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The impact of corporate lifecycle on Fama–French three-factor model

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HIGHLIGHTS

- This paper develops a discrete-time asset pricing model under a framework of the partial equilibrium and analyzes how the firm lifecycle impacts on the relationship between two determinates and expected stock return.
- The negative impact of firm size on expected stock returns will weaken as corporate lifecycle processes.
- The positive impact of book-to-market ratio on expected stock returns is not changing over time.

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ABSTRACT

From the Fama–French three-factor model, the expected stock return is a negative function of market value of equity (i.e., firm size), and also positive of book-to-market ratio. In this paper, we develop a discrete-time asset pricing model under a framework of the partial equilibrium and analyze how the corporate lifecycle impacts on the relationship between them. The results show that as firms become mature, the negative impact of market value of equity, which reflects the relative importance of growth options, on expected stock returns will weaken. In contrast, the positive relationship between the book-to-market ratio and expected stock returns is not changing over time. The theoretical analysis is supported by the empirical results of A-share listed firms from 1998 to 2016 in China.

1. Introduction

On the basis of capital asset pricing model [1–4] point out that in addition to the market beta, book to market ratio and market value of equity (i.e., firm size) are also the two important determinates for the cross-section of expected return. By constructing a small-minus-big portfolio factor based on firm size and a high-minus-low portfolio factor based on book-to-market ratio, and combining a market portfolio factor, they proposed a well-known three-factor model [5]. However, the mechanism behind the relationship between them remains controversial, and two points of view are broadly discussed, such as risk-based rational pricing or behavioral-based mispricing.[1]

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[1] For example, [6] pointed out that both the book-to-market ratio and the market value of equity (firm size) are related to the volatility of firm earnings. Therefore, the two determinates, especially the book-to-market ratio, reflect the financial distress risk. [7] argued that high book-to-market ratio stocks have higher expected stock return is due to the suboptimal behavior of the typical investor and not because of fundamentally risk. [8] argued that book-to-market ratio does not reflect risk but reflect investor's preferences for the "firm characteristic", investors prefer to hold growth stocks with good fundamentals, and not prefer to value stocks with poor fundamentals, resulting in high returns for high book-to-market ratio stocks.

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[9] decomposed firm assets into asset-in-place and growth options.[2] They established a discrete-time asset pricing model and pointed out that the dynamic exercising of growth options affects the risk and return of assets by changing the relative composition of assets. They also derived the theoretical relationship between expected return and book-to-market ratio and market value of equity. [10] constructed a dynamic general equilibrium production economy to explicitly link expected stock return to firm size and the book-to-market ratio. They pointed out that firm size and book-to-market ratio are correlated with the true conditional market beta and therefore appear to predict stock returns. [11] linked expected stock returns to firm size and book-to-market ratio by introducing operating leverage and finite growth opportunities. They pointed out that book-to-market effect is related to operating leverage, while firm size captures the residual importance of growth options relative to asset-in-place. In the neoclassical framework with rational expectations and competitive equilibrium, [12] demonstrated asset-in-place are much riskier than growth options, especially in bad times when the price of risk is high. Because high book-to-market stocks have more asset-in-place assets than those of low book-to-market stocks, thus investors require higher stock returns for compensation. Taken nonconvex adjustment costs and irreversibility of investment into consideration, [13] also provided a rational explanation for value premium.[3]

However, both the classical research of [9] and the various extensions of the above-mentioned research did not take the dynamic changes of the future growth opportunities and their uncertainties into consideration, thus it cannot reveal the dynamic changes of growth opportunities as well as the impact on the risk–return along with firm lifecycle. In fact, for a typical firm, the relative importance of growth options gradually declines over time, because when the firm is growing, the available growth opportunities of firms are decreasing, and asset-in-place is increasing due to the exercising of available growth opportunities. Further, since the exercising of growth opportunities convert the assets from option status with high systematic risk into underlying status with low systematic risk [14,15], the systematic risk of total assets decreases. More importantly, if the firm size reflects the relative importance of growth options, it can be expected that the impact of firm size on the expected stock return will also decline as the corporate lifecycle goes by.

Based on the model of [9], this paper expands the condition that the gradually decline of growth opportunities as corporate lifecycle progresses and studies how corporate lifecycle affects the relationship between firm size or book-to-market ratio and expected stock return theoretically. The paper also examines theoretical predictions by using a sample of Chinese listed firms during 1998 and 2016. The results show that the negative relationship between the market value of equity and the expected stock return will gradually weaken as firm become mature, and the positive relationship between book-to-market ratio and expected stock return is not change.

This paper contributes to two streams in the existing literature. First, we theoretically extend the study of the impact of book-to-market ratio and firm size on expected return from the perspective of corporate lifecycle, while other papers from the dynamic general equilibrium [10], fixed operating leverage and finite growth opportunities [11,16,17], competitive equilibrium [12], nonconvex adjustment costs [13]. Second, our paper supports for the first time a new possible mechanism about the negative relationship between firm size and expected stock return from the perspective of corporate lifecycle, although plenty of empirical research investigate the impact of firm size on the expected stock return for the Chinese stock market [18–23].

The remaining of the paper proceeds as follows: First, we construct a discrete-time asset pricing model by considering the growth opportunities decease over time and obtain the testable theoretical prediction; In Section 3, empirical design and empirical results are represented.

2. Model

Our model is related to Berk et al. [9] who developed an investment-based asset-pricing model under a framework of the partial equilibrium to analyze how firm's collection of projects determines its risk and expected return change over time. Our model is directly to analyze how the decreasing of growth options over firm lifecycle determines the changes of the explanatory power of two pricing factors, i.e. book-to-market ratio and firm size, on the risk premium of total assets.

2.1. Assumption

Following the framework of [9], we assume that a firm operates with an infinite horizon in discrete time, at each date $t \in \{0,1,2,\dots\}$ a possible project becomes available. The key assumption of our paper which different from [9] is the project arrives in each date with a probability and the probability present a decrease function over time. This assumption is motivated by [24] and [25] which shows a decline trend of firm growth opportunities over time,[4] for any time k, we define $p(k)$ as the

[2] Asset-in-place are the projects which have already invested and can generate cash flows in the future, while growth options are the investment opportunities which have not yet been invested, this paper cross use of the term of growth options or growth opportunities .

[3] Value premium refers to the high book-to-market ratio stocks have higher expected stock return than those of low book-to-market ratio stocks.

[4] There are a plenty of papers supported the evidence that the growth opportunities will decrease over firm lifecycle [26,27]. [26] found that the newly listing firms (relatively young) have more growth opportunities than non-newly listing firms (relatively mature). [27] pointed out that young firms face relatively abundant investment opportunities with limited resources, whereas mature firms have higher profitability and fewer attractive investment opportunities. Moreover, By using Tobin Q as the proxy of growth opportunities and *RT/TA* or *RT/TE* as the corporate lifecycle proxies, we find there is a negative relation between Tobin Q and *RT/TA* or *RT/TE*, it predicts that the growth opportunities show a downward trend with corporate lifecycle.