

Real options, irreversible investment and firm uncertainty: New evidence from U.S. firms

Laarni T. Bulan*

Brandeis University International Business School, 415 South Street MS 032, Waltham, MA 02454, USA

Received 26 November 2003; received in revised form 16 April 2004; accepted 12 September 2004

Available online 24 March 2005

Abstract

This paper investigates real options behavior in capital budgeting decisions using a firm-level panel data set of U.S. companies in the manufacturing sector. Specifically, this paper looks at the relationship between the firm's investment to capital ratio and total firm uncertainty, measured as the volatility of the firm's equity returns. Total firm uncertainty is decomposed into its market, industry and firm-specific components. Given that the irreversibility of capital is derived from asset-specificity at the industry level, increased industry uncertainty displays a pronounced negative effect on firm investment consistent with real options behavior. Increased firm-specific uncertainty is also found to depress firm investment—a result that can be attributed to real options behavior and not just managerial risk aversion. The results are robust to various specifications that control for the firm's investment opportunities that are captured by Tobin's q , cash flow, marginal profitability of capital and firm leverage.

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JEL classification: G31

Keywords: Real options; Irreversible investment

1. Introduction

What is it about real options that has made it a buzz word on the *Street*? Why is it that real options theory has caught the attention of academics and practitioners alike? In a survey of corporate finance practices in the U.S., [Graham and Harvey \(2001\)](#) find that more than 70% of the CFOs surveyed rely on

* Tel.: +1 781 736 2294; fax: +1 781 736 2269.

E-mail address: lbulan@brandeis.edu.

discounted cash flows and the Capital Asset Pricing Model (CAPM) for their capital budgeting decisions. Despite the popularity of Net Present Value (NPV), it has long been acknowledged that it fails to capture an important feature of the investment decision—that of managerial flexibility in a dynamic and uncertain environment. Among the various methods that have been devised to address this shortcoming of the NPV model, the use of option-pricing techniques holds the most promise. In contrast to the static NPV invest-now-or-never rule, real option methods maximize the value of the investment opportunity, i.e. maximize the value of a call option.¹

The ability to delay investment decisions is valuable when the investment is irreversible and the future is uncertain. The irreversibility of investment expenditures stems from capital specificity at the industry level and/or at the firm level.² If managers can wait for the resolution of uncertainty before deciding to pursue the irreversible investment, they can avoid potentially large losses by foregoing the investment altogether when the outcome is unfavorable. Hence, a familiar result from option-pricing applies to irreversible investments: the greater the uncertainty in an investment's expected future cash flows, the more valuable is this option to delay the investment. This in turn reduces the incentive for exercising the option today.

This paper investigates real options behavior in capital budgeting decisions of U.S. companies in the manufacturing sector. In particular, this paper tests whether real options models can explain the relationship between firm investment and uncertainty. Although a majority of firms may not actually be employing real options techniques yet, McDonald (2000) points out that arbitrary methods such as hurdle rates and profitability indexes can actually approximate the optimal decision under real options, i.e. the same factors that increase the value of the option to delay investment also increase firm hurdle rates and profitability requirements.

By improving on the empirical methods of prior studies, this paper provides substantial evidence at the firm-level and makes two significant contributions towards finding support for real options behavior of firm managers. First, the approach taken in this paper is to use an “asset-pricing” model to decompose the total uncertainty faced by an individual firm into its systematic and firm-specific components and then relate these measures to the firm's investment behavior. The traditional view asserts that it is only systematic risk (e.g. market uncertainty under the CAPM), as it affects the firm's cost of capital, that should matter for firm investment. Real options models predict the contrary, that it is total risk or total firm uncertainty that should matter for firm investment. By decomposing risk in this manner, we can identify whether firm-specific risk adds value through the firm's investment (or growth) options and hence, identify whether it influences investment decisions. Second, in addition to a market component, total firm uncertainty is decomposed further to account for the effect of industry-wide variations. Distinguishing between industry uncertainty and firm-specific uncertainty is important for irreversible investments. Dixit and Pindyck (1994) argue that the irreversibility of capital is more pronounced at the

¹ McDonald and Siegel (1986) present a tractable solution to the valuation of an option to invest in an irreversible project. Early work in this area include Baldwin (1982), Bernanke (1983) and McDonald and Siegel (1985). Titman (1985) specifically focuses on the valuation of land while Brennan and Schwartz (1985) evaluate investments in natural resource projects.

² See Dixit and Pindyck (1994), McDonald and Siegel (1986) and Pindyck (1988). Homogeneous capital goods that are not industry or firm-specific (such as office equipment) are still partially irreversible because of the lemons problem. Abel, Dixit, Eberly, and Pindyck (1996) and Abel and Eberly (1994) define partial irreversibility (or costly reversibility) as the case when the purchase price of capital is greater than its resale price.

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