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North America Fixed Income Strategy
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Interest rate derivatives 2022 Outlook

Skating away on the thin ice of a new year

Note: This piece is part of the ***US Fixed Income Markets 2022 Outlook***, featuring our strategists' views on the year ahead across asset classes.

US Rates Strategy

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- Large forces are in play. The Fed's taper will drop UST purchases from an annualized $700bn 10-year equivalents to zero. Fiscal policy and net government financing needs are susceptible to similarly large swings. The Treasury General Account is likely to rise by several hundred billion in 1H22, while the Fed's RRP balances seem likely to climb by 200bn
- All this comes alongside benchmark transition. Much new risk-taking in swaps has already migrated to SOFR-based swaps, and the swaptions market transition is now beginning and likely to rapidly accelerate in 1H22
- SOFR swaps are new to investors, with only a brief history. But that history - spanning a period that has seen rate hikes, cuts and QE - suggests that SOFR swaps will behave more like fed funds OIS swaps, barring episodic deviations driven by banking sector leverage constraints. Such episodes will likely be modulated going forward through the use of the RRP channel
- Relative to their Libor brethren, look for SOFR swap spreads to exhibit less susceptibility to widening during flights to quality, but more sensitivity to rising Fed tightening expectations
- We examine the outlook for Reserves & commercial bank deposits. Reserves have likely peaked, and bank deposits are projected to grow by ~800bn
- We describe fair value models for 10-year maturity matched SOFR swap spreads, as well as companion models for the 2s/10s and 10s/30s swap spread curves. Look for maturity matched swap spreads in the 10- and 30-year sectors to narrow to -35bp and -55bp, respectively, driven by the Fed's taper and a slower pace of bank UST demand in 2022
- Front end spreads are likely to narrow sharply as the TGA begins ramping up in December - January, but will likely drift back upwards on the back of rising Fed tightening expectations
- Implied volatility in low yield regimes is strongly anchored by a vol-rate relationship, with a small set of additional factors - market depth, rates, the Fed's MBS purchases and Fed tightening expectations - helping to explain implied volatility movements. We describe a fair value framework for implied volatility based on these factors for a diverse set of structures across the vol grid. Look for 5Yx10Y to climb to 6bp/day, and 10Yx10Y to rise to 5bp/day by mid-year
- The yield curve is highly sensitive to 2-year real yields, and therefore to inflation expectations as priced into inflation swaps. With inflation expectations likely to remain volatile, we look for elevated curve volatility and wide trading ranges for yield curves. Investors should avoid seeking yield curve carry.

See page 25 for analyst certification and important disclosures.

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Interest Rate Derivatives

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Skating away on the thin ice of a new year

It has been quite the rollercoaster this year, both in a broader macroeconomic sense as well as more narrowly in the derivatives markets. The year began with the second

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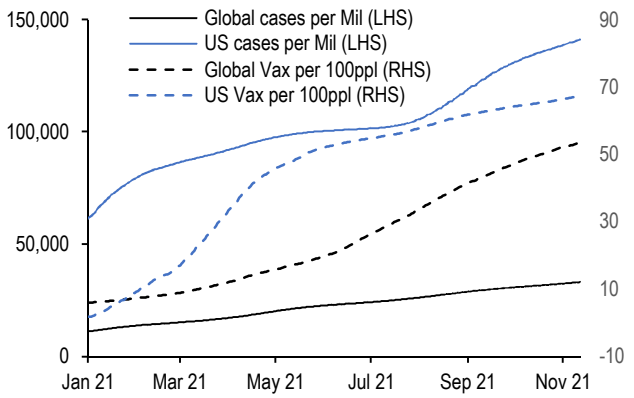
wave of COVID-19 infections at its peak in the US, followed by many months of steady improvement driven by vaccine rollouts. Late summer brought a brief resurgence of the pandemic driven by the Delta variant, but this too has been steadily improving in recent months in the US, and the stringency of pandemic-era government restrictions has been declining (**Exhibits 1 and 2**).

Exhibit 1: COVID cases in the US gained renewed momentum with the Delta variant, but growth in cases is now slowing

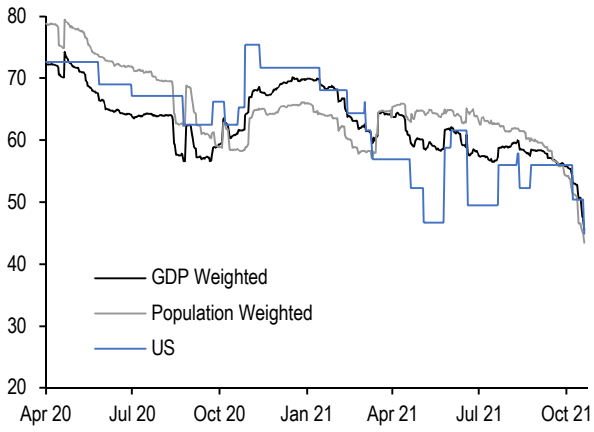
COVID-19 cases per million people globally and the US (LHS) versus the number of people that have received at least one dosage of the COVID-19 vaccine per 100 (RHS)



Source: J.P. Morgan, ourworldindata.org

Exhibit 2: Stringency measures put in place during the pandemic have decreased globally, helping support economic activity

Global Oxford Government Stringency Index weighted by population and 2019 GDP as well as just the U.S.; unit-less Index level



Source: J.P. Morgan, ourworldindata.org, IMF

With respect to the macroeconomy, tightening labor markets and rising inflation expectations are now well formed cracks in the ice. The unemployment rate has declined from 6.7% at the end of 2020 to 4.6% currently, with the pace of declines picking up in the second half of the year. Measures of inflation and inflation expectations have similarly drifted higher over the year. TIPS market 5-year breakeven differentials, for instance, have risen from just under 200bp at YE2020 to over 300bp now. Notably, while rising inflation was initially seen to be transitory by market participants in much of 1H21, sentiment shifted on a dime in the second half of the year as inflation was seen as more persistent, with implications for Fed policy and the yield curve. This is best illustrated by looking at the 5s/10s swap yield curve, in relation to breakevens. The 5s/10s yield curve steepened alongside the 1Q21 rise in breakevens (**Exhibit 3)**, consistent with expectations that inflation will prove sufficiently transitory for the Fed to remain patient. In contrast, the story of the second half of the year has been one of persistent and rising inflation expectations pulling forward expectations of tighter monetary policy and flattening the yield curve.

Monetary tightening expectations reached some fruition with the Fed's commencement of tapering in November but this is, of course, merely the beginning. Much of next year and beyond will be influenced by shifting policy expectations, giving rise to many questions. Will the pace of taper be maintained or perhaps even be accelerated? Will rate hikes commence sooner than currently expected? Will the pace of hiking resemble the glacial pace of the 2016-18 cycle, or be closer to the steady pace of the 2004-06 hikes? What might the terminal funds rate be at the end of the next hiking cycle? And last but not least, could tightening trigger economic weakness and force the Fed to backtrack on policy? These are all "policy factors" that will likely drive markets in 2022. Whatever one's view is on these questions, the

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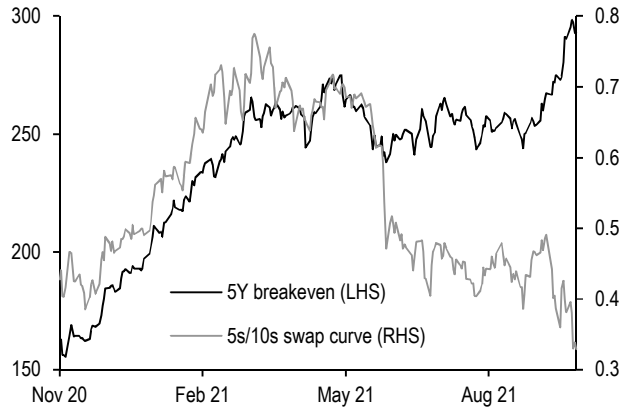
broader point is that the answers are unknown and characterized by significant uncertainty, with the resulting potential for volatility in markets.

It is not just monetary policy on the move however. Fiscal policy has been unusually volatile over the course of the year. Just over the past year, the outlook for Treasury's net financing needs in coming years has swung by hundreds of billions of dollars, driven by shifting economic prospects as well as fiscal policy expectations as indicated by CBO projections (**Exhibit 4**). These are clearly large swings, with clear implications for swap spreads.

Exhibit 3: The view of inflation as transitory itself proved transitory, giving way in the second half to a pull-forward of tightening expectations that flattened the yield curve

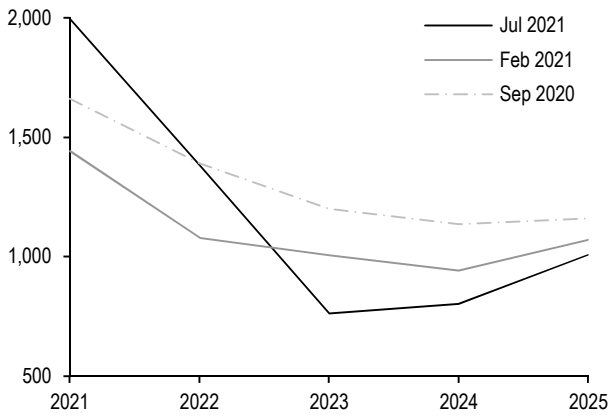
5-year TIPS breakeven (LHS; bp) versus the 5s/10s swap curve (RHS; bp)



Source: J.P. Morgan

Exhibit 4: Projections of Treasury's net financing needs have been unusually volatile, shifting by hundreds of billions in each of the next few years

Projected US Treasury net financing needs, at various points in time over the past year; $bn per year



Source: C.B.O., J.P. Morgan

Beyond these seismic forces, there are compositional factors at play impacting the private financial sector. It is often underappreciated that the Fed's liability creation associated with quantitative easing takes three main forms – Reserves (or liabilities to banks), RRP (liabilities to non-banks) and the TGA (liability to the Treasury). Historically, QE has mainly been accompanied by changes in Reserves, with the TGA remaining mostly stable and RRP balances remaining close to zero. While the TGA has historically been managed to a stable level, this changes in periods where debt ceiling issues come into play. Indeed, the TGA has shrunk since March of this year by $1.2Tn, dramatically altering the quantity and composition of the Fed's liabilities to the private sector associated with QE over this period (**Exhibit 5**). This is expected to change in the next few months, as the debt ceiling issue is resolved and TGA ramped up back towards ~750bn. Moreover, as the banking sector copes with dramatic increases in leverage caused by QE-driven Reserve growth, disincentives to deposit creation (because of leverage-based capital rules) have forced the Fed to sharply scale up its RRP program (which effectively disintermediates the banking system with regards to QE, and enables the Fed to create liabilities to non-bank participants).

This is especially relevant for swap market participants, via at least two channels. First, since SOFR is closely linked to repo rates, the Fed's RRP program and rate-corridor policies will impact swap spreads. Second, the evolution of the Fed's liabilities will impact bank deposits and bank leverage, in turn impacting bank demand for Treasuries and thus swap spreads.

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Exhibit 5: This time is different – the mix of marginal Fed balance sheet liabilities associated with QE is no longer dominated by reserves

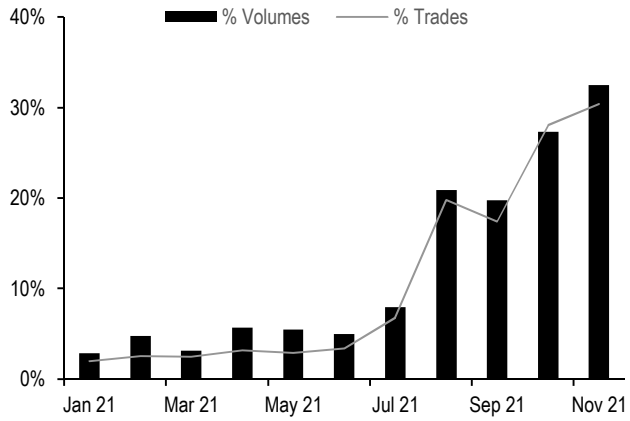
Change in the Federal Reserve's total assets, Reserve liabilities, RRP and TGA balances, during four different periods of balance sheet growth; $bn

	Change in				Relative to change in assets (%)		
Period	Assets	Reserves	RRP	TGA	Reserves	RRP	TGA
Sep-08 - Jun-14	3472.4	2628.4	170.9	102.5	76	5	3
Dec-17 - Sep-19	-609.1	-801.3	-60.9	123.9	132	10	-20
Mar-20 - Mar-21	3567.4	2199.9	7.4	621.8	62	0	17
Mar-21 - Nov-21	940.7	383.4	1508.5	-849.7	41	160	-90

Source: J.P. Morgan, Federal Reserve H.4, FRED

Exhibit 6: SOFR swap trades are rising as a fraction of overall volume and trade-count, but SOFR dominance in new risk-taking is likely much higher because of legacy Libor swap unwinds

Percentage of monthly volumes and trades for USD SOFR-linked fixed-to-float swaps, aggregated across all maturities; %



Last transactions reported as of COB Thursday 11/15/21.

Source: J.P. Morgan, SDR, Bloomberg Finance L.P.

If all this wasn't enough, it is also a period of transition in the derivatives market. This year brought significant developments on the benchmark-reform front. In March, the U.K. FCA's announcement triggered the fixing of fallback spreads, which will be used to determine any Libor-linked cash flows for derivatives after the appropriate sunset date for the relevant IBOR (June 30th 2023, for the much-used USD 3-month Libor). Thus, every Libor swap with a maturity date beyond mid-2023 is in effect a blend of a short term Libor swap and a forward starting SOFR swap (with an additional annuity on floating leg). In recent months, active swap market participants have already shifted most new risk into SOFR-based swaps, and legacy swap books linked to Libor continue to be unwound (**Exhibit 6**). In the swaptions market, however, the transition to SOFR is nascent and is really expected to pick up steam in 2022. Thus, market participants will have to navigate benchmark transition and re-examine their understanding and expectations of how swap spreads might behave in various regimes, even as they move forward into the cloudy year ahead.

In the remainder of this piece, we try to shed some light on these topics. We begin by examining how SOFR swaps might differ from their Libor brethren going forward. We then turn to the Fed's balance sheet evolution in 2022, with a specific focus on projecting the composition of its liabilities. This is necessary to project overall deposits in the system, which in turn drives bank demand for Treasuries and swap spreads. As we discuss later, **we believe Reserves have likely peaked, and project system-wide deposit growth of ~$800bn, which should lead to about ~$100bn in bank demand for Treasuries**.

Then, we develop a framework for thinking about swap spread fair value across the curve in the coming year. Based on that, **we look for 10-year and 30-year SOFR swap spreads to narrow to -35bp and -55bp, respectively by mid-year.** Our **outlook for front end spreads is more nuanced**, because of TGA dynamics, and we look for **spreads to be biased narrower initially, before drifting wider into mid-year**. After that, we turn to the outlook for volatility. We do this by developing a framework that begins with the strongly prevalent vol-rate relationship in any low-

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yield environment, but then extend it to include the effects of Fed tightening expectations (a dominant theme in 2022), market depth and liquidity, as well as the Fed's large impact on volatility via its MBS purchases. Notably, such a framework seems to apply across the entire volatility grid, and suggests that **intermediate expiry volatility in the 3Yx10Y sector should rise towards 6.0bp/day**. Finally, we discuss the sensitivity of the yield curve to real short rates and therefore inflation swap yields, leading us to look for wide yield curve trading ranges and elevated curve volatility in 2022. We also recommend that investors avoid yield curve carry trades in the year ahead.

Getting to know SOFR Swap spreads - making history, and learning from it

As we contemplate the drivers for swap spreads in the year ahead and their likely evolution, it is important to begin with the realization that the character of swap spreads is now different, thanks to the shift in benchmark index from Libor to SOFR. That **revision in character of the swaps market means that at least some of our intuition regarding how spreads might behave in certain market environments will need to be rethought**. For instance, market participants are used to the notion that front end swap spreads typically widen sharply in flight-to-quality episodes. This has typically been fueled by both the flight-to-Treasuries in such periods, as well as a rise in risk premia that impacts credit spreads and Libor. Front end SOFR swap spreads are less prone to such widening - as seen in the March-May 2020 period, SOFR swap spreads barely rose beyond their pre-COVID-19 levels in that period, even as 2Y Libor swap spreads widened 20bp (**Exhibit 7**).

Beyond that observation, we also need to understand how SOFR swap spreads might differ from their Libor counterparts, with respect to shifts in rate hiking expectations, the impact of QE, and other such drivers.

To develop some intuition in this regard, we begin with an examination of overnight SOFR itself, over the limited history that is available. To a first approximation, SOFR may be expected to track the effective funds rate. Indeed, as seen in **Exhibit 8**, SOFR has tracked the Fed-effective rate to within an error of ~5bp over its life - a period that, while short, has nonetheless seen rate hikes as well as cuts and a regime of massive QE. But this exhibit also shows two notable spikes, corresponding to episodes of banking system leverage constraints and reserve scarcity that led to spikes in repo rates (which in turn affects SOFR). We believe there are two lessons from this going forward for swap spreads. First, **SOFR as a rate derived from repo markets, is susceptible to financial system leverage constraints**. Second, **Fed policy is now more than two-dimensional,** and we need to consider more than just rate policy and asset purchases. **Policy rate differentials between IOER and the Reverse Repo rate and RRP-policy will also be material to SOFR and swap spreads**. That said, **we expect that the availability and use of channels such as RRP will help modulate these impacts, and we would expect SOFR to remain broadly in line with the fed funds rate**.

With this as context, **we first create a synthetic history of SOFR swap spreads, going back to 2000**. For each major tenor (specifically, 2s, 3s, 5s, 7s, 10s, 20s and 30s), we (i) regress the term SOFR rate minus OIS rate difference against the term OIS rate over the period since mid-2018, and (ii) use that relationship to create a synthetic SOFR - OIS rate differential for periods before 2018, while also (iii) ensuring continuity at the switchover point between actual and synthetic historical

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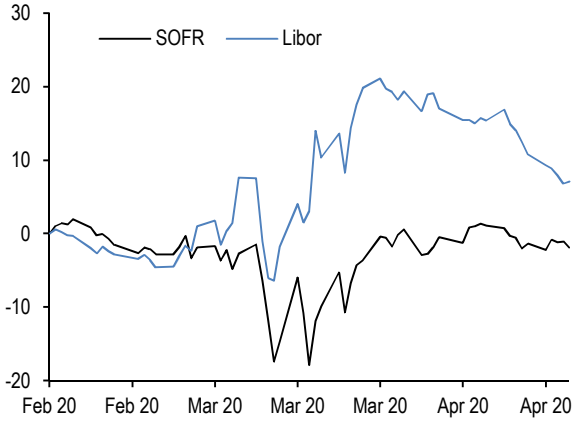
series. From that, we then derive synthetic SOFR term swap rates as well as SOFR swap spreads.

Exhibit 7: A city of two tales – front end swap spreads widened in 2Q20 as they typically do in flights-to-quality, but 2-year SOFR spreads exhibited little such widening

2-year SOFR and Libor matched maturity swap spreads*; bp

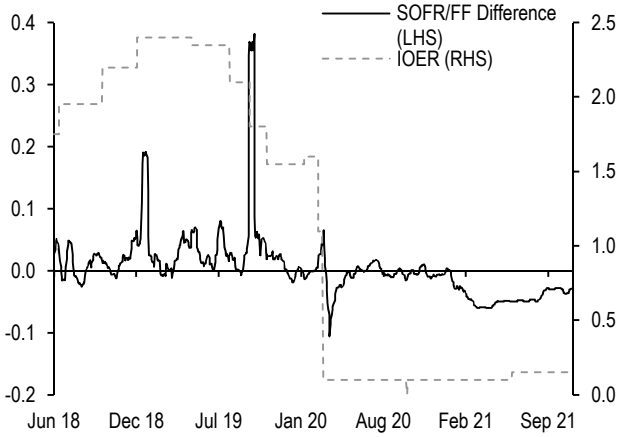


* Throughout this piece, we define swap spread as the swap yield minus Treasury yield difference, regardless of the floating rate benchmark.

Source: J.P. Morgan

Exhibit 8: In its short life, SOFR has closely tracked the effective funds rate closely through a period spanning rate hikes, cuts and QE, barring a few leverage-driven spikes

2-week moving average of the SOFR minus effective fed funds rate difference (LHS; %), versus level of IOER (RHS; %)



Source: J.P. Morgan

Using this synthetic history, we draw three main lessons about SOFR swap spreads, beginning with the front end. Our first takeaway, as already noted but reiterated here, is that **flight-to-quality episodes will produce little widening in SOFR swap spreads**, as is evident by looking at **Exhibit 9** which shows SOFR as well as Libor spreads in the 2-year sector.

Second, the empirical effect of rate hikes and hiking expectations is likely to be more pronounced on SOFR spreads relative to Libor swap spreads. This is possibly because rate hikes typically coincide with a healthier economy, auguring well for credit and therefore dampening the impact of rate hiking expectations on Libor-swap spreads relative to SOFR spreads. We can see this by examining the SOFR minus Libor 2Y swap spread differential, in periods where the 1Y / 2Yx1Y curve (a proxy measure of the amount of tightening priced into the forward curve) swung considerably. For instance, between June 2013 and June 2016, this measure of Fed expectations rose and fell by over 100bp, and SOFR swap spreads widened (and then narrowed) by ~10bp (**Exhibit 10**) more than corresponding swap spreads. This message is also corroborated by more recent evidence using actual SOFR spread data (rather than synthetic historical data) since 2019. The point here is that **the same lack of credit sensitivity that makes SOFR swap spreads less susceptible to flights to quality also makes SOFR spreads more sensitive to rate hike expectations.**

Third, we attempt to examine the comparative response of SOFR swap spreads (versus Libor swap spread) to swings in the Fed Balance sheet. In **Exhibit 11**, we show the SOFR-Libor 2Y swap spread differential, adjusted for Fed tightening expectations, versus the size of the Fed's balance sheet in different episodes where quantitative easing or tightening was underway. The message is consistent with SOFR spreads being an attenuated version of Libor swap spreads. **In periods of QE,**

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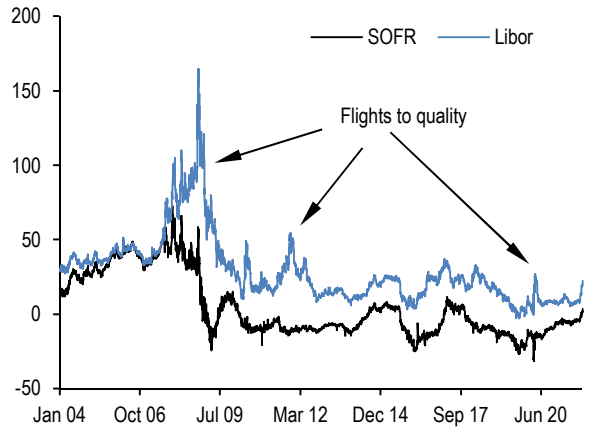
SOFR spreads richen by less than Libor spreads (Exhibit 11). The correlation is similar in periods of QT, but with a larger coefficient in magnitude (**Exhibit 12**). We are cautious about reading too much into the coefficient asymmetry between QE and QT, given the much more limited experience with QT. But directionally, as taper progresses and eventually turns to QT, we would expect swap spreads to narrow, but SOFR spreads will likely narrow slightly less than the corresponding Libor spreads might have.

Exhibit 9: SOFR spreads – no lift during flights to quality

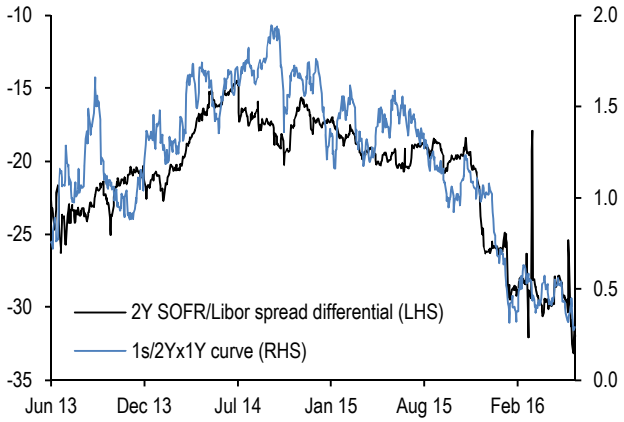
2-year SOFR and Libor matched maturity swap spreads; bp



Source: J.P. Morgan

Exhibit 10: Taking a hike - SOFR spreads will likely be more sensitive to Fed hiking expectations than their Libor counterparts

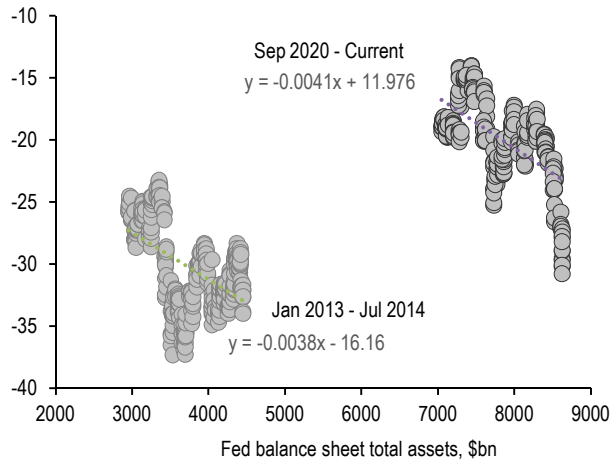
2-year SOFR minus Libor matched maturity swap spread differential (LHS; bp) versus the 1Y / 2Yx1Y curve (RHS; %)



Source: J.P. Morgan

Exhibit 11: SOFR spreads respond less to Fed asset purchases, thus narrowing relative to Libor swap spreads in periods of QE…

2Y SOFR minus Libor swap spread differential adjusted for Fed expectations * (y-axis; bp) versus the size of the Fed balance sheet assets (x-axis; $bn), during selected periods of Fed balance sheet growth

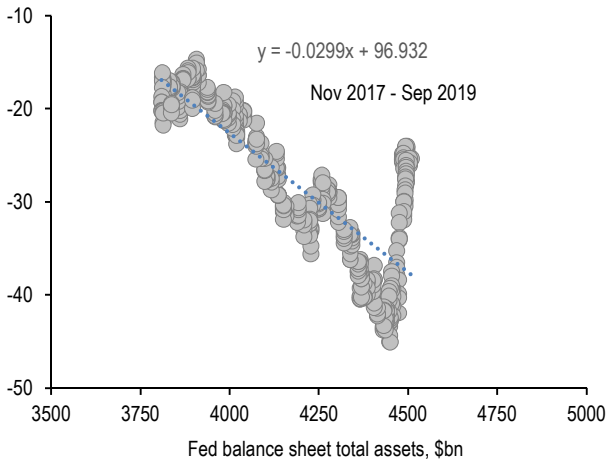


* Calculated as 2Y SOFR swap spread minus 2Y Libor swap spread – 9.0 * 1Y / 2Yx1Y swap curve (in % points).

Source: J.P. Morgan, Federal Reserve H.4

Exhibit 12: … and widening relative to Libor swap spreads during episodes of quantitative tightening

2Y SOFR minus Libor swap spread differential adjusted for Fed expectations * (y-axis; bp) versus the size of the Fed balance sheet assets (x-axis; $bn), during a recent period of Fed balance sheet shrinkage



* Calculated as 2Y SOFR swap spread minus 2Y Libor swap spread – 9.0 * 1Y / 2Yx1Y swap curve (in % points).

Source: J.P. Morgan, Federal Reserve, H.4

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Lastly, we note that spreads are also driven by other factors that are benchmark independent. For instance, high grade issuance (some fraction of which tends to get swapped by the issuer) tends to bias swap spreads narrower, while bank demand for USTs has emerged as a significant factor helping bias spreads wider. Such factors should be agnostic to the choice of benchmark index used in the swaps market, and we would expect these to impact SOFR spreads in much the same way that they might have impacted Libor swap spreads.

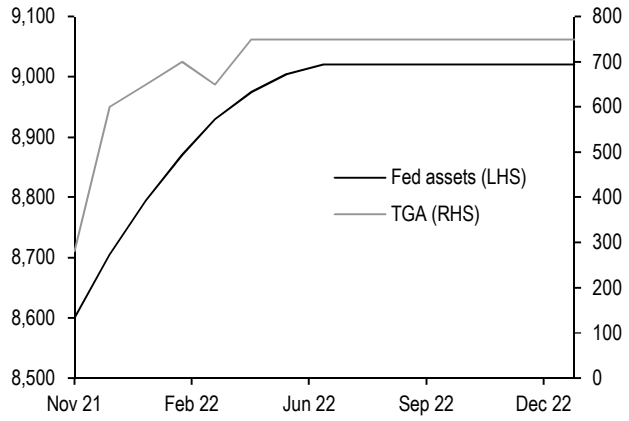
Armed with this intuition, as well as the necessary historical data (albeit synthetic for periods before 2018), we are almost ready to develop a fair value framework for swap spreads. But first, since bank demand for USTs has become such an important influence on swap spreads (unsurprising, given the immense scale of deposit creation in recent history), we first discuss our outlook for bank deposits in the year ahead.

QE, Reserves & Bank Deposits

The trajectory of the Fed's QE in the year ahead is reasonably well known - tapering has already commenced, and additional asset purchases by the Fed will end by mid-June, with some chance of an accelerated finish should economic conditions warrant it. As a baseline view, assuming taper completion as scheduled, it is straightforward to project that total assets on the Fed's balance sheet will climb at a falling pace and stabilize at ~9tn by mid-2022. It is similarly straightforward to project the TGA balance. Assuming the debt ceiling is properly resolved (i.e., not via some other stop-gap measure) by year end, the Treasury is likely to take the TGA up to approximately $750bn in our Treasury strategists' view. After accounting for some intra-year seasonality, our TGA projections and our projection for total Fed balance sheet assets are shown in **Exhibit 13**.

Exhibit 13: Assuming the debt ceiling issue is resolved, both the TGA as well as total Fed balance sheet assets are likely to level off early in 2022

Projected Fed balance sheet assets (LHS; $bn) and the Treasury general account (TGA) balance over time (RHS; $bn)



Source: J.P. Morgan

Exhibit 14: Bank leverage constraints have created disincentives to deposit growth, lowering the response of Reserves to growth in Fed assets, while the beta to TGA remains close to negative one

Statistics from regressing the change in Reserve Balances, versus change in total Fed balance sheet assets and change in TGA balance, over selected periods of Fed balance sheet growth and shrinkage*

	Beta		T-statistic		
Period	Assets	TGA	Assets	TGA	R-squared
Sep-08 - Jun-14	0.54	-0.82	39.0	-22.4	54%
Dec-17 - Sep-19	0.95	-0.94	8.1	-26.5	65%
Mar-20 - Mar-21	0.79	-0.70	66.5	-28.3	94%
Mar-21 - Nov-21	0.28	-0.88	1.1	-14.0	59%

* Regressions over specified periods, using rolling monthly changes in all series.

Source: J.P. Morgan, FRED, Federal Reserve H.4

We can now project Reserves going forward in 2022. As seen in **Exhibit 14**, changes in reserves have been well explained by changes in Fed assets and TGA balance, in episodes of both Fed balance sheet growth and shrinkage. Moreover, the partial beta of reserves with respect to total assets has historically been sizeable, at 0.5 or higher. But **over the past six months, banking system leverage**

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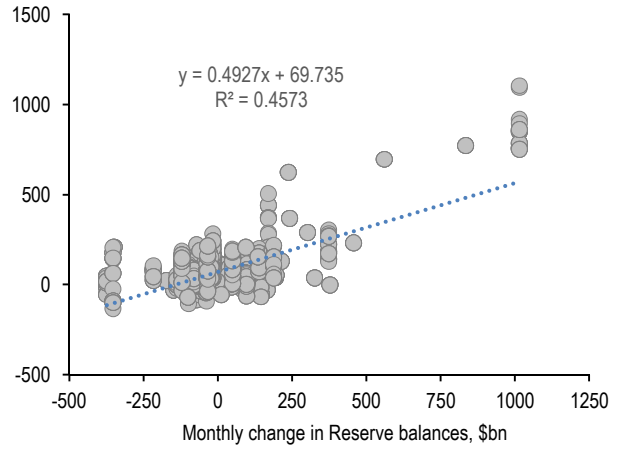
considerations have resulted in disincentives to bank balance sheet growth, forcing the Fed into expanding RRPs as an alternative liability channel. As a result, given growth in RRPs, the **partial beta of Reserves to Fed assets has sharply fallen**; indeed, over the past two to three months, it has been smaller still.

But through it all, **reserves have exhibited a ~80 - 90% negative beta with respect to swings in the TGA** - i.e., all else equal, a $100bn increase in the TGA has tended to produce an $80 - 90bn decline in Reserves. It is worth noting that this should indeed be the case - to the extent that such a regression is able to approximate the true partial sensitivity of Reserves to TGA with all else held constant, it should produce a coefficient close to -1 because the total liabilities on the Fed's balance sheet would not (by assumption) change.

Exhibit 15: Growth in commercial bank deposits has exhibited a ~50% beta to reserve growth, in addition to a monthly drift of ~70bn in organic growth

Monthly change in deposits of large domestically chartered commercial banks, versus monthly change in Reserve Balances; $bn



* Regression over the past 10 years

Source: J.P. Morgan, FRED, Federal Reserve H.8, H.4

Exhibit 16: Reserves have likely peaked, while RRP balances and the TGA will likely rise next year, which should help slow deposit growth to about $800bn in 2022

Projected evolution of Fed assets, Reserves, TGA, RRP balances, and commercial bank deposits in 2022; $bn

Period	Fed B/S Assets	Reserves	TGA	RRP	Commercial bank deposits
Dec-21	8,705	3,830	600	1,761	17,646
Jan-22	8,795	3,801	650	1,830	17,699
Feb-22	8,870	3,770	700	1,887	17,750
Mar-22	8,930	3,821	650	1,945	17,851
Apr-22	8,975	3,743	750	1,968	17,874
May-22	9,005	3,747	750	1,994	17,947
Jun-22	9,020	3,750	750	2,007	18,018
Jul-22	9,020	3,750	750	2,007	18,088
Aug-22	9,020	3,750	750	2,007	18,158
Sep-22	9,020	3,750	750	2,007	18,228
Oct-22	9,020	3,750	750	2,007	18,298
Nov-22	9,020	3,750	750	2,007	18,368
Dec-22	9,020	3,750	750	2,007	18,438

Source: J.P. Morgan

Going forward, we would anticipate that the partial beta of Reserves versus assets is likely to be even smaller than the 28% seen in the past eight months - perhaps just 15% or so based on recent trends. Using that estimate, and using a partial TGA beta of -0.85, we can project Reserves going forward. Then, we can also project RRP balances as the residual since total change in Fed assets should equal the total change in liabilities. Implicit in this is the assumption that changes in other Fed liabilities will be immaterial. Finally, we note that bank deposits are themselves reasonably well explained by reserves - over the past 10 years, the **monthly change in total commercial bank deposits has had a beta of 50-60% with respect to monthly change in reserves**, in addition to an organic monthly drift of ~70bn (**Exhibit 15**). Using that relationship, we project that **system-wide bank deposits are likely to grow by ~$800bn in the year ahead**. These projections are shown in **Exhibit 16**. Lastly, our Treasury strategists estimate that **such deposit growth should result in about ~$100bn to $125bn in bank demand for Treasuries**.

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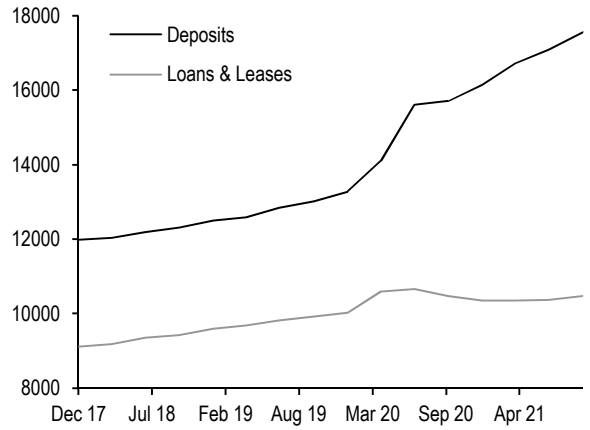
A fair value framework for 10-year SOFR swap spreads

We are now ready to detail our fair value framework for intermediate maturity SOFR swap spreads going forward, and develop a view on its likely evolution in 2022.

Our framework utilizes four key factors that have been important drivers of spreads in recent years. The first is the **forward funds rate** (specifically, the 1Y forward 1M OIS rate). This has been one of the most long-standing drivers of swap spreads, with a positive correlation to swap spreads (which, for completeness, we define as the matched maturity SOFR swap yield minus the OTR 10-year note yield). Second, **the Fed's purchases of USTs** have unsurprisingly been a key factor impacting spreads, and the tapering of such purchases will be a dominant theme in 1H22. We therefore use the monthly purchases of USTs by the Fed (translated into duration-weighted 10-year equivalents) as a second driver.

Exhibit 17: Steep growth in deposits coupled with tepid loan growth has led to considerable bank demand for USTs in the pandemic era

Commercial bank deposits and loans; $mn



Source: J.P. Morgan, FRED, Federal Reserve H.8

Exhibit 18: The JPMorgan fair value model for 10-year maturity matched SOFR swap spreads

Statistics from a regression of 10-year maturity matched SOFR swap spreads against the forward funds rate* (%), monthly Fed purchases of USTs ($bn 10s), monthly High Grade Corporate debt issuance ($bn) and bank demand for USTs ($bn)

			Factor value	
Factor	**Coefficient**	**T-stat**	**Current**	**Jun-22**
Intercept	-33.6	-60.2		
Fed expectations (+)	2.44	10.5	0.59	1.25
Fed UST purchases (+)	0.18	17.7	56.8	0
HG issuance, monthly pace (3M avg), bn (-)	-0.06	-21.4	100	125
Bank demand for USTs, $bn 10s (+)	0.019	12.5	210	100
R-squared	73.7%		-	
		Fair value, bp	-24	-35
		Current	-22	-

* Forward funds rate defined as 12M forward 1M OIS rate, in %. Fed purchases calculated as rolling 1M sum, in $bn 10-year equivalents. Monthly HG issuance calculated as rolling 3M sum divided by three. Bank demand is assumed to be 12% of change in net deposits.

Dates from 11/2017 – 11/2021, excluding 3/2020 - 6/2020, due to COVID-19 related temporary distortion, in order to estimate more representative coefficients.

The signs listed alongside each factor denotes the expected sign of the coefficient, if applicable.

Source: J.P. Morgan

A third factor in the model is **high grade issuance**, which we measure as the monthly pace averaged over a rolling 3-month period. Although HG issuance is widely understood by market participants to exert strong but tactical narrowing pressures on spreads in periods where it is elevated, it is usually relatively stable except for intra-year seasonal variations. Thus, quantifying the impact of such issuance has always been statistically tricky. But the COVID-19 period has been helpful in this regard. Thanks to the initial freeze in markets, subsequent reopening and pre-funding by corporations, and the subsequent economic recovery, we have recently seen HG issuance swing up and down to the tune of $200bn, which is helpful in refining estimates of the spread beta to issuance. It is also helpful, going forward, in assessing near term issuance impacts as HG issuance fluctuates over the course of the year.

Last but not least, we use projections of **bank demand for USTs**. Unprecedented swings in the Fed's balance sheet have led to similarly unprecedented shifts in

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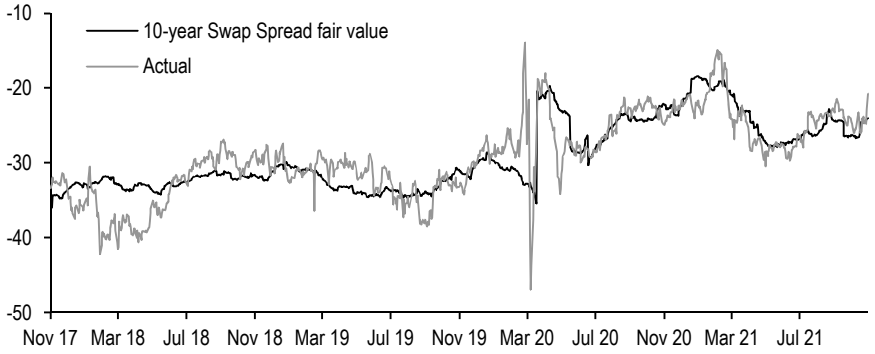
commercial bank deposits in the economy. Loan growth, on the other hand, is much slower moving and determined by macroeconomic trends - given the post-pandemic backdrop, loan growth has essentially stayed flat as deposits have risen sharply (**Exhibit 17**). For bank balance sheets in the aggregate, this gap creates a demand for securities in general, some fraction of which manifests as demand for USTs. Our Treasury strategists estimate that each $100bn in incremental deposits creates ~12bn in UST demand, *ceteris paribus*. This resulting demand is an important influence on swap spreads, and we include this as our fourth factor.

Exhibit 19: Our fair value framework is reasonably successful in capturing the twists and turns that swap spreads have taken recently

10-year matched maturity SOFR swap spread fair value* versus actual; bp 11/2017 – 11/2021



* Fair value estimated using coefficients from Exhibit 18 and the values of each driver.
Source: J.P. Morgan

We estimate our model over four years of history. This choice reflects a tradeoff between the need to include a reasonable amount of history during a tightening cycle (given that we may soon be in one), while also minimizing reliance on the synthetic data we have been forced to create because of the transition to SOFR. **Exhibit 18** presents details of our model coefficients and related statistics. As seen in **Exhibit 19**, our model tracks the twists and turns of swap spreads reasonably well over the past two years.

As we apply this framework to look forward into 1H22, three out of four factors are likely to pressure swap spreads narrower. The completion of taper should bias spreads narrower by ~10bp. High grade issuance is typically elevated in the first half of the year, again adding ~1.5 - 2bp of narrowing pressure. Similarly, bank demand for USTs is likely to slow down from current levels, in large part because Reserve growth has likely peaked and deposit growth in the system is likely to be slower than the heady pace of the recent past. The only offset is a rising funds rate, which should help bias spreads modestly wider, but will likely be insufficient to overcome the other effects. All in all, **SOFR swap spreads in the 10-year sector will likely trend narrower in coming months, to about -35bp or so.**

Long end swap spreads

We now build an empirical model for the 10s/30s swap spread curve. Modeling this spread curve, rather than the level of long end spreads, allows us to focus on the impact of drivers specific to the long end, while also incorporating factors that can impact spread levels broadly across the curve.

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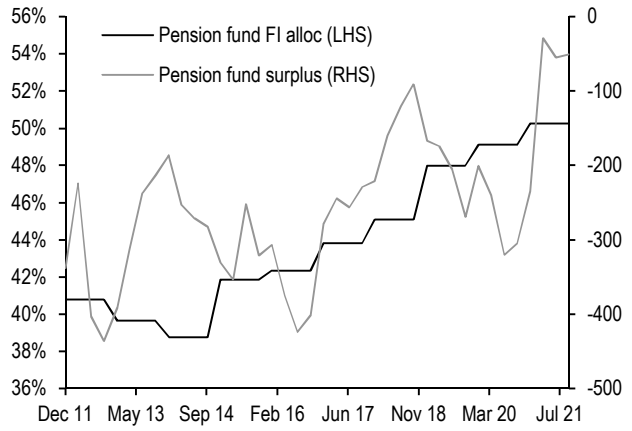
Our framework relies on four different drivers for this spread curve. The first is **the 10s/30s Treasury yield curve** - this is a long standing factor driving the spread curve, with an inverse relationship - as the Treasury curve flattens, the spread curve tends to steepen, and vice versa.

Two other factors in our model attempt to capture dynamics that are somewhat unique to the long end. The first of these is **hedging flows from variable annuity sponsors / hedgers**. Variable annuities are complex financial products that allow insurance company policyholders to receive equity linked returns in the accumulation phase of an annuity, but with a minimum guaranteed annuitization. To summarize very briefly, the risk profile of such products is that they behave like equities when equities are performing well, but like very long-dated fixed income instruments when equities go down. As a result, the sponsoring insurance company needs to hedge this risk, by receiving or paying in long dated swaps as the risk profile shifts. We have attempted to quantify the aggregate duration needs of VA hedgers - for a detailed discussion of our methodology, see *Interest Rate Risk in Variable Annuities, JPMorgan Research Note, Sep 2011* (available upon request). But this factor remains a significant factor impacting the long end of the spread curve.

Exhibit 20: Pension plans are now in surplus territory, which makes the economics of shifting asset allocations towards LDI-based targets more manageable

Fixed income allocations for the top 100 pensions weighted by assets (LHS; %) against the aggregate pension surplus for those plans (RHS; $bn)



Source: J.P. Morgan, Milliman

Exhibit 21: Our fair value model for the 10s/30s SOFR swap spread curve points to a relatively stable spread curve that is only modestly steeper than current levels

Statistics from a regression of 10s/30s maturity matched SOFR spread curve (bp) against the on-the-run 10s/30s curve (%), aggregate duration of Variable Annuities ($bn 20-year equivalents), aggregate Pension Surplus ($bn), Fed purchases of USTs (measured in $bn 10-year equivalents)

			Factor value	
Factor	**Coefficient**	**T-stat**	**Current**	**Jun-22**
Intercept	-12.1	-29.4		
10s/30s OTR curve (-), %	-10.42	-11.1	0.37	0.45
VA Duration (-), $bn 20s	-0.07	-10.2	109	79
Pensions surplus (+), $bn	0.02	11.9	5	85
Fed UST Purchases, $bn 10s	-0.011	-6.1	57	0
R-squared	72%		-	
		Fair value, bp	-24	-20
		Current	-25	-

Daily data from 11/2015 - 11/2021, excluding 3/2020 - 6/2020, due to COVID-19 related temporary distortions, in order to estimate more representative coefficients. The signs listed alongside each factor indicate the expected sign of the coefficient, if applicable.
Source: J.P. Morgan, Milliman

The second factor specific to the long end in our model for the spread curve is the **net surplus of the top hundred pension plans**. Traditionally, pension funds - which have fixed-income-like liabilities (the Pension Benefit Obligation) to their beneficiaries - have owned a sizeable fraction of equities in their asset portfolio, while using swaps / derivatives and "low-cash" strategies such as STRIPS to add duration to their portfolios. As fund management philosophy has shifted towards "Liability Driven Investing" in recent years in order to minimize surplus volatility, these fund managers have a clear incentive to add fixed income assets. However, the economic consequences (to the plan sponsor) of such an asset allocation shift has historically be a significant negative, and therefore a deterrent.

Thanks to the strong rally in equities, pension plans are now in surplus territory and the cost of Equity-to-FI shifts have become much more favorable. All else equal,

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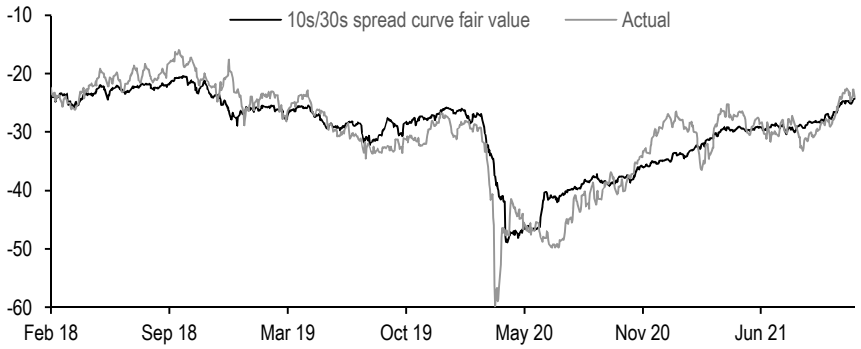
these investors are likely to reallocate into cash-fixed income assets (rather than seek duration merely via derivatives) as fund surpluses grow. Indeed, there is evidence of an uptrend in FI allocations, as the stock market has produced steady improvements in funded ratios and brought pension fund surpluses from considerably negative levels to zero currently (**Exhibit 20**).

The **last factor in our model is the Fed's QE-related UST purchases**. While this factor impacts swap spreads across the entire curve, it does not do so equally - as a result, the spread curve is impacted by swings in Fed purchases, motivating us to include it as a fourth factor.

Exhibit 22: Our fair value model for the 10s/30s SOFR swap spread curve tracks reasonably well in recent years
30Y minus 10Y SOFR swap spread curve, fair value* versus actual; bp



* Fair value calculation based on model described in Exhibit 21.
Source: J.P. Morgan.

We put these factors into a model for the 10s/30s swap spread curve. In this case, however, we estimate the model over the past six years. The reason is to span a period that sees considerable variation in this spread curve outside the pandemic era (which did see considerable variation but may not be a good regime to base future predictions on). Our model coefficients and statistics are shown in **Exhibit 21**, and **Exhibit 22** shows that this model has reasonably tracked moves in the spread curve in recent years.

In order to use it to project the spread curve in 2022, we in turn need to project the drivers. For the 10s/30s curve, we use our Treasury strategists' forecasts, and Fed purchases are assumed to decline to zero, consistent with the current schedule for tapering. In order to project pension fund surpluses and the aggregate duration of variable annuities, we take utilize the fact that these factors have been well correlated to rates and equities, and use our projections for rates and equities to estimate these quantities at a mid-year horizon.

It is worth noting that three of four factors point to a modest steepening bias in the spread curve. The exception is the 10s/30s yield curve, where our Treasury strategists are looking for a modest steepening in the curve, which in turn augurs a relatively insignificant ~1bp flattening bias in the spread curve. All in all, **given our fair value estimate of -35bp for 10-year spreads, and a -20bp estimate for the spread curve fair value, we project long end SOFR spreads at -55bp by mid-year 2022.**

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Swap spreads at the front end of the curve

Similar to our approach towards long end spreads, **we develop a fair value framework for the 2s/10s spread curve**, from which we infer fair values for 2-year maturity matched SOFR swap spreads. Our choice of history too is similar - we use six years of history, in order to span sufficient up-and-down variation in the spread curve being modeled, outside of just the pandemic period.

Our model has four different factors. Here too, the spread curve is inversely correlated to the **Treasury yield curve**. The **forward funds rate is also a key driver** impacting swap spreads across the curve; indeed, it impacts front end spreads more than it does 10-year spreads, therefore resulting in a negative coefficient when modeling the spread curve.

Third, **the level of spreads itself is a factor**. Since front end spreads tend to be stickier than the long end, the spread curve tends to steepen when spreads rise, and flatten when spreads narrow. We account for this by including the 10-year swap spread as a third factor. Lastly, since the **Fed's QE-related purchases** can have different impacts at different points on the curve, we include Fed purchases as our fourth factor. The positive coefficient here suggests that Fed purchases have empirically tended to richen Treasuries (versus swaps) by a larger magnitude in the belly of the curve than in the front end of the curve.

Exhibit 23: Our fair value model for the 2s/10s SOFR swap spread curve points to a significantly flatter spread curve by mid-2022, with front end spreads not too far from current levels

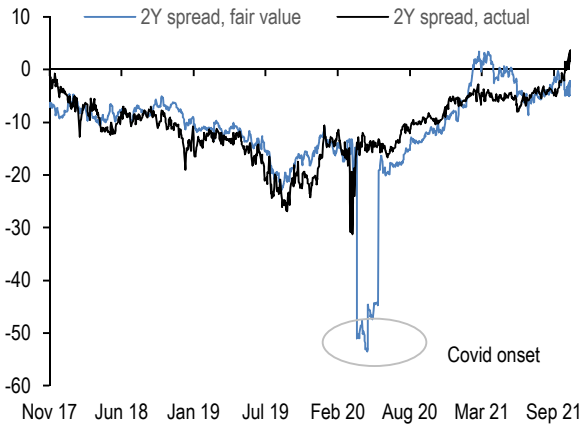
Statistics from a regression of 2s/10s matched maturity SOFR spread curve against the OTR 2s/10s curve (%), 10-year matched maturity SOFR spread (bp) , 12M forward 1M OIS (%) and Fed UST purchases ($bn 10s)

			Factor value	
Factor	Coefficient	T-stat	Current	Jun-22
Intercept	8.6	5.7		
2s/10s UST Curve (-)	-17.3	-37.0	1.03	1.3
10Y Spread (+)	0.5	18.1	-22	-36
Fwd funds rate (-)	-4.0	-11.3	0.59	1.25
Fed UST purchases ($bn 10s)	0.08	4.7	57	0
R-squared	77%		-	
Fair value, 2s/10s spread curve (bp)			-18	-37
Fair value, 2Y swap spread (bp)			-4	0.8
Current 2Y swap spread			3	-

Period: 11/2015 - 11/2021, excluding 3/2020 - 6/2020, due to COVID-19.
Source: J.P. Morgan

Exhibit 24: Our fair value framework for front end SOFR swap spreadsis reasonably effecting in tracking actual moves

2Y SOFR swap spread, fair value* versus actual; bp



* Fair value derived from the fair value model for the 2s/10s spread curve described in Exhibit 23.

Source: J.P. Morgan

Exhibit 23 shows our model coefficient and statistics, and **Exhibit 24** provides visual confirmation of its effectiveness in capturing spread variations. Applying this to the year ahead, based on our projected values for the drivers (2s/10s curve, 10-year spreads and the forward funds rate) and using our baseline assumption of taper completion by June 2022, we project that the spread curve should flatten to about -37bp by mid-year. Lastly, using our projections for this spread curve as well as 10-year spreads, **we infer fair values for 2-year SOFR spreads of -4bp currently, and 0bp by mid-year.**

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Exhibit 25: JPMorgan forecast for SOFR swap spreads

Projected SOFR swap spreads for mid-2022

	Actual 19-Nov-21	2Q22 30-Jun
SOFR Swap Spread (bp)		
2-year	3	0
5-year	-15	-20
10-year	-22	-35
30-year	-47	-55

Source: J.P. Morgan

Finally, we model spreads in other tenors (e.g., 5-years) as a simple regression versus surrounding points (2s and 10s in this case). Putting it all together, **our projections for SOFR swap spreads are shown in Exhibit 25.**

Volatility - Back to the future

It has been a year of two distinct halves in the volatility markets. The first half of the year, while already characterized by improving growth and rising inflation, was set against the backdrop of a view that inflation would prove transitory and the Fed would remain on hold over a multi-year horizon. All that changed in the second half, with inflation proving persistent, with Labor supply not climbing as expected, and with growing expectations that monetary stimulus would need to be unwound. As the year comes to a close, withdrawal of quantitative stimulus is underway, and expectations of Fed rate hikes are being pulled forward. Through it all, implied volatility levels have essentially risen sharply higher. After first making all-time lows in the early part of the year, implied vol levels are finishing the year sharply higher (**Exhibit 26**).

Exhibit 26: A snapshot of implied volatility in 2021

Summary statistics for implied volatility at selected points across spanning the vol grid, year-to-date in 2021; bp/day

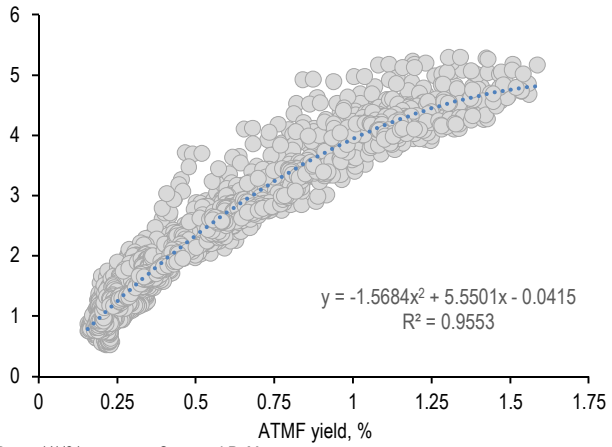
	Avg	Std dev	Min	Percentile 25th	Percentile 50th	Percentile 75th	Max	Current
3Mx2Y	1.9	0.9	0.9	1.3	1.7	2.0	4.9	4.5
6Mx2Y	2.3	0.9	1.1	1.8	2.2	2.5	5.0	4.7
6Mx5Y	4.0	0.6	2.4	3.9	4.1	4.3	5.3	5.0
6Mx10Y	4.6	0.3	3.7	4.4	4.6	4.8	5.2	5.0
6Mx30Y	4.6	0.2	4.1	4.4	4.6	4.8	5.2	4.9
2Yx10Y	4.6	0.3	3.8	4.4	4.6	4.8	5.0	4.9
5Yx10Y	4.4	0.2	3.9	4.3	4.4	4.6	4.8	4.5
5Yx30Y	4.0	0.1	3.6	3.9	4.0	4.1	4.3	4.1
10Yx10Y	4.0	0.1	3.6	3.9	4.0	4.1	4.2	4.0

Dates 1/1/21 to 11/19/21

Source: J.P. Morgan

Exhibit 27: The vol-rate-tango - in low yield periods where zero is seen as a floor on rates, implied volatility becomes homogenous across structures and correlated to rates, as it has been recently

Swaption implied volatility for 3M, 6M, and 9M expiries on 1-, 2-, 3- and 5-year tails (y-axis; bp/day) versus the corresponding ATMF yield (x-axis; %); bp



Dates 1/1/21 – present. Source: J.P. Morgan

As we look ahead, we begin with the observation that the backdrop is one we have seen before. We are - once again - in a period of ZIRP and considerable quantitative easing (albeit at a slowing pace due to the taper), morphing into a period of policy uncertainty as we contemplate the onset and pace of rate hikes. The year 2013, for instance, began similarly, with implieds at record lows and QE underway, before switching gears mid-year to a period of rising expectations of rate hikes and tapering.

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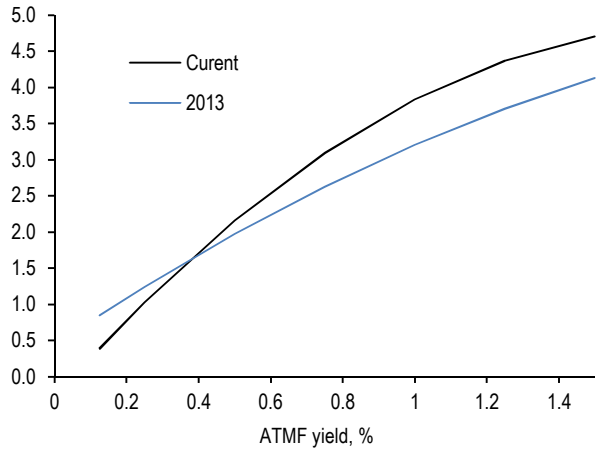
Those expectations of tightening were not subsequently realized until several years later, but the period nonetheless useful lessons to offer as we consider the outlook for option volatility.

The first is that in periods where front end rates are low enough, and zero is perceived as a lower bound on rates, **implied volatility starts to become homogenous across structures, determined significantly by ATMF yield levels**. This has certainly been the case recently (**Exhibit 27**), but was also the case, for instance, as of mid-2013 (**Exhibit 28**).

Exhibit 28: Déjà vu – in the year leading up to the taper tantrum in 2013, implied volatility was correlated to rates, similar to now

Quadratic fit for swaption implied volatility for 3M, 6M, and 9M expiries on 1-, 2-, 3- and 5-year tails versus ATMF yield; 05/2012-05/2013, & 11/2020-11/2021; bp/day

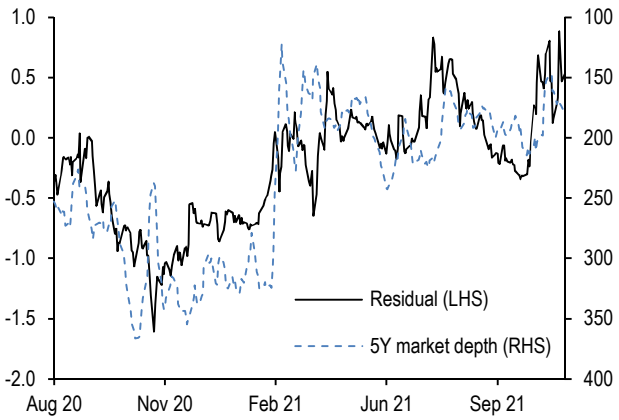


Dates 1/1/13-12/31/13 and 11/20 – present

Source: J.P. Morgan

Exhibit 29: It's not all about rates – other factors, such as liquidity conditions have caused deviations from fitted levels recently …

6Mx5Y ATMF implied volatility minus fitted value from a simple vol-vs-rate fit*, (LHS; bp/day) versus market depth** for 5-year US Treasuries (RHS inverted; $mn); Aug 2020 - present

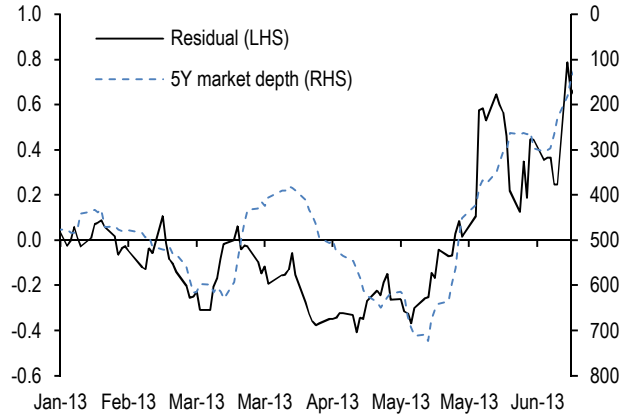


* Estimated based on a vol-versus-rate fitted relationship

** Market depth is the 5-day moving average of the three bids and offers by queue position, using the top 3 bids and offers in Treasury notes and bonds, averaged between 8:30 and 10:30am daily. Source: J.P. Morgan

Exhibit 30: … as they also did in 2013

6Mx5Y ATMF implied volatility minus fitted value from a simple vol-vs-rate fit*, (LHS; bp/day) versus market depth** for 5-year US Treasuries (RHS inverted; $mn); 01/2013 – 06/2013

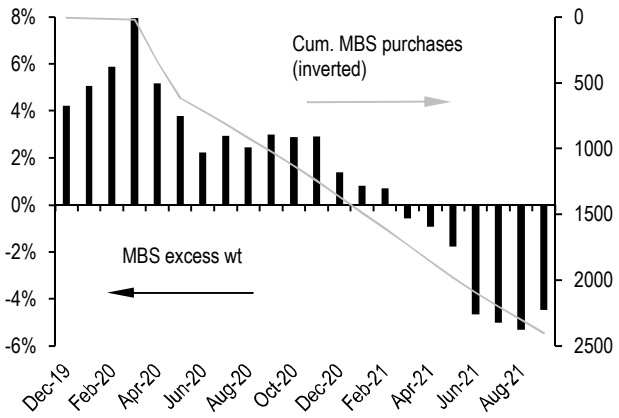


* Estimated based on a vol-versus-rate fitted relationship

** Market depth is the 5-day moving average of the three bids and offers by queue position, using the top 3 bids and offers in Treasury notes and bonds, averaged between 8:30 and 10:30am daily. Source: J.P. Morgan

Exhibit 31: Mortgage market convexity demand takes a back seat in periods of QE, because the Fed's MBS purchases leaves asset managers short MBS - and long convexity - relative to benchmark

MBS weight minus neutral weight for the top active Fixed Income funds (LHS, %) versus cumulative MBS purchases by the Fed since 1Q20 (RHS; $bn)



Source: J.P. Morgan

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Second, it is of course not the case that implieds are determined solely by rates - just that rates are perhaps the most important factor. But adjusted for rates, it is easy to see that other factors can influence implieds. For instance, the spread between 6Mx5Y implied volatility and its fitted value (based on the vol-rate empirical relationship) has been impacted by swings in market depth recently (**Exhibit 29**), just as it was in 2013 (**Exhibit 30**).

Where are we going with this? We believe a framework for estimating implied vol fair values should begin with the vol-rate relationship, but extend it to account for other factors. Beyond market depth, other factors likely to structurally influence implied volatility include MBS purchases by the Fed (and its taper), and Fed rate hike expectations. Normally, we might include a measure of mortgage convexity to capture demand for mortgage market hedgers. However, in the current environment, that is overwhelmed by the Fed's MBS purchases, which indirectly impacts the volatility markets by leaving fixed income investors short MBS (and therefore long convexity) relative to their benchmarks (Exhibit 31). Thus, for the foreseeable future, the relevant mortgage market dynamic (for the purposes of driving volatility) appears to be the quantum of Fed MBS purchases, rather than factors such as MBS or MSR index convexity profiles.

One model to rule them all

Our fair value framework for implied volatility stitches these factors together with the vol-rate relationship that is pervasive in low rate regimes. We do so as follows.

First, we start by fitting the vol-rate relationship as already discussed, and we use that to derive the fitted fair value for a hypothetical fixed-forward swaption at an ATMF yield of 1%. This **fixed-forward implied volatility** serves as a reference implied volatility level, at a reference rate level, relative to which we can measure implied volatility differentials, which we then seek to model.

In principle, for any given swaption structure, the difference between actual implied volatility and the fixed-forward implied vol estimate will vary because the swaption structure's ATMF yield is different from the fixed value of 1%. In addition, it will also vary because of all the other factors we have identified - the Fed's QE related MBS purchases, Fed hiking expectations, and market depth. This motivates **our choice of the four factors** that we select as independent drivers.

The first is the **underlying ATMF swap yield minus the reference value of 1%**. (Of course, subtracting 1% from the forward swap yield merely shifts the intercept, but it is useful for interpretive purposes). The **second factor is duration-weighted market depth across the curve**. Our **third factor is Fed purchases of MBS on a rolling 1-month basis**. And our **last factor is Fed tightening expectations**, measured as the 2Y forward 1M OIS rate minus the spot 1M OIS rate.

We use this framework to model vol points spanning the grid, but estimated using data only since May 2020. The reason for this is simply that prior to the pandemic, rates were well in excess of levels where the very premise of our vol-rate relationship is valid.

Strikingly, this is a useful construct for thinking about implied volatilities across the grid, all the way from 3Mx2Y in the upper left to the 10Yx10Y sector. Our model coefficients and statistics, as well as their application to generate fair value projections (current as well as at a mid-year 2022 horizon) are all shown in **Exhibit**

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32. We make several key observations from this exhibit. First, our model produces coefficients with intuitive signs across almost all these points. All market-depth coefficients are negative, and almost all Fed purchase coefficients are negative, as one might expect. In addition, the coefficient with respect to the ATMF minus fixed-forward differential would be expected to be positive, as indeed it is in all but one instance. Fed tightening expectations are more mixed in sign, but the expected signage here is less clear in any case. Second, from a statistical significance as well as explained variance perspective, this framework seems to work well across the vol grid.

Exhibit 32: Implied volatility spreads over fixed-forward volatility are well explained by forward yields, market depth, Fed purchases of MBS, and rate hike expectations across the volatility grid

Statistics from a regression of implied volatility minus fixed-forward volatility* for various different swaption structures, against (i) ATM forward yield minus 1%, (ii) weighted market depth** ($mn), (iii) monthly Fed purchases of MBS ($bn), and (iv) tightening expectations***

	Coefficients					T-statistic							Imp. Vol			
Structure	ATMF minus fixed fwd	Wtd. Mkt Depth	Monthly Fed MBS purch	Tightening Expect.	Const	ATMF minus fixed fwd	Wtd. Mkt Depth	Monthly Fed MBS purch	Tightening Expect.	Const	R^2	Cur. ATMF	Actual	Fair Value	Mis-pricing	Jun 2022 Exp
3Mx2Y	2.40	-0.0017	0.0024	1.50	-0.7	9.1	-11.0	2.6	13.0	-3.5	94%	0.92	4.54	4.52	0.02	4.7
6Mx2Y	-0.68	-0.0020	-0.0018	3.30	-2.3	-2.0	-12.0	-1.8	16.0	-9.2	94%	1.09	4.68	4.81	-0.13	6.2
6Mx5Y	4.10	-0.0017	-0.0057	-1.10	1.7	36.0	-10.0	-4.8	-8.6	10.0	94%	1.49	4.99	5.09	-0.09	4.8
6Mx10Y	1.90	-0.0015	-0.0078	-0.15	1.3	36.0	-10.0	-7.9	-2.1	10.0	92%	1.72	4.98	5.08	-0.11	5.5
1Yx5Y	3.30	-0.0013	-0.0075	-0.72	1.3	39.0	-7.7	-6.6	-6.4	8.5	95%	1.64	5.05	5.20	-0.15	5.3
1Yx10Y	1.80	-0.0011	-0.0093	-0.08	1.1	38.0	-8.3	-9.9	-1.2	9.9	93%	1.80	4.95	5.01	-0.07	5.7
3Yx10Y	1.30	-0.0007	-0.0087	0.34	0.6	37.0	-5.1	-9.8	6.1	5.5	92%	1.94	4.74	4.99	-0.25	5.9
5Yx10Y	1.10	-0.0005	-0.0089	0.49	0.4	32.0	-3.7	-9.6	9.1	3.5	90%	1.99	4.52	4.87	-0.35	5.9
5Yx30Y	0.82	-0.0005	-0.0072	0.36	0.2	25.0	-3.7	-8.7	7.7	1.9	85%	1.83	4.12	4.30	-0.18	5.1
10Yx10Y	0.79	-0.0003	-0.0078	0.47	0.0	24.0	-2.3	-9.1	9.6	0.2	86%	2.00	4.01	4.36	-0.35	5.3

Drivers					
Cur	Varies	300	100	1.25	1
Jun-22	Varies	500	0	1.75	1

Dates: 5/20 to present.

* Fixed forward volatility refers to implied volatility estimated using the previously discussed vol-vs-rate fit, at an ATMF yield of 1%

** Market depth is the 5-day moving average of the three bids and offers by queue position, using the top 3 bids and offers in Treasury notes and bonds, averaged between 8:30 and 10:30am daily. Duration-weighted market-depth calculated as weighted sum of market depth in 2s, 5s, 10s and 30s, using weights of 0.25, 0.5, 1 and 2 respectively.

*** Tightening expectations measured by 2Y forward 1M OIS rate minus the spot 1M OIS rate.

Source: J.P. Morgan

Lastly, our approach indicates that **short expiry implied volatility is currently close to fair, while longer expiries are cheap**. Indeed, this cheapness of longer expiries is even more so when one considers the outlook going forward - in particular, **we would look for 3Yx10Y and 5Yx10Y implied volatility to rise towards 6bp/day, while 5Yx30Y and 10Yx10Y swaption implied volatility is likely to rise towards 5bp/day. Implieds in the upper left such as 3Mx2Y and 6Mx5Y should trade near 4.75bp/day, which is similar to current levels.**

Swap yield curve

It has been a year of considerable volatility in the swap yield curve. The 2s/10s SOFR swap curve, for instance, began the year near 60bp, steepened by 80bp into mid-year before flattening 60bp to its current level of 80bp. The unusually large trading ranges in curve slopes speaks to the inflationary regime shift that we experienced in 2021. Yield curves were positively correlated with yield levels for much of 1H21, steepening in a selloff since inflation was then viewed as transitory and the Fed seen as being stimulative for a prolonged period. Since then, of course,

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much has changed, the yield curves became negatively correlated to yield levels and curves have flattened. Basic statistics regarding SOFR yield curves are shown in **Exhibit 33**.

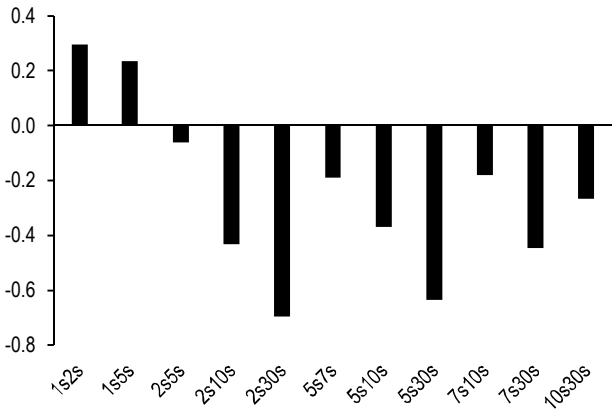
Looking a bit more closely at yield curve flattening, particularly since June 1st of this year which seemed to mark a turning point, we see curve behavior that mimics previous tightening regimes in textbook fashion. As seen in **Exhibit 34**, the very front end of the curve - 1s/5s and 1s/2s has steepened, while curves anchored in longer maturities have flattened considerably. This has tended to be the profile of Fed hiking regimes in the past, where the very front end steepens in the lead up and only flattens once tightening actually begins.

Exhibit 33: This year has seen wide trading ranges in the yield curve
Summary statistics for SOFR yield curves between various different tenor pairs; year-to-date in 2021; %

	Begin	Change	End	Min	Mean	Med.	Max
1s2s	0.01	0.36	0.36	0.00	0.11	0.07	0.38
1s5s	0.18	0.70	0.89	0.18	0.61	0.63	0.93
2s5s	0.18	0.35	0.53	0.17	0.50	0.53	0.72
2s10s	0.63	0.18	0.81	0.63	1.02	0.98	1.40
2s30s	1.09	-0.14	0.95	0.91	1.38	1.30	1.81
5s7s	0.20	-0.05	0.16	0.15	0.27	0.25	0.39
5s10s	0.46	-0.17	0.29	0.27	0.52	0.52	0.74
5s30s	0.91	-0.48	0.43	0.41	0.87	0.96	1.20
7s10s	0.25	-0.12	0.13	0.13	0.25	0.27	0.35
7s30s	0.70	-0.44	0.27	0.26	0.60	0.66	0.84
10s30s	0.45	-0.31	0.14	0.13	0.35	0.38	0.50

Source: J.P. Morgan

Exhibit 34: Yield curve flattening in the second half of the year has exhibited the classic "outside-in" flattening pattern seen before in the lead up to Fed tightening
SOFR yield curve changes since 6/1/21, between various different tenor pairs; %



Source: J.P. Morgan

Yield curve movements are thus signaling that we are no longer in a Fed-on-hold regime, and curve behavior is indicative of a tightening or pre-tightening regime. Straightaway, this has one immediate implication for investors' trading themes in the year ahead - **investors should avoid yield curve carry trades going into 2022**. To demonstrate this, we analyzed a back-test of 11 different butterfly trades where we received fixed in the belly versus paying 50-50 risk in the wings. Trades were initiated daily and held for three months, spanning the entire period from Jan 2003 - Aug 2021. Upon unwind, we calculated the cross sectional beta between the P/L on the 11 trades, versus the *ex-ante* carry on each butterfly trade. This beta is therefore a summary measure indicating the usefulness of carry as a theme that is available for each historical date. Finally, in order to get a sense of the regimes where carry is useful and where it is not, we classify each historical date into one of six regimes, based on observable criteria. Specifically, on each date, we look at the 3-month change in the OIS curve (which we define as 2Yx1M minus 1M OIS) as of that date, and bucket it into six regimes based on the ranges shown in **Exhibit 35**.

Exhibit 36 shows carry betas averaged over the dates within each regime, versus the mid-point of the OIS curve change range that defines each regime. As can be seen, carry is typically useful most of the time. But in periods where the change in the OIS curve is signaling moderate tightening or more, carry betas turn negative. Currently, the OIS curve has steepened by about 75bp over the past three months, which puts us

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in the right-most tightening bucket. Therefore, we recommend that clients avoid seeking carry on the yield curve in coming months.

Exhibit 35: Details of the ranges for the 3M change in the OIS curve, that are used to classify historical dates into six different regimes

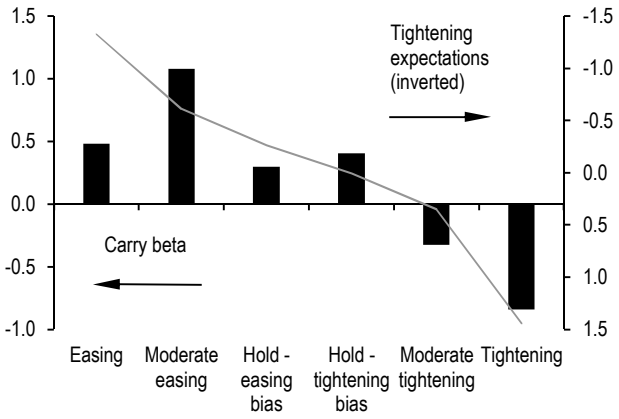
Minimum and maximum 3M change in the OIS curve* used to classify each historical date into one of six different regimes, and the # of dates between 01/2003 – 08/2021 falling into each bucket

		OIS Curve change	
Regime	# Dates	Min	Max
Easing	233	-1.81	-0.83
Moderate easing	699	-0.83	-0.39
Hold - easing bias	932	-0.39	-0.14
Hold - tightening bias	1,398	-0.14	0.15
Moderate tightening	932	0.15	0.55
Tightening	466	0.55	2.34

* OIS curve defined as 2Yx1M minus 1M OIS rate differential.
Source: J.P. Morgan

Exhibit 36: Yield curve carry is a poor predictor of P/L in tightening regimes

Carry beta* averaged over each of six identified regime (LHS; unit-less) against the mid-point of the range for the 3M change in OIS curve used to define the regime (RHS; %)



* Carry beta calculated for each date, between 01/2003 – 08/2021. Beta defined as the regression beta between P/L on 11 different butterflies initiated on that date, and the carry on the trades as of that date. Trades are assumed to be held for 3M. Butterflies included are 2/3/5, 3/5/7, 5/7/10, 10/20/30, 2/5/10, 3/7/10, 5/10/20, 5/10/30, 7/10/20, 7/20/30, and 10/20/30.
Source: J.P. Morgan

Beyond avoiding carry, **inflation expectations priced into the inflation swap market are likely to be an important driver of the yield curve**. Over fairly long periods of history, the slope of the yield curve has been inversely correlated to real short rates. For instance, as seen in **Exhibit 37**, the 5s/30s swap curve has been negatively correlated to real 2-year swap yields (defined as 2-year swap yield minus 2-year inflation swap yield) over the past 15 years, after adjusting for the size of Fed's balance sheet (which controls for the cumulative Fed balance sheet expansion and its depressive effect on term premium and the curve). But the 5s/30s curve is just one example - this is in fact more broadly true of yield curves, with only the exception of curves where both tenors are relatively short in maturity. As seen in **Exhibit 38**, the yield curve between numerous tenor-pairs has had a negative beta to real 2-year yields, after adjusting for the effect of the Fed's balance sheet (which too, appropriately, has a negative partial beta).

This has implications for the curve going forward into the next year. The inflation swap market is currently pricing in a moderation in 2Y inflation going forward, from about 4% currently to closer to 3% on a 6- and 12 months forward basis (**Exhibit 39**). Fair values for the curve are quite sensitive to real short rates, and thus inflation expectations; as seen in **Exhibit 40**, holding all else equal and assuming 2-year inflation will hover around 3% by mid-year, the yield curve appears mostly fair. In contrast, if 2-year inflation swaps in mid-2022 remain closer to its current level of 4%, the yield curve looks considerably flat. To use the 5s/30s curve as an example, the difference in curve fair value between 3% and 4% inflation (measured in the 2-year inflation swap rate) is as much as 50bp.

This all suggests that the yield curve should be considerably volatile in 2022. The volatility of 2-year inflation has climbed steadily recently, and is running at about 5bp/day currently. This translates into an annualized one-sigma of 75bp, implying curves such as 5s/30s and 2s/30s could be considerably volatile in 2022 given their

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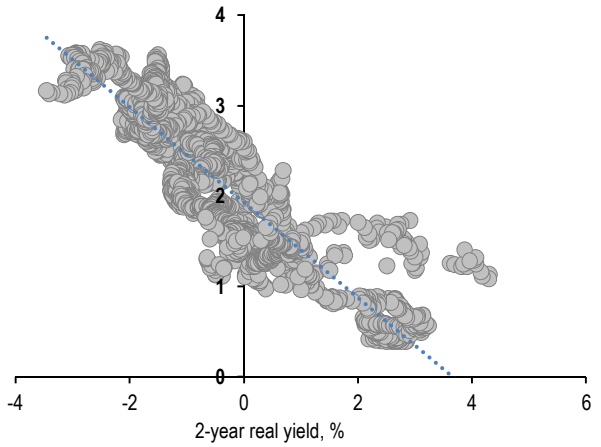
high sensitivity to inflation expectations. **This leaves us with weaker conviction in long term views on the curve, but with a tilt towards overweighting curve volatility, and towards trading yield curves versus inflation swaps.**

Exhibit 37: Real 2-year yields are a significant driver of the yield curve …

5s/30s SOFR swap curve (y-axis; %) adjusted for the size of the Fed's balance sheet* versus real** 2-year swap yields (x-axis; %)



* Calculated as 30Y yield minus 5Y yield plus 0.31 * Fed B/S size ($Tn).

** Measured as 2-year swap yield minus 2-year inflation swap yield

Dates from 11/06 to11/21

Source: J.P. Morgan

Exhibit 38: … between numerous different tenor pairs

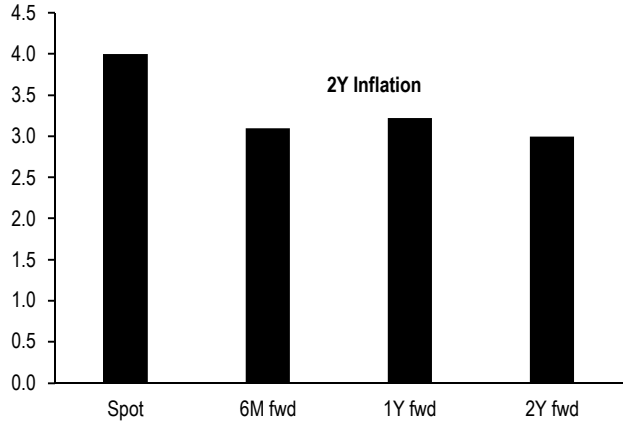
Coefficients and R^2 from a regression* of the yield curve for various tenor-pairs versus 2-year real yields and the Fed's balance sheet assets ($Tn)

	2Y Real Yield	Fed B/S	Alpha	R-squared (%)
1s5s	-0.27	-0.21	1.40	23.8
2s5s	-0.23	-0.18	1.11	31.8
2s10s	-0.52	-0.35	2.22	49.0
2s30s	-0.75	-0.49	3.05	59.7
5s7s	-0.15	-0.09	0.57	60.0
5s10s	-0.29	-0.18	1.10	64.9
5s30s	-0.53	-0.31	1.93	71.3
7s10s	-0.14	-0.09	0.54	68.9
7s30s	-0.38	-0.22	1.36	73.7
10s30s	-0.24	-0.14	0.83	74.6

Source: J.P. Morgan, FRED, Federal Reserve H.4. Regression over past 15 years

Exhibit 39: Inflation swaps are pricing in moderation going forward

Spot, 6M forward, 1Y forward, and 2Y forward 2-year inflation swap yield, %



As of 11/18/21

Source: J.P. Morgan

Exhibit 40: Yield curve fair value is quite sensitive to 2-year real yields, and thus to inflation swap rates

6-month forward yield curve slope for various tenor-pairs, and its fair value* assuming 2-year inflation at 3% and 4%, all else held constant

		2Y inflation = 3%		2Y inflation = 4%	
	6M fwd curve	Fair value	Mispricing	Fair value	Mispricing
1s5s	0.74	0.06	0.68	0.33	0.41
2s5s	0.39	0.02	0.37	0.24	0.14
2s10s	0.61	0.13	0.48	0.65	-0.04
2s30s	0.68	0.24	0.44	1.00	-0.31
5s7s	0.12	0.04	0.08	0.19	-0.06
5s10s	0.22	0.11	0.12	0.40	-0.17
5s30s	0.30	0.22	0.08	0.75	-0.45
7s10s	0.10	0.07	0.03	0.21	-0.11
7s30s	0.18	0.18	0.00	0.56	-0.38
10s30s	0.08	0.11	-0.03	0.35	-0.27

* Fair value calculations based on regressions detailed in Exhibit 38.

Source: J.P. Morgan

Trading themes

- **As new risk shifts to SOFR-linked swaps, look for SOFR swap spreads to exhibit less credit sensitivity and more rate sensitivity.** SOFR swap spreads at the front end are much less likely to widen during flights to quality, in comparison to Libor swap spreads which experience greater credit-driven widening. On the other hand, the typical tendency for credit spreads to narrow as

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tightening expectations rise in a healthy economic environment will likely also be absent, and should make SOFR swap spreads more sensitive to tightening expectations.

- **Position for narrower 10-year SOFR swap spreads over the medium term.** Taper is now a reality, and we project that Reserves have likely peaked and bank demand for USTs will slow considerably from their pace in 2021. These factors, coupled with a tendency for High Grade issuance (and associated swapping activity) to be elevated in the first half of the year, lead us to look for 10-year SOFR swap spreads to narrow towards -35bp.
- **Position for narrower 30-year SOFR swap spreads over the medium term.** Long end spreads are likely to drift narrower in 1H22, mostly in line with the narrowing in 10-year spreads and with the spread curve only steepening modestly. We look for 30-year maturity matched SOFR spreads to drift lower to -55bp.
- **Trade the 10s/30s spread curve's correlation with rates and risky assets.** The two main factors driving the 10s/30s spread curve in the coming year are likely to be aggregate VA duration and the net surplus of the top 100 pension funds. These two are in turn well correlated to level of 10-year yields and the S&P500. Thus, the long end spread curve is likely to create attractive cross-asset relative value trading opportunities.
- **Trade the swings in front end spreads - first narrower, then wider in 2022.** Maturity matched 2-year swap spreads are considerably wide to fair value currently. Looking ahead to late December, a likely ramp up in the TGA (once the debt ceiling is resolved) should catalyze a narrowing in spreads to fair value. But front end spreads should drift wider in 1H22 on the back of Fed tightening expectations.
- **Position for a rise in intermediate and longer expiry volatility.** Implied volatility across the grid is well explained by rates, market depth, the Fed's MBS purchases and tightening expectations. Fed tightening will likely pulled forward ever closer as we move through 2022, and longer expiries are most sensitive to this factor. We look for 3Yx10Y and 5Yx10Y swaption implied volatility to trend towards 6bp/day, and for 5Yx30Y and 10Yx10Y implieds to drift towards 5bp/day.
- **Trade the vol-rate correlation, especially in the upper left sector of the vol grid.** A strong vol-rate relationship is an essential characteristic of low yield regimes where zero is seen as a floor. This relationship should persist in 1H22, especially in the upper left where ATMF yields are the lowest. In addition, while other factors also drive implied volatility levels, these factors are less significant in the upper left, permitting investors to seek relative value trading opportunities that rely on the vol-rate correlation.
- **A pre-tightening regime is not conducive to yield curve carry - avoid carry trades in 2022.** Carry trades can work much of the time, but history suggests that in periods of heightened expectations of Fed tightening, carry is a poor predictor of P/L. Indeed, the cross sectional beta between butterfly trades and *ex-ante* carry turns negative in such regimes, suggesting that trades with negative carry are likely to outperform in these periods.
- **Trade the yield curve versus inflation swaps in 2022.** The yield curve between many different tenor pairs has been negatively correlated to real 2-year yields (defined as 2-year swap yield minus the 2-year inflation swap rate), with

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numerically significant betas. With significant volatility expected in both sectors in the year ahead, this relationship should provide fertile ground for relative value trading opportunities.

- **Position for elevated curve volatility in 2022.** As noted above, the yield curve between many different tenor pairs has been negatively correlated to real 2-year yields (defined as 2-year swap yield minus the 2-year inflation swap rate), with numerically significant betas. Inflation swap yields in the 2-year sector, and 2-year real swap yields, have become considerably volatile and should remain so in the year ahead given the considerable macroeconomic uncertainty in this regard. Therefore, the yield curve is likely to exhibit considerable volatility in the year ahead and we expect it to trade in relatively wide ranges. Look to opportunistically add exposure to yield curve volatility via yield curve spread options in 2022.

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