Cummins, Hassett, and Oliner, "Investment Behavior, Observable Expectations, and Internal Funds"

Appendix B: Construction of Q^E and $\hat{Q}$

Overview

Our empirical work uses the measure of *Q* derived by Michael A. Salinger and Lawrence H. Summers (1983), which adjusts for the presence of debt, taxes, and assets other than fixed capital:

$$Q_{i,t} = \frac{1}{(1-\tau_t)}\left[\frac{L_{i,t}V_{i,t} + B_{i,t} - A_{i,t} - C_{i,t}}{p_t^k(1-\delta)K_{i,t-1}} - 1\right]\frac{p_t^k(1-\Gamma_{i,t})}{p_t}, \tag{B1}$$

where τ is the marginal corporate tax rate; *L* is an indicator variable that equals unity if the firm is not paying dividends and $(1-m_t)/(1-z_t)$ if the firm is paying dividends, with *m* representing the personal tax rate on dividends and *z* the accrual-equivalent capital gains tax rate; *V* is the unobservable discounted value of expected payouts to existing shareholders; *B* is the book value of outstanding debt; *A* is the present value of the depreciation allowances on investment made before period *t*; *C* is net current assets; p_t^k is the price of capital goods; $p_t^k(1-\delta)K_{i,t-1}$ is the replacement value of the firm's inherited capital stock; *p* is the price of output; and Γ is the present value of tax benefits for each unit of current investment spending. For example, with an investment tax credit at rate $k_{i,t}$,

$$\Gamma_{i,t} = k_{i,t} + \sum_{s=t}^{\infty}\left(1+\rho_s+\pi_s^e\right)^{t-s}\tau_s DEP_{i,s}(s-t), \tag{B2}$$

where ρ is the risk-free real interest rate (assumed to equal 3 percent), π^e is the expected inflation rate, and $DEP_{i,s}(a)$ is the depreciation allowance permitted for an asset of age *a*.

As described in the paper, we calculate two variants of Q that are identical except for the way in which we proxy for the firm's intrinsic equity value, V. The first variant, denoted Q^E, uses the firm's stock market valuation (V^E) as the proxy for V. The second variant, denoted $\hat{Q}$, incorporates a proxy based on analysts' earnings expectations, $\hat{V}$. The next section of this appendix discusses the construction of V^E and $\hat{V}$.

Unless noted otherwise, the remaining components of $Q_{i,t}$ come from Compustat data. The value of debt is the sum of short-term debt (data item 34) and long-term debt (data item 9), both measured at book value at the start of period t. We calculate the present value of the depreciation allowances on investment made before period t according to the method in Salinger and Summers (1983). Net current assets equals current assets (data item 4) minus current liabilities excluding short-term debt (data item 70 + data item 71 + data item 72) at the start of period t. The replacement cost of the capital stock is calculated using the standard perpetual inventory method with the initial observation set equal to the book value of the firm's first reported net stock of property, plant, and equipment (data item 8) and an industry-level rate of economic depreciation constructed from Charles R. Hulten and Frank Wykoff (1981). The data on expected inflation are annual averages of the monthly expectations in the Livingston Survey, administered by the Federal Reserve Bank of Philadelphia. The tax parameters (k, m, z, τ, and DEP) are updated from those used in Jason G. Cummins et al. (1994), who constructed firm-specific investment tax credits and depreciation allowances to reflect the asset composition of the firm's two-digit SIC sector. Finally, the prices of capital and output are from the NBER/Census database http://www.nber.org/nberces.

Detail on the construction of V^E ***and*** $\hat{V}$

V^E proxies for the firm's intrinsic equity value in Q^E and is measured as the sum of the market value of common stock and the market value of preferred stock at the start of period *t*. Using Compustat data, we calculate the market value of common stock as the number of common shares outstanding (data item 25) multiplied by the share price (data item 24), both dated at the end of the previous fiscal year. The market value of preferred stock is calculated as the firm's preferred dividend payout (data item 19) divided by Standard and Poor's preferred dividend yield, obtained from Citibase.

$\hat{V}$ is the analyst-based measure of equity value used to form $\hat{Q}$. Let $E_t^c\left[\Pi_{i,t+s}^a\right]$ denote the analysts' consensus forecast of earnings for firm *i* in year *t+s*, based on information available at the beginning of period *t*. As described in the paper,

(B3) $$\hat{V}_{i,t} = E_t^c\left[\Pi_{i,t}^a + \beta_{t+1}\Pi_{i,t+1}^a + \ldots + \beta_{t+s}\Pi_{i,t+s}^a + \ldots + \beta_{t+S}\Pi_{i,t+S}^a + \beta_{t+S+1}\tilde{\Pi}_{i,t+S+1}^a\right],$$

where β_{t+s} represents the discount factor between year *t* and year *t*+*s*; *t*+*S* is the most distant year for which analysts issue forecasts in year *t*; and $\tilde{\Pi}_{i,t+S+1}^a$ is an imputation for earnings in year *t*+*S*+1 and beyond. We use the consensus forecasts from I/B/E/S for $E_t^c\left[\Pi_{i,t}^a\right]$ and $E_t^c\left[\Pi_{i,t+1}^a\right]$. However, few analysts provide annual forecasts beyond the current year and the year ahead. As a result, we calculate the implied level of earnings for years *t*+2, *t*+3, and *t*+4 from a separate forecast of earnings growth reported by I/B/E/S – the so-called "long-term growth" forecast, which represents the analysts' consensus forecast of the firm's annual average growth of earnings over the coming three to five years. Let $LTG_{i,t}$ denote this long-term growth forecast. To calculate the implied level of earnings beyond year *t*+1, we grow out the average of $E_t^c\left[\Pi_{i,t}^a\right]$

and $E_t^c\left[\Pi_{i,t+1}^a\right]$ at the rate $LTG_{i,t}$. We use the average of these two annual forecasts, denoted by $E_t^c\left[\bar{\Pi}_{i,t}^a\right]$, as the base for this extrapolation because the long-term growth forecast is intended as a measure of trend growth that smoothes through the current state of the business cycle. The final term in equation (B3) is the imputation for earnings beyond year *t*+*S*. We assume that the growth rate for earnings beyond year *S* equals the growth rate for the entire economy. Specifically, the level of expected earnings in year *t*+*S* is turned into a growth perpetuity by dividing it by $(\bar{r}-\bar{g})$, where $\bar{g}$ is the mean growth rate of nominal GDP for the sample period as a whole (about 6 percent), and $\bar{r}$ is the mean nominal equity return for the sample period as a whole (about 15 percent).

With these assumptions, equation (B3) becomes

$$\text{(B4)} \qquad \hat{V}_{i,t} = E_t^c\left[\Pi_{i,t}^a + \beta_{t+1}\Pi_{i,t+1}^a + \sum_{s=2}^{4}\beta_{t+s}\bar{\Pi}_{i,t}^a\left(1+LTG_{i,t}\right)^{s-1} + \beta_{t+5}\frac{\bar{\Pi}_{i,t}^a\left(1+LTG_{i,t}\right)^3}{\bar{r}-\bar{g}}\right].$$

To calculate the discount factor, we assume that $\beta_{t+s} = (\beta_t)^s$, where β_t reflects the annual nominal equity return expected by investors as of year *t*. We measure this nominal equity return as the one-year Treasury bill rate in year *t* plus a fixed 8 percent equity risk premium. This choice for the equity premium is consistent with the guidance offered by Richard A. Brealey and Stewart C. Myers (2000, p. 160): "… we believe a range of 6 to 8.5 percent is reasonable for the United States. We are most comfortable with figures toward the upper end of the range."

The discount factor described above varies over time but not over firms. We also calculated a variant of $\hat{V}$ that allows for firm-specific variation in the discount factor based on the Capital Asset Pricing Model (CAPM). According to the CAPM, the firm's required equity return is

(B5) $$r_{i,t} = r_{f,t} + BETA_i \left(r_{m,t} - r_{f,t} \right),$$

where $r_{f,t}$ is the risk-free interest rate (measured, as above, by the one-year Treasury bill rate in year *t*); $r_{m,t}$ is the expected return on the market portfolio (measured, as above, by the Treasury bill rate in year *t* plus a constant equity risk premium of 8 percent); and $BETA_i$ is the firm's market risk, constructed from CRSP data as the correlation coefficient of the firm's daily stock return and the daily value-weighted market return. Given the firm-specific equity return $r_{i,t}$ defined by equation (B5), the resulting discount factor is

(B6) $$\beta_{i,t+s}^{CAPM} = \left(\beta_{i,t}^{CAPM} \right)^s = \left[1 / \left(1 + r_{i,t} \right) \right]^s .$$

Using β^{CAPM} in equation (B4) generates the CAPM-based measure of $\hat{V}$, which is substituted into equation (B1) to obtain the CAPM-based measure of $\hat{Q}$.

References

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