

Trend and cycle decomposition for macroeconomic variables after the COVID pandemic

Ferdinando Biscosi (GOPA Luxembourg)

Stefano Grassi (University of Rome “Tor Vergata”)

Gian Luigi Mazzi (Senior Consultant)

Francesco Ravazzolo (BI Norwegian Business School and Free University of Bozen-Bolzano)

Rosa Ruggeri-Cannata (European Commission | Eurostat)

Piotr Ronkowski (European Commission | Eurostat)

Honia Vlachou (GOPA Luxembourg)

June 2022

Introduction

- Review several methods to deal with data subjects (in some periods) with high volatility.
- Select automatic additive outlier detection.
- Apply three different approaches to compute trends and cycles:
 - Hodrick-Prescott (HP),
 - Christiano-Fitzgerald approximation and
 - Harvey and Trimbur (2003) approach.
- Apply to GDP, Industrial Production (IPI) and Employment (EMP) data for Euro Area.
- Additive outliers found in
 - 2020M4 and 2020M8 for monthly IPI and
 - 2020Q2 for GDP and Employment quarterly data.
- Results indicate reliable trend and cycle estimates during the COVID-19 crisis.

Dealing with COVID-period values

- Additive outliers: $AO(t_0) = \begin{cases} 1 & t = t_0 \\ 0 & t \neq t_0 \end{cases}$
- Level shifts (LS): $LS(t_0) = \begin{cases} 0 & t \geq t_0 \\ -1 & t < t_0 \end{cases}$
- Transitory changes (TC): $TC(t_0) = \begin{cases} \alpha^{t-t_0} & t \geq t_0 \\ 0 & t < t_0 \end{cases}$
- Best choice in simulations and empirical applications is AO:
 $Y_t = y_t + wI_{(t-1)}$ where Y_t series of interest, $t-1$ is the unknown location of the outlier, and w denotes the magnitude of the outlier. Trends and cycles applied to y_t .

Trend and cycle decompositions

- **Hodrick-Prescott (HP)**

$$y_t = \psi_t + \tau_t$$

The two-sided HP (HP2s) filter estimates the trend component by solving a minimization problem.

- **Christiano-Fitzgerald approximation**

$$\begin{aligned} y_t &= x_t + o_t \\ x_t &= B(L)y_t \end{aligned}$$

- **Harvey and Trimbur (HT)**

$$y_t = \mu_t + \psi_t + \epsilon_t \quad \epsilon_t \sim N(0, \sigma_\epsilon^2)$$

$$\mu_t = \mu_{t-1} + \nu_{t-1}$$

$$\nu_t = \nu_{t-1} + \xi_t \quad \xi_t \sim N(0, \sigma_\chi^2)$$

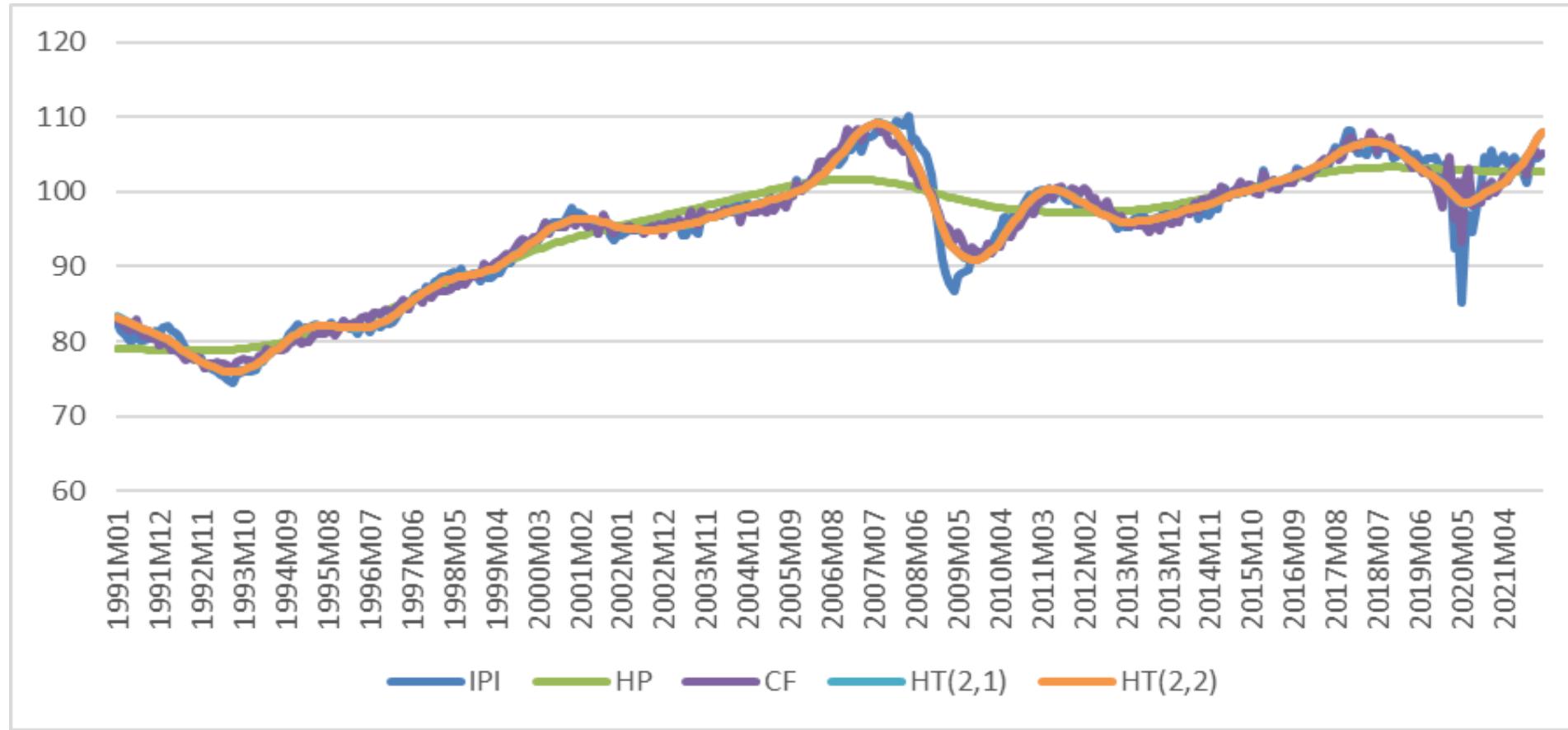
$$\begin{pmatrix} \psi_{1,t} \\ \psi_{-1,t} \end{pmatrix} = \rho \begin{pmatrix} \cos \lambda & \sin \lambda \\ -\sin \lambda & \cos \lambda \end{pmatrix} \begin{pmatrix} \psi_{1,t-1} \\ \psi_{-1,t-1} \end{pmatrix} + \begin{pmatrix} \omega_t \\ 0 \end{pmatrix}, (\omega_t) \sim N(0, \sigma_\omega^2)$$

Empirical Applications

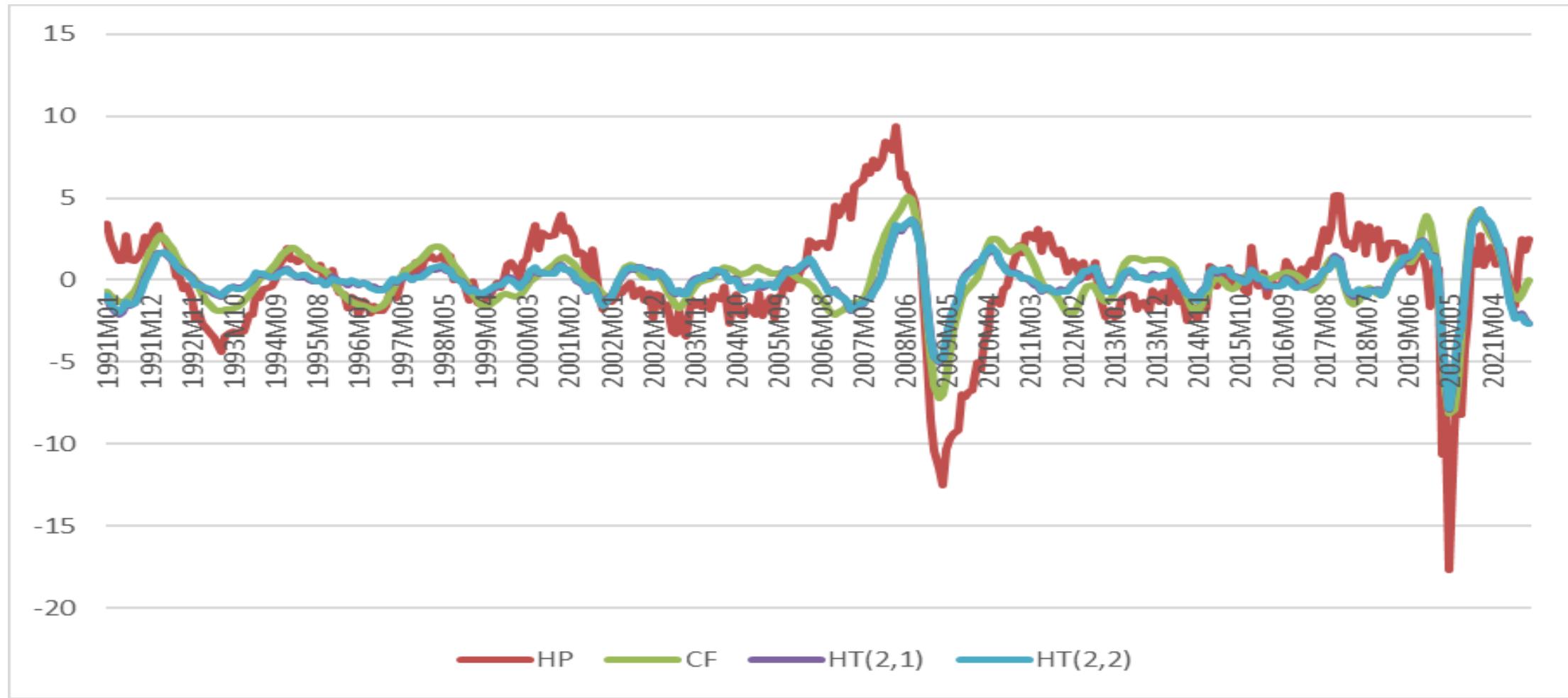
Data from Eurostat:

- EA IPI in the period 1991M1-2022M02.
AO in 2020M4 and 2020M8.
- EA GDP in the period 1995Q1-2022Q1.
AO in 2020Q2
- EA EMP in the period 1995Q1-2021Q4.
AO in 2020Q2

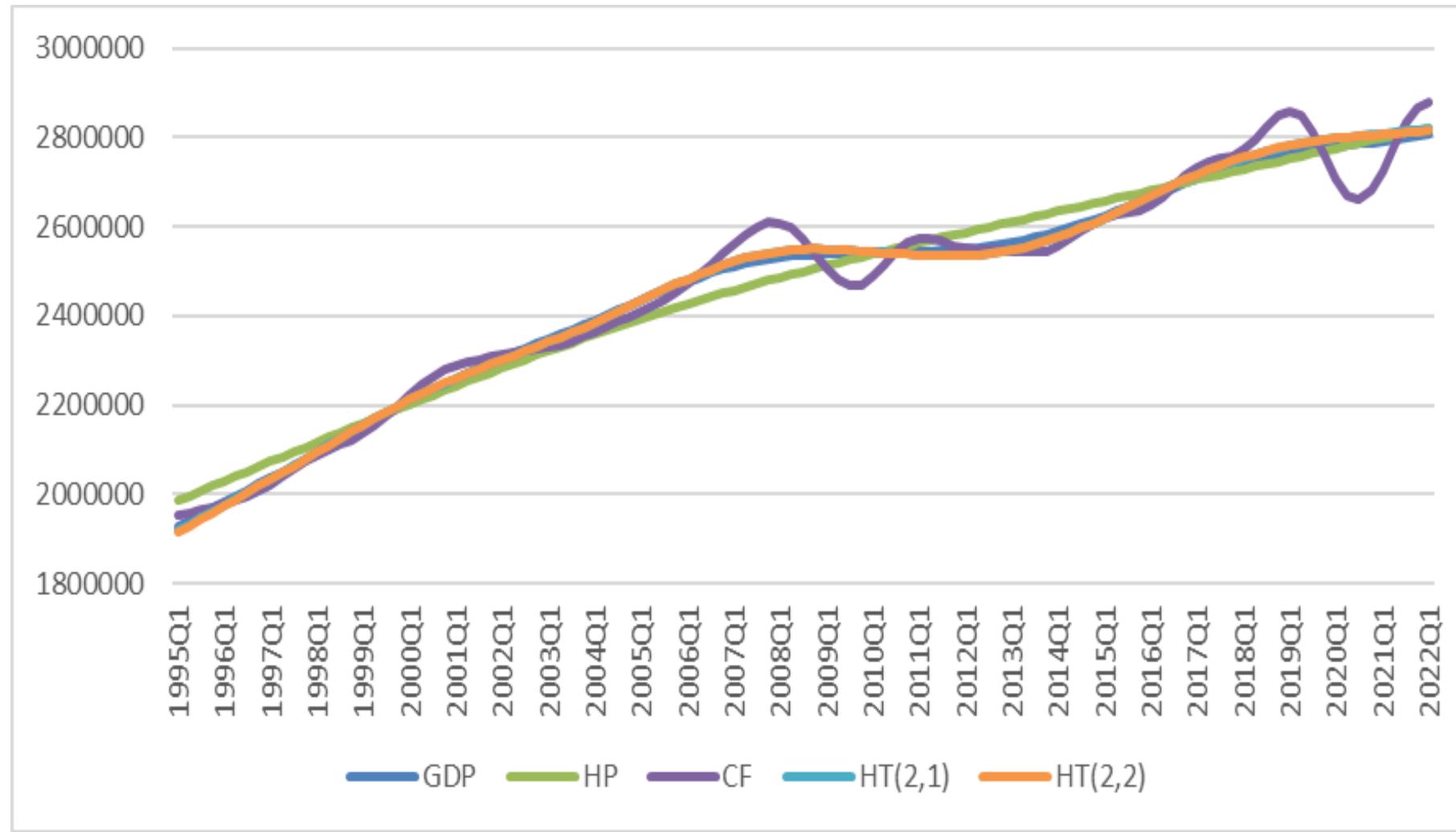
Empirical application: EA IPI trend estimates



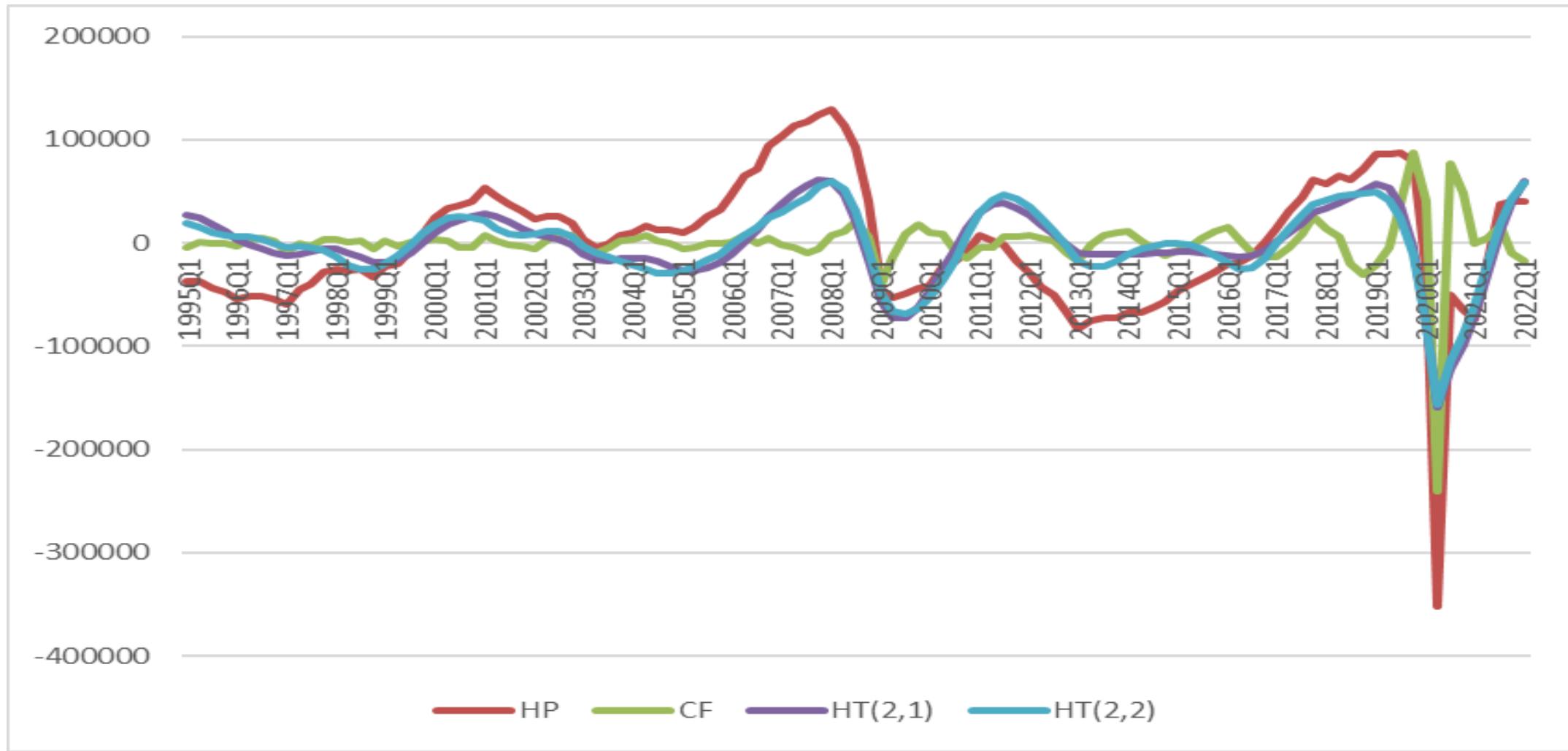
Empirical application: EA IPI cycle estimates



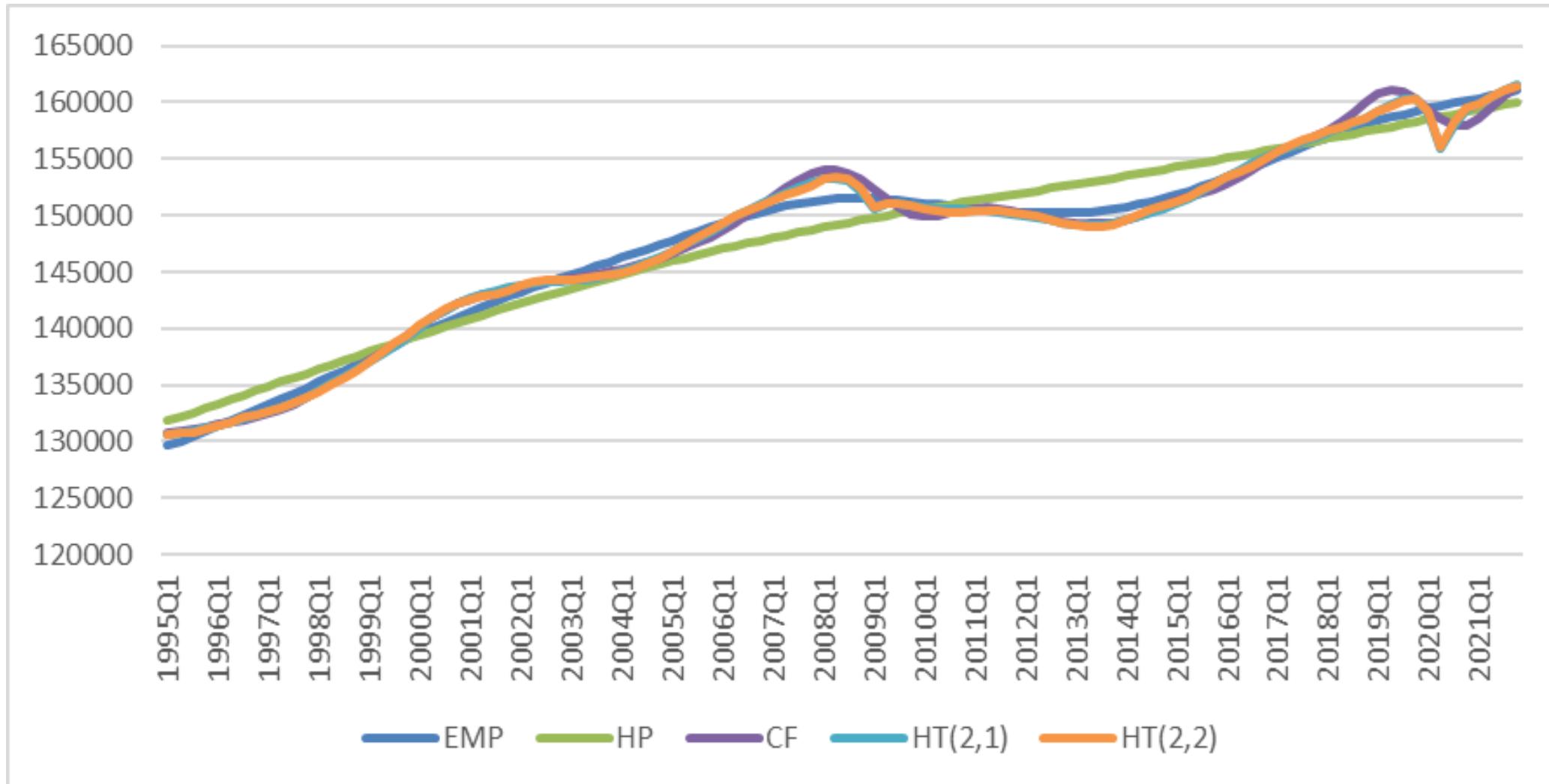
Empirical application: EA GDP trend estimates



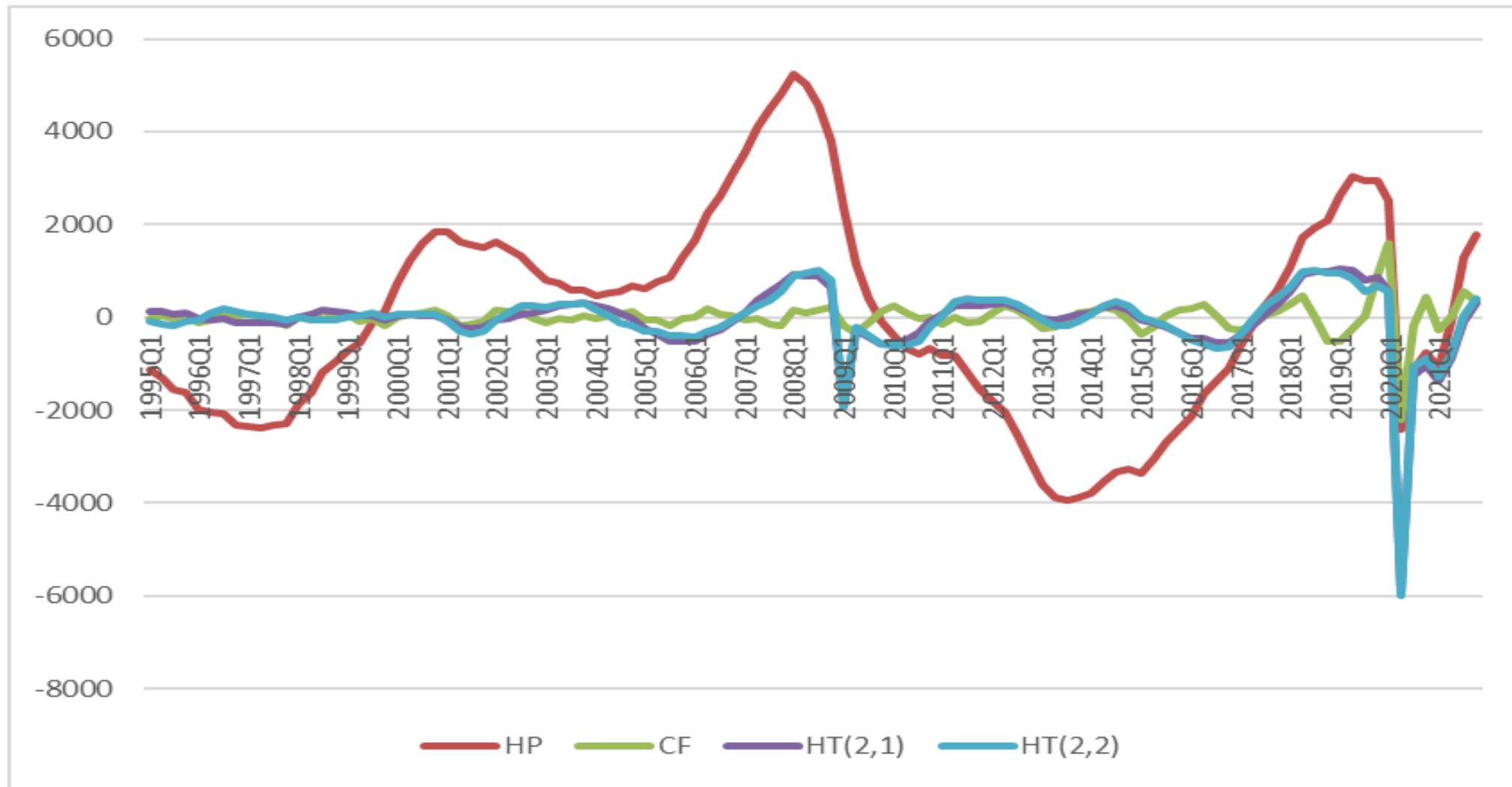
Empirical application: EA GDP cycles estimates



Empirical application: EA Employment trend estimates



Empirical application: EA Employment cycles estimates



Conclusion

- The paper presented an empirical comparative analysis based on
 - a number of trend-cycle decomposition methods,
 - alternative outlier configurations and
 - variables available at different frequency and with different degrees of volatility.
- The results obtained tend to exclude the use of outliers configurations affecting temporarily or definitively the level of the series
 - Transitory change
 - Level shift
- The simple use of two additive outliers in 2020 for monthly data and just one for quarterly data seem to provide most reliable results.

Thank you!

Case 1: normal DGP

$$y_t = \mu_t + \psi_t + \epsilon_t \quad \epsilon_t \sim N(0, \sigma_\epsilon^2)$$

$$\mu_t = \mu_{t-1} + v_{t-1}$$

$$v_t = v_{t-1} + \xi_t \quad \xi_t \sim N(0, \sigma_\xi^2)$$

$$\begin{pmatrix} \psi_t \\ \psi_t^* \end{pmatrix} = \rho \begin{pmatrix} \sin \lambda & \sin \lambda \\ -\sin \lambda & \cos \lambda \end{pmatrix} \begin{pmatrix} \psi_{t-1} \\ \psi_{t-1}^* \end{pmatrix} + \begin{pmatrix} \omega_t \\ \omega_t^* \end{pmatrix}, \quad \begin{pmatrix} \omega_t \\ \omega_t^* \end{pmatrix} \sim N \begin{pmatrix} 0, \sigma_\omega^2 & 0 \\ 0 & \sigma_{\omega^*}^2 \end{pmatrix}$$

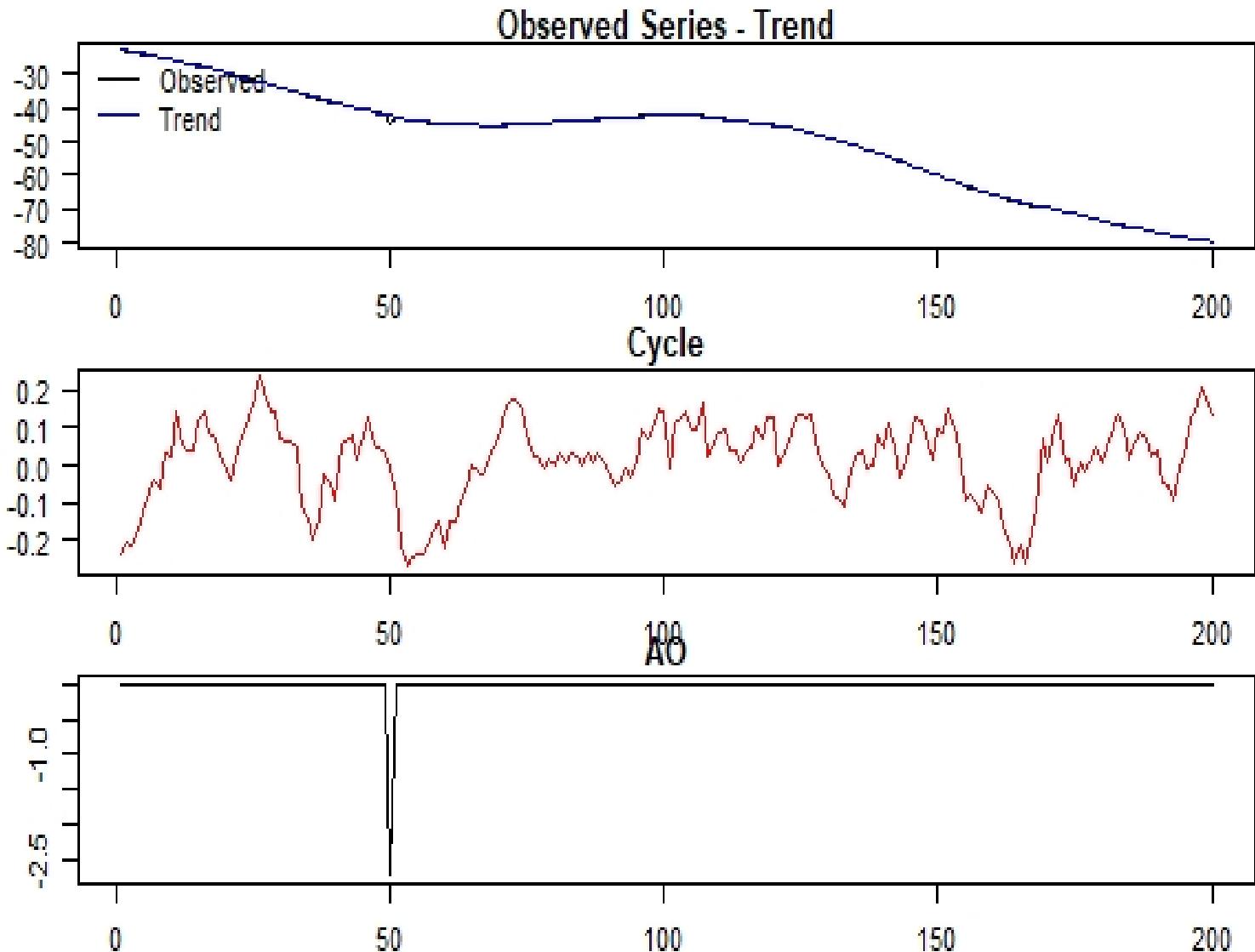
$$\lambda=0.20; \rho=0.90; \sigma_\xi^2=0.05; \sigma_\eta^2=0.05 \text{ and } \sigma_\epsilon^2=0.025$$

See Koopman, Lit and Lucas (2016)

Case 2: Additive outlier

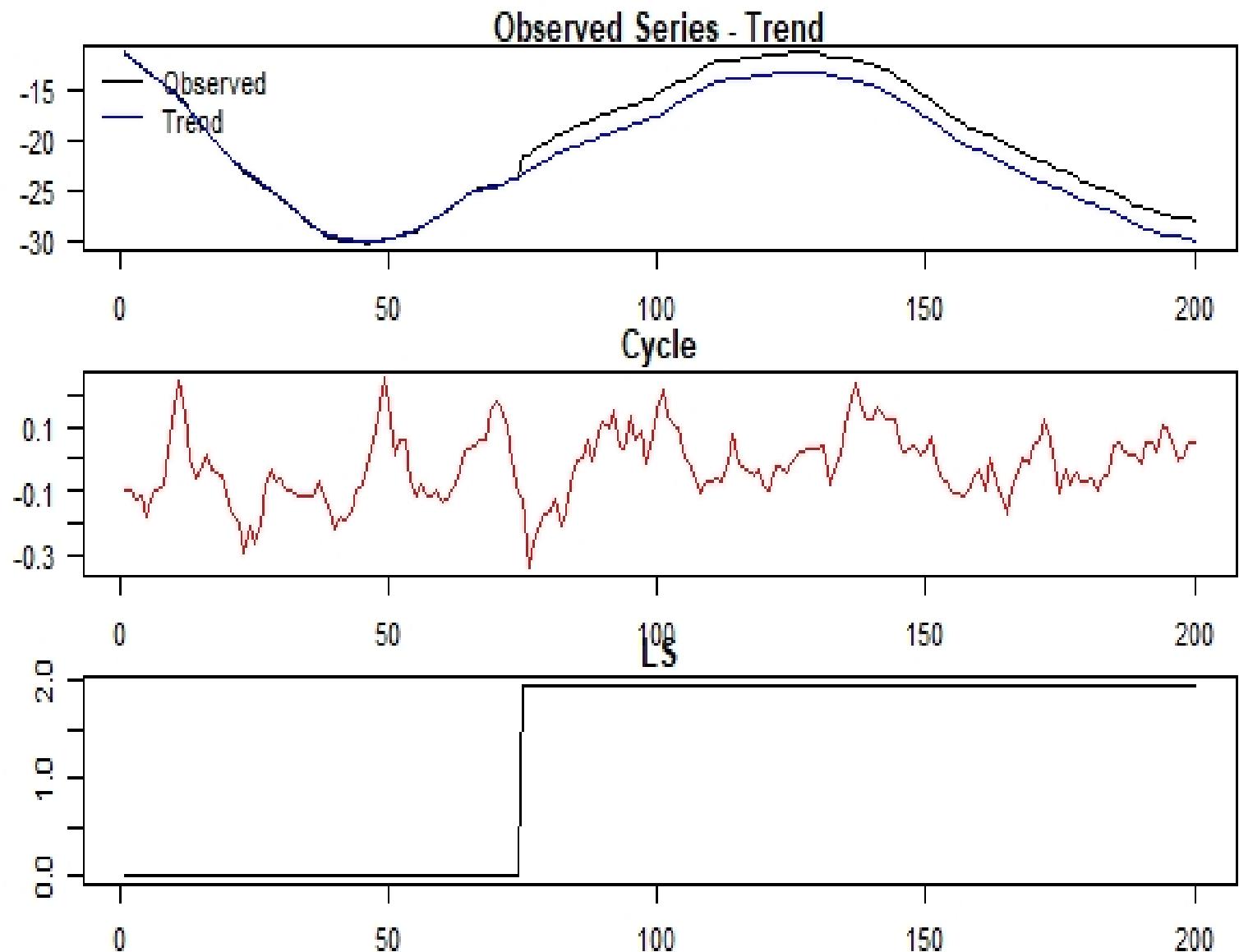
$$AO(t_0) = \begin{cases} 1 & t = t_0 \\ 0 & t \neq t_0 \end{cases}$$

Break in the series



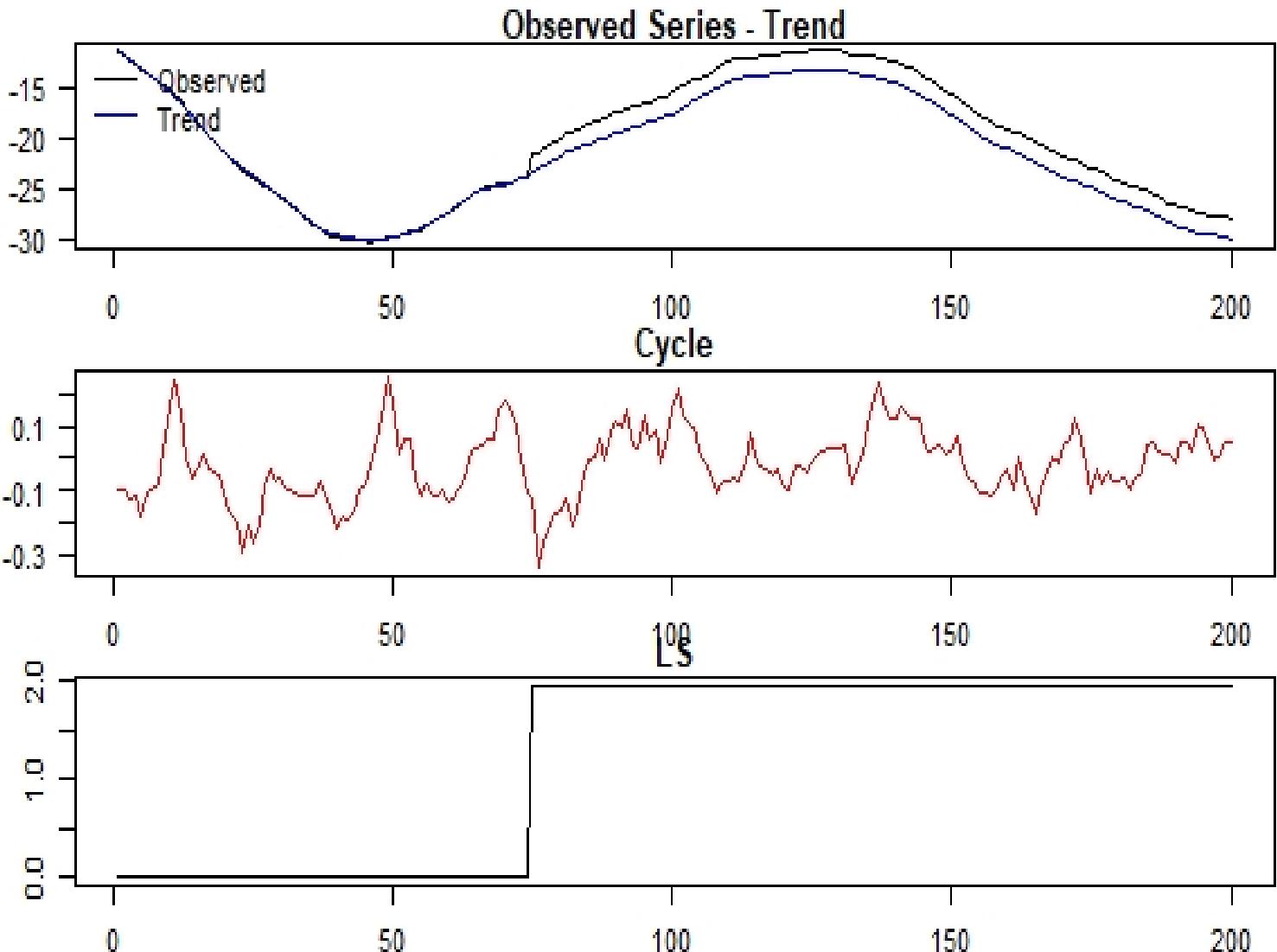
Case 3: Level Shift

$$LS(t_0) = \begin{cases} 0 & t \geq t_0 \\ -1 & t < t_0 \end{cases}$$

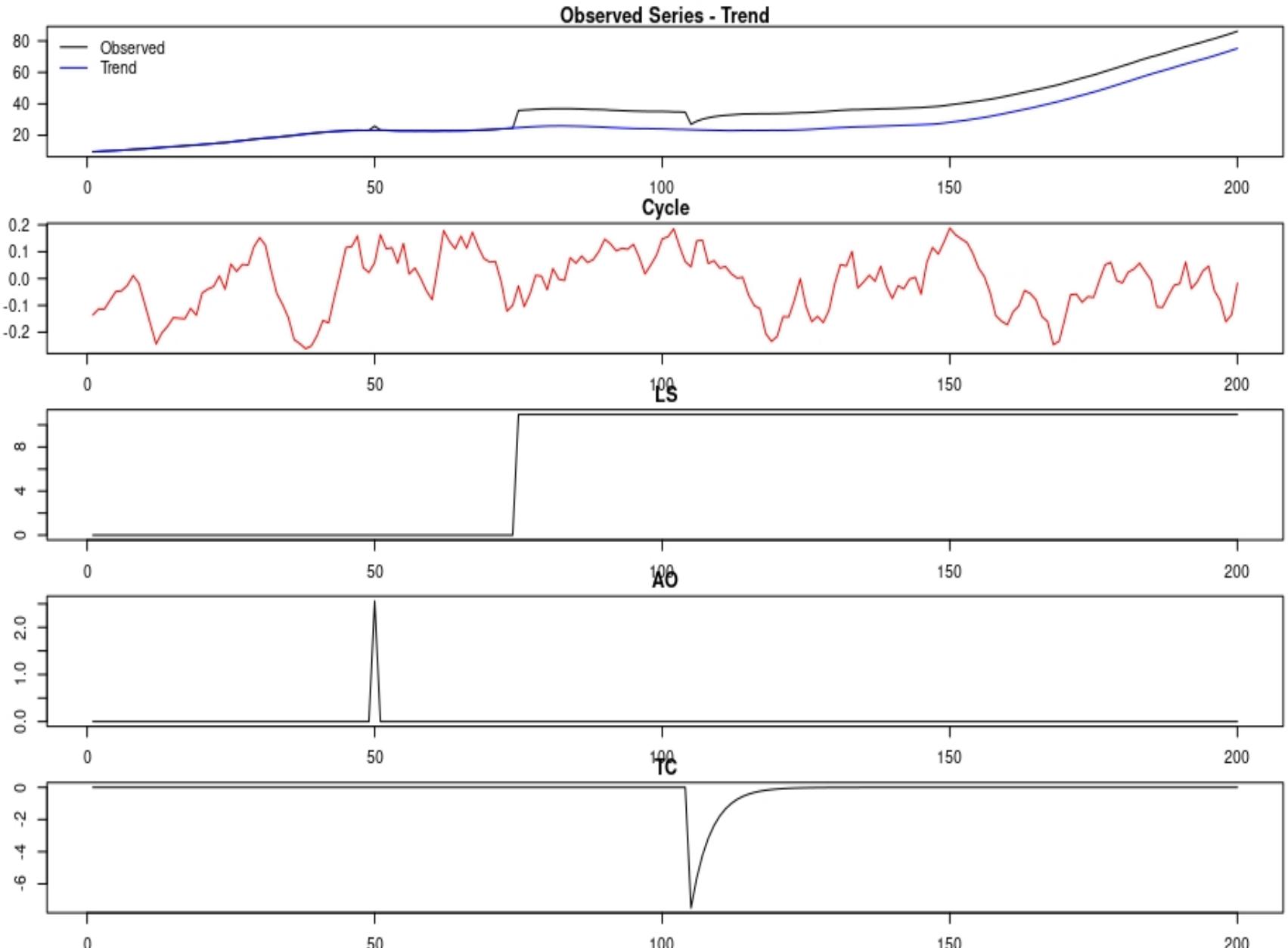


Case 4: Transitory change

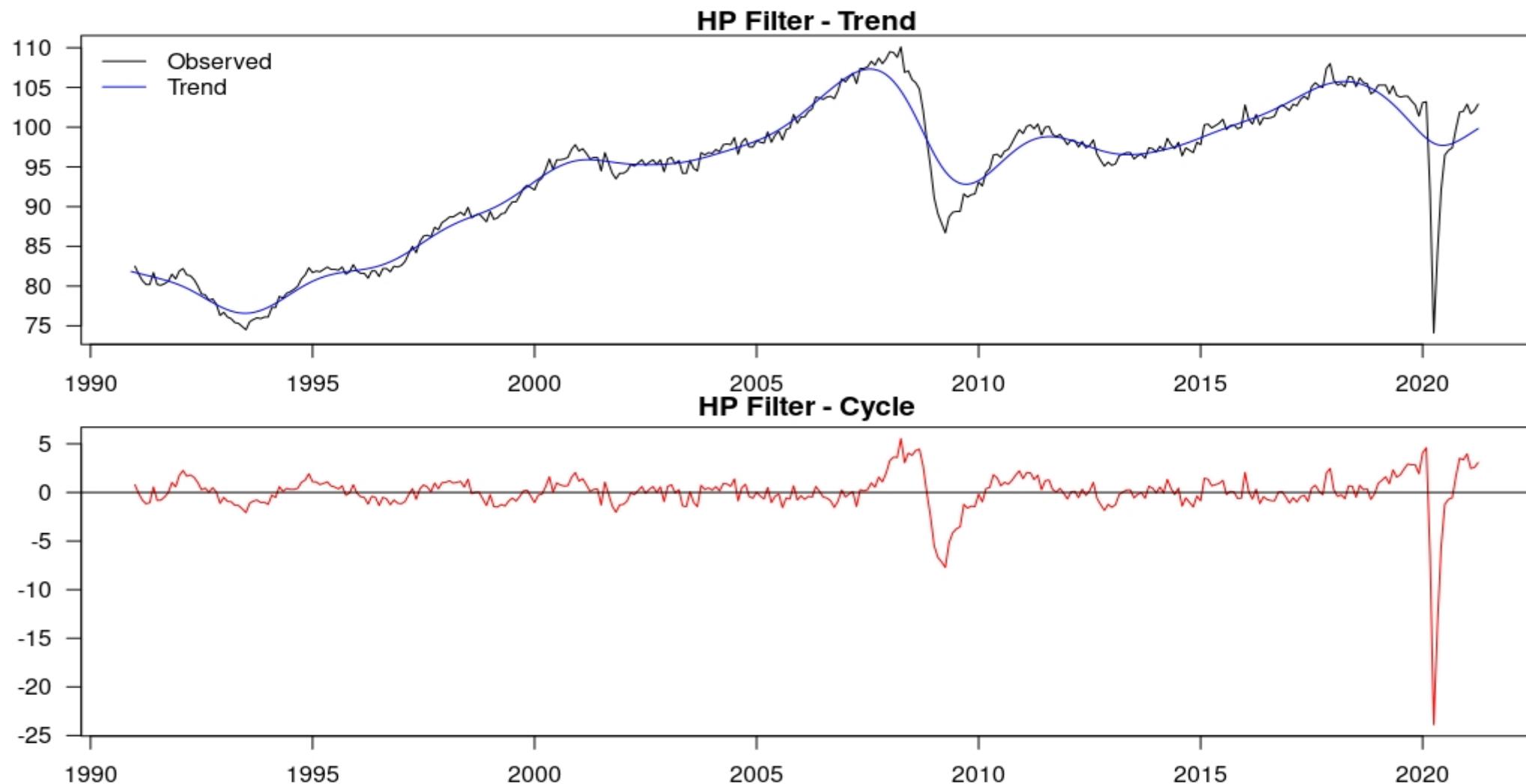
$$TC(t_0) = \begin{cases} \alpha^{t-t_0} & t \geq t_0 \\ 0 & t < t_0 \end{cases}$$



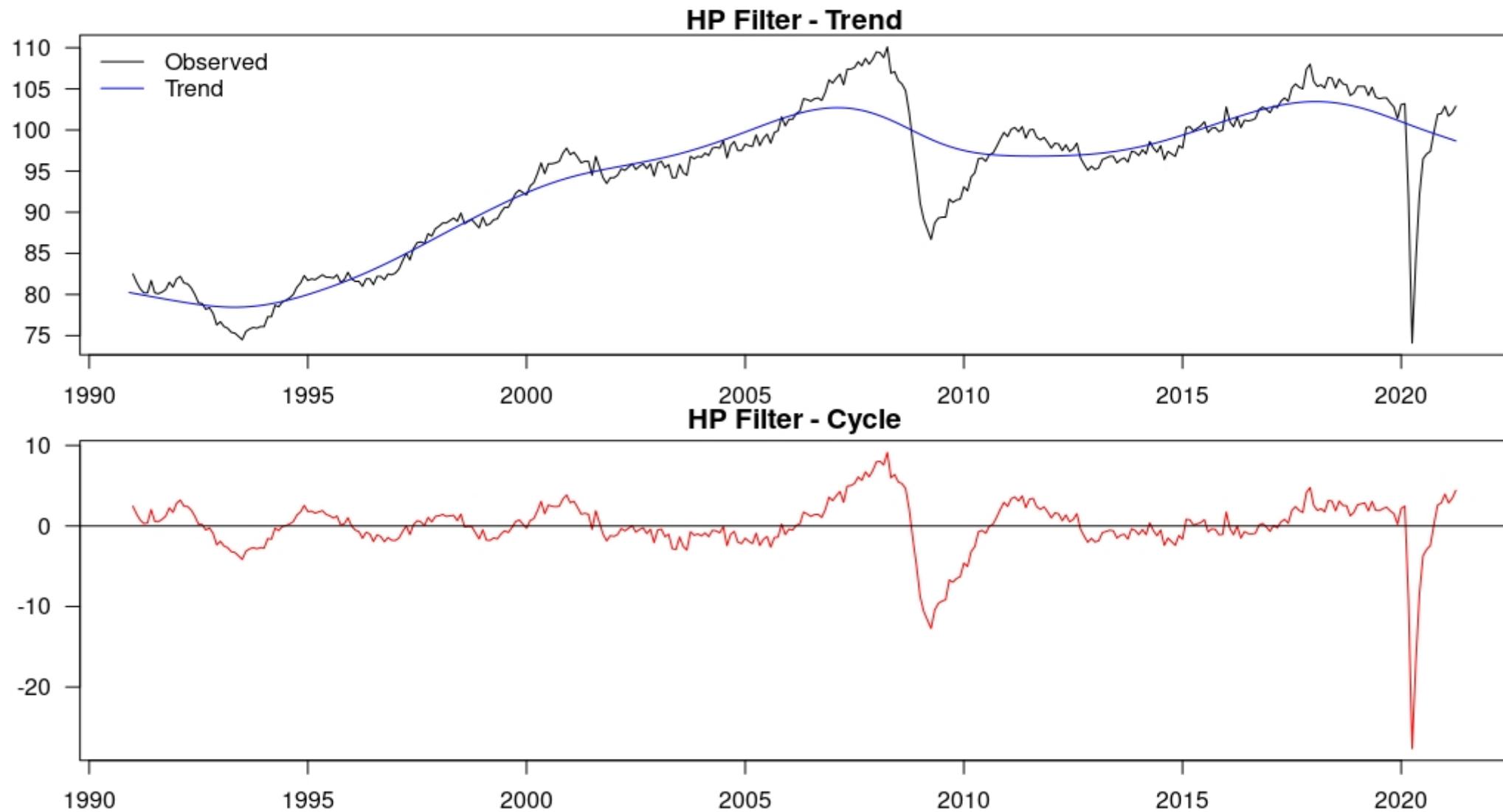
Case 5: All



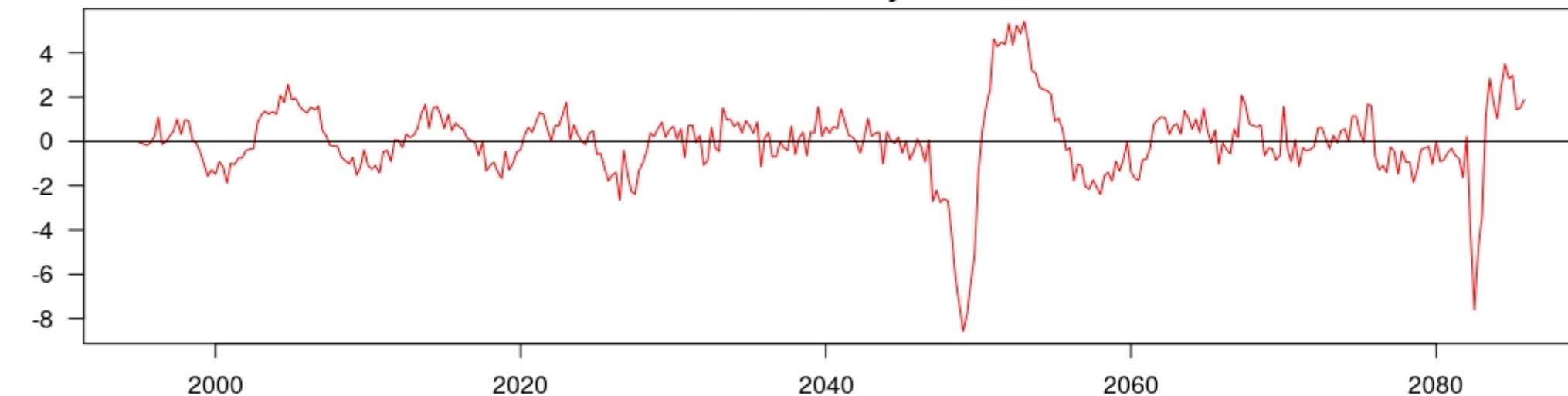
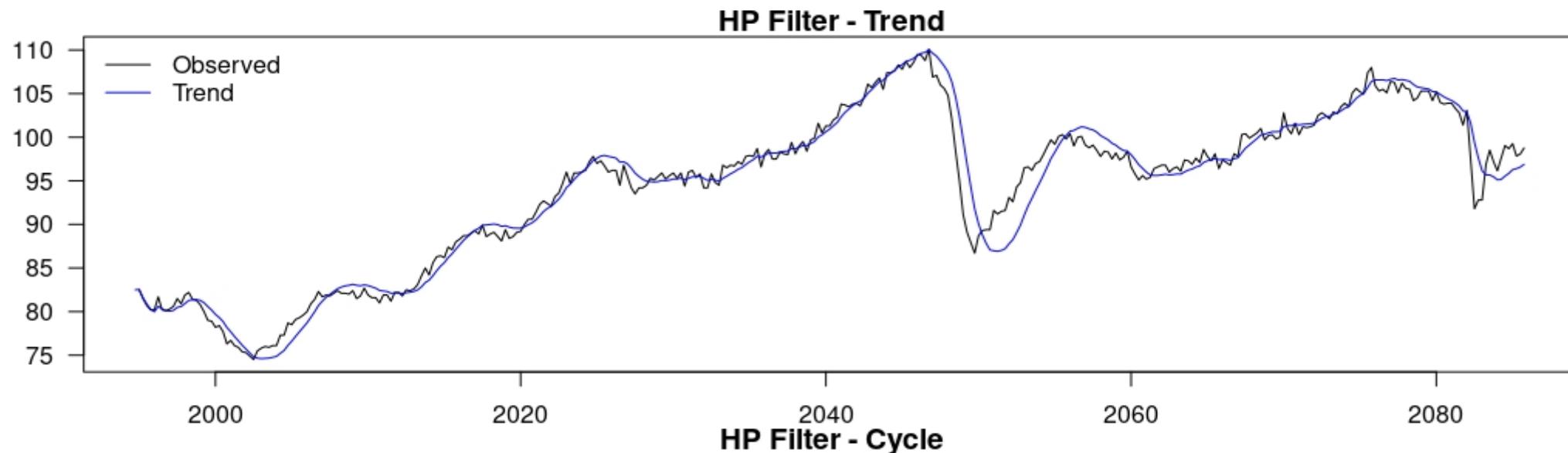
Empirical application: EA IPI, HP2s



Empirical application: EA IPI, adj-HP1s



Empirical application: EA IPI, AC-HP2s



Thank you!