Is the Phillips curve in the Euro area stable?

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Phillips Curve

- The Phillips Curve (PC) is an equation that associates business cycle with price developments. Central in macroeconomics.
- In a very simple form, it suggests that inflation is a function of the business cycle.

$$\pi_t = \alpha + \beta y_t$$
$$\pi_t = \gamma - \delta u_t$$

- Inflation can be some variable representing either price or wage inflation (thus the equation becomes Wage Phillips curve - WPC), and the business cycle variables are typically observables (unemployment or output growth) or deviations from an equilibrium value (output or unemployment gaps)
- Inflation expectations may also matter - a DSGE implies a forward looking PC as oposed to the traditional approach which includes lags of inflation.

$$\pi_t = \alpha + \beta E_t \pi_{t+1} + \gamma y_t + \delta \pi_{\tau-1}$$

Recent literature

- The recent literature emphasizes the disconnection between inflation and the business cycle after the financial crisis, especially in the Euro Area. Several explanations are proposed.
- Bulligan and Viviano (IZA Labor Policy 2017) - quarterly data post Euro - find mixed results for EA countries; in some bigger effect of business cycle on wages, in others weaker. Bonam et al (EconMod 2021) - quarterly data post Euro - also find mixed results for several EA countries.
- Gross and Semmler (OxBES 2018) - monthly data post Euro, interpolated if needed - argue that there is a convex relationship between inflation and output gap in EA and that PC is flatter during recessions. Similar evidence are found by Chin (EmpEC 2019) for the US (quarterly data after 1960); he argues that the coefficient in output gap is bigger in high inflation periods (e.g. in 70s). Thus, in the recent low inflation period one should expect to find such a disconnect according to these evidence.

Recent literature II

- Mazumder (EconMod 2018) and Ball and Mazumder (ECB 2020) - quarterly post Euro data - argue that such a disconnection is actually the result of misspecification, and that properly modeling the PC accounts for the most part of the observed disconnection. Using the proper measure of inflation expectations (short-term survey expectations) or the correct definition of inflation (core inflation defined as a weighted median of industry inflation rates) goes far into explaining the "missing inflation" puzzle.
- Big differences in the empirical implementation in these work make results not directly comparable, certainly not with those of the common methodology.

Approach taken here

- Main approach taken: test for breaks in PC.
- Various models used:
  - baseline with only gap variable
  - ARDL with contemporaneous gap variable + 1 lag of inflation and gap
  - best model implied by eliminating regressors of ARDL using BIC.
  - both PC and WPC equations
- Testing for structural breaks using a Bai - Perron procedure (supF and UDmax statistics) and BIC minimization. Implemented in Gretl (StructBreak package).
- Estimates of time-varrying elasticities using recursive and rolling window OLS (25-year windows)

Data

Variable	AMECO code
GDP deflator	PVGD
Nominal unit labor cost	PLCD
Real unit labor cost	QLCD
Output gap	AVGDGP
Unemployment rate	ZUTN
NAWRU	ZNAWRU

- price inflation: $\Delta^2 ln(PVGD)$; nulc: $\Delta^2 ln(PLCD)$; rulc: $\Delta ln(QLCD)$; unemployment gap: ZUTN - ZNAWRU.

Price Phillips curves SB tests- output gap

A. F tests

	PC - ygap	ARDL PC - ygap	PC Opt - ygap
SupF(1/0)	15.99***	35.17***	16.88***
SupF(2/0)	15.79***	54.47***	11.40***
SupF(2/1)	14.62***	27.44***	4.57
Udmax	15.99***	54.47***	16.88***

B. BIC (bold is minimum)

No of Breaks	PC - ygap	ARDL PC - ygap	PC Opt - ygap
0	-0.446	-0.501	-0.438
1	**-0.662**	**-0.950**	**-0.736**
2	-0.524	-0.798	-0.610

C. Break Dates

	PC - ygap	ARDL PC - ygap	PC Opt - ygap
1 break	1988	1988	1988
2 breaks 1st break	1988	1981	1988
2 breaks 2nd break	2009	1990	2009
SEQ 1st break at 1%	1989	1989	1989
SEQ 2nd break at 1%	NA	1994	NA

Price Phillips curves SB tests - unemployment gap

A. F tests

	PC - ugap	ARDL PC - ugap	PC Opt - ugap
SupF(1/0)	7.75	14.95*	8.11*
SupF(2/0)	9.51**	11.12	7.46**
SupF(2/1)	7.98	8.85	6.27
Udmax	9.51	14.95*	8.11*

B. BIC (bold is minimum)

No of Breaks	PC - ugap	ARDL PC - ugap	PC Opt - ugap
0	-0.215	-0.299	-0.214
1	**-0.263**	**-0.331**	**-0.343**
2	-0.127	-0.225	-0.235

C. Break Dates

	PC - ugap	ARDL PC - ugap	PC Opt - ugap
1 break	1987	1981	1987
2 breaks 1st break	1981	1981	1987
2 breaks 2nd break	2007	1990	2001
SEQ 1st break at 1%	NA	NA	NA
SEQ 2nd break at 1%	NA	NA	NA

Results PC ygap

B. Models with output gap

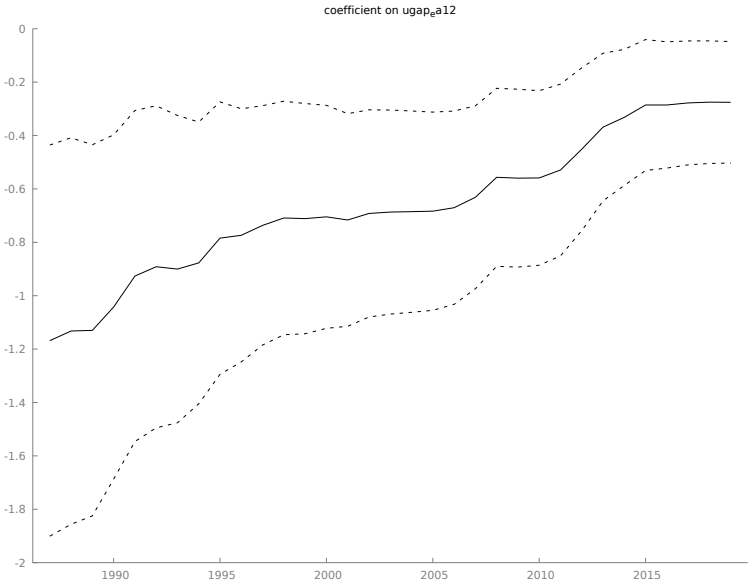
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	1972 - 2019	1973 - 2019	1972 - 2019	1972 - 1987	1973 - 1987	1972 - 1987	1988 - 2019	1988 - 2019	1988 -
	Baseline	ARDL	OPT	Baseline	ARDL	OPT	Baseline	ARDL	OPT
const	−0.07175	−0.03230		−0.02973	0.08398		−0.04139	−0.05361	
	(0.1183)	(0.1198)		(0.2503)	(0.2135)		(0.08008)	(0.07807)	
ygap	0.3105***	0.3635***	0.3135***	0.8178***	0.5159*	0.8213***	0.1396***	0.2310***	0.1403
	(0.07287)	(0.1006)	(0.07222)	(0.1766)	(0.2553)	(0.1683)	(0.04666)	(0.06097)	(0.0460
$\Delta\pi_{t-1}$		0.2067			−0.2832			−0.01397	
		(0.1536)			(0.3360)			(0.1389)	
$ygap_{t-1}$		−0.09528			0.6971			−0.1325*	
		(0.1172)			(0.4036)			(0.06522)	
n	48	47	48	16	15	16	32	32	32
$\bar{R}^2$	0.2674	0.2823	0.2861	0.5770	0.7372	0.6135	0.2043	0.2735	0.2301
ℓ	−57.41	−54.91	−57.61	−21.43	−15.65	−21.44	−19.02	−16.46	−19.16
BIC	122.57	125.22	119.08	48.41	42.13	45.65	44.98	46.79	41.79

Results PC ugap

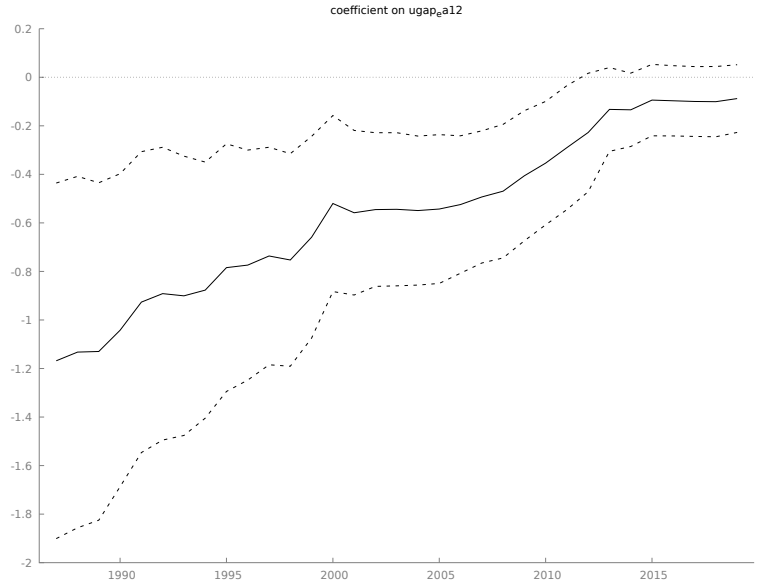
A. Models with unemployment gap

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	1972 - 2019	1973 - 2019	1972 - 2019	1972 - 1987	1973 - 1987	1972 - 1987	1988 - 2019	1988 - 2019	
	Baseline	ARDL	OPT	Baseline	ARDL	OPT	Baseline	ARDL	OPT
const	−0.02616	−0.003103		−0.009888	0.1381		−0.01500	−0.05044	
	(0.1372)	(0.1369)		(0.3173)	(0.3579)		(0.09247)	(0.08181)	
ugap	−0.2695**	−0.5761**	−0.2755**	−1.166**	−1.330	−1.168***	−0.09349	−0.4482***	−0.096
	(0.1214)	(0.2330)	(0.1161)	(0.3972)	(1.026)	(0.3738)	(0.07323)	(0.1226)	(0.0692
$\Delta\pi_{t-1}$		0.1923			0.04070			−0.03758	
		(0.1450)			(0.3203)			(0.1307)	
$ugap_{t-1}$		0.3824			0.01698			0.4115***	
		(0.2357)			(1.155)			(0.1218)	
n	48	47	48	16	15	16	32	32	32
$\bar{R}^2$	0.0771	0.1216	0.1071	0.3366	0.3184	0.3944	0.0199	0.2559	0.0593
ℓ	−62.96	−59.66	−62.98	−25.03	−22.79	−25.03	−22.36	−16.85	−22.37
BIC	133.66	134.71	129.82	55.61	56.42	52.83	51.65	47.55	48.21

Optimized models estimates - ugap



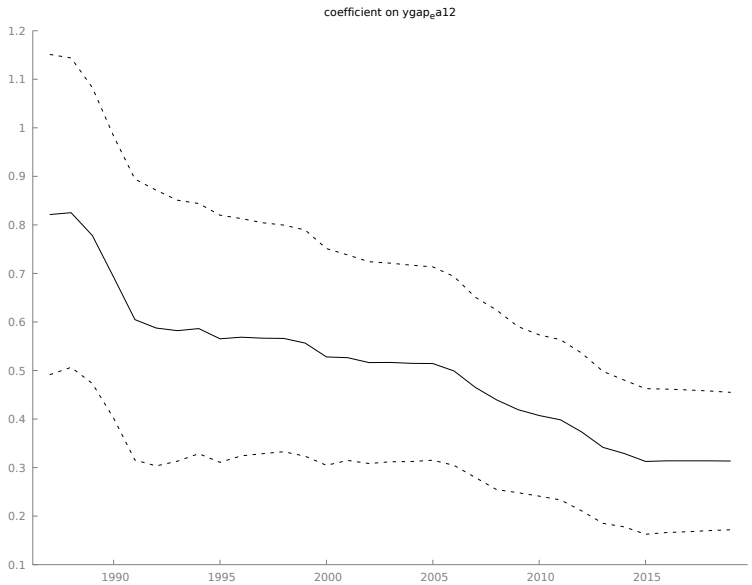
(a) recursive LS



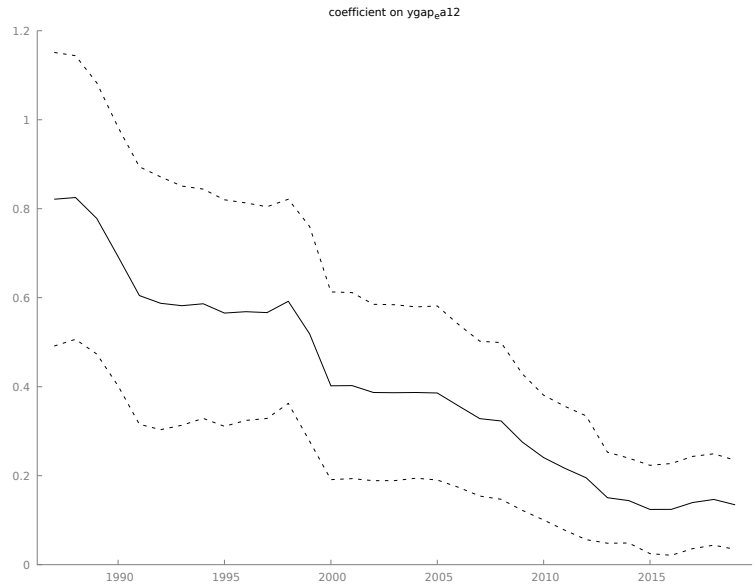
(b) rolling sample LS

Figure: Optimized price Phillips curves - unemployment gap

Optimized models estimates - ygap



(a) recursive LS



(b) rolling sample LS

Figure: optimized price Phillips curves - output gap

Wage Phillips curve

Table 4: Structural break tests for wage Phillips curves

A. F tests

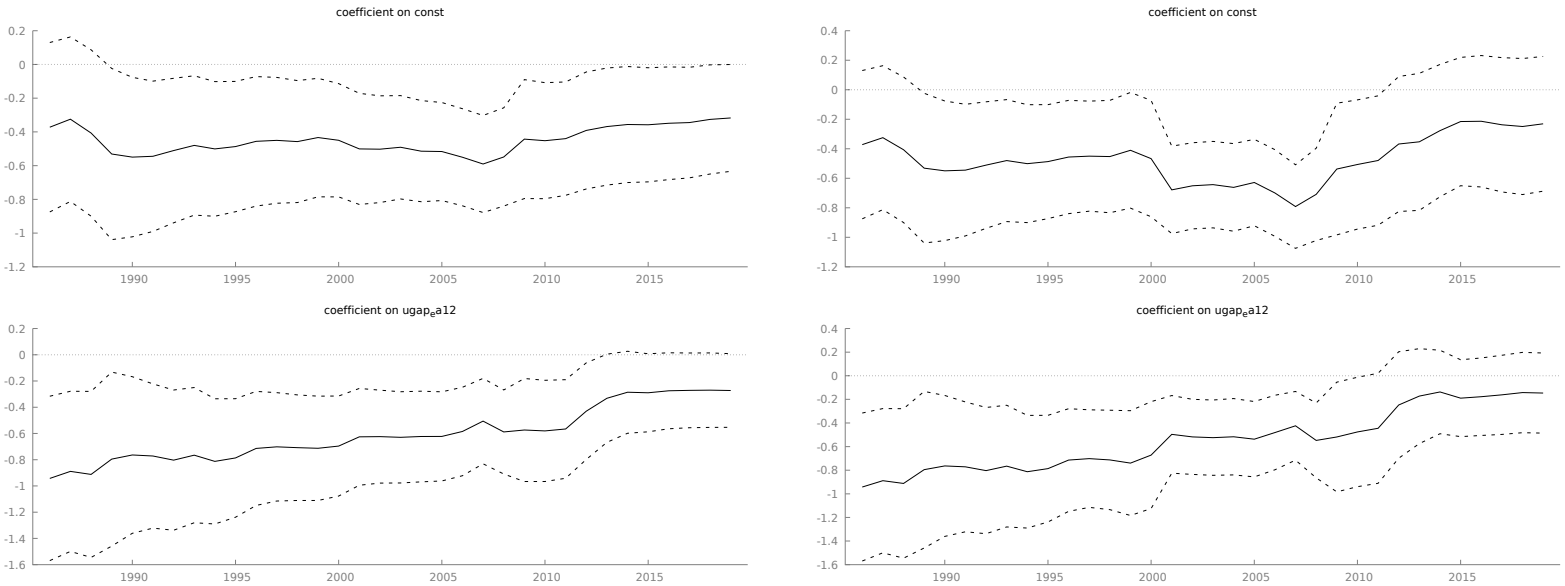
	NULC WPC	ARDL NULC WPC	OPT NULC WPC	RULC WPC	ARDL RULC WPC	OPT RULC WPC
SupF(1/0)	6.98	8.59	6.52	12.50**	24.33***	30.16***
SupF(2/0)	3.45	21.72***	3.07	8.89*	23.30***	47.21***
SupF(2/1)	0.63	4.75	0.62	3.73	21.28***	14.10*
Udmax	6.98	21.72***	6.52	12.50**	24.33***	47.21***
B. BIC (bold is minimum)						
0	0.917	0.872	0.917	0.114	-0.166	-0.158
1	0.997	1.072	0.933	0.062	-0.237	-0.265
2	1.221	1.252	1.084	0.210	-0.228	-0.264
C. Break Dates						
1 break	1994	1994	1994	2007	2007	2010

RULC WPC

Table 5B: Wage Phillips curves: dependent variable: real ULC (Δln(QLCD))

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	1972 -2019	1973 -2019	1973 -2019	1972 - 2006	1973 - 2006	1973 - 2006	2007 - 2019	2007 - 2019	2007 2019
	Baseline	ARDL	OPT	Baseline	ARDL	OPT	Baseline	ARDL	OPT
const	−0.3170*	−0.2614	−0.2913*	−0.5503***	−0.5832***	−0.5352***	0.3511	0.4010	0.398
	(0.1617)	(0.1559)	(0.1451)	(0.1468)	(0.1598)	(0.1311)	(0.4209)	(0.3191)	(0.319
ugap	−0.2726*	0.4842*	0.5480**	−0.5849***	0.2317	0.1751	−0.2476	0.9397*	0.737(
	(0.1431)	(0.2743)	(0.2469)	(0.1719)	(0.2902)	(0.2674)	(0.2539)	(0.4280)	(0.378
$\Delta rulc_{t-1}$		0.08020			−0.09130			−0.2456	
		(0.1448)			(0.1696)			(0.2436)	
$ugap_{t-1}$		−0.8728***	−0.9487***		−1.028***	−0.9243***		−1.312**	−1.10
		(0.2823)	(0.2449)		(0.3323)	(0.2681)		(0.4190)	(0.365
n	48	47	47	35	34	34	13	13	13
$\bar{R}^2$	0.0529	0.2641	0.2757	0.2372	0.4113	0.4248	-0.0041	0.4242	0.423
ℓ	−70.85	−62.80	−62.97	−43.57	−37.13	−37.29	−20.60	−15.68	−16.3
BIC	149.43	141.00	137.48	94.24	88.36	85.16	46.33	41.63	45

RULC WPC



(a) recursive LS

(b) rolling sample LS

Figure: Baseline wage Phillips curves - real ULC and unemployment gap

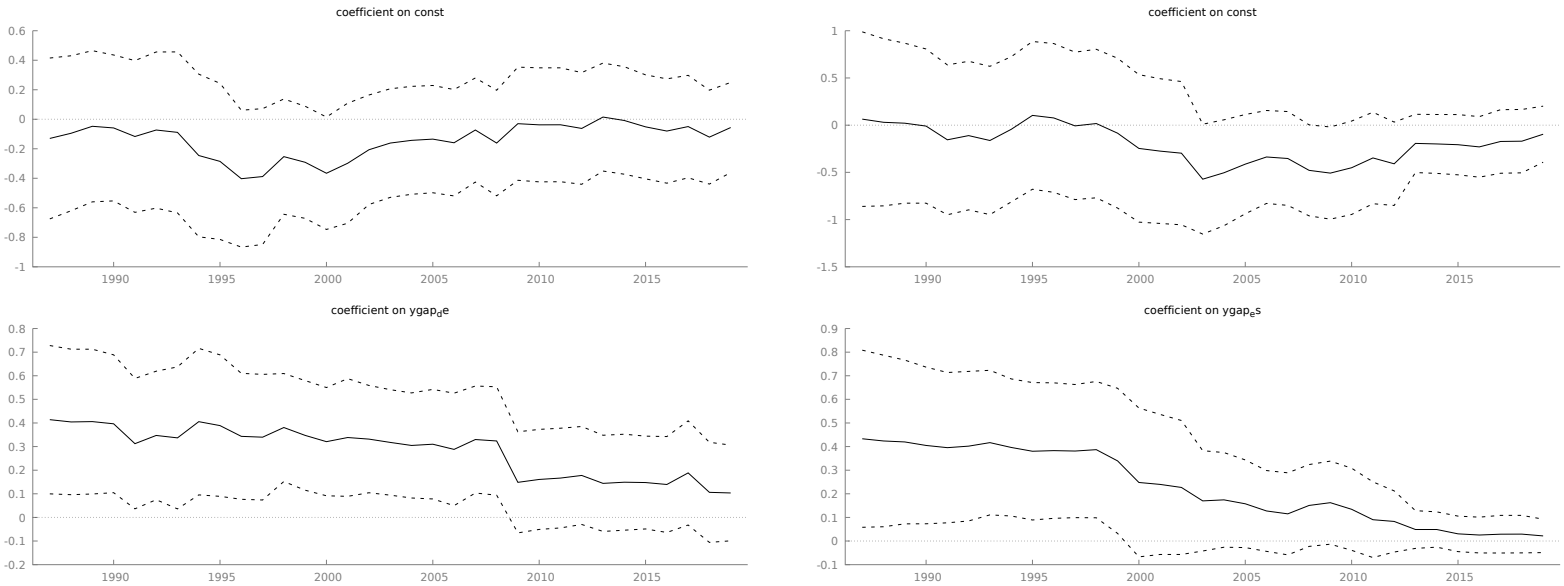
Using Hamilton's gap measure

- Hamilton (2018) has criticized forcefully against the use of the HP filter.
- He has proposed a different approach to extract the cyclical components of a time series, specifically to use the residual from a projection ot the time series on some of its more distant lags, typically at least twice the periodicity of the data.
- I have used the original Hamilton filter in order produce the resulting unemployment and output gap variables, and then I test for structural breaks on the set of models mentioned in the previour two subsections using the aforementioned variables instead of Commission's estimates of output and unemployment gaps.
- The results suggest that no breaks are detected using gaps from Hamilton's filters. This does not necessarily make these gap estimates better than ones in the AMECO database, but it raises the question of why this happens.

Results for big 4

- Have applied the same procedure in big 4 of Eurozone: Germany, France, Italy, Spain.
- The results imply that there is no evidence of break for France.
- There is some non conclusive evidence of breaks in mid-2000s for the wage Phillips curve using RULC in Germany, but it is far from definitive.
- There is some evidence of breaks in the Phillips curves for inflation in the case of Spain.
- The results for Italy suggest that there are breaks on the Phillips curve relationships. 80s for PC and WPC with NULC, mid-nineties for WPC with RULC.
- Recurcive - rolling LS suggest that in these countries we also observe a weakening of the Phillips curve.

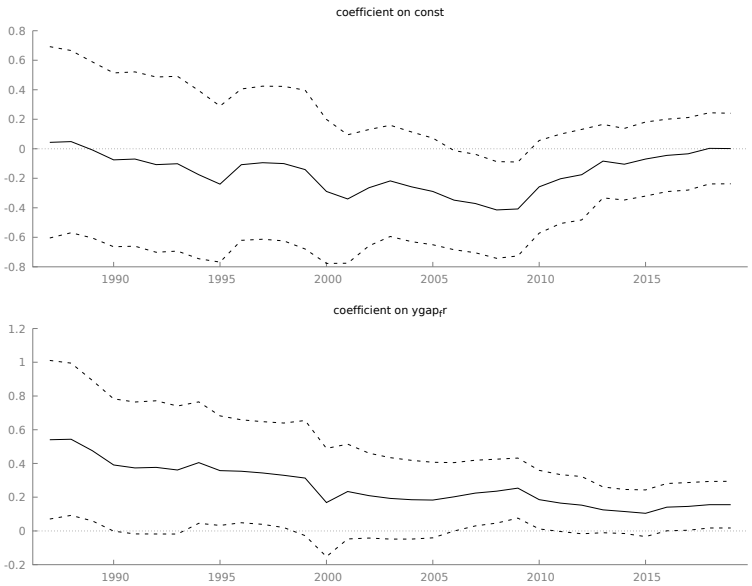
PC for Germany & Spain



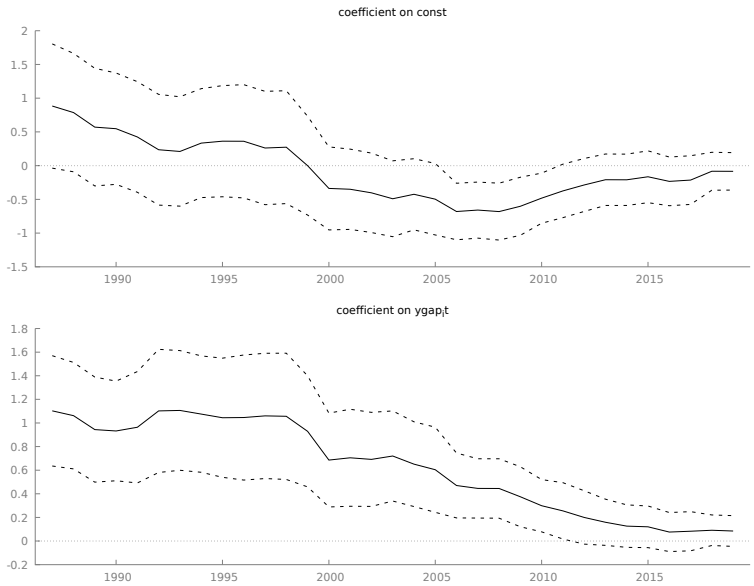
(a) Germany (b) Spain

Figure: Baseline Phillips curves with output gap - rolling LS DE &ES

PC for France & Italy



(a) France



(b) Italy

Figure: Baseline Phillips curves with output gap - rolling LS FR & IT

Concluding Remarks

- The results suggest a weakening of the effect of business cycle / slack on the Phillips curve.
- They imply a deterioration of the inflation-unemployment trade-off in the later part of the sample.
- Another implication of the results is that estimates of unemployment and consequently output gaps under the assumption of a stable model could be misleading.
- One way forward may be to shorten the sample so that it starts after 1980 or even after 1990 and use quarterly data, at the cost of having less cycles available.
- Or we may consider modifying the model - perhaps other variables may help to explain some periods. FTPL?

THANK YOU FOR YOUR ATTENTION