Strategic incentives in dynamic duopoly ☆

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Abstract

We compare steady states of open loop and locally stable Markov perfect equilibria (MPE) in a general symmetric differential game duopoly model with costs of adjustment. Strategic incentives at the MPE depend on whether an increase in the state variable of a firm hurts or helps the rival and on whether at the MPE there is intertemporal strategic substitutability or complementarity. A full characterization is provided in the linear-quadratic case. Then with price competition and costly production adjustment, static strategic complementarity turns into intertemporal strategic substitutability and the MPE steady-state outcome is more competitive than static Bertrand competition.
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1. Introduction

Much progress has been made in the study of dynamic interaction among firms, particularly in the study of collusive behavior. Quite a few models of strategic

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noncollusive rivalry have been developed that also consider Markov perfect equilibria as solution concept. However, owing to the inherent difficulty of analyzing fully dynamic models, two-stage models continue to be the workhorse of the analysis.

In this paper we provide a taxonomy of strategic incentives arising in duopolistic interaction over an infinite horizon in the presence of adjustment costs. Adjustment costs are important in quite a few industries as evidenced by several empirical studies at the micro level.[1] Indeed, capacity (or the production run) is costly to adjust in some industries; in others, because of menu costs, it is prices that are difficult to adjust. Adjustment cost dynamics are typically rich in that they depart from the repeated game framework, allow commitment possibilities, and make the steady-state outcomes different from the outcomes of static competition. The presence of adjustment costs, for example, must be taken into account when estimating the degree of product differentiation in a market. This is so because the standard hypothesis of static Bertrand pricing will not hold if either production or prices are costly to adjust and estimation results that take no account of this adjustment will be subject to bias. Dynamics with adjustment costs are also critical for characterizing such macro phenomena as the dynamics of aggregate investment or the effect of monetary policy on price levels and inflation.[2]

The analysis is cast in the context of a differential game of a duopoly market with differentiated products. The presence of adjustment costs will imply that a firm will have incentives to behave strategically (e.g., trying to condition rival's responses) and to depart from the naive optimization of a firm that does not try to influence future market outcomes. Strategic incentives will be characterized by comparing trajectories and steady states of open loop and Markov perfect equilibria (MPE) of the dynamic game. Our aims may be listed as follows.

- Establish an infinite-horizon differential game counterpart of the classification by [21] of strategic incentives in two-stage games.[3]
- Provide a complete characterization of the linear-quadratic case-extending previous work of [38,14], who examined the case of Cournot competition with production adjustment costs.
- Explain the role of adjustment costs in preserving, or reversing, short-run (static) strategic substitutability or complementarity in the intertemporal framework.
- Provide a dynamic equilibrium rationalization of the "Stackelberg warfare point" [46], showing that the outcomes of dynamic interaction need not lie between the

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[1] See, for example, [24]. Hall [23] provides recent evidence on adjustment costs. For the empirical implementation of dynamic models with adjustment costs (and evidence of adjustment factors in the rice and coffee export markets) see [27–29]. Slade [44] provides estimates of price adjustment costs in the retail grocery sector.

[2] See, for example, [7,40].

[3] See also [9]. Lapham and Ware [31] provide a taxonomy of the strategic incentives in discrete time dynamic games for small adjustment costs. Benoit and Krishna [4] and Davidson and Deneckere [12] analyze strategic incentives in the choice of capacity followed by collusive pricing supported with repeated competition.