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Individual preferences and the effect of uncertainty on irreversible investment☆

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Abstract

This paper considers a relationship between investment behavior and an agent's preferences in a stochastic one-sector growth model with irreversible investment. Further, it explores the effect of uncertainty in investment policies by using a non-expected utility function. Since uncertainty has an impact on investment policies not only through an option value but also through a risk-adjusted time preference rate in a general equilibrium framework, it is significant to distinguish the two preference parameters of the agent. While the previous partial equilibrium models with irreversible investment have exhibited a negative relationship between the desired capital stock and uncertainty, this paper implies that it is possible to generate a positive relationship for the appropriate parameters. This shows that the results of Hartman and Abel have been robust even in a general equilibrium model.

Keywords: Irreversible investment; Relative risk aversion; Intertemporal elasticity of substitution

1. Introduction

This paper considers a relationship between investment policies and an agent's preferences in a stochastic one-sector growth model with irreversible investment. In particular, we focus on investment policies in a general equilibrium framework. The main objective of this paper is to examine the impact of uncertainty in investment behavior in a general equilibrium model with irreversible investment. Pommeret (2002) shows that uncertainty affects the optimal decision of irreversible investment through two transmission channels in a general equilibrium framework: one is an option value, and the other is agent's preferences. However, he does not distinguish the effect of the two preference parameters of the agent because he adopts the constant relative risk aversion (CRRA) utility function. We analyze the effect of uncertainty in investment policies by using a non-expected utility function by

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Epstein–Zin/Kreps–Porteus, which enables us to shed light on the relationship between irreversible investment and uncertainty in a general equilibrium framework.

Let us consider the previous literature regarding the relationships between uncertainty and irreversible investment. Arrow (1968) has been an early and prominent publication introducing the concept of irreversibility.[1] Once investments are undertaken and capital equipment is built by a firm, it may be difficult to recover the investment costs and break down the equipment even if the firm desires to withdraw from the enterprise later. In other words, there exist sunk costs; thereby, investments contain the characteristic of irreversibility.

Hartman (1972) has shown that increased output price uncertainty leads to a competitive risk-neutral firm, which faces convex adjustment costs to increase its investment in a discrete-time dynamic model without irreversibility. Abel (1983) has verified that the result of Hartman (1972) also holds by using a continuous-time setting in which price follows a geometric Brownian motion with mean zero. These Hartman–Abel paradoxical results, wherein investment increases as uncertainty increases, are interesting and probably against our common sense; however, they are robust since the profit function is convex for output price. In reality, Ferderer (1993) and Leahy and Whited (1996) have found empirical evidence for the negative relationship between investment and uncertainty, considering the partial equilibrium model with irreversibility or the industry equilibrium model with irreversibility.

Recently, there have been numerous papers on a partial equilibrium model with irreversible investment. McDonald and Siegel (1986) is a seminal paper that introduces irreversibility into the partial equilibrium model of a firm, studying an optimal timing of one-time-only investment in an irreversible project by means of the optimal stopping of dynamic programming. They have shown that in the case of reasonable parameter values, it is optimal to wait until the benefits are twice the investment costs. Pindyck (1988) has applied the option pricing technique to incremental investments and capacity choices. In general, it is believed that uncertainty causes firms to decrease investments in the partial equilibrium model with irreversibility.[2]

In contrast, with regard to general equilibrium literature with irreversibility,[3] there exist few papers. A general equilibrium approach to irreversible investment is not new [a paper by Dumas (1989) is usually credited for being the first such study; since then, other studies have adopted a similar approach]. However, the research on irreversible investment has developed mostly by using a partial or industry-level equilibrium approach. Faig (2001) has provided analytical results that explain the contrast between the consequences of investment irreversibility for individual firms and those of irreversibility on the effective wealth of consumers and the return on assets. Faig (2001) has also shown that as long as the intertemporal elasticity of substitution is realistically low (less than one), the investment irreversibility not only prevents capital destruction but also induces capital creation. However, Faig (2001) has not considered the effect of uncertainty in the capital stock in terms of long-run periods. While our paper considers a persistent macroeconomic uncertainty, Gilchrist and Williams (2000) have exhibited a general equilibrium model with a non-persistent idiosyncratic shock and irreversible investment. In such a model, uncertainty reduces the idiosyncratic investments but encourages aggregate investments. In Faig (2001) and Gilchrist and Williams (2000), although uncertainty reduces investments at the firm level, it increases investment at the entire economy level. This result is achieved by assuming that shocks are transitory. After all, even today, the situation is such that the effect of uncertainty in investments is ambiguous in a general equilibrium framework with irreversible investment. A major portion of the papers pertaining to a general equilibrium framework with irreversible investment applies to numerical analysis and simulation techniques.[4] Kogan (2001) has proposed a general equilibrium model of a two-sector production economy with irreversible investment. He implies that the relationship between uncertainty and capital stock is ambiguous. Hugonnier et al. (2005) show that the general equilibrium feedback effects of lumpy

[1] Nakamura (1999) has expressed that irreversibility can be considered as a special case of asymmetric costs wherein the downward cost is infinite.

[2] With regard to a firm's decision of irreversible investment under uncertainty, Dixit and Pindyck (1994) is an excellent comprehensive book. See also Harison (1990). See Leahy (1993) with regard to the industry dynamics. Recent development in this literature includes the impact of learning (Decamps and Mariotti, 2004) or competition (Grenadier, 2002) on the timing of investment. See Guo et al. (2005) for cyclical variations in investment. See also Cooper (2006).

[3] Van and Vailakis (2003) and Jamet (2004) introduce heterogeneous agents into a general equilibrium model with irreversible investment.

[4] For instance, see Dow and Olson (1992), Ejarque (1998), and Coleman (1997). Coleman (1997) has examined the behavior of the real interest rate in a general equilibrium multi-sector model with irreversible investment. It is also shown that, because of the desire to smooth consumption, in the case of irreversible investment, a rise in uncertainty concerning the future return to capital tends to lead to more current investments and a lower real interest rate.