Structural Change and Business Cycle Fluctuations

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"Business Cycle"

(1) Comovement of many sectors/variables in macroeconomy

(2) This comovement is sufficiently strong and widespread that it does not "average out" $\Rightarrow$ Sums, averages, or aggregates serve as business cycle indices

(3) Focus is on comovement over specifi certain periodicities:

- Not 'long-run'
- Not 'high-frequency' or 'seasonal'

Part 1: Satoshi Urasawa

Business cycle index = GDP: Y_t

Explicit about Business cycle periodicities (6-32 quarters):

$$Y_t \rightarrow Y_t^{\text{Business Cycle}}$$

Other variables: $X_t \rightarrow X_t^{\text{Business Cycle}}$

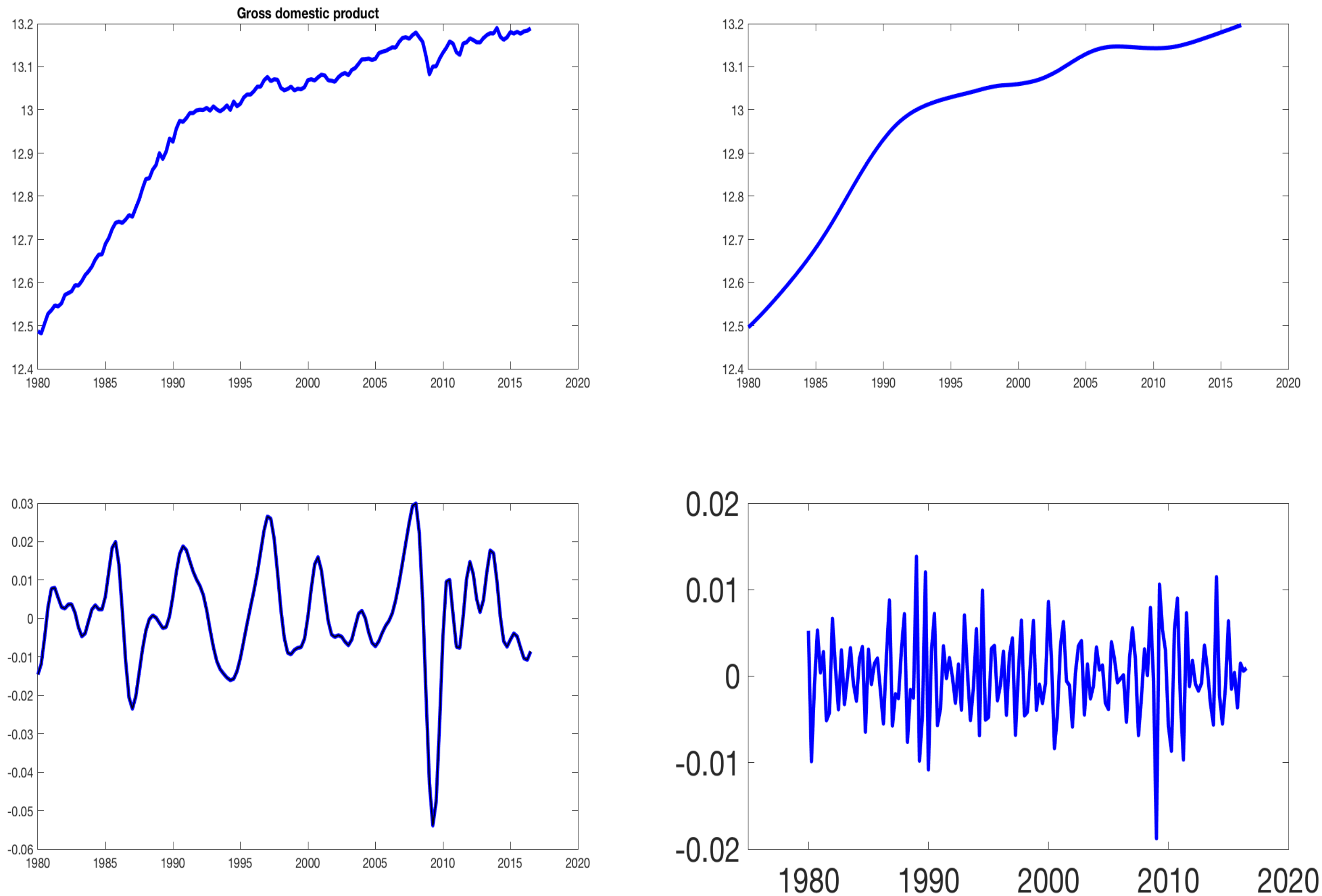
Comovement: $\text{cor}(X_t^{\text{Business Cycle}}, Y_{t+k}^{\text{Business Cycle}})$

Instability: Have these business cycle cross-correlations changed?

Answers:

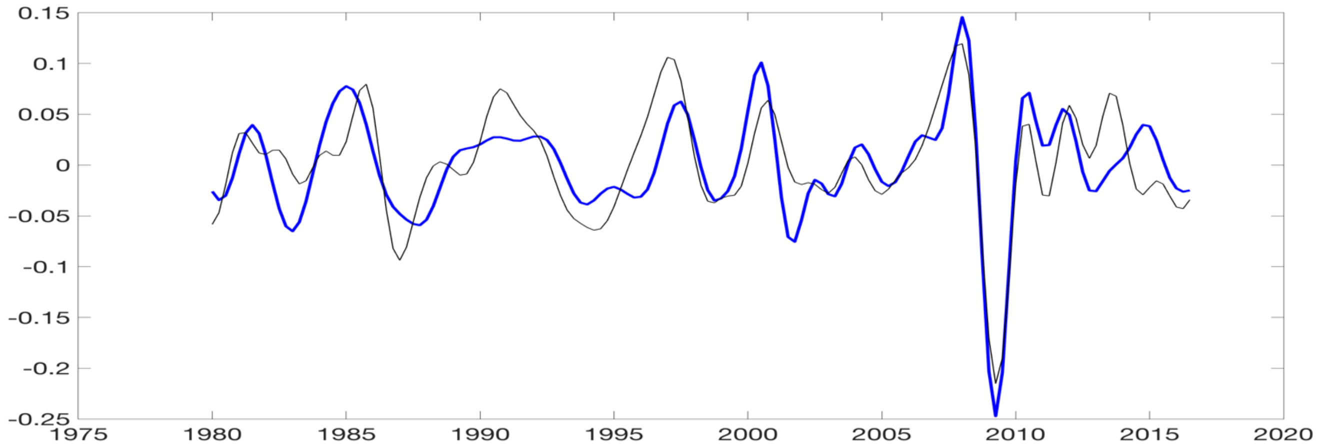
- Generally no (or not by much)
- Some exceptions: Res. Investment, exports, employee hours

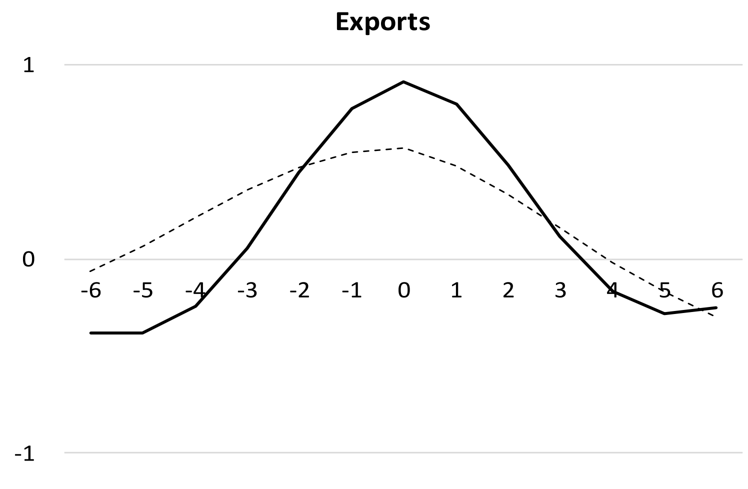
GDP in Japan 1980-2016



Instability: Sample or Population ?

Example: Exports and GDP





Part 2: Makoto Hazama

DFM Framework: $X_{it} = \lambda_i' F_t + u_{it}$

Comovement: $\lambda_i' F_t$

Business cycle index: F_t or $\lambda_{GDP}' F_t$

Business cycle periodicities: *very* low-frequencies eliminated (differencing, local demeaning), everything else included.

Instability: $\lambda_i = \lambda_{it}$? Changes in F_t process?

Answers:

- Lots of instability in λ_i. Instability in F_t [examines $E(F_t F_t')$]
- Not much instability in $\lambda_{GDP}' F_t$

BC-cors versus DFM:

- DFM: Joint probability model ⇒ coherent inference
- DFM: Interpretation like that in VAR/SVARs but extended to many more variables
- BC-cors: well-defined periodicities
- BC-cors: simple interpretation of instability
- DFM interpretation of instability is tricky because F_t is latent and $\lambda_i'F_t = \lambda_i'PP^{-1}F_t$.

  Is instability in λ_i or F_t or both?

Sampling uncertainty using BC-cors:

- Back of the envelope for *i.i.d.* observations
  - $SE(\hat{\rho}) \approx 1/\sqrt{\text{Sample Size}}$
  - Sample size for 6-32 Bandpass $\approx \left(\frac{2}{6} - \frac{2}{32}\right) \times T \approx 0.3T$
  - $T_1 = T_2 = 146/2 = 73.$
  - $SE\left(\hat{\rho}_2 - \hat{\rho}_1\right) \approx \sqrt{2} \,/\, \sqrt{0.3 \times 73} = 0.30$
  - (Even larger for serially correlated data)

Where can we get more information?

- Other series?
- Other periodicities?

$\Rightarrow$

Use DFM as parametric framework for BC-cors

(Usual tradeoff of benefit from smaller variance at the cost of bias from misspecification)

Mechanics: Basic idea

Model:

$$X_{it} = \lambda_i' F_t + u_{it}$$
$$Y_t = \lambda_{GDP}' F_t + u_{GDP,t}$$
$$\Phi(L) F_t = \varepsilon_t$$
$$\phi_i(L) u_{it} = e_{it}$$

$$X_{it}^{BC} = \sum_{j=-\infty}^{\infty} a_j X_{it-j} \quad \text{and} \quad Y_t^{BC} = \sum_{j=-\infty}^{\infty} a_j Y_{t-j}$$

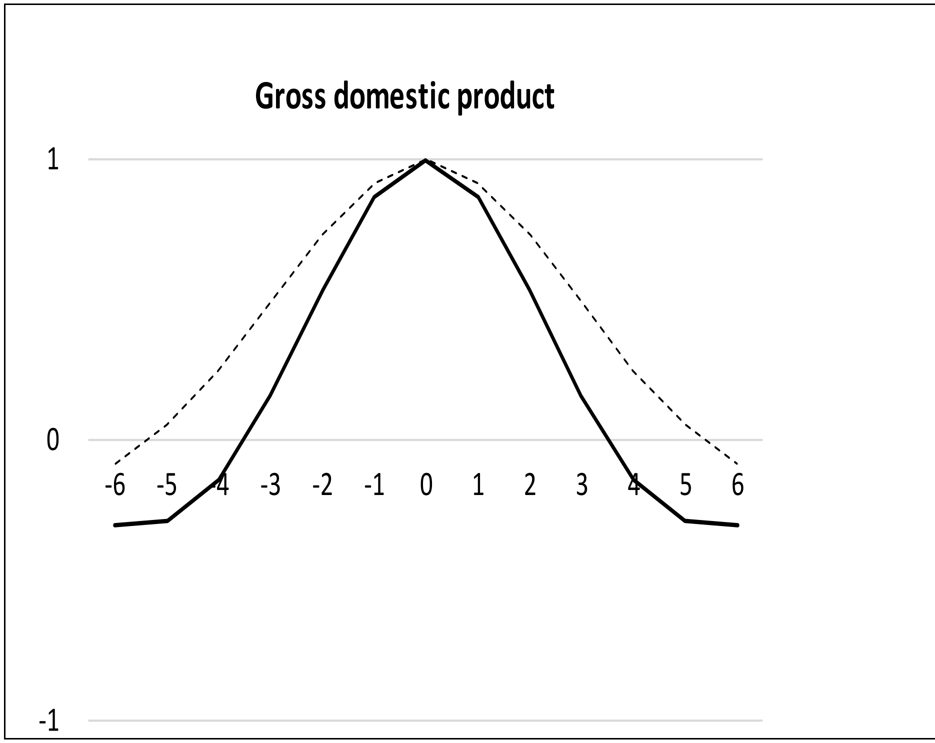
Accouting exercise $\Rightarrow$ cor(X_{it}^{BC}, Y_t^{BC}) as a function of DFM parameters.

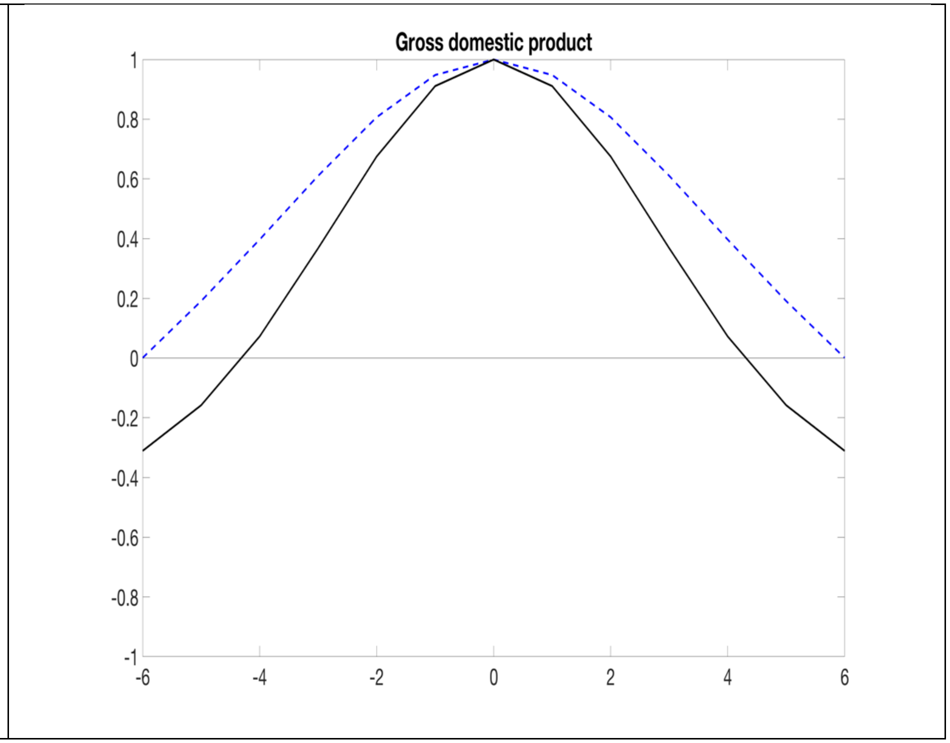
Estimate DFM over two periods (Hazama) and see how cor(X_{it}^{BC}, Y_t^{BC}) changes (Urasawa).

Results: (using four factors, VAR(2) for F and AR(2) for u's and Urasawa's quarterly dataset)

BC-cor (direct)

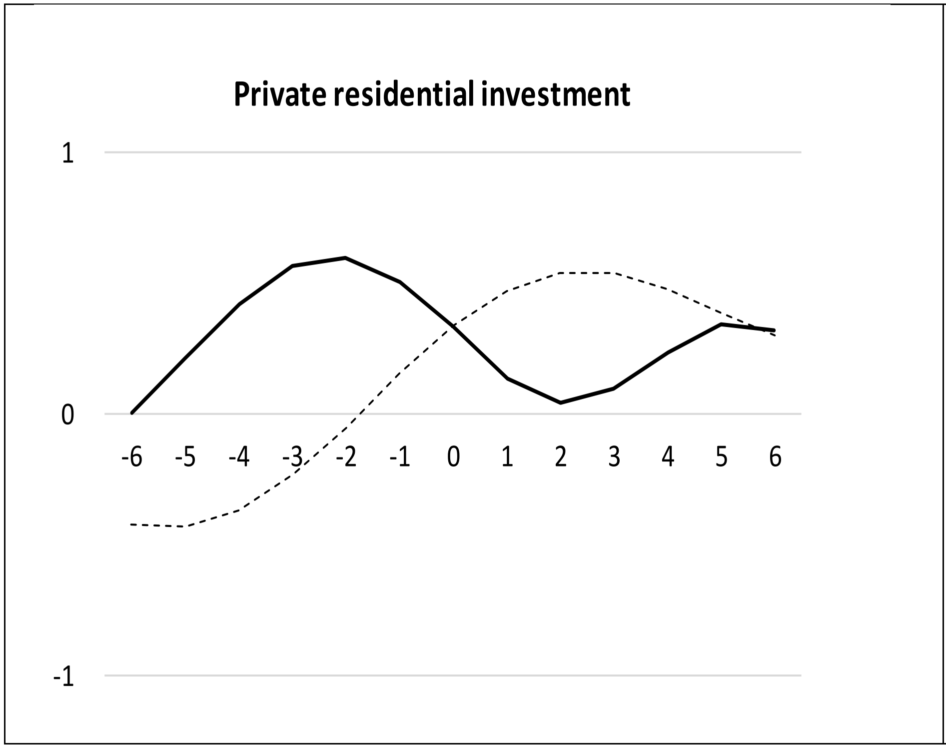
BC-cor (DFM)

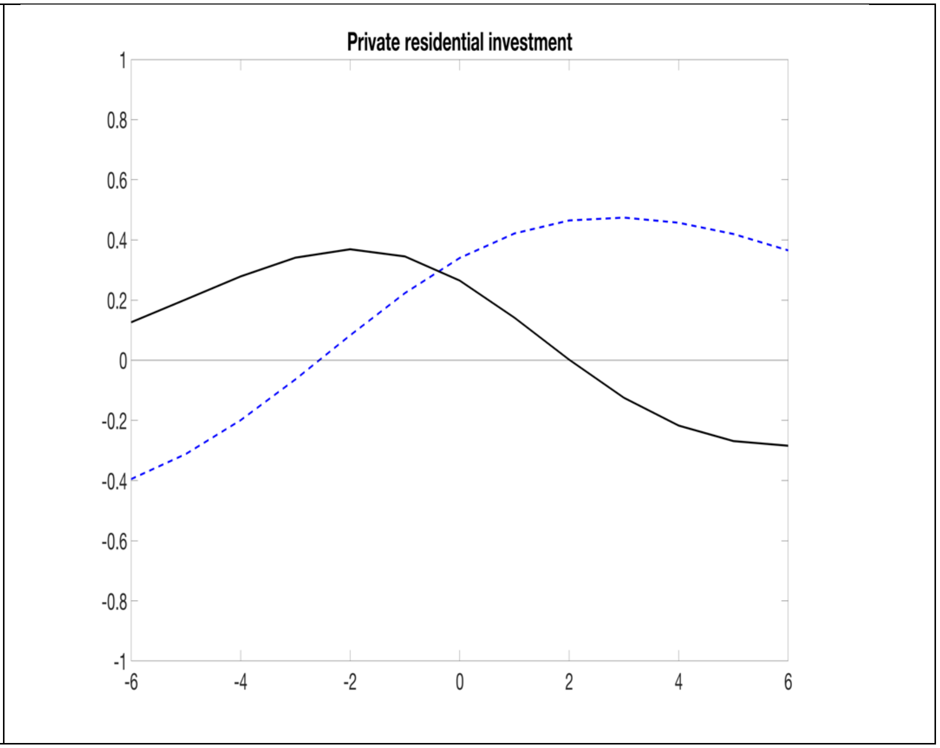




BC-cor (direct)

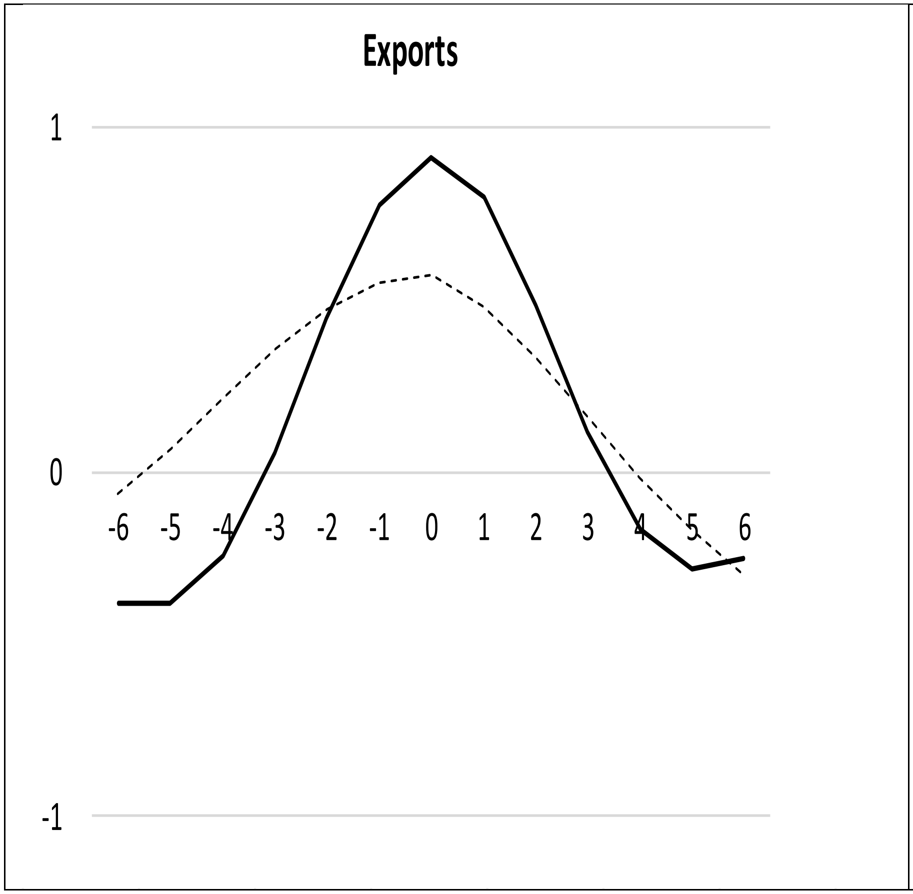
BC-cor (DFM)

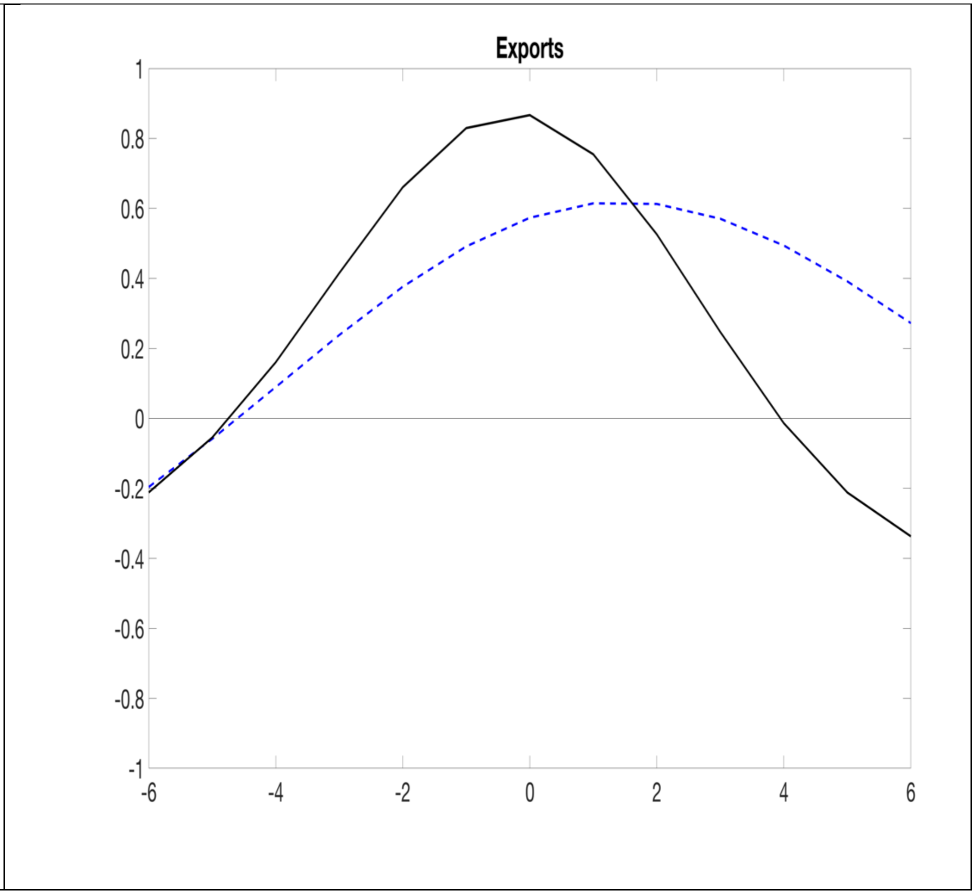




From leading to lagging

BC-cor (direct) | BC-cor (DFM)

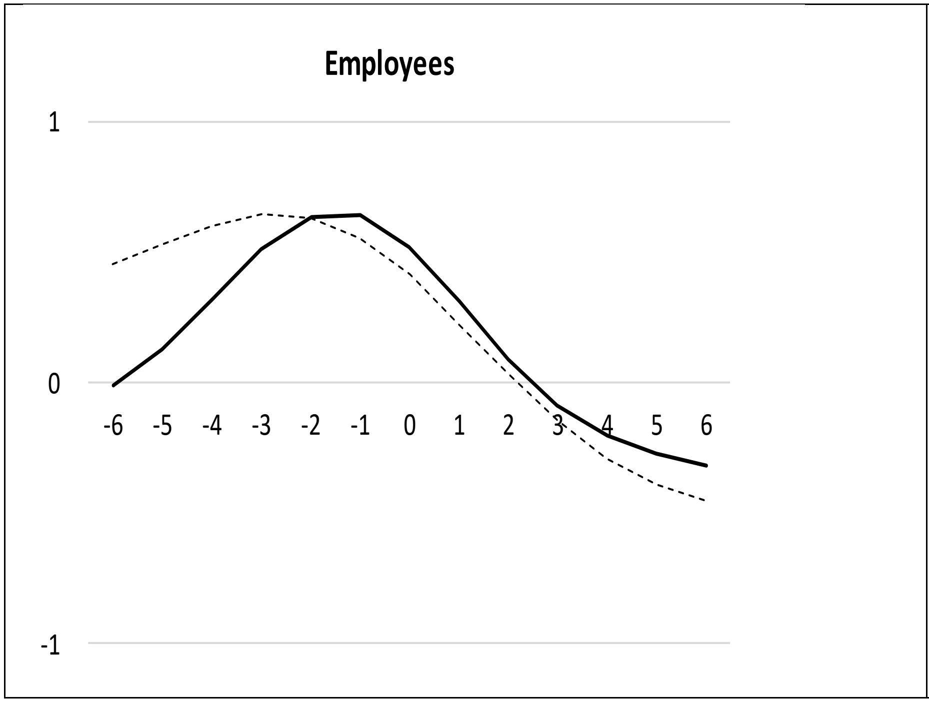


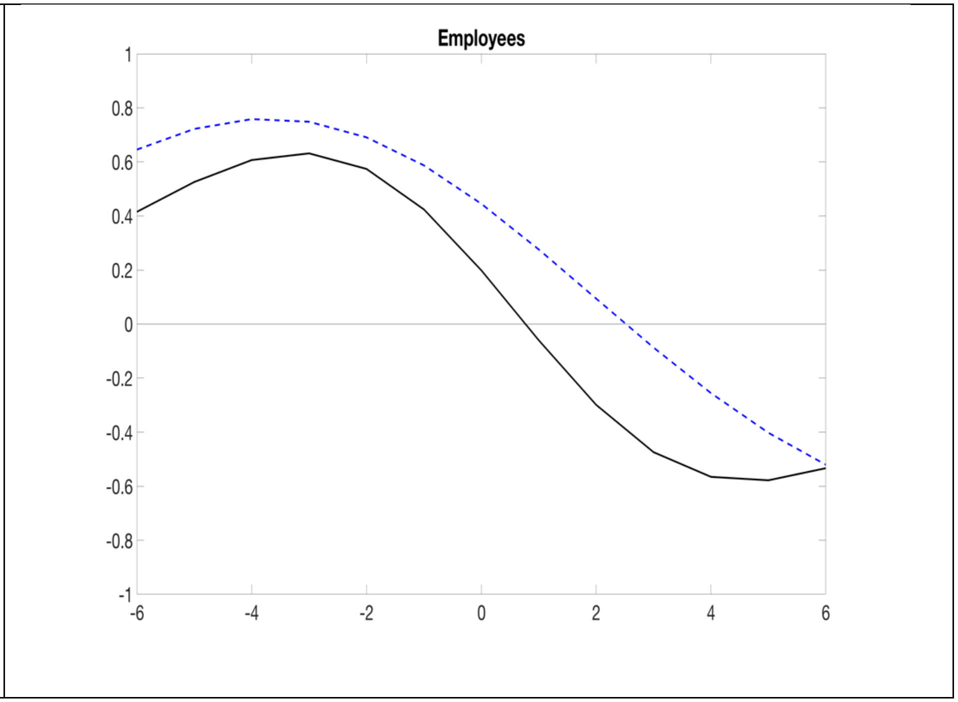


Increase in correlation

BC-cor (direct)

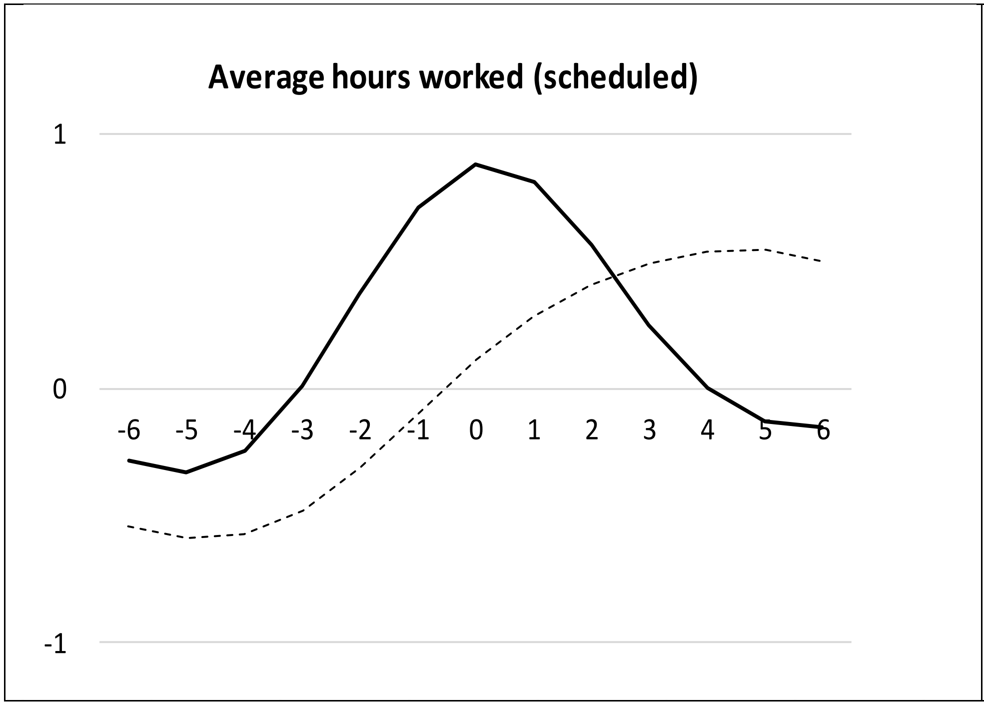
BC-cor (DFM)



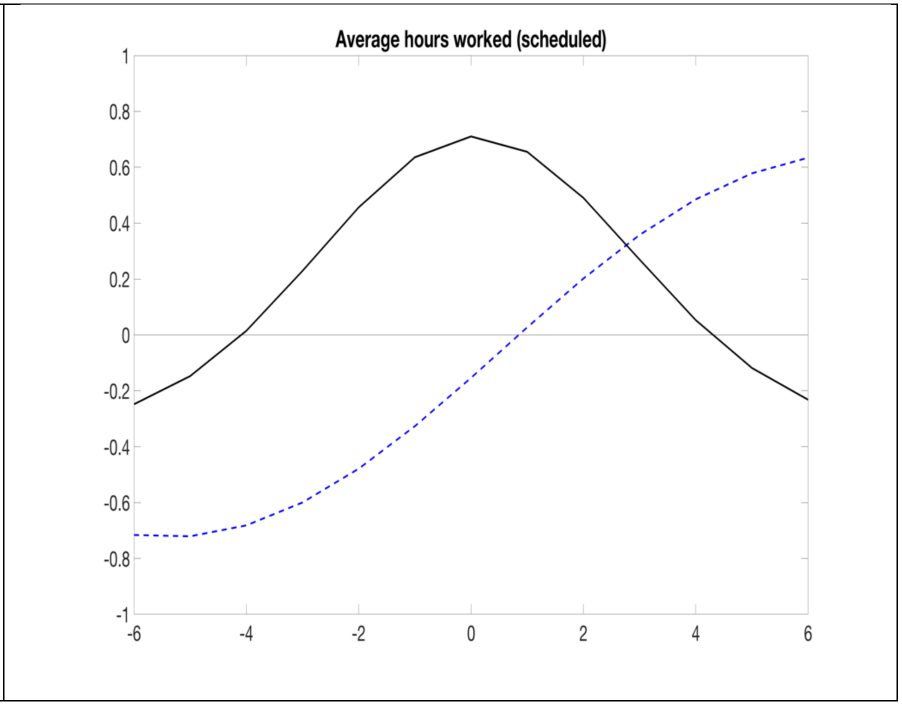


Correlation at long lags has decreased

BC-cor (direct)



BC-cor (DFM)



Notable increase in contemporaneous correlation

How large is the business cycle comovement?

Is it stable?

Business Cycle Comovent in the DFM model: $X_{it} = \lambda_i' F_t + u_{it}$

$R_F^2(BC)$ (4 factors, 1980-2016)

GDP	0.83
Private Consumption	0.68
Res Investment	0.26
Gov. Consumption	0.19
Exports	0.83
Imports	0.78
Employees	0.78
Avg Hours (scheduled)	0.61
Avg Hours (non-scheduled)	0.92
Labor Productivity	0.78
Prices	0.89
Monetary base	0.08
Stock Prices	0.36
US GDP	0.84
Avg (47 Series)	0.62

Stability

Series	$R_F^2(BC)$ 1980-1998	$R_F^2(BC)$ 1998-2016			
GDP	0.83	0.91			
Pr. Cons.	0.82	0.73			
Res Invest,	0.43	0.25			
Gov. Cons.	0.03	0.67			
Exports	0.69	0.92			
Imports	0.76	0.85			
Employees	0.84	0.81			
Avg hrs (sch)	0.80	0.67			
Avg hurs (non-sch)	0.96	0.94			
Labor Prod	0.76	0.88			
Prices	0.90	0.94			
Monetary base	0.69	0.24			
Stock Prices	0.38	0.46			
US GDP	0.59	0.66			
Avg (47 Series)	0.69	0.69			

Stability

Series	$R_F^2(BC)$ 1980-1998	$R_F^2(BC)$ 1998-2016	Ratio of Standard Deviat)ions $\sigma_{1998\text{-}2016}/\sigma_{1980\text{-}1998}$		
			Total	***F***	***u***
GDP	0.83	0.91	1.07	1.12	0.78
Pr. Cons.	0.82	0.73	1.06	1.00	1.28
Res Invest,	0.43	0.25	0.89	0.69	1.02
Gov. Cons.	0.03	0.67	1.10	4.91	0.65
Exports	0.69	0.92	2.67	3.08	1.39
Imports	0.76	0.85	0.86	0.91	0.67
Employees	0.84	0.81	0.75	0.74	0.81
Avg hrs (sch)	0.80	0.67	0.87	0.80	1.11
Avg hurs (non-sch)	0.96	0.94	0.93	0.92	1.16
Labor Prod	0.76	0.88	1.20	1.29	0.86
Prices	0.90	0.94	0.86	0.89	0.64
Monetary base	0.69	0.24	2.61	1.53	4.11
Stock Prices	0.38	0.46	1.28	1.41	1.19
US GDP	0.59	0.66	0.72	0.76	0.65
Avg (47 Series)	0.69	0.69			

R^2(BC) for 47 Time Series