Appendix A. Construction of distance to default

This appendix explains how we construct the distance to default covariate, following a recipe similar to those of Vassalou and Xing (2004), Crosbie and Bohn (2002), Hillegeist, Keating, Cram, and Lundstedt (2004), and Bharath and Shumway (2004). For a given firm, the distance to default is, roughly speaking, the number of standard deviations of asset growth by which a firm's market value of assets exceeds a liability measure. Formally, for a given firm at time t, the distance to default is defined as

$$D_t = \frac{\ln(V_t/L_t) + (\mu_A - \frac{1}{2}\sigma_A^2)T}{\sigma_A\sqrt{T}}, \tag{19}$$

where V_t is the market value of the firm's assets at time t and L_t is a liability measure, defined below, that is often known in industry practice as the "default point." Here, μ_A and σ_A measure the firm's mean rate of asset growth and asset volatility, respectively, and T is a chosen time horizon, typically taken to be 4 quarters.

Following the standard established by Moodys KMV (see Crosbie and Bohn, 2002, as followed by Vassalou and Xing, 2004), the default point L_t is measured as the firm's book measure of short-term debt, plus one half of its long-term debt (Compustat item 51), based on its quarterly accounting balance sheet. We have measured short term debt as the larger of Compustat items 45 ("Debt in current liabilities") and 49 ("Total Current Liabilities"). If these accounting measures of debt are missing in the Compustat quarterly file, but available in the annual file, we replace the missing data with the associated annual debt observation.

We estimate the assets V_t and volatility σ_A according to a call-option pricing formula, following the theory of Merton (1974) and Black and Scholes (1973). In this setting, the market value of equity, W_t, is that of an option on the value of a firm's assets, currently valued at V_t, with strike price of L_t and time T to expiration.

We take the initial asset value V_t to be the sum of W_t (end-of-quarter stock price times number of shares outstanding, from the CRSP database) and the book value of total debt (the sum of short-term debt and long-term debt from Compustat). We take the risk-free return r to be the one-year T-bill rate. We solve for the asset value V_t and asset volatility σ_A by iteratively applying the equations:

$$W_t = V_t\Phi(d_1) - L_t e^{-rT}\Phi(d_2), \tag{20}$$

$$\sigma_A = \mathrm{sdev}(\ln(V_t) - \ln(V_{t-1})), \tag{21}$$

where

$$d_1 = \frac{\ln(V_t/L_t) + (r + \frac{1}{2}\sigma_A^2)T}{\sigma_A\sqrt{T}}, \tag{22}$$

$d_2 = d_1 - \sigma_A\sqrt{T}$, $\Phi(\cdot)$ is the standard normal cumulative distribution function, and $\mathrm{sdev}(\cdot)$ denotes sample standard deviation. Eq. (20) is a variant of the call-option pricing formula of Black and Scholes (1973), allowing, through (21), an estimate of the asset volatility σ_A. For simplicity, by using (21), we avoided the calculation of the volatility implied by the option pricing model (as in Crosbie and Bohn, 2002; Hillegeist, Keating, Cram, and Lundstedt, 2004), but instead estimated σ_A as the sample standard deviation of the time series of asset-value growth, $\ln(V_t) - \ln(V_{t-1})$.