CSA Curves – Pricing Collateralized Interest Rate Swaps under a CSA.

Abstract

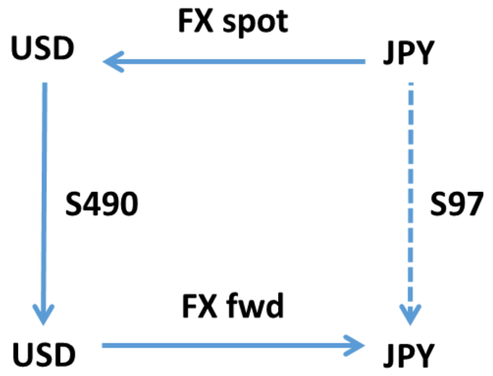
Many OTC derivative transactions are traded under Credit Support Annexes (CSAs) which explicitly stipulate terms for collateral posting. This document describes Bloomberg's CSA curves which are used to price collateralized interest rate (IR) products. These CSA curves are calibrated to cross-currency basis swap or cross-currency swap quotes via standard bootstrapping under the assumption that *the implied FX forwards should be invariant to the currency in which the collateral is posted*.

Introduction

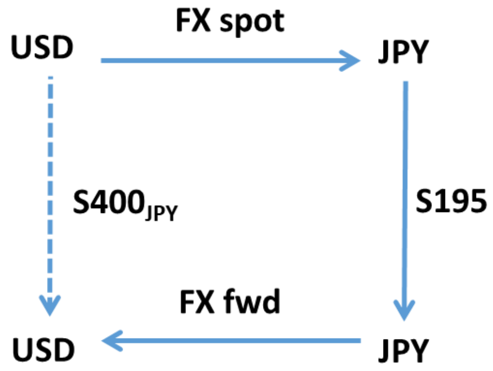
A CSA stipulates the currency (or currencies) in which the (cash) collateral of OTC derivative transactions can be posted and the rate of interest paid on that (cash) collateral. For example, Figure 1 shows a USDJPY non-resettable cross-currency basis swap with collateral posted in USD and SOFR as the rate of interest paid on collateral by construction (N.B. Bloomberg assumes USDJPY resettable cross-currency basis swaps are collateralized in USD with SOFR as the rate of interest paid on collateral). Note that the currency of the cashflows and collateral are the same for the USD leg, hence its cashflows are discounted using the USD SOFR curve S490. But the JPY cashflows have to be discounted by the JPY vs. USD Basis curve S97.

Fig. 1 - 5Y USDJPY non-resettable cross-currency basis swap with collateral posted in USD and SOFR as the rate of interest paid collateral

Note that the curve S97 can be decomposed via FX parity into SOFR discount factors and USDJPY FX forwards as shown in Figure 2.



a. USD collateral, SOFRRATE Index paid on collateral



b. JPY collateral, MUTKCALM Index paid on collateral

Fig. 2 - Decomposition of CSA curves via FX parity

When the collateral is posted in JPY instead of USD, as shown in Figure 3, the cash flows of the same USDJPY basis swap now need be discounted differently. In the example, given the interest rate paid on collateral is the Bank of Japan uncollateralized overnight call rate (TONA) it is clear that the JPY cashflows should be discounted by the JPY OIS curve S195. However, it is not as obvious how the USD cashflows should be discounted.

By following the same argument that is used to decompose the basis curve S97 into SOFR discount factors and USDJPY FX forwards, the discount factors of the CSA curve $S400_{JPY}$ can also be decomposed via the FX parity into TONA discount factors and USDJPY FX forwards as shown in Figure 2b. Since the FX forwards, implied from S97, are expected to be invariant to the choice of the collateral currency, the discount factors of $S400_{JPY}$ can therefore be easily calculated from S97, S195 and S490.

Fig. 3 - 5Y USDJPY non-resettable cross-currency basis swap with collateral posted in JPY and the Bank of Japan uncollateralized overnight call rate (TONA) as interest rate paid on collateral

CSA Discount Curves in Bloomberg

The CSA discount curve is represented by a curve number + cashflow currency. As highlighted in Figure 4, 400 represents the CSA curve number. Different to other curves, curve number 400 represents a set of CSA discount curves, each one corresponding to a single collateral currency.

In SWDF, CSA curves only support source 8 curve types; the curve title explicitly shows which cashflow currency the CSA curve is used to discount.

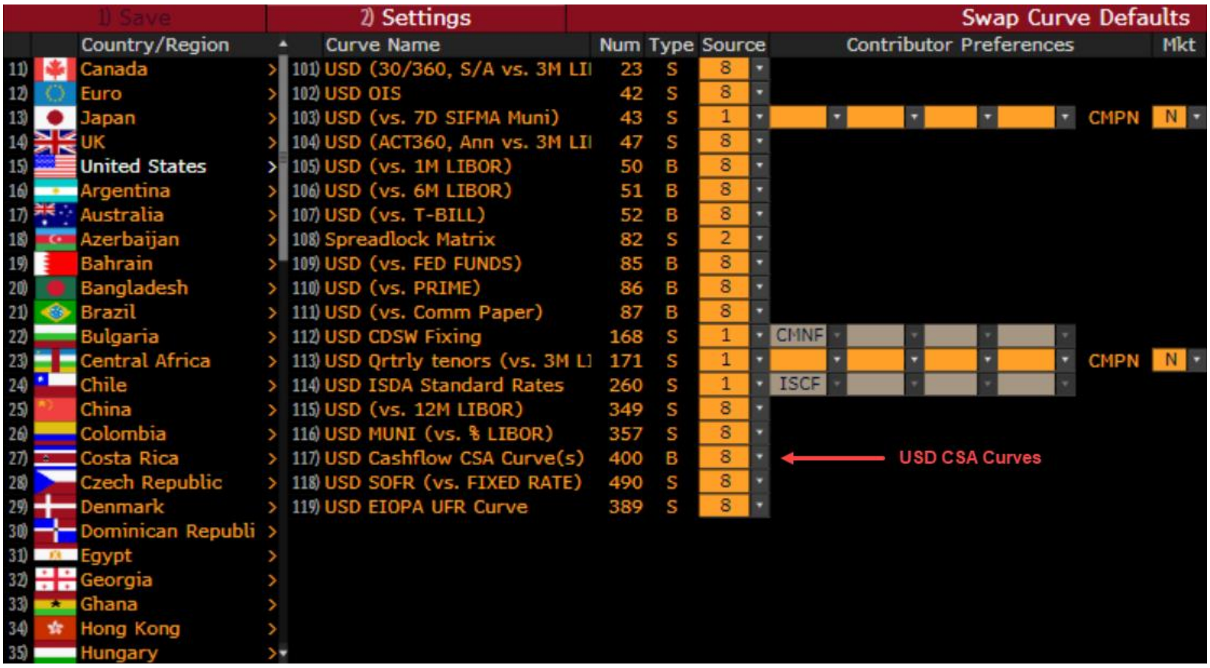


Fig. 4. USD Cashflow CSA Curves, {SWDF USD<GO>}

By typing {ICVS 400<GO>} (for example) in the Bloomberg terminal a user can specify different collateral currencies within the CSA curve. For a particular collateral currency a user can select the appropriate curve for the collateral interest rate. The CSA curve name is dynamically generated based on cash flow currency and collateral currency. For example, BB GBP Collateral for USD C/F is the CSA curve 400, with collateral currency GBP, used to discount USD cashflows.

CSA curves are composite curves based on a curve representing the collateral interest rate and other curves used to generate the FX forwards between cashflow currency and collateral currency. Within the ICVS screen, the curve representing the collateral interest rate can be selected by the user and the individual underlying curves used within the CSA wrapper can be viewed, as show in Figure 5.

Assuming S141 is selected as Collateral Curve (reflecting SONIA as the interest rate paid on collateral), in the example of USD cashflows collateralized in GBP, curves S91, S141, and S490 will be listed in the drop down. In the case of no liquid direct FX quotes between the cashflow currency and non-USD collateral currency, the implied FX forwards are bridged through USD or EUR. For example: CAD cashflows collateralized in GBP, there is no liquid direct quote from CAD to GBP, so FX forwards will be implied thought CAD->USD, USD->GBP. As a result, the bridge currency is USD. As a further example, for PLN cashflows collateralized in USD, PLN doesn’t quote directly against USD. Instead it is quoted against EUR, so EUR will be the bridge currency. The bridge currency information also is shown in ICVS screen.

CSA curves don’t display instruments directly since they are composites of other curves. A set of dates are shown to display the zero rates/discount factors under ICVS Curve Analysis tab.

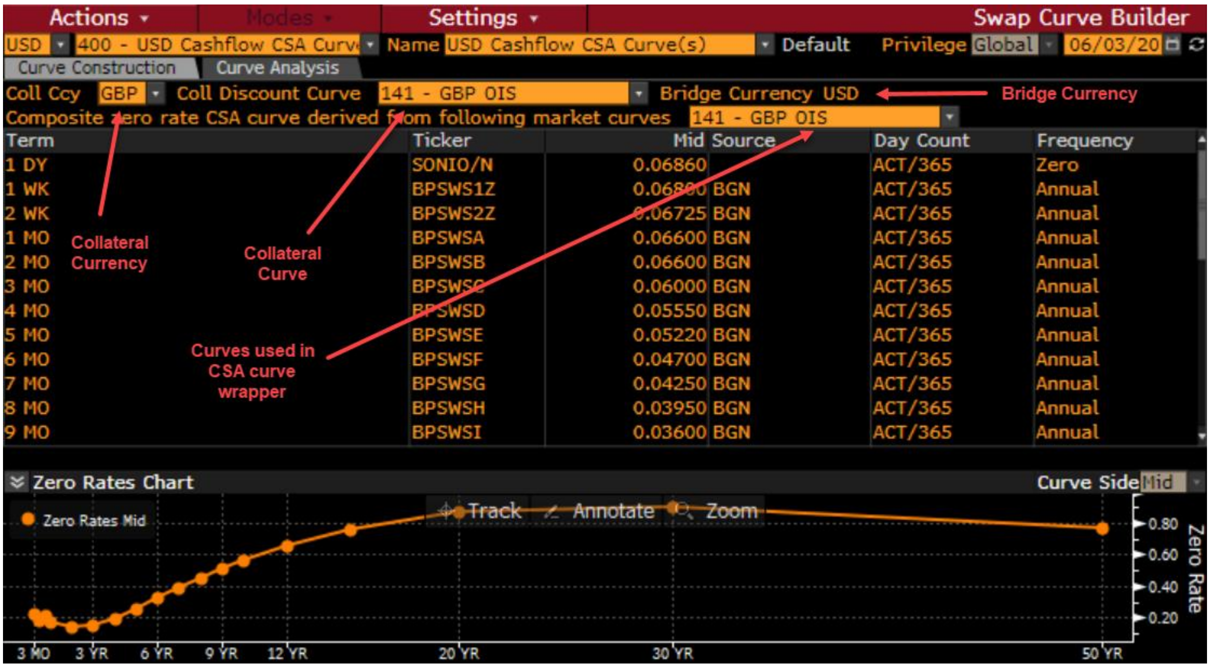


Fig. 5. USD Cashflow CSA curve with collateral posted in GBP and SONIA as interest rate paid on collateral

Methodology

Now let us formalize the methodology for stripping CSA curves by generalizing the discussion in the previous sections.

To calculate discount factors that can be used to discount cashflows in one currency, C_1, collateralized in another currency, C_2, all we need are the FX spot and forward rates from C_1 to C_2, and the discount factors in C_2. Let

$$FX_{C1\to C2}^{FWD}(T) = FX\ forward\ rate\ to\ convert\ from\ C_1\ to\ C_2\ at\ time\ T$$

$$FX_{C1\to C2}^{SPOT} = FX_{C1\to C2}^{FWD}(0) = FX\ spot\ rate\ to\ convert\ from\ C_1\ to\ C_2$$

$$D_{C2}(T) = discount\ factor\ at\ time\ T\ for\ currency\ C_2$$

Under the assumption that FX forwards are independent of collateralization we conclude that

$$\frac{D_{C1\to C2}^{CSA}(T)}{D_{C2}(T)} = \frac{FX_{C1\to C2}^{FWD}(T)}{FX_{C1\to C2}^{FWD}(0)} = \frac{D_{C1}(T)}{D_{C2\to C1}^{CSA}(T)}$$

It is worth noting that cross-currency basis curves like S97 (or cross-currency swap curves) are special cases of CSA curves in which the collateral currency coincides with the traditional definition of cross currency basis swaps [1], and therefore these curves are used to determine the FX forwards needed for other CSA curves.

References

[1] "Building Bloomberg Interest Rate Curves," DOCS 2064159, Bloomberg

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