Modelling instability via a generalized Rulkov map: bursts, synchronization and chaos regularization in financial markets

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The Rulkov map has been successfully employed for describing bursts, mutual synchronization and chaos regularization in biology. Then, its applications have been extended to physics, engineering, medicine, etc. In this work we find an application of a generalized Rulkov map to finance where the impact of COVID-19 can be clearly seen in the considered dataset. We examine the Financial Stress Index as well as a number of time series diversified by asset classes (swaps, equity and bonds), market (emerging vs developed), issuer (corporate vs government bond), maturity (short vs long). We find that a calibration of a single Rulkov map or of coupled Rulkov maps could describe the alternation between calm periods and financial turmoil (including a black swan) as well the synchronizing mechanism operating across markets. This result is compared to the so-called Naive and the ARIMA-GARCH model to determine how a chaotic deterministic model stands with respect first to a simple model and, second, to an advanced stochastic model expressly designed for handling moving average, autoregression, cointegration and heteroscedastic volatility.
Finally, we give some theoretical considerations about the stability of the nonlinear system described by our generalized Rulkov map.