

# Has the Phillips Curve Flattened and Why?

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# Introduction

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- ▶ The correlation between inflation and real activity at business cycle frequencies has decreased in the 1990s (e.g. Atkeson and Ohanian, 2001, Stock and Watson, 2007, 2008, 2020).

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If the Phillips curve indeed became flat, it would imply that more extreme policy measures would be necessary to maintain inflation at its target value... Hence its high policy relevance



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- ▶ While it is well-known how to estimate DSGEs and Structural VARs in the presence of instabilities...
- ▶ ... On the other hand, DSGEs and Structural VARs are full-information estimation procedures: potential mis-specification in any other part of the model might potentially contaminate the Phillips curve estimate

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- ▶ No methods were available to estimate IV with time-varying parameters.
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- ▶ Our approach relies on the novel methodology proposed by Inoue et al. (2022)
- ▶ We estimate local projections and instrumental variables models with time-varying parameters (TVP-LP-IV).
- ▶ We also propose a novel TVP-LP-IV methodological approach robust to weak instruments.

# Empirical findings

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- ▶ We find that the decrease in the correlation between unemployment and inflation cannot be attributed to monetary policy; rather, to the decrease in the slope of the Phillips curve.
- ▶ Our time-varying estimation dates the decrease in the slope of the Phillips curve back to the 1980s, although it started reverting back in the most recent pandemic period.

## Relationship to literature: Overview

In contrast to our work, most of the existing literature relies either on:

- ▶ **reduced-form time-varying** parameter approaches (Stock-Watson, 2008; Ball-Mazumder, 2019)
- ▶ **semi-structural time-varying** parameter approaches (Galí-Gambetti, 2018; Bergholt et al., 2022);
- ▶ **structural models estimation in given sub-samples** (Del Negro et al., 2020);
- ▶ **IV estimation in given sub-samples** (Barnichon-Mesters, 2020, 2021)

In contrast to these works, we focus on the structural Phillips curve, estimated via IV, allowing for general forms of time-variation.

## Relationship to literature: Reduced-form Approaches

Reduced-form approaches attempt at studying the correlation between inflation and unemployment.

- ▶ Stock and Watson (2008) suggest that Phillips curve forecasts are better than competing multivariate forecasts, although their performance is episodic, pointing to instabilities.
- ▶ Ball and Mazumder (2019) argue that expected inflation was backward-looking until the late 1990s, but then became strongly anchored at the central bank's target value.

Differently from them, we also address the endogeneity problem and estimate the structural Phillips curve.

## Relationship to literature: Semi-structural Approaches

There are also semi-structural approaches:

- ▶ Galí and Gambetti (2018) estimate a time-varying parameter Vector Autoregression (VAR) model to identify economic shocks, then use such shocks to purge the Phillips curve variables and achieve identification.
- ▶ Bergholt et al. (2022) estimate structural shocks using sign restrictions in constant-parameter VARs; then, they investigate changes in the Phillips curve over time using inflation and unemployment data purged by the relevant shocks in either sub-samples or rolling windows.

Differently from them, we directly estimate the Phillips curve using instrumental variable methods that do not require identifying all the structural shocks in the economy.

## Relationship to the literature: Structural Approaches

A third strand of the literature relies on structural models.

- ▶ Del Negro et al. (2020) investigate whether the flattening of the Phillips curve is the explanation behind the disconnect between inflation and unemployment by focusing on (Structural) Time-varying parameter VARs and DSGE models in sub-samples, before and after 1989.

Differently from their work, we rely directly on estimating the structural Phillips curve via limited-information methods, which are more robust to mis-specification than full-information methods, and let the instability in inflation dynamics to freely emerge within our time-varying instrumental variable (TVP-IV) estimator.

## Relationship to the literature: IV Approaches

A fourth strand of the literature focuses on IV or external information.

- ▶ McLeay and Tenreyro (2019) argue that, if inflation follows a seemingly exogenous statistical process, unrelated to the output gap, that does not mean that the Phillips curve has disappeared: by increasing inflation when output is below potential, monetary policy can generate a negative correlation between inflation and the output gap, blurring the identification of the Phillips curve.
- ▶ Barnichon and Mesters (2020, 2021) estimate the Phillips curve and the Phillips multiplier using narrative monetary policy shocks as instruments to address the endogeneity problem. To take into account time-variation, they split the sample at a known break date.

These papers do not allow for general patterns of time variation, which is instead the main contribution of our paper.

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# The Phillips relation

We consider the **Phillips relation**:

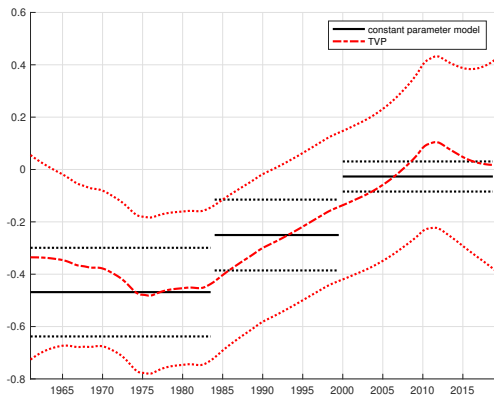
$$E_t \Delta_4 \pi_t^4 = \beta_{0,t} + \beta_{1,t} x_t^4, \quad (1)$$

where:

- ▶  $z_t^4$  is the change in the average value of variable “z” between times t and t-3
- ▶  $\Delta_4 = (1 - L^4)$ ,  $L$  denotes the lag operator such that  $Lx_t = x_{t-1}$
- ▶  $x_t$  is a measure of slack (mainly unemployment gap, CBO)
- ▶  $\pi_t$  is inflation, measured by personal consumption expenditure price index (PCE excluding food and energy, PCEExFE).



# The Phillips relation



Our TVP-LP estimate of  $\beta_{1,t}$  in red; Stock and Watson's (2020) sub-sample estimates in black. Dotted lines are 90 percent bands

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- ▶ It has disappeared in the data in the most recent period.
- ▶ But this does not mean that the Phillips curve has disappeared!
- ▶ The Phillips relation measures the correlation between inflation and unemployment, while the Phillips curve measures the trade-off between inflation and unemployment due to supply shocks.

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# The structural Phillips curve

Our benchmark NK Phillips curve is a classic version by Galí and Gertler (1999, GG), Galí, Gertler, and López-Salido (2005, GGLS):

$$\pi_t = c_t + \gamma_{f,t}\pi_{t+1} + \gamma_{b,t}\pi_{t-1} + \lambda_t x_t + u_t,$$

where:

- ▶  $\pi_t$  denotes inflation.
- ▶  $x_t$  denotes the measure of real marginal cost (the unemployment gap)
- ▶  $u_t$  is an unobserved shock

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- ▶ Instrument set: two lags of the unemployment gap and output gap.

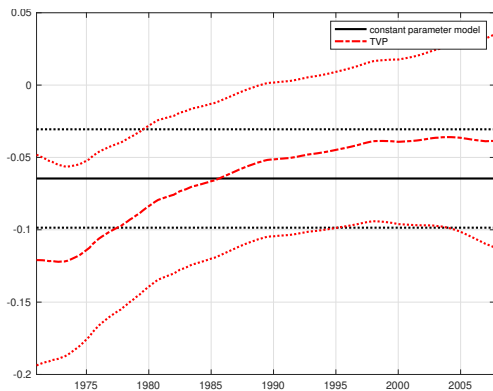
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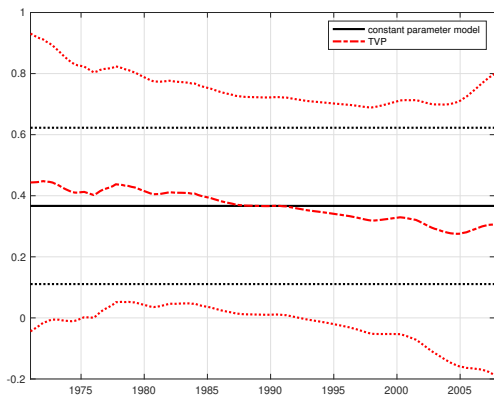
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- ▶ Instrument set: two lags of the unemployment gap and output gap.
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- ▶ Approach: We estimate it using the TVP-IV approach developed in Inoue et al. (2022). The parameter path is estimated according to a minimum weighted average risk criterion.

# The slope of the structural Phillips curve



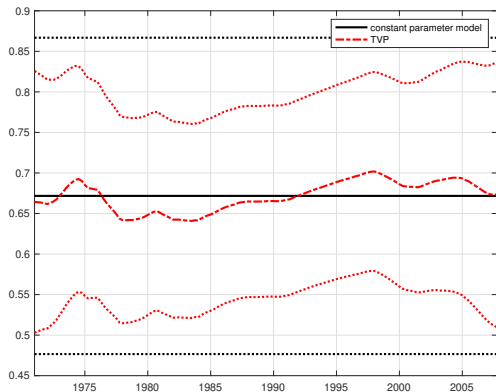
Our TVP-IV estimate of  $\lambda_t$  in red. Constant parameter estimate in black. Dotted lines are 90 percent bands.

# The forward-looking inflation parameter in the structural Phillips curve



Our TVP-IV estimate of  $\gamma_{f,t}$  in red. Constant parameter estimate in black. Dotted lines are 90 percent bands.

# The backward-looking inflation parameter in the structural Phillips curve



Our TVP-IV estimate of  $\gamma_{b,t}$  in red. Constant parameter estimate in black. Dotted lines are 90 percent bands.



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- ▶ The importance of the backward-looking component in the Phillips curve ( $\gamma_{b,t}$ ) has remained constant over time.

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# The Phillips multiplier

Barnichon and Mesters (2021) propose the “Phillips multiplier” as an alternative measure of the inflation-unemployment trade-off faced by policymakers.

$$\sum_{j=0}^h \pi_{t+j} = \mathcal{P}_h \sum_{j=0}^h u_{t+j} + \text{controls} + e_{t+h}, \quad (2)$$

where  $\mathcal{P}_h$  is the “Phillips multiplier.”

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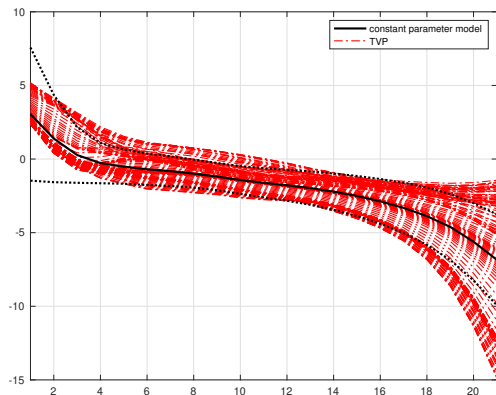
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- ▶ We will estimate a **time-varying Phillips multiplier**  $\mathcal{P}_{h,t}$  using our method.
- ▶ This will give us an estimate of the time-varying trade-off between inflation and unemployment in the classical specification of the Phillips curve a' la GG.

# The time-varying Phillips multiplier



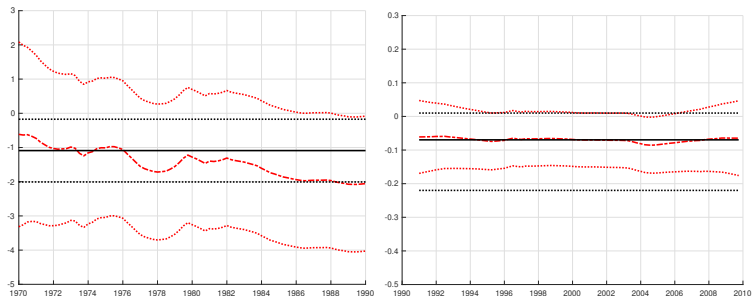
Note: the x-axis reports the horizon of the impulse responses

The time-varying estimate of the Phillips multiplier in red. Constant parameter estimate in black. Dotted lines are 90 percent bands.



# The time-varying Phillips multiplier, $\mathcal{P}_{h,t}$ , $h = 12$

pre-1990 and post-1990:



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# Main Empirical Conclusions

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- ▶ or the slope of the structural Phillips curve

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- ▶ ... this causes unemployment to rise, resulting in a positive correlation between inflation and unemployment that biases the slope coefficient of the Phillips curve toward zero.
- ▶ See Haldane and Quah (1999); Roberts (2006); Williams (2006); Mishkin (2007); Carlstrom, Fuerst, and Paustian (2009); McLeay and Tenreyro (2018).



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- ▶ Thus, the endogeneity problem can be solved using valid and relevant instruments.
- ▶ In the presence of an endogeneity bias due to monetary policy actions, IV estimates will still be consistent provided the instruments satisfy the required statistical conditions – that is, the chosen instruments should be both valid and relevant.

## Reliability of our Estimates

Our main results feature instruments that are both **valid and strong**.  
In fact:

- ▶ Hansen's J-statistic equals 1.955, with a p-value of 0.3763, indicating that the instruments are valid (conditional on the maintained assumption that a subset of instruments are valid).

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- ▶ Lewis and Mertens's (2022) weak IV test statistic equals 16.0254, and it is greater than the 90% critical value 14.0533, indicating that the instruments are strong.

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With the method robust to weak instruments we will investigate two alternative specifications:

- I. monetary policy shocks as instruments
- II. Gali' et al.'s (GGLS) specification

## Specification I: using monetary policy shocks as IV

The model is the hybrid Phillips curve in Barnichon and Mesters (2021):

$$\pi_t = c_t + \gamma_{f,t}\pi_{t+4}^4 + \gamma_{b,t}\pi_{t-1}^4 + \lambda_t x_t + u_t,$$

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- ▶  $x_t$ : the unemployment gap (Hodrick-Prescott filtered with  $\lambda^{hp} = 1600$ ).
- ▶ Instruments: Almond parameterization of 20 lags of Romer and Romer's monetary policy shocks (Barnichon-Mesters, 2021)

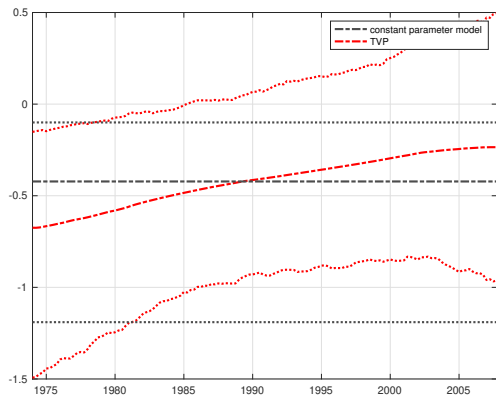
## Specification I: using monetary policy shocks as IV

The model is the hybrid Phillips curve in Barnichon and Mesters (2021):

$$\pi_t = c_t + \gamma_{f,t}\pi_{t+4}^4 + \gamma_{b,t}\pi_{t-1}^4 + \lambda_t x_t + u_t,$$

- ▶  $\pi_t$ : the (annualized) quarter-to-quarter inflation, measured by personal consumption expenditure price index (PCE excluding food and energy)
- ▶  $\pi_{t-1}^4 = \frac{1}{4}(\pi_{t-1} + \pi_{t-2} + \pi_{t-3} + \pi_{t-4})$ .
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# The slope of the structural Phillips curve using monetary policy shocks as instruments



Our TVP-IV estimate of  $\lambda_t$  in red. Constant parameter estimate in black. Dotted lines are 90 percent bands.



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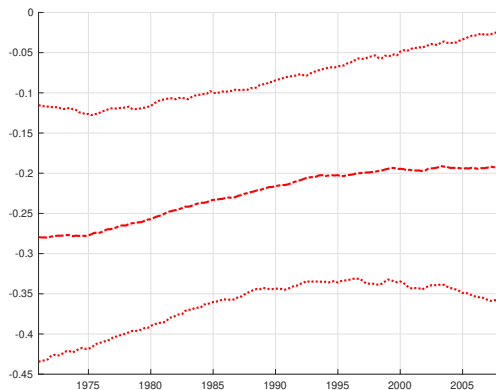
- ▶  $\pi_t$ : inflation measured by the GDP deflator
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# The slope of the structural Phillips curve: robustness to weak instruments



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# Outline

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Contributions

The Phillips Relation

The Structural Phillips Curve

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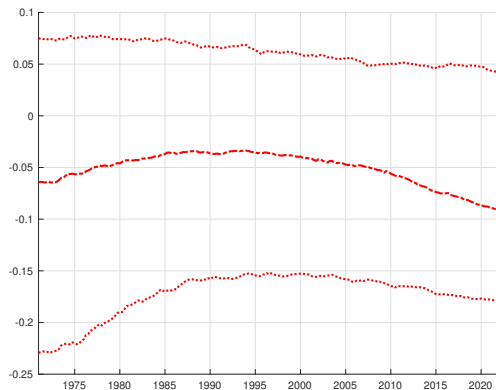
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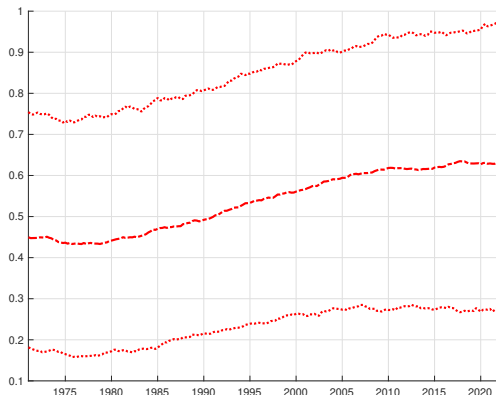
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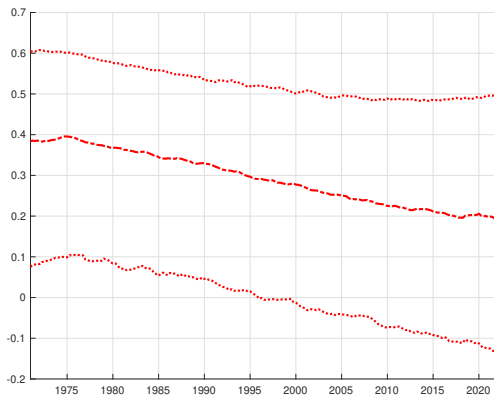
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# Conclusions I

We contribute to the debate surrounding the instability of the relation between unemployment and inflation over time by offering insights from a **flexible time-varying instrumental variable approach**.

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- ▶ We find that the weakening of the cyclical correlation between inflation and unemployment is due to a **flattening of the slope of the Phillips curve**, rather than to monetary policy.
- ▶ The slope of the structural Phillips curve has decreased over time since the 1980s.
- ▶ In the most recent period since the Great Recession and during the recent pandemic, the slope of the Phillips curve has increased again.

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