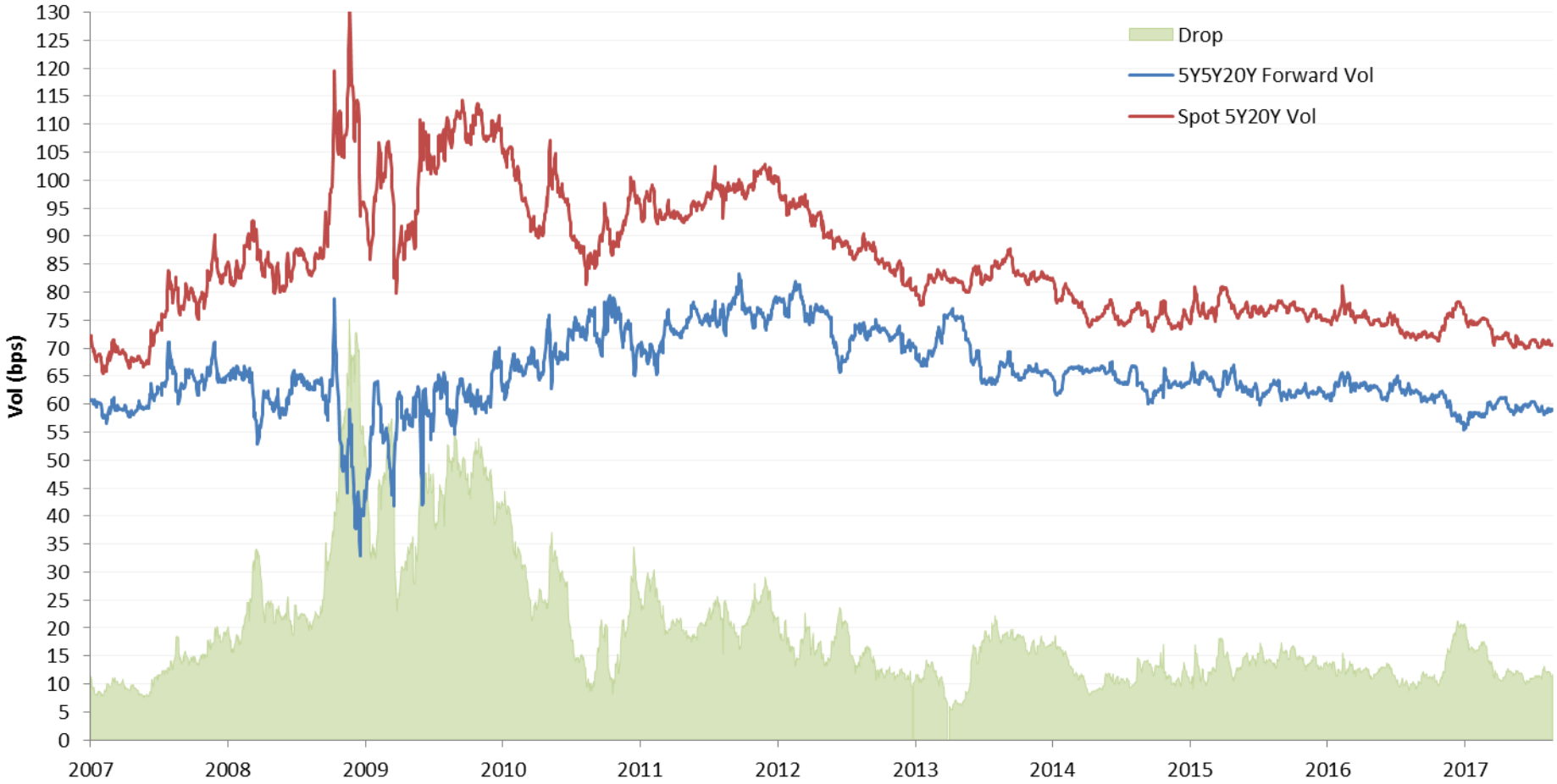
Source: *Citi*

Note: *Past performance is not an indicator of future performance*
These values are estimates only.

Historical Spot vs Forward Volatility

5y5y20y = 5y forward 5y20y vol

Historical Implied USD Spot and Forward Volatility
(Normalised Volatility, bps)



***Source**: Citi*

***Note**: Past performance is not an indicator of future performance*
These values are estimates only.

USD 5y5y20y

ATM Straddle options can be used to approximate a forward volatility exposure

The table below shows the 3 swaption positions used to approximate a forward vol exposure

CCY	Type	Notional	Expiry	Tail	Strike	ATM Spread	Forward Premium	Delta[1]	Gamma[2]	Vega[3]	3m Theta[4]	3m Roll[5]	3m Roll Breakdown: Swap Rates	Theta	Vega Roll
5y5y20y forward volatility trade approximation															
USD	s	$ 100mm	10y	20y	2.65%	a+0	25,465k	-17k	820	335k	-256k	-118k	-6k	-256k	144k
USD	s	$ 73mm	5y	5y	2.51%	a+0	4,853k	-2k	189	57k	-112k	-122k	1k	-112k	-12k
USD	s	$ -77mm	5y	25y	2.62%	a+0	-18,267k	17k	-936	-242k	407k	396k	11k	407k	-22k
							Total	**-2k**	**72**	**149k**	**40k**	**155k**	**6k**	**40k**	**109k**

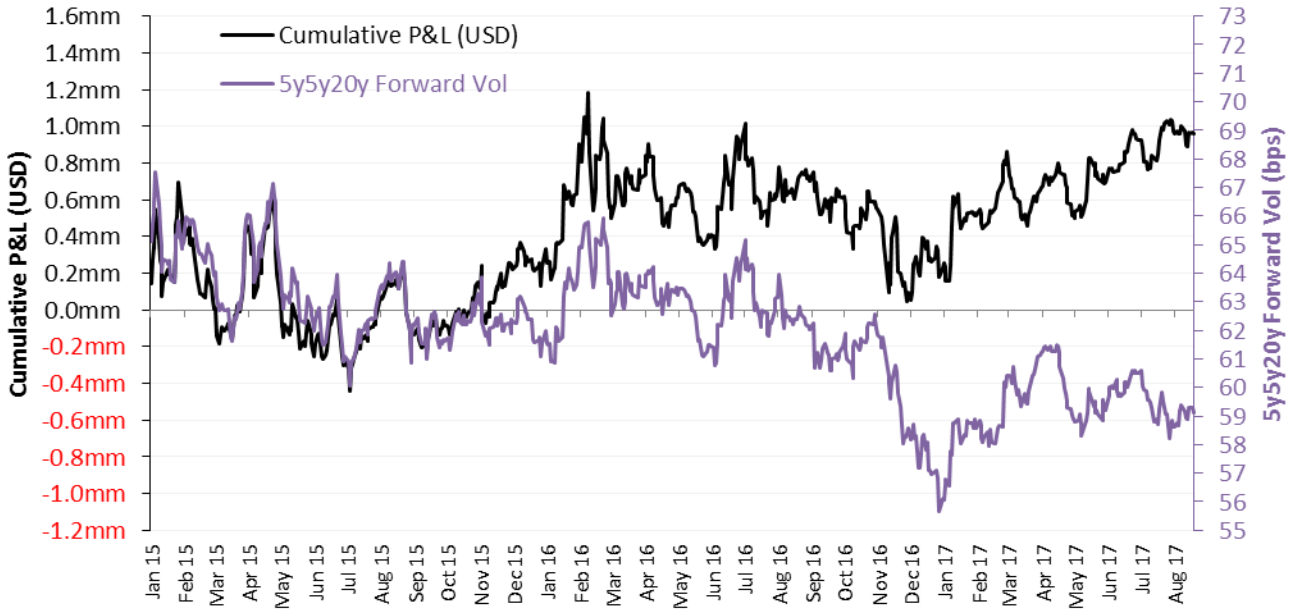
The notionals are based on the vega weightings implied by the forward volatility model formula shown earlier.

Equivalent to a forward vega of $157k

The chart shows how the historical P&L of the above swaption structure if it was traded in January-2015 (i.e. using historical ATM strikes), compared with the model implied 5y5y20y forward volatility.

This assumes no rebalancing, so extra delta and vega exposures appear over time as the strikes move away from ATM.

Historical P&L vs. Model Implied Forward Vol:



***Source**: Citi*

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