Inflation Targeting and Business Cycle Synchronization

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Few Monetary Strategies exist

- Fixed exchange rates
- Money growth targets
- Hybrid/Ill-defined strategies
- Inflation Targets; focus here

Inflation Targeting

- Popular, swiftly-spreading, durable monetary institution
- Much studied
  - Theoretical work on normative properties
    - Ex: Benigno and Benigno, Obstfeld and Rogoff
  - Empirical work on domestic aspects of IT
    - Ex: Ball and Sheridan: does IT matter for inflation?
    - Ex: Siklos: did inflation process change?
- Little empirical work on international aspects of IT

Focus Here: Monetary Sovereignty

- Does IT provide insulation from foreign shocks?
  - Mundell's "Trinity" insulation: Yes!
- Focus is on domestic *real* phenomena
- Are business cycles less synchronized for countries that target inflation?
  - Natural comparison is countries that fix exchange rates or are in monetary union

Should Business Cycles be less synchronized for ITs?

- IT countries all float (mostly pretty cleanly)
- Compare "Insulation" properties of fixed and floating regimes:
  - Negative foreign shock hits with nominal rigidities
    - Requires fall in real exchange rate
  - Faster, less costly to adjust nominal exchange rate
    - Alternative is wait for excess supply in labor, goods markets to push nominal wages, prices down
    - But that implies decline in output, employment

Still, Ambiguities Have Always Existed (important?)

- Mundell formalized both SOE and 2-country models in 1960s

2-country model	Foreign Shock	Domestic Effect
Fix	**Financial**	+
	Real	ambiguous,* probably +
Float	**Financial**	-
	Real	+, small except for v/large

* Depends on effect of higher world interest rate (-) vs higher demand for domestic exports

But Easy to Motivate Opposite Finding Theoretically

- We develop a small theoretical model of an open economy with conventional blocks:

Lucas-style *Aggregate Supply*

$$y_t = \beta(p_t - E_{t-1}p_t) + u_t$$

Conventional *Aggregate Demand*

$$y_t = E_t y_{t+1} - \delta r_t + \theta y_t^* - \kappa(p_t - p_t^* - s_t) + h_t$$

PPP deviation

$$p_t = p_t^* + s_t + g_t$$

Foreign Economy

- y* is white noise
- $p_t^* = \psi y_t^*$ $\psi>0$

We include Alternate Monetary Regimes

- Taylor-style rule interest rate weighted to encompass:

    1. Inflation-Targeting (IT)
    2. Output-Stabilization (OS)
    3. Exchange Rate Stabilization (ERS)
    4. No Active Policy (NAP)

$$i_t = A(E_t p_{t+1} - p_t - \bar{\pi}) + B(\beta(p_t - E_{t-1} p_t) + u_t - \bar{y}) + C(s_t - \bar{s}).$$

Can Derive Covariance of Domestic, Foreign Output

Case	Parameters	Cov(y,y*), flexible prices	Cov(y,y*), sticky prices ($\beta \to \infty$)
No Active Policy (NAP)	A=B=C=0	$\frac{\beta\theta\sigma_{y^*}^2}{(\beta+\delta)}$	$\theta\sigma_{y^*}^2$
Inflation Targeting (IT)	A>0, B=C=0	$\frac{\beta\sigma_{y^*}^2\theta}{(\beta+\delta-\delta A)}$	$\theta\sigma_{y^*}^2$
Output Stabilization (OS)	B>0, A=C=0	$\frac{\beta\theta\sigma_{y^*}^2}{(\beta+\delta\beta B+\delta)}$	$\frac{\theta\sigma_{y^*}^2}{(1+\delta B)}$
Exchange Rate Stabilization (ERS)	C>0, A=B=0	$\frac{\beta(\theta+\delta\psi C)\sigma_{y^*}^2}{(\beta+\delta+\delta C)}$	
Fixed Exchange Rate (FER)	$C \to \infty$, A=B=0	$\beta\psi\sigma_{y^*}^2$	

Comparing Covariances Across Monetary Regimes

Conclude ranking of cross-country business cycle covariances is:

$$Cov(y,y^*)(IT) > Cov(y,y^*)(NAP) > Cov(y,y^*)(OS)$$

and the relation of Cov(y,y*) (ERS) to other regimes is parameter parameter-dependent.

Key Intuition

- Stabilizing output dampens the domestic output response to a foreign output shock (OS<NAP)
- Inflating targeting, allows output to move more while stabilizing prices (IT>NAP)

- So, may theoretically expect business cycles to be more synchronized for Inflation Targeters

Data Set

- Want many observations with, or comparable to, the set of inflation targeters.
  - Include EMU for purposes of comparison
- NZ began IT in 1990; 26 other IT countries since
  - Include all countries at least as large as smallest IT (Iceland) and as rich as poorest IT (Philippines)

Data Set continued

- 1974 - 2007(span pre-, post-IT era)
  - Quarterly data for business cycles
- 64 countries have reliable GDP data
  - Includes many fixed exchange rates
  - Includes 15 EMU countries, Ecuador (CU)
  - Many missing observations
  - All SA

List of Countries (IT Reliable GDP data start-dates tabulated)

	IT	Data
Argentina		1994
Australia	1993	1974
Austria		1974
Belarus		1996
Belgium		1974
Brazil	1999	1995
Bulgaria		2002
Canada	1991	1974
Chile	1991	1984
China		1998
Colombia	1999	1998
Costa Rica		2004
Croatia		1997
Cyprus		1999
Czech Republic	1998	1998
Denmark		1974
Ecuador		1995
Estonia		1997
Finland	1993	1974
France		1974
Georgia		2000
Germany		1974
Greece		1974
Hong Kong, China		1977
Hungary	2001	1999
Iceland	2001	2001
Indonesia	2005	1997
Iran		1999
Ireland		1974
Israel	1992	1984
Italy		1974
Jamaica		2000
Japan		1974
Korea	1998	1974
Latvia		1996
Lithuania		1997
Luxembourg		1999
Macao, China		2002
Malta		1974
Mauritius		2003
Mexico	1999	1997
Morocco		2002
Netherlands		1974
New Zealand	1990	1974
Norway	2001	1974
Peru	2002	1983
Philippines	2002	1985
Poland	1998	1999
Portugal		1974
Romania	2005	2002
Russia		1995
Singapore		1987
Slovakia	2005	1997
Slovenia		1996
South Africa	2000	1994
Spain	1995	1974
Sweden	1993	1974
Switzerland	2000	1974
Thailand	2000	1997
Tunisia		2004
Turkey	2006	1991
USA		1974
United Kingdom	1992	1974
Venezuela		2001

Dates indicate year of entry into inflation targeting, and year of earliest reliable output data.

Sources for GDP Data

- IMF's *International Financial Statistics*
- IMF's *World Economic Outlook*
- OECD
  - Many checks for mistakes, errors
  - Also construct analogues for G-3 and G-7
    - Weights from sample averages of PPP-adjusted aggregate GDP from PWT 6.2

De-Trending Techniques

- Focus here is business cycles, deviations from trend
- Four Models for Underlying Trends:
  - Hodrick-Prescott filter (smoother = 1600)
  - Baxter-King band-pass filter (6-32 quarters)
  - Fourth-Differences (growth rates)
  - Linear Regression Model (linear, quadratic trends, quarterly dummies)

Create Business Cycle Deviations

- $y_{i,t}^{HP} \equiv y_{i,t} - \hat{y}_{i,t}^{HP}$
- $y_{i,t}^{BK} \equiv y_{i,t} - \hat{y}_{i,t}^{BK}$
- $y_{i,t}^{Growth} \equiv y_{i,t} - y_{i,t-4}$
- $y_{i,t}^{Linear} \equiv y_{i,t} - (\hat{\alpha} + \hat{\beta}t + \hat{\gamma}t^2 + \widehat{\delta_1}D_{1,t} + \widehat{\delta_2}D_{2,t} + \widehat{\delta_3}D_{3,t})$
  - Natural Logarithms throughout

Measures of Business Cycle Synchronization (BCS)

- Conventional Pearson Correlation Coefficient

$$\widehat{\rho}^{d}_{i,j,\tau} \equiv \frac{1}{T-1}\sum_{t=1}^{\tau}\left(\frac{y^{d}_{i,t}-\bar{y}^{d}_{i,\tau}}{\sigma^{d}_{i}}\right)\left(\frac{y^{d}_{j,t}-\bar{y}^{d}_{j,\tau}}{\sigma^{d}_{j}}\right)$$

  - Estimated *over time* (from 20 quarterly observations/5 years) *for a pair of countries* ("dyad")

Determinants of BCS

- Follow Baxter-Kouparitsas "BK: (2005) in using four robust conventional variables:

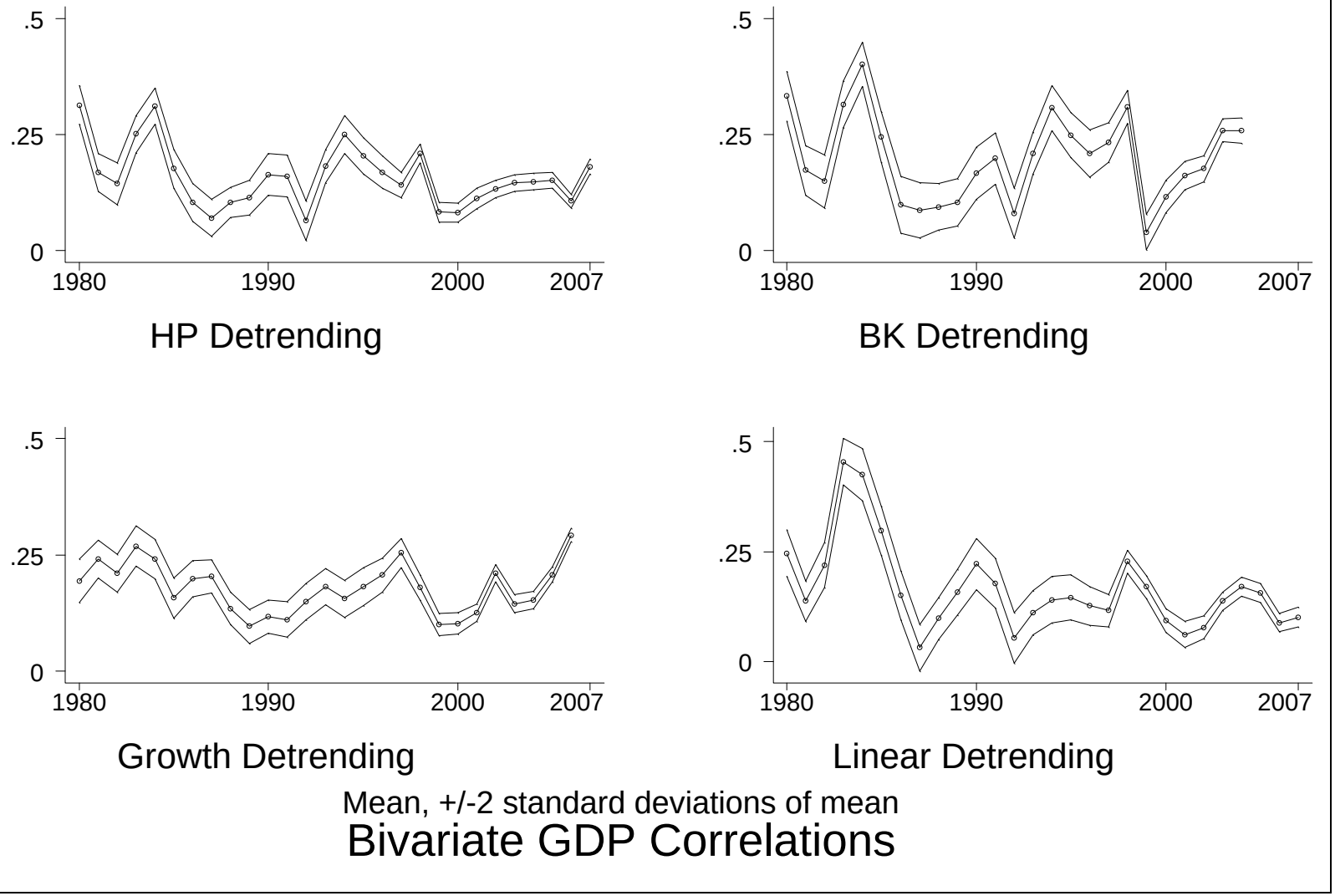
1. Trade between i and j at τ
    - Most important, only time-varying
2. Log distance between i and j
3. Dummy for both i and j developed countries
4. Dummy for both i and j developing countries

Trade Measure

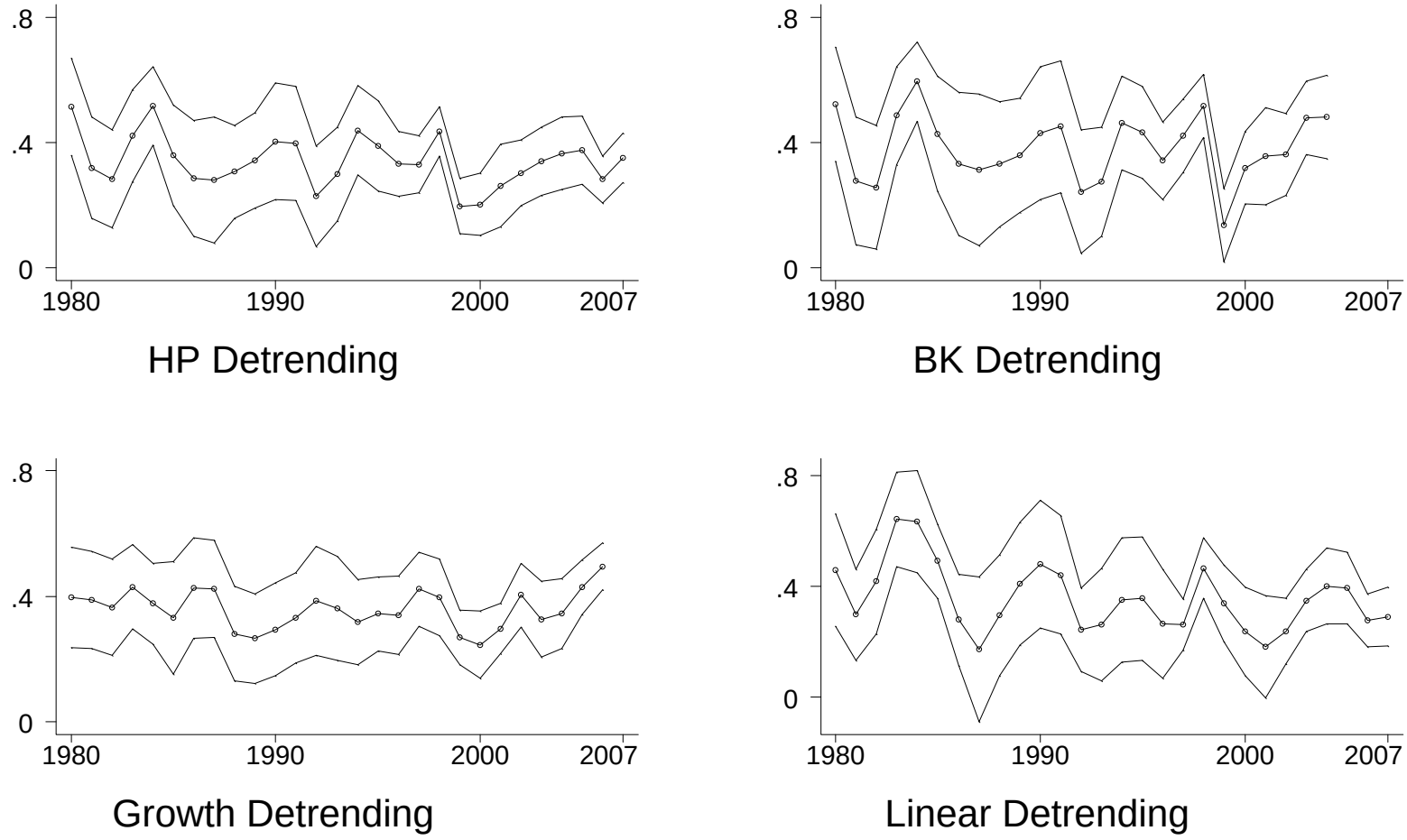
- Measured a la BK (bilateral trade of i,j over aggregate of i's trade and j's trade)
  - Computed with IMF DoT data
  - Frankel-Rose (1998)
- Sometimes add financial analogue with CPIS data
  - Imbs (2006)
  - Stocks, not flows, for 2002-2006

First Look at the Time Series

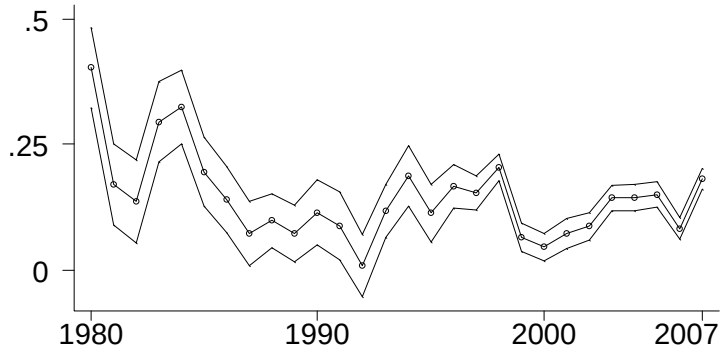
- Look for:
  - Evidence of "Decoupling" of business cycles over time?
    - (Few; and BCS often *rises*!)
  - Lots of volatility over time



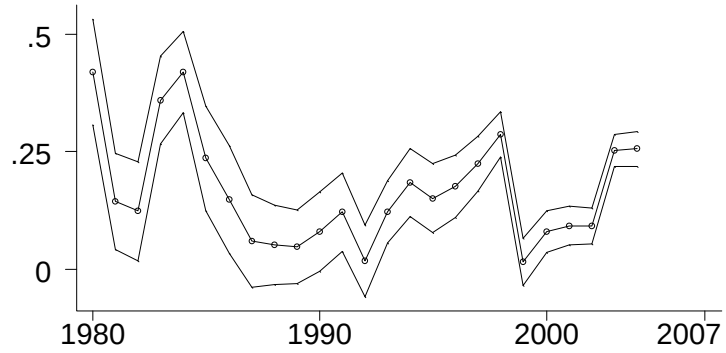
The Entire Data Distribution: Is that a Downward Trend?



Countries Paired with the G-7



HP Detrending



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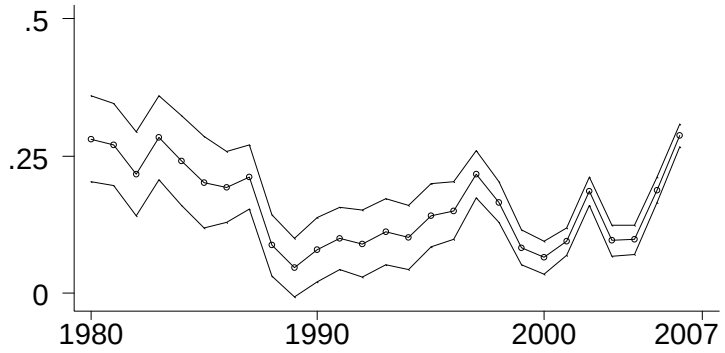
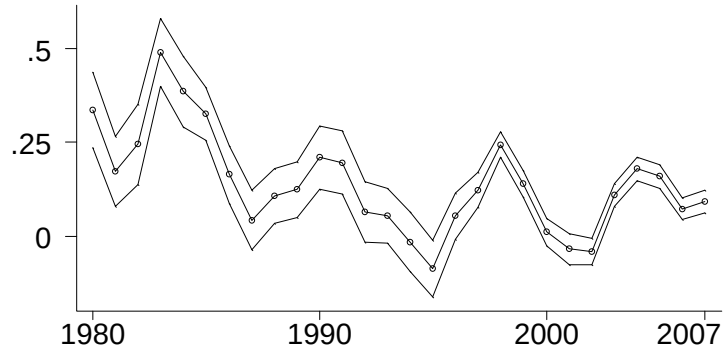


Growth Detrending

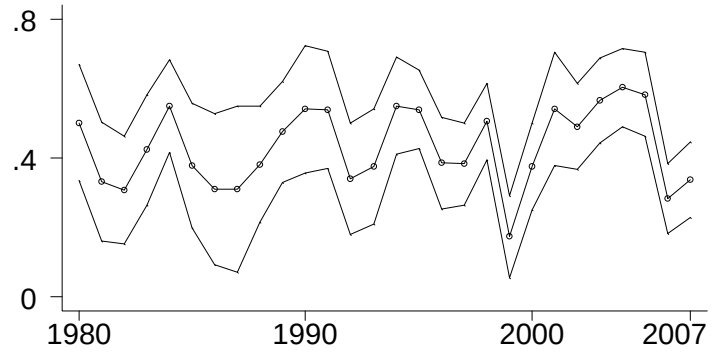


Linear Detrending

Mean, +/-2 standard deviations of mean

Bivariate GDP Correlations, Industrial-LDC pairs

Industrial Country-LDC Pairings



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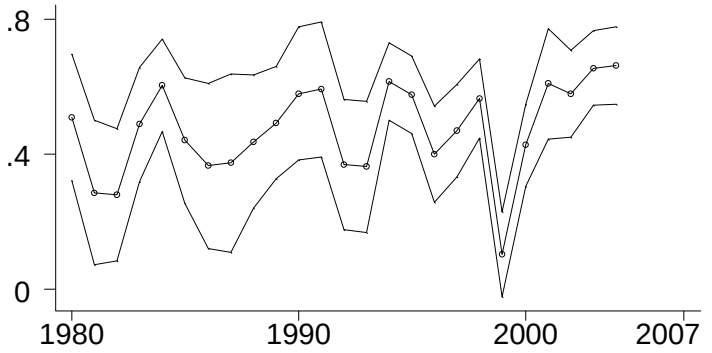
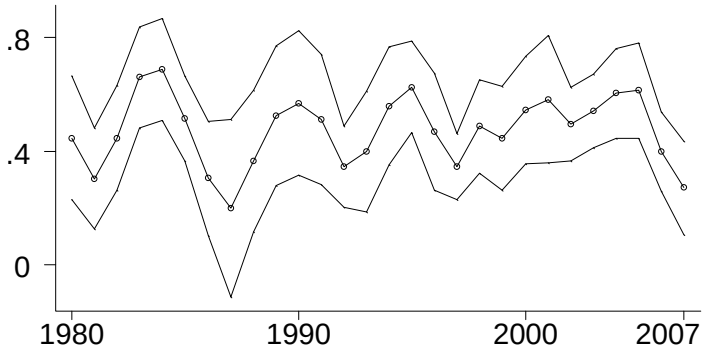


BK Detrending

Growth Detrending

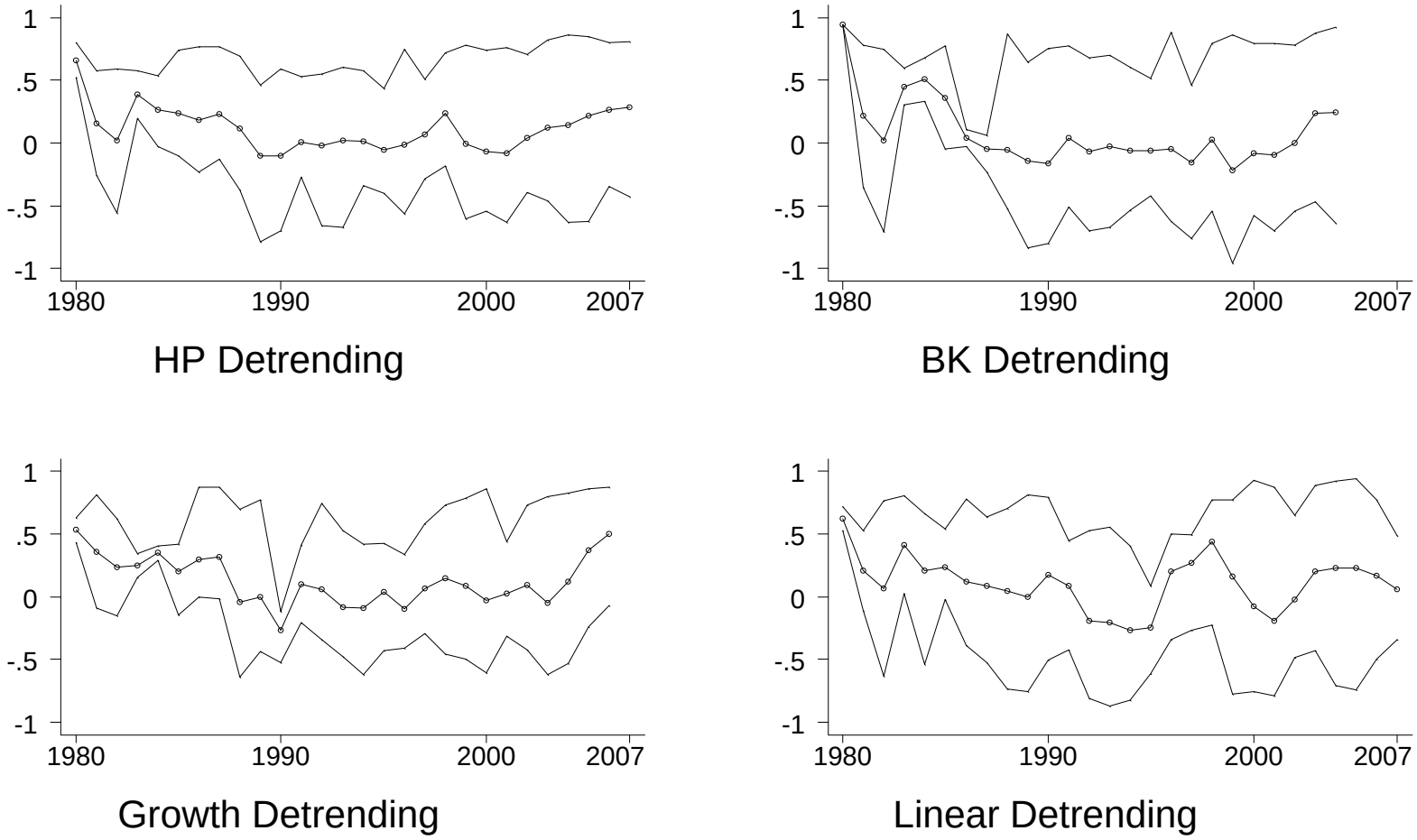


Linear Detrending

Mean, +/-2 standard deviations of mean

GDP Correlations with G7, LDCs only

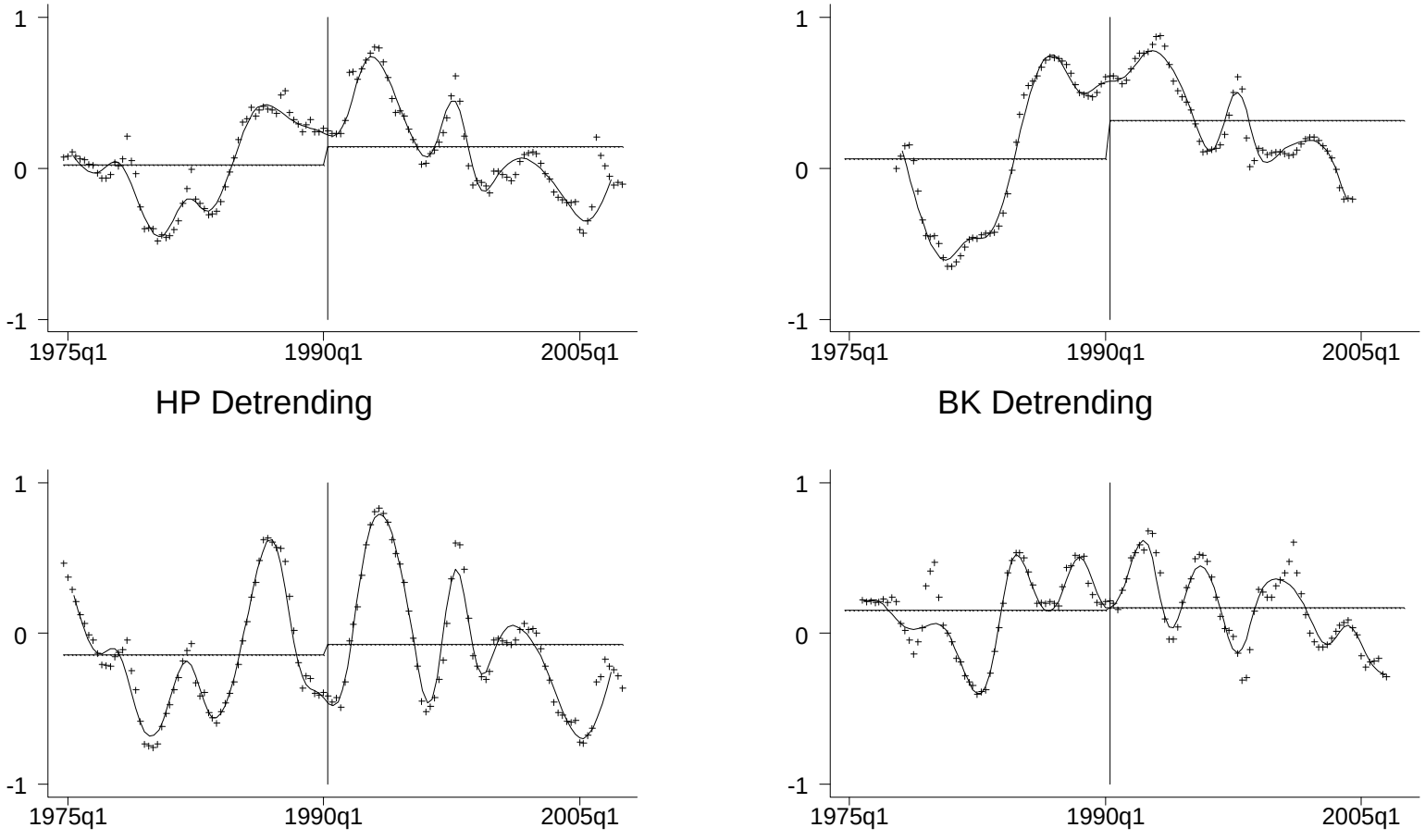
Developing Countries and the G-7



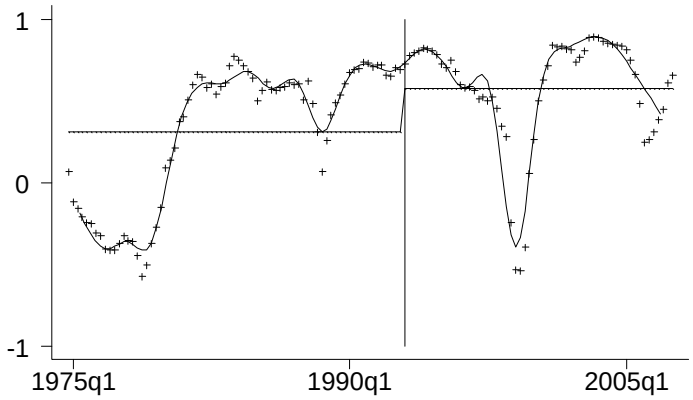
Developing Countries and the US

A Further Look at the Time Series

- Look for:
  - Breaks at onset of inflation targeting?
    - (Few; and BCS often *rises*!)



The First Inflation Targeter



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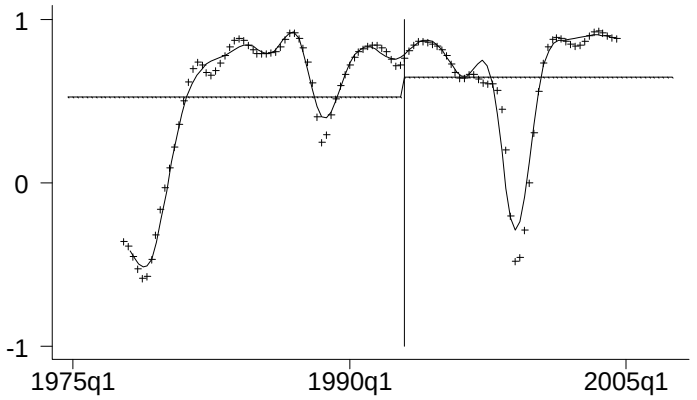

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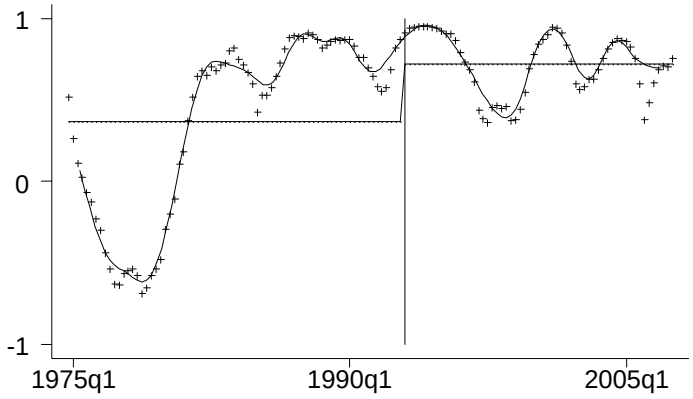

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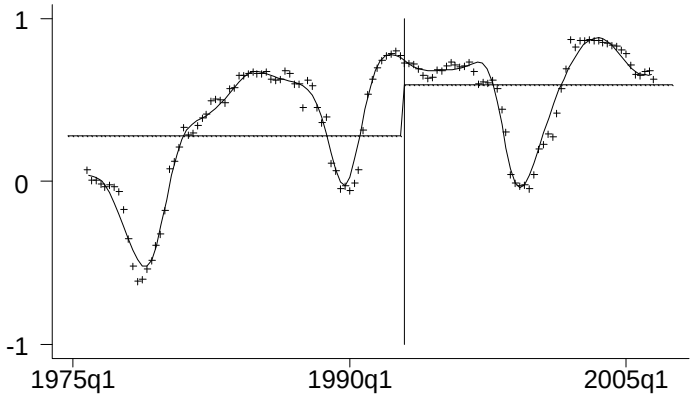
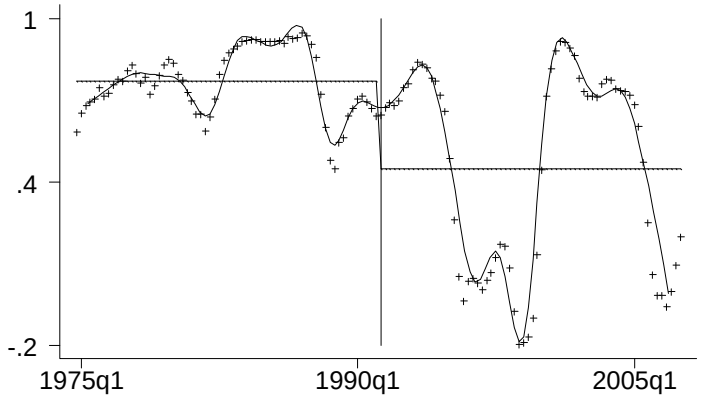


Growth Detrending

5-year MA correlation with G7

Business Cycle Synchronization: Sweden



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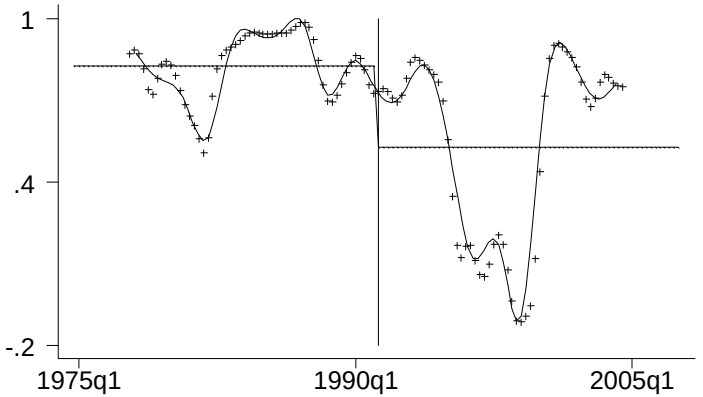

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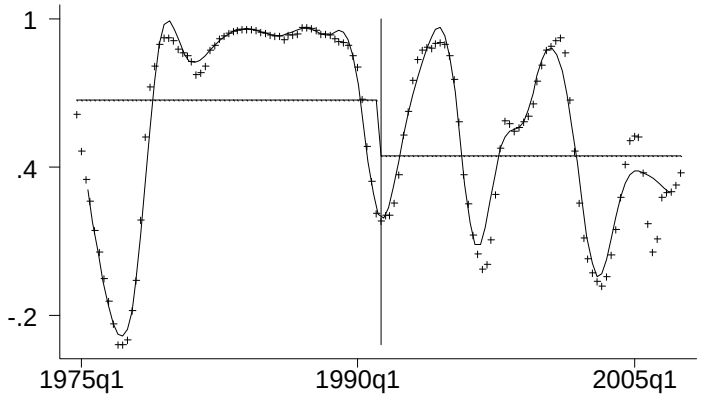

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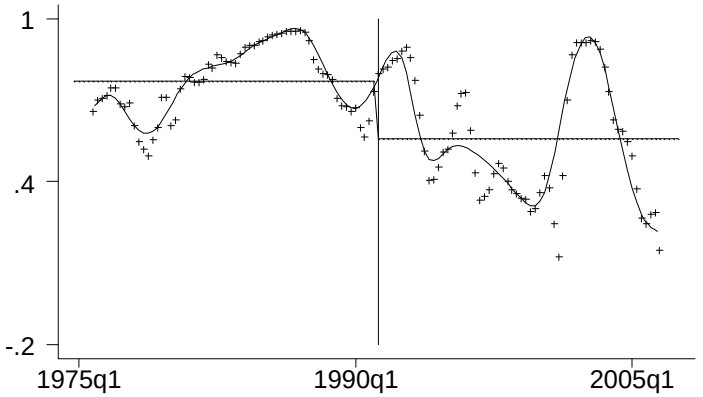
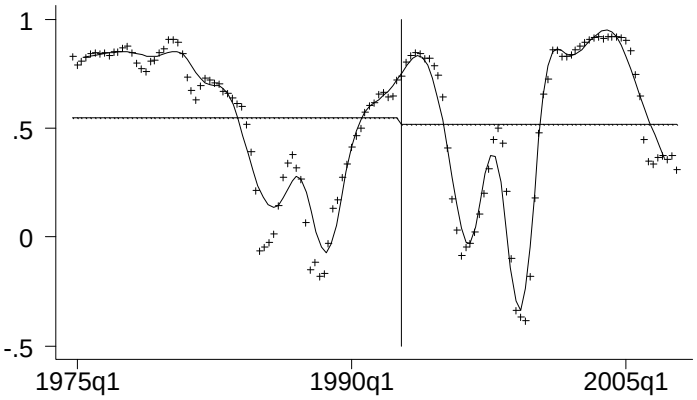


Growth Detrending

5-year MA correlation with G3

Business Cycle Synchronization: Canada

Finally a Fall in BCS!



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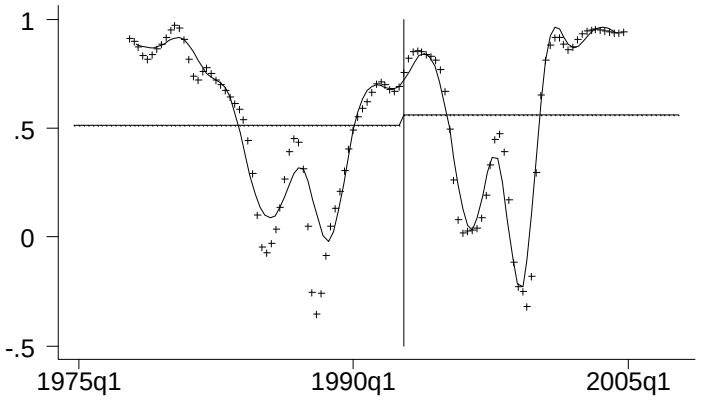

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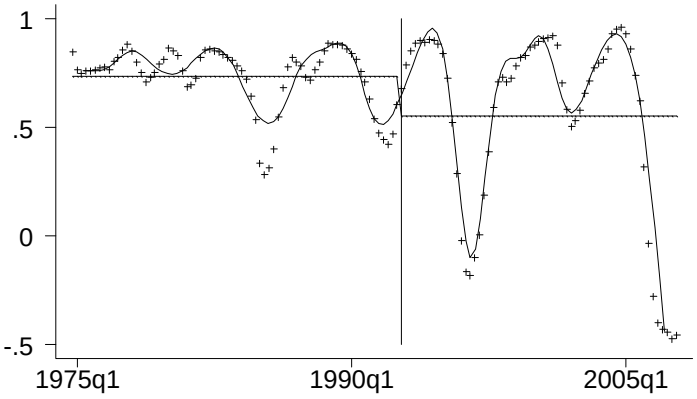
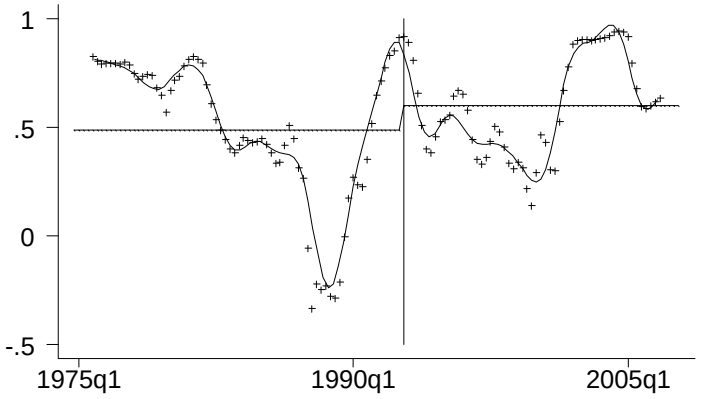


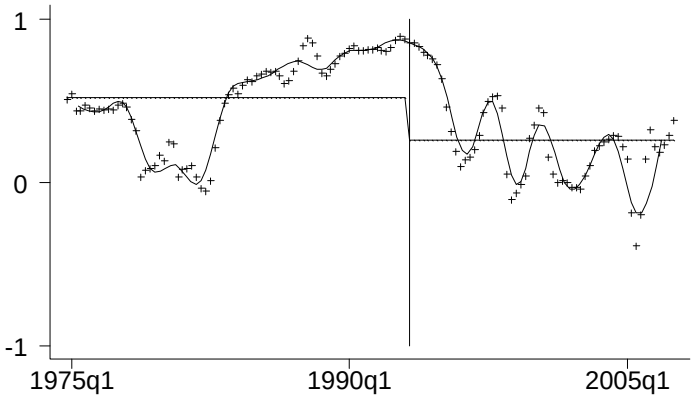
Linear Detrending



Growth Detrending

5-year MA correlation with G3

Business Cycle Synchronization: UK



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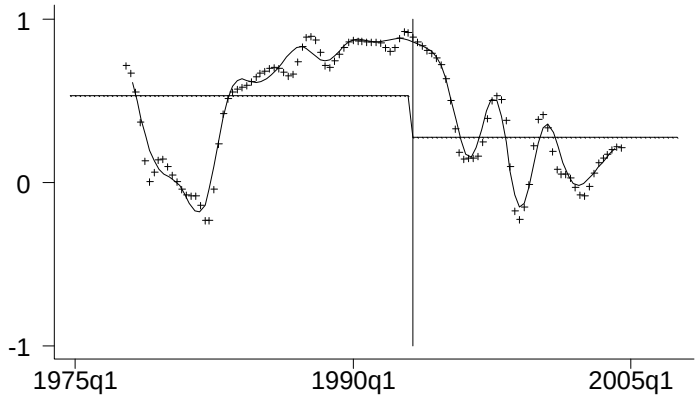

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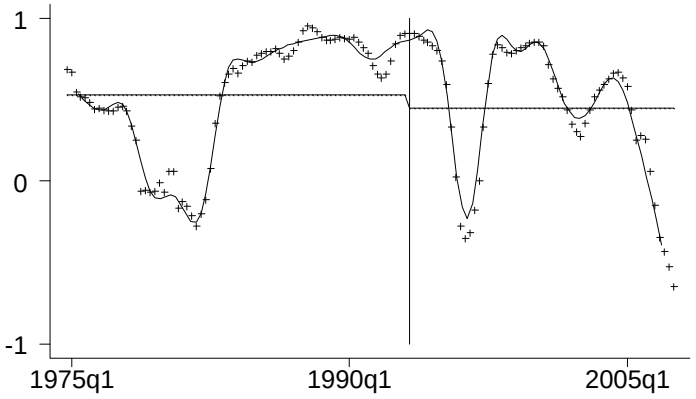

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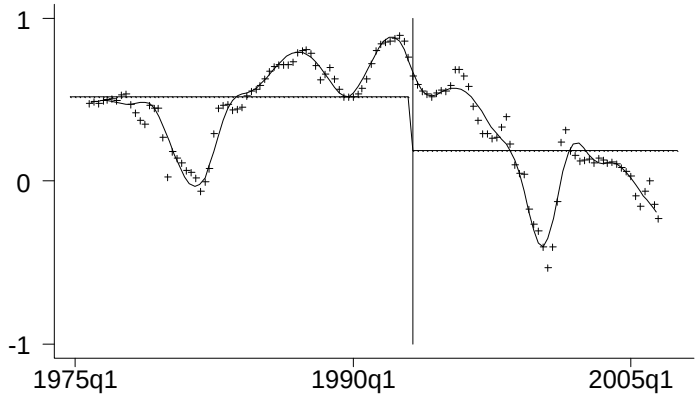
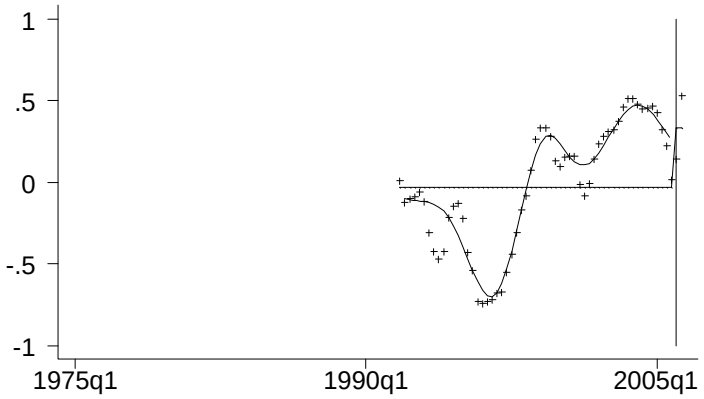


Growth Detrending

5-year MA correlation with G7

Business Cycle Synchronization: Australia



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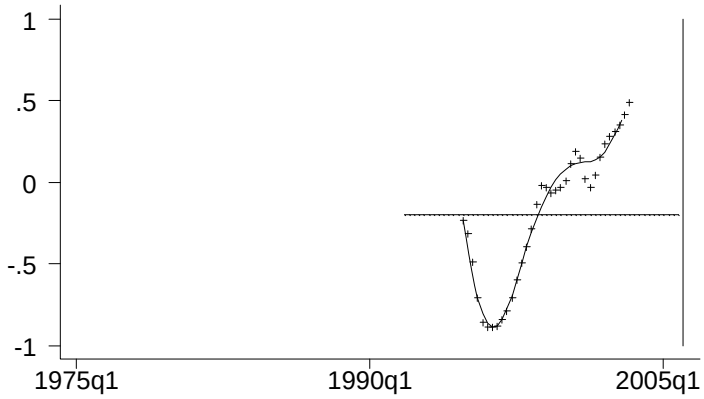

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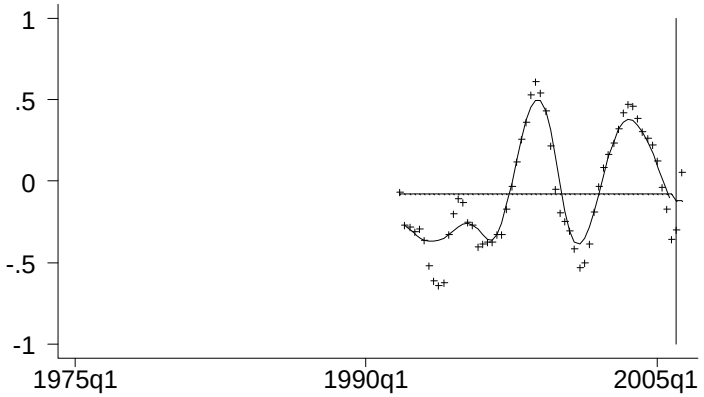
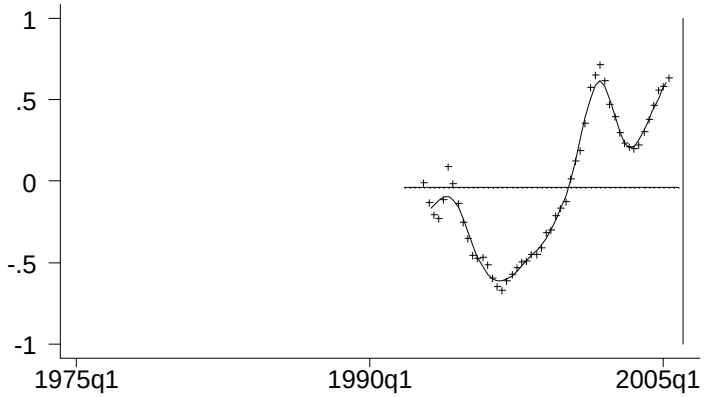


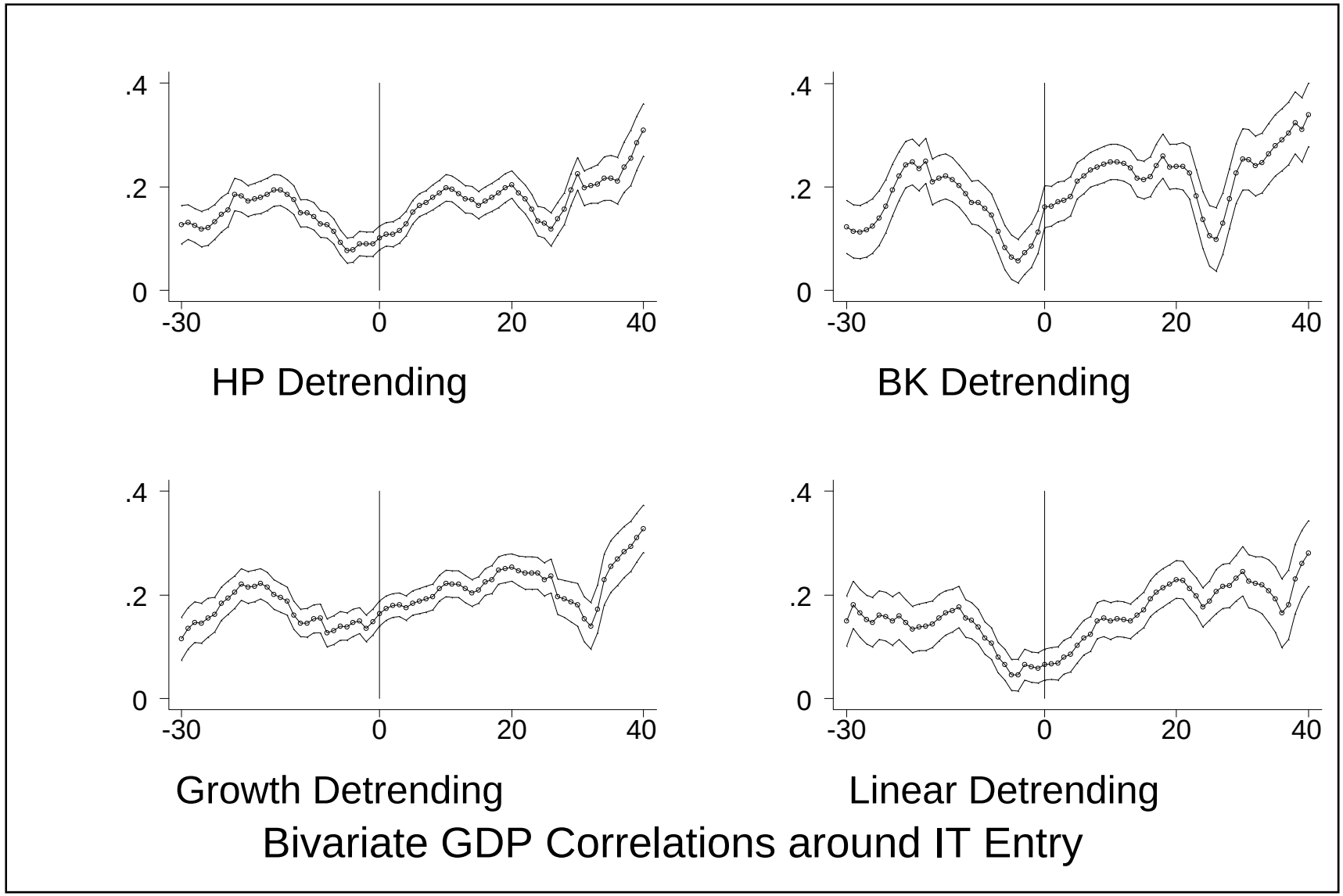
Linear Detrending



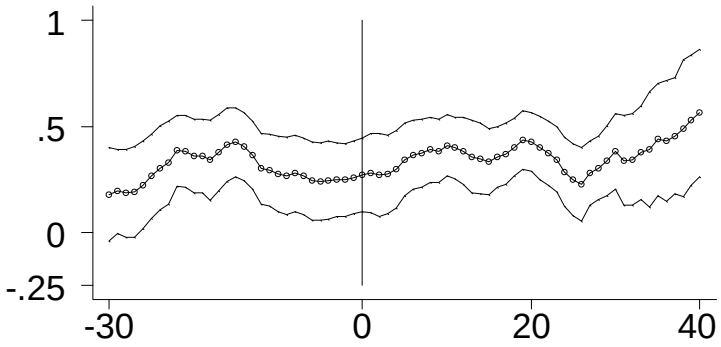
Growth Detrending

5-year MA correlation with G7

Business Cycle Synchronization: Turkey



An Event Study for *all* Inflation Targeters



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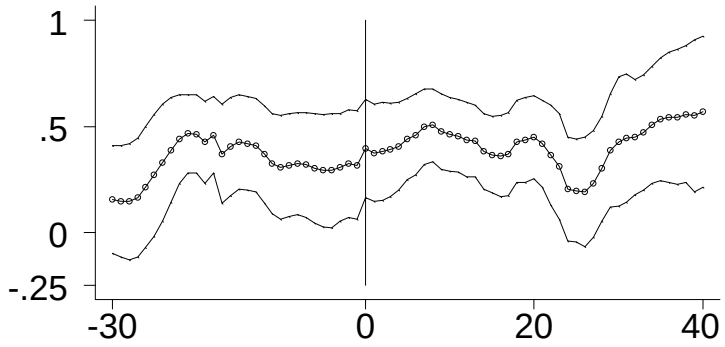

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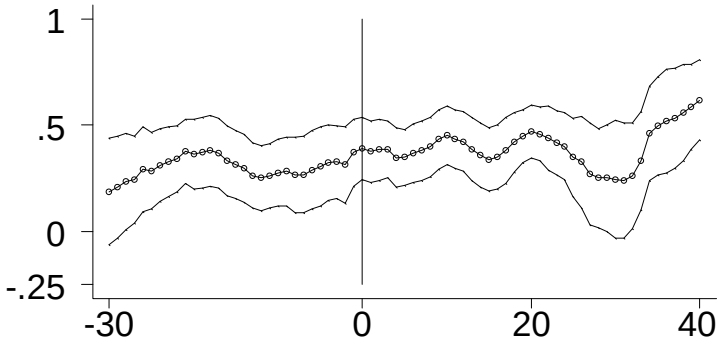
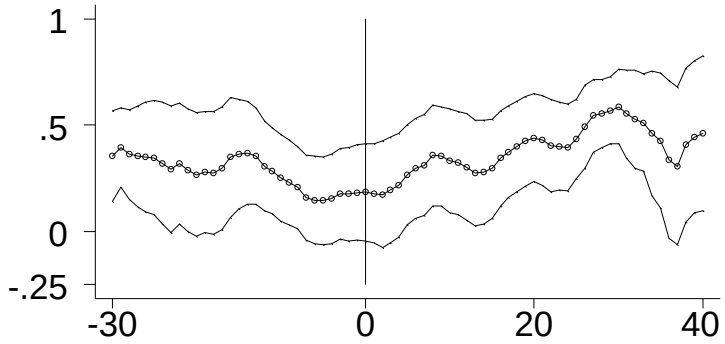


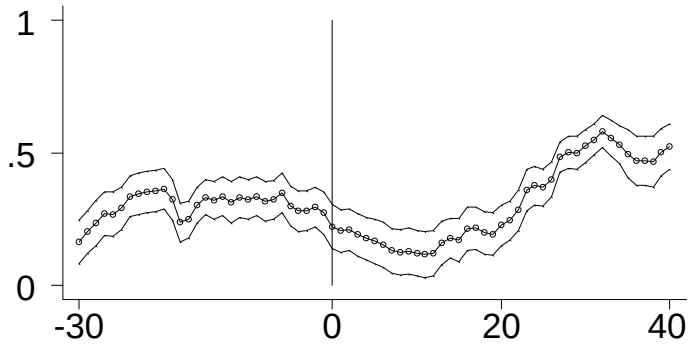
Growth Detrending



Linear Detrending

Bivariate GDP Correlations with G7 around IT Entry

Does that Positive Drift Vanish?



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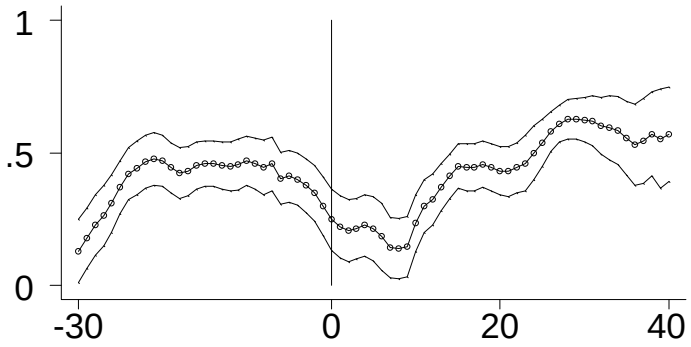
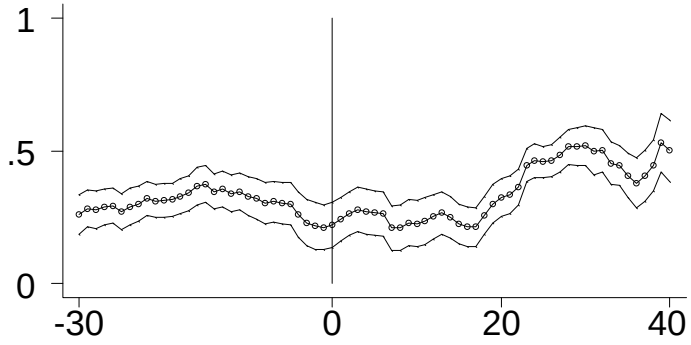
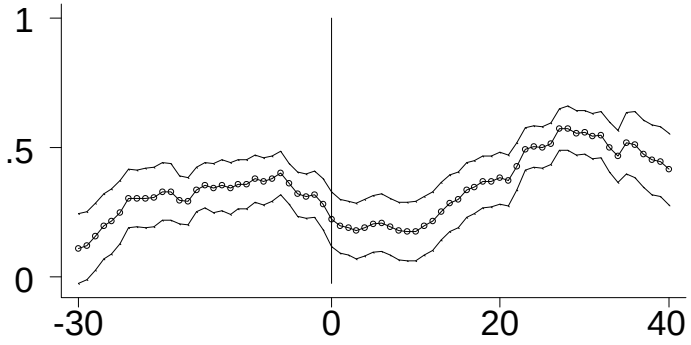


BK Detrending



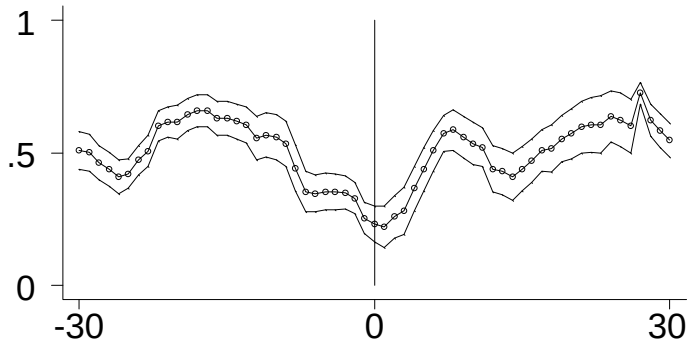
Growth Detrending



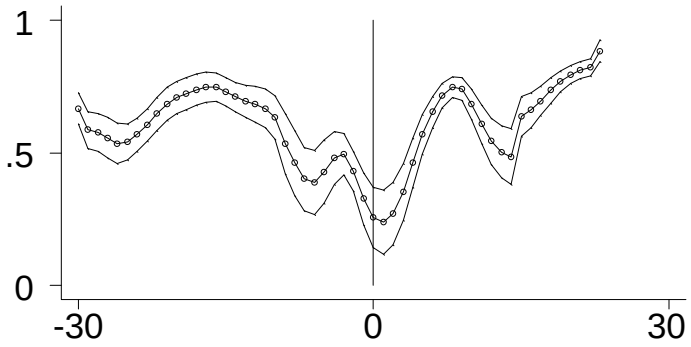
Linear Detrending

Bivariate GDP Correlations around Entry into Fixed Exchange Rate

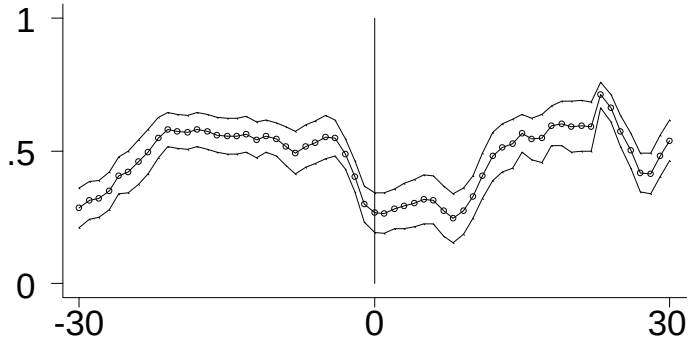
By way of Contrast, entries into Gross Reinhart-Rogoff Fixes



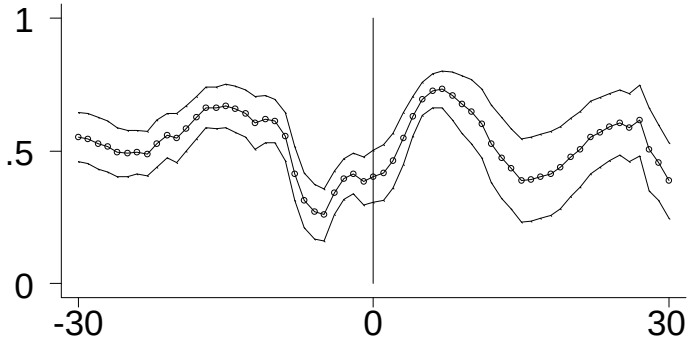
HP Detrending



BK Detrending



Growth Detrending



Linear Detrending

Bivariate GDP Correlations around EMU Entry

… and EMU. Note the Higher Levels

Regression Analysis

- Event studies intrinsically univariate; do not control for other reasons why BCS might vary across countries / time
  - Also use limited data
- Remedy both problems with standard regression techniques

Regression Model

$$\widehat{\rho}^{d}_{i,j,\tau} = \beta_1 IT(1)_{i,j,\tau} + \beta_2 IT(2)_{i,j,\tau} + \gamma_{Fix,1} Fix(1)_{i,j,\tau}$$

$$+ \gamma_{Fix,2} Fix(2)_{i,j,\tau} + \gamma_{MU,1} MU(1)_{i,j,\tau}$$

$$+ \gamma_{MU,2} MU(2)_{i,j,\tau} + \theta_T Trade_{i,j,\tau} + \theta_D Dist_{i,j}$$

$$+ \theta_I Ind_{i,j} + \theta_L LDC_{i,j} + \{\delta_{i,j}\} + \{\delta_\tau\} + \epsilon^{d}_{i,j,\tau}$$

- Coefficients of interest: {β}, the effects of IT on BCS
  - Common-Sense checks: {γ}, effects of Fixes/MU

Controls from Baxter-Kouparitsas

- Bilateral Trade (normalized by multivariate aggregates of both countries)
  - Also, log distance, dummies for both countries being both industrial/developing
- All four of the robust effects on BCS

Estimation Technique

- Least Squares
  - Time Effects
  - With and without dyadic fixed effects
- Sample data every 20^{th} observation (avoid dependence, since BCS measure is moving average)

	One IT	Both IT	Fixed ER	Both MU	One IT	Both IT	Fixed ER	Both MU
HP Detrending	.03 (.02)	.05* (.02)	.27** (.05)	.41** (.03)	.03 (.02)	-.04 (.03)	.14** (.05)	.08 (.05)
BK Detrending	.02 (.04)	.06 (.04)	.21 (.12)	.59** (.01)	.03 (.04)	.02 (.06)	.04 (.07)	.11* (.05)
Linear Detrending	.05* (.02)	.07 (.04)	.34** (.07)	.55 (.22)	.14** (.03)	.01 (.05)	.24** (.07)	.18** (.06)
Growth Detrending	.03 (.02)	.01 (.05)	.20* (.07)	.23** (.01)	.00 (.03)	-.10* (.04)	.10* (.05)	-.02 (.05)
Fixed Effects	Time	Time	Time	Time	Time, Dyads	Time, Dyads	Time, Dyads	Time, Dyads

Bilateral, without Controls

	One IT	Both IT	Fixed ER	Both MU	One IT	Both IT	Fixed ER	Both MU
HP Detrending	.03 (.02)	.05 (.02)	.22** (.05)	.29** (.03)	.03 (.02)	-.03 (.03)	.14** (.05)	.11* (.05)
BK Detrending	.04 (.02)	.07 (.03)	.09 (.10)	.40** (.03)	.03 (.04)	.02 (.06)	.01 (.09)	.15** (.05)
Linear Detrending	.06** (.01)	.07 (.04)	.28** (.05)	.41 (.18)	.14** (.03)	.02 (.05)	.26** (.07)	.22** (.06)
Growth Detrending	.02 (.02)	.01 (.05)	.12 (.06)	.06* (.02)	.01 (.03)	-.10* (.04)	.07 (.05)	-.03 (.06)
Fixed Effects	Time	Time	Time	Time	Time, Dyads	Time, Dyads	Time, Dyads	Time, Dyads

Bilateral, with Controls

Results

- Effect of IT on BCS: Generally Weak Results
  - 32 coefficients (= 4 detrenders x 2 FE x 2 controls x 2 #IT)
    - 2 significantly negative at 5% (none at 1%)
    - 28 positive (!), 5 at 5% (1 at 1%)
  - Generally insensitive results
    - Detrending/fixed effects/controls

Strong Signs that Fixing/Monetary Union Raise BCS

- 11 of 32 coefficients positive at 1%; 5 more at 5%
  - 2/32 negative, neither significantly
- So data/methodology able to reveal significant, sensible results
- Analogues for BCS with G-7 deliver similar results

Country in:	**IT**	**Fix**	**MU**	**IT**	**Fix**	**MU**
HP	.11	.03	.15	-.02	.03	-.04
Detrending	(.07)	(.05)	(.19)	(.11)	(.10)	(.14)
BK	.16	.05	.44**	.00	.23*	.27*
Detrending	(.09)	(.10)	(.02)	(.13)	(.11)	(.12)
Linear	.14	.13	.37	.08	.20	.27*
Detrending	(.07)	(.12)	(.19)	(.13)	(.10)	(.12)
Growth	.04	.04	.21*	-.09	.10	-.03
Detrending	(.09)	(.05)	(.08)	(.10)	(.10)	(.14)
Fixed				Time,	Time,	Time,
Effects	Time	Time	Time	Dyads	Dyads	Dyads

G-7, without Controls

Country in:	**IT**	**Fix**	**MU**	**IT**	**Fix**	**MU**
HP	.07	.01	.02	.01	.07	-.03
Detrending	(.05)	(.03)	(.15)	(.11)	(.10)	(.14)
BK	.12	.03	.20**	.05	.27*	.29*
Detrending	(.07)	(.10)	(.04)	(.13)	(.11)	(.14)
Linear	.09	.13	.20	.13	.26**	.28*
Detrending	(.06)	(.10)	(.12)	(.12)	(.10)	(.12)
Growth	.00	.02	-.00	-.07	.13	-.03
Detrending	(.07)	(.04)	(.06)	(.11)	(.10)	(.14)
Fixed				Time,	Time,	Time,
Effects	Time	Time	Time	Dyads	Dyads	Dyads

G-7, with Controls

Adding Financial Integration

	One IT	Both IT	Fix	MU	One IT	Both IT	Fix	MU
HP	.07* (.01)	.02 (.02)	.25 (.07)	.29* (.01)	.19** (.06)	.06 (.07)	-.39** (.05)	n/a
BK	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Linear	.11* (.004)	.05 (.04)	.26 (.02)	.39 (.17)	.40** (.06)	.19 (.12)	-.22** (.06)	n/a
Growth	.02 (.05)	-.02 (.09)	.07 (.03)	.05 (.04)	.23** (.07)	-.01 (.13)	-.14 (.15)	n/a
Fixed Effects	Time	Time	Time	Time	Time, Dyads	Time, Dyads	Time, Dyads	Time, Dyads

- Little effect (little data!)

Problems with OLS

- Many potentially serious problems with LS
  - Most important: monetary regimes not chosen randomly
    - Fixes, currency union chosen to affect BCS
    - Perhaps countries target inflation to insulate themselves
    - So worry about exogeneity
  - IT countries may not be random sample
    - Special features which linear controls may not capture

Treatment Methodology

- Consider relevant observations (dyad x period) as “treatments” (IT participation), compare treatments to “controls” (non-IT)
- Match treatments to controls using propensity score, conditional probability of assignment to treatment given vector of observed covariates

Methodological Details

- Since $\{\hat{\rho}^{d}_{i,j,\tau}\}$ constructed from MA of 20 observations, only use every 20^{th} observation
- Use Baxter-Kouparitsas vector of 4 variables for covariates
  - Check by adding financial integration (2002-2006 data)
- Initial estimator: nearest neighbor (5 matches)
  - Check with 4 different estimators

Initial Choice of Treatment/Control

- Treatment: dyads with one IT country (1,041 obs.)
- Control: observations since 1990 without IT (5,038 obs.)
    - Check with 6 other treatment/control combinations

Treatment	IT, any (1041)	IT, any (30)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, Fix/MU (276)
Control	Any (5038)	G-7 (532)	Fix or MU (469)	Fix (267)	Fix or MU* (3185)	No fix or MU (1853)	Fix or MU (478)
HP	.08** (.01)	.08 (.07)	-.03 (.05)	-.08 (.06)	.09** (.02)	.06** (.02)	.08* (.04)
BK	.14** (.03)	.11 (.10)	.03 (.07)	-.04 (.08)	.15** (.03)	.12** (.03)	.17** (.06)
Linear	.10** (.02)	.07 (.09)	.02 (.07)	-.02 (.08)	.12** (.02)	.08** (.02)	.01 (.06)
Growth	.13** (.02)	.14* (.06)	.03 (.05)	-.06 (.06)	.15** (.02)	.11** (.02)	.11** (.04)

Default and Changes to Treatment/Control

	NN (5)	**NN** (1)	**NN** (5)	**Strat.**	**Kernel**	**Radius**
HP	.08** (.01)	.08** (.02)	.07** (.02)	.06** (.01)	.07** (.02)	.08** (.01)
BK	.14** (.03)	.12** (.03)	.16** (.04)	.08** (.02)	.10** (.02)	.12** (.02)
Linear	.10** (.02)	.10** (.03)	.12** (.03)	.11** (.02)	.11** (.02)	.12** (.02)
Growth	.13** (.02)	.13** (.02)	.17** (.02)	.13** (.01)	.13** (.01)	.13** (.01)
PS	Standard	Standard	Augment	Standard	Standard	Standard
Effect	Average	Average	Average	Treated	Treated	Treated

Default and Different Estimators

Results: Default Estimates

- For all four de-trending techniques, treatment effect of IT on BCS is *positive*
  - All four statistically significantly positive at 1%
  - Having one IT country raises $\{\hat{\rho}^{d}_{i,j,\tau}\}$ by around .10
  - Average value of $\{\hat{\rho}^{d}_{i,j,\tau}\}$ is only .15, so treatment effect is economically large

Sensitivity

- IT seems to *increase* BCS with G-7!
  - Statistically insignificant effects though
- Effect of IT "treatment" on BCS close to that of fixing exchange rate/monetary union!
  - Smaller effects, but statistically insignificant differences
- Difference estimators make little difference to economic or statistical significance

Natural Contrast to IT: EMU

Estimator	NN, (5)	NN (2)	NN (5)	Strat.	Radius	Kernel
Model	standard	standard	augmented	standard	standard	standard
HP	.171*	.161	.139	.077	.147**	.108**
Detrending	(.077)	(.107)	(.090)	(.046)	(.042)	(.036)
BK	.240**	.219	.376**	.096	.194**	.146*
Detrending	(.093)	(.128)	(.080)	(.052)	(.051)	(.064)
Linear	.275**	.234	.247*	.122*	.206**	.156**
Detrending	(.099)	(.149)	(.126)	(.052)	(.054)	(.051)
Growth	.101	.107	-.029	.139**	.179**	.154**
Detrending	(.069)	(.095)	(.088)	(.037)	(.040)	(.037)

- Positive, bigger effects than those of IT (methodology works!)

Covariances (instead of Correlation Coefficients)

Treatment (number)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, any (1041)	IT, Fix/MU (276)
Control (number)	Any (5038)	Fix or MU (469)	Fix (267)	Fix or MU* (3185)	No fix or MU (1853)	Fix or MU (478)
HP	-.000 (.001)	-.001 (.001)	-.002 (.001)	.001 (.001)	-.002 (.001)	.001 (.001)
BK	.003** (.001)	.001 (.001)	.000 (.001)	.003** (.001)	.003** (.001)	.002 (.001)
Linear	.008** (.002	-.002 (.003)	-.004 (.004)	.006** (.002)	.009** (.003	-.003 (.003)
Growth	53** (19)	23 (24)	-10 (29)	58** (15)	45 (23)	24 (15)

Coefficients, standard errors, multiplied by 100

Quick Summary

- Little evidence of "Decoupling in Practice
- Inflation Targeting associated in theory and empirics with *greater* business cycle synchronization across countries

Conclusion

- Advent of IT coincided with "Great Moderation"
- Long Unresolved debate: coincidence? did policy matter?
  - Typically addressed empirically with domestic macro phenomena (inflation, growth)
- But IT strongly linked with greater BCS
  - Nudges us towards view that IT effect causal, not luck