Client engineering of XVA

Crises challenge client XVA management when continuous collateralisation is not possible, because a derivative locks in the client credit level and the provider's funding level, on the trade date, for the life of the trade. Chris Kenyon prices XVA reduction strategies from the client point of view, comparing multiple-trade strategies using mandatory breaks or restructuring, with modifications of a single trade using a reset

XVAs are not immutable: clients can change XVA charges by changing their trading strategies while keeping the same underlying trade. Mandatory breaks, resets and restructuring are all commonly used, as otherwise a trade will lock in the current client credit risk and bank funding risk for the whole life of the trade. Here, we develop a precise quantitative framework from the client point of view and use recent crises to provide typical quantification. We compare modifications of a single trade using a reset with multiple trade strategies using mandatory breaks or restructuring. This XVA engineering is particularly important when clients want to control for (or potentially take advantage of) changes in their credit default swap (CDS) levels or their bank's funding costs. Multiple-trade strategies are inefficient when there is no credit change because later trades have XVA priced in without including the probability of client survival. This is because only surviving clients will enter into continuation trades. Pricing from the client point of view is necessary because continuation trades in multiple-trade strategies are, by definition, invisible to the provider. This means that pricing must use risk-neutral measures, and real-world-conditional risk-neutral measures. We analyse previous crises and recovery periods to inform our numerical examples on CDS shock sizes, and to investigate how long it takes a firm's CDS to recover and to see by how much it does.

We price from the client perspective, so $\mathbb{P}$-measures are important. All $\mathbb{P}$-measures are subjective as they depend on user-chosen criteria, eg, the calibration or backtesting setup. Our approach is to provide a mix of $\mathbb{P}$-measure information and scenarios that allow clients to assess the risks of alternatives. We do not collapse this information within an expectation. This is because clients do not hedge own-credit and provider-funding, so we do not want to prejudge which scenario is most important to clients. This also avoids the anchoring effect of giving a single number, since clients are not hedgers, unlike banks.

For credit shocks and recovery we analyse a comprehensive CDS database (2002–20) and give the historical $\mathbb{P}$-measure of shock recovery against time from shock for different shock sizes (see table A). This analysis defines the range of credit recovery and timing we use in results tables B and C. While a vaccine for SARS-CoV-2 will be available in the next few months (Krammer 2020), recovery from previous economic shocks has generally taken between six months and two to three years. In our numerical examples we consider credit valuation adjustment (CVA) on an interest rate swap (IRS). The $\mathbb{P}$-conditional $\mathbb{Q}$-measure is less important than might be expected because continuation trades are done at-the-money (ATM). This means that changes in rate levels are largely factored out. We address changes in rate volatility by scenario analysis in table D.

The pricing of derivatives from the client's point of view seems to be absent from the literature, probably because clients are assumed to be price takers. However, as we demonstrate, clients can chose which prices (instruments) they take, and when, to achieve their objectives. This moves their price-taking decisions into the realm of multistage stochastic optimisation (Birge & Louveaux 2011) for portfolios. However, we are interested in a simpler setup. Designing hedging strategies for clients is a service that is typically provided by banks and informed by joint assessment of scenarios and risks. Derivative pricing that takes into account the actions of non-financial institutions is typical, so as to capture prepayment in mortgage-backed securities (Sirignano *et al* 2016). Similar considerations apply for pricing revolving credit facilities, but the published literature is almost non-existent.

The contributions of this article are as follows. First, the pricing of XVA from the client point of view, enabling comparison between multiple-trade and single-trade XVA reduction strategies. We provide a precise characterisation of the required probability spaces and of the conditional probability spaces. Second, we compare restructuring, mandatory breaks and resets. Third, we provide a quantification of CDS shocks and recoveries from history in order to inform choices about strategies and timing. Finally, we give numerical examples to quantify the trade-offs between different strategies. XVA reduction strategies must be priced from the client point of view, and this is almost unique in the XVA literature.

Client pricing

First we give some definitions and contract examples using mandatory break/restructuring and reset, then we introduce the probability framework. We price from a client shareholder value point of view, not from a firm value point of view. That is, we assume the client has no interest in events after their own default.

■ **Mandatory break/restructuring and reset definitions and examples.**

Definition 1 (Mandatory break)

- A mandatory break is a legal agreement to end a derivative on the date specified, at the current market price, and it is part of the term sheet.
- The market price is defined as the price of the derivative ignoring default risk and funding costs.

Restructuring has the same effect as a mandatory break post-trade, providing XVA rebates are available. In mandatory break and restructuring, the original contract stops and a new contract is entered into for the remaining life of the original trade. Since the new contract is only required by a surviving client, the default probability resets, as shown in figure 1(d). The key difference versus a reset is that the credit and funding levels are also reset to whatever the current levels are at the time of the start of the new contract. The profiles for reset and mandatory break after three years are slightly different because the reset is in the $\mathbb{Q}$-measure and the mandatory break continuation exposure is in the $\mathbb{P}$-conditional $\mathbb{Q}$-measure, where we have picked the same-as-now future $\mathbb{P}$-measure. The subsection later in the paper that is titled

'Probability spaces and conditional probability spaces' provides a rigorous setup.

Definition 2 (Reset)

- A reset is a legal agreement to change some aspect of the trade on the date specified such that the net present value (NPV) becomes zero. The NPV difference is calculated as the current market price (as above). It is part of the term sheet.
- The market price is defined as the price of the derivative ignoring default risk and funding costs.

A 'multiple-trade strategy' occurs with a mandatory break, because there is a second trade after the mandatory break. This second trade we call the 'continuation trade'. This is also true for restructuring.

Figure 1 shows the exposure and default probability profiles of the vanilla trade ((a), (b)), then the effects of a mandatory break/restructuring ((c), (d)) and reset ((e), (f)).

CVA and FVA. Client valuation of trades with resets is the same as that of the provider: there are no uncertainties in the pricing of CVAs and FVAs.

Client valuation of trades with a mandatory break/restructuring includes the continuation trade after the mandatory break. The continuation trade could be with a different provider from the original trade, and it must be estimated by the client. The market will also have moved by the mandatory break date, so the client also needs to estimate this effect. With a crisis, the client aims to put the mandatory break after the crisis so as not to lock in the crisis-level credit and funding risks for any longer than is necessary.

When clients use restructuring, they wait and observe the market before acting. It is necessary to include the choice to potentially restructure later in the original assessment of XVA in order to compare strategies. We assume equivalence with a mandatory break here for simplicity, ie, there is a 100% rebate available on demand for XVA.

Clients therefore view XVA from a future conditional measure perspective for a mandatory break/restructuring, because they do not hedge their own default, they do not hedge their derivative provider's funding cost and they assume their own survival. This requires the following probability development.

Probability spaces and conditional probability spaces. To handle client valuation in the $\mathbb{P}$-measure conditional on their survival, we introduce the probability space:

$$X = (\Omega, \mathcal{F}, \mathbb{P})$$

on a set of events Ω with a filtration $\mathcal{F}(t)$ and corresponding probability measures $\mathbb{P}(t)$. The equivalent probability space with a risk-neutral measure is:

$$Y = (\Omega, \mathcal{F}, \mathbb{Q})$$

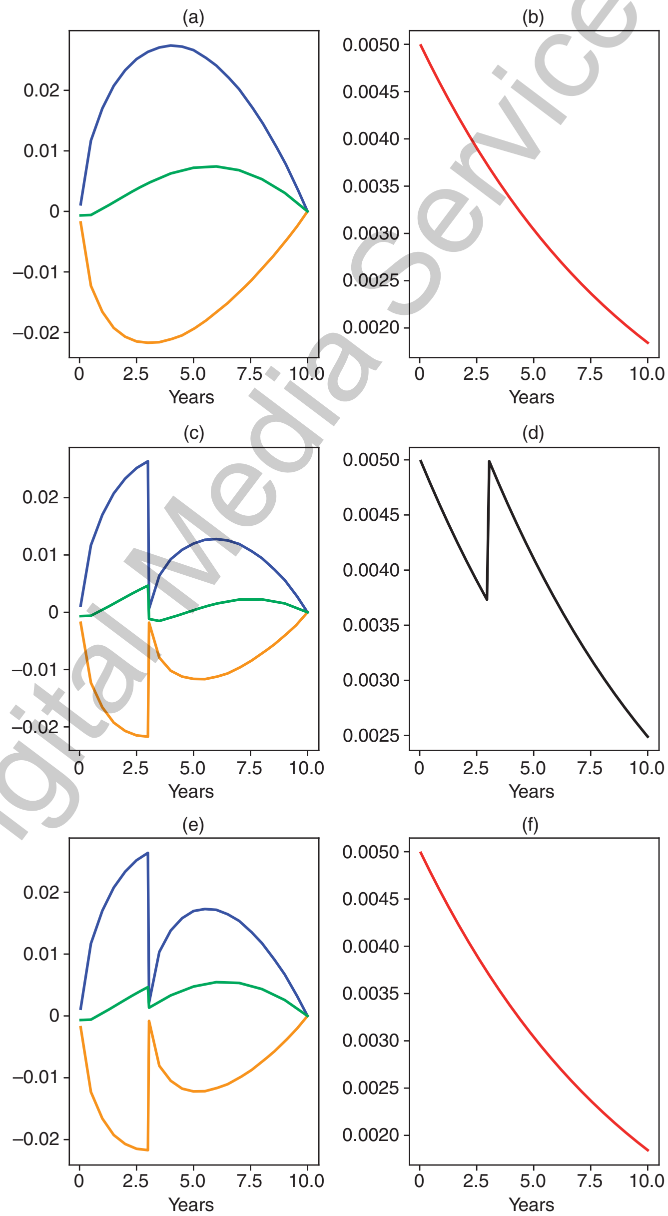
$\mathbb{P}(t)$ are the physical measures from the point of view of t_0. Given a mandatory break date $t_{\rm m}$ and a set of events (a path) up to $t_{\rm m}$, $\omega \in \mathcal{F}(t_{\rm m})$, we define sets of conditional probability spaces from X as:

$$X_\omega = \{(\Omega_\omega, \mathcal{F}_\omega, \mathbb{P}_\omega) \mid \omega \in \mathcal{F}(t_{\rm m})\} \quad (1)$$

$$X_{\omega,{\rm C}} = \{(\Omega_{\omega,{\rm C}}, \mathcal{F}_{\omega,{\rm C}}, \mathbb{P}_{\omega,{\rm C}}) \mid \omega \in \mathcal{F}(t_{\rm m}) \text{ and } \tau_{\rm C} > t_{\rm m}\} \quad (2)$$

$\tau_{\rm C}$ is the default time of the counterparty. Ω_ω denotes all possible events conditional on the set of events ω up to $t_{\rm m}$. $\mathcal{F}_\omega$ is the filtration $\mathcal{F}$ conditional on the set of events ω up to $t_{\rm m}$. $\mathbb{P}_\omega(t)$ denotes the probability measures $\mathbb{P}(t)$ for $t \geqslant t_{\rm m}$ conditional on the set of events ω up to $t_{\rm m}$.

1 Exposures (left) and default probabilities (right) for a 10Y IRS



(a) EPE (expected positive exposure), EV (expected value) and ENE (expected negative exposure) profiles for 10Y ATM EUR IRSs with unit notional as of May 29, 2020. (b) The default probability curve. The curve gives the probability of default for the next six months. (c) EPE, EV and ENE profiles for the same trade with a mandatory break after three years and the profiles for the new seven-year ATM IRS continuation trade assumed by the client that the bank uses from three years to 10 years. (d) The default probability curve used by the bank from t_0 to three years, and the default probability curve assumed by the client that the bank uses from three years to 10 years. (e) EPE, EV and ENE profiles for the same trade with a reset after three years. (f) The default probability curve used by the bank from t_0 to trade maturity

Hence, X_ω is the set of all future probability spaces at $t_{\rm m}$, indexed by the state of the world ω up to $t_{\rm m}$, and $X_{\omega,{\rm C}}$ is the set of all future probability spaces where the client survived up to and including $t_{\rm m}$. This modifies $(\Omega_\omega, \mathcal{F}_\omega, \mathbb{P}_\omega)$ to $(\Omega_{\omega,{\rm C}}, \mathcal{F}_{\omega,{\rm C}}, \mathbb{P}_{\omega,{\rm C}})$ by adding the additional conditioning.

Figure 2 illustrates the probability spaces X and $X_{\omega=\omega_a}$ for a specific ω_a. The vertical 'state' axis indicates the multidimensional state of the world. Lines indicate which states are reachable from each other. We have chosen a recombining tree because it makes it easier to display $\mathcal{F}$ and $\mathcal{F}_{\omega_a}$. In the context of the figure, $X_{\omega,\mathrm{C}}$ consists of those conditional probability spaces where the client does not default on the possible paths ω up to t_m. So, for example, it may be that only some of the points at t_m exist in $\bigcup_\omega\{\Omega_{\omega,\mathrm{C}}\}$ considering all ω in $\mathcal{F}$ up to t_m.

Now, for the probability spaces in X_ω or $X_{\omega,\mathrm{C}}$, we can create sets of equivalent risk-neutral probability spaces Y_ω or $Y_{\omega,\mathrm{C}}$, respectively. That is:

$$Y_\omega = \{(\Omega_\omega, \mathcal{F}_\omega, \mathbb{Q}_\omega) \mid \omega \in \mathcal{F}(t_\mathrm{m})\} \tag{3}$$

$$Y_{\omega,\mathrm{C}} = \{(\Omega_{\omega,\mathrm{C}}, \mathcal{F}_{\omega,\mathrm{C}}, \mathbb{Q}_{\omega,\mathrm{C}}) \mid \omega \in \mathcal{F}(t_\mathrm{m}) \text{ and } \tau_\mathrm{C} > t_\mathrm{m}\} \tag{4}$$

These Y_ω and $Y_{\omega,\mathrm{C}}$ are equivalent to X_ω and $X_{\omega,\mathrm{C}}$ because they see the same events – the same filtrations – but have different measures, and they agree on sets of measure zero (Shreve 2004, definition 1.6.3). For example, the $\mathbb{Q}_{\omega,\mathrm{C}}$ are found by calibrating to the future $\mathbb{P}_{\omega,\mathrm{C}}$-measure observables at t_m for each $\omega \in \mathcal{F}(t_\mathrm{m})$ and $\tau_\mathrm{C} > t_\mathrm{m}$.

Pricing at t_0. Here, we give the normal pricing, ie, without a mandatory break or reset. This covers pricing with reset as this contract is priced in its entirety at t_0.

Derivative providers price XVA as the risk-neutral expected loss of a derivative, or portfolio, from counterparty default and the funding cost while the trade is alive. We assume independence of exposure and default for simplicity. Following Burgard & Kjaer (2014), the XVA at inception is:

$$\mathrm{CVA}(t_0; t_0, T) = L_{\mathrm{GD}} \int_{u=t_0}^{u=T} \lambda(u) \mathrm{e}^{\int_{s=t_0}^{s=u} -\lambda(s)\,\mathrm{d}s} \times \mathbb{E}^{\mathbb{Q}}[D_{r_F}(u)\Pi^+(u)]\,\mathrm{d}u \tag{5}$$

$$\mathrm{FVA}(t_0; t_0, T) = \int_{u=t_0}^{u=T} s_F(t) \mathrm{e}^{\int_{s=t_0}^{s=u} -\lambda(u)\,\mathrm{d}s} \times \mathbb{E}^{\mathbb{Q}}[D_{r_F}(u)\Pi(u)]\,\mathrm{d}u \tag{6}$$

$\mathrm{CVA}(t_0; t_0, T)$ means that the CVA is calculated at t_0 for exposure from t_0 to T, and similarly for FVA. We make the definition:

$$\mathrm{XVA}^{\mathbb{Q}}(t_0; t_0, T) := \mathrm{CVA}(t_0; t_0, T) + \mathrm{FVA}(t_0; t_0, T) \tag{7}$$

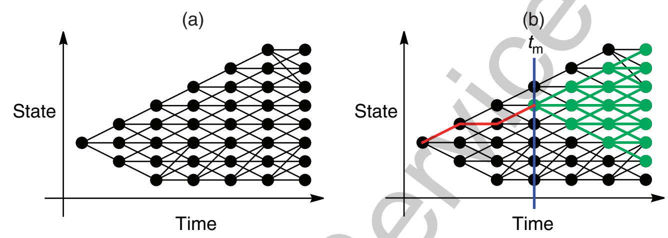
where we include the measure that the XVA used for clarity. Also, $\lambda(t)$ is the counterparty hazard rate, Π^+ is the positive exposure of the position with respect to the counterparty, and $r_F(t) := s_F(t) + r(t)$ is the bank funding cost, with separation into funding spread and riskless rate.

Since trades end on their mandatory break dates, XVA is calculated up to the mandatory break date of the derivatives with mandatory breaks and up to the full term with resets, where T is the date of the last payment. To continue the trade after a mandatory break the client must enter a new trade and pay XVA on this continuation trade.

Pricing with mandatory breaks at $t > t_0$. To price mandatory breaks from the client point of view we need to price the trade and the XVA after the mandatory break/restructuring as well as the trade and the XVA before the mandatory break/restructuring.

Clients do not hedge their own default probability nor the funding cost of the provider, so they value XVA in the real world, ie, the $\mathbb{P}$-measure. Clients will only enter into a trade after a mandatory break if they survive, so we need to consider this.

2 Illustration of (a) unconditional and (b) conditional probability spaces



(a) $X = (\Omega, \mathcal{F}, \mathbb{P})$, where Ω is represented by the circles and $\mathcal{F}$ is represented by the lines. (b) $X_{\omega_a} = (\Omega_{\omega_a}, \mathcal{F}_{\omega_a}, \mathbb{P}_{\omega_a})$ for a specific ω_a in $\mathcal{F}$ up to t_m, where ω_a is shown as a red path, Ω_{ω_a} is represented by green dots because only these are reachable from ω_a, and $\mathcal{F}_{\omega_a}$ is represented by the green lines as these are the only futures reachable from ω_a. In $X_{\omega_a,C}$, $\Omega_{\omega_a,C}$ will be the empty set if the client C defaulted along the path ω_a, otherwise $\Omega_{\omega_a,C} = \Omega_{\omega_a}$

A key factor in mandatory break valuation is the setup of the continuation trade after the mandatory break. This will typically be ATM, not at the previous level. The settlement at the mandatory break date provides the hedge against changes in riskless value from changes in market level. This is the functional hedge aspect of the trade in action.

Assuming a single trade, without a mandatory break the XVA – CVA and FVA here – cost to a client is just (7):

$$\mathrm{XVA}_{\mathrm{Client}}(t_0; t_0, T) = \mathrm{XVA}^{\mathbb{Q}}(t_0; t_0, T) \tag{8}$$

The reset case is covered by the above when the exposures within (5) and (6) are from the resetting trade.

With a mandatory break at t_m, the client cost is the sum of the XVA on the trade with the mandatory break and the later continuation trade to original trade maturity:

$$\mathrm{XVA}^{\mathrm{MB}}_{\mathrm{Client}}(t_0, \omega; t_0, T) = \mathrm{XVA}^{\mathbb{Q}}(t_0; t_0, t_\mathrm{m}) + \mathrm{XVA}^{\mathbb{Q}_{\omega,\mathrm{C}}}(t_\mathrm{m}; t_\mathrm{m}, T) \tag{9}$$

$\mathrm{XVA}^{\mathrm{MB}}_{\mathrm{Client}}(t_0, t_\mathrm{m}; t_0, T)$ is a random variable because it depends on the future state of the world via the events up to t_m, ie, ω, and the client survival up to t_m within $\mathbb{Q}_{\omega,\mathrm{C}}$. As we saw above, $\mathbb{Q}_{\omega,\mathrm{C}}$ is a future risk-neutral measure dependent on earlier $\mathbb{P}$-measures.

The client cannot hedge $\mathrm{XVA}^{\mathbb{Q}_{\omega,\mathrm{C}}}(t_\mathrm{m}; t_\mathrm{m}, T)$ at t_0 with the street at a price the client will accept when the client considers that the observed CDS curve does not reflect the client's recovery post-crisis. Also, counterparties may be reluctant to trade CDSs that refer to the client with the client. In short, the client's view is that supply and demand for their CDSs does not reflect future credit risk levels but does include additional premiums. Another way of saying this is that the client does not calibrate the drift of their $\mathbb{P}$-measures to the current observed CDS curve.

Below we look at examples of how the mandatory break changes the total XVA cost to the client, $\mathrm{MB}(t_\mathrm{m}, \omega)$, as a function of the mandatory break date t_m and the assumptions on recovery, ie, $\mathbb{P}_{\omega,\mathrm{C}}$:

$$\begin{aligned}\mathrm{MB}(t_\mathrm{m}, \omega) &:= \mathrm{XVA}_{\mathrm{Client}}(t_0; t_0, T) - \mathrm{XVA}^{\mathrm{MB}}_{\mathrm{Client}}(t_0, \omega; t_0, T) \\ &= \mathrm{XVA}^{\mathbb{Q}}(t_0; t_0, T) - (\mathrm{XVA}^{\mathbb{Q}}(t_0; t_0, t_\mathrm{m}) \\ &\qquad + \mathrm{XVA}^{\mathbb{Q}_{\omega,\mathrm{C}}}(t_\mathrm{m}; t_\mathrm{m}, T))\end{aligned} \tag{10}$$

We characterise classes of ω by the change in credit spread of the client at $t_{\rm m}$ relative to t_0.

We now look at historical CDS shocks and recovery to inform the numerical examples.

Crises and recovery

Here, we analyse CDS shocks and their recovery. The CDS universe that we use is preselected for a minimal level of liquidity, and it starts in May 2002 and ends in May 2020. The main indicator we use is the maximum of the 1Y and 5Y CDS spreads to allow for CDS curve and liquidity changes under stress.

We want to detect shocks that are significant to firms and recoveries that are usable for hedging purposes, so data is prepared as follows to reduce the effects of noise, insufficient data and missing data.

- We only consider names from three regions – Asia, Europe and North America – because these have the largest number of active names (more than 500 each).
- We remove any name that has less than 2.1 years of data. We have derived the figure of 2.1 as a cutoff from the window of 1 year for detecting shocks and the 1 year no-detect period after a shock detection. Gaps are permitted and are linearly interpolated. We use a window size of 1 year, so if there is less than 2 years of data, the name will not provide a useful contribution.
- Apply a 21-point median filter. This takes the median across a month so that the results are not affected by daily noise.

Data preparation reduces the initial data set from 10.1 million observations to 6.6 million and the total number of names from 5,400 to 3,400. Very roughly half of the names are active on any given date. The results may obviously be biased towards liquid names so this caveat should be included when making any use of the results in this paper.

We define a shock in historical CDSs as follows:

- A shock for an individual company is an increase of CDS spread over a past window of at least a given size, where this shock occurs at least one window period after any previous shock.
  - The window period chosen is one year.
  - We look at shocks with sizes of 250 basis points, 500bp and 1,000bp. Shock size is measured as:

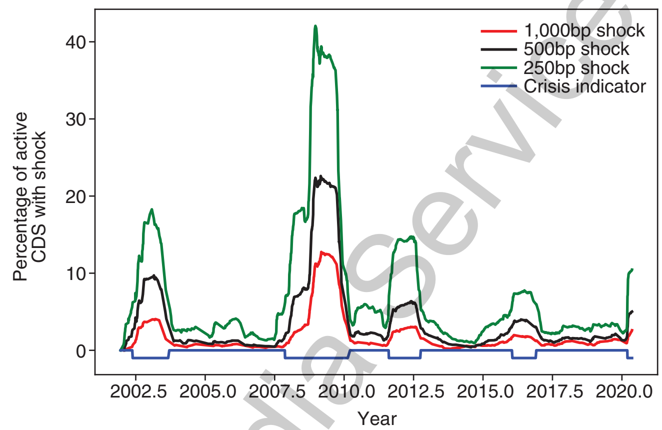
$$\text{shock size} := \text{CDS}(t) - \text{quantile}(10\%, \{\text{CDS}(u) : t-1 \leqslant u < t\}) \quad (11)$$

- A crisis for the market is when the percentage of CDS names undergoing shocks is at least a given percentage of active CDS names.
- Recovery is the change in CDS spread at fixed horizons after a shock for an individual company.
  - Change in CDS spread at 0.5Y, 1Y, 2Y, 3Y, 4Y and 5Y horizons after each shock.
  - CDS spread change at each horizon is defined as the change to the median CDS level at $\pm 5\%$ of the horizon. This enables us to model clients having some flexibility on exactly when to transact any re-hedge, ie, considering horizon h with a shock date of t:

$$\begin{aligned}\text{CDS spread change} \\ &:= \text{quantile}(50\%, \{\text{CDS}(u) : t + 0.95 \times h \leqslant u < t + 1.05 \times h\}) \\ &\quad - \text{CDS}(t) \qquad (12)\end{aligned}$$

The blue line in figure 3 shows the definition of market crises that we have used: 6% of active names with at least a 250bp shock in the last year. This definition was chosen to highlight the periods with elevated percentages of CDSs with shocks. Small variations to this definition have little effect on results.

3 Percentage of active names with shocks over the last year



The different colours correspond to different shock sizes: green is 250bp, black is 500bp and red is 1,000bp. Crisis periods are shown by lowered levels of the blue curve. Small variations to this definition have no effect on the results

Numerical results

First we describe historical recovery from shocks, and then we discuss the effects of alternative XVA management strategies.

Recovery from shocks. Table A gives the quantiles of the distribution of changes in CDS spreads as defined in (12) for horizons of $\{0.5\text{Y}, 1\text{Y}, 2\text{Y}, 3\text{Y}, 4\text{Y}, 5\text{Y}\}$ in crisis periods. We make the following observations:

- Looking at the median rows (starting with 0.50), by two years most of the initial shock is recovered. For the largest shock, 1,000bp, 80% of the recovery is after one year.
- At least 5% of the time there is no recovery. Things get worse.
- 25% of the time there is mild recovery until five years, when most of the shock is recovered. For the largest shock, even in the 25th percentile, 70% of the recovery is present by two years.

There appears to be survivor bias in this analysis since we only observe CDSs that do not default. However, from a mandatory break point of view this is correct, because in the case of default the client is not concerned about trade renewal. That is, we only want to consider cases where the client survives. There is no bias from the mandatory break use and design perspective.

We now have a quantification of both recovery and risk or degree of recovery from historical CDS shocks. Now we need to add the CVA quantification with respect to a mandatory break and then we need to bring the two parts together.

Effects of XVA management strategies. Next we look at XVA management strategies, letting the timescale of shock recovery (ie, 1–5 years) and the sizes of the observed shocks and recoveries (ie, 250–1,000bp) in the previous section inform the range of our analysis.

We consider an example 10-year EUR IRS as of May 29, 2020, where the client receives the floating rate. This is typical in that it provides the client with protection from increases in interest rates. EUR is currently at historically low levels, but rates can go down as well as up beyond previous levels.

A. Quantiles of the distribution of changes in CDS spreads from shocks for horizons of {0.5Y,1Y,2Y,3Y,4Y,5Y} in crisis periods

Shock 250.0	Horizon (years) 0.5Y	1.0Y	2.0Y	3.0Y	4.0Y	5.0Y	n at 2Y
0.05	−920	−1,230	−1,490	−1,345	−1,500	−1,617	1,686
0.25	−171	−251	−316	−331	−337	−347	1,686
0.50	−28	−160	−205	−176	−212	−233	1,686
0.75	171	62	−91	−81	−93	−152	1,686
0.95	1,331	1,728	417	380	437	175	1,686
Shock 500.0	**0.5Y**	**1.0Y**	**2.0Y**	**3.0Y**	**4.0Y**	**5.0Y**	**n at 2Y**
0.05	−1,370	−2,293	−2,433	−2,277	−2,462	−2,769	898
0.25	−342	−515	−613	−637	−691	−710	898
0.50	−64	−350	−453	−438	−493	−534	898
0.75	352	−9	−262	−266	−307	−416	898
0.95	3,140	2,951	741	475	487	132	898
Shock 1,000.0	**0.5Y**	**1.0Y**	**2.0Y**	**3.0Y**	**4.0Y**	**5.0Y**	**n at 2Y**
0.05	−1,546	−2,750	−3,361	−2,943	−3,317	−3,026	469
0.25	−715	−1,042	−1,241	−1,199	−1,280	−1,378	469
0.50	−237	−812	−953	−915	−999	−1,096	469
0.75	773	−89	−714	−658	−797	−936	469
0.95	6,557	5,194	822	334	792	−221	469

All shocks and changes are in basis points. The number of shocks in the last column (n) is for the 2Y horizon. The first column gives the quantiles of the distribution of the change in CDS spread. We display the {5%, 25%, 50%, 75%, 95%} quantiles

B. XVA reduction as a percentage of XVA charge without a reset for reset points at 1Y to 5Y and for CDS shocks of 500bp and 1,000bp

IRS maturity	dVol	Shock	CDS level reached	Reset point (years) 1	2	3	4	5
10	0.0	500.0	600.0	19.9	24.9	24.2	20.7	16.0
		1,000.0	1,100.0	21.8	24.8	22.1	17.5	12.5

Note that the CDS level is locked in for the whole life of the trade. A dVol of zero means that there is no change to the interest rate volatility

When pricing forward XVA, we assume that the current interest curve and the volatility are the same at the mandatory break point. This assumption is often called 'same as now', as opposed to 'risk neutral', where, for example, we would move up the yield curve. We also consider changes in volatility at the mandatory break point below. We compare this with using a reset priced at t_0. It cannot, therefore, benefit from later changes in client credit risk but, as mentioned above, it has the advantage of using conditional survival probability for the part of the trade after the reset (and, in fact, for all times).

■ **Reset.** Table B shows the XVA reduction as a percentage of XVA charge without a reset for reset points at 1Y to 5Y and for CDS shocks of 500bp and 1,000bp. Note that the CDS level is locked in for the whole life of the trade. In this example the change in exposure from the different reset dates roughly balances the different default probabilities. There is a 20–25% reduction in XVA for reset points at 1–5 years. This reduction has little dependence on the CDS level.

Since the trade has a reset, there is no dependence on the $\mathbb{P}$-measure, or on later realised CDS levels or realised interest rate volatility levels.

■ **A mandatory break and restructuring.** We assume that the continuation trade is ATM. Table C shows the reduction in XVA compared with a trade without a mandatory break, or post-trade restructuring. We assume that the restructuring rebate pays 100% of the XVA and is available. The continuation trade is at the future CDS level of the client, so we include a range of possibilities, including improvement and worsening. Even with significantly worse CDS levels, there is little increase in total XVA: less than 5%. For as-is CDS levels, the mandatory break is roughly half as effective as a reset. This is because the surviving client at the mandatory break date pays XVA without the benefit of the conditional survival probability: defaulting clients simply have no need of the continuation trade.

When the CDS level improves after the initial shock, the reduction in XVA can be two to three times the reduction from a reset. For a 500bp shock, starting from 100bp, the breakeven with respect to a reset is an improvement of roughly one-quarter of the shock. For a 1,000bp shock, the breakeven is roughly one-third of the shock. The XVA reduction pattern is almost always better with a shorter mandatory break date, provided the CDS level has improved.

Table D shows XVA reduction as a percentage of XVA charge without a mandatory break for mandatory break points at 2Y for CDS shocks of 500bp and 1,000bp. We also consider CDS change at the time of entering into the continuation trade. We cover interest rate volatility differences of −10bp to +10bp, while the yield curve is the same as t_0 for continuation trade. We observe that there is significant interplay between the volatility effect and the CDS change effect, as we would expect, as both are important in XVA. As the CDS recovery increases, there is less relative effect of changes in volatility.

Discussion and conclusions

We have considered client XVA management using either mandatory breaks/restructuring or resets as tools adapted for recovery from crises and normal times, respectively, and we have looked at the crossover between them. Restructuring is similar in terms of XVA effects to mandatory breaks, but it can be done on any date if the provider agrees and if an XVA rebate is given. The issue when CDS levels are high is that a derivative locks in the client credit risk level and the provider's funding level on the trade date for the life of the trade.

Analysis of historical crises defined by CDS shocks between 2002 and 2020 shows that recovery is largely complete two years after the initial shock, if we consider the median CVA recovery. For 500bp shocks, 75% of the names recover by at least half after two years, with 5% showing continuing deterioration.

We found that if the CDS level does not recover, or if there was no shock in the first place, then a reset for a 10Y IRS is roughly twice as effective in reducing XVA as a mandatory break. If the CDS level improves for the client by even one-third of the shock to the CDS level, then a mandatory break or restructuring is at least as good as a reset, and it can be several times better. Analysis of CDS shock recovery from historical crises indicates that this level of recovery occurs in at least 75% of cases.

Pricing from the client point of view answers the question of whether a mandatory break followed by a continuation contract is a true break, ie, two separate contracts, or whether it is, in practice, just a single contract. For both parties the riskless price of the continuation trade after a mandatory break is different when seen from the original start date compared with the continuation from a reset, because it is a $\mathbb{Q}$-in-$\mathbb{P}$-measure price not a $\mathbb{Q}$-measure price. We provided a precise definition of the relevant probability spaces and measures. The client also faces higher XVA with a mandatory break than with a single contract containing a reset. These differences are invisible when pricing from the usual bank point of view, because then only the contract up to the mandatory break is priced. However, from the client's point of view, a reset in a single trade must be compared to a mandatory break/restructuring with two sequential trades.

C. XVA reduction as a percentage of XVA charge without a mandatory break for mandatory break points at 1Y to 5Y and for CDS shocks of 500bp and 1,000bp

			CDS level		Mandatory break point (years)				
Maturity	dVol	Shock	reached	CDS change	1	2	3	4	5
10	0.0	500.0	600.0	−250.0	−4.4	2.0	4.9	5.9	5.7
				0.0	12.6	15.9	15.7	13.8	11.1
				125.0	23.5	24.5	22.2	18.5	14.2
				250.0	36.4	34.5	29.7	23.8	17.6
				500.0	69.4	59.4	47.7	36.0	25.4
		1,000.0	1,100.0	−500.0	−2.9	−3.1	−4.0	−4.2	−3.7
				0.0	7.6	6.5	4.2	2.5	1.4
				250.0	16.7	14.2	10.4	7.2	4.8
				500.0	29.4	24.5	18.5	13.2	8.8
				1,000.0	71.8	57.0	42.3	29.7	19.5

We also consider CDS change at the time of entering into the continuation trade. Interest rate volatility and yield curve are the same as t_0 for continuation trade. Negative reductions indicate increases

D. XVA reduction as a percentage of XVA charge without a mandatory break for mandatory break points at 2Y and for CDS shocks of 500bp and 1,000bp

		CDS level			Volatility change (bp)		
Maturity	Shock	reached	Split at	CDS change	−10.0	0.0	10.0
10	500.0	600.0	2Y	−250.0	18.8	2.0	−14.8
				0.0	29.3	15.9	2.4
				125.0	35.9	24.5	13.1
				250.0	43.5	34.5	25.6
				500.0	62.4	59.4	56.5
	1,000.0	1,100.0	2Y	−500.0	13.5	−3.1	−19.7
				0.0	20.8	6.5	−7.8
				250.0	26.7	14.2	1.6
				500.0	34.6	24.5	14.5
				1,000.0	59.2	57.0	54.8

We also consider CDS change at the time of entering into the continuation trade. We cover interest rate volatility differences of −10bp to +10bp, while the yield curve is the same as t_0 for continuation trade. Negative reductions indicate increases

Hedge accounting is highly relevant and it will be covered elsewhere in detail (Kenyon & Kenyon 2020). A key aspect is that accounting can follow the 'entity's risk management objective and strategy for undertaking the hedge', so it is not limited to contracts that exist at some particular time, eg, at original trade inception. This objective and strategy require 'formal documentation' by the entity (see IFRS 2018, section 6.4.1.b), and they must meet the hedge effectiveness tests in section B6.4.1, including the effects of credit risk in section B6.4.7.

This paper is almost unique in taking the client's perspective in XVA valuation using a real-world perspective, rather than considering valuation from the provider's side in the risk-neutral perspective. However, consideration of a mandatory break makes this a requirement, as the provider is indifferent (all risk is hedged), whereas the client is exposed to changes in their own credit risk and the provider's funding risk. Since we are currently in the midst of the Covid-19 crisis, as defined by CDS shocks, we have considered mandatory break valuation from this point of view, ie, within a crisis from the historical CDS analysis. During normal times, or for clients unaffected by XVA, with no significant changes in CDS level a reset can be twice as effective as a mandatory break. Restructuring can have further complexities. ■

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