Co-Investment Games between
Supply Chain Parties with Interdependent Infrastructure

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Key words: Supply Chain Management, Differential Games, Investment, Optimal Control.

Abstract

The ability to collect detailed information about customer behavior and the ease of communication due to new technologies (including Internet and IT) have motivated extensive research into dynamic decision making in general and continuous-time production, pricing and investment strategies in particular. The carry over to investments in supply chain infrastructures by interacting firms, sharing wholly or partly common goals and information has not received any particular attention however.

This paper considers co-investment in a supply chain infrastructure using an inter-temporal model. We assume that firms’ capital is essentially the supply chain’s infrastructure. As a result, firms’ policies consist in selecting an optimal level of employment as well as the level of co-investment in the supply chain infrastructure. Several applications and examples are presented and open-loop, as well as feedback solutions are found for non-cooperating firms, long- and short-run investment cooperation and non-simultaneous moves.

In particular, we show that a solution based on Nash and Stackelberg differential games provides the same level of capital investment. Thus, selecting the leader and the follower in a co-investment program does not matter. Furthermore, we show that in general, co-investments by firms vary both over time and across firms, and thereby render difficult the implementation of co-investment programs for future capital development. To overcome this problem, we derive conditions for firms’ investment share to remain unchanged over time and
thus be easily planned. This ensures a certain sustainable level, $K$, of infrastructure capital. We demonstrate that when the infrastructure capital is different from $K$, two approaches are possible to attain steady investments.

The first approach is non-cooperative. If the parties do not cooperate, then the supply chain attains a stationary investment equilibrium as the investment period tends to infinity. To determine whether such an equilibrium exists, systems of equations are constructed which provide open- and closed-loop Nash equilibria. The other approach consists in using open-loop policies for cooperating, which can be short- and long-run. An ultimate way of short-run cooperation is a one-time partnership. We show that even if competing firms are able to cooperate only in a short run, there exists a one-time investment such that the firms can reach a stationary Nash equilibrium in no-time and stay there infinitely long.