Simulating corporate dynamics via the Rulkov map

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Abstract. This paper deals with corporate dynamics as they emerge from mutual interaction between firms competing on the market. As it is commonly observed, corporate dynamics may oscillate between periods of fierce competitions and calmer periods when companies settle in their niche. This is much like mutual synchronization and chaos regularization of bursts in a group of chaotically bursting cells modelled by the Rulkov map. This paper supports the idea that nature is governed by simple laws from physics to engineering, from biology to economics. For this reason the Rulkov map may be applied to economics for describing corporate dynamics.

Introduction

Corporate dynamics are the results of complex interactions between firms and subject to the law of demand and supply. Those dynamics are nonlinear and display oscillations. Monopoly is when a single firm controls the market. Duopoly is when two firms share the control. The latter may consists of different equilibria: from an equilibrium in which consumers' demand is split evenly between the two firms to a scenario in which one firm dominates the other. Duopoly has been extensively studied in economics and game theory and typically fall either under the Cournot model (where the two firms take the competitor's output as fixed) or under the Bertrand model (where the two firms take the competitor's price as fixed) [6]. Those models assume homogeneous good market with constant marginal costs and uncertainty regarding rivals' costs. This implies that marginal and average costs are equal. So, even there is a strong incentive to collude, the equilibrium is when price equal marginal cost as in perfect competition. Samuelson demonstrated that "non-trivial subgame perfect duopoly equilibria can be supported by continuous reaction functions when previous-period actions of both firms are arguments of reaction functions" [5].

Results and discussion

The Rulkov map is a two-dimensional map introduced by Nikolai F. Rulkov to model biological neurons that displays chaotic bursting behaviour [4]. Apart from the computational advantage, the said map is able to synchronize and regularize bursts in a group of chaotically bursting entities [2]. To this end, Rulkov map may be applied to account for mutual synchronization and chaos regularization of activity bursts in a group of chaotic competing firms. While the first dimension may represent the instantaneous activity of firms the second can model the trend. Fig. 1 displays the phase space in case of duopoly as modelled with Rulkov chaotic neurons [3] interacting via symmetrical reaction functions. In fact, coupled Rulkov maps have been used for analysing cooperative dynamics [1]. The said interaction shows transitions between stationary, periodic, quasiperiodic, and chaotic regimes.

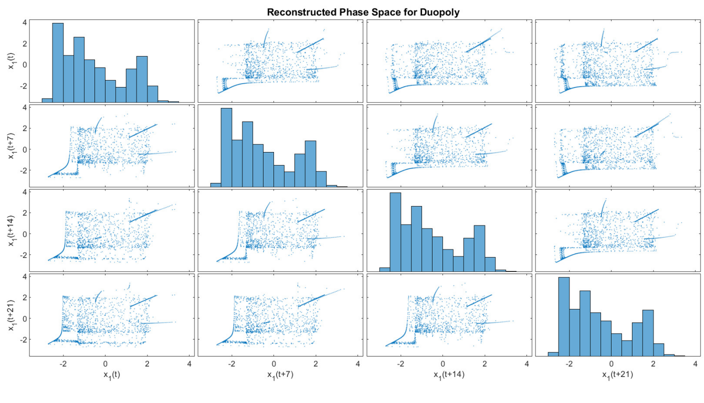

Figure 1: Reconstructed phase space for perfect duopoly equilibria *à la* Samuelson where firms' reaction functions are simulated via a coupled symmetrical Rulkov map.

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