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Optimal investment of private equity ☆

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ABSTRACT

We investigate the implications of illiquidity and compensation structure on the investment decision of Private Equity (PE). We use a real option model to capture the optimal entry of PE investment for the risk-averse investors, and it shows that the illiquidity has ambiguous effects on the investment hurdle. Different from the economic implications of standard real option, our model shows that high illiquidity may accelerate or delay the investment decision. Management fees or carried interest will induce under-investment of PE. Moreover, our theoretical predictions are supported by the empirical evidence.

1. Introduction

Private Equity (PE) has emerged as an important area of economy in the last decades and managed more than $2.5 trillion (The CityUK 2010). PE accounts for a substantial share of aggregate investment and production. The decision to start a PE project is driven by, among other things, illiquidity, compensation structure and idiosyncratic risk. We investigate the implications of these factors on the investment choice. In a continuous-time model, we provide a tractable methodology for the risk-averse investors.

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For our model design, we mainly focus on two aspects: illiquidity and compensation structure. PE investment is risky due to uncertain future income. The investment objectives focus on long lock-up period projects with idiosyncratic risk such as biotechnology, medical development, nature resources and R&D. These areas are non redeployable and highly specialized. Hence, we need formulate our modeling approach for the investment behavior under illiquidity risk environment.

The second aspect is compensation structure. The investors' return from real projects depends on the final liquidation value when the projects mature and usually behaves concave. The projects mature through an initial public offering (IPO), full or partial sale to a third party or secondary buy-outs. The payoff mechanism is according to the following priority: first the preferred return for the investors to recover the initial investment and subsequent management fee, then carried interest for the managers to catch up the prescribed incentive share, finally the profit sharing between the investors and managers. This kind of compensation structure makes the option based on real investment in PE quite different with the standard real option and financial option where the typical assumption is the lump-sum payoff or a flow payoff.

In our paper, we try to focus on the following interesting questions: What is the impact of illiquidity on the optimal investment timing? How could the compensation structure affects the valuation of growth option and investment decision? To solve these questions, we need to model the decision making process of risk-averse investors in incomplete market. We extend the real option model of Miao and Wang (2007) by incorporating the illiquidity and compensation structure of PE investment. In addition, we assume that the investors could hedge the risk by the risky asset in the financial market. Hence, they not only decide the optimal timing to exercise the real option, but they also make intertemporal portfolio and consumption decisions as in Merton (1971) model.

Our model gives four main contributions. First, increasing illiquidity has an ambiguous influence on the investment timing and this is different with the standard real option theory (see Dixit and Pindyck (1994)). We find that the investment threshold is convex with duration. Second, the model indicates that the investors prefer a lower carried interest. However a smaller management fee may not be optimal for the investors. Finally, the model matches the empirical findings in Summers (1987) that the firms require a hurdle return from the new project about four times the cost.

Our research relates to the literature about real option model and its application in economy activities. For example, Brennan and Schwartz (1985) and McDonald and Siegel (1986) analyze the investment problem under uncertainty and build the standard real option model. Majd and Pindyck (1987) enrich the analysis with a time-to-build feature and consider a model of irreversible investment under uncertainty with maximal rate of investment. Pindyck (1991) review some basic models and discuss the implications that the irreversibility of investment may have for policy. Quigg (1993) use the samples from market prices to examine the empirical predictions of the real option model. Dixit and Pindyck (1994) treat the real option method as an analytical tool applied to the economy activities. Henderson (2007) and Hugonnier and Morellec (2007) analyze the investment decision under incomplete markets. Bolton, Wang and Yang (working paper) consider the irreversible investment under uncertainty for a firm facing external financing cost and extend the traditional real option model. Miao and Wang (2007) extend the standard real option approach to an incomplete markets and analyze the investment and consumption decisions. Based on the real option framework, Chen et al. (2010) explore the investment and capital structure under incomplete markets. Sorensen et al. (2014) investigate whether the performance of PE investments is sufficient to compensate investors for illiquidity, managers' compensation and idiosyncratic risks.

The remainder of the paper proceeds as follows. Section 2 presents the model. Section 3 derives the solutions. Section 4 provides the numerical results and empirical study. Section 5 concludes.

2. Model setup

We consider the investors with the investment opportunity modeled as in McDonald and Siegel (1986). At any point in time $\tau > 0$, the investors can exercise the opportunity by paying a fixed outlay $I > 0$. This cost is financed from the investors' own wealth. If there is a shortage of funds, they can borrow at the risk free rate r. Upon exercising, the investors then immediately establish a PE fund

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