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Pricing the Idiosyncratic Risk in the Cost of Capital: A Comprehensive Model

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Abstract

Despite the mixed evidence, recent empirical works highlight the importance of idiosyncratic risk in the stock market. On this basis, this note elaborates an approach to price directly the specific risk in the cost of capital, both for scientific empirical purposes and practitioner's investment valuation. For extremely high leverage values, the cost of risky debt tends to approximate the unlevered cost of capital. Exploiting a Merton model, we show a simple solution to calculate in practice every cost of capital version, providing a comprehensive framework. A worked example is provided to simplify the concrete application.

Keywords

Idiosyncratic Risk, Leverage, Pricing, Merton Model, WACC, Valuation

1. Introduction

The price of idiosyncratic risk in equity returns and risk premiums has always been an important topic for corporate finance academics and experts. Despite the mixed evidence, several empirical works highlight the importance of idiosyncratic risk in the stock market (see, among others, Goyal & Santa-Clara, 2003 and recently Begin et al., 2020; Bozhkov et al., 2020). The topic is timely also considering the effect of the specific risk in the recent pandemic situation (Baek et al., 2020) and the determinants of this kind of risk (see for example Zhang, 2016).

In this note, we assume the perspective of attributing the idiosyncratic risk premium to a listed firm, pricing the total risk in place of the systematic one like in the CAPM.

Differently from Laghi and Marcantonio (2016), we do not exploit an implied dividend discount approach for measuring the total risk premium; instead, we proceed in two steps: 1) We conceptually demonstrate how, in a totally levered firm, the unlevered cost of capital is obtainable referring to the cost of debt; 2) We provide how to calculate the cost of capital in practice using a Merton Model (1974).

In this way, we can calculate the cost of capital even in absence of distributable earnings or firm margins generation. A worked example is reported.

The novelty of the present work is represented by those following key points: a) different from the classic CAPM, the cost of capital arises from the cost of debt, implying a necessary pricing of firm idiosyncratic risk sources and b) the model allows to move inside the same framework among the different cost of capital versions (cost of debt, unlevered cost of capital, weighted average cost of capital and cost of equity), allowing a higher coherency for firm and investment project valuation.

The paper is organized as following: Section 2 develops the conceptual model; Section 3 provides the application using the Merton Model; Section 4 reports a numerical example of application and Section 5 concludes.

2. The "Totally Levered Approach"

The basic concept of the model is that in a fully levered situation, third party lenders suffer both default and operating business risk, like shareholders do in an unlevered firm case. The risk of incurring losses (downside risk) is the same for debtholders and shareholders. Consequently, both should be characterized by the same cost of capital. In this situation, third-party lenders would exclusively hold the right to make use of the operating cash flows generated by the investments, or they would be de facto shareholders of the firm (Turner, 2014).

Using the standard Weighted Average Cost of Capital (WACC) formulae in absence of taxation (or in the pre-tax version, Miles & Ezzell, 1980):

$$r_0 = r_E \frac{E}{V} + r_D \frac{D}{V} \tag{1}$$

in which $r_0 = r_D$ for $D \to V$. r_E is the levered cost of equity, r_D is the cost of debt, E/V and D/V are the weight of equity and debt, respectively. r_0 is the unlevered cost of capital.

This view is in line with the previous literature. Solomon (1963) wrote "But in practice k_i, the average rate of interest paid on debt, must rise as leverage is increased. For extreme leverage positions, i.e., as the company approaches an all-debt situation, it is clear that k_i will be at least equal to k_0". k_0 is the unlevered cost of capital.

More recently, Copeland et al. (2005) reported graphically (fig. 13.9, p. 471) that in the risky debt case (both with and without corporate taxation) the cost of debt increases until it is equal to the unlevered cost of capital when $D/(D+E) = 1$ ($E = 0$).

3. Exploiting the Merton Model for the Cost of Equity Estimation

3.1. Standard Merton Model

Following Merton (1974), the present value of a stock (E) is

$$E = VN\left(d_1\right) - De^{-rT}N\left(d_2\right) \tag{2}$$

And the equity standard deviation is:

$$\sigma_E = \sigma_V \frac{V}{E} N\left(d_1\right) \tag{3}$$

where V is the value of assets, D is the face value of debt upon expiry (with interests), r is the risk-free rate, T the time, σ_E is the standard deviation of equity and σ_V is the asset volatility. De^{-rT} is the present value of debt.

d_1 and d_2 are defined as following:

$$d_1 = \frac{\ln\left(\frac{V}{D}\right) + \left(r + \frac{\sigma_V^2}{2}\right)T}{\sigma_V\sqrt{T}}$$

and

$$d_2 = d_1 - \sigma_V\sqrt{T}$$

We know that the credit spread $s(T)$ is

$$s\left(T\right) = y\left(T\right) - r = -\frac{1}{T}\ln\left[\frac{V}{De^{-rT}}N\left(-d_1\right) + N\left(d_2\right)\right] \tag{4}$$

where $y(T)$ is the yield required by debtholders.

3.2. Moving to a Totally Levered Situation

It is known that exploiting the value of equity, the facial value of debt, the standard deviation of equity, the risk-free rate and the time, we can use the previous equations in order to the extract the value of assets and the asset volatility.

Starting from a certain level of firm value and asset volatility and pushing up the present value of debt to match the value of assets ($V = De^{-rT}$), we can apply the totally levered approach described in Section 2.

The credit spread able to price the total (diversifiable and non-diversifiable) risk in the unlevered cost of capital will be:

$$s\left(T\right) = y\left(T\right) - r = -\frac{1}{T}\ln\left[N\left(-d_1\right) + N\left(d_2\right)\right] \tag{5}$$

and

$$d_1 = \frac{-rT + \left(r + \frac{\sigma_V^2}{2}\right)T}{\sigma_V\sqrt{T}} = \frac{\frac{\sigma_V^2}{2}T}{\sigma_V\sqrt{T}} = \frac{\sigma_V}{2}\sqrt{T}$$

$$d_2 = d_1 - \sigma_V\sqrt{T} = \frac{\sigma_V}{2}\sqrt{T} - \sigma_V\sqrt{T} = -\frac{\sigma_V}{2}\sqrt{T}$$

Consequently, Equation (5) becomes:

$$s(T) = y(T) - r = -\frac{1}{T}\ln\left[2N\left(-\frac{\sigma_V}{2}\sqrt{T}\right)\right] \tag{6}$$

Considering that the shareholders usually require an annual remuneration for their capital invested, the expiration time (T) should be equal to 1.

4. A Worked Example

4.1. Starting Data

In this section, we provide a simple example to highlight the application of the Merton model and the cost of capital calculation for each version (cost of debt, unlevered cost of capital, weighted average cost of capital and cost of equity).

Let's suppose a firm is characterized by the following variables:

- A risk-free rate of 2%;
- A value of assets equal to 100;
- An asset volatility equal to 20%;
- A face value of debt upon expiry equal to 70;
- A time equal to 1.

4.2. The Cost of Debt

d_1 and d_2 will be respectively:

$$d_1 = \frac{\ln\left(\frac{100}{70}\right) + \left(2\% + \frac{20\%^2}{2}\right)1}{20\%\sqrt{1}} = 1.9834$$

$$d_2 = 1.9834 - 20\% = 1.7834$$

The credit spread to be added to the risk-free rate to find the cost of debt will be:

$$s(T) = y(T) - r = -\ln\left[\frac{100}{70\mathrm{e}^{-2\%1}}N(-1.9834) + N(1.7834)\right] = 0.28\%$$

And the cost of debt will be:

$$r_D = y(T) = r + s(T) = 2\% + 0.28\% = 2.28\%$$

4.3. The Unlevered Cost of Capital

The credit spread to price in the unlevered cost of capital will be:

$$s(T) = y(T) - r = -\frac{1}{T}\ln\left[2N\left(-\frac{\sigma_V}{2}\sqrt{T}\right)\right] = -\ln\left[2N\left(-\frac{20\%}{2}1\right)\right] = 8.3\%$$

With a risk-free rate of 2%, the unlevered cost of capital would be:

$$r_0 = y(T) = r + s(T) = 2\% + 8.3\% = 10.3\%$$

4.4. The Cost of Equity

To obtain the cost of equity, we need the market value of equity and debt respectively.

The market value of equity will be:

$$E = 100N(1.9834) - 70e^{-2\%1}N(1.7834) = 31.58$$

Thus, the market value of debt will be:

$$B = 100 - 31.58 = 68.42$$

Exploiting the second proposition of Modigliani and Miller (1963) and assuming a corporate tax rate of 30%, we will have the cost of equity equal to:

$$\begin{aligned} r_E &= r_0 + (r_0 - r_D)\frac{B}{E}(1 - t_c) \\ &= 10.3\% + (10.3\% - 2.28\%)\frac{68.42}{31.58}(1 - 30\%) \\ &= 22.46\% \end{aligned}$$

4.5. The Weighted Average Cost of Capital (WACC)

At this point we can proceed with the WACC calculation:

$$\begin{aligned} \text{WACC} &= r_E\frac{E}{V} + r_D(1 - t_c)\frac{B}{V} \\ &= 22.46\%\frac{31.58}{100} + 2.28\%(1 - 30\%)\frac{68.42}{100} \\ &= 8.18\% \end{aligned}$$

5. Conclusion

In this note, we provide a viable and simple solution to directly price the total risk (both systematic and idiosyncratic components) in the cost of capital. The main strength point of the model is to treat all the cost of capital versions in the same framework, avoiding a certain lack of consistency in the hypothesis between the cost of equity and the cost of debt calculation. The model could be useful for financial analysts and experts in company and investment project valuation, when they decide to price an additional risk premium due to firm specific factors (like size, governance etc.). In addition, it can be useful for academic empirical purposes.

However, the model presented in this paper cannot be applied for non-listed firms, due to the lack of data. As a consequence, future research should elaborate a model applicable also for unlisted firms. Finally, a focus on the evolutions of Merton model could improve the precision of the model in defining the appropriate cost of capital risk premium.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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