The Dutch Business Cycle:
A finite sample approximation of selected indicators

Ard den Reijer
De Nederlandsche Bank

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Outline

- Business cycles: definition and extraction
  - business cycle frequencies versus model-based cycle
- Business cycle indicator
  - Construction and composition of coincident and leading indices
- Real-time analysis
  - Reliability of real-time business cycle estimates

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Business cycle indicator

- Business cycles can broadly be defined as oscillating motions of economic activity, which are visible as more or less simultaneous patterns of fluctuations of macroeconomic variables such as output, interest rates, unemployment and prices.

- Policy institutions operate a business cycle indicator as an instrument to measure and forecast the business cycle and its turning points

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Business cycle indicators

- NBER´s approach of coincident and leading indicators
  - Conference Board, OECD
- Regularly published cyclical indicators for Holland
  - CBS, CPB, DNB, EUR, OECD, Rabobank and RuG
- Trend filter Methodologies
  - Moving average, Phase Average Trend (PAT), (symmetric) growth rates, Hodrick-Prescott (HP), Baxter-King (BK), Christiano-Fitzgerald (CF), Unobserved Component (UOC) models / Kalman-filter

Trend filter: axiom

- **Burns & Mitchell (1946, p3)**
  - **"… in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own."**
- **Filter typology (Schleicher, 2004)**
  - **Model based filter: define a model and optimally extract the modeled cycle from the actual data**
  - **Band-pass filters: optimal finite sample isolation of business cycle frequencies**

Trend filter: Christiano-Fitzgerald

- Optimal band-pass filter for I(1)-processes
  - I(1)-process approximates Granger´s (1966) typical spectral shape of an economic variable
- Optimal End-of-Sample filter
  - Asymmetric filter, which becomes one-sided at end-of-sample
- Convergence to ideal band-pass filter
  - time-varying filter weights due to maximum window size = full sample
  - Filter weights converge to ideal weights as window size expands
  - Property holds for all approximate band-pass filters (cf Baxter-King)

Approximate band-pass filters

- **Ideal band-pass filter coefficients: (Priestley, 1982)**

Let $2 \le p_l < p_u < \infty$

$$\begin{cases} B_j = \dfrac{\sin(jb) - \sin(ja)}{j\pi}, \; j \ge 1 \\ B_0 = \dfrac{b-a}{\pi}, a = \dfrac{2\pi}{p_u}, b = \dfrac{2\pi}{p_l} \end{cases} \Leftrightarrow \quad B\left(e^{-i\omega}\right) = \begin{cases} 1, \omega \in (a,b) \\ 0 \text{ otherwise} \end{cases}$$

- **Discrete-time Fourier transform:** $f_x(\omega) = \dfrac{1}{2\pi} \sum_{t=-\infty}^{\infty} x_t e^{-i\omega t}$ **, which maps**

T **observations from a stationary time series variable** $\{x_t\}^T_{t=1}$

on a continuous interval ω ∈ [0,π].

Approximate band-pass filters: BK

- *f*+*p*+1 weighted least squares projections

$$\underset{\hat{B}_j^{p,f},\, j=-f,\dots,p}{\arg\min} \int_{-\pi}^{\pi} \left| B\left(e^{-i\omega}\right) - \hat{B}_j^{p,f}\left(e^{-i\omega}\right) \right|^2 f_x(\omega)\, d\omega$$

- Solution of Baxter&King (1999) under conditions:
  - Trend elimination
  - Time-invariant, symmetric filter

$$f_x(\omega) = \begin{cases} \infty \text{ for } \omega = 0 \\ 1 \text{ otherwise} \end{cases}$$

- BK-filter reads as: $\hat{B}_j^{k,k} = B_j + \frac{\Delta}{(1+2k)},\ j = 0, \pm 1, \dots, \pm k$

$$\text{with } \Delta = -\left[B_0 + 2\sum_{j=1}^{k} B_j\right]$$

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Approximate band-pass filters: CF

- **Solution of Christiano & Fitzgerald (2003) under conditions:**
  - **x_t follows a Random Walk,** $f_x(\omega) = [2(1-\cos(\omega))]^{-1}$
  - **Filter is symmetric:** $\hat{B}_j^{\,p,f} = \hat{B}_{-j}^{\,p,f}$ **for j<min{*p,f*}**
- **CF-filter reads as:** $\forall t, t = 1,\ldots,T$ where $f = T - t + 1,\ p = t - 1$

$$\begin{cases} \hat{B}_j^{\,p,f} = B_j,\ j = -p+1,\ldots, f-1 \\ \hat{B}_{-p}^{\,p,f} = \frac{B_0}{2} - \sum_0^{p-1} B_j,\ \hat{B}_f^{\,p,f} = \frac{B_0}{2} - \sum_0^{f-1} B_j \end{cases}$$

- **Note that CF and BK converge as k→∞ p,f →∞:** $\hat{B}_j \to B_j$

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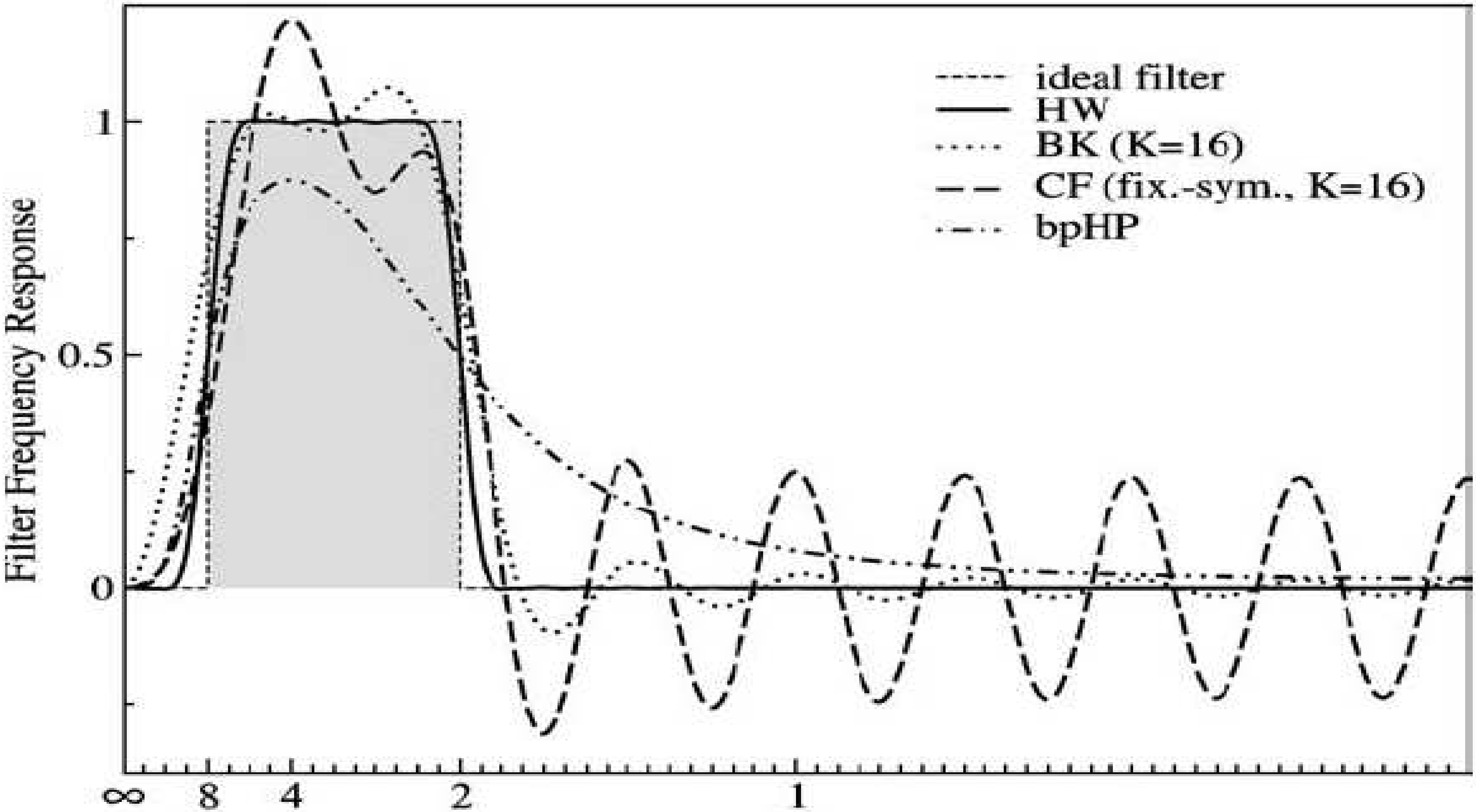
Approximate band-pass filters



Iacobucci & Noullez (2005), A Frequency Selective Filter for Short-Length Time Series ,Computational Economics 25: 75-102.

Trend filter: CF versus HP

- HP-filter in the frequency domain
  - one-sided band-pass filter

    quarterly resp. monthly data, λ=1600 and λ=129600 → 7.96 jaar (Ravn & Uhlig, 2002)
  - need also HP-filter for seasonal + irregular (AMP, 2005)
- HP-filter as an UC-model:
  - trend component I(2), Cyclical component I(0), no seasonal component
  - parameter λ = inverse signal-to-noise ratio

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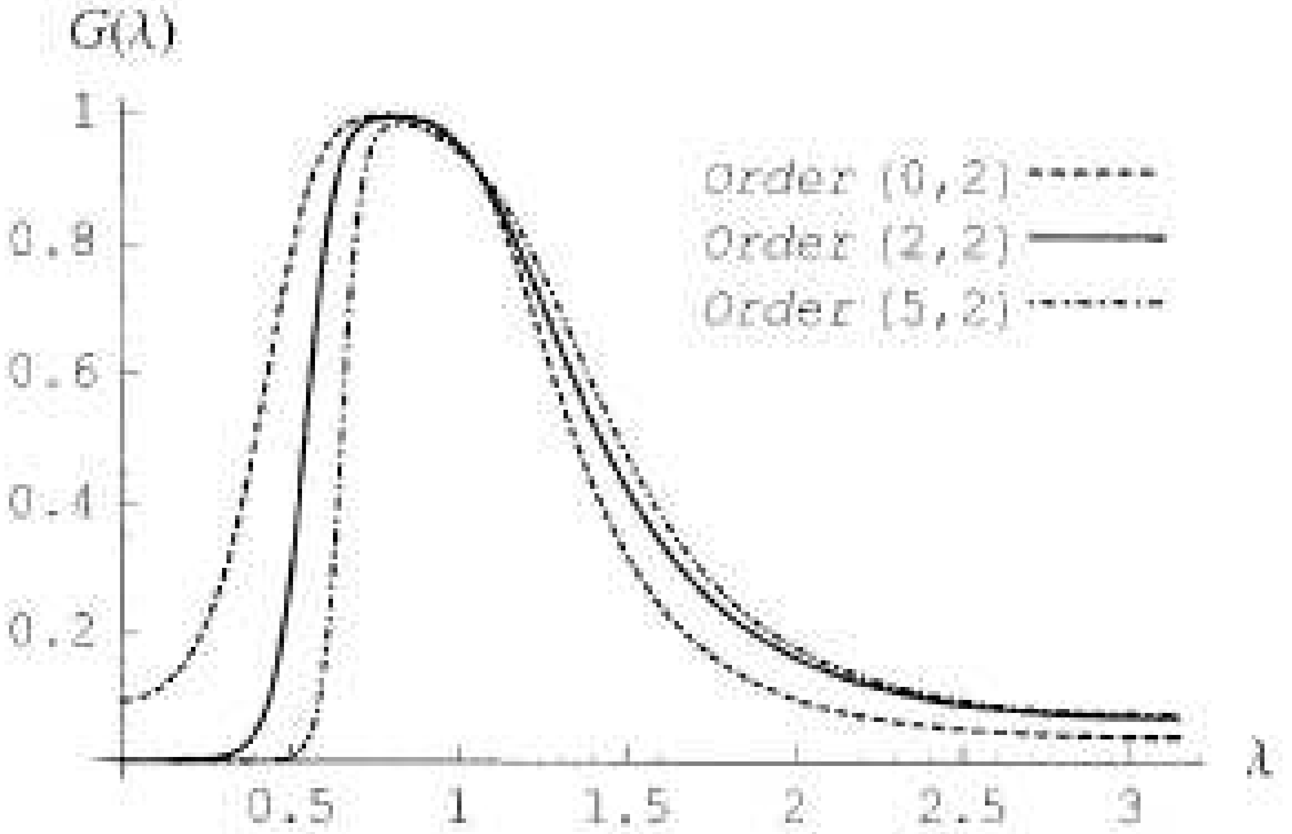
Trend filter: CF versus UC

- **Are statisticians more influential than econometricians? (Harvey & Trimbur, RES 2003)**
  - **Economic specification of UC-model → sub-optimal band-pass filter**
  - **Optimal specification frequency domain → parameters UC-model not economic interpretable**
- **UC is a parametric model: identity**
  - **Adding new observations can cause an alternative model specification to get a higher likelihood, which potentially causes a radical change in the historical pattern of the cycle.**

Are statisticians more influential than econometricians?

FIGURE 8.—GAIN FUNCTIONS OF GENERALIZED BANDPASS BUTTERWORTH FILTERS OF ORDERS (0, 2), (2, 2), AND (5, 2) WITH $q_\kappa = q_\zeta = 1$, $\rho = 0.9$, AND $\lambda_c = \pi/4$



Harvey, A.C. and T.M. Trimbur, 2003, General Model-Based Filters for Extracting Cycles and Trends in Economic Time series, The Review of Economics and Statistics, 85(2), 244-255.

Are statisticians more influential than econometricians?

- Unobserved Components model $x_t = \mu_{m,t} + \psi_{n,t} + \varepsilon_t,\ \varepsilon_t \sim WN\left(0, \sigma_\varepsilon^{\ 2}\right)$
  - *M*th-order stochastic trend: $\mu_{1,t} = \mu_{1,t-1} + \zeta_t,\ \zeta_t \sim WN\left(0, \sigma_\zeta^{\ 2}\right)$
    $\mu_{i,t} = \mu_{i,t-1} + \mu_{i-1,t},\ i = 2 \ldots m$
  - *N*th-order stochastic cycle: $\psi_{n,t}$
- Apply Generalized Butterworth filter, GBF(m,n,q)
  - note HP-filter special case with *m*=2, *n*=0, *q*=1/1600
- Statistical optimality, prefer high number for *M* and *N*
- Econometric specification: time series are I(M), so M≤2

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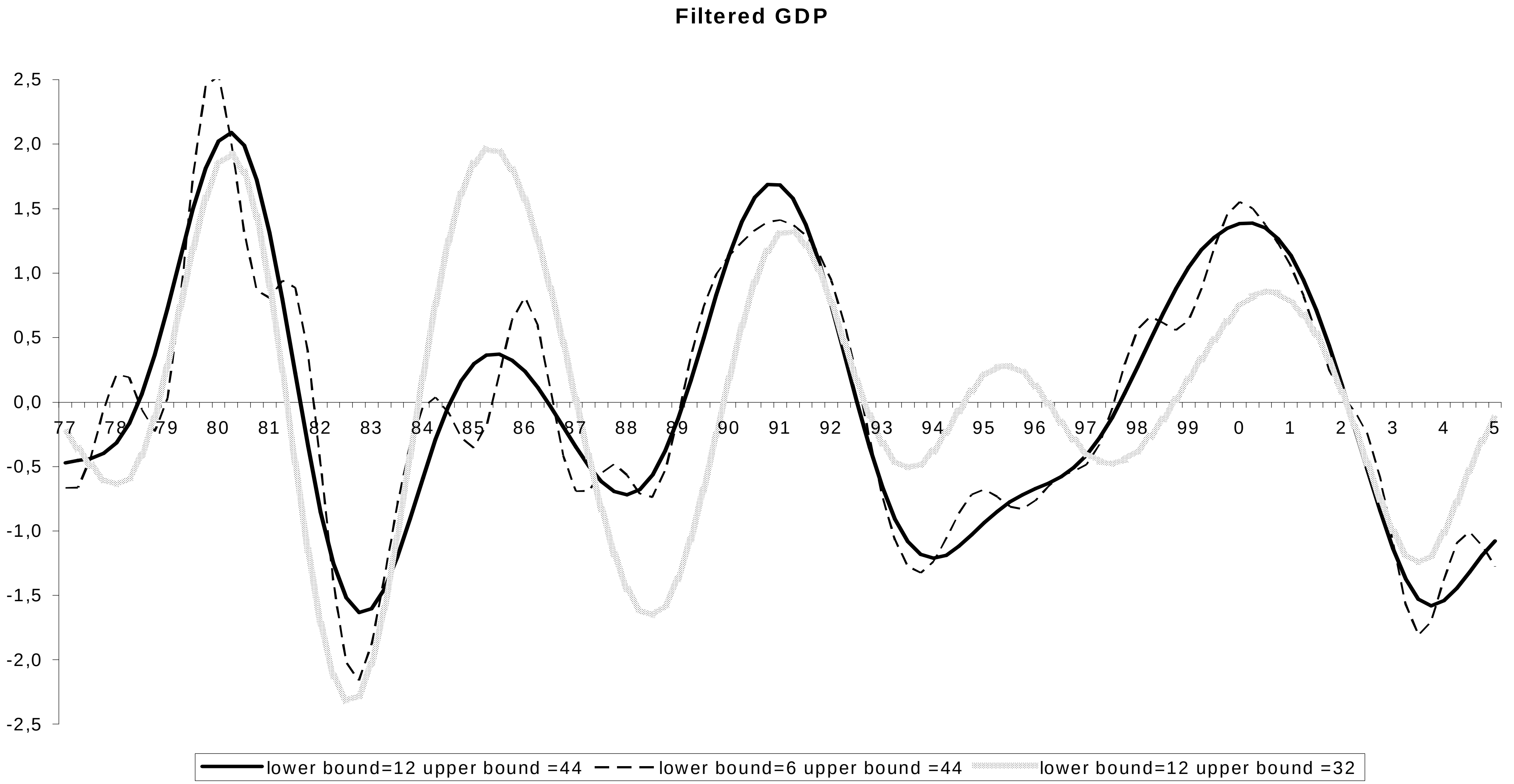
Business cycle frequencies

- Lower bound: 3 years
  - Filtering irregalur + seasonal + short period cyclicality
  - Improves relation between Coincident Index and Leading Index
- Upper bound: 11 years
  - U.S. 8 years, Stock&Watson (2000), Baxter&King (1999)
  - Euro area 10 years, Agresti & Mojon (2001)
  - Netherlands: 10-11 years. Length cyclical motion GDP according to alternative filter specifications (CBS, 2005)

Cyclical GDP: 1.5/3 years – 8/11 years



Composite coincident index

- CEPR dating committee
  - GDP, industrial production, employment, consumption, investment
- NBER dating committee + Conference Board
  - GDP, industrial production, employment, disposable income, wholesale and retail sales
- Available data for the Netherlands
  - industrial production (6 weeks delay), household consumption (8 weeks delay)
  - Proxy employment: invoiced hours of staffing employment from Randstad Netherlands (<2 weeks delay) (cf Franses & De Groot, 2004).

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Composite Leading Index

- Moore & Shiskin´s (1967) system of economic and statistical criteria
  - minimum correlation + lead $\rho_i^{\max} = \max_{l=0,\dots,36} \rho\left(CI_t, LI_{i,t-l}\right)$
  - Selected indicator variable should either cause or quickly react to the business cycle
  - Balanced representation between Business & consumer surveys, monetary & Financial data and real activity variables

Composition of leading index

Leading indicator variable	Maximum correlation	Lead time in months	Current Assessment June 2007
Industrial Production	0.9 (with GDP)	0	+
Household Consumption	0.9 (with GDP)	0	+
Staffing Employment	0.6 (with GDP)	0	-
IFO-indicator Germany	0.81	9	+
Expected business activity	0.86	9	+
3-months euro/guilder interest rate	0.87	26	-
Yield curve	0.72	30	-
Stock finished products	0.71	10	+
Order arrivals	0.78	15	-
Consumer confidence	0.86	11	+
Stock market index (AEX)	0.73	7	+
Registered motor vehicles	0.81	9	+
Real house price	0.77	7	+
OECD´s leading indicator for the U.S.	0.77	18	-

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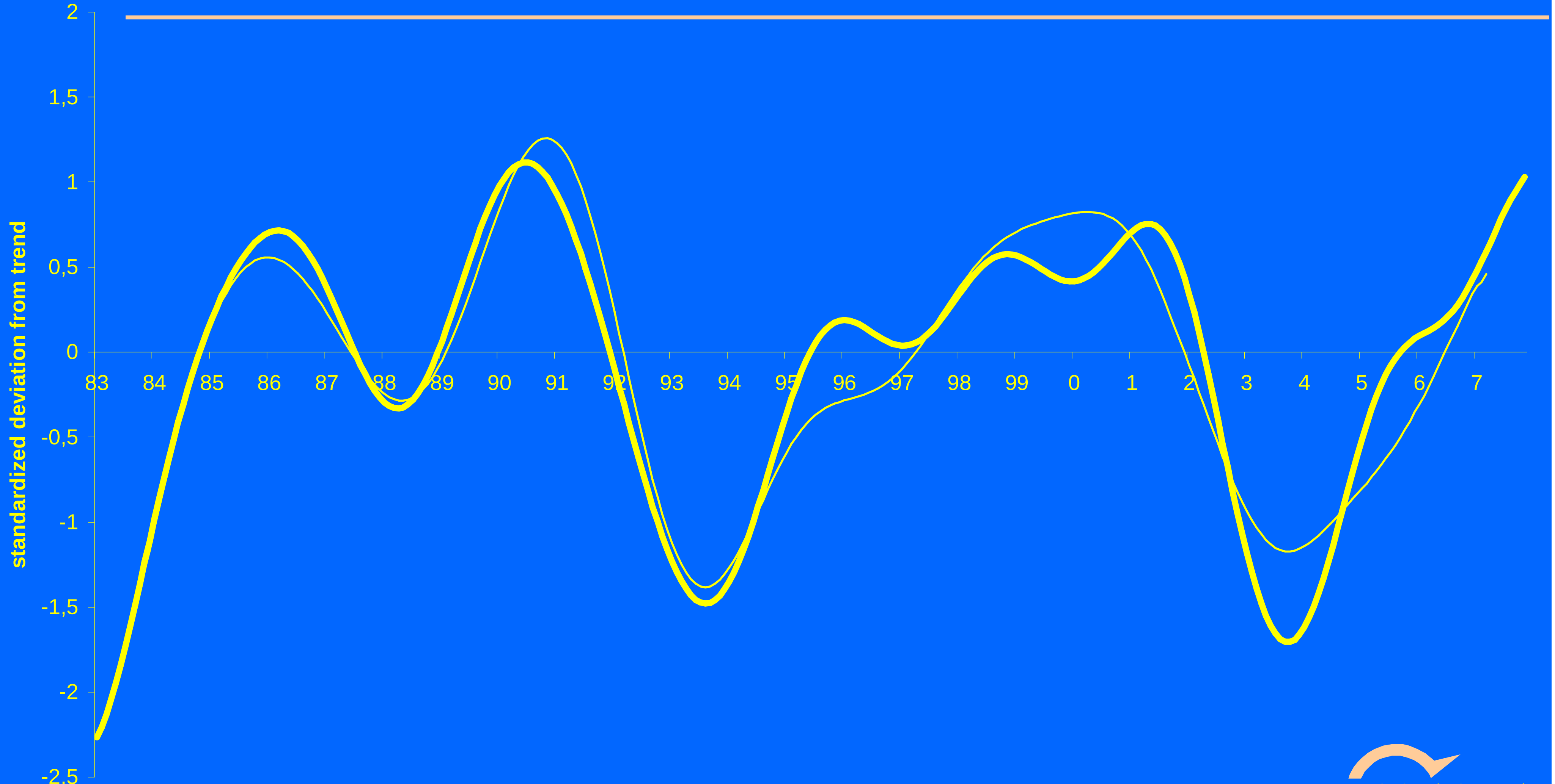
DNB business cycle indicator, June 2007, see WWW.DNB.NL



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2
1,5
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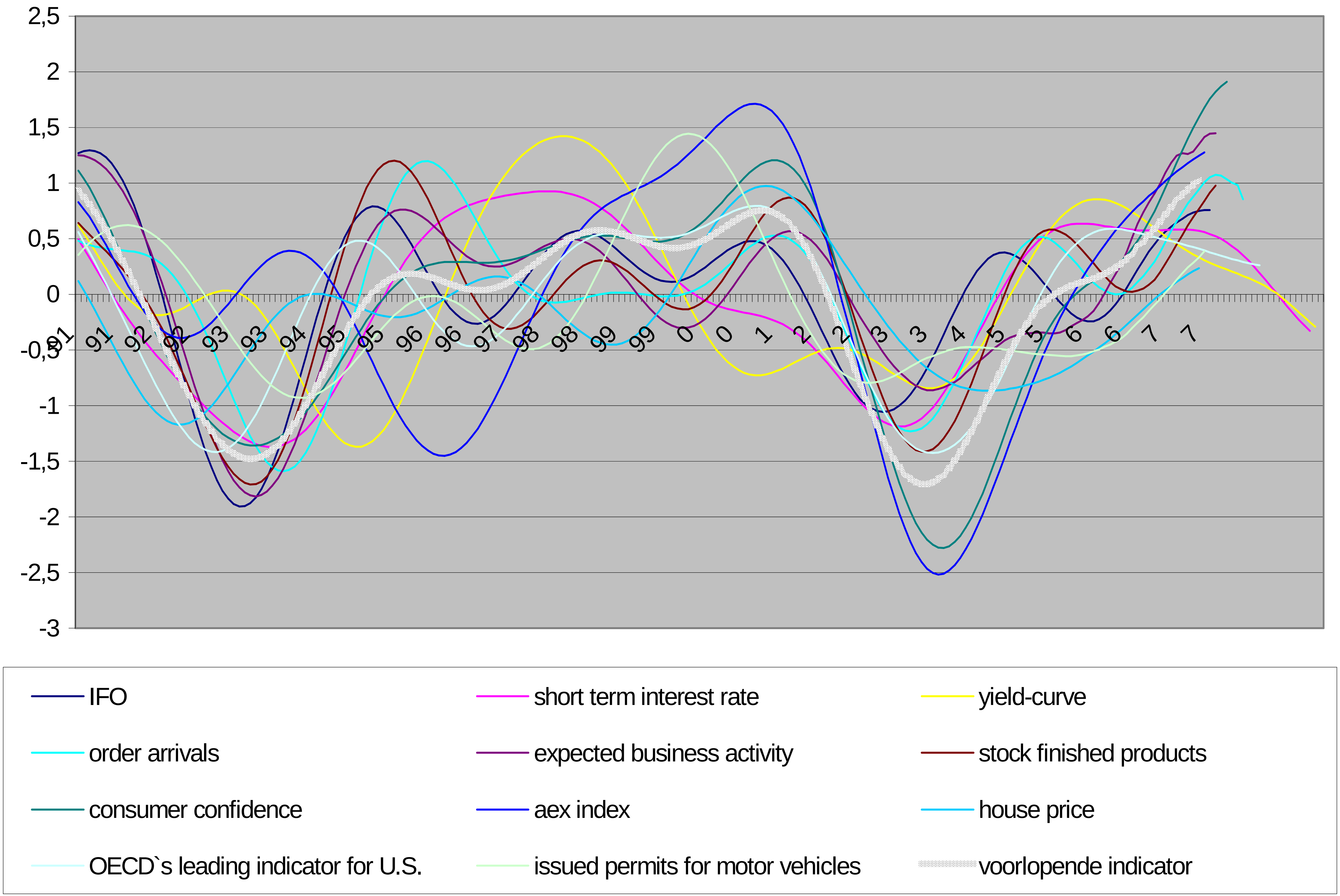
staffing employment
industrial production
household consumption
referentie index



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IFO
short term interest rate
yield-curve
order arrivals
expected business activity
stock finished products
consumer confidence
aex index
house price
OECD`s leading indicator for U.S.
issued permits for motor vehicles
voorlopende indicator

Real-time analysis

- Operational indicator, so real-time assessment is key focus (Orphanides & Van Norden, RES, 2002)

- End-of-Sample properties of filter/indicator as compared to mid-sample properties
  - Bias towards zero
  - Inducing phase shifts

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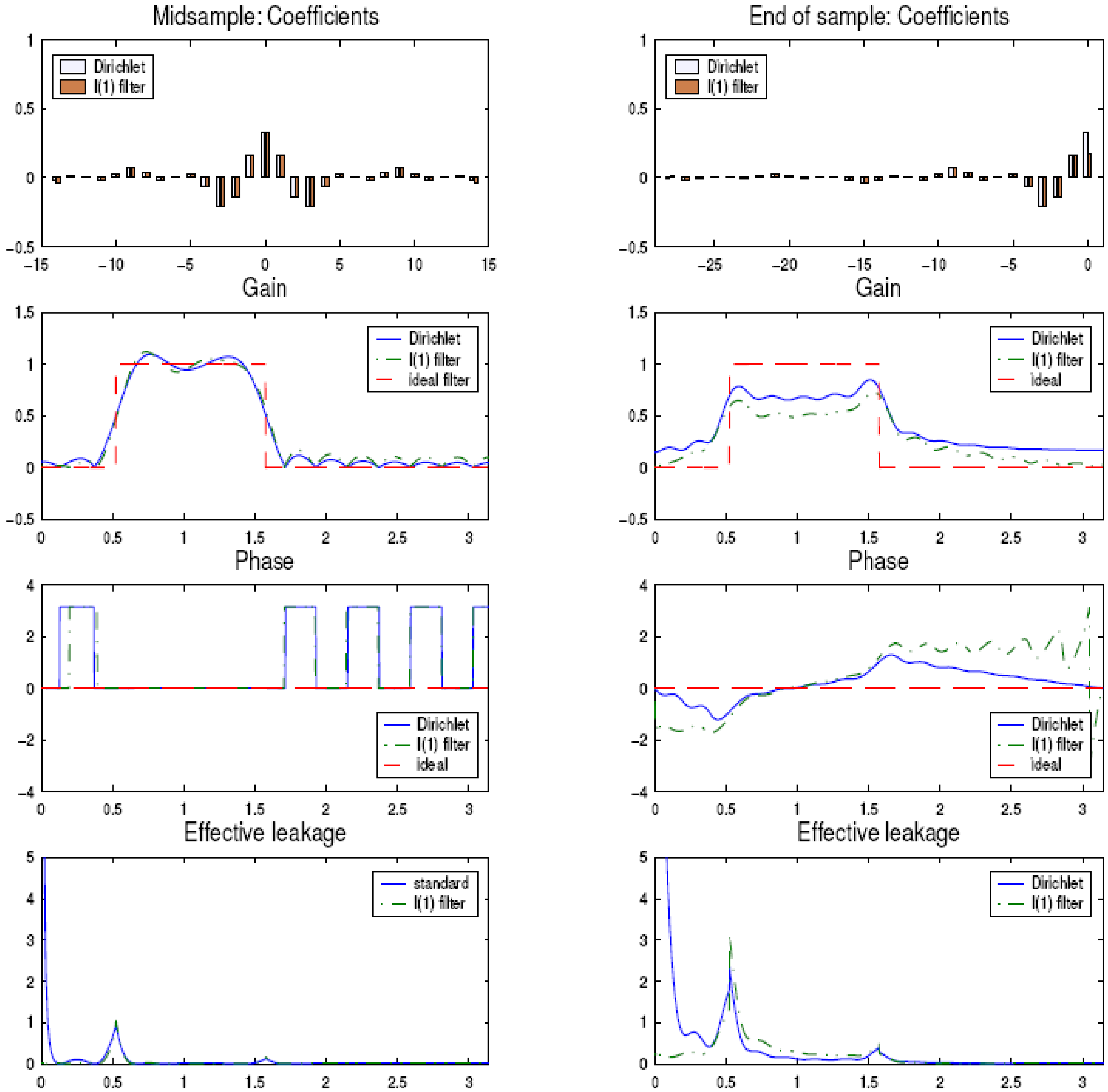

Schleicher, 2003, Kolmogorov-Wiener Filters for Finite Time-Series, mimeo

Real-time analysis: CF-filter´s gain

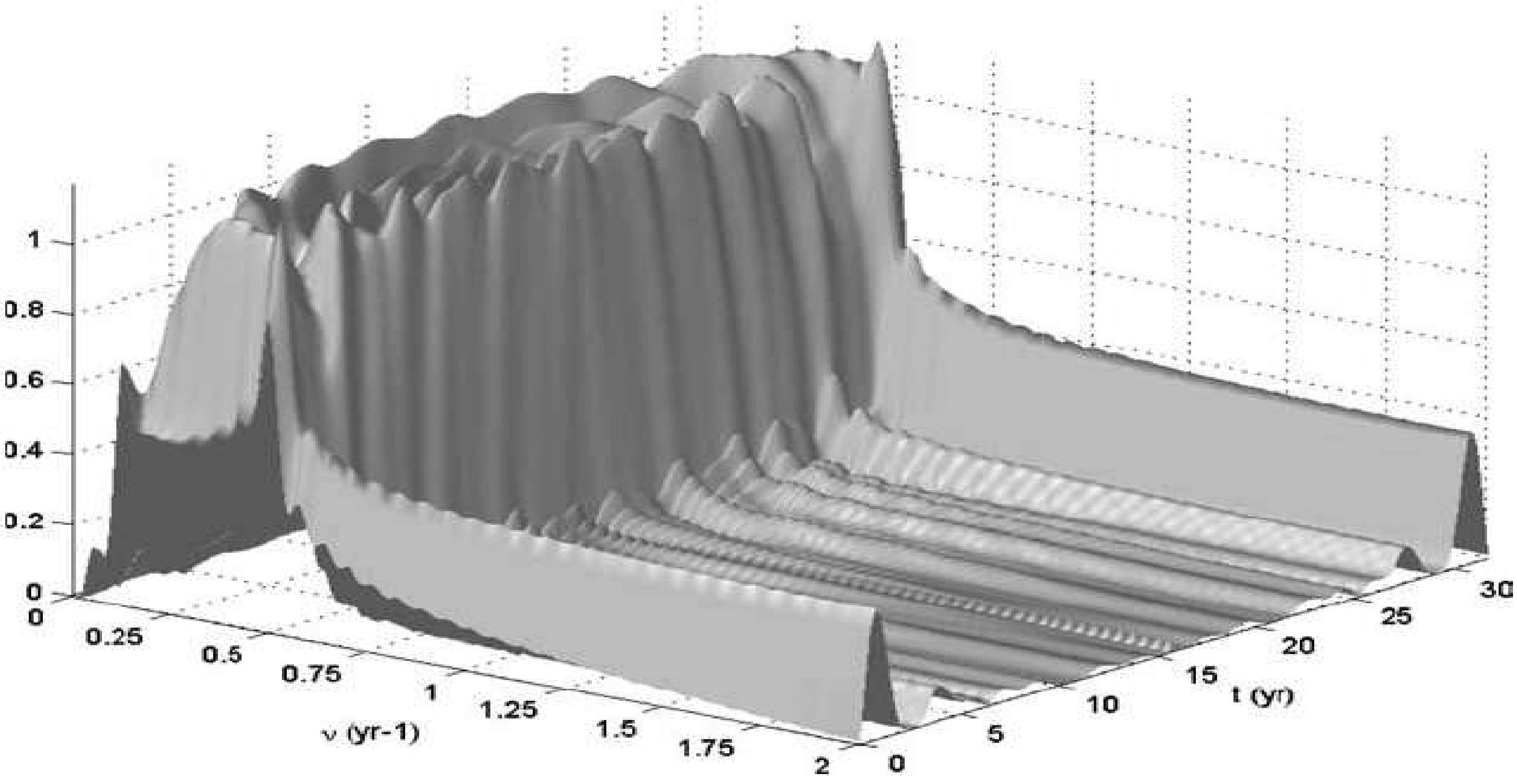

Figure 6. CF Random Walk Filter (II): gain.

Iacobucci & Noullez (2005), A Frequency Selective Filter for Short-Length Time Series ,Computational Economics 25: 75-102.

Real-time analysis

- Revision equals $Y_{t|t} - Y_{t|t+k}$ for k=1…66 (half a cycle) and Y={CI, LI, CI-LI}
- Out-of-sample simulation covering 1988.2-1999.11
  - so 1st run based on a full cycle 1977.2-1988.2
  - so final run of 1999.11 based on 66 future observations: $Y_{1999.11|2005.5}$

Table 5: The size of adjustment of the indicators from their mid-sample estimates.

variable/observations	i=1	i=12	i=23	i=34	i=45	i=56
CI, absolute	0.32	0.28	0.20	0.12	0.06	0.03
LI, absolute	0.35	0.27	0.18	0.12	0.08	0.05
CI	-0.12	-0.10	-0.06	-0.03	-0.01	-0.00
LI	0.12	0.08	0.04	0.03	0.02	0.01
CI-LI, absolute	0.23	0.20	0.18	0.17	0.17	0.17
CI-LI	-0.16	-0.10	-0.04	0.01	0.04	0.05

Mean of the difference between the coincident and the corresponding leading indicators as more observations become available.

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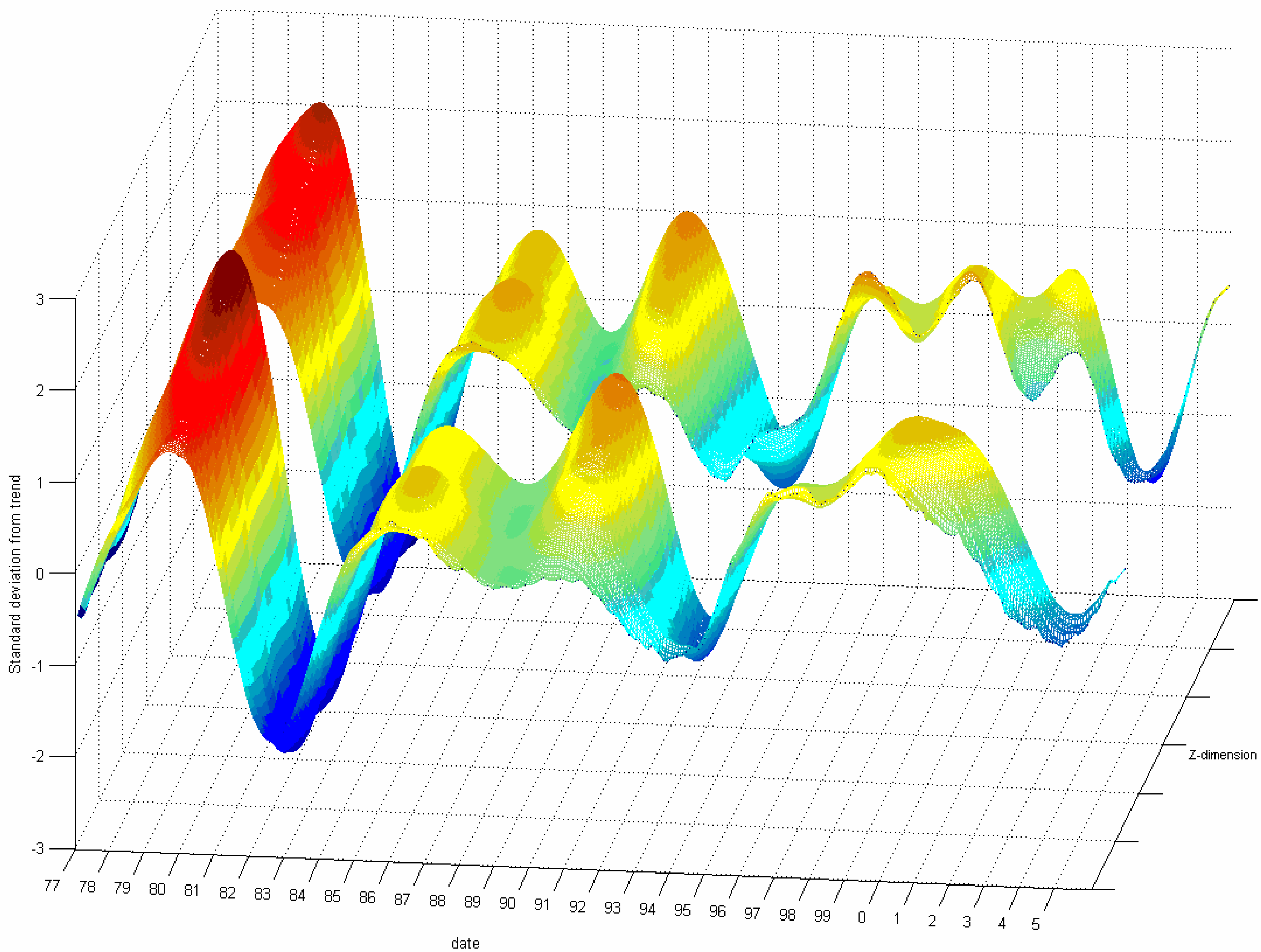
Standard deviation from trend
3
2
1
0
-1
-2
-3
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 0 1 2 3 4 5
date
Z-dimension

Real-time analysis

- Peaks and troughs more pronounced as more data arrives
  - $Var(Y_{t|t}) < Var(Y_{t|t+k})$ for $Y=\{CI, LI\}$
- Revision CI (3 vrbls) of same magnitude as revision LI (11 vrbls)
- CI and LI converge towards each other
  - $\rho(CI_{t|t}, LI_{t|t}) < \rho(CI_{t|t+k}, LI_{t|t+k})$
- $LI_{t|t}$ contains no additional information to $CI_{t|t}$ in approaching $CI_{t|t+66}$

$$\underset{\alpha\in[0,1]}{\operatorname{argmin}}\left\{E\left|\alpha CI_{t|t+i-1}+(1-\alpha)LI_{t|t+i+6}-CI_{t|t+66}\right|\right\}\Rightarrow\forall i=1\ldots66,\ \alpha^{opt}=1$$

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Summary

- Business cycle timely measurable as average of cyclical fluctuations lasting longer than 3 but shorter than 11 years in industrial production, household consumption and staffing employment

- Early signal of business cycle visible in 11 leading variables consisting of surveys, financial and real activity variables

- As more data arrives, the composite coincident and leading indices converge to their definite patterns and towards each other.

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