# Markov regime-switching model

This subsection contains the details of the Markov-Regime-Switching model. Our aim is to estimate the probability of an influenza pandemic period starting (i.e. a pandemic occurring) and the probability of exiting the period of post-pandemic period of increased risk of disease outbreaks. We assume that annual mortality rates follow a log-normal distribution.[[1]](#footnote-1)

where the mean and variance of the underlying distribution is allowed to vary between the two distinct regimes of periods of low and high disease outbreak risk, r = {1,2}.

Markov-Regime-Switching models have been used to analyse business cycle behaviour (Hamilton (1989), Doornik (2013)) and also in the detection of infectious disease outbreaks (Martínez-Beneito et al. (2008), Unkel et al. (2012)).

We test the assumption of two regimes versus a single regime, by performing a quasi-likelihood test for regime-switching models based on Bostwick and Steigerwald (2014) and reject at the 1% level the null hypothesis that the variation in the data is explained by only one regime. The table below shows the results from estimating the Markov-Switching model with two regimes and Table 2 shows the implied properties of each mortality regime in each case.

Table 1: Two disease outbreak regimes – MS model estimates

|  |  |  |  |
| --- | --- | --- | --- |
| Glasgow 1907 - 1972 | Coefficient | Std. Error | 95% Confidence Interval |
| μ₁ | 4.11 | 0.119 | [3.87, 4.34] |
| μ₂ | 5.55 | 0.192 | [5.17, 5.93] |
| σ₁ | 0.74 | 0.083 | [0.60, 0.92] |
| σ₂ | 0.85 | 0.125 | [0.64, 1.13] |
| p₁₁ | 0.98 | 0.021 | [0.85, 0.99] |
| p₂₁ | 0.05 | 0.044 | [0.01, 0.24] |

Log Likelihood -83.856, 1% critical value: 7.8184, value of test statistic: 25.9288

Table 2: Characteristics of mortality regimes

|  |  |  |  |
| --- | --- | --- | --- |
| Glasgow 1907 - 1972 |  |  | exp. duration |
| Regime I | 80 | 68 | 50 |
| Regime II | 369 | 380 | 20 |
|  |  |  |  |

Expectation and standard deviation of mortality rates based on point estimates in Table 1.

# References

Bostwick, V. K., & Steigerwald, D. G. (2014). Obtaining critical values for test of Markov regime switching. *The Stata Journal*, *14*(3), 481-498.

Doornik, J. A. (2013). A Markov-switching model with component structure for US GNP. *Economics Letters*, *118*(2), 265-268.

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica: Journal of the econometric society*, 357-384.

Martínez‐Beneito, M. A., Conesa, D., López‐Quílez, A., & López‐Maside, A. (2008). Bayesian Markov switching models for the early detection of influenza epidemics. *Statistics in medicine*, *27*(22), 4455-4468.

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1. The log-normal has a long right tail which makes it suitable to approximate the distribution of mortality from infectious diseases. [↑](#footnote-ref-1)