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

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

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3 Dynamic Harmonic Regression Model

The DHR model consist 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).
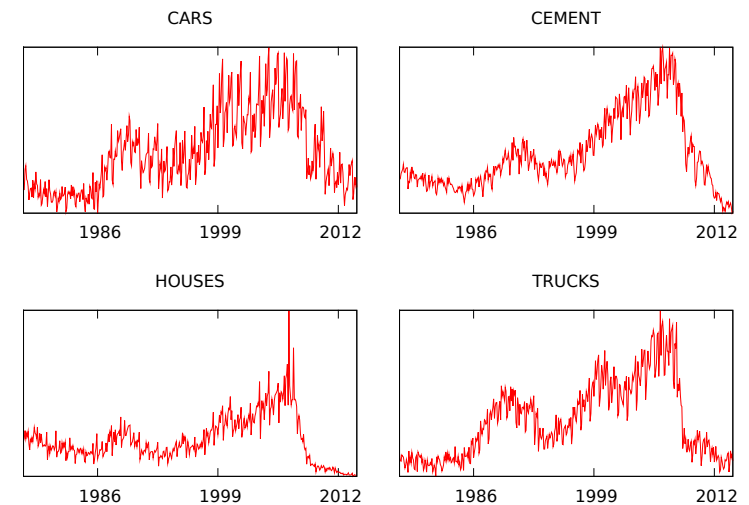- The model is fitted in the frequency domain

4 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

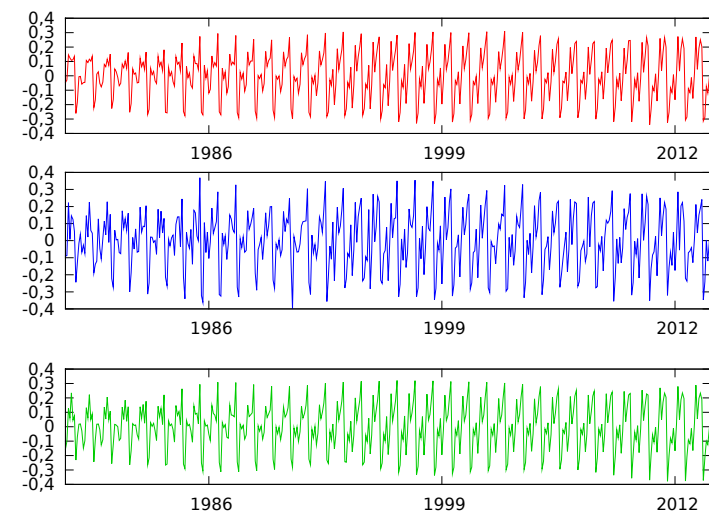**5** Small empirical exercise

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6 Several signal extraction methodologies

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

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7 Car registrations Seasonal Factors: DHR, ST, X12

8 Seasonally adjusted Car registrations: DHR, ST, X12
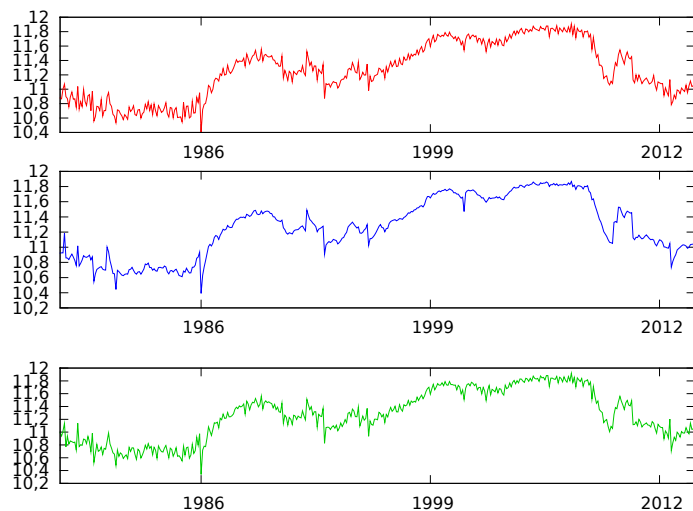
9 FAC – First Difference of Seasonally adjusted Car registrations

FAC (DHR)

FAC (SEATS-TRAMO)

FAC (X12)
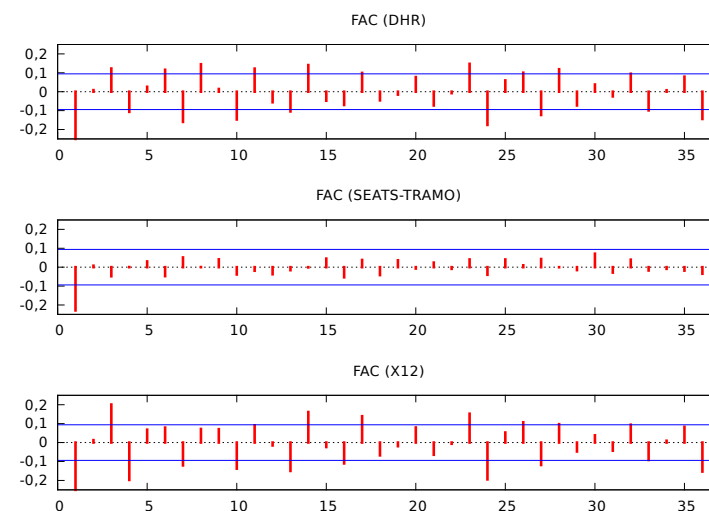
10 Summary of tentative results of the four series

- 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
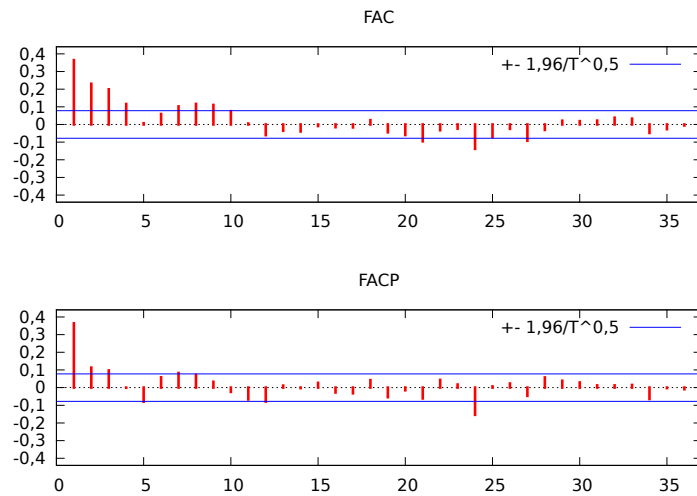- Retail sales

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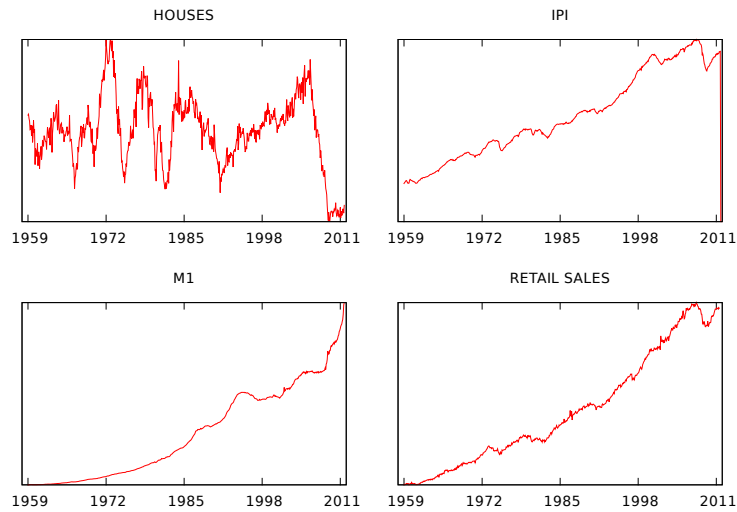
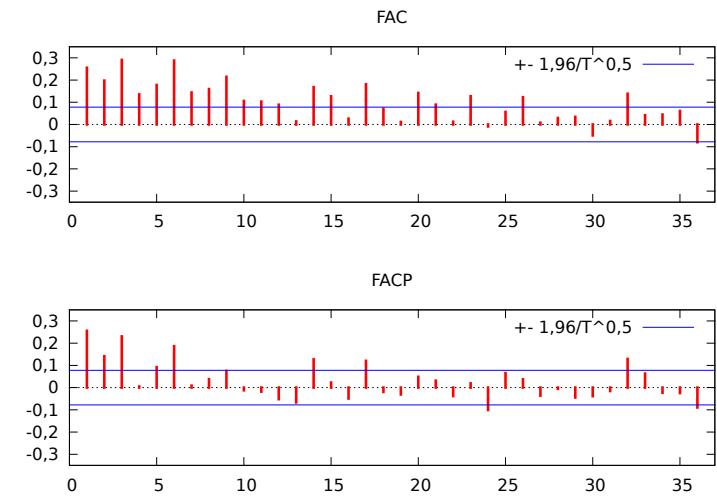**13** Results from a Stock & Watson data base: Housing starts
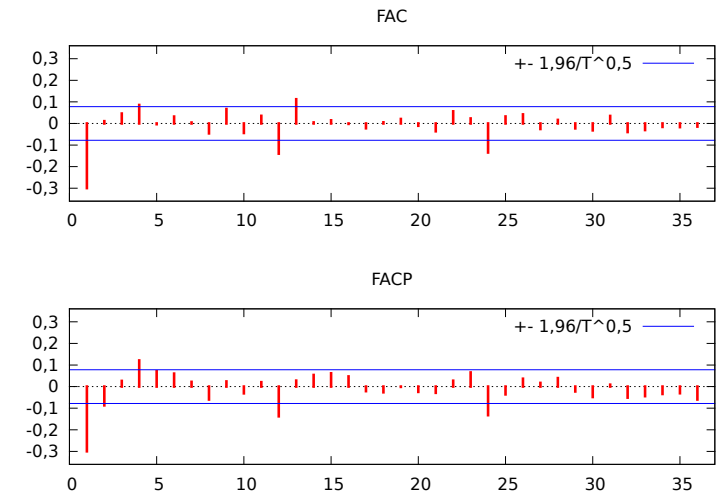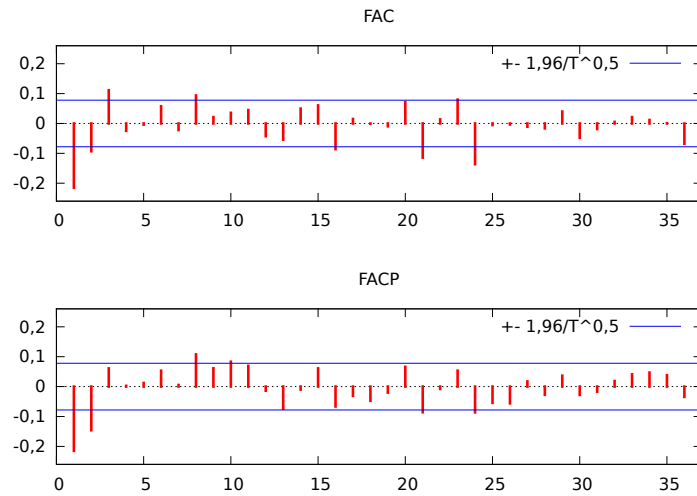
14 Results from a Stock & Watson data base: IPI

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

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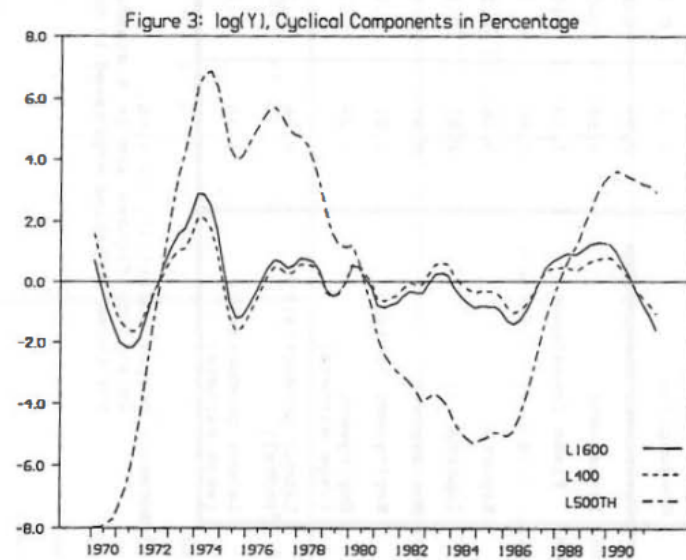
FAC

FACP

17 Hodrick–Prescott filter

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

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

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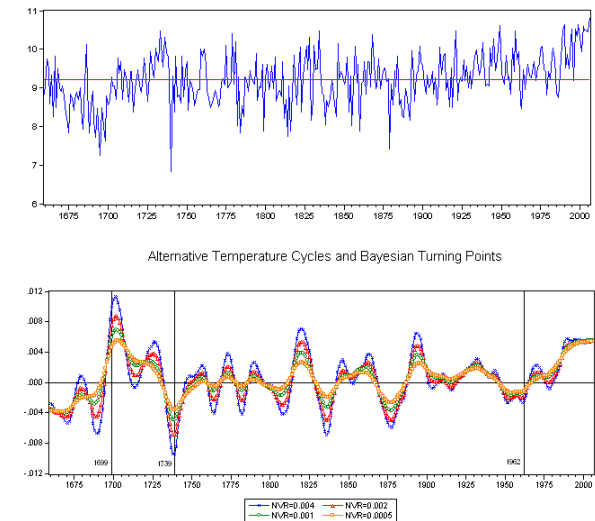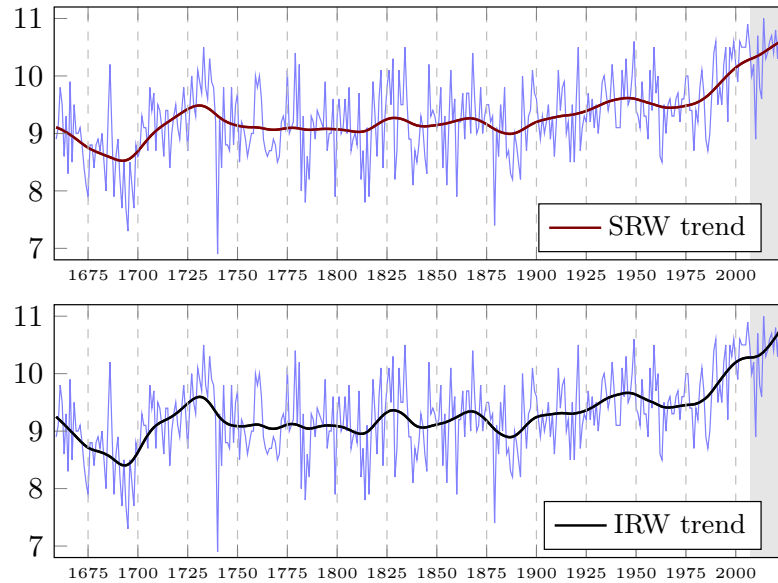
18 Hodrick–Prescott filter

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

19 The Central England Temperature (CET)
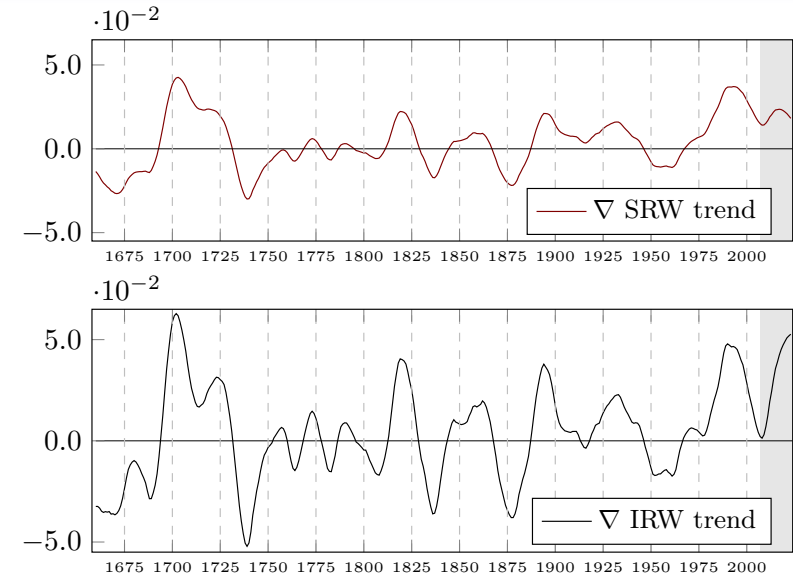

Alternative Temperature Cycles and Bayesian Turning Points

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
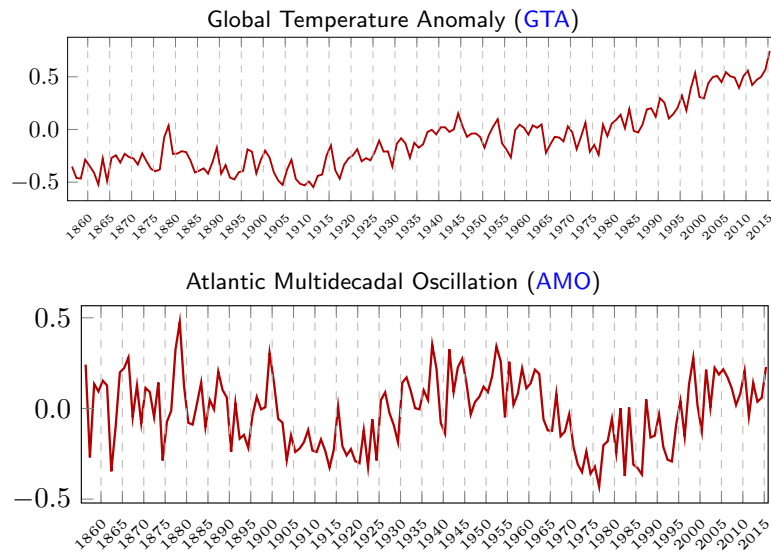
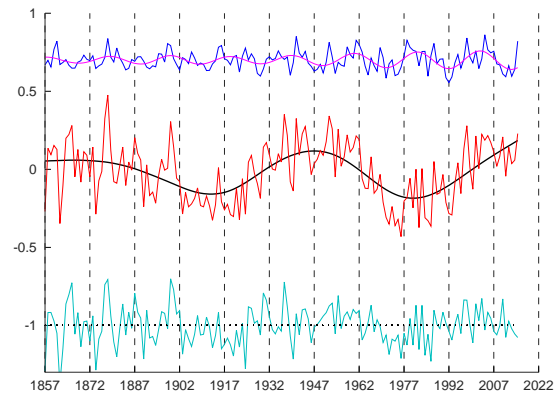Trend, Cycle (shifted +0.7 units) and irregular (shifted -1 units) DHR components
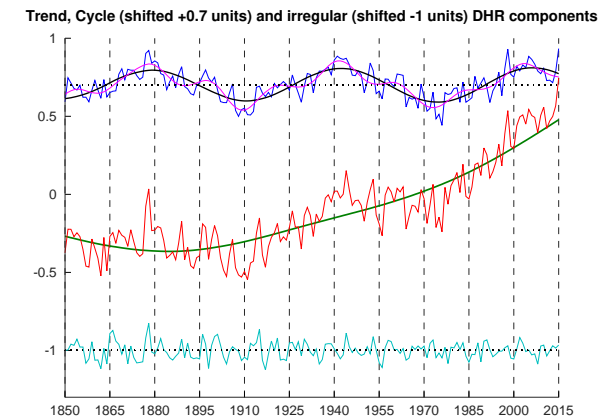
$$GTA = T + S^{63} + S^{21} + \sum (\text{other harmonics}) + Irreg$$

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

DHR Trend-cycle component for AMO

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

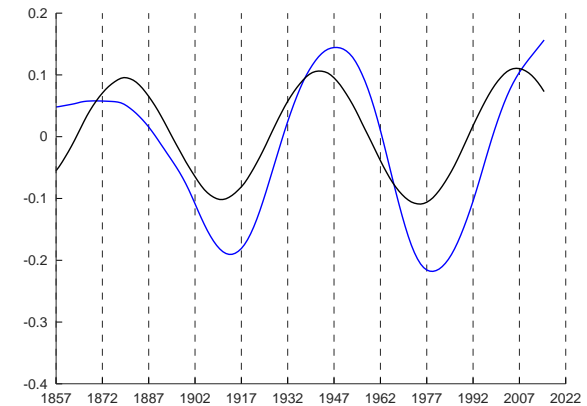$$AMO = T + S^{21} + \sum(\text{other harmonics}) + Irreg$$

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

Not clear
GTA has a periodic cycle, but not AMO

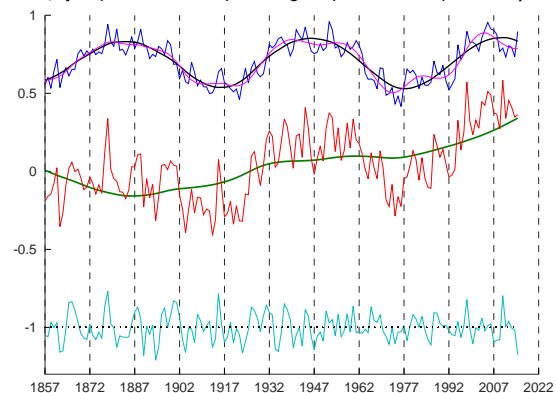**Cycles of 63 year approx. for GTA (black) and AMO (blue)**

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

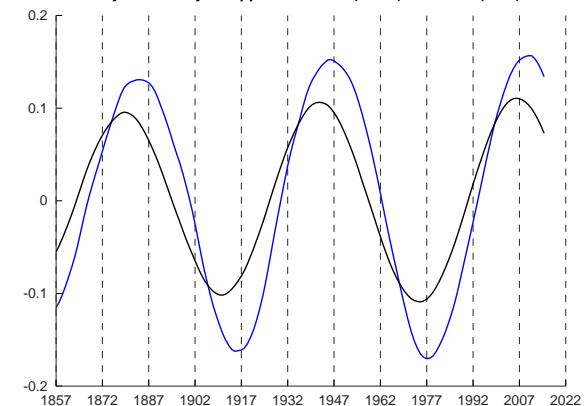$$AMO_{\text{with trend}} = T + S^{63} + S^{21} + \sum(\text{other harmonics}) + Irreg$$

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

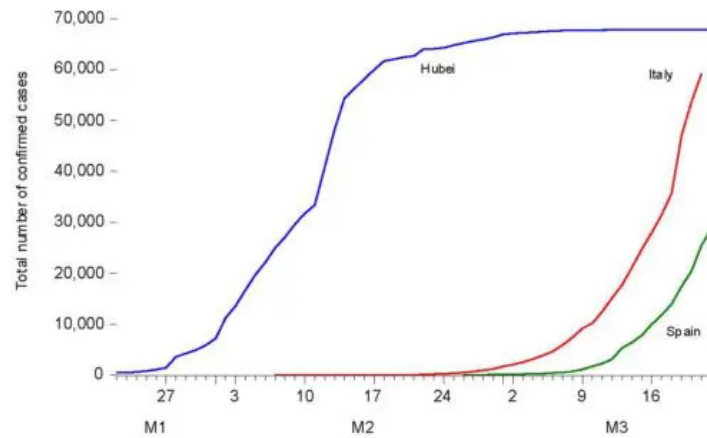

Figure 1: Number of confirmed cases at 3/22/2020
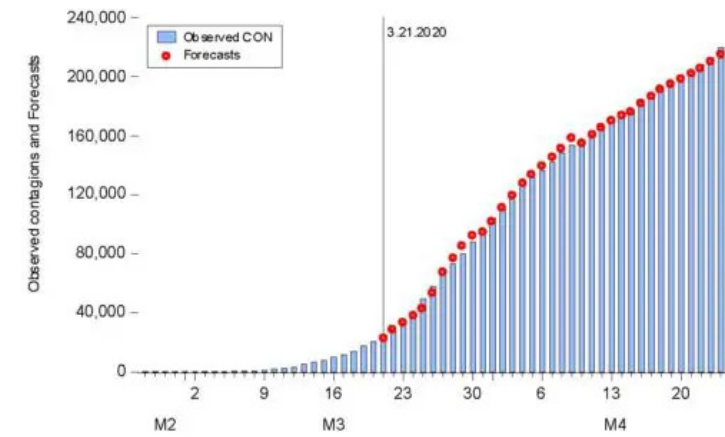
29 Observed contagions and forecasts in Spain

Figure 2: Observed contagions and Forecasts in Spain

30 Observed deaths and forecasts in Spain
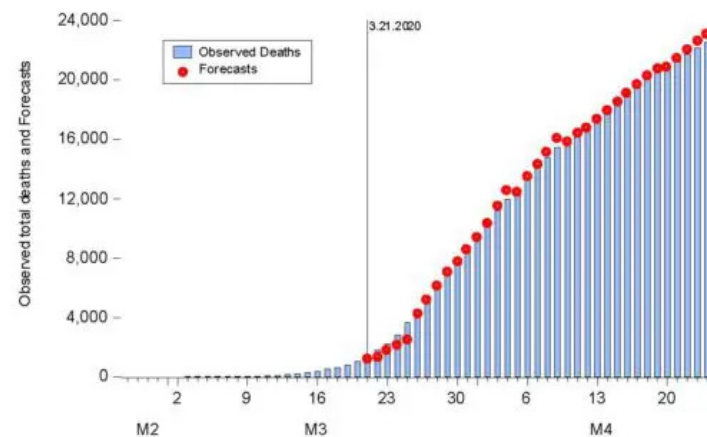

Figure 3: Observed Deaths and Forecasts in Spain

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.