The dangers of using Seasonal Adjustment and other filters in Econometrics

Some economic and environmental examples

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OCGtools: processing OCG's ...

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 Dynamic Harmonic Regression Model

The DHR model is the sum of several unobserved components:

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

- DHR components $\boldsymbol{s}^j \equiv \{s_t^j\}_{t\in\mathbb{Z}}$, 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 $\boldsymbol{a}^j \equiv \{a_t^j\}_{t\in\mathbb{Z}}$ and $\boldsymbol{b}^j \equiv \{b_t^j\}_{t\in\mathbb{Z}}$. Index $j = 0$ corresponds to the trend (or zero frequency term).
- $\boldsymbol{e} \equiv \{e_t\}_{t\in\mathbb{Z}}$, is a stationary with zero mean and variance $\sigma_{\boldsymbol{e}}^2$
- Fitted in the frequency domain

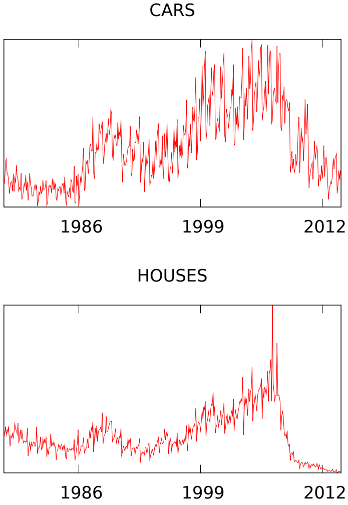
4 Small empirical exercise

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



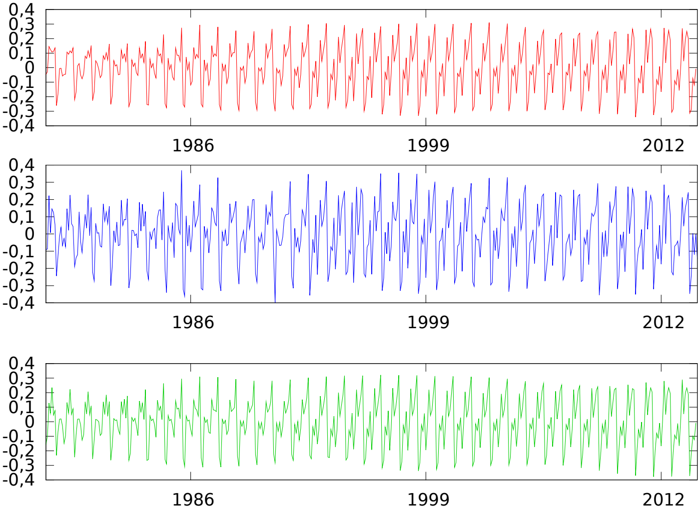
6 Several signal extraction methodologies

Using several model-based signal extraction methodologies, namely

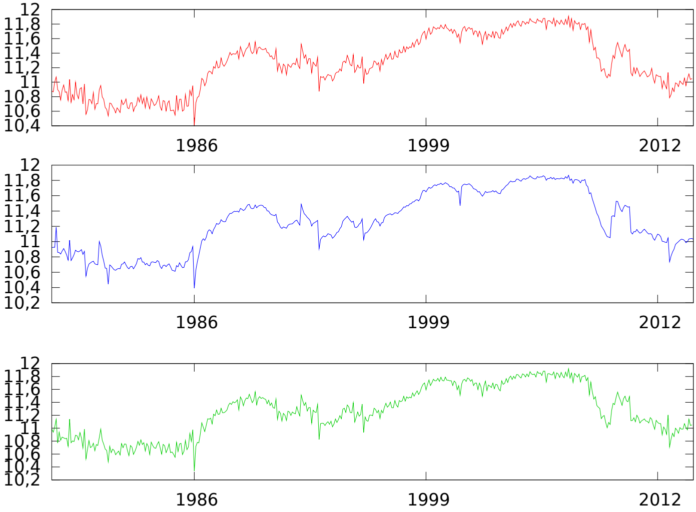
- SEATS-TRAMO
- X-12 ARIMA
- Linear Dynamic Harmonic Regression (Bujosa et al., 2007)

Disclaimer and explanation of the posterior empirical results

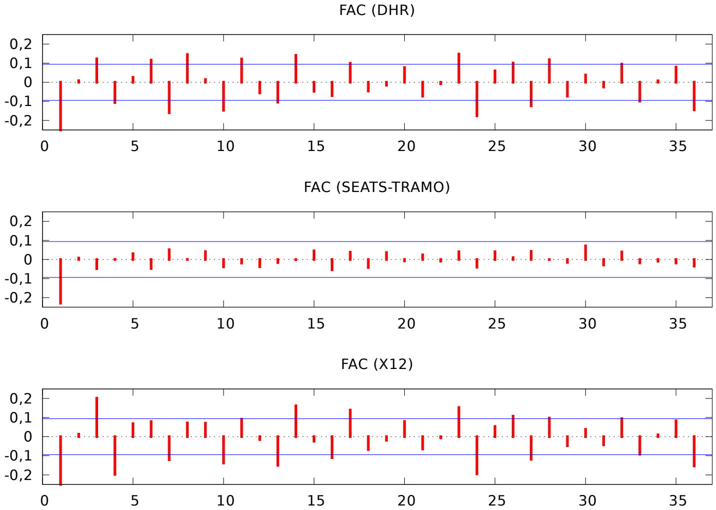
7 Car registrations Seasonal Factors: DHR, ST, X12



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

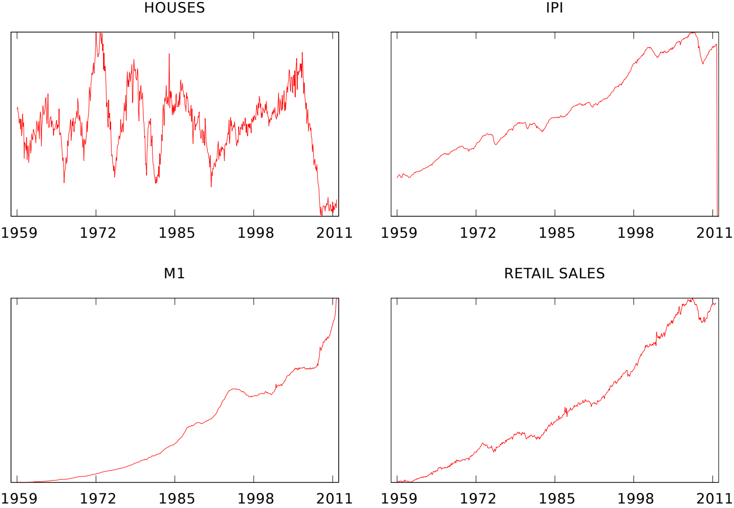
- As a matter of fact when you don't use this option in SEATS-TRAMO there is evidence of seasonality in the SA series

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

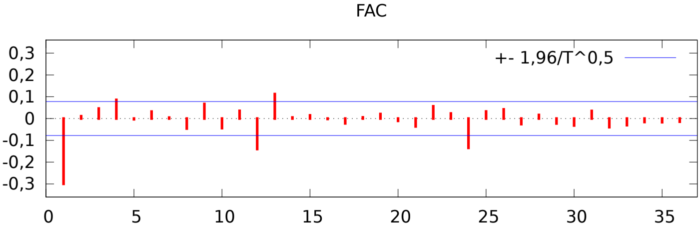
11 Results from a Stock & Watson data base

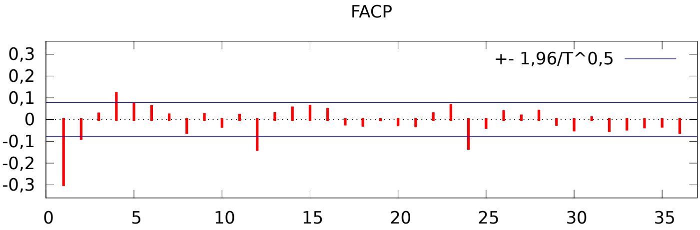
- Housing starts
- IPI
- Money supply – M1
- Retail sales

12 Results from a Stock & Watson data base

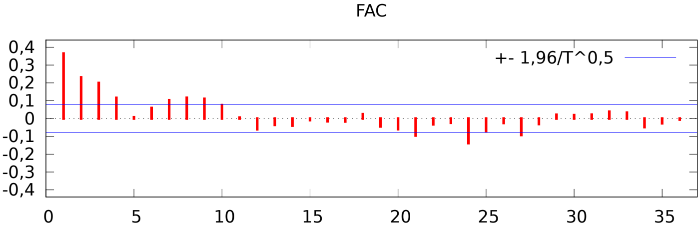


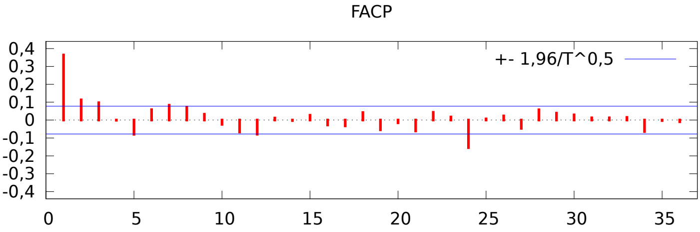
13 Results from a Stock & Watson data base: Housing starts



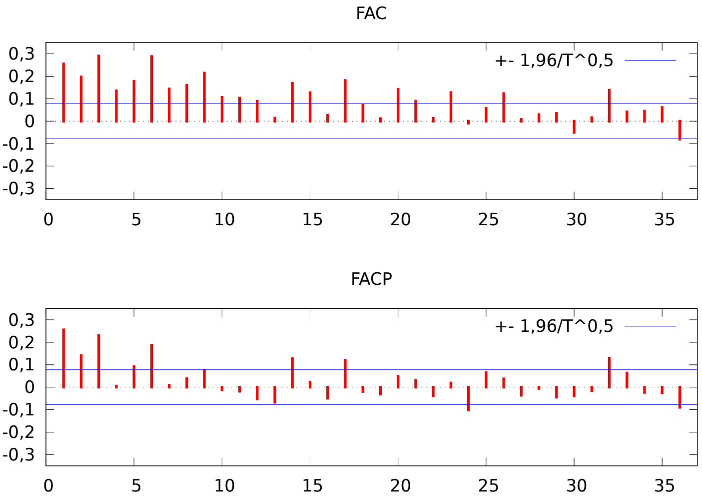


14 Results from a Stock & Watson data base: IPI

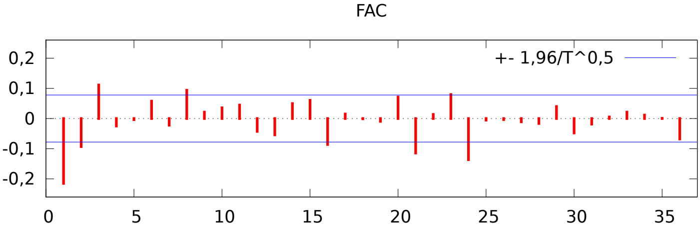


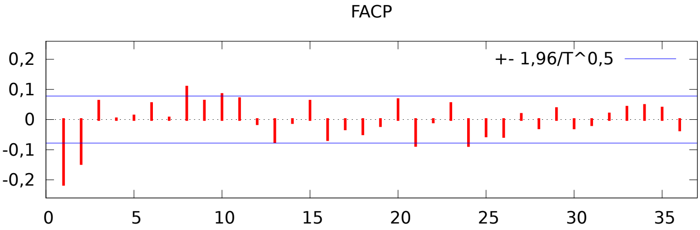


15 Results from a Stock & Watson data base: Money supply



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





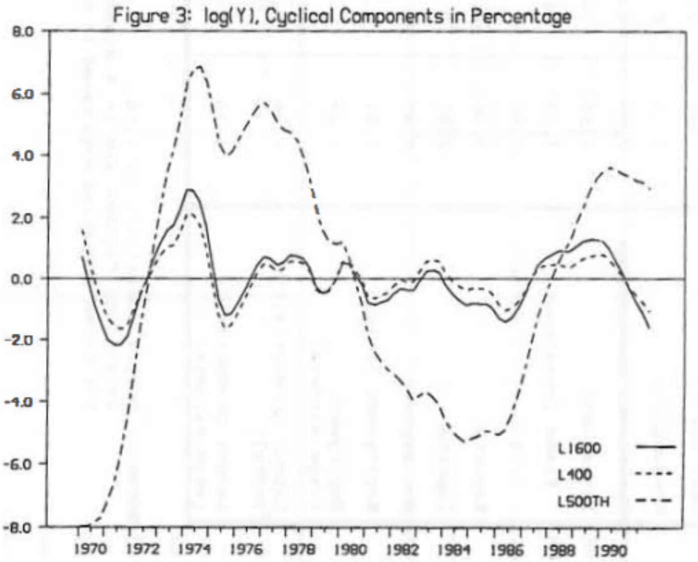
17 Hodrick–Prescott filter

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

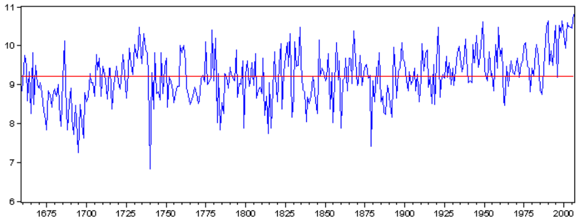
Given a positive λ, there is a trend component τ that solves

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

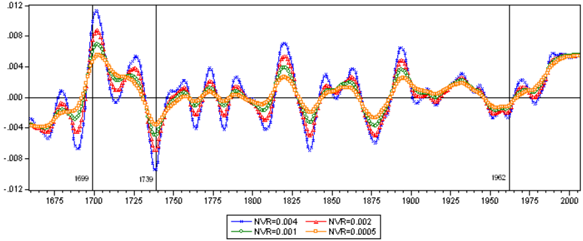
18 Hodrick–Prescott filter



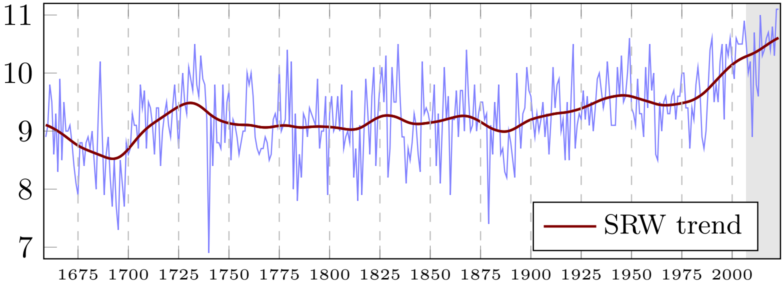
19 The Central England Temperature (CET)

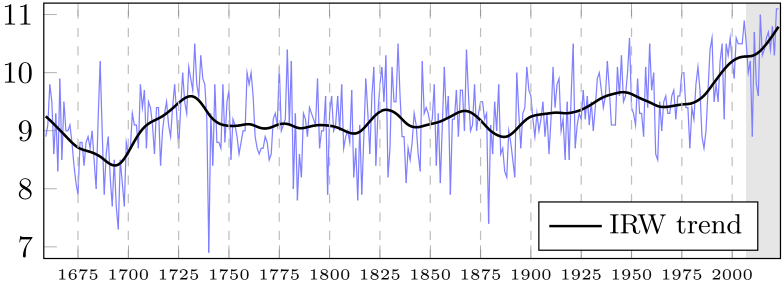


Alternative Temperature Cycles and Bayesian Turning Points



20 The Central England Temperature 1659–2023 (CET)





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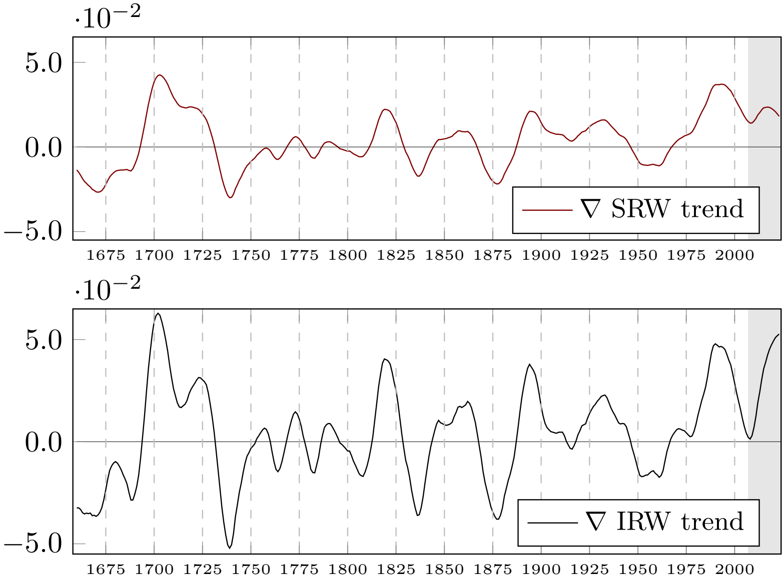
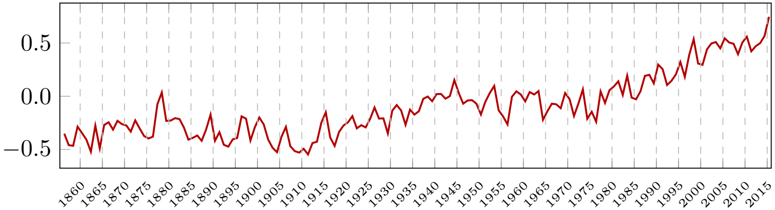
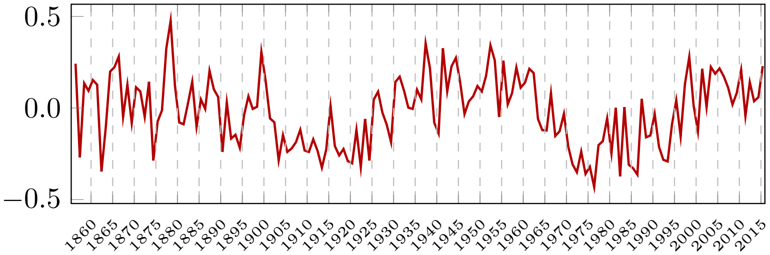


22 Modelling of Global Climate Change

Global Temperature Anomaly (GTA)

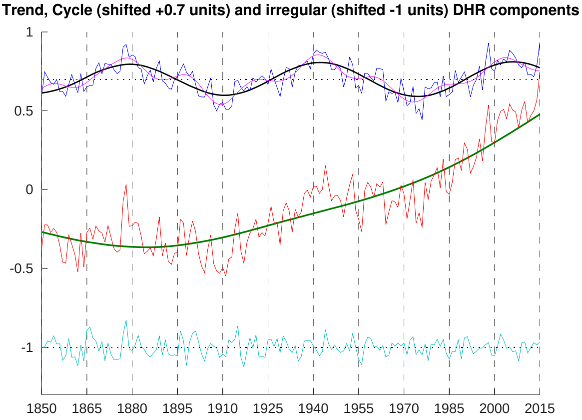


Atlantic Multidecadal Oscillation (AMO)



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

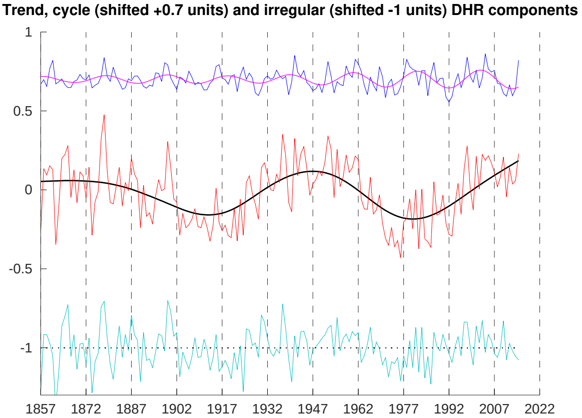
DHR components for GTA



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

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

DHR Trend-cycle component for AMO

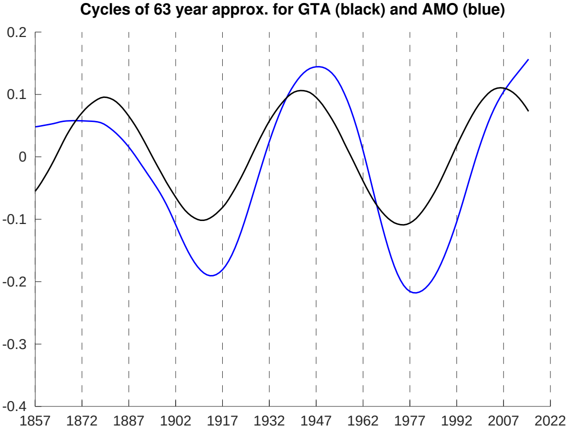


$$AMO = T + S^{21} + \sum(\text{other harmonics}) + Irreg$$

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

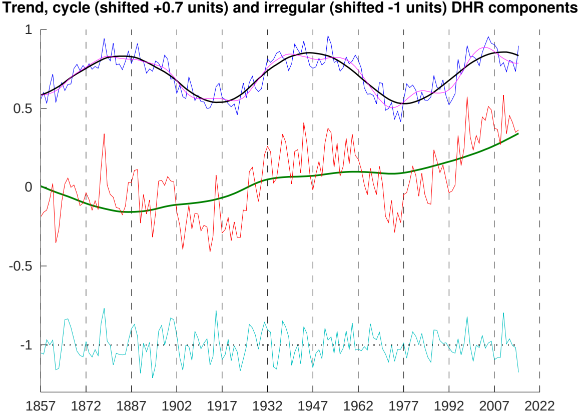
Not clear

GTA has a periodic cycle, but not AMO



26 Have original AMO and GTA a common 63-years cycle?

DHR components for *"original"* AMO data

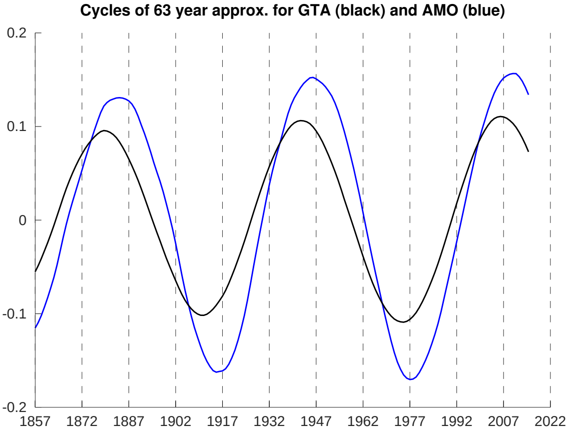


$$AMO_{\text{with trend}} = T + S^{63} + S^{21} + \sum(\text{other harmonics}) + Irreg$$

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

They seem to have a common cycle

(as suggested in Professor Young's article)



28 Number of confirmed cases at 3/22/2020

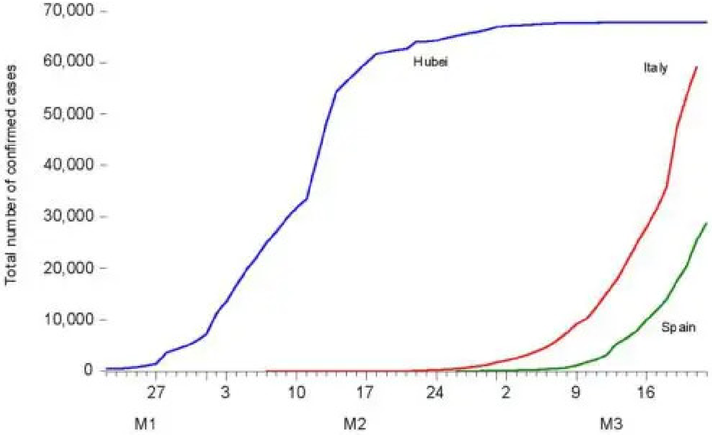


Figure 1: Number of confirmed cases at 3/22/2020

29 Observed contagions and forecasts in Spain

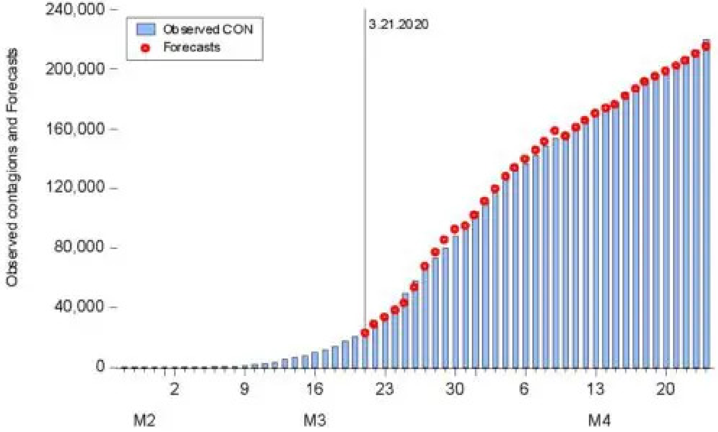


Figure 2: Observed contagions and Forecasts in Spain

30 Observed deaths and forecasts in Spain

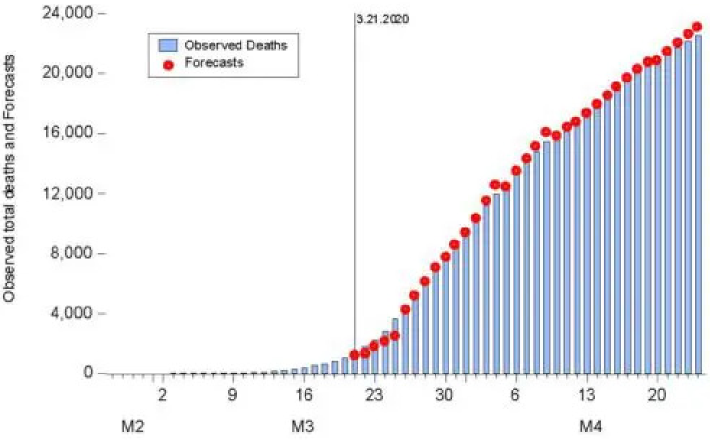


Figure 3: Observed Deaths and Forecasts in Spain

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.