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The cost of capital and optimal financing policy in a dynamic setting

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ABSTRACT

This paper revisits the Modigliani–Miller propositions on the optimal financing policy and cost of capital in a dynamic setting. In an environment without taxes and bankruptcy costs, the results are generally consistent with the Modigliani–Miller Propositions 1 and 2. However, the first proposition should be presented and interpreted more carefully, as given firm characteristics, there is only one optimal capital structure. Thus, a firm's capital structure is relevant. A relaxation of assumptions about either taxes or bankruptcy costs leads to conclusions that are generally different from those in Modigliani and Miller (1958). The model predicts that leverage and sales-to-capital ratios decrease but firm size and capital stock increase with the subjective discount factor of the firm's manager if there are taxes and bankruptcy costs. The empirical analysis supports these predictions.

1. Introduction

What is the optimal capital structure of a firm? The seminal paper by Modigliani and Miller (1958) shed some light on this issue using a static partial equilibrium model and assuming that: (a) capital markets are perfect; (b) there are no arbitrage opportunities; (c) individual investors can borrow at the same interest rate as firms; (d) expected earnings before interest and taxes (EBIT) do not depend on the firm's capital structure; (e) there are no taxes and no bankruptcy costs, that is, the cost of debt does not depend on the firm's leverage.

Modigliani and Miller (1958, 1963) reach several fundamental conclusions on the company's capital structure and cost of capital:

1. The "*market value of any firm is independent of its capital structure and is given by capitalizing its expected return at the rate ρ_k appropriate to its class. <...> the average cost of capital, to any firm is completely independent of its capital structure and is equal to the capitalization rate of a pure equity stream of its class*." This is known as *Modigliani–Miller Proposition 1*.[1] Later, the proposition was interpreted as that the firm's financial policy is irrelevant.
2. Return on equity capital of the levered firm is equal to the sum of the weighted average cost of capital (WACC) of the unlevered firm and the product of the debt-to-equity ratio and the difference between the WACC of the unlevered firm and cost of debt (*Modigliani–Miller Proposition 2*).
3. If there are taxes, firm value increases and the WACC decreases with leverage (suggesting that the optimal capital structure of a firm is 100% debt).
4. If there are bankruptcy costs, Modigliani–Miller Proposition 1 is unaffected; however, the return on equity capital of the levered firm increases with the debt-to-equity ratio but at decreasing rate (rather than constant as in Modigliani–Miller Proposition 2).[2]

The first three conclusions have been recognized as the foundation of modern corporate finance, and each student enrolled in an undergraduate finance degree or MBA program is required to learn them.

Modigliani and Miller (1958, 1963) as well as the later studies (for example, Kraus and Litzenberger (1973)) ignore the dynamic nature of a firm. The authors employ a static partial equilibrium model. There are two key differences between static and dynamic

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[1] ρ_k denotes the appropriate capitalization rate for a pure equity stream in the class. The text in italics is taken from Modigliani and Miller (1958, pp. 268–269). Modigliani–Miller Proposition 1 can be interpreted as implying that the capital structure impacts firm value because the assumptions in the first paragraph might not be realistic (Stiglitz, 1988).

[2] Modigliani and Miller (1958) explain graphically this statement rather than prove analytically.

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models. Firstly, static models do not include the firm's manager's time and risk preferences that impact her production, investing, and financing choices. We do not directly observe the time and risk preferences of the firm's manager; however, they can be instrumented by executive compensation structure as it is used to align the managerial incentives with shareholders' interests. Several empirical studies report the significant relation between CEO compensation structure and firm's capital structure. Agrawal and Mandelker (1987) find that firms whose managers have more equity incentives, rely more on long-term debt and preferred stock financing following an acquisition or a sell-off. Mehran (1992) reports that firms that grant their CEOs more stock options have more long-term debt. Ortiz-Molina (2007) argues that pay for performance sensitivity increases with convertible debt but decreases with straight debt. Bhagat et al. (2011) find that long-term debt-to-assets and short-term debt-to-assets ratios decrease with the manager's cash compensation. Another stream of literature examines the impact of equity based compensation on firm risk. Guay (1999) reports the positive impact of the sensitivity of CEO wealth to stock volatility on stock return volatility. Rajgopal and Shevlin (2002) provide evidence that stock options encourage managers to invest in risky projects. Coles et al. (2006) find that managerial compensation structure with higher sensitivity of CEO wealth to stock volatility and lower CEO pay-performance sensitivity lead to higher total debt-to-assets ratio. Thus, we can conclude that the manager's incentives and preferences are important determinants of her long-term financing and investing decisions. Time preferences determine how earnings are distributed over time. A lower subjective discount factor (or less patient manager) means that more earnings will be generated in the earlier periods.[3] Risk preferences show the magnitude of a manager's response to a shock. The response of a more risk-averse manager to a shock will be weaker and slower. Models without time and risk preferences might imply suboptimal financing and investing decisions. Secondly, static models do not explicitly include a production function with physical capital and labor (and/or raw materials) as the inputs. Instead, they assume that a firm generates a certain stream of earnings. However, there are an infinite number of different combinations of capital stock and other production factors that generate the same level of earnings. Capital stock can be used to determine firm value; therefore, static models without explicit production function might be not able always properly assess firm value.

In this paper, I use a dynamic partial equilibrium model developed in Karpavičius (2014) to analyze whether the conclusions of Modigliani and Miller (1958) hold in a dynamic environment. The model replicates the life and simplified behavior of a representative firm in a dynamic world and is based on the following assumptions:

- a firm's manager maximizes a certain objective function that positively depends on shareholder value;
- in each time period, the firm's manager makes several simultaneous decisions, specifically, how much capital to raise in the external equity and debt markets, how much to produce, and how much to invest in capital stock;
- a firm uses a mix of equity and debt to finance its activities;
- debt has advantages (such as tax deductibility of interest expenses and lower costs) and disadvantages (increased bankruptcy risk)[4];
- there are no agency costs of debt;
- a firm produces a single tradable final good that is sold in a competitive market;
- the relation among all endogenous variables and their dynamics are jointly determined in equilibrium.

First, I consider an environment without taxes and bankruptcy costs. I show that a firm's capital structure is relevant. Given firm characteristics, there is only one optimal capital structure. The result is in contrast to the popular interpretation of Modigliani–Miller Proposition 1 that the firm's financing policy is irrelevant. One of the determinants of optimal financial leverage is the time preferences of the firm's manager; however, risk preferences do not play any role in determining the optimal capital structure. I find that firms with more impatient managers have proportionally more debt. Prior research suggests that present-biased individuals have significantly higher amounts of credit card debt (Meier and Sprenger, 2010). Cronqvist et al. (2012) provide evidence on a positive relation between CEO personal and corporate leverage, which is consistent with behavioral consistency theory. They argue that debt averse CEOs would have less personal debt, and the firms they manage would be less levered, ceteris paribus. Taken together, more patient managers (or managers with a higher subjective discount factor) would have less personal debt, and their firms would have less debt too. The model of this paper supports this prediction. Static models by construction do not include the time preferences of the firm's manager and cannot reveal the important relation between the latter and the firm's optimal financing policy. Further, consistent with Modigliani–Miller Proposition 1, I show that WACC and the value of the firm are independent of its capital structure.

In an environment with taxes but without bankruptcy costs, the optimal capital structure is the mix of equity and debt rather than 100% debt. The results imply that the impact of taxes on the firm's optimal capital structure is less important than previously thought. Firm value and WACC are not impacted by the time preferences of the firm's manager and are constant when leverage changes. The results are not consistent with Modigliani and Miller (1958, 1963) who argue that firm value increases and WACC decreases with leverage. The results are driven by the capital stock. I show that it does not depend on the tax rate in this environment. Thus, constant value of assets leads to constant firm value in order to satisfy the balance sheet equation. This result gives us constant WACC, assuming fixed EBIT and discounted cash flow at WACC valuation model.

Further, I assume that there are bankruptcy costs but there are no taxes. I show that debt financing decreases and the optimal capital stock increases with the subjective discount factor of the firm's manager in this environment. This leads to the higher firm value as the latter is proportional to capital stock. Thus, there is a negative relation between firm value and financial leverage. Fixed EBIT and higher firm value imply that WACC decreases with the subjective discount factor of the firm's manager. Thus, the relation between financial leverage and WACC is positive. The results are in contrast to Modigliani and Miller (1958) who argue that Modigliani–Miller Proposition 1 is unaffected in this environment. However, the relation between return on equity capital and debt-to-equity ratio is expressed by a concave function, consistent with Modigliani and Miller (1958).

Lastly, I test the model's implications using the sample of US firms during the period 1992–2009. Graham et al. (2013) report that impatient CEOs receive relatively less stock, options, and bonuses, suggesting that more patient CEOs (or CEOs with the greater subjective discount factor), are more likely to be compensated via stock, options, and bonuses. Thus, I assume that the ratio of equity-based compensation to total compensation is a proxy for the subjective discount factor. The model predicts that leverage and sales-to-capital ratios decrease but firm size and capital stock increase with the subjective discount factor of the firm's manager if there are taxes

[3] A lower subjective discount factor is equivalent to a higher subjective discount rate.

[4] These features will be disabled in certain parts of the analysis.