The dangers of using Seasonal Adjustment and other filters in Econometrics

Some economic and environmental examples

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1 Introduction

- When using seasonally unadjusted data, how can we decide what is the optimal seasonal adjustment to use?
  - Not theoretical point of view

- Do we have sensible statistical tools to discriminate among the different available alternatives?

- Knowing that the *estimated* components are not *observable*, is it enough to pay attention to just the component of interest and forget about the remaining ones?

- Is the ideal property of *orthogonality* among the different component reasonably fulfilled?

- How potential *outliers* and other variants of *intervention* analysis affect final estimated components?

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2 Traditional approach

$$y_t \; = \; T_t \; + \; C_t \; + \; S_t \; + \; e_t$$

3 Small empirical exercise

Four monthly time series pertaining to the Spanish economic CLI used in: http://uam-ucm-economic-indicators.es/

- CAR REGISTRATIONS
- HOUSING STARTS
- CEMENT CONSUMPTION
- TRUCKS

From 1978M01 to 2013M12

4 Small empirical exercise
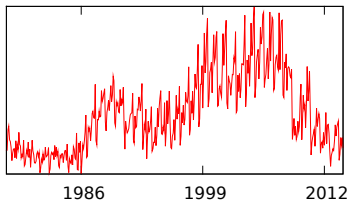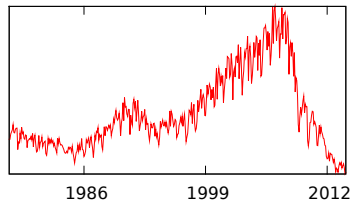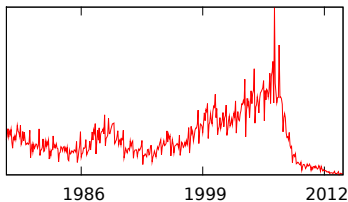
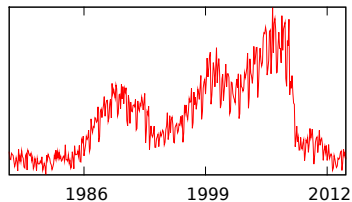Using several model-based signal extraction methodologies, namely

- SEATS-TRAMO
- X-12 ARIMA
- Linear Dynamic Harmonic Regression (Bujosa et al., 2007)

Disclaimer and explanation of the posterior empirical results

6 Dynamic Harmonic Regression Model

The DHR model consists of several unobserved components plus an irregular stationary zero mean component $\boldsymbol{e} = \{e_t\}_{t \in \mathbb{Z}}$

$$\boldsymbol{y} \ = \ \sum_{j=0}^{R} \boldsymbol{s}^j \ + \ \boldsymbol{e}. \tag{1}$$

- DHR components $\boldsymbol{s}^j \ = \ \{s_t^j\}_{t \in \mathbb{Z}}$ are oscillatory

$$s_t^j \ = \ a_t^j \cos(\omega_j t) + b_t^j \sin(\omega_j t), \tag{2}$$

  where frequency ω_j is associated to the j-th component.

- Oscillations are modulated by two GRW processes $\boldsymbol{a}^j = \{a_t^j\}_{t \in \mathbb{Z}}$ and $\boldsymbol{b}^j = \{b_t^j\}_{t \in \mathbb{Z}}$.
- $\omega_0 = 0$ corresponds to the trend (or zero frequency term).
- The model is fitted in the frequency domain.

7 Car registrations Seasonal Factors: DHR, ST, X12
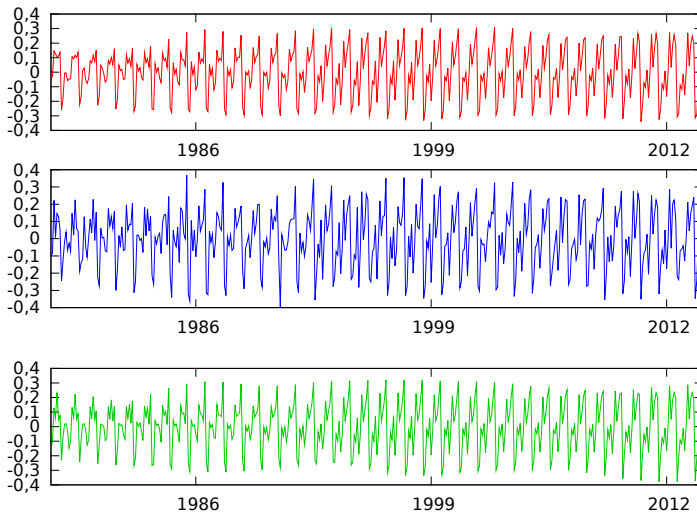
8 Seasonally adjusted Car registrations: DHR, ST, X12
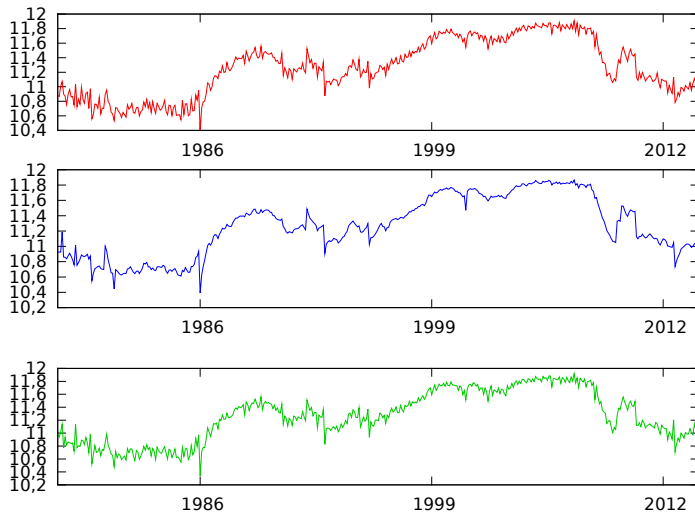
9 FAC – First Difference of Seasonally adjusted Car registrations
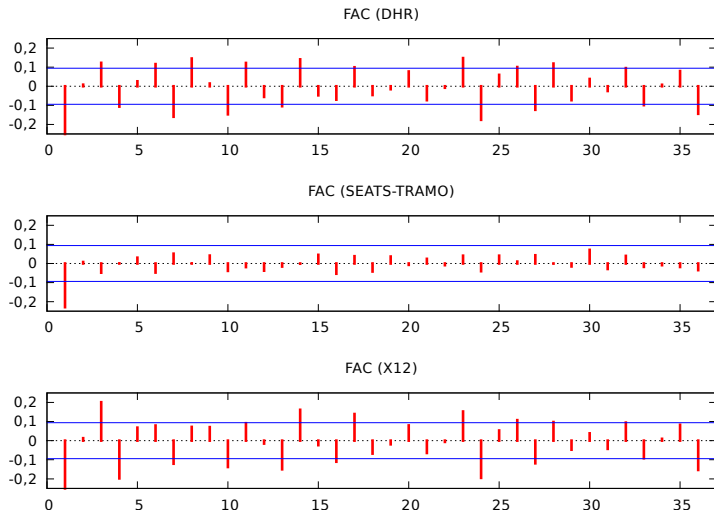
10 Summary of tentative results of the four series

- Outlier detection plus other interventions as easter effects and calendar effects are crucial in the estimation of unobserved components models

- As a matter of fact when you don't use this option in SEATS-TRAMO there is evidence of seasonality in the SA series

- Using outlier detection plus easter and calendar effects produce considerable reduction in the estimated residual variances ranging from 21% to 31%

11 Results from a Stock & Watson data base

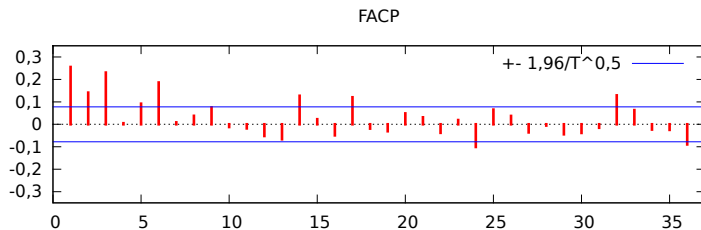- Housing starts
- IPI
- Money supply – M1
- Retail sales

12 Results from a Stock & Watson data base
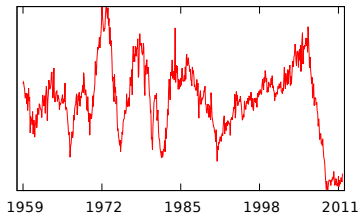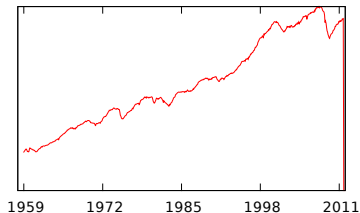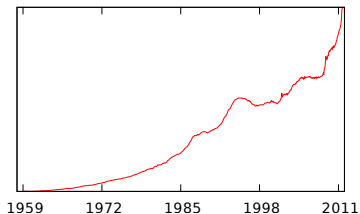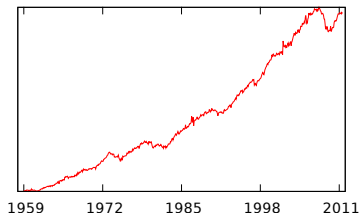
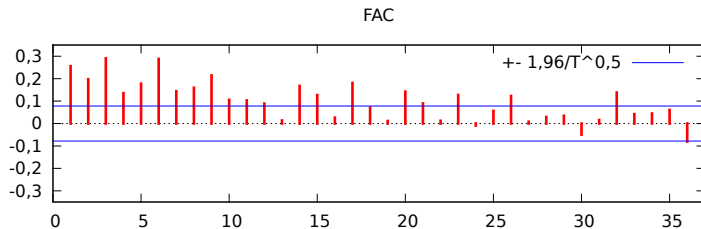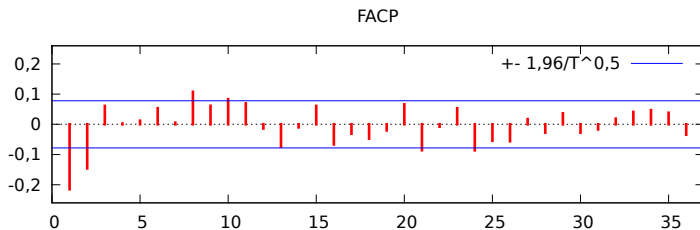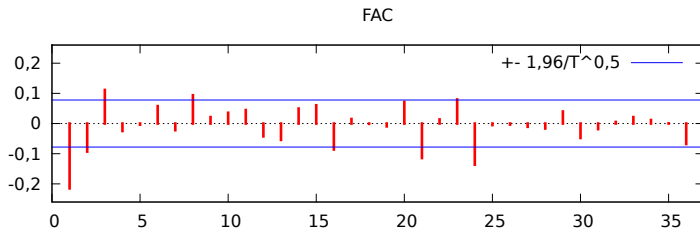**13** Results from a Stock & Watson data base: Housing starts
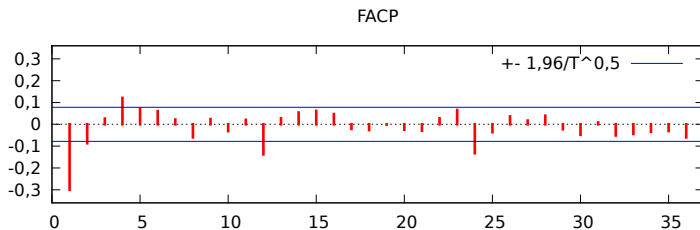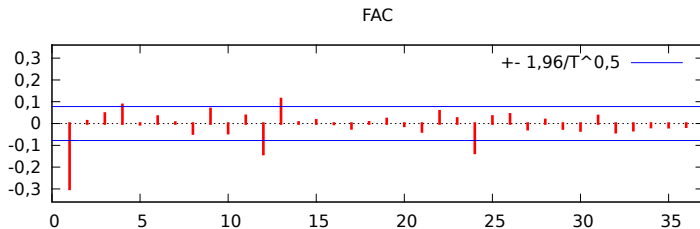
14 Results from a Stock & Watson data base: IPI

FAC

FACP
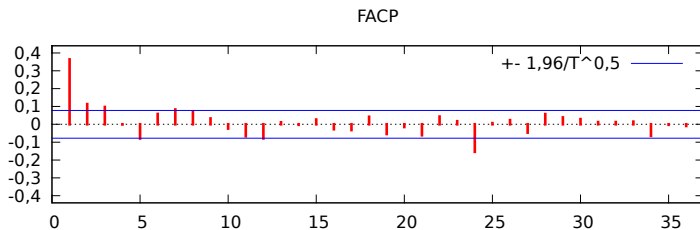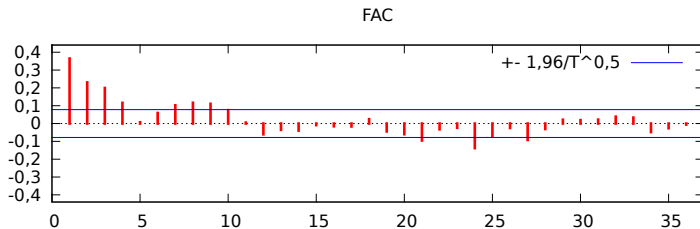
15 Results from a Stock & Watson data base: Money supply

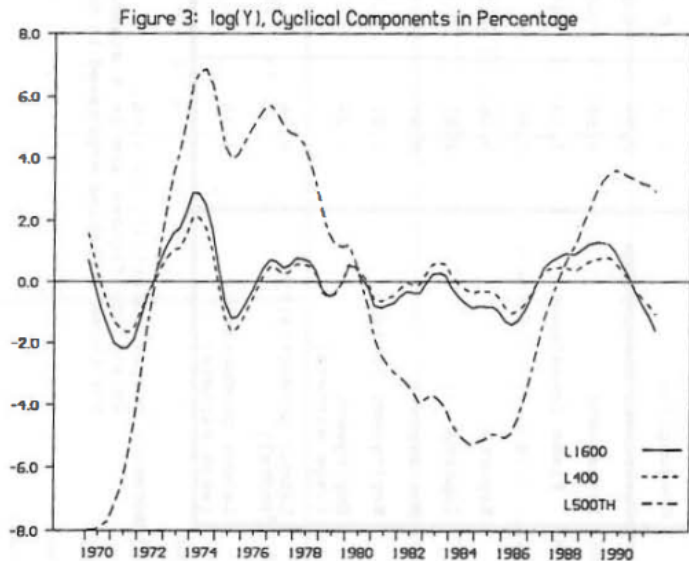## 16 | Results from a Stock & Watson data base: Retail sales

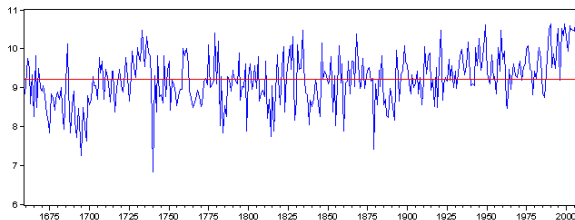FAC

FACP

$\boxed{\textbf{17}}$ Hodrick–Prescott filter

$$y_t = \tau_t + c_t + \epsilon_t$$

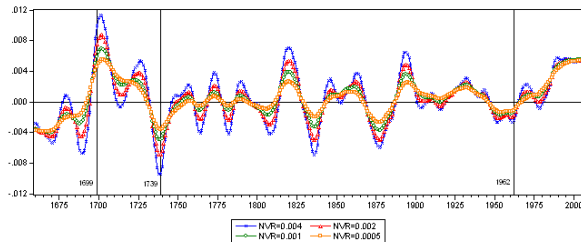Given a positive λ, there is a trend component τ that solves

$$\min_{\tau} \left(\sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} \left[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}) \right]^2 \right)$$

18 Hodrick–Prescott filter

Figure 3: log(Y), Cyclical Components in Percentage

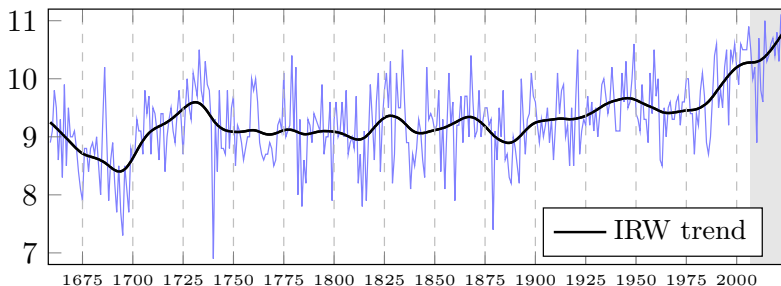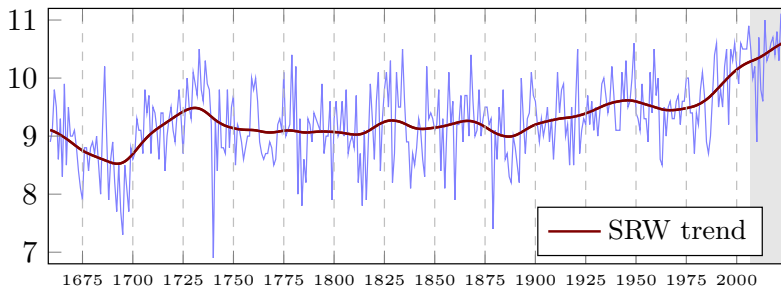**19** The Central England Temperature 1659–2007 (CET)

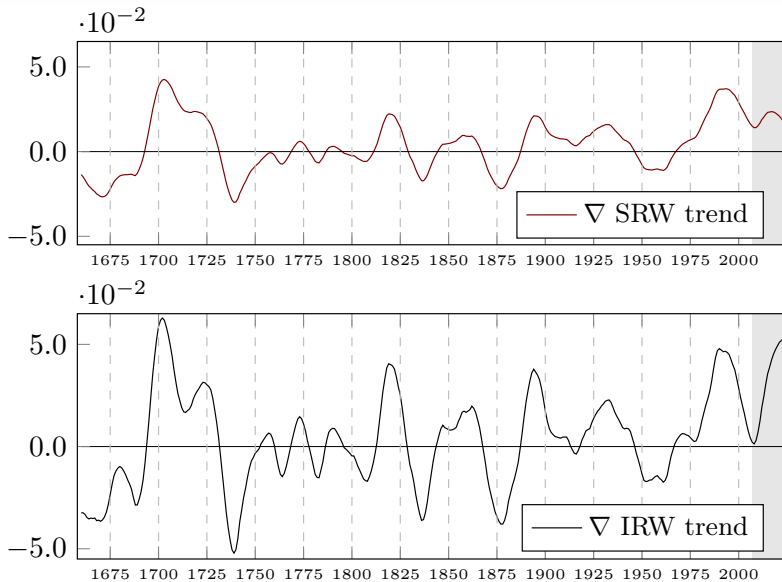Alternative Temperature Cycles and Bayesian Turning Points

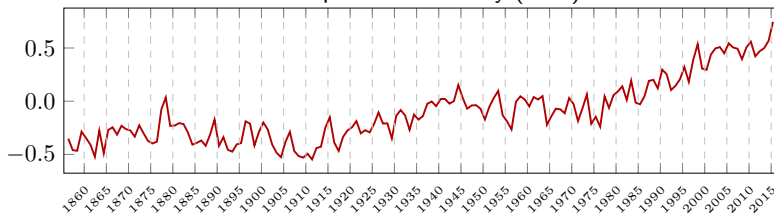**20** The Central England Temperature 1659–2023 (CET)

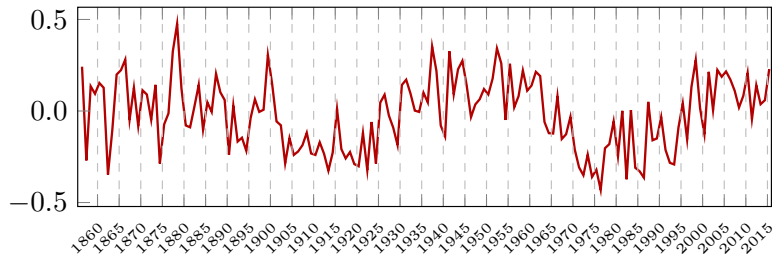**21** The Central England Temperature 1659–2023 (CET)

22 | Modelling of Global Climate Change

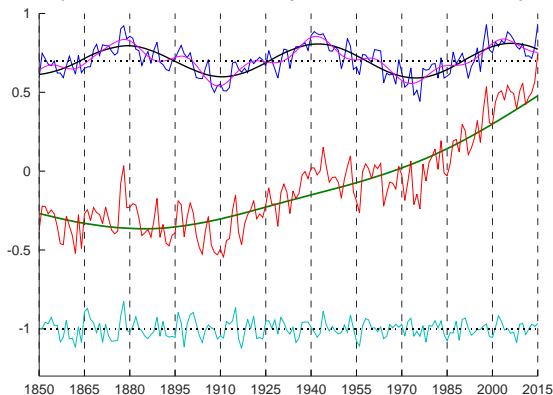Global Temperature Anomaly (GTA)

Atlantic Multidecadal Oscillation (AMO)

23   Have AMO and GTA a common 63-years cycle?

DHR components for GTA

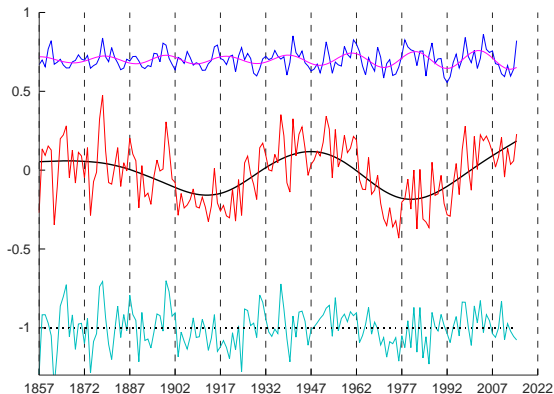Trend, Cycle (shifted +0.7 units) and irregular (shifted -1 units) DHR components

$$GTA = T + S^{63} + S^{21} + \sum (\text{other harmonics}) + Irreg$$

DHR Trend-cycle component for AMO

Trend, cycle (shifted +0.7 units) and irregular (shifted -1 units) DHR components
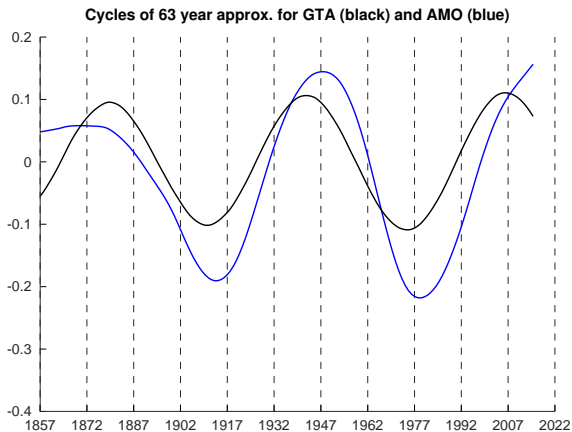
$$AMO = T + S^{21} + \sum(\text{other harmonics}) + Irreg$$

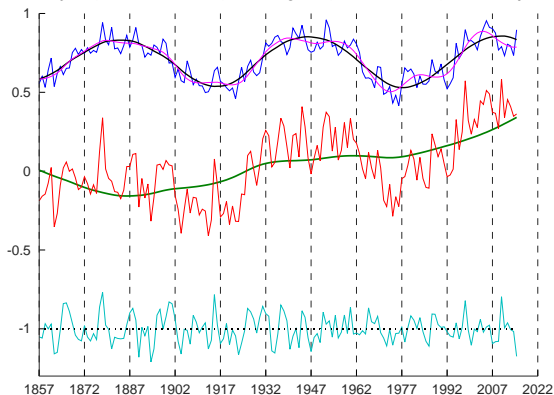**25** Have AMO and GTA a common 63-years cycle?

Not clear

GTA has a periodic cycle, but not AMO

Cycles of 63 year approx. for GTA (black) and AMO (blue)

26   Have original AMO and GTA a common 63-years cycle?
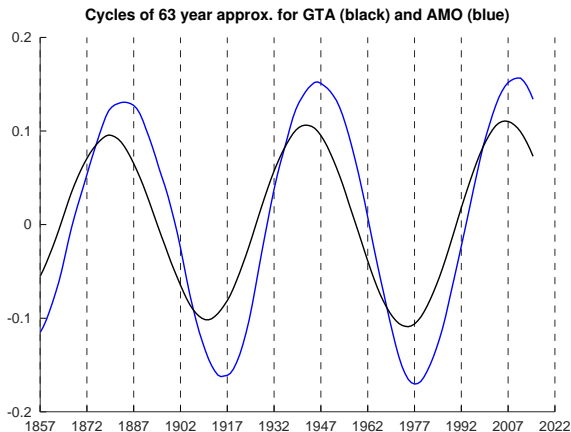
DHR components for "original" AMO data

Trend, cycle (shifted +0.7 units) and irregular (shifted -1 units) DHR components

$$AMO_{\text{with trend}} = T + S^{63} + S^{21} + \sum (\text{other harmonics}) + Irreg$$

27 Have the *"original"* AMO and GTA a common cycle?

They seem to have a common cycle

(as suggested in Professor Young's article)

Cycles of 63 year approx. for GTA (black) and AMO (blue)

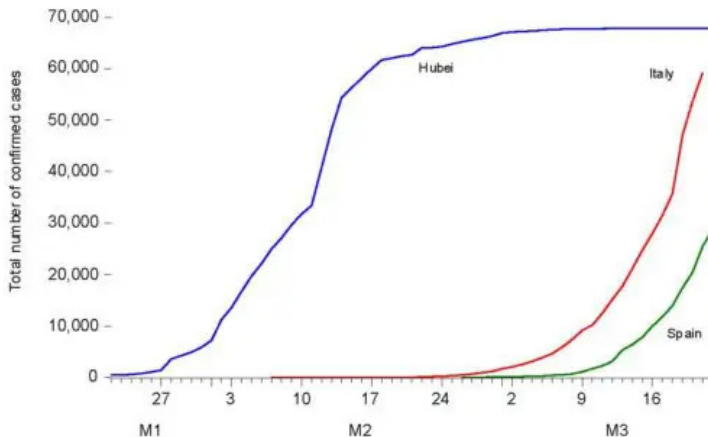## **28** Number of confirmed cases at 3/22/2020

Figure 1: Number of confirmed cases at 3/22/2020

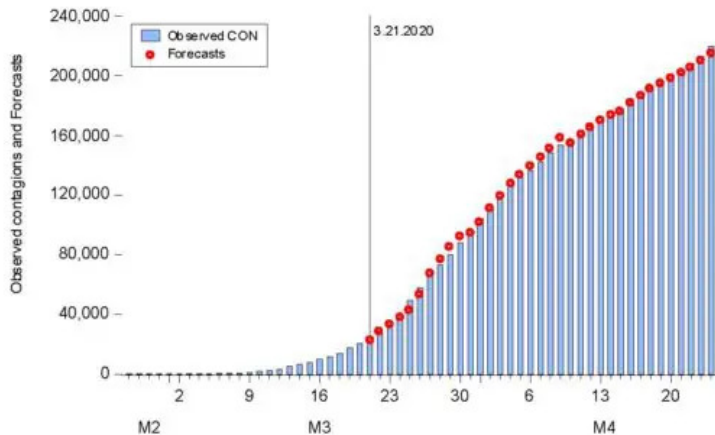## 29 Observed contagions and forecasts in Spain

Figure 2: Observed contagions and Forecasts in Spain
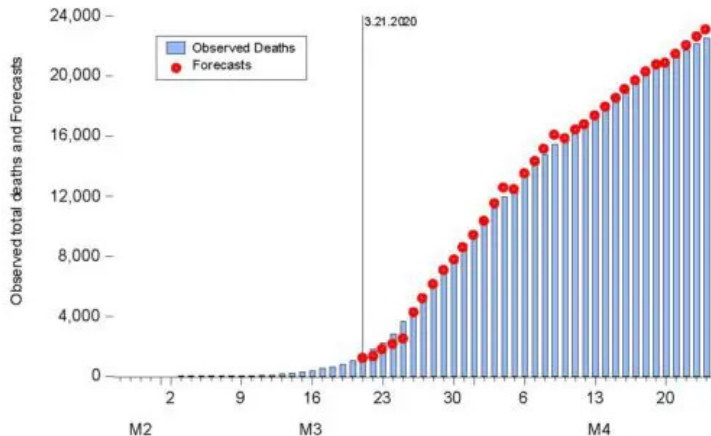
30 Observed deaths and forecasts in Spain

Figure 3: Observed Deaths and Forecasts in Spain

Bujosa, M., García-Ferrer, A., and Young, P. C. (2007). Linear dynamic harmonic regression. *Comput. Stat. Data Anal.*, **52**(2), 999–1024. ISSN 0167-9473.