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Regime switching continuous time Markov chains.

We study estimation and calibration of continuous time Markov chains (CTMC) aiming at modelling Health Insurance and Long Term Care products as done in [1]. Previously, we study the sensibility of a CTMC to a change on the structure of the intensity matrix governing the Kolmogorov equations. As part of this study we develop regime switching for CTMC, along the lines of regime switching for ordinary differential equations presented in [2], considering gluing different intensities matrices in different interval components of time interval where we study the CTMC.

Theorem [Regime switching Markov chains: existence] *Let $\mathbf{Q}_1(t)$ defined for $t \in [0, t_1]$ and $\mathbf{Q}_2(t)$ defined for $t \in [t_1, T]$, two intensities matrices. Then, there exists $\tilde{\mathbf{P}}(t)$ such that:*

1. *in $[0, t_1]$ we have that $\tilde{\mathbf{P}} \equiv \mathbf{P}_1$ where \mathbf{P}_1 is a solution of the Cauchy problem $\mathbf{P}'_1 = \mathbf{P}_1 \mathbf{Q}_1$ with the usual initial conditions;*
2. *in $[t_1, T]$ we have that $\tilde{\mathbf{P}} \equiv \mathbf{P}_2$ where \mathbf{P}_2 is a solution of the Cauchy problem $\mathbf{P}'_2 = \mathbf{P}_2 \mathbf{Q}_2$ with the initial conditions given by $\mathbf{P}_1(t_1)$;*
3. *$\tilde{\mathbf{P}}$ is a transition probability matrix.*

We also present numerical studies detailing the solution of several examples of regime switching Markov chains.

REFERENCES

- [1] M. L. Esquível, G. R. Guerreiro, M. C. Oliveira and P. Corte Real (2021) Calibration of Transition Intensities for a Multistate Model: application to Long-Term Care. *Risks*, **9**(2):37 1–17.
- [2] M. L. Esquível, N. P. Krasii and G. R. Guerreiro, and P. Patrício (2021) The multicompartment SI(RD) model with regime switching: an application to COVID-19 pandemic. *Symmetry*, **13**(12):2427–2450 .