On the use of Statistical Process Control in Monitoring Mortality. An Application to European Countries
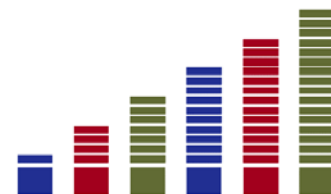
Speed Talk Session 4

Ana Debón, Vicent Giner-Bosch, Majarlika Cabrerizo-Cabanos

Universitat Politècnica de València

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Contents

1. Introducción
2. Methodologhy
3. Application to European countries
- Results for each country
- Results for clustering: Eastern Europe and Western Europe
4. Conclusions
5. References

Introduction

[Motivation](#)

- Notable progress in health in recent decades.
- Different causes of mortality between developed and developing countries.
- EUROPE: Great variability between mortality rates of the countries that compose it

[Main objetive](#)

In this work, we address the study of the trend of the European mortality by means of Standard Mortality Ratio (SMR).

SMR: the ratio of the actual number of deaths in studied population A to the number of deaths that would be expected to in population A if it experienced the age-specific death rates of the standard population.
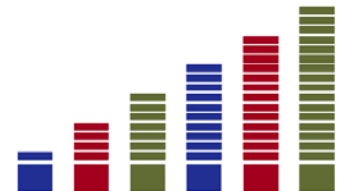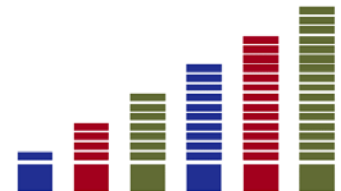
Methodology

Statistical tools

- Time series
- Control Charts

The joint use of time series and statistical process control (SPC) techniques to model and monitor the behavior of the SMR is explored (Knoth and Schmid, 2004).

Specific objetives

- Analysis of the SMR time series for each European Country.
- The use of control chart to detect trend changes in mortality.

Data

- Time period: from1990 to 2009

- 26 European Countries: Austria, Belarus, Belgium, Czech

Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom and Ukraine.

- Database: Human Mortality Database (Human Mortality Database, 2015).

Software

Free statistical software R, R-packages

such as tseries (Trapletti and Hornik,

2015) for time series, and qcc (Scrucca,
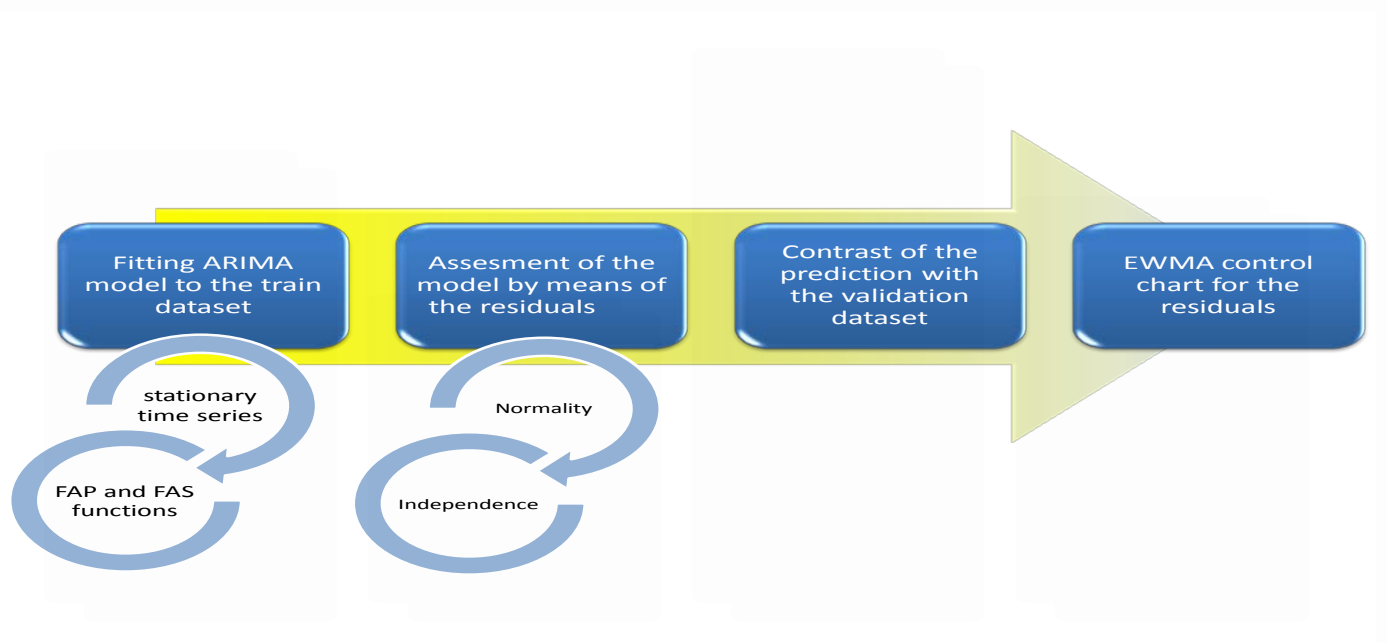
2004) for control charts.
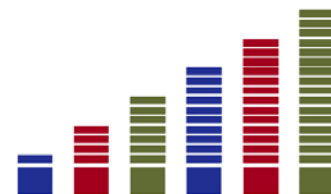
Hold out

- Train dataset: 15 first observations
- Validation dataset: 5 last observations

Procedure

| Fitting ARIMA model to the train dataset | Assesment of the model by means of the residuals | Contrast of the prediction with the validation dataset | EWMA control chart for the residuals |

stationary time series

Normality

FAP and FAS functions

Independence

Results for each country

- Countries with SMR lower than 1: Germany, Austria, Belgium, Denmark, Spain, Finland, France, Netherlands, Ireland, Italy, Luxembourg, Norway, Portugal, United Kingdom, Sweden and Switzerland.
- Countries with SMR greater than 1: Belarus, Slovenia, Slovakia, Estonia, Hungary, Latvia, Lithuania, Poland, Czech Republic and Ukraine.
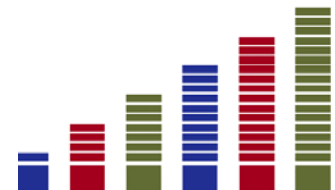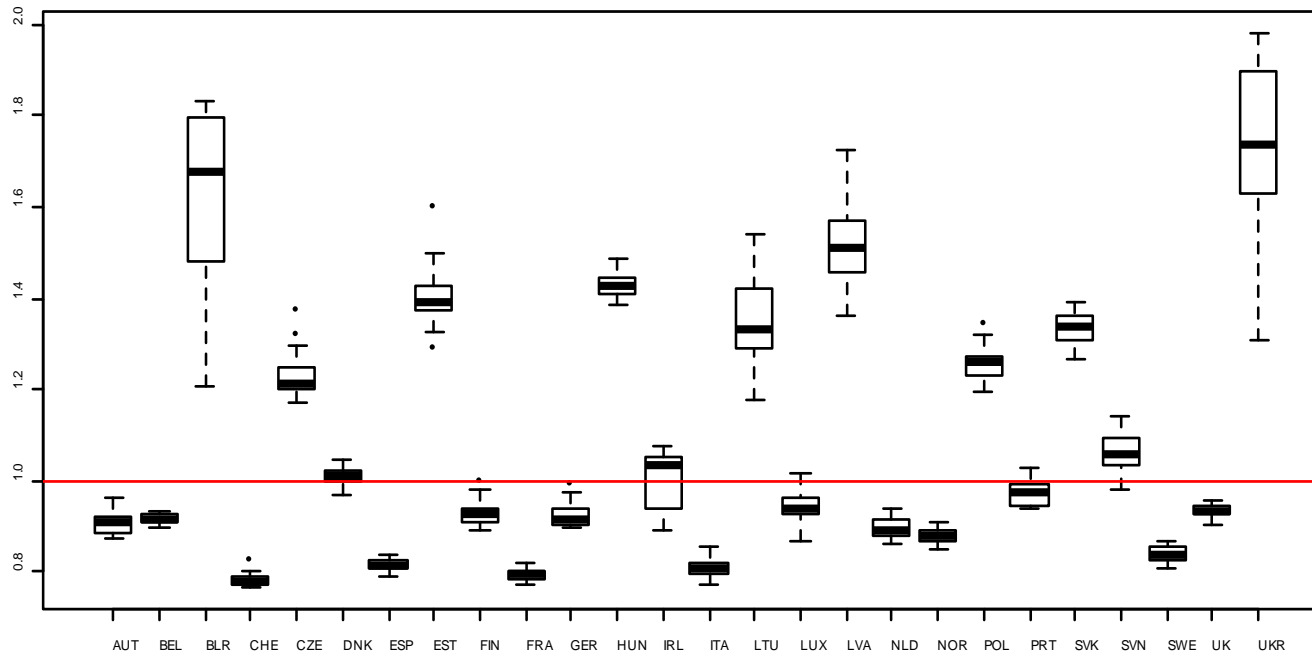
Results for cluster

Different behaviour betweem Eastern Europa and Western
Europa

- Different traditions and culture.

- Disparate Economic and social development (Herta Gongola, 2004).
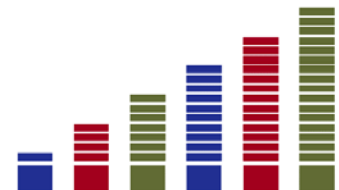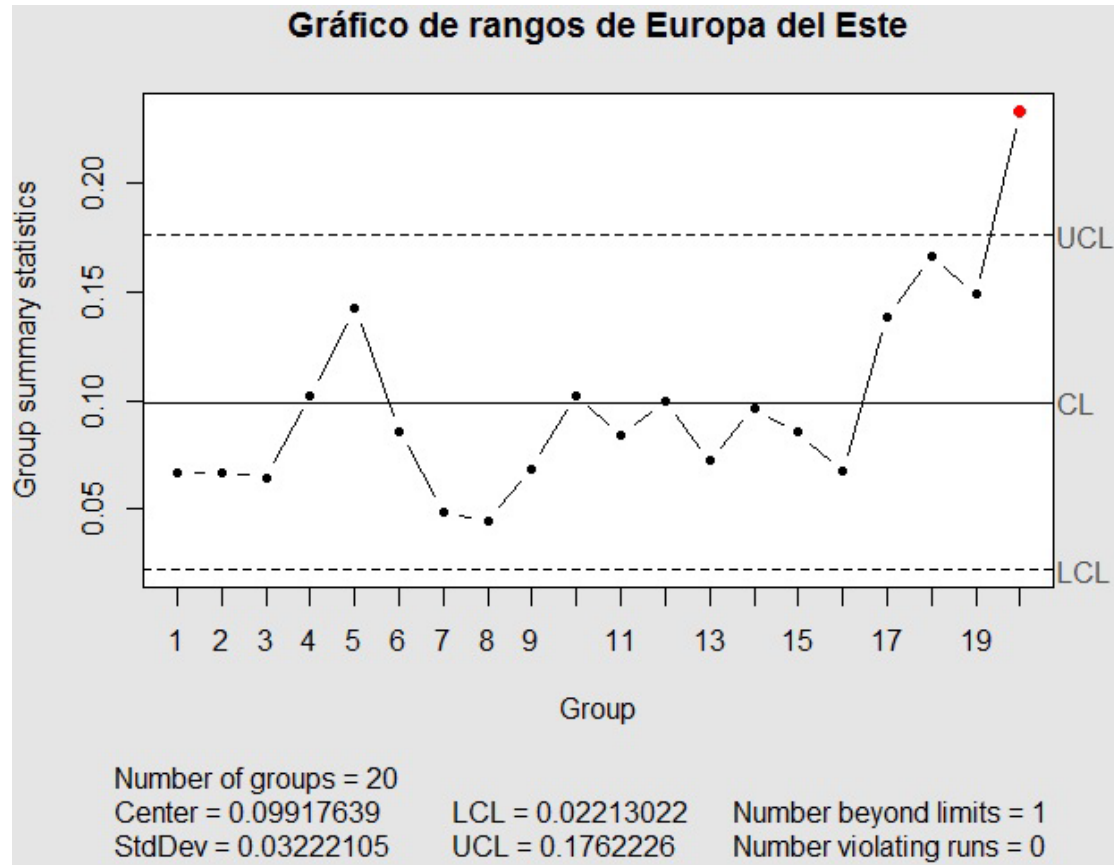
- Example: Contrast for levels of SMR.

Clusters

- Western Europa: Portugal, Spain, France, Switzerland, Italy, Austria, Luxembourg, Belgium, Germany, Netherlands, Denmark, Sweden, United Kingdom, Ireland, Norway and Finland.

- Eastern Europa: Estonia, Latvia, Lituania, Polonia, Belarus, Ukraine, Czech Republic, Slovakia, Hungary, Slovenia.

Application to Eastern Europe

Control chart for residuals range: Large differences of SMR in 2009 between countries of the Eastern Europe region.

Gráfico de rangos de Europa del Este

Number of groups = 20
Center = 0.09917639
StdDev = 0.03222105
LCL = 0.02213022
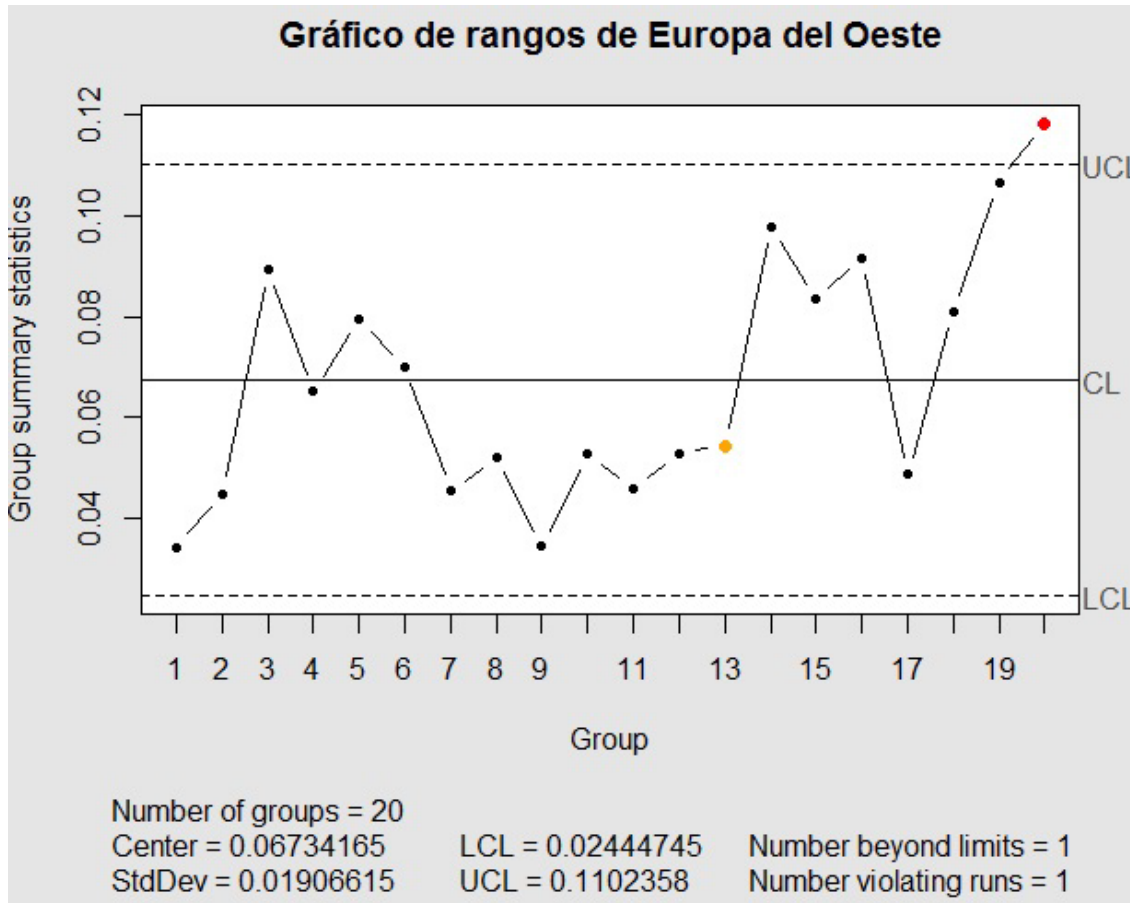UCL = 0.1762226
Number beyond limits = 1
Number violating runs = 0

Application to Western Europe

Control chart for residuals range: Large differences of SMR in 2009 between countries of the Western Europe region; in addition, a sequence of 7 observations with same sign (1997-2003).

Gráfico de rangos de Europa del Oeste
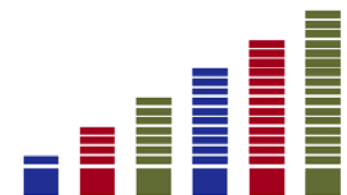
Conclusions

- Combined use of time series and control charts EWMA to monitor mortality on residuals of the time series adjusted to SMR. The methodology used to detect possible situations in which the behavior of mortality of countries, is changing with respect to the predictable.

- 11 out of the countries considered show the expected behavior outside limits: Estonia, France, Netherlands, Hungary, Ireland, Italy, Latvia, Lithuania, United Kingdom, Czech Republic and Ukraine.

- Two types of countries: one with SMR greater than 1 (usually Eastern Europe) and SMR lower than one (generally Western Europe).

- Western Europe has an average range of residues lower than Eastern Europe, which means that mortality is much more homogeneous and stable in Western Europe.
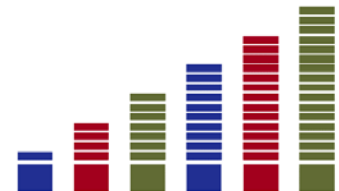
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