Online Appendix

Appendix A: The concept in a multiperiod framework

Using the reduced-form model notation proposed by Doshi, el al. (2013),[1] the yearly CDS spread $S_t^{c,h}$ for a h-year sovereign c CDS contract can be computed as the rate which equates the present value of the payments (premium leg) to the present value of the expected payout (loss leg),

$$\overbrace{\mathbf{E}_t\left[S_t^{c,h}\sum_{j=1}^{h}q_{t+j}^{c}A_{t+j}\left(t+j\right)\right]}^{\text{premium leg}}=\overbrace{\mathbf{E}_t\left[\sum_{j=1}^{h}\left(1-R^c\right)\left(q_{t+j-1}^{c}-q_{t+j}^{c}\right)A\left(t+j\right)\right]}^{\text{loss leg}}, \qquad (1)$$

where R^c is the recovery rate (as a proportion of the face value of the protection), q_{t+j}^c is the survival probability at time $t+j$, $q_{t+j-1}^c - q_{t+j}^c$ is the probability that the credit event occurs during the interval $(t+j-1, t+j)$ and $A\left(t+j\right)$ is the riskless discount rate $\exp\left(-\sum_{j=0}^{h-1} r_{t+j}\right)$ with r_{t+j} being the risk free rate. In terms of notation, $(1-R^c)$ is the loss given default, $\lambda_{t+j}^c = (1-R^c)\left(q_{t+j-1}^c - q_{t+j}^c\right)$ and $\mathbf{E}_t\sum_{j=1}^{h}\lambda_{t+j}^c A\left(t+j\right)$ is the present value of the expected loss as a percentage of exposure after a credit event.

From the point of view of an international investor based for example in the United States, if the contract has a face value of the protection denominated in US dollars ($) using (1) then

$$S_t^{c,h,USD}=\frac{\mathbf{E}_t\left[\sum_{j=1}^{h}\lambda_{t+j}^{c}A\left(t+j\right)\right]}{\mathbf{E}_t\left[\sum_{j=1}^{h}q_{t+j}^{c}A\left(t+j\right)\right]}, \qquad (2)$$

[1] The only difference vis-à-vis Doshi, et al (2013) is that they use an indicator function, we use in our notation the survival probability.

if instead the contract has a face value of the protection denominated in euro, then

$$S_t^{c,h,EUR} = \frac{\mathbf{E}_t\left[\sum_{j=1}^h X_{t+j}^{L,c}\lambda_{t+j}^c A\left(t+j\right)\right]}{\mathbf{E}_t\left[\sum_{j=1}^h X_{t+j}^{P,c} q_{t+j}^c A\left(t+j\right)\right]}, \tag{3}$$

where $X_{t+j}^{P,c}$ is the USD/EUR exchange rate contingent upon a credit event not having occurred, $X_{t+j}^{L,c}$ is the USD exchange rate versus the euro or the new legal currency contingent upon a credit event having occurred over the period $t+h$ and $A\left(t+j\right)$ is the riskless discount rate prevailing in the US dollar money market.

Divide numerator and denominator by the current USD/EUR exchange rate, $X_t^{P,c}$, then

$$S_t^{c,h,EUR} = \frac{\mathbf{E}_t\left[\sum_{j=1}^h \left(1+x_{t+j}^{L,c}\right)\lambda_{t+j}^c A\left(t+j\right)\right]}{\mathbf{E}_t\left[\sum_{j=1}^h \left(1+x_{t+j}^{P,c}\right) q_{t+j}^c A\left(t+j\right)\right]}, \tag{4}$$

where $x_{t+j}^{P,c} = X_{t+j}^{P,c}/X_t^{P,c} - 1$ is the USD/EUR exchange rate appreciation contingent upon a credit event not having occurred and $x_{t+j}^{L,c} = X_{t+j}^{L,c}/X_t^{P,c} - 1$ is the exchange rate appreciation of the euro or the new legal currency against the US dollar contingent upon a credit event having occurred.

Assume that in the absence of a credit event the exchange rate follows a random walk, $X_{t+j}^{P,c} = X_t^{P,c} + \varepsilon_t^c$ where ε_t^c is a white noise (i.e. $\mathbf{E}_t\varepsilon_t^c = 0$, $cov(\varepsilon_t^c, \varepsilon_s^c) = 0$ if $t \neq s$, $var(\varepsilon_t^c) = \sigma^2$), then $\mathbf{E}_t X_{t+j}^{P,c} = X_t^{P,c}$ and $\mathbf{E}_t \sum_{j=1}^h \left(1+x_{t+j}^{P,c}\right) q_{t+j}^c A\left(t+j\right) = \mathbf{E}_t \sum_{j=1}^h q_{t+j}^c A\left(t+j\right)$.[2] Hence, (4) can be written as

$$S_t^{c,h,EUR} = \frac{\mathbf{E}_t\left[\sum_{j=1}^h \left(1+x_{t+j}^{L,c}\right)\lambda_{t+j}^c A\left(t+j\right)\right]}{\mathbf{E}_t\left[\sum_{j=1}^h q_{t+j}^c A\left(t+j\right)\right]}. \tag{5}$$

This implies that the quanto CDS, that is the difference between the USD- and the EUR-denominated CDS spreads, can be computed subtracting (5) from (2)

$$Q_t^{c,h} = \frac{\mathbf{E}_t\left[\sum_{j=1}^h \lambda_{t+j}^c A\left(t+j\right)\right]}{\mathbf{E}_t\left[\sum_{j=1}^h q_{t+j}^c A\left(t+j\right)\right]} - \frac{\mathbf{E}_t\left[\sum_{j=1}^h \left(1+x_{t+j}^{L,c}\right)\lambda_{t+j}^c A\left(t+j\right)\right]}{\mathbf{E}_t\left[\sum_{j=1}^h q_{t+j}^c A\left(t+j\right)\right]}, \tag{6}$$

[2] Similar results are obtained if the exchange rate is driven by the uncovered interest parity condition: $x_{t+j}^{P,c} = r_{t+j-1}^{USD} - r_{t+j-1}^{EUR}$, given that $\mathbf{E}_t \sum_{j=1}^h \left(1 + r_{t+j-1}^{USD} - r_{t+j-1}^{EUR}\right) q_{t+j}^c A\left(t+j\right) \approx \mathbf{E}_t \sum_{j=1}^h q_{t+j}^c A\left(t+j\right)$.

which can be rewritten as

$$Q_t^{c,h} = \overbrace{\frac{\mathbf{E}_t\left[\sum_{j=1}^{h}\lambda_{t+j}^{c}A(t+j)\right]}{\mathbf{E}_t\left[\sum_{j=1}^{h}q_{t+j}^{c}A(t+j)\right]} - \frac{\mathbf{E}_t\left[\sum_{j=1}^{h}\lambda_{t+j}^{c}A(t+j)\right]}{\mathbf{E}_t\left[\sum_{j=1}^{h}q_{t+j}^{c}A(t+j)\right]}}^{\text{Credit risk } (=0)}$$

$$+ \overbrace{\frac{\mathbf{E}_t\left[\sum_{j=1}^{h}\lambda_{t+j}^{c}A(t+j)\right]}{\mathbf{E}_t\left[\sum_{j=1}^{h}q_{t+j}^{c}A(t+j)\right]}\mathbf{E}_t\left[\sum_{j=1}^{h}-x_{t+j}^{L,c}\right]}^{\text{Credit event probability-weighted expected currency depreciation } (+)} \tag{7}$$

$$+ \overbrace{\frac{\mathbf{COV}_t\left[\sum_{j=1}^{h}-x_{t+j}^{L,c},\sum_{j=1}^{h}\lambda_{t+j}^{c}A(t+j)\right]}{\mathbf{E}_t\left[\sum_{j=1}^{h}q_{t+j}^{c}A(t+j)\right]}}^{\text{currency risk associated with expected loss } (+)},$$

By subtracting the EUR-denominated CDS from the USD-denominated CDS, the credit risk component becomes nil and what is left is the expected depreciation and the currency risk component. Given that in case of a credit event among euro area countries the US dollar is expected to appreciate, then $X_{t+i}^{L,c} < X_t^{P,c}$ and $x_{t+i}^{L,c} = X_{t+i}^{L,c}/X_t^{P,c} - 1 < 0$. Therefore, the second component of (7), namely the credit event probability-weighted country c's expected currency depreciation against the US dollar, is positive. Moreover, the larger the expected loss, the larger the expected depreciation; hence the third component of (7), namely the currency risk associated with the expected loss, is also positive: $\mathbf{COV}_t\left[\sum_{j=1}^{h}-x_{t+j}^{L,c},\sum_{j=1}^{h}\lambda_{t+j}^{c}A(t+j)\right] > 0$. Therefore,

$$Q_t^{c,h} = S_t^{c,h,USD}\mathbf{E}_t\left[\sum_{j=1}^{h}-x_{t+j}^{L,c}\right] + \frac{\mathbf{COV}_t\left[\sum_{j=1}^{h}-x_{t+j}^{L,c},\sum_{j=1}^{h}\lambda_{t+j}^{c}A(t+j)\right]}{\mathbf{E}_t\left[\sum_{j=1}^{h}q_{t+j}^{c}A(t+j)\right]} > 0. \tag{8}$$

$Q_t^{c,h}$ measures the compensation demanded by market participants for the risk associated in holding euro-denominated assets that the US dollar appreciates against the euro or the new legacy currency after a credit event.

Intra-euro area redenomination risk, $I_t^{c,b,h}$, is defined by subtracting from (8) an euro area benchmark country b' quanto CDS:

$$I_t^{c,b,h} = Q_t^{c,h} - Q_t^{b,h}. \qquad (9)$$

Given that the expected probability of a credit event in the benchmark country is negligible, we expect

$$I_t^{c,b,h}\Big|_{\lambda_t^{c,h} > \lambda_t^{b,h}} \geq 0. \qquad (10)$$

The propositions that $Q_t^{c,h} > 0$ and $I_t^{c,b,h}|_{\lambda_t^{c,h} > \lambda_t^{b,h}} \geq 0$ are key features that should characterise the data.

Appendix B: Description of the Variables

This appendix provides details about the definition, sources and timing of the data used in the study.

Panel A: Main Variables of the single country VAR

X1 = US government bond yield at 5-year maturity.

The US government bond yield at 5-year maturity is United States 5-year government benchmark bond yield in US dollar provided by Bloomberg.

X2 = the US stock market index.

The US stock market is the Thomson DataStream Global Equity Index for the United States provided by Thomson Reuters.

X3 = US volatility premium.

The US volatility premium is calculated as the difference between the square of VIX index (obtained from Thomson Reuters) and the square of conditional volatility for the US stock market obtained as a GARCH(1,1) on the daily US stock market returns.

X4 = US investment grade.

The US investment grade is the spread between the United States corporate BBB and AAA 7-10-year (USD) Merrill Lynch Bond Index provided by Thomson Reuters.

X5 = EUR depreciation versus USD 5-year forward.

The euro depreciation versus USD 5-year forward is computed using the covered interest rate parity condition as a difference between the euro area and the US OIS risk free rates at

5-year maturity. The Euro and USD Overnight Interest Swaps (OIS) rate at 5-year maturity are provided by Bloomberg.

X6 = EUR depreciation versus USD.

The exchange rate is expressed as units of euro per US dollar and is obtained from the ECB.

X7 = 10-delta EUR/USD 1-month implied volatility (skew).

The 10-delta dollar-euro option implied volatility skew is the difference in the US Dollar/Euro 1-month Black-Scholes implied volatilities of an out-of-the-money 10-delta call option and an out-of-the-money 10-delta put option for OTC currency option markets provided by Bloomberg. A dollar-euro put (call) option is a European option of selling (buying) euro at the contractual option strike price in an exchange of US dollars at the option maturity.

X8 = Break-even inflation rate 5-yr forward.

The break-even inflation rate 5-yr forward is the five-year forward break-even inflation rate five years ahead provided by the ECB.

X9 = German 5-yr CDS.

The German CDS spreads are obtained from Bloomberg. They are midmarket indicative prices for five-year sovereign CDS contracts.

X10 = EA 5-yr OIS.

The EA 5-yr OIS is the Euro OIS rate at 5-year maturity provided by Bloomberg.

X11 = Euro area stock market volatility.

The euro area stock market volatility is the realised volatility for the euro area stock market obtained as a GARCH(1,1) on the daily euro area stock market returns provided by Thomson DataStream.

X12 = Euro area investment grade.

The euro area investment grade is the spread between the European Monetary Union corporate BBB and AAA 7-10-year (Euro) Merrill Lynch Bond Index provided by Thomson DataStream.

X13 = KfW-Bund spread.

The KfW-Bund spread is the difference between the 5-year KfW ('Kreditanstalt für Wiederaufbau') bond and the German sovereign bond (i.e. Bund). They are both guaranteed by the German government and, therefore, carry the same default risk. Any differences between agency and government bond yields should reflect international investors' preference for assets with the lowest liquidity risk.

X14 = Greek sovereign spread.

The Greek sovereign spread is the difference between the 10-year Greek sovereign bond and the 10-year Euro OIS provided by Bloomberg.

X15 = Sovereign yield bid-ask spread.

The sovereign bid-ask spread is the difference between the 5-year bid and ask EUR-denominated sovereign yield provided by Bloomberg.

X16 = Redenomination risk.

Redenomination risk is defined as a difference between the quanto CDS of Italy, Spain or France and the quanto CDS of Germany. The USD- and EUR-denominated CDS at 3-year maturity are provided by Thomson Reuters.

X17 = Domestic stock market.

The domestic stock market is the Thomson DataStream Global Equity Index for the country provided by Thomson Reuters.

X18 = Sovereign yield spreads.

The sovereign yield spreads are the difference between the 5-year EUR-denominated sovereign bond of Italy, Spain and France and the 5-year Euro OIS rate provided by Bloomberg. They are midmarket prices for five-year sovereigns.

Panel B: Main Variables of the FAVAR

X1 = US 1st PC

US 1st PC is the first principal component of US government bond yield at 5-year maturity, the US stock market index, US volatility premium and US investment grade.

X2 = FX 1st PC

FX 1st PC is the first principal component of EUR depreciation versus USD 5-year forward, EUR depreciation versus USD and 10-delta EUR/USD implied volatility.

X3 = EA 1st PC is the first principal component of break-even inflation rate 5-yr forward and the EA 5-yr OIS.

X4 = German 5-yr CDS

The German CDS spreads are midmarket indicative prices for five-year sovereign CDS contracts.

X5 = EA risk 1st PC

EA risk 1st PC is the first principal component of euro area stock market volatility, euro area investment grade and KfW-Bund spread.

X6 = Greek sovereign spread

The Greek sovereign spread is the difference between the 10-year Greek sovereign bond and the 10-year Euro OIS rate.

X7 = CDS bid-ask spread 1st PC

CDS bid-ask spread 1st PC is the first principal component of Italian, Spanish and French CDS bid-ask spread.

X8 = Sovereign yield bid-ask spread 1st PC

Sovereign yield bid-ask spread 1st PC is the first principal component of Italian, Spanish and French sovereign yield bid-ask spread.

X9-11 = IT/ES/FR redenomination risk

Redenomination risk is defined as a difference between the quanto CDS of Italy, Spain or France and the quanto CDS of Germany at 3-year maturity.

X12 = Domestic stock market 1st PC

Domestic stock market 1st PC is the first principal component of Italian, Spanish and French domestic stock markets

X13-X15 = IT/ES/FR CDS spreads

The CDS spreads for Italy, Spain and France are midmarket indicative prices for five-year USD-denominated sovereign CDS contracts.

X16-X18 = IT/ES/FR Sovereign yield spreads.

The sovereign yield spreads are the difference between the 5-year EUR-denominated sovereign bond of Italy, Spain and France and the 5-year Euro OIS rate. They are midmarket prices for five-year sovereigns.

Variables used as robustness check:

- The US price-earnings ratio is based on the Thomson DataStream Global Equity Index for the United States provided by Thomson Reuters.

- The net flows (inflows minus outflows) into mutual funds are obtained from EPFR Global.

- The CDS spreads for the United States are provided by Bloomberg. They are midmarket indicative prices for five-year CDS contracts. The CDS contract references the sovereign.

- The credit spreads of other sovereigns is computed as an average of CDS spreads all the other euro area countries.

- The EUR/USD implied volatility provided by Bloomberg.

- The 10-delta dollar-euro option 1-year implied volatility provided by Bloomberg.

- The local expected budget deficit to GDP ratio is computed as a ratio between the expected budget balance and the expected nominal GDP; the latter in turn computed using expected inflation and GDP growth. The data provider is consensus forecast. The observations are monthly.

- The German sovereign spread is the difference between the 5-year Bund and the 5-year Euro OIS rate provided by Bloomberg. They are midmarket prices for five-year sovereigns.

- The commodity prices are gold and oil provided by Thomson Reuters.

- The redenomination risk at 5-year maturity is defined as a difference between the quanto CDS of Italy, Spain or France and the quanto CDS of Germany at 5-year maturity. The USD- and EUR-denominated CDS at 5-year maturity are provided by Thomson Reuters.

- The first two principle components extracted from the global and exchange rate variables specifically for the FAVAR.

- The first two principle components extracted from the regional variables specifically for the FAVAR.