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Irreversible investment with regime shifts

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Abstract

Under the real options approach to investment under uncertainty, agents formulate optimal policies under the assumption that firms' growth prospects do not vary over time. This paper proposes and solves a model of investment decisions in which the growth rate and volatility of the decision variable shift between different states at random times. A value-maximizing investment policy is derived such that in each regime the firm's investment policy is optimal and recognizes the possibility of a regime shift. Under this policy, investment is intermittent and increases with marginal q. Moreover, investment typically is very small but, in some states, the capital stock jumps. Implications for marginal q and the user cost of capital are also examined.

JEL classification: D92; E22; E32

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1. Introduction

The notion that regime shifts are important in explaining the cyclical features of real macroeconomic variables as proposed by Hamilton [15] is now widely accepted. Motivated by anecdotal evidence, a pervasive manifestation of this view is that regime shifts, by changing firms growth prospects, affect capital accumulation and investment decisions. On economic grounds, there are indeed reasons to believe that regime shifts contain the possibility of significant impact on firms policy choices. For example, business cycle expansion and contraction "regimes" potentially have sizable effects on the profitability or riskiness of investment and, hence, on firms' willingness to invest in physical or human capital. Yet, despite these potential effects, we still know very little about the relation between regime shifts and investment decisions.

The idea that shifts in a firm's environment can have first-order effects on its investment policy can be related to the burgeoning literature on investment decisions under uncertainty (see the survey by Dixit and Pindyck [9]). In this literature, investment opportunities are analyzed as options written on real assets and the optimal investment policy is derived by maximizing the value of the option to invest. Because option values depend on the riskiness of the underlying asset, volatility is an important determinant of the optimal investment policy. Despite this observation, models of investment decisions typically presume that this very parameter is fixed. It is not difficult to imagine however that as volatility changes over the business cycle, so does the value-maximizing investment policy.

This paper develops a framework to study the behavior of investment when the dynamics of the decision variable are subject to discrete regime shifts at random times. Following Hamilton, we define shifts in regime for a process as "episodes across which the behavior of the series is markedly different". To emphasize the impact of regime shifts on investment decisions and capital accumulation, we construct a simple model of capacity choice that builds on earlier work by Pindyck [26] and Abel and Eberly [3]. Specifically, we consider an infinitely lived firm that produces output with its capital stock and variable factors of production. The price of the firm's output fluctuates randomly, yielding a stochastic continuous stream of cash flows. At any time t, the firm can (irreversibly) increase capacity by purchasing capital. Investment arises when the marginal valuation of capital equals the purchase price of capital.

Models of investment decisions under uncertainty generally presume that the firm's operating profits are subject to a multiplicative shock that evolves according to a geometric Brownian motion.[1] Implicit in this modeling is the assumption that the

[1] Statistical tests of the option theory of irreversible investment typically are specified under this assumption (see for example [18]). In fact, Harchaoui and Lasserre note that "the empirical experiment in which agents respond to changes in α [the drift rate] or σ [volatility]" cannot be experimented within their econometric model because the theoretical model does not yield any analytical solution for this underlying process. In this paper, we provide such a solution. In his survey paper, Chirinko [8, pp. 1905–1906] also points out the importance of the time-varying volatility for the econometric specification of investment equations.