Breaks in the Phillips Curve: Evidence from Panel Data

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Recent flattening of the Phillips curve

"There was a time where there was a tight connection between unemployment and inflation. That time is long gone." (Jerome Powell, March 2021)

"... gradualism is a well-established principle for central banks in times of uncertainty. When faced with uncertainty about the resilience of the economy, it pays to move carefully." (Christine Lagarde, March 2022)

Recent flattening of the Phillips curve

- The well-known relation between inflation and economic slack was first documented by Phillips (1958)
- The Phillips curve is a key element of the new Keynesian macroeconomic model
- Mounting evidence of time-variation in the Phillips curve
  - Particularly a flattening in recent decades
- Such a flattening may hinder central banks' ability to control inflation

Papers on Phillips curve instability

Authors	Sample	Method	Finding	Notes
Ball and Mazumder (2011)	1960-2010	Random Walk parameter Slope is linear function of level and variance	Steepening around 1970, flattening in 80s	Lower and more stable inflation both flatten curve. Paper uses median and core CPI
Ball and Mazumder (2019)	1985-2015	Sup Wald test	Flattening break in 1995	Break identified indirectly from expectations formation. Paper uses median CPI.
Perron and Yamamoto (2015)	1960-1997	Sup Wald test	Break in 1991	Uses GDP deflator.
Matheson & Stavrev (2013)	1961-2012	Random Walk parameter	Flattening in 80s	Uses headline CPI inflation.
Gali and Gambetti (2019)	1964-2017	Regimes with fixed dates	Flattening in 2007	Wage Phillips curve
Leduc and Wilson (2017)	1991-2015	Regimes with fixed dates	Flattening in 2009	Wage Phillips curve
Hooper et al. (2019)	1961-2018	Regimes with fixed dates	Flattening in 1988	Uses headline and core PCE and average hourly earnings and MSA panel data.
Coibion & Gorodnichenko (2015)	1961-2007	Regimes with fixed dates	Possible break in 1985; mixed evidence	No break if augmented with household expectations. Uses various aggregate inflation measures (CPI, core CPI...)
Coibion et al. (2013)	1968-2013	Regimes with fixed dates	Flattening break in 1985	Break in price Phillips curve not wage Phillips curve
Roberts (2006)	1960-2002	Regimes with fixed dates	Flattening break in 1983	Uses core PCE inflation.
Hazell et al. (2002)	1978-2018	Regimes with fixed dates	Break in 1990 but not significant	State level panel data
Cerrato and Gitti (2022)	1990-2022	Regimes with fixed dates	Flattening in pandemic; steepened after	MSA level panel data
Fitzgerald et al. (2020)	1977-2018	Regimes with fixed dates	No significant break	MSA level panel data
Williams (2006)	1980-2016	Recursive regressions	Flattening in the 90s	Core CPI and PCE
Del Negro et al. (2020)	1964-2019	Regimes with fixed dates	Break in 1990	Estimated in VAR
Barnichon & Mesters (2021)	1969-2007	Regimes with fixed dates	Break in 1990	Phillips multiplier not slope of curve. Uses headline PCE
Gilchrist & Zakrajsek (2019)	1962-2017	Sup-Wald test Interact gap with trade share	Mixed results; possible break in 80s	Panel and aggregated data (CPI and PPI)
Inoue et al. (2022)	1970-2021	IV estimation with RW parameters	Flattening until early 2000s; then steepening	Uses core PCE
Blanchard (2016)	1960-2014	Random walk parameter	Flattening in the 1980s	Uses headline CPI

Endogeneity problem in national Phillips curve

- The majority of the existing literature focuses on the aggregate Phillips curve
- However, several recent papers note that if the central bank is successfully targeting inflation, the slope of the Phillips curve is biased towards zero
  - e.g. Hooper et al (2020), Fitzgerald and Nicolini (2014) and McLeay and Tenreyro (2020)
- Disaggregate data and time fixed effects avoids this problem
  - Since the central bank does not target inflation in any one particular region or sector
  - The problem would not be solved with disaggregate data but without time fixed effects, because in that case some of the identification would come from the time series dimension where there is endogeneity

Applying panel break methods to disaggregate data

- Cross-sectional information can help identify sources of instability in Phillips curves:
  - Regional (MSA or state) versus industry and country (EU) data
  - Circumvents the endogeneity problem
  - Reveals cross-sectional heterogeneity in the Phillips curve
- Exploiting cross-sectional information adds power to break tests
  - Univariate break tests have weak power
  - Commonality of timing and impact of breaks increases power significantly

Potential causes of flattening Phillips curve

- Import penetration, especially from China
  - China joined the WTO on December 11, 2001
  - Aueret al.(2017), Stock and Watson (2020), Gilchrist and Zakrajsek (2019), and Firat (2020) all show how greater trade openness can flatten the Phillips curve
- Declining unionization
- Inflation being stable at a low level
  - Little need to pay attention to inflation in wage setting

Data

Data

- Industry-level price data
  - PCE price indexes for 16 industry components. Quarterly, 1959Q1-2022Q3
  - CPI inflation data for 31 industries. Quarterly, 1954Q1-2022Q3
- Wage data
  - Average hourly earnings for 50 states and DC. Quarterly, 1980q1-2019q4
- CPI MSA-level inflation rates for 22 cities. Annual, 1980-2022
- EU inflation data for 28 countries. Annual, 1986-2021

Model

MSA- and EU-level Break Model

- Phillips curve can shift an unknown number of times (K) at unknown locations $\tau = (\tau_1, \ldots, \tau_K)$
- Breaks assumed to be common, affecting all series simultaneously
  - only identifies breaks to the Phillips curve that are truly common
- For regimes $k = 1, \ldots, K+1$ the baseline MSA-level breakpoint model is

$$\pi_{it} = \alpha_i + \gamma_t + \rho_k \pi_{it-1} + \lambda_k URATE_{it-1} + \epsilon_{it}, \qquad t = \tau_{k-1} + 1, \ldots, \tau_k$$

  - π_{it}: inflation rate for series i at time t
  - $URATE_{it-1}$: unemployment rate for series i at time $t-1$
- The same model is applied to the EU (annual) data, except UGAP replaces UR

Industry-level Break Model

- We do not have an industry-level unemployment rate
- We therefore substitute the aggregate unemployment gap for the disaggregate unemployment gap used in the EU model
- Time fixed effects are not separately identifiable from the aggregate unemployment gap
- The effect of CPI inflation expectations, BC_{t-1}, is identified in the absence of time-fixed effects, yielding the model (for regime $k = 1, \ldots, K+1$ and $t = \tau_{k-1} + 1, \ldots, \tau_k$):

$$\pi_{it} = \alpha_i + \rho_k \pi_{it-1} + \lambda_k UGAP_{t-1} + \psi_k BC_{t-1} + \epsilon_{it}.$$

Priors and Estimation

- Regime durations have a Poisson prior such that breaks occur, on average, every 20 years
- An Normal-Inverse Gamma prior is specified over the regression coefficients and variances which are relatively uninformative
- Each model is estimated using a multi-step reversible jump MCMC algorithm (Smith and Timmermann, 2021)

Empirical Results

Industry results: PCE (1959-2022)

16 quarterly industry-level inflation rates

	1959-1972	1972-2001	2001-2022	1959-2022
		All industries		
PC	-0.51***	-0.87***	0.24	-0.24***
AR	0.31***	0.37***	0.12***	0.26***
		All industries (ex. food and energy)		
PC	-0.35***	-0.53***	0.09*	-0.16***
		Goods		
PC	-0.62***	-1.16***	0.57*	-0.19
		Services		
PC	-0.35***	-0.59***	-0.02	-0.21***

MSA results: CPI (1980-2022)

22 annual inflation rates

	1980-1999	2000-2022	1980-2022
All MSAs			
PC	-0.29***	-0.25***	-0.23***
Above and below median rate of import penetration from China			
PC (above)	-0.41***	-0.29***	-0.28***
PC (below)	-0.19***	-0.18**	-0.18***
Kink at 5% U rate			
PC	-0.28***	-0.22***	-0.21***
Extra PC (Urate $<$5%)	-0.16	-0.27***	-0.19***

Wage Phillips curve: AHE (51 States 1980-2019)

51 quarterly wage inflation rates

	1980:1-1989:4	1990:1-2019:4	1980:1-2019:4
		Linear model	
PC	-0.46***	-0.34***	-0.39***
		Nonlinear model	
		Kink at 5%	
PC	-0.41***	-0.25***	-0.33***
Extra PC (U $<$ 5%)	-0.60***	-0.50***	-0.52***

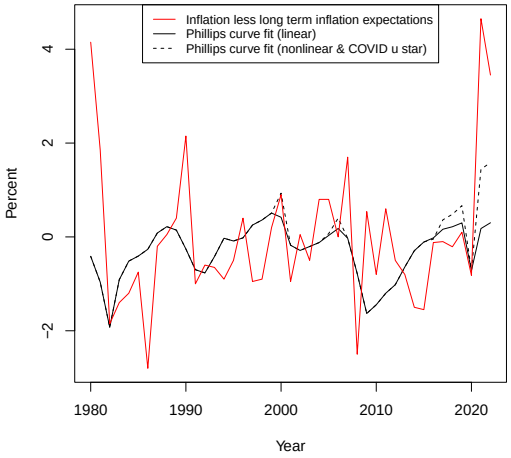
EU results (1986-2021)

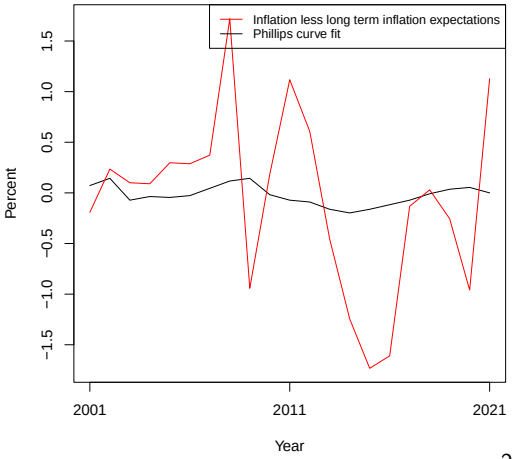
28 country-level annual inflation rates

	1986-2003	2004-2021	1986-2021
All countries			
PC	-0.72**	-0.09***	-0.15
Goods vs services			
PC (servs.)	-0.34***	-0.15***	-0.19***
PC (goods)	-0.33***	-0.07**	-0.11***
Nonlinear model			
PC	-1.17***	-0.02	-0.14
Extra PC (UGAP $<$ -1.5%)	3.30	-0.58***	-0.13

Aggregate Implications

Aggregate implications: Historical inflation





Optimal monetary policy

- Standard model comprising a Phillips curve and an IS curve:

$$u_t = \beta_u u_{t-1} + \beta_i i_{t-1} + \epsilon_{t,u},$$
$$\pi_t = \gamma_u u_{t-1} + \gamma_\pi \pi_{t-1} + \epsilon_{t,\pi},$$

  u_t is unemployment gap; π_t is inflation; i_t is policy rate at time t

- CB minimizes $E(u_t^2 + \pi_t^2)$ using the rule $i_t = \rho_u u_{t-1} + \rho_\pi \pi_{t-1}$

- This implies a VAR of the form $x_t = Ax_{t-1} + \epsilon_t$: where

$$A = \begin{pmatrix} \beta_u + \beta_i \rho_u & \beta_i(\rho_\pi - 1) \\ \gamma_u & \gamma_\pi \end{pmatrix}$$

  and $\epsilon_t = (\epsilon_{t,u}, \epsilon_{t,\pi})'$ is $N(0, \Sigma)$ with $\Sigma = diag(\sigma_u^2, \sigma_\pi^2)$.

Optimal monetary policy

- CB's loss function: $\omega_{11} + \omega_{22}$, where $\Omega = [\omega_{ij}]$ is the unconditional variance of x_t and Ω solves $\Omega = A\Omega A' + \Sigma$
- Estimate IS curve using Bayesian no-break regression of the quarterly U.S. national unemployment gap on an intercept, its own one quarter lag, and the lagged real federal funds rate.
- Plug in posterior draws for $(\beta_u, \beta_i, \gamma_u, \gamma_\pi, \sigma_u^2, \sigma_\pi^2)$, and find ρ_u and ρ_π that minimizes this loss

Aggregate implications: Optimal monetary policy

Model specification	Optimal coefficient	
	Unemployment	Inflation
US		
No break	-0.88	0.68
Break	-0.68	1.10
Break in PC mean holding distribution fixed	-0.82	0.77
EU		
No break	-1.01	1.19
Break	-0.65	1.26
Break in PC mean holding distribution fixed	-0.97	1.19

Conclusions

Conclusions

1. We find evidence of up to two breaks in the price Phillips curve
   - One in early-1970s, after which the slope steepens
   - One in early-2000s, after which the slope flattens
2. The steepening is largest for the food and energy sectors
3. The flattening is broad-based across sectors, but greater for goods than services
   - Services more sheltered from globalization and import penetration
4. The wage Phillips curve has also flattened, but less than the price PC
5. Ignoring breaks causes the steepening (kink) of the PC in tight labor markets to be under-estimated