Online Appendix: "Are credit default swaps a sideshow? Evidence that information flows from equity to CDS markets"

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Abstract

Section A of the appendix discusses the theoretical motivation for the definition of the credit protection return. Section B of the appendix discusses the calculation of the standard errors in Table 3 Panel C, Table 4 Panel C, and Table 9.

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A Credit protection return

This discussion relates the properties of a hypothetical credit protection contract in which the buyer of protection pays an up-front premium in exchange for a cash payment if and only if the reference bond defaults before the expiration of the contract to the typical credit default swap (CDS). In practice, the credit protection contract is not traded independently but is embedded within a credit default swap. Our approach is to extract the return to holding credit protection from quoted CDS spreads.

In an idealized credit default swap contract, the party buying credit protection agrees to make all payments made by the underlying reference floating rate risky note (trading at par). The party selling protection agrees to make all payments made by a floating rate riskless note with identical maturity (again, trading at par). Hence, both sides of the swap have zero initial value because the two parties are exchanging payments on bonds with the same initial market value (normalized to be \$1).

In the absence of default, the party buying protection pays $Y^{ref}_{1,t+k} = \pi_{n,t} + Y_{1,t+k}$ and receives $Y_{1,t+k}$ at the end of each period $t+k$ for any $k \in \{0, \dots, n-1\}$ where $Y_{1,t}$ is the yield to maturity on the 1-period zero coupon default free bond (spot rate) starting at date t, $Y^{ref}_{1,t}$ is the corresponding yield on the 1-period reference bond, and n is the number of periods until expiration of the credit default swap. Thus, the net payment from the perspective of the purchaser absent default is $(\pi_{n,t} + Y_{1,t+k}) - Y_{1,t+k}$ at the end of period $t+k$, that is, the credit spread on the CDS contract is equal to the default premium in the yield of the reference note, $\pi_{n,t}$.

If default occurs in period j, the net payment for each period k where $j \leq k < n-1$ is the proceeds from the post-default bankruptcy or renegotiation minus $Y_{1,t+j}$. Essentially, in default the party purchasing protection remits the recovery proceeds while the party selling protection continues to execute all payments associated with the riskless note until the end of the swap contract. In practice, the swap terminates prematurely upon default and the party selling protection must deliver the par value of the default free note in exchange for the reference security (or cash equivalent). This arrangement is economically equivalent to the idealized swap contract which never terminates prematurely because the present value of the remaining payments for the default free bond is always equal to par value by construction and the market value of the reference security is the present value of the recovery proceeds.

Consider a change in the value of the protection buyer's position between t and t', where these two points in time are close together so that the intervening cash flows are negligible. For example, t and t' are one day apart within the three-month period between payments set for the typical CDS contract. We evaluate this change in value by opening a position at t and closing out the position at t' by arranging a new contract on the opposite side (as a seller of protection). The initial value of this long position at t is $V^p_{t,t} = 0$ but changes at t' to $V^p_{t,t'}$ and the gain or loss is realized by closing the position at t' by taking an opposing position with value $V^p_{t',t'}$. For each swap position we also denote the market value of the constituent legs of the swap. Let $V^{df}_{t,t'}$ be the market value at $t'$of the stream of default free cash flows received by the buyer of protection for a swap opened at t and $V^{ref}_{t,t'}$ is the market value of the corresponding stream of cash flows based on the reference bond paid by the buyer of protection.

$$V^p_{t,t'} - V^p_{t',t'} = \left(V^{df}_{t,t'} - V^{ref}_{t,t'}\right) - \left(V^{df}_{t',t'} - V^{ref}_{t',t'}\right) = V^{ref}_{t',t'} - V^{ref}_{t,t'} \quad (1)$$

This result follows from the fact that the default free floating rate obligations under the contract at t and t' are identical, and therefore, the present value of these payments under the opposite contract positions perfectly offset. The profit realized at t' to the buyer of protection at t is given by the difference in the present value of payments based on the reference bond induced by the change in the credit spread and is equivalent to the present value of the difference of the credit spread at t' and t.

To calculate the present value of these differential payments, we consider the term structure of default free bonds and account for the possibility that the payments will cease due to default. We define $Y_{m,t}$ as the yield to maturity on the m-period zero coupon default free bond starting at t. We also define $\pi^h_{k,t}$ as the credit spread for a hypothetical security that pays 0 at $t+k$ if the reference bond defaults before $t+k$ and 1 at $t+k$ otherwise. Using this hypothetical credit spread, the change in value of the swap is

$$V^p_{t,t'} - V^p_{t',t'} = V^{ref}_{t',t'} - V^{ref}_{t,t'} = \left(\pi_{n,t'} - \pi_{n,t}\right) \sum_{k=1}^{n} \frac{1}{\left(1 + Y_{k,t'} + \pi^h_{k,t'}\right)^k}. \quad (2)$$

The CDS contract can be recast as a credit protection agreement with an up-front insurance premium equal to the discounted present value of the credit spread at t. The premium for this implicit insurance contract is given by

$$PV(\pi_{n,t}) = \pi_{n,t} \sum_{k=1}^{n} \frac{1}{\left(1 + Y_{k,t} + \pi^h_{k,t}\right)^k}. \quad (3)$$

Thus, the return on the implicit insurance contract is the profit from the trades of the protection buyer divided by this implicit premium.

$$\frac{V^p_{t,t'} - V^p_{t',t'}}{PV(\pi_{n,t})} = \left(\frac{\pi_{n,t'} - \pi_{n,t}}{\pi_{n,t}}\right) \left(\frac{\sum_{k=1}^{n} \frac{1}{\left(1+Y_{k,t'}+\pi^h_{k,t'}\right)^k}}{\sum_{k=1}^{n} \frac{1}{\left(1+Y_{k,t}+\pi^h_{k,t}\right)^k}}\right) \quad (4)$$

We label this return as the credit protection return and it is equal to the percentage change in the quoted CDS spread adjusted by the ratio of two annuity factors. In practice, this annuity ratio will always be close to one relative to the percentage change in the CDS spread. Thus, the credit protection return is well approximated by the percentage change in the credit spread. We use the percentage change in the credit spread as the credit protection return in the empirical analysis below. Further refinements that incorporate the ratio of these annuity factors require additional assumptions regarding recovery rates and generate qualitatively and quantitatively similar results.

B Standard errors

This section of the appendix discusses the standard error correction employed in Table 3 Panel C, Table 4 Panel C, and Table 9.

Let X be the matrix of regressors, θ the vector of parameters, and ε the vector of errors. The panel has T periods and J firms. Under the appropriate regularity conditions, $\sqrt{\frac{1}{T}}(\hat{\theta} - \theta)$ is asymptotically distributed $N(0, (X'X)^{-1} S(X'X)^{-1})$ where $S = \Gamma_0 + \sum_{q=1}^{\infty}(\Gamma_q + \Gamma_q')$ and $\Gamma_q = E[(\sum_{j=1}^{J} X_{j,t}\varepsilon_{j,t})'(\sum_{j=1}^{J} X_{j,t-q}\varepsilon_{j,t-q})]$. The matrix Γ_0 captures the contemporaneous covariance, while the matrix Γ_q captures the covariance structure between observations that are q periods apart. While we do not make any assumptions about contemporaneous covariation, we assume that $X_{j,t}'\varepsilon_{j,t}$ follows an autoregressive process given by $X_{j,t}'\varepsilon_{j,t} = \rho X_{j,t-1}'\varepsilon_{j,t-1} + \eta_{j,t}'$ where $\rho < 1$ is a scalar and $E[(\sum_{j=1}^{J} X_{j,t-q}\varepsilon_{j,t-q})'(\sum_{j=1}^{J} \eta_{j,t})] = 0$ for any $q > 0$.

These assumptions imply $\Gamma_q = \rho^q\Gamma_0$ and therefore, $S = [(1+\rho)\,/\,(1-\rho)]\Gamma_0$. (Derivation and details are in DellaVigna and Pollet, 2007) The higher the autocorrelation coefficient ρ, the larger the terms in the matrix S. Since Γ_0 and ρ are unknown, we estimate Γ_0 with $\frac{1}{T}\sum_{t=1}^{T} X_t'\hat{\varepsilon}_t\hat{\varepsilon}_t'X_t$ where X_t is the matrix of regressors and $\hat{\varepsilon}_t$ is the vector of estimated residuals for each cross-section. We estimate ρ from the pooled regression for each element of $X_{j,t}'\hat{\varepsilon}_{j,t}$ on the respective element of $X_{j,t-1}'\hat{\varepsilon}_{j,t-1}$.