

The dangers of using Seasonal Adjustment and other filters in Econometrics

Some economic and environmental examples

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2 Traditional approach

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

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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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3 Dynamic Harmonic Regression Model

The DHR model is the sum of several unobserved components:

$$y = \sum_{j=0}^R s^j + e \quad (1)$$

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

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

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

- Oscillations are modulated by two GRW processes $a^j \equiv \{a_t^j\}_{t \in \mathbb{Z}}$ and $b^j \equiv \{b_t^j\}_{t \in \mathbb{Z}}$. Index $j = 0$ corresponds to the trend (or zero frequency term).
- $e \equiv \{e_t\}_{t \in \mathbb{Z}}$, is a stationary with zero mean and variance σ_e^2
- Fitted in the frequency domain

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4 Small empirical exercise

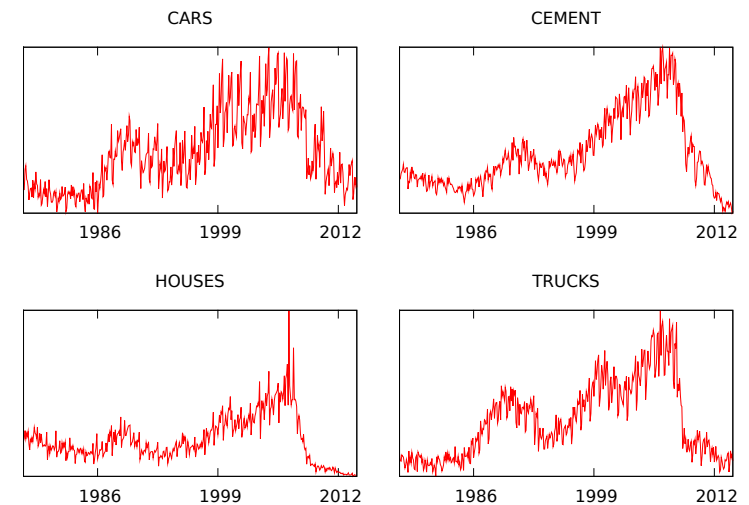
Four monthly time series pertaining to the Spanish economic CLI used in: <http://uam-ucm-economic-indicators.es/>

- CAR REGISTRATIONS
- HOUSING STARTS
- CEMENT CONSUMPTION
- TRUCKS

From 1978M01 to 2013M12

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5 Small empirical exercise



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6 Several signal extraction methodologies

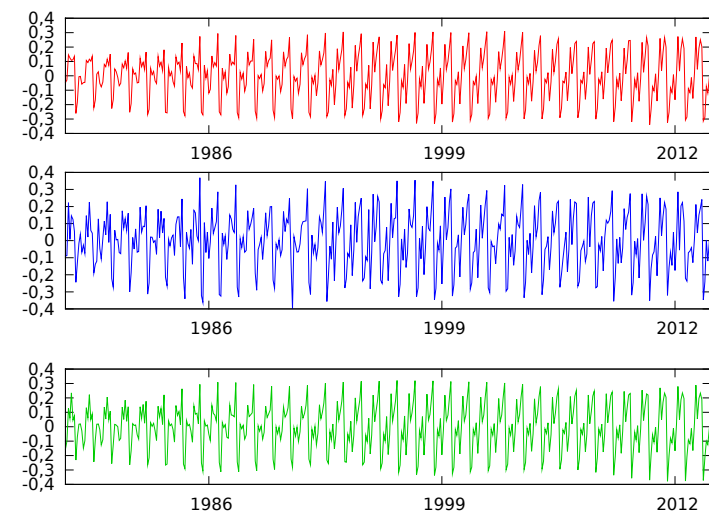
Using several model-based signal extraction methodologies, namely

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

Disclaimer and explanation of the posterior empirical results

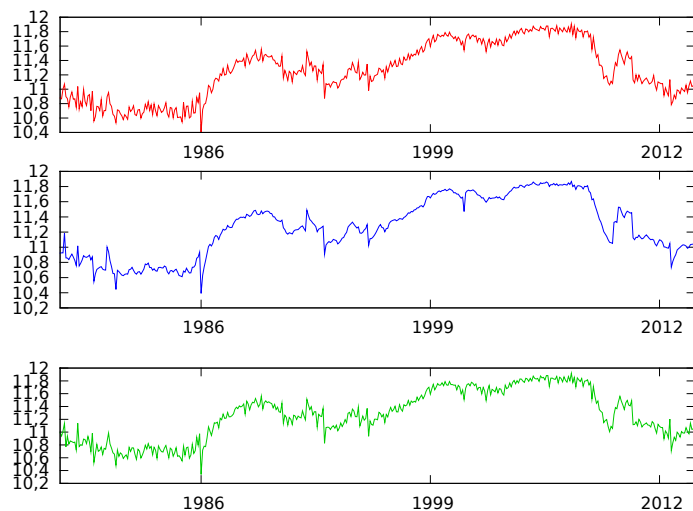
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7 Car registrations Seasonal Factors: DHR, ST, X12



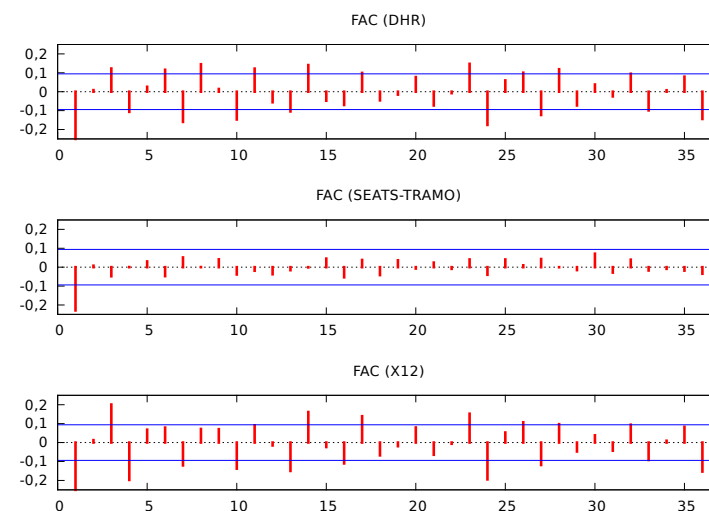
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8 Seasonally adjusted Car registrations: DHR, ST, X12



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9 FAC – First Difference of Seasonally adjusted Car registrations



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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%

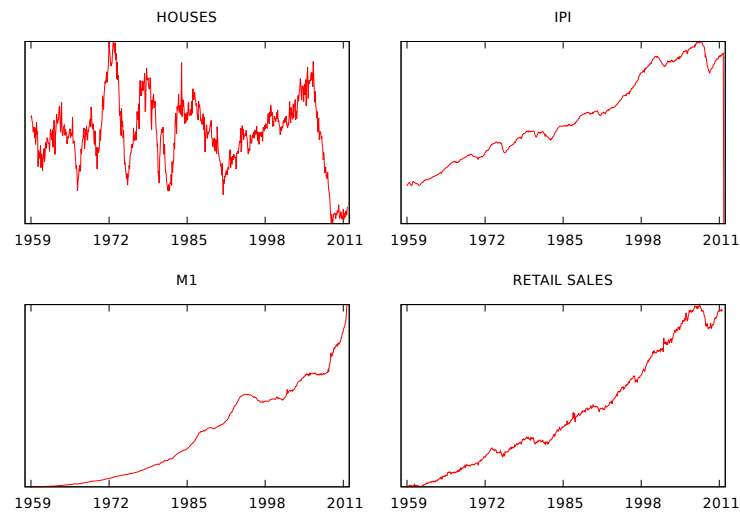
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11 Results from a Stock & Watson data base

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

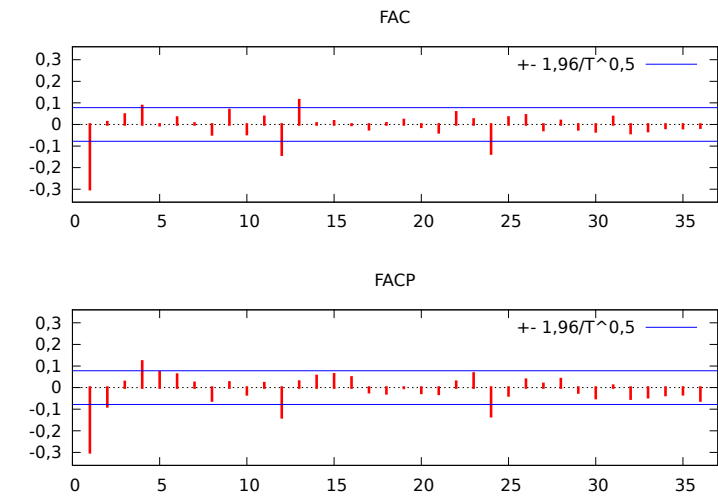
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12 Results from a Stock & Watson data base



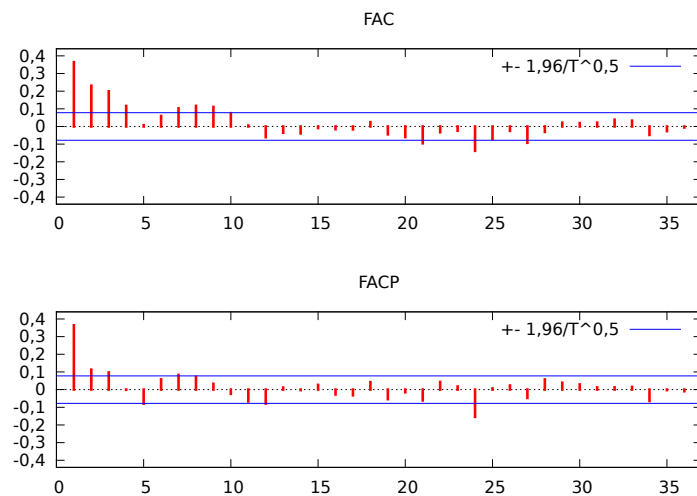
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13 Results from a Stock & Watson data base: Housing starts



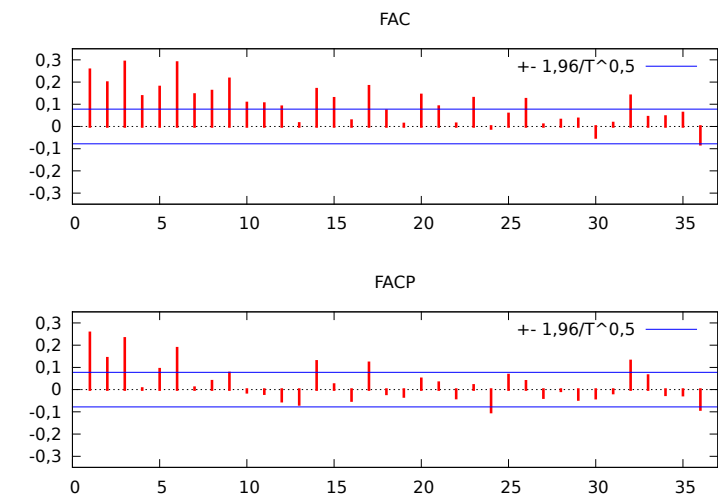
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14 Results from a Stock & Watson data base: IPI



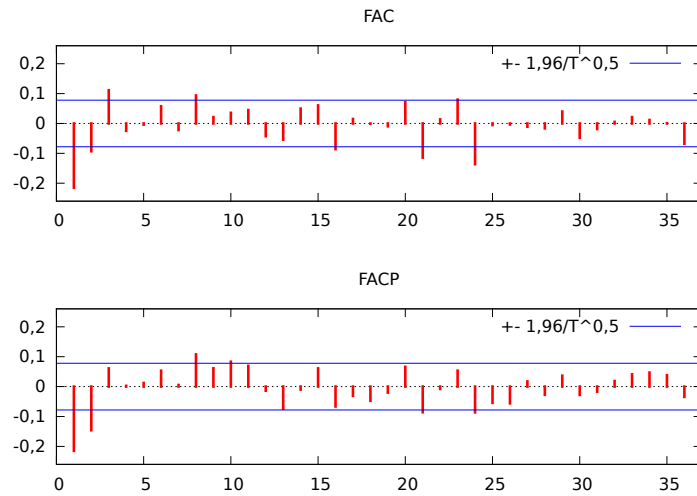
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15 Results from a Stock & Watson data base: Money supply



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



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17 Hodrick–Prescott filter

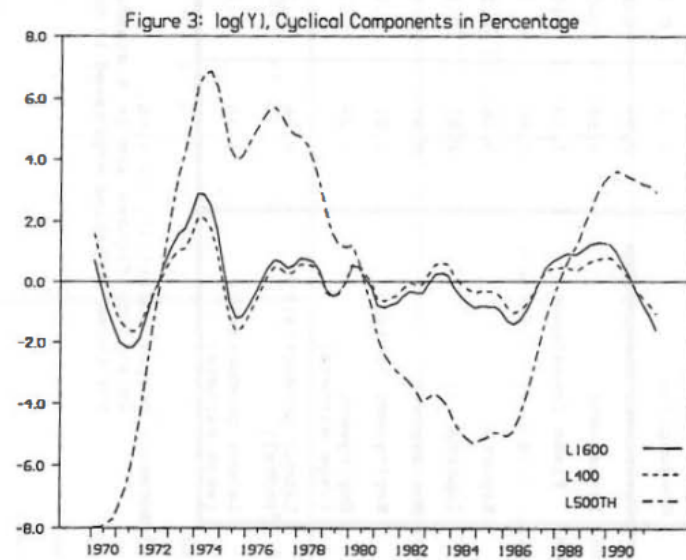
$$y_t = \tau_t + c_t + \epsilon_t$$

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

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

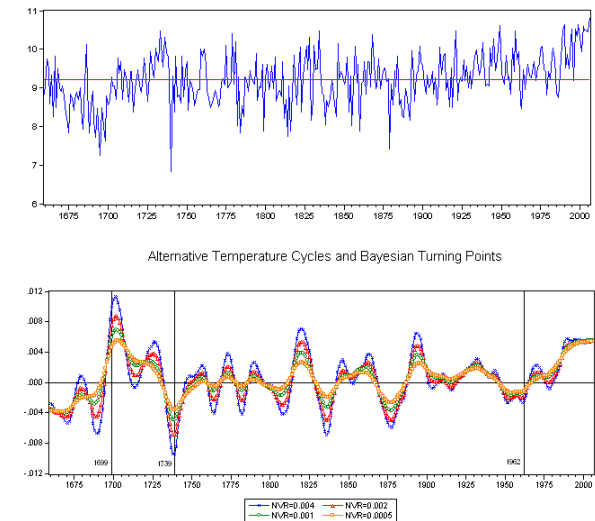
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18 Hodrick–Prescott filter



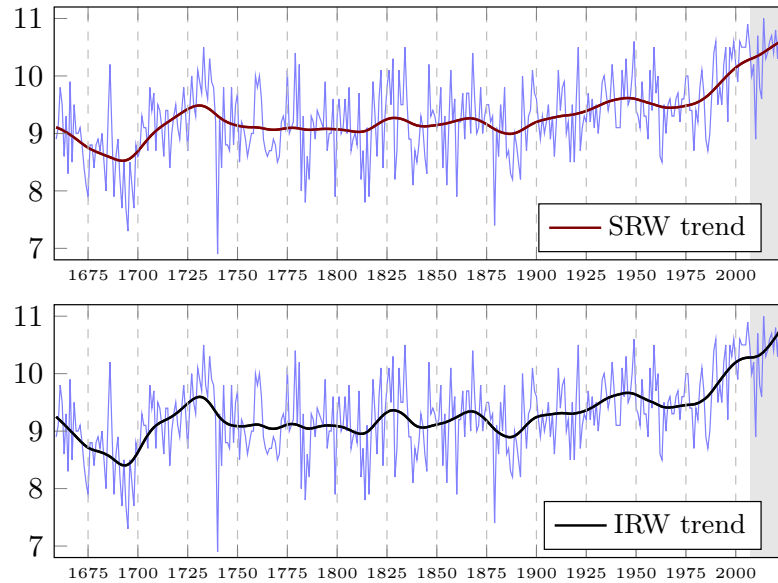
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19 The Central England Temperature (CET)



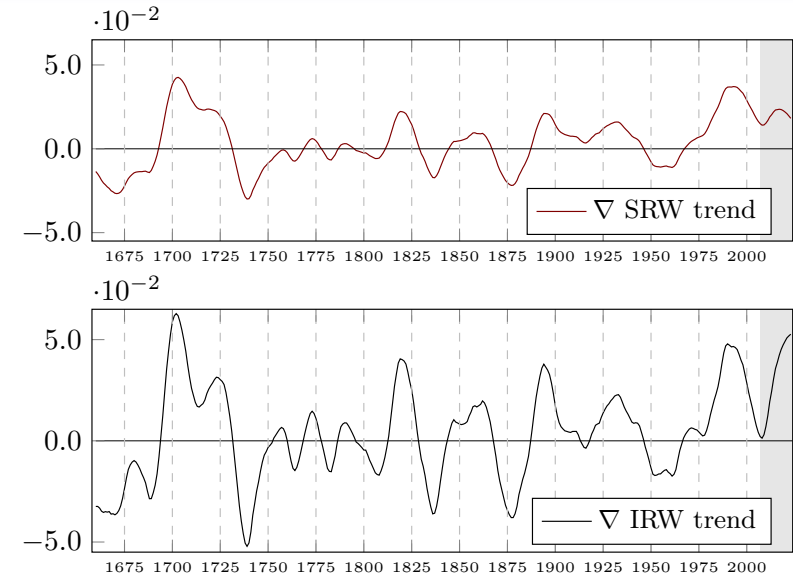
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20 The Central England Temperature 1659–2023 (CET)



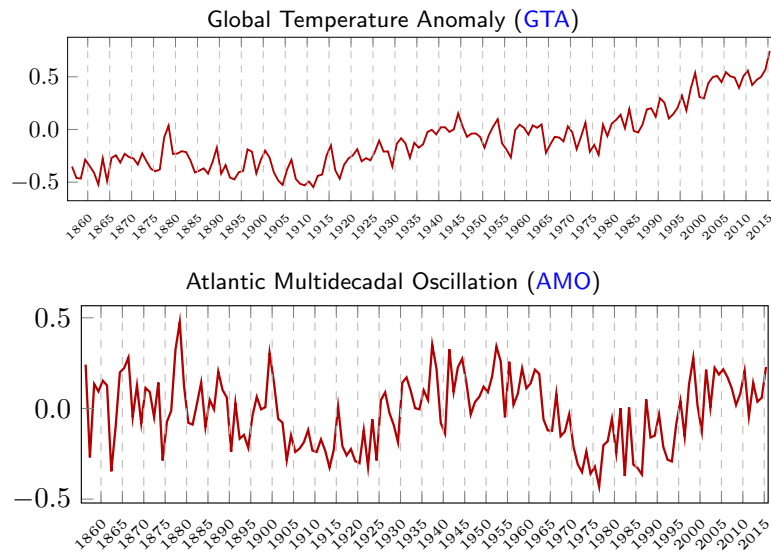
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21 The Central England Temperature 1659–2023 (CET)



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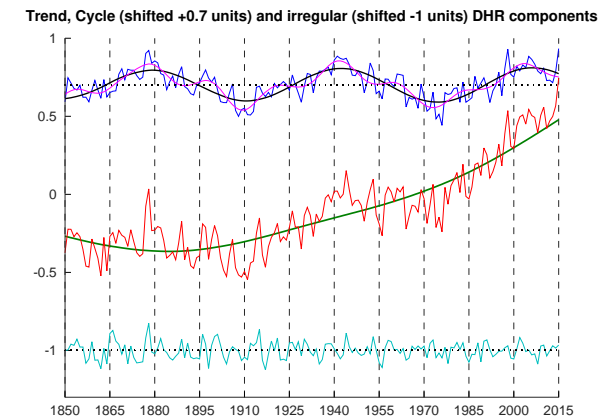
22 Modelling of Global Climate Change



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

DHR components for GTA



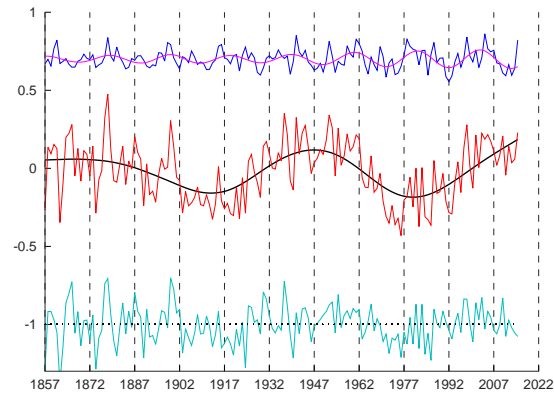
$$GTA = T + S^{63} + S^{21} + \sum(\text{other harmonics}) + Irreg$$

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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



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

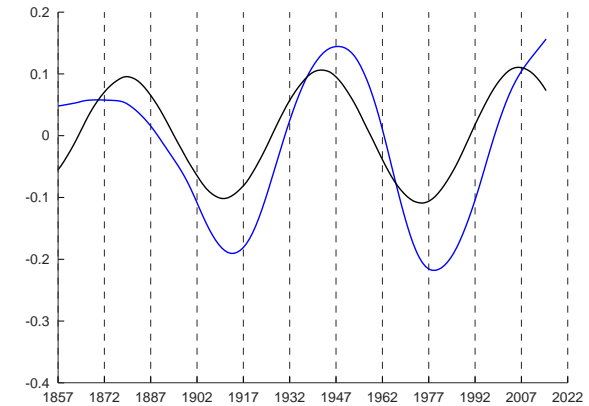
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25 Have AMO and GTA a common 63-years cycle?

Not clear

GTA has a periodic cycle, but not AMO

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

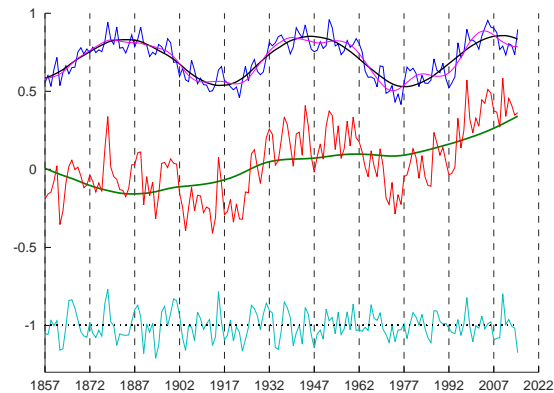


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26 Have original AMO and GTA a common 63-years cycle?

DHR components for "original" AMO data

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



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

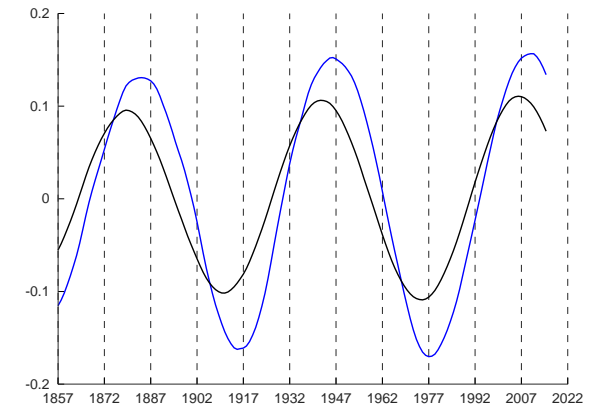
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27 Have the "original" AMO and GTA a common cycle?

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)



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28 Number of confirmed cases at 3/22/2020

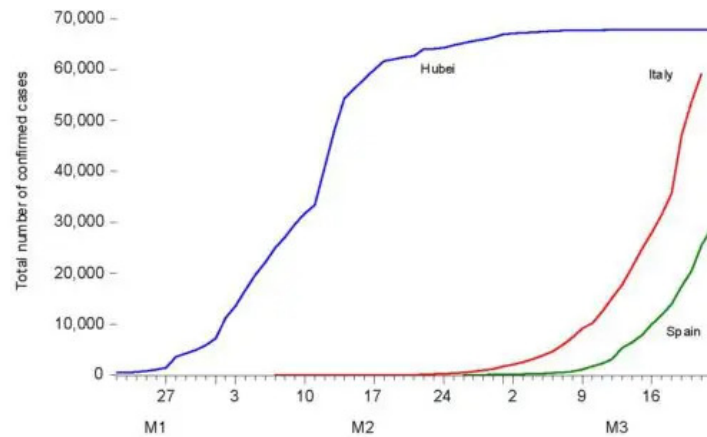


Figure 1: Number of confirmed cases at 3/22/2020

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29 Observed contagions and forecasts in Spain

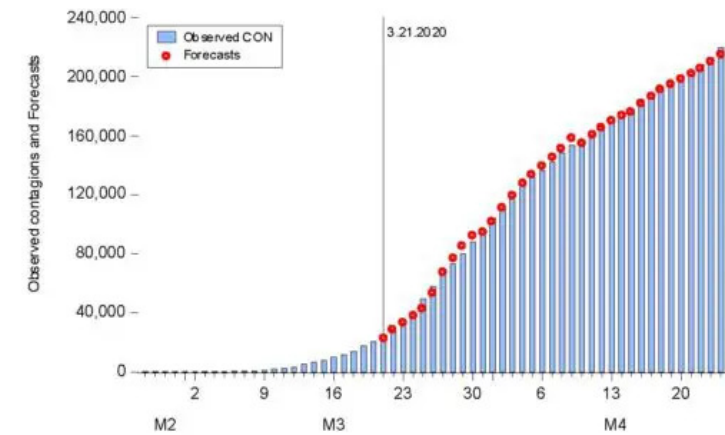


Figure 2: Observed contagions and Forecasts in Spain

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30 Observed deaths and forecasts in Spain

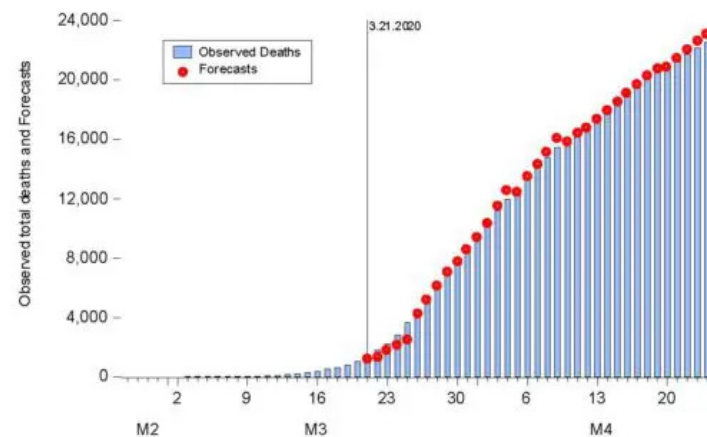


Figure 3: Observed Deaths and Forecasts in Spain

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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.

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