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# Corporate control and real investment in incomplete markets

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## Abstract

In the standard real options approach to investment under uncertainty, agents formulate optimal policies under the assumptions of risk neutrality or perfect capital markets. However, in most situations, corporate executives face incomplete markets either because they receive compensation packages that restrict their portfolios or because cash flows from the firm's investment opportunities are not spanned by those of existing assets. The present paper examines the impact of managerial risk aversion on investment decisions when the manager is exposed to idiosyncratic risk and faces the risk of a control challenge. In the paper, the investment policy selected by the manager reflects a trade-off between his incentives to reduce risk and the need to ensure sufficient efficiency to prevent control challenges. The analysis demonstrates that risk aversion induces the manager to speed up investment, leading to a significant erosion of the value of the option to wait.

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## 1. Introduction

Since the seminal contributions of Brennan and Schwartz (1985) and McDonald and Siegel (1986), the literature analyzing investment decisions using the real option approach has developed substantially.<sup>1</sup> One of the most cited result in this literature is that, with uncertainty and irreversibility, there exists a significant option value of waiting to invest. As a consequence, firms should only invest when the asset value exceeds the investment cost by a potentially large option premium. However, the assumptions of risk-neutrality or perfect capital markets on which this result relies are not particularly relevant to most real-world environments. While large shareholders may be able to perfectly diversify their wealth, corporate executives are typically exposed to idiosyncratic risk.<sup>2</sup> As a result, their policy choices should reflect their attitude towards risk.

In this paper, we show how managerial risk aversion can affect investment policy and firm value when managers face incomplete markets. To make the intuition as clear as possible, we use a simple generalization of the standard McDonald and Siegel (1986) framework in which the manager is exposed to idiosyncratic risk and cannot undo this exposure by trading in the firm's assets. In that model, the firm has perpetual rights to a project and seeks to determine the investment date that maximizes the value of the project. In addition, "risk aversion by investors is introduced [...] by supposing that options to invest are owned by well-diversified investors, who need only be compensated for the systematic component of the risk of projects and options to invest." Within the present paper, the decision maker faces incomplete markets and cannot eliminate idiosyncratic risk. Therefore, he requires compensation for both idiosyncratic and systematic risks.

The derivation of the results in the paper proceeds in two steps. The first step solves the portfolio policy of the manager and derives his indirect utility of wealth. The second step examines the impact of risk aversion and market incompleteness on investment decisions. To get conservative estimates of the distortions implied by managerial risk aversion, we allow the manager to reduce his risk exposure in two ways. First, the manager can invest in the market portfolio and a risk-free asset. Second, he can select the timing of investment, thereby affecting firm risk. In addition, we presume that when the policy choices of the manager erode firm value, the manager can face the threat of a control challenge and incur a cost that increases with deviations from value-maximization in investment policy.

The analysis in the paper reveals that when the manager has control rights over investment policy, his investment decisions reflect a trade-off between his incentives to invest early to reduce idiosyncratic risk and the need to ensure sufficient efficiency to prevent costly control transactions. The paper also demonstrates that managerial

<sup>1</sup>Dixit and Pindyck (1994) survey early real options models. Recent developments include the impact of competition (see Grenadier, 2002), financial leverage (Hennessy, 2004), learning (Descamps et al., 2004), liquidity (Mello and Parsons, 2000), macroeconomic conditions (Guo et al., 2005), and agency (Grenadier and Wang, 2005).

<sup>2</sup>Exposure to idiosyncratic risk may arise because the cash flows from the firm's projects are not spanned by those of existing assets, because of transaction costs, or because of compensation packages.

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