Slack and Cyclically Sensitive Inflation

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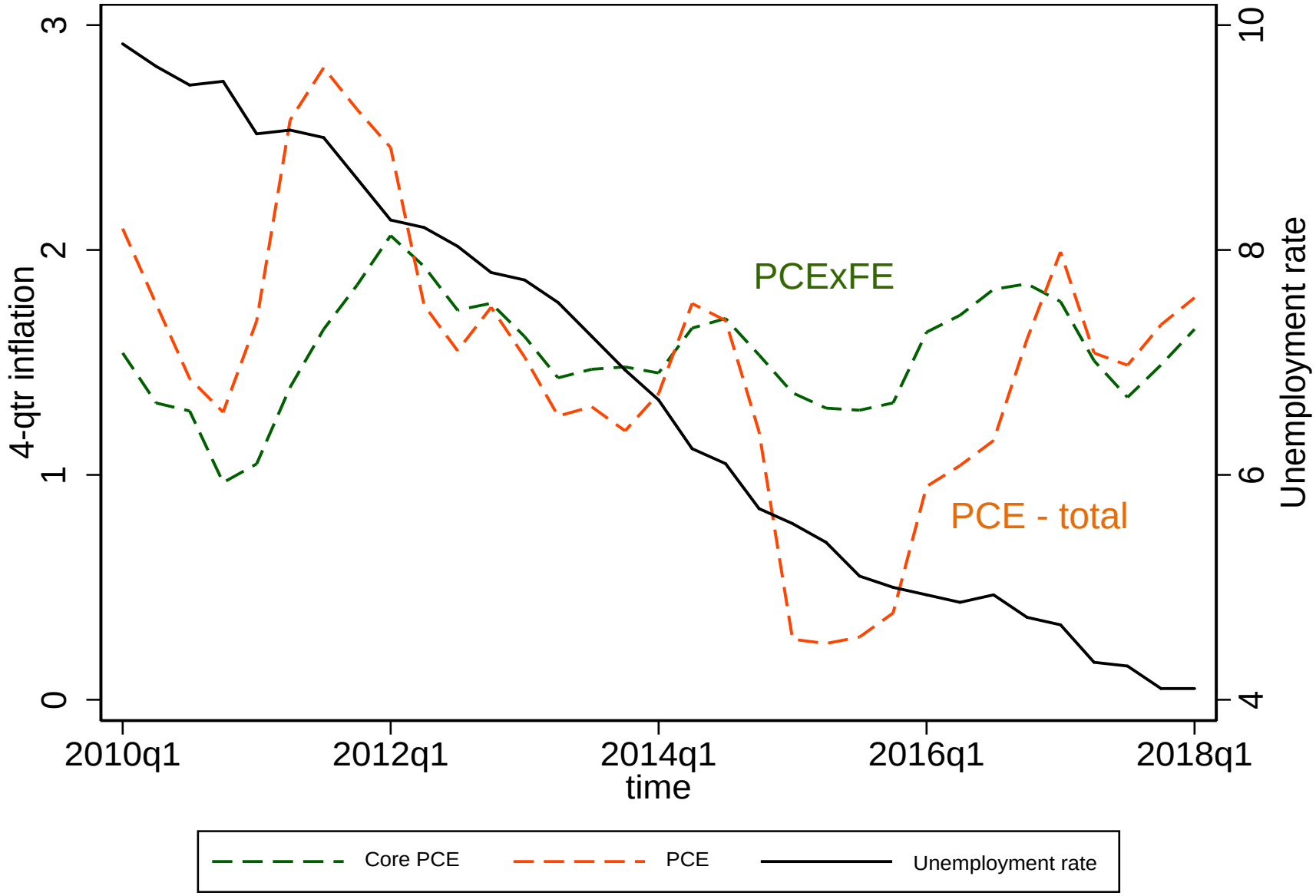
Sintra, Portugal

Where is the cyclical pressure on inflation?

US:

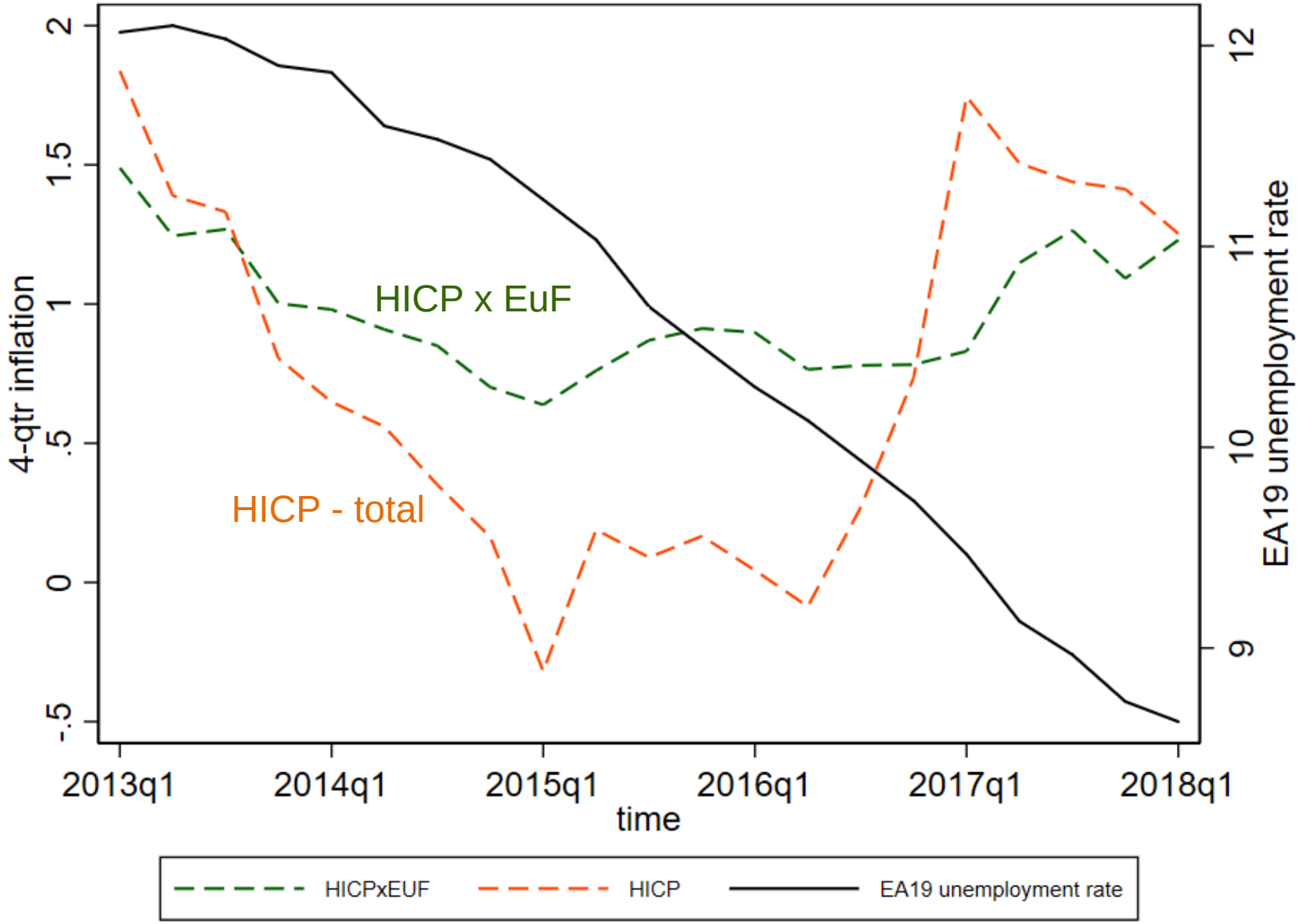
- Unemployment rate
- 4-quarter inflation



Where is the cyclical pressure on inflation?

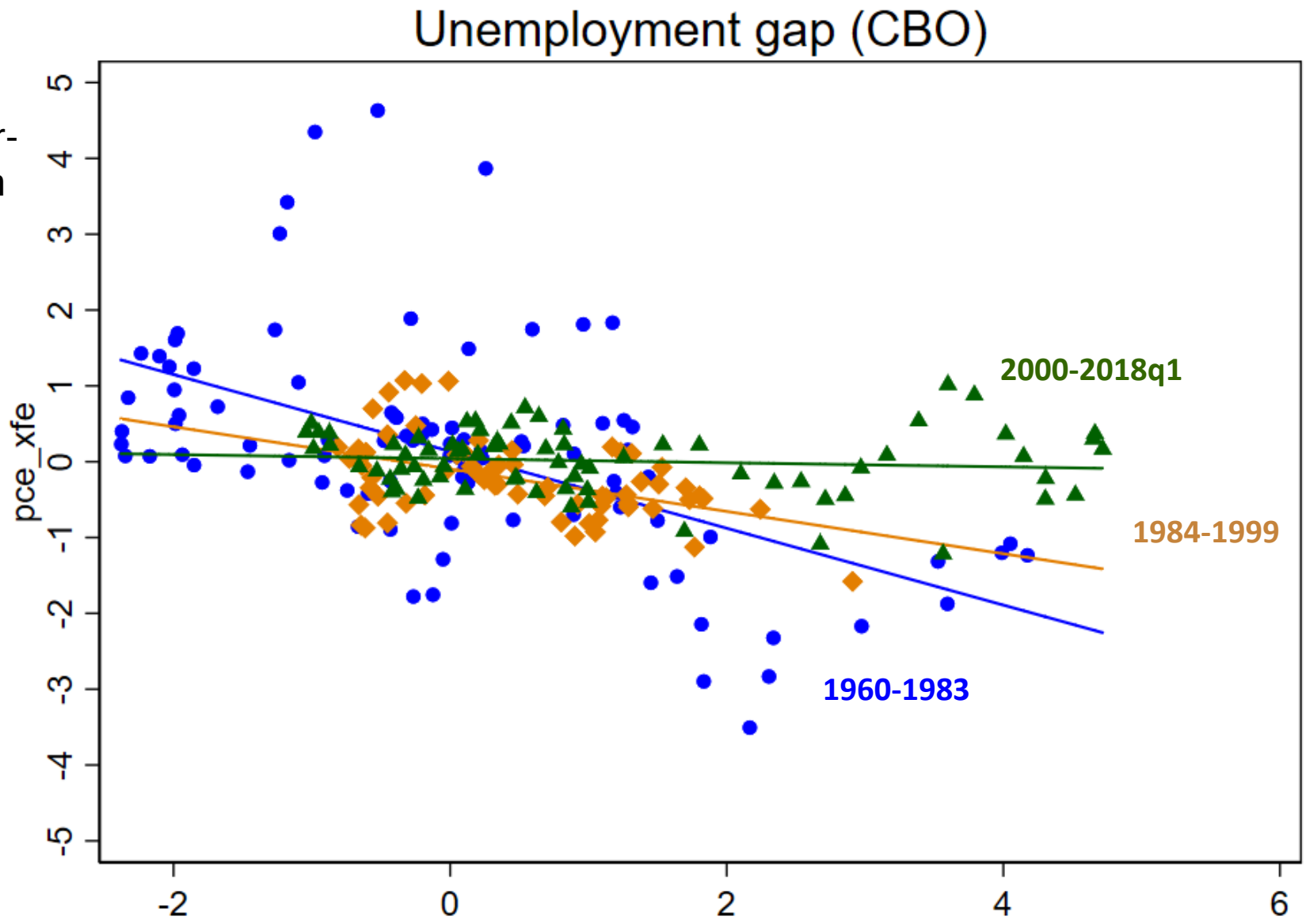
Euro Area data:

- Unemployment rate
- 4-quarter inflation



The Flattening U.S. Phillips Curve – using PCExFE & CBO unemployment gap

Four-quarter changes of four-quarter inflation



Slack and Cyclically Sensitive Inflation

Outline

A. US
- Can the (aggregate) PC be resuscitated by using a different slack measure? (no)
- Do some components move cyclically (yes)
- Construct index of cyclically sensitive inflation (CSI)

B. EA
- Do some components move cyclically (yes)
- Construct index of cyclically sensitive inflation (CSI)

C. Discussion & implications

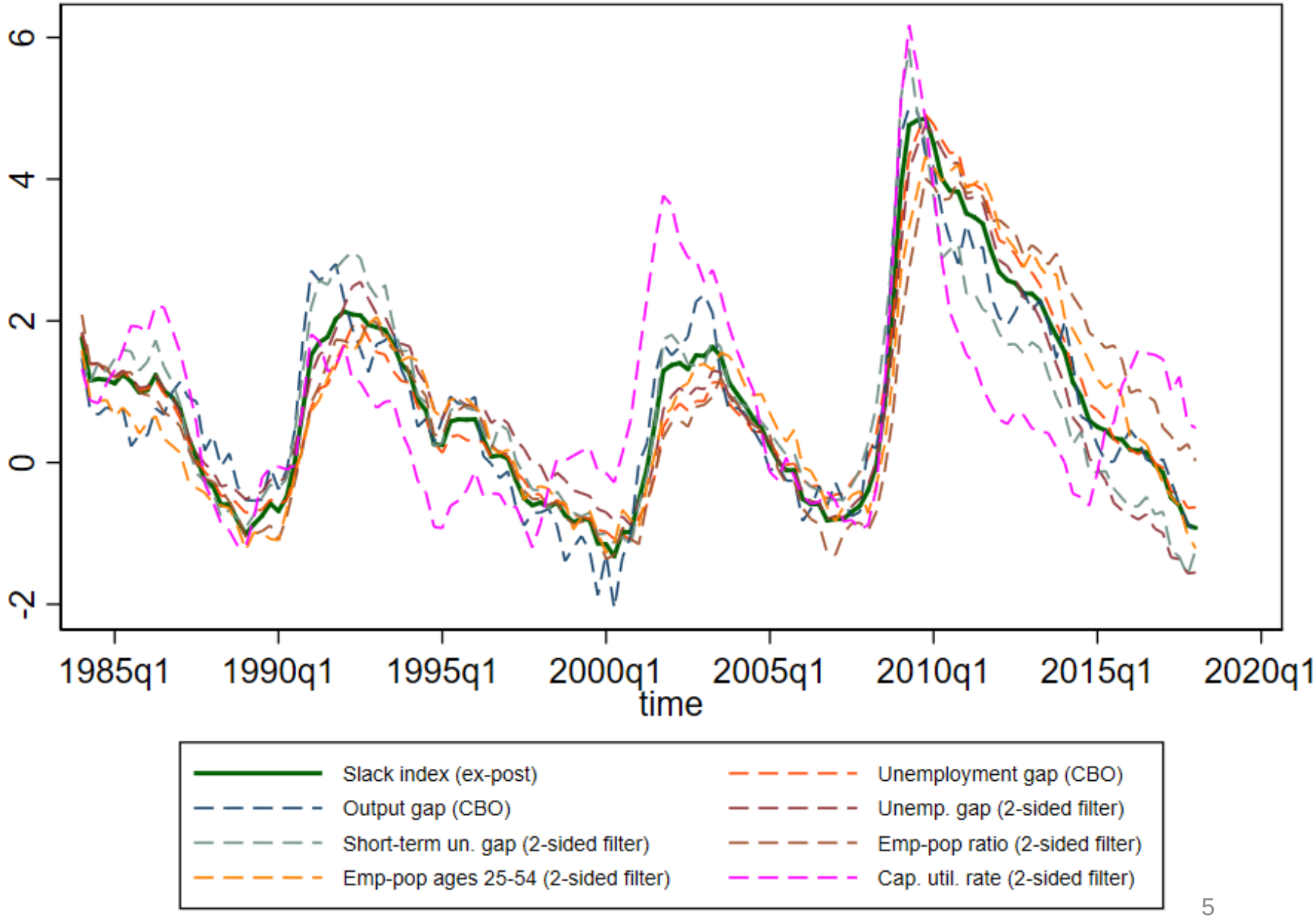
Data comments

- All data are quarterly
- Inflation is 4-quarter inflation (e.g. Q1-to-Q1): $\pi_t^4 = 100\ln(P_t / P_{t-4})$
- Changes in inflation are 4-quarter change: $\Delta_4\pi_t^4 = \pi_t^4 - \pi_{t-4}^4$

US: Can the Phillips Curve be Resuscitated by Using a Different Slack Measure?

Gaps and Slack

- The real-time gap problem (Orphanides & van Norden (2003))
- Theory doesn't provide a single gap measure
- The depth of this recession might pose special problems for some slack measures
- We consider 7 gap measures: 2 CBO gaps, 5 two-sided smoother estimates of potential
  - Also gap index (1st principal component)



US: Contemporaneous Phillips correlations & slopes: various gaps & PCExFE (4Q change)

	Correlation			Slope (SE)		
	1960-1983	1984-1999	2000-2018q1	1960-1983	1984-1999	2000-2018q1
Ex-post slack						
Unemployment gap (CBO)	-0.52	-0.48	-0.11	-0.47	-0.28	-0.03
				(0.11)	(0.09)	(0.04)
GDP gap (CBO)	-0.51	-0.35	-0.24	-0.31	-0.18	-0.06
				(0.05)	(0.07)	(0.04)
Unemployment gap (two-sided filtered)	-0.57	-0.49	-0.07	-0.60	-0.29	-0.02
				(0.13)	(0.10)	(0.04)
Short-term unemployment gap (two-sided filtered)	-0.53	-0.49	-0.25	-0.38	-0.22	-0.07
				(0.08)	(0.08)	(0.05)
Employment-population ratio (two-sided filtered)	-0.56	-0.44	-0.02	-0.73	-0.24	-0.01
				(0.17)	(0.09)	(0.04)

US: Phillips correlations & slopes: various gaps, ctd

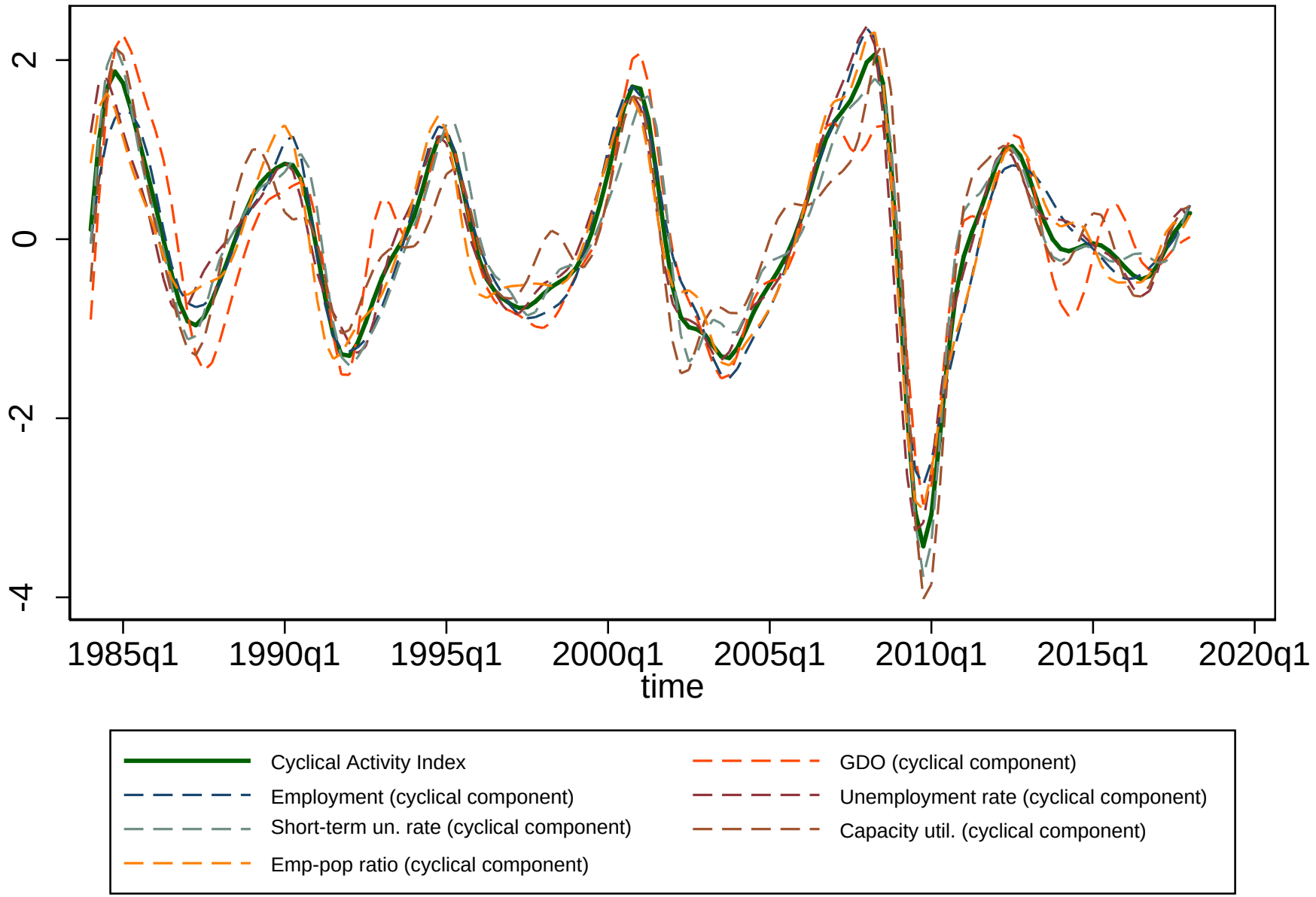
	Correlation			Slope (SE)		
	1960-1983	**1984-1999**	**2000-2018q1**	**1960-1983**	**1984-1999**	**2000-2018q1**
Employment-population ratio ages 25-54 (two-sided filtered)	-0.49	-0.44	-0.03	-0.74 (0.13)	-0.25 (0.10)	-0.01 (0.04)
Capacity utlilization rate (two-sided filtered)	-0.64	-0.45	-0.24	-0.52 (0.10)	-0.23 (0.08)	-0.07 (0.03)
Gap index	-0.57	-0.47	-0.14	-0.53 (0.10)	-0.25 (0.09)	-0.04 (0.04)
Real-time slack						
Unemployment rate	-0.49	-0.40	-0.09	-0.43 (0.09)	-0.20 (0.07)	-0.02 (0.04)
Short-term unemployment rate	-0.44	-0.35	-0.24	-0.30 (0.07)	-0.14 (0.06)	-0.08 (0.06)

US: PCE Inflation Components: Measurement Issues & Cyclical Properties

- We consider ~39% of consumption to have well-measured price inflation
- ~17% of consumption has poorly measured price inflation.
- The main problems are:
  - New/improved goods
  - Use of input costs instead of consumer prices for some services
  - Lack of market prices for some services

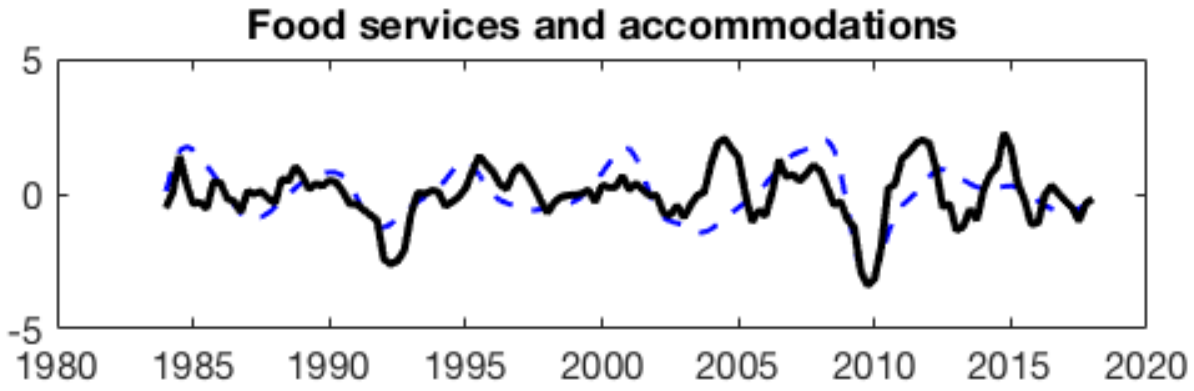
Sector	Share (2000s)	Subtotals
A. Well-measured		
Housing ex utilities	0.16	**0.34**
Recreation services	0.04	
Food and beverages for off-premises consumption	0.08	
Food services and accommodations	0.06	
Housing - energy utilities component	0.02	**0.05**
Gasoline and other energy goods	0.03	
B. Some information content		
Other services	0.09	**0.29**
Other nondurable goods	0.08	
Transportation services	0.03	
Motor vehicles and parts	0.04	
Other durable goods	0.02	
Furnishings and durable household equipment	0.03	
Health care	0.16	**0.16**
C. Poorly measured		
Financial services and insurance	0.08	**0.17**
Clothing and footwear	0.03	
Recreational goods and vehicles	0.03	
NPISH	0.03	

US: Cyclical activity measures (32 quarter band-pass filtered)

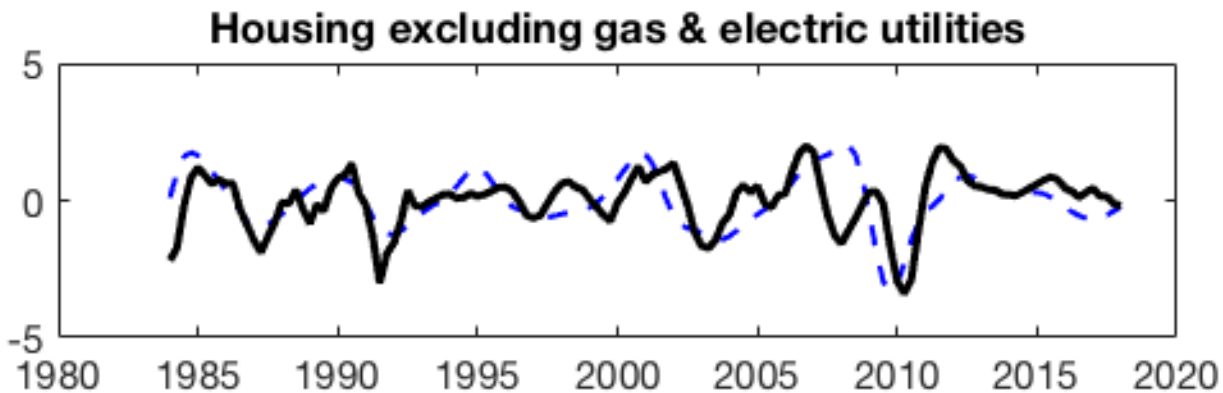


The **cyclical activity index (CAI)** is the first principal component of the 6 band-passed activity variables

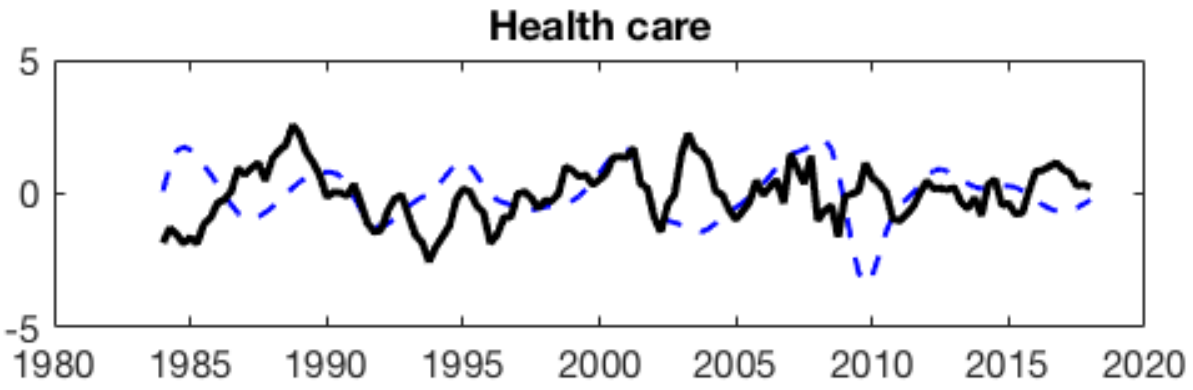
US: Cyclical Properties of PCE Components: Four Examples



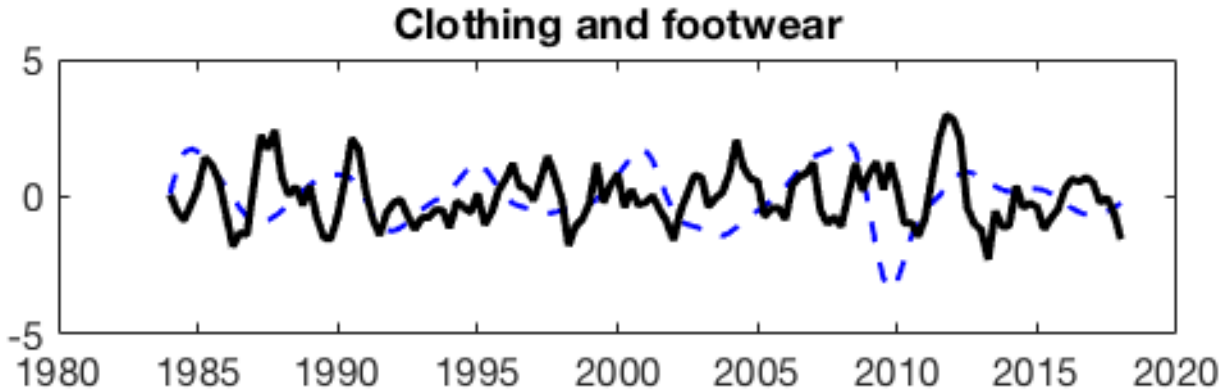
Correlation = 0.46



Correlation = 0.48



Correlation = -0.11



Correlation = -0.09

Black: inflation component Blue: Cyclical Activity Index

US: Correlation of 4Q differences of 4Q inflation with Cyclical Activity Index

Housing excluding gas & electric utilities	0.475
Food services & accommodations	0.463
Food and beverages purchased for off-premises consumption	0.426
Recreation services	0.278
Recreational goods and vehicles	0.255
Other services	0.153
NPISH	0.138
Gas & electric utilities	0.130
Other durable goods	0.100
Furnishings & durable household equipment	0.095
Other nondurable goods	0.061
Transportation services	0.019
Gasoline & other energy goods	-0.040
Clothing & footwear	-0.089
Health care	-0.107
Financial services & insurance	-0.114
Motor vehicles and parts	-0.366

Cyclically Sensitive Inflation: Methods

- **Treat the Phillips curve as a statistical measurement problem**
  - Components each have different amounts of signal and noise

- **Incorporate judgmental assessment of measurement quality**
  - Eliminate Recreational goods & vehicles, Clothing & footwear, Financial services & insurance, and NPISH

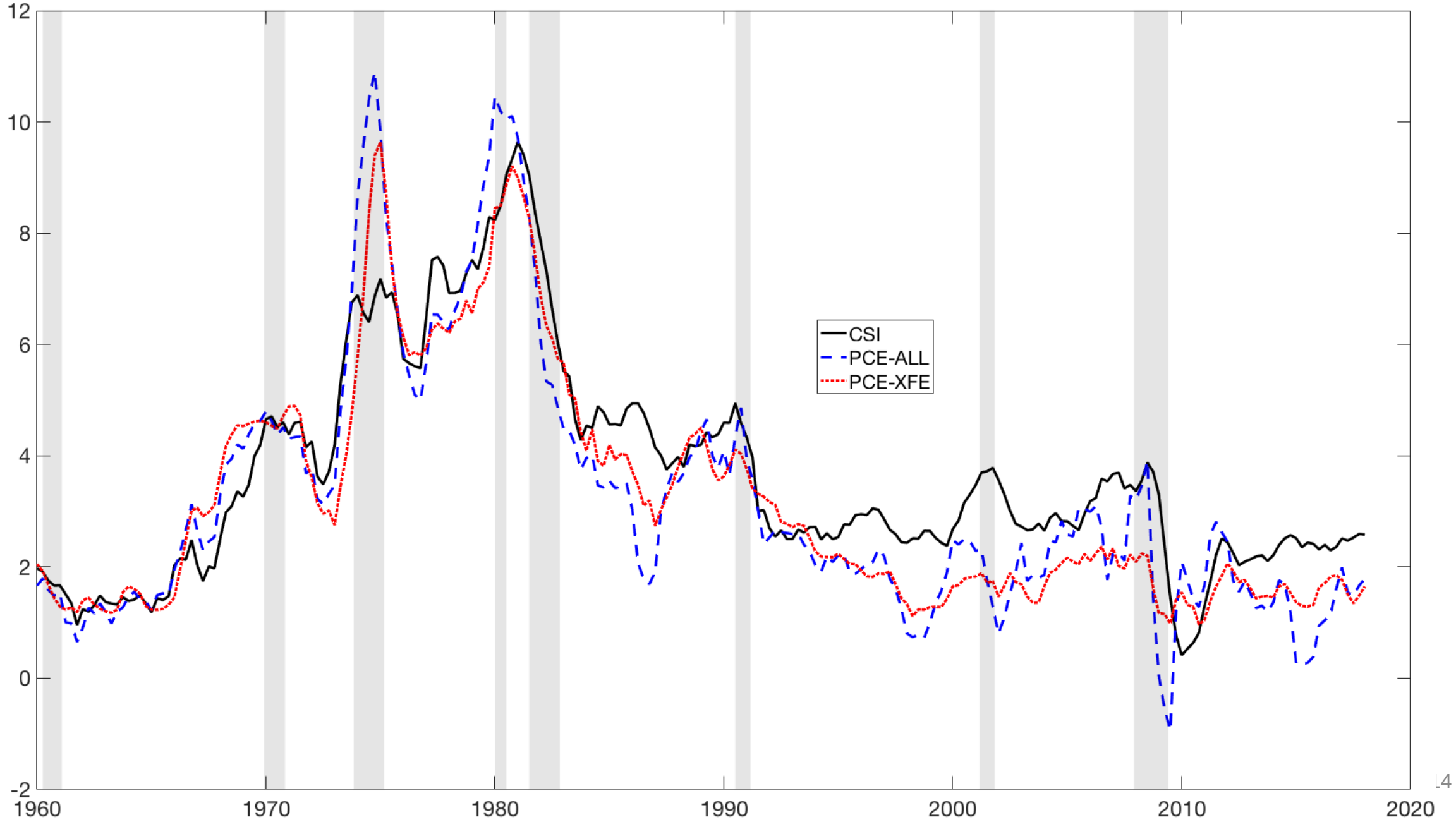
- **CSI - single slack indicator approach**
  - What are the inflation index weights that yields the most cyclical inflation index?
  - Estimate the regression,

$$CAI_t = \alpha + \gamma \sum_{i=1}^{13} \omega_i \Delta_4 \pi_{it}^4 + v_t \quad \text{s.t.} \quad \sum_{i=1}^{13} \omega_i = 1 \ \text{ and } \ 0 \le \omega_i \le 1$$

US: Benchmark CSI specification using *CAI* – estimated 1984-2018q1

Component	Corr with CAI	CSI weight
Housing excluding gas & electric utilities	0.475	**0.627**
Food services & accommodations	0.463	0.040
Food and beverages purchased for off-premises consumption	0.426	**0.159**
Recreation services	0.278	**0.080**
Recreational goods and vehicles	0.255	*excluded*
Other services	0.153	0.072
NPISH	0.138	*excluded*
Gas & electric utilities	0.13	0.022
Other durable goods	0.1	0
Furnishings & durable household equipment	0.095	0
Other nondurable goods	0.061	0
Transportation services	0.019	0
Gasoline & other energy goods	-0.04	0
Clothing & footwear	-0.089	*excluded*
Health care	-0.107	0
Financial services & insurance	-0.114	*excluded*
Motor vehicles and parts	-0.366	0

US: CSI, PCExFE, and PCE-all inflation (4 quarter inflation)



US: CSI Phillips correlations & slopes

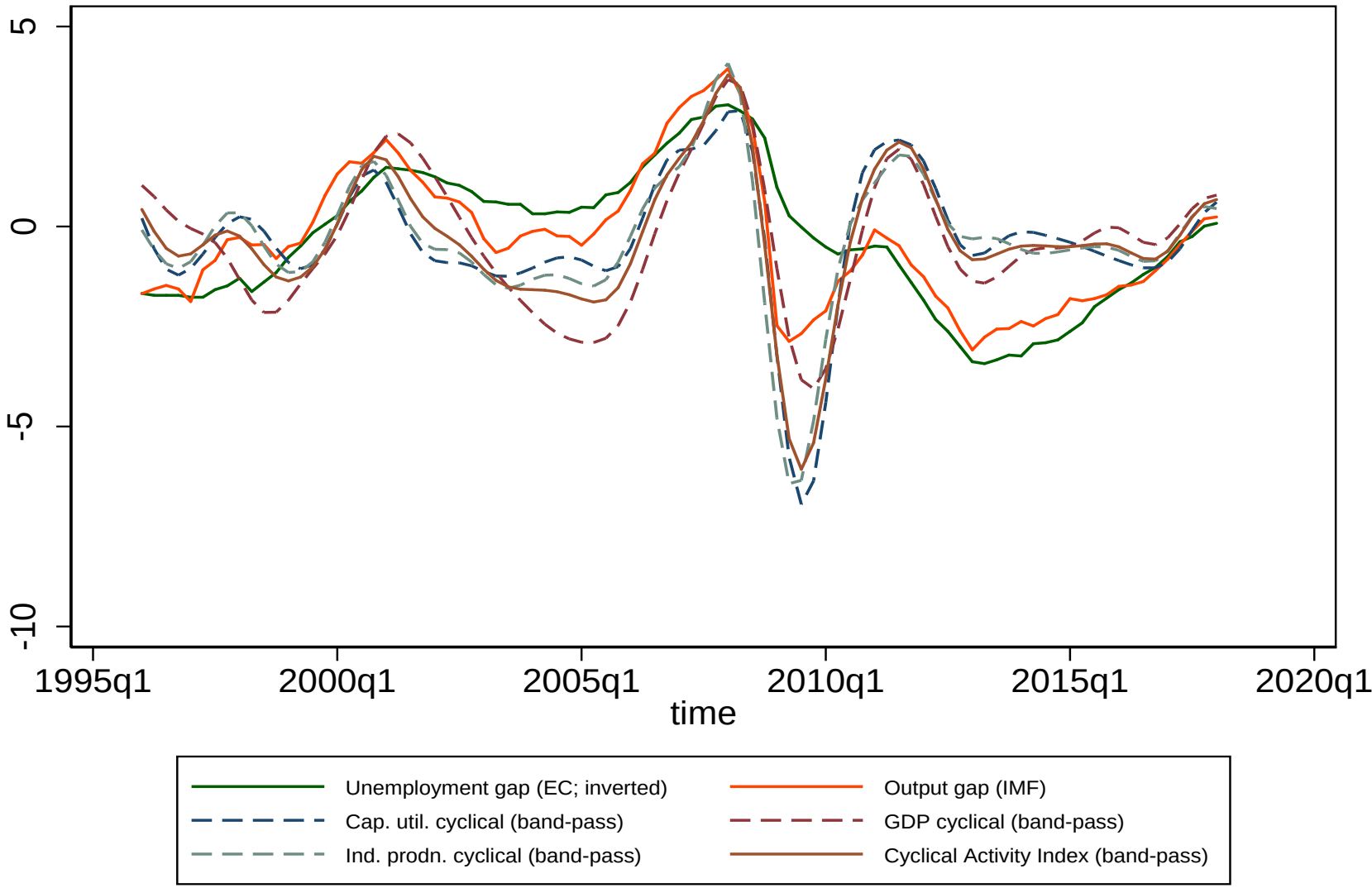
	Correlation			Slope (SE)		
	1960-1983	1984-1999	2000-2018q1	1960-1983	1984-1999	2000-2018q1
Ex-post slack						
Unemployment gap (CBO)	-0.61	-0.34	-0.32	-0.42	-0.21	-0.16
				(0.10)	(0.10)	(0.15)
GDP gap (CBO)	-0.62	-0.53	-0.49	-0.29	-0.29	-0.25
				(0.08)	(0.13)	(0.14)
Unemployment gap (two-sided filtered)	-0.64	-0.36	-0.32	-0.52	-0.22	-0.15
				(0.12)	(0.10)	(0.15)
Short-term unemployment gap (two-sided filtered)	-0.62	-0.46	-0.55	-0.34	-0.22	-0.29
				(0.09)	(0.10)	(0.13)
Employment-population ratio (two-sided filtered)	-0.59	-0.31	-0.19	-0.59	-0.18	-0.09
				(0.15)	(0.09)	(0.12)
Employment-population ratio ages 25-54 (two-sided filtered)	-0.50	-0.28	-0.24	-0.58	-0.17	-0.12
				(0.15)	(0.11)	(0.14)
Capacity utilization rate (two-sided filtered)	-0.70	-0.47	-0.64	-0.43	-0.25	-0.35
				(0.08)	(0.12)	(0.11)
Gap index	-0.65	-0.42	-0.41	-0.46	-0.23	-0.21
				(0.11)	(0.10)	(0.15)
Real-time slack						
Unemployment rate	-0.56	-0.32	-0.30	-0.38	-0.17	-0.15
				(0.11)	(0.09)	(0.15)
Short-term unemployment rate	-0.52	-0.34	-0.54	-0.28	-0.14	-0.37
				(0.09)	(0.09)	(0.17)

EA CSI : Slack Measures and Cyclical Activity Index

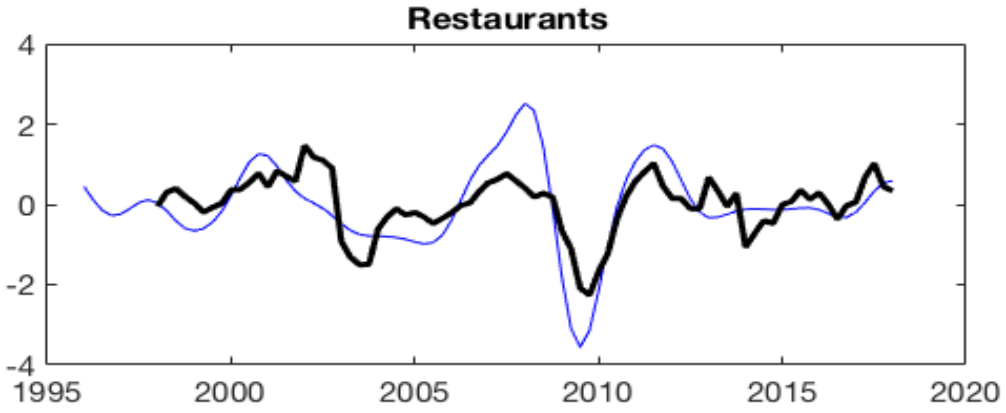
EA slack measures

- Unemployment gap (EC)
- Output gap (IMF)
- Band-passed activity variables:
  - GDP
  - Capacity utilization
  - Industrial production

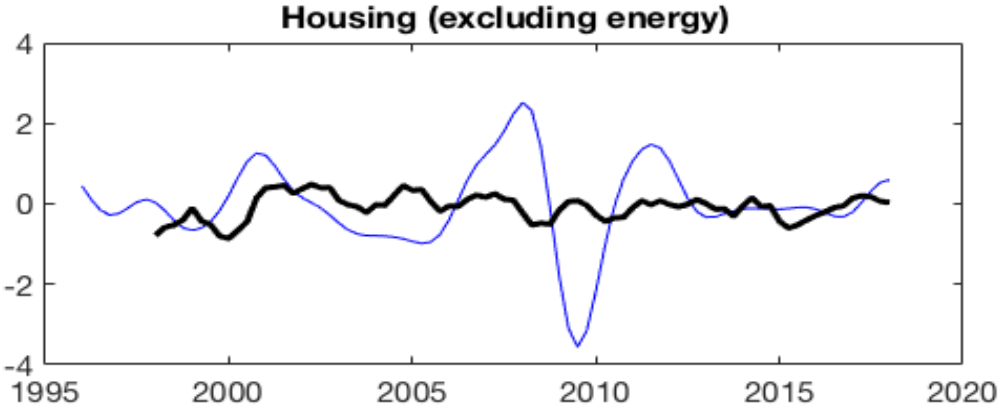
EA Cyclical Activity Index = average of three band-passed variables (standardized)



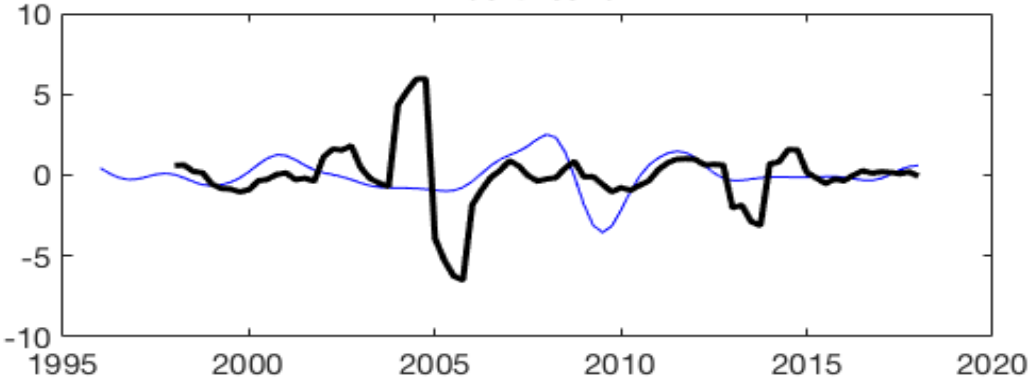
EA: HICP Components: 12 Second-Tier Components (Housing is ex energy)



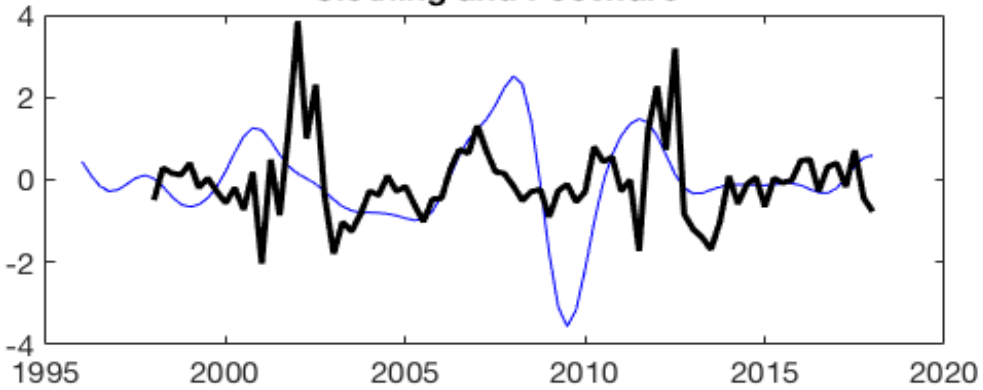
Correlation = 0.72



Correlation = 0.02



Correlation = 0.12



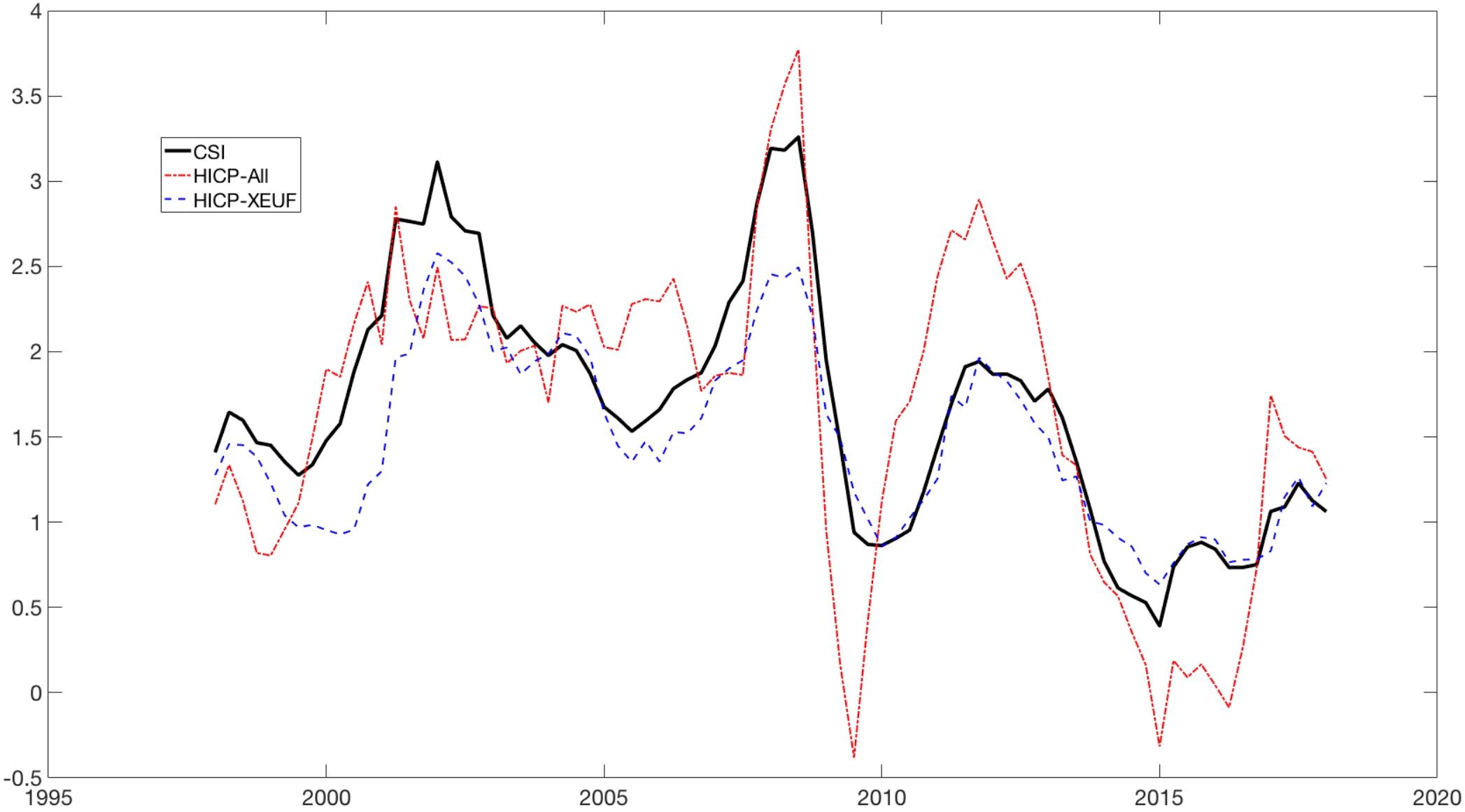
Correlation = 0.16

Black: inflation component Blue: Cyclical Activity Index

EA: Benchmark CSI specification using *CAI* – estimated 1996-2018q1

Component and HICP code	Consumption share (2018)	Correlation between cyclical activity index and 4-qtr change in 4-qtr inflation	CSI weight (w_i)
Food & non-alcoholic beverages (01)	0.155	**0.73**	**0.125**
Alcohol, tobacco, & narcotics (02)	0.040	-0.05	0.000
Clothing & footwear (03)	0.059	0.16	0.000
Housing excluding energy (04x)	0.064	0.02	0.000
Furnishings, household items, & maintenance (05)	0.062	**0.63**	**0.440**
Health (06)	0.048	0.12	0.042
Transport goods & services (07)	0.154	0.21	0.043
Communications (08)	0.032	-0.06	0.000
Recreation & culture (09)	0.092	0.24	0.000
Education (10)	0.010	0.27	0.011
Restaurants & hotels (11)	0.098	**0.72**	**0.338**
Misc. goods & services (12)	0.092	0.35	0.000

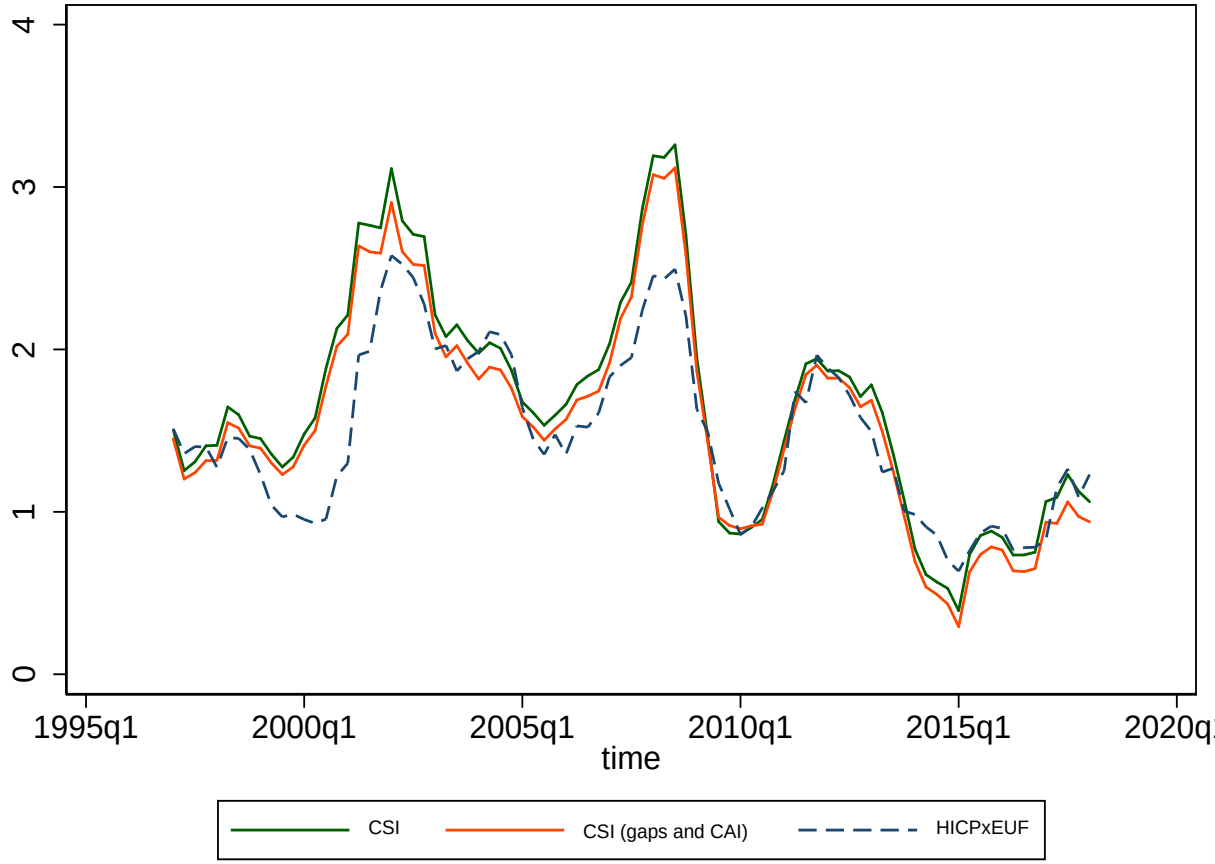
EA CSI, HICPxEUF, and HICP-all inflation (4 quarter inflation)



Sensitivity check: Gap index instead of band-passed activity index

4-quarter inflation

CSI using gap index



CSI with index weights estimated (band-passed, unemployment gap, output gap). 82% of the weight is on band-passed.

Take-aways

1. **Changing slack measures doesn't solve the PC puzzle (US)**

2. **Cyclical behavior varies substantially across components.**
   - In ways that largely make sense based on the nature of the markets (local v. global) and on measurement quality

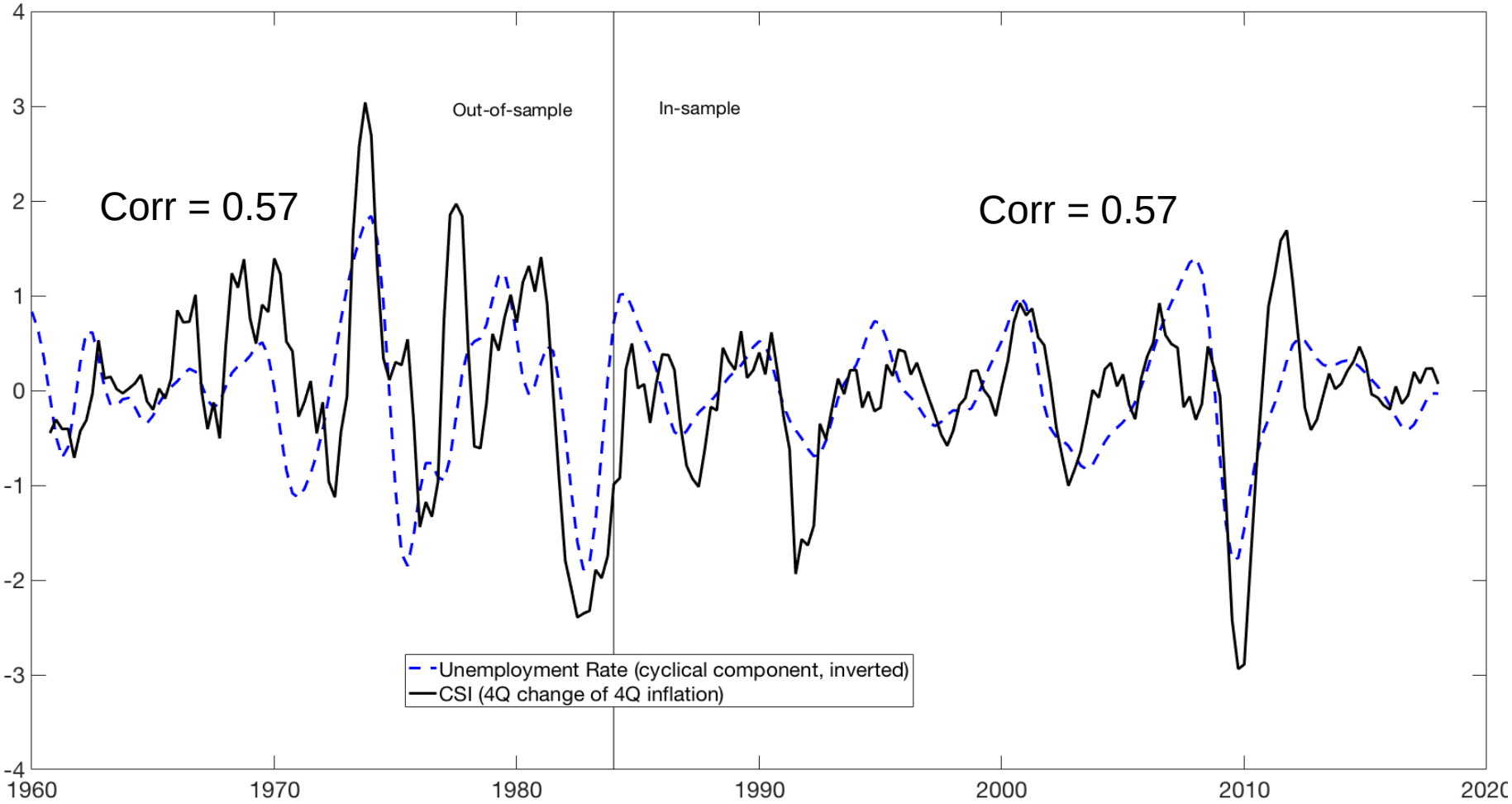
3. **Current outlook: US**
   - From 2013q1-2018q1, PCExFE is unchanged (1.5%), CSI has increased from 2.1% to 2.6%

4. **Current outlook: EA**
   - CSI has different weights than HICPxEUF – but recent behavior is very similar
   - 2016q1-2018q1: EA-CSI increased from 0.9% to 1.2%, same as HICPxEUF

5. **Next steps**
   - Implement monthly (12-month inflation)
   - Work with third-tier components – especially in EA (differentiate goods and services)
   - Resolve conceptual/empirical issue: band-passed activity index or gap or ???

Additional Slides

US: Sensitivity check: Pre-sample stability



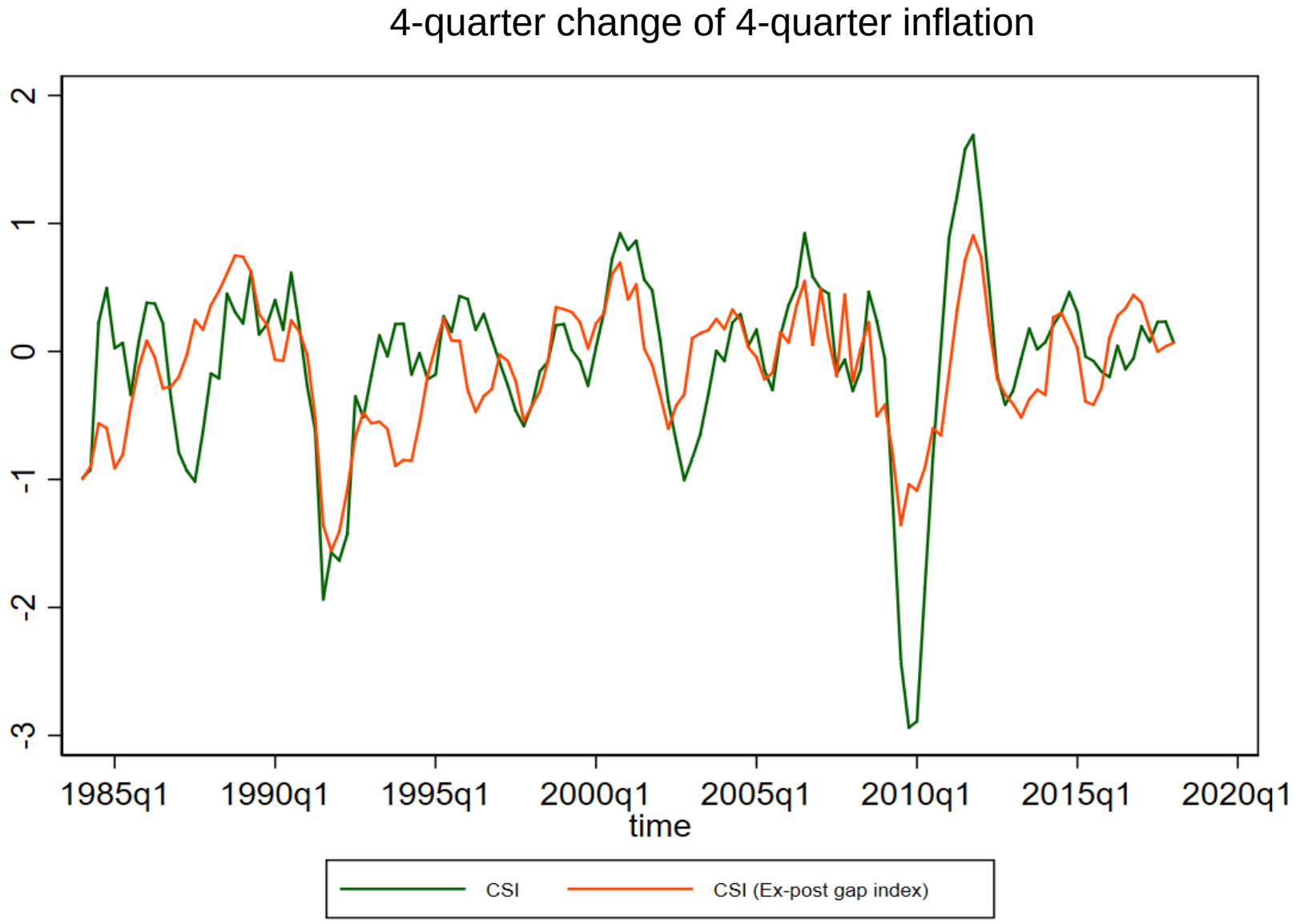
Other sensitivity checks

1. Rolling regression
2. Use all 17 components
3. Constrained canonical correlations using all 7 band-pass activity variables
4. **Use gap instead of band-passed activity indexes**

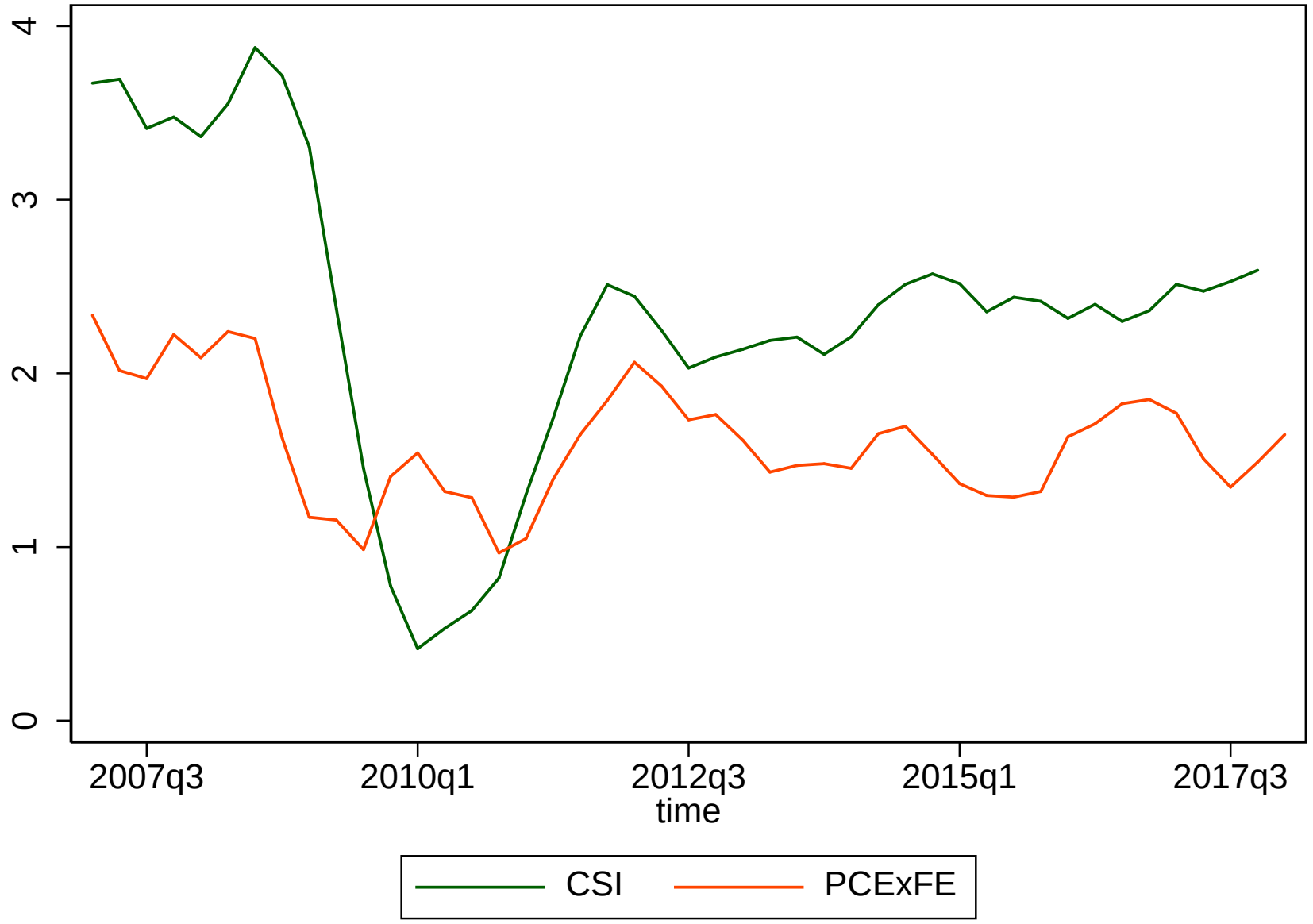
US: Sensitivity check: Gap index instead of band-passed activity index

CSI inflation index differs if gap index is used instead of band-passed.

If activity weights *and* CSI weights are chosen simultaneously, the slack variable chosen is band-passed activity index – not a gap!



US: Recent values, CSI and PCExFE (quarterly inflation)



US: PCE components and their shares, sorted by 2000-2014 share

Sector	1960-2014	1960-1979	1980-1999	2000-2014
Housing and utilities	0.18	0.17	0.18	0.18
Health care	0.11	0.07	0.13	0.16
Other services	0.08	0.08	0.08	0.09
Other nondurable goods	0.08	0.08	0.07	0.08
Food and beverages for off-premises consumption	0.12	0.16	0.10	0.08
Financial services and insurance	0.06	0.05	0.07	0.08
Food services and accommodations	0.06	0.06	0.07	0.06
Motor vehicles and parts	0.05	0.06	0.05	0.04
Recreation services	0.03	0.02	0.03	0.04
Clothing and footwear	0.05	0.07	0.05	0.03
Recreational goods and vehicles	0.03	0.03	0.03	0.03
Gasoline and other energy goods	0.04	0.04	0.04	0.03
Transportation services	0.03	0.03	0.03	0.03
Furnishings and durable household equipment	0.04	0.04	0.03	0.03
Final consumption expenditures of nonprofit institutions serving households (NPISHs)	0.02	0.02	0.02	0.03
Other durable goods	0.02	0.02	0.02	0.02

The PCE price index: a brief review of methods

- **The PCE price index is computed by the Bureau of Economic Analysis (BEA)**
  - Most component price series are CPI indexes for components, computed by the Bureau of Labor Statistics (BLS)
  - Differences between PCE-PI and CPI:
    - PCE concept is final consumption, CPI is "out of pocket" spending
    - Share weights are from the NIPA surveys
    - PCE-PI is revised for methodological changes (if possible), CPI is not
    - Some divergence in price concepts, in which PCE uses PPI not CPI prices

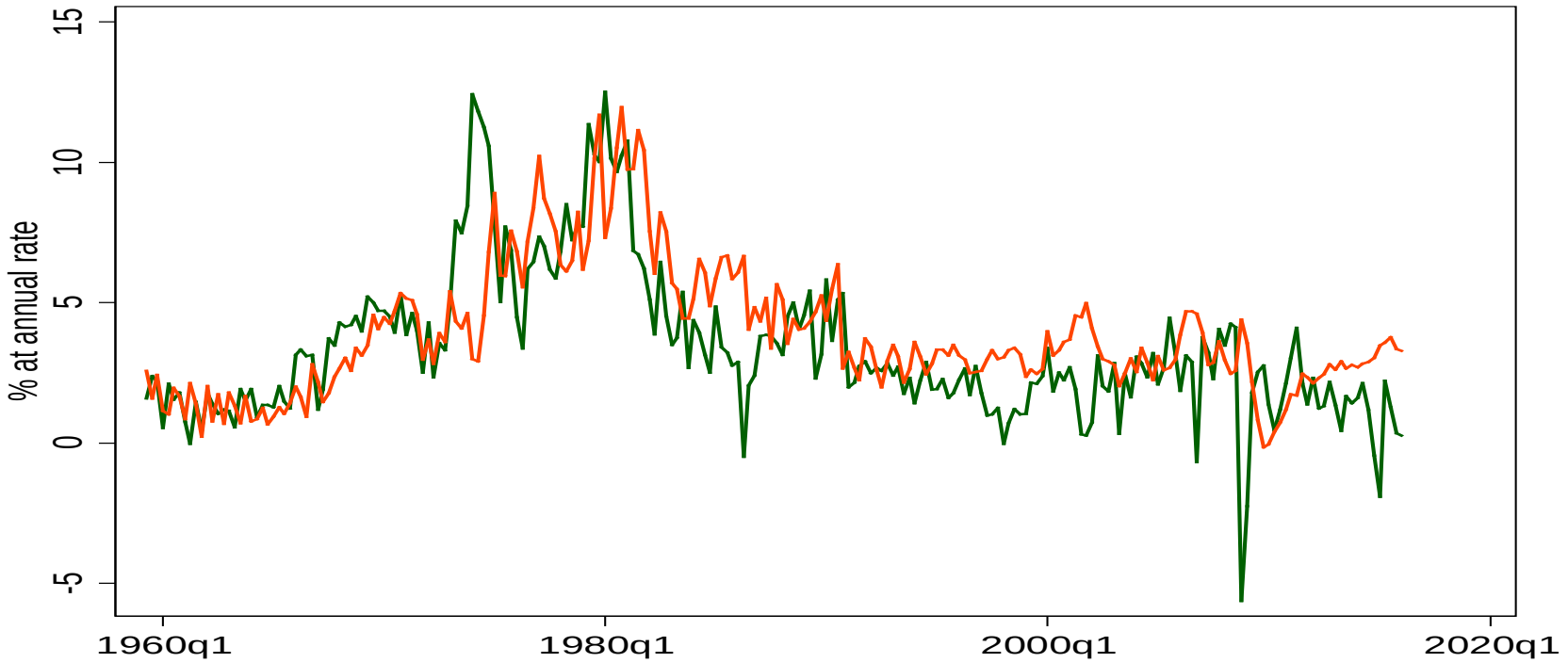
- **The market price component of the CPI has 211 item strata**
  - Goods and services. Nondurables: < 3 yrs life. Services: cannot be inventoried.
  - Main sampling rotation structures:
    a) food at home, lodging, most consumer end-energy goods, telephone services, used cars, some odds and ends: Single panel sample monthly
    b) Everything else except rent (most regions): 2 panels, alternating months
    c) rent: 6 panels, each sampled every 6 months
  - The market price component of the CPI has 211 item strata
  - Market-based CPI has several well-known problems
    - New goods problem: no quality adjustment, just skip first month price
    - Replacement goods problem: quality adjustment by (a) hedonic regression or, if not possible, (b) production cost

The PCE price index: a brief review of methods, ctd.

- **The PCE-PI and the CPI are also computed for sectors without posted market prices. There are various methodologies:**
  - The first step is defining the unit to be priced. For example
    - For legal services:
      - an end-consumer legal service (e.g. will), with a fixed production function (hours of attorney, legal aide, etc) and changing input wages;
      - or, an hour of a law office's time
    - For hospital services: a service bundle (e.g., 2 day stay + 1 cardiac catheterization + 2 EKGs + 2 IV doses blood thinner drug + …)
  - These are priced from (randomly selected) bills or interviews
  - Other price indexes for unpriced services include unpriced services of nonprofits (religious institutions, etc.), unpriced banking services (liquidity services)
  - However, many services have market prices (Red Sox ticket; a room at Sonesta)

- **Special indexes:**
  - PCE-xE: excludes gasoline & other energy goods + energy utilities component of housing
  - PCE-xFE: also excludes food at home (but not food at restaurants)
  - Market-based CPI (excludes all non-market price estimates)

PCE (green) and component (orange): Housing ex energy util. (qtrly)

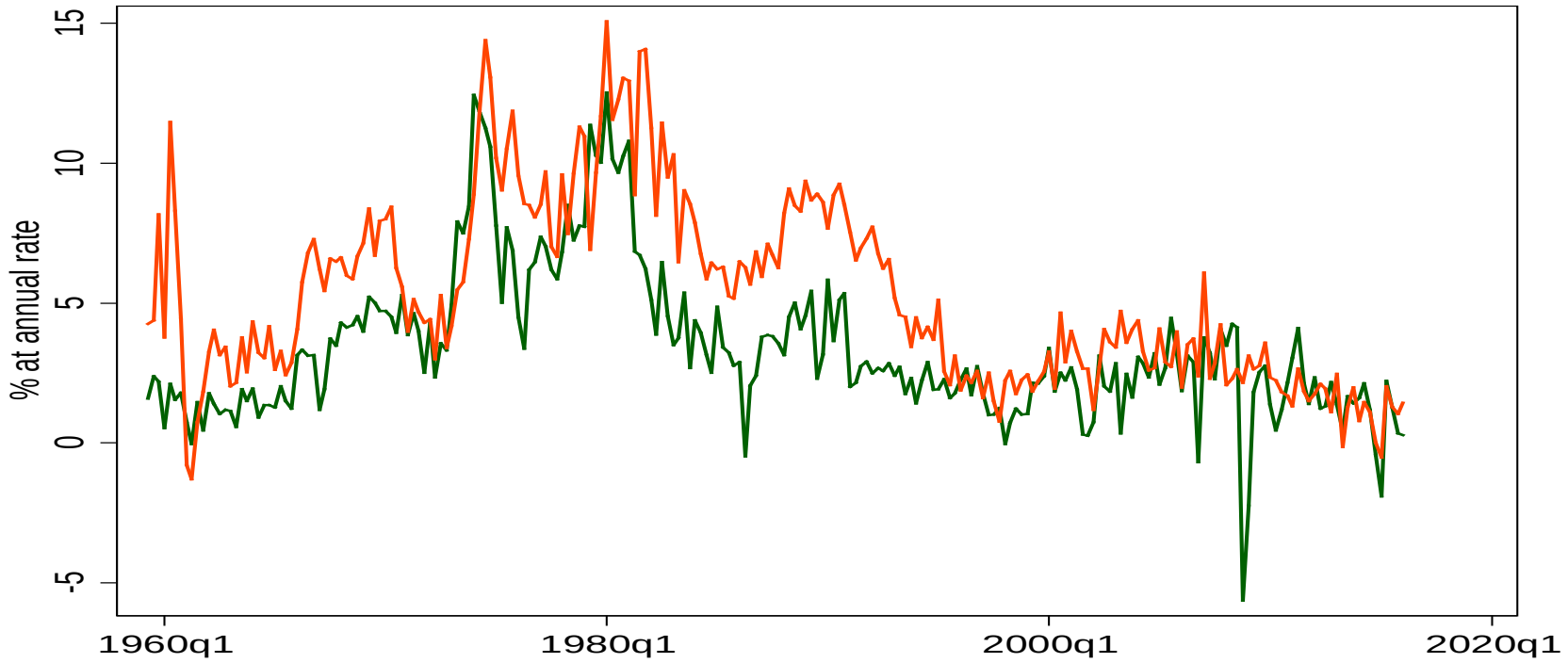


Rent paid by renters	Actual market rent excluding utilities 6 rotating panels, surveyed every 6 months Price index(t) = This month's panel price relative × price index(t-1)
Owner-equivalent rent	Post-1983: Actual market rent excluding utilities Pre-1983: Payment flows (mortgage payments, etc) 6 rotating panels, index construction as for renters
Misc.	Surveyed units fractionally represent rental and owned units Boarding schools, group homes use renter's rent index Utilities: CPI for water & sewer maint; CPI for garbage & trash collection

Housing: energy utilities

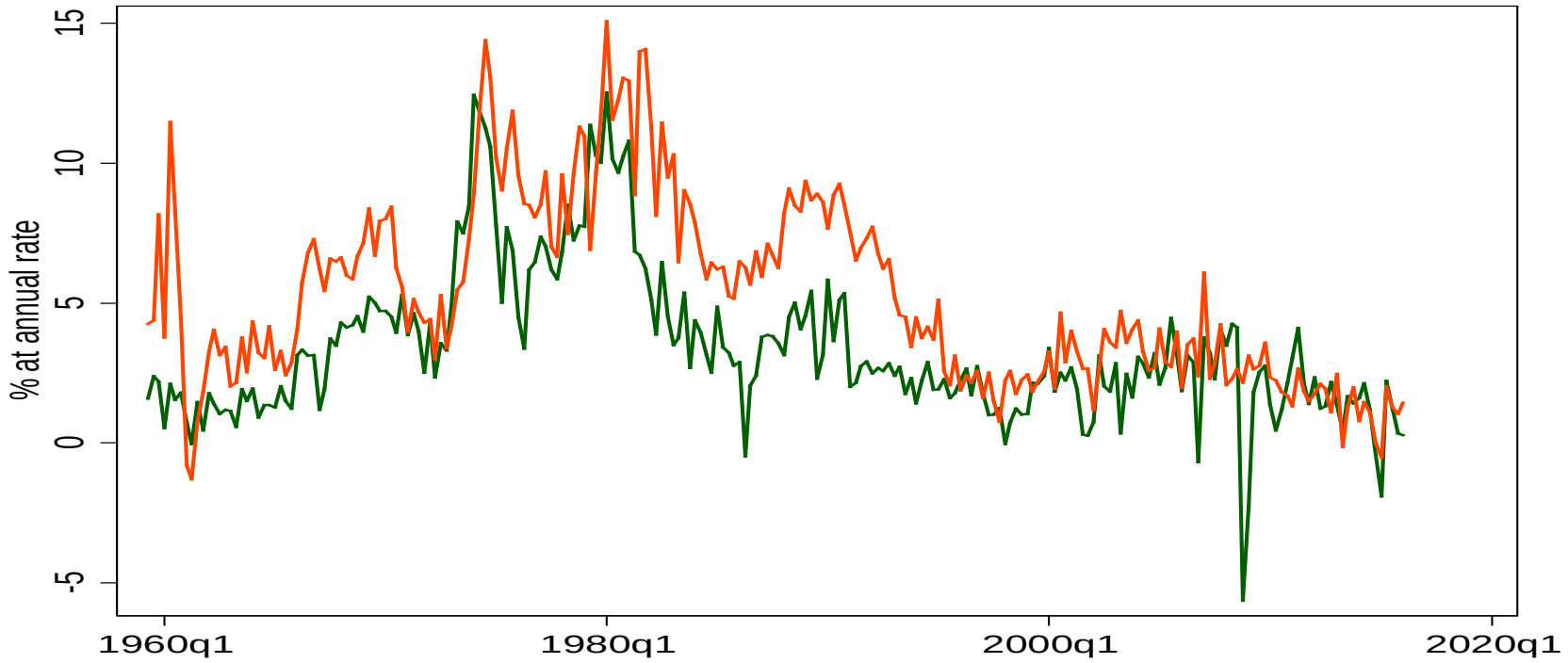
Electricity	CPI for electricity
Natural gas	CPI for utllity-provided natural gas

Health care (expenditure share 2000-2016 = 0.16): CPI



CPI v. PCE	CPI covers out-of-pocket medical (paid by consumers). PCE covers consumption of medical services. Most medical services in the U.S. do not have a market price – they are negotiated health plan prices
CPI: Outpatient physician's services, paramedics, hospitals, nursing homes	Provision-of-services concept. CPI outpatient: price of visit for a specific illness. CPI hospital (post-87): price of bundle of services provided (3-day stay + 1 catheterization + 2 EKGs +…) by insurer reimbursement category. CPI pharma: by drug. Pre-87: cost of hospital inputs
Dental & other medical	CPI for dental services, CPI for other medical services

Health care (0.16): PCE

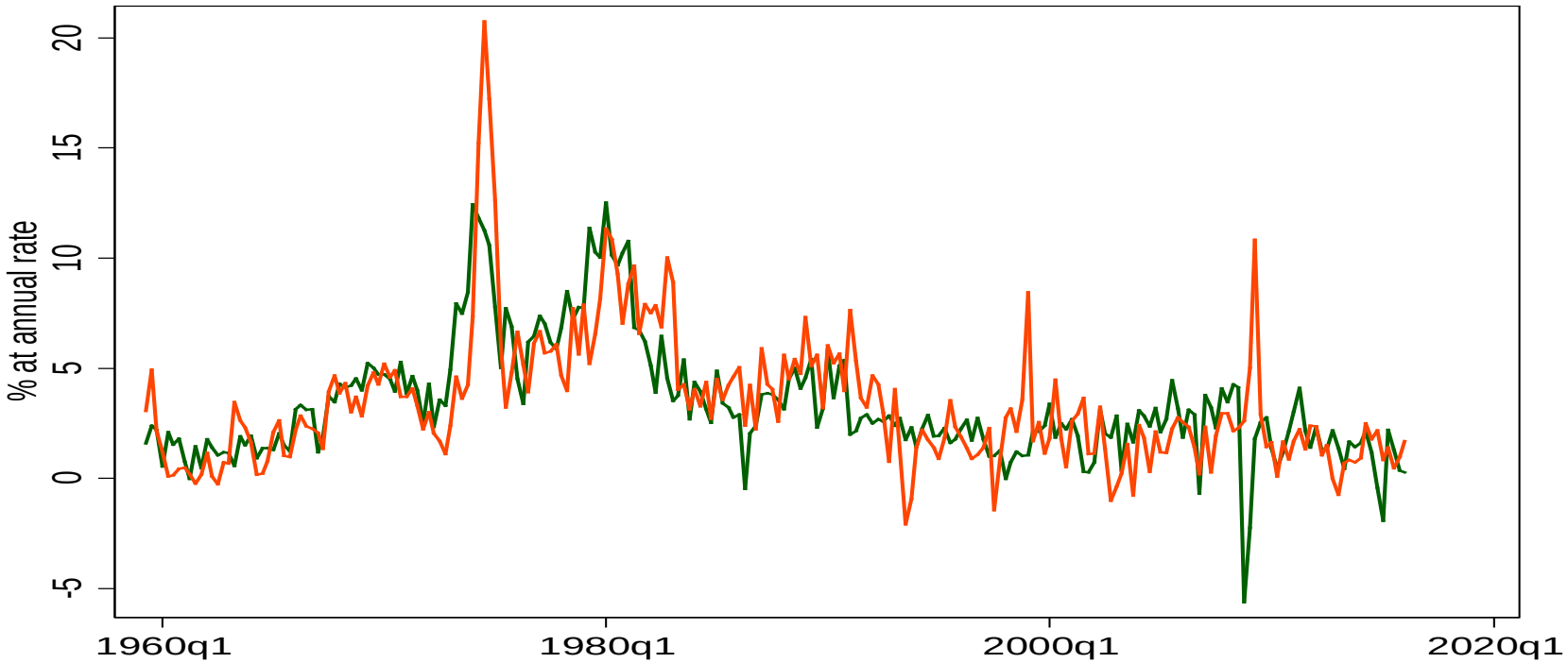


PPI concept	PPI usually first transaction price rec'd by producer. For health care, PPI since 1993 is DRG-based, broken out by service providers
PCE: Physician services	PPI for physician offices. Unit is office visit for a given condition
PCE: hospital services	PPI for hospitals. Unit is a hospital episode for a given condition
PCE: nursing homes	PPI for nursing homes. Cost of inputs basis (hourly wages etc.)
PCE: paramedical	PPI for paramedical
Dental & other medical	Uses CPIs for dental services, for other medical services

Other services (0.09)

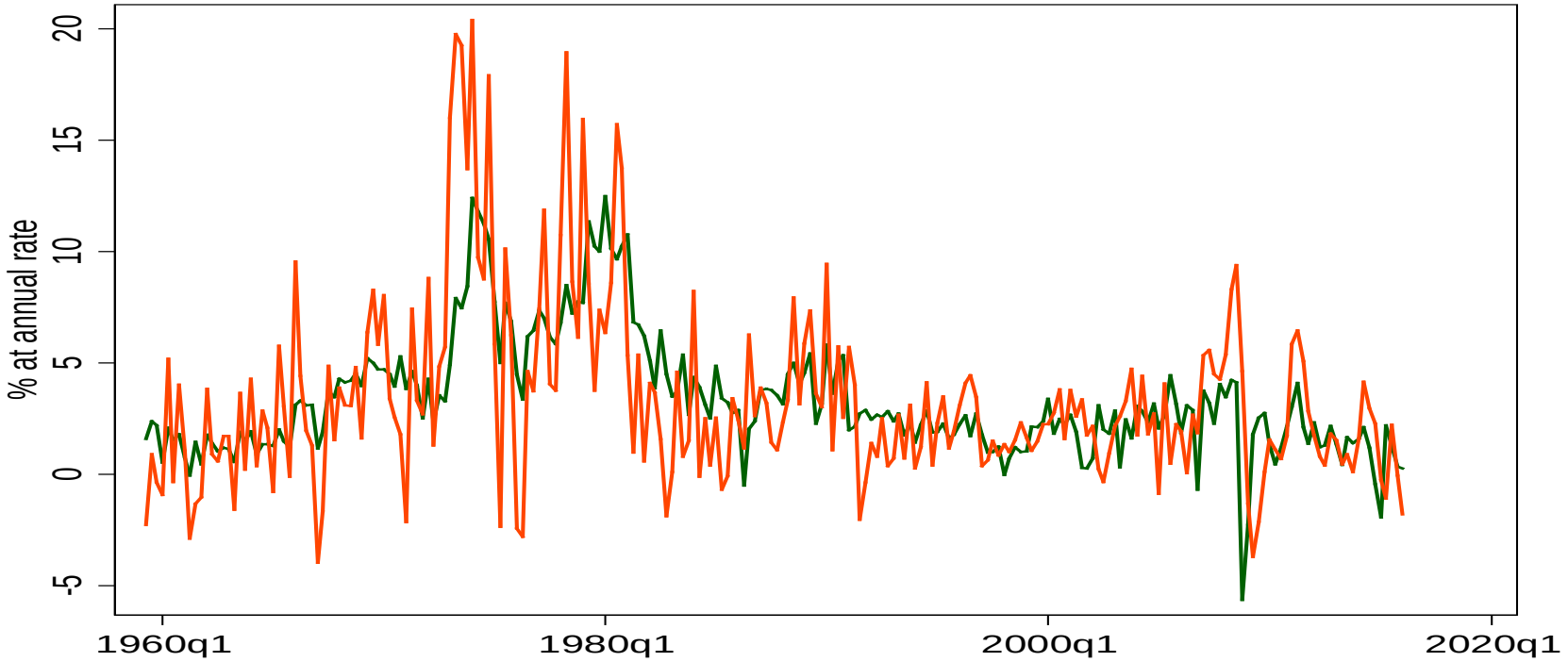
Communication	CPI for wireless phone service, CPI for land line phone service
Internet	CPI for internet services
Education	CPI for college education; CPI for private primary & secondary schools
Legal, accounting	Cost basis (cost of 1 hr law office time, or mix of time for given service)
Social services	Cost basis, some CPI (child care)
Misc.	CPI for postage, CPI for funeral services, CPI for haircuts; net foreign travel (complicated)

Other nondurable goods (0.08)



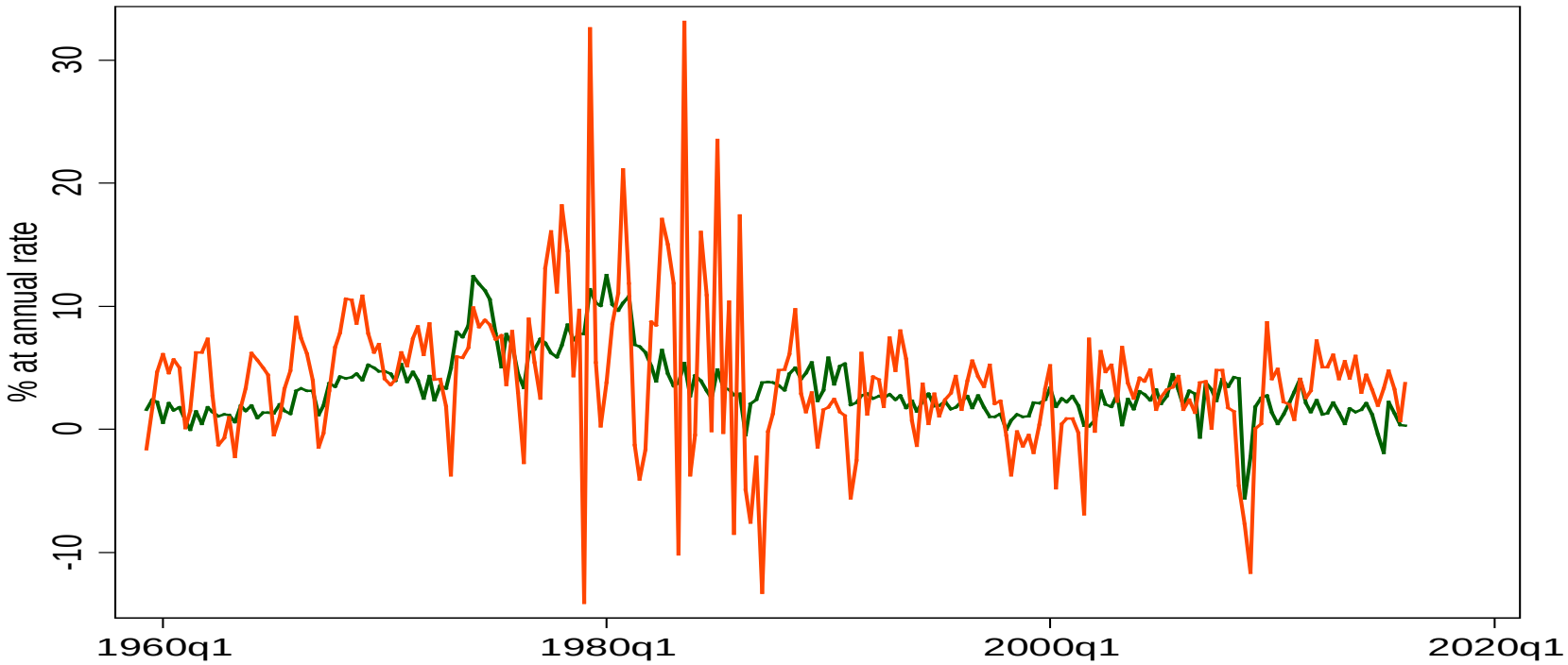
Tobacco	CPI-tobacco
Pharmaceuticals	CPIs for prescription & OTC drugs, CPI for med. eqpt sold to consumers
Recreational nondurables	CPIs for toys, plants & flowers, pets, photographic supplies,…
Personal care	Various CPIs for personal care items
Misc. home goods	CPIs: newspapers & magazines, household supplies
Spending abroad	(net, including in-kind personal remittances) complicated, non-mkt

Food & beverages off-premises (0.08)



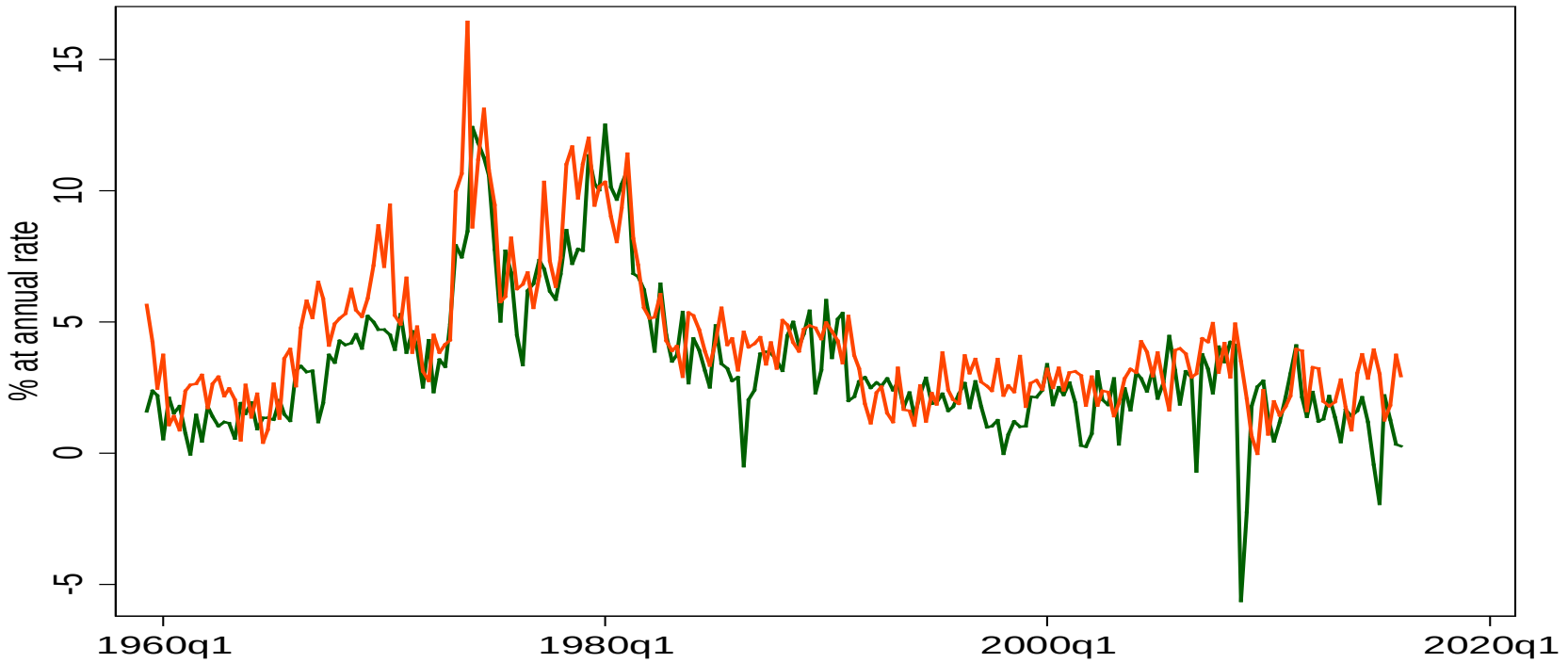
Food & nonalcoholic beverages, off-premises	Detailed price components for food at home
Alcohol, off-premises	Various CPIs (beer, wine, distilled spirits) for off-premises

Financial services & insurance (0.08)



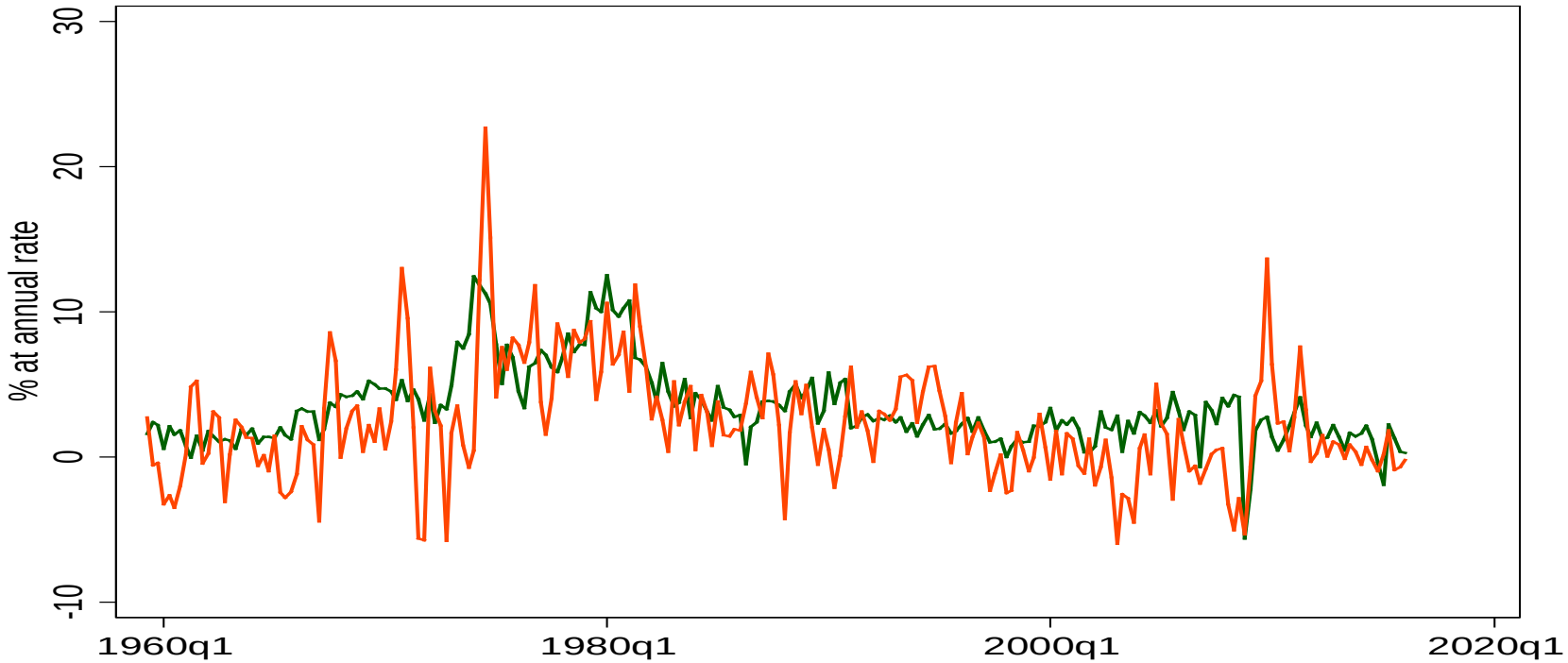
Financial services provided w/out payment	Estimated based on imputed below-market interest on checking account. Alternative interest rate changed to “stabilized” (smoothed) rate in 2013, revised back to 1985
Financial fees	CPI for checking account and other bank services (market prices).
Insurance	Price index is for the value of insurance services provided (risk pooling, intermediation) = all premiums – expected losses; cost-based using PPI
Brokers’ fees	PPI (cost-based)

Food services & accommodations (0.06)



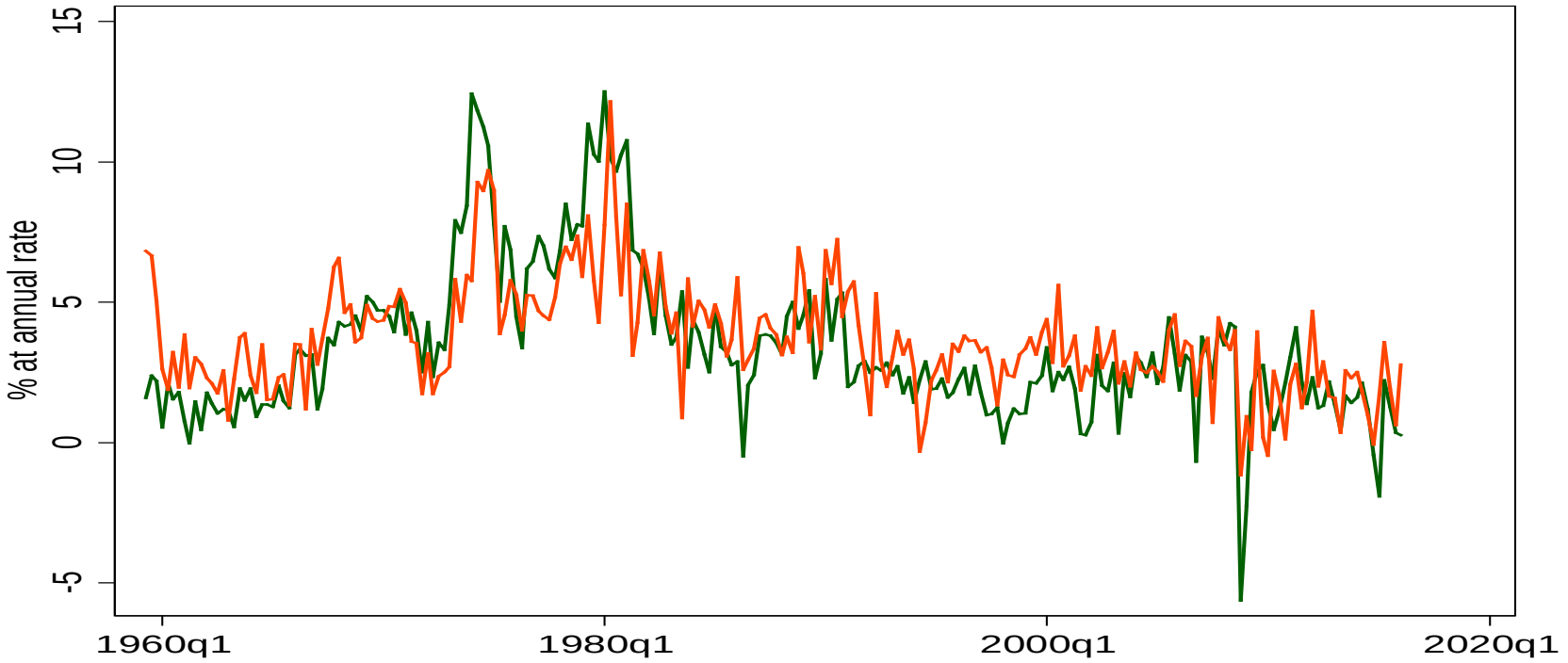
Purchased meals & beverages	CPI for categories of purchased meals & beverages (restaurant meals, bars, fast food, etc)
Institutional food & drink	Use market-based CPI for purchased meals & beverages by category
Accommodations	CPI for purchased lodging away from home. Boarding at schools: separate (market-price) CPI

Motor vehicles & parts (0.04)



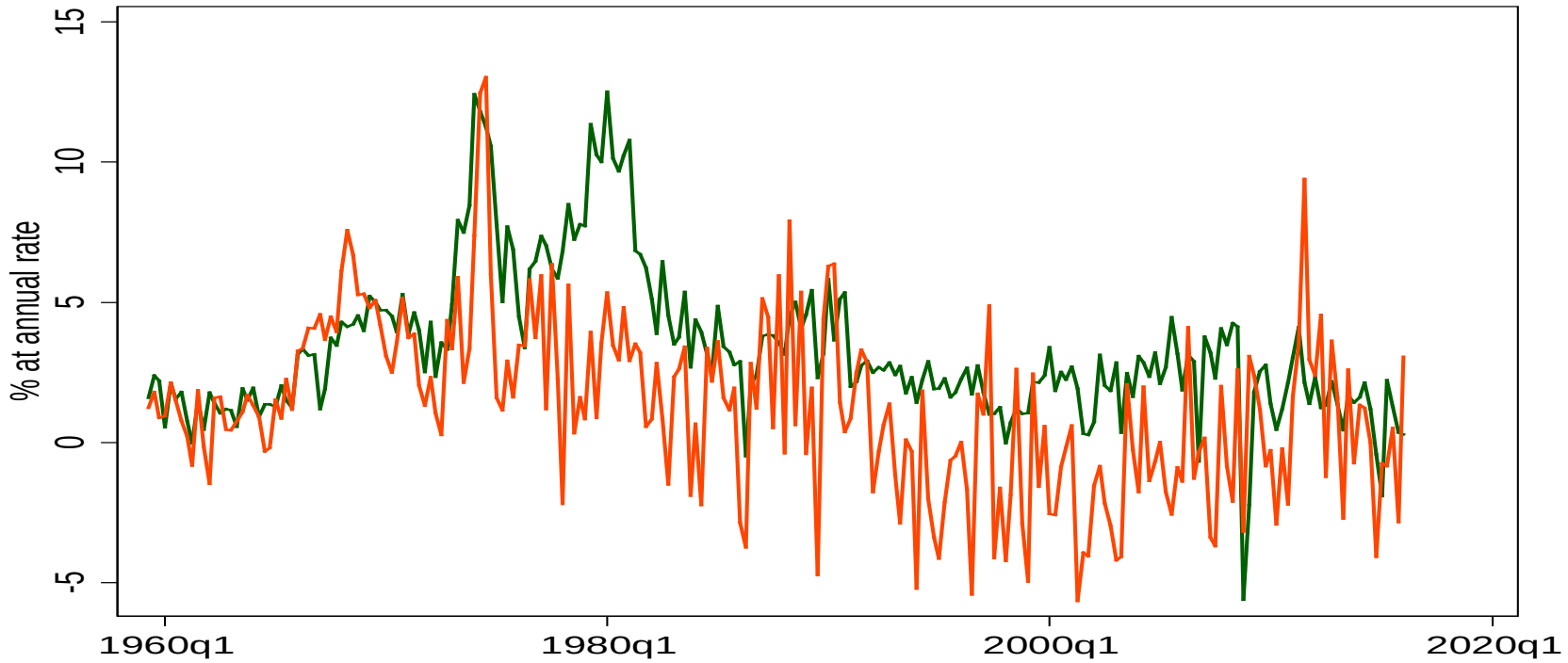
New cars & trucks	CPI-new cars: sticker price + 30-day average dealer markup or discount. Year to year quality changes priced on production cost.
Used cars & trucks	Secondary source price data, with quality adjustments when new
Parts	CPI for tires; CPI for parts

Recreation services (0.04)



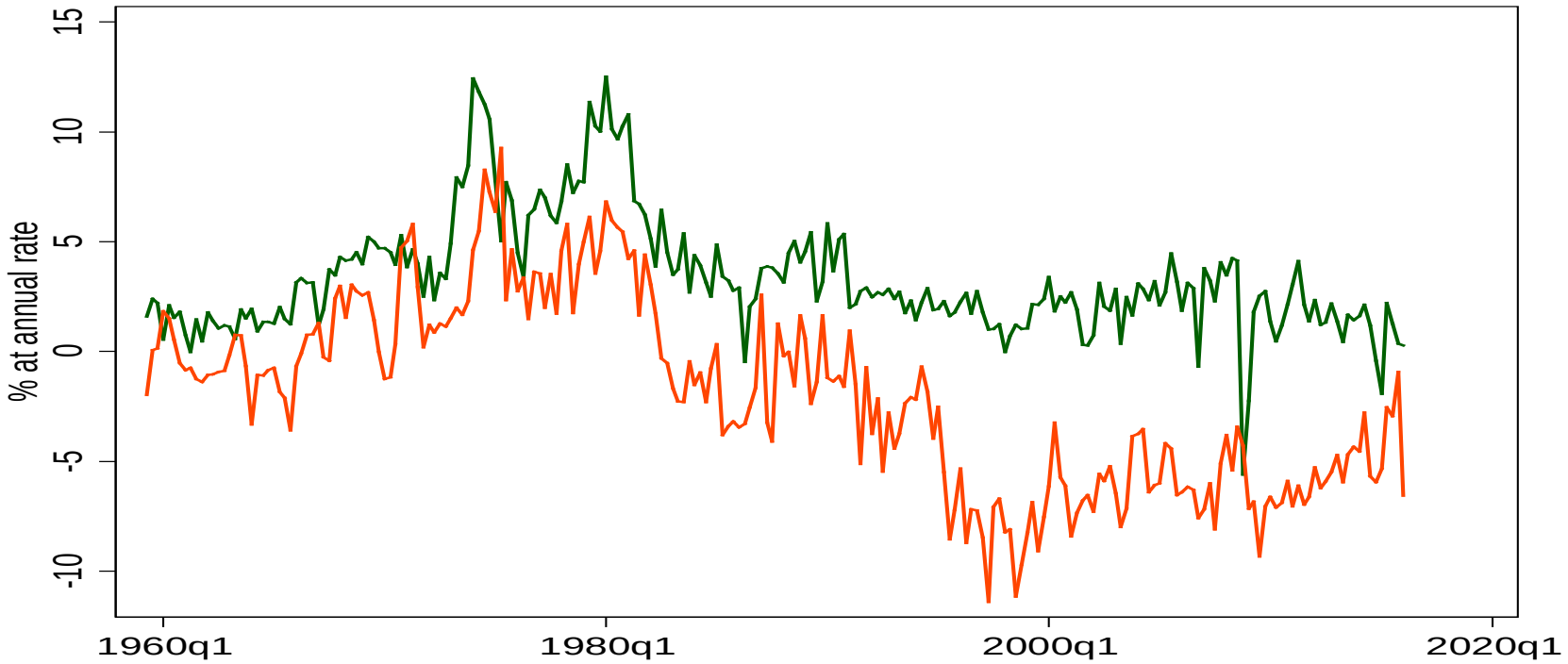
Sports centers & clubs, theaters, museums, etc.	CPI for specific categories, e.g. club dues and fees; admission to sporting events. Monthly/bi-monthly/6-month sample
Audio/video & info processing services	CPI for cable & satellite TV; CPI for film processing; CPI for video/audio rental
Other	Gambling: CPI-U; pet care: CPI-veterinary services, etc.

Clothing & footwear (0.03)



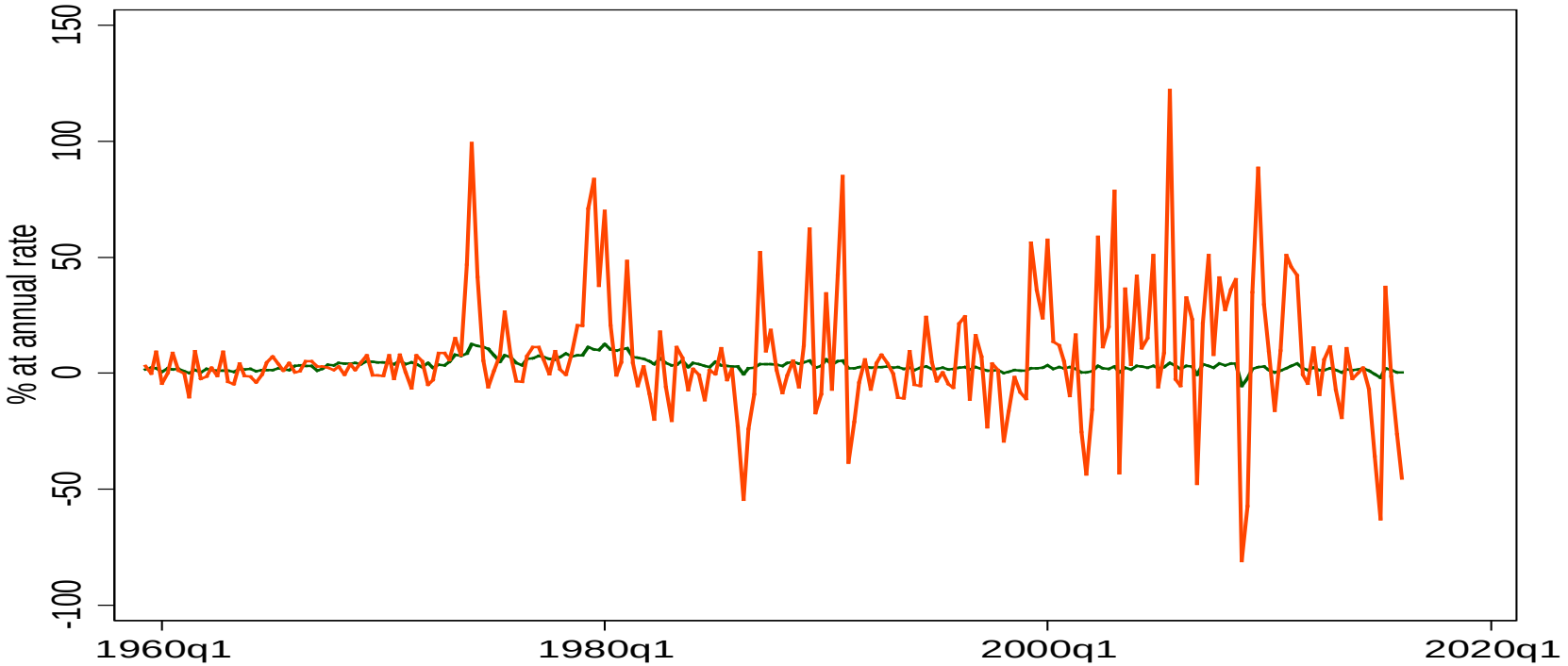
Market purchased clothing	Various CPIs. Note new/replacement goods issue however.
Military & uniforms	Cost-based

Recreational goods & vehicles (0.03)



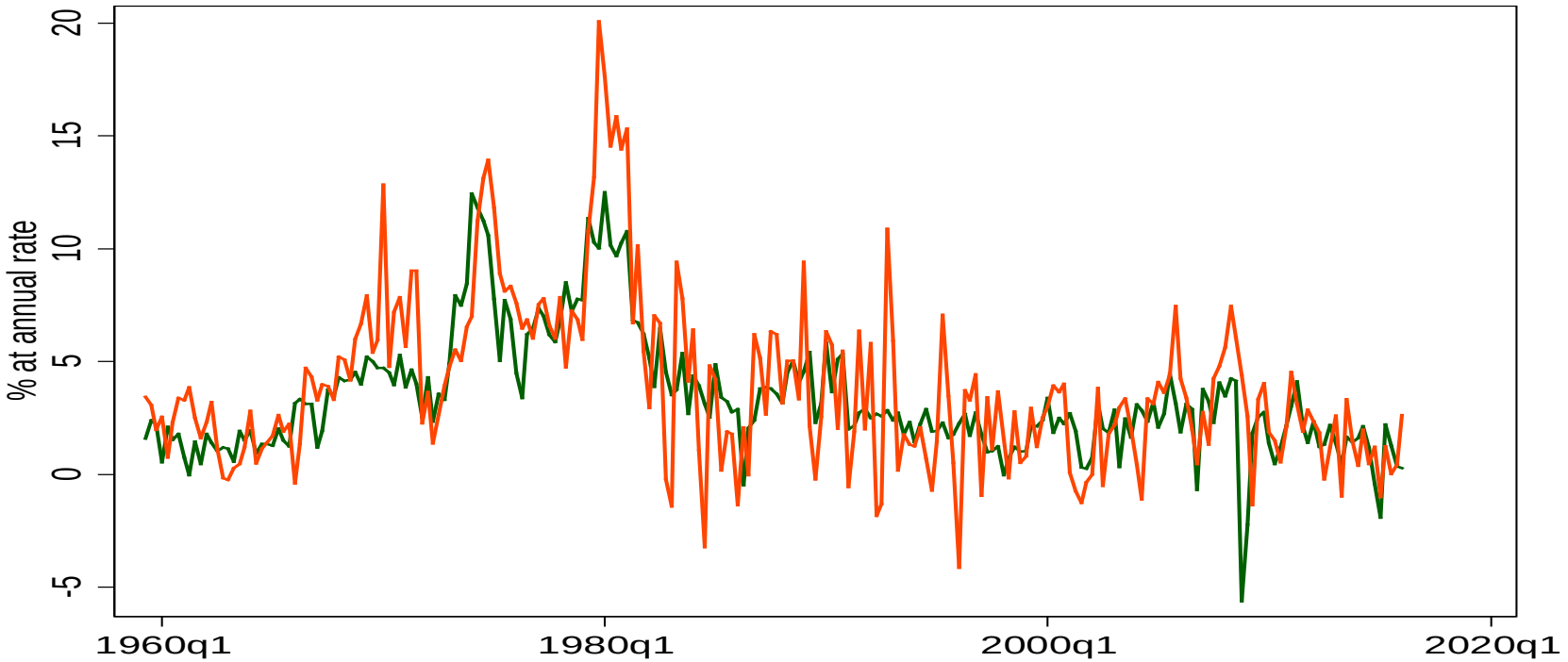
Video, audio, home computers	Various CPIs including CPI for home computers, CPI for computer software and accessories, and CPI for consumer digital communications and information processing eqpt
Sporting eqp	CPI for sporting eqpt
Recreational books	CPI for recreational books
Musical instruments	CPI for musical instruments

Gasoline & other energy goods (0.03)



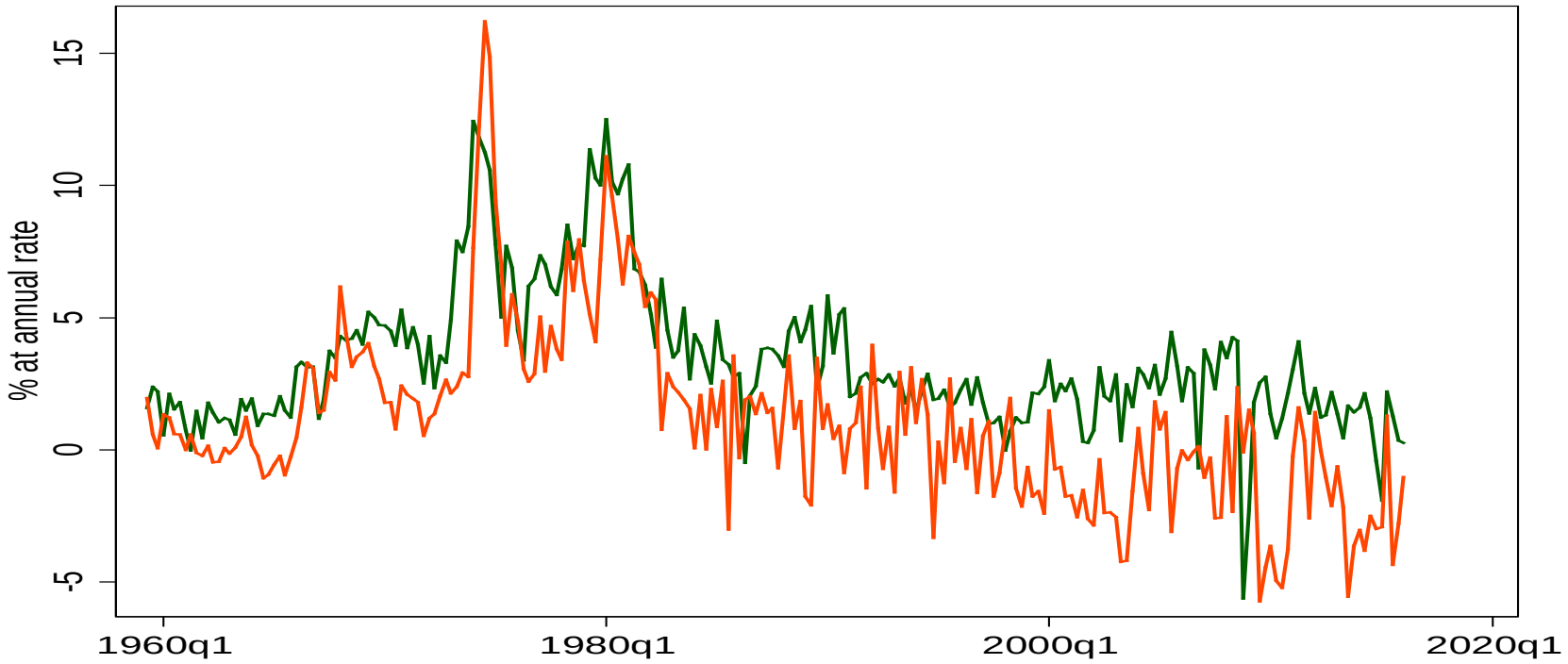
Motor fuels	CPI for motor fuels
Other fuels	CPIs for propane, kerosene, wood

Transportation services (0.03)



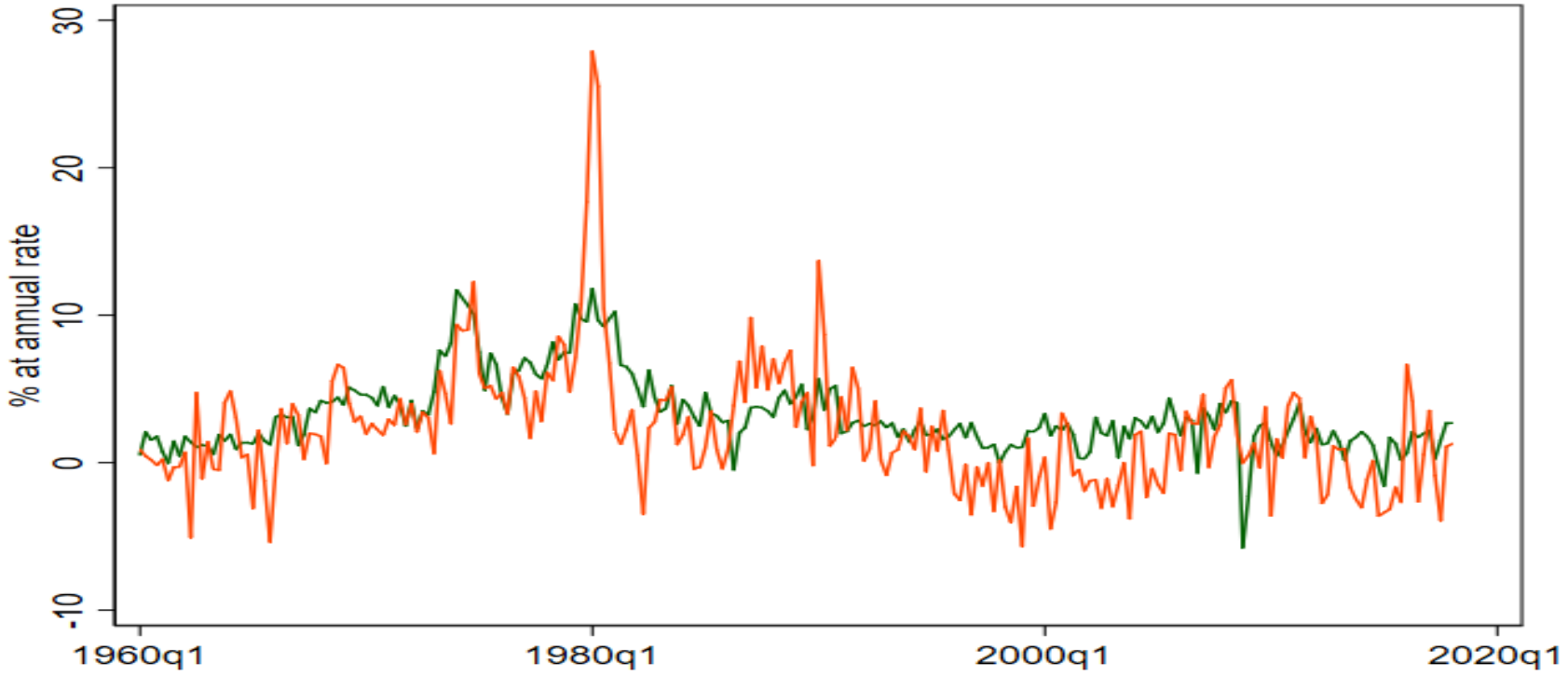
Airline travel	PPI (cost-based: passenger revenues/total passenger-miles) (however CPI is based on actual prices, currently sampled off the Web)
Intracity	CPI (covers taxis, busses, etc.)
Intercity busses, trains	CPI (market prices)
Water	CPI (ferries, etc.)

Furnishings & household durables (0.03)



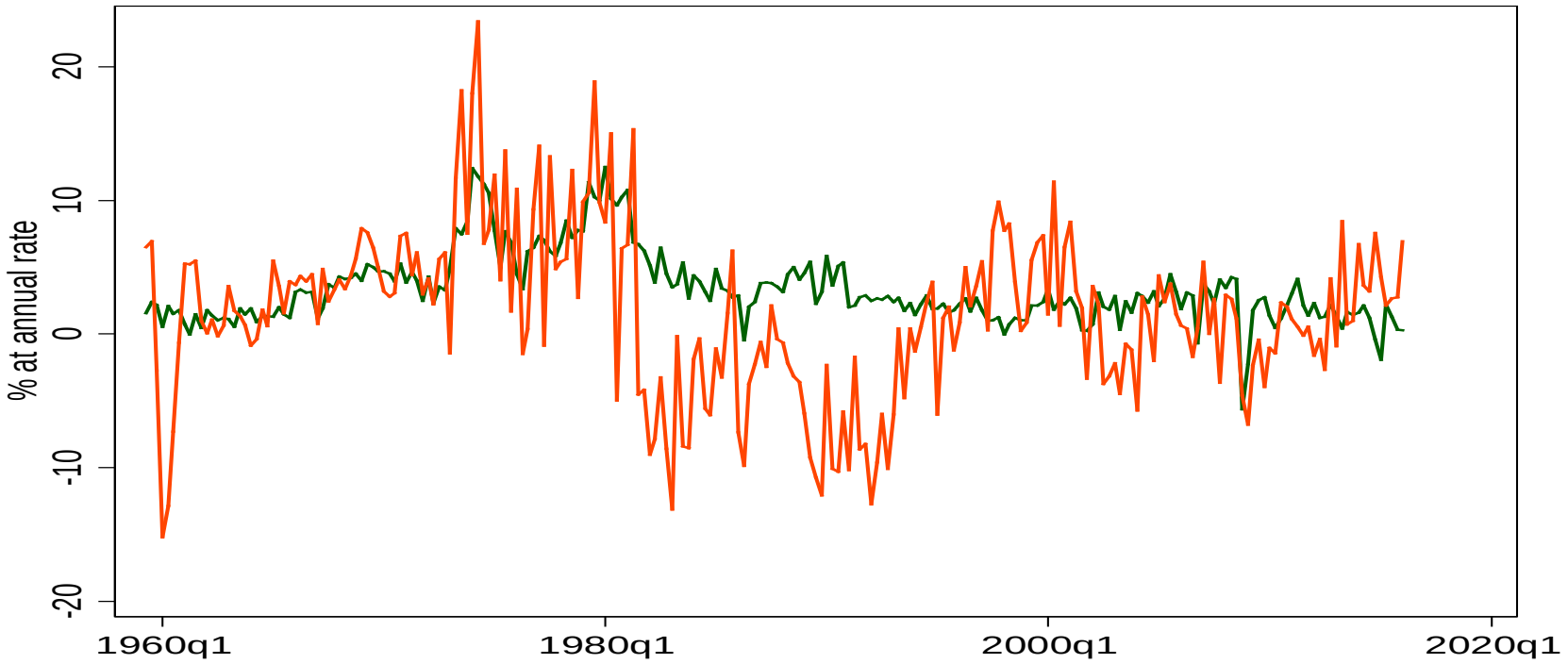
Furniture & bedding	CPI for furniture & bedding; CPI for clocks & lamps; related CPIs
Household appliances	Various CPIs
Tools, house & garden eqpt	Various CPIs

Other durable goods (0.02)



Misc. durable goods	Watches, jewelry, educational books, luggage, telephone equipment. All based on CPIs (market prices)

Final consumption expenditures of nonprofit institutions serving households (NPISHs) (0.03)



NPISH definition	Current operating expenditures by nonprofits less sales to households and other sectors.
Prices	By construction, essentially everything in NPISHs does not have a market price, so costs of inputs are used for priced outputs. Example: price of 1 hour of a minister's time = minister's hourly wage