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THE AWAKENING OF INFLATION AND THE RETURN OF THE PHILLIPS CURVE IN THE EURO AREA

by Stefano Neri*, Cristina Conflitti* and Alessandro Lin*

Abstract

During the 2021-22 high-inflation surge, euro-area firms significantly increased the frequency with which they adjusted prices. This paper documents that such a shift in price-setting behaviour led to a transitory steepening of the Phillips curve, which had remained persistently flat throughout the preceding low-inflation period. In a model with nominal rigidities, a higher frequency of price adjustments steepens the Phillips curve and enhances the transmission of monetary policy, enabling central banks to contain cost-push shocks with a smaller loss in output. We provide robust empirical evidence for the euro area using panel local projections, confirming the link between the frequency of price changes, the slope of the Phillips curve in the euro area, and the increased effectiveness of monetary policy.

JEL Classification: C22, C23, E27, E31, E52.

Keywords: Phillips curve, DSGE model, price setting, monetary policy, panel local projections.
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1. Introduction and motivation[1]

Over the past twenty-five years, the euro area has moved through distinct inflation regimes. Prior to the Global Financial Crisis (GFC), inflation remained stable at around 2–3 per cent. After the crisis, weak aggregate demand, financial fragmentation, and persistent economic slack ushered in a prolonged low-inflation phase despite increasingly accommodative monetary policy by the European Central Bank (ECB). This pattern reversed abruptly after the COVID -19 pandemic and the 2021-22 energy crisis, which produced the sharpest inflation increase in the history of the European Monetary Union. Inflation peaked at above 10 per cent in autumn 2022 and then declined rapidly, with only a modest deterioration in activity and labour-market conditions.

A key mechanism behind this decoupling is firms' price-setting behaviour. In the standard New Keynesian model, inflation becomes more sensitive to macroeconomic conditions when prices are reset more frequently (e.g. Galí, 2008).[2] Cavallo et al. (2024) document a substantial increase in the frequency of price changes after the 2021-22 energy price shocks, a pattern inconsistent with constant Calvo (1983) type price rigidity but consistent with state-dependent pricing frameworks (Golosov and Lucas, 2007; Nakamura and Steinsson, 2010). In 2021-22, euro area inflation was driven to a large extent by intense cost pressures – especially energy prices and supply-chain disruptions – as opposed to domestic demand or labour-market slack as in the U.S. (Bańbura et al., 2023 and Neri, 2025). These shocks can push markups away from their targets, prompting rapid price adjustments (Cavallo et al., 2024).[3]

Our contribution is threefold. First, we provide new estimates of the slope of the euro-area Phillips curve and track its evolution over time using both time-series and cross-country methods. Second, we study the monetary policy implications of a parsimonious New Keynesian model with endogenous repricing frequency, which steepens the Phillips curve (Gasteiger and Grimaud, 2023). Third, we empirically test the model's predictions with panel local projections, a flexible framework well-suited to uncover state dependence in the data (Jordà and Taylor, 2025).

Our analysis delivers three findings. First, the slope of the euro-area Phillips curve varies sharply across macroeconomic episodes, rejecting a stable inflation-slack relationship. Second, within the model, cost-push shocks raise both inflation and the frequency of price adjustment, strengthening monetary policy transmission and lowering the sacrifice ratio. Third, panel local projections point to state-dependent effects: when energy price inflation is high, monetary policy

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[1] We thank Fabio Busetti, Francesco Corsello, Fadi Hassan, Lorenzo Mori, Kevin Pallara, Tiziano Ropele, Alfonso Rosolia, Fabrizio Venditti, Stefania Villa and Ignazio Visco for their useful comments and suggestions.

[2] It is worth noting that if inflation follows a unit root process, then a shock to inflation will lead to a permanent increase in its level, see Bruno (1995).

[3] Gautier et al. (2024) provide stylized facts about price settings in 11 euro area countries in a low inflation environment: (1) the distribution of price changes is characterized by frequent large and small changes; (2) the size of price changes rises with inflation, but their frequency does not; (3) these changes are due to movements in the fraction of price changes rather than by the absolute size of price changes. For evidence on the U.S., see Montag and Villar Vallenas (2025).

shocks have larger disinflationary effects and a smaller impact on unemployment than when energy inflation is low, consistent with the theoretical model.

Related literature. – Recent papers study how the frequency price adjustment varies over time and across items of the consumer price basket, and how it co-moves with inflation. Gautier et al. (2026), Montag and Villar Vallenas (2023) and Cavallo et al. (2024) show that repricing becomes more frequent when during episodes of large shocks to firms' costs such as the reopening of the U.S. economy after the most acute phase of the COVID-19 pandemic (Montag and Villar, 2022) and the energy crisis between late 2021 and late 2022 in the euro area (Cavallo et al., 2024 and Gautier et al., 2026). The results in these studies speak in favour of models of state-dependent pricing.

Based on the stylized facts documented above, Blanco et al. (2024), Cavallo et al. (2024) and Gasteiger and Grimaud (2023) develop theoretical models in which the fraction of price changes evolves endogenously with cost-push shocks or inflation. The mechanism is straightforward: when markups deviate from desired levels, firms have stronger incentives to reprice. Large cost-push shocks compress margins and trigger more frequent price adjustments.

In parallel, interest in the Phillips curve slope has revived after the 2021-22 inflation surge. Benigno and Eggertsson (2023, 2024) develop a search-and-matching model with wage rigidity that generates a strongly non-linear Phillips curve in the labour-market tightness-inflation space. Blanco et al. (2024a) develop a sticky-price model with a feedback loop between inflation and the fraction of price changes, which steepens the Phillips curve in periods of high inflation. Gasteiger and Grimaud (2023) introduce endogenous price-setting frequency in a standard New Keynesian model, yielding a non-linear Phillips curve as prices become more flexible in expansions than in recessions. For the euro area, Ascari et al. (2025) model endogenous adjustment in price and wage-setting frequencies, giving rise to non-linear price and wage Phillips curves. The authors estimate the model using euro area data and find that inflationary supply shocks trigger more frequent price adjustments.

This paper advances the literature by exploiting cross-country heterogeneity within the euro area to document non-linearities in the Phillips curve (Benigno and Eggertsson, 2023; Blanco et al., 2024). It provides, to the best of our knowledge, the first empirical evidence of the state-dependent monetary policy transmission, as implied by models of endogenous repricing frequency (Gasteiger and Grimaud, 2023, Ascari et al., 2025), based on panel local projections (Jordà and Taylor, 2025).

Outline. – The remainder of the paper is as follows. Section 2 documents stylised facts and Section 3 shows time series and panel estimates of the euro-area Phillips curve. Section 4 analyses the state-dependent transmission of monetary policy in a New Keynesian model and Section 5 empirically evaluates the model's implications. Section 6 concludes.

2. Inflation, the frequency of price adjustment and unemployment

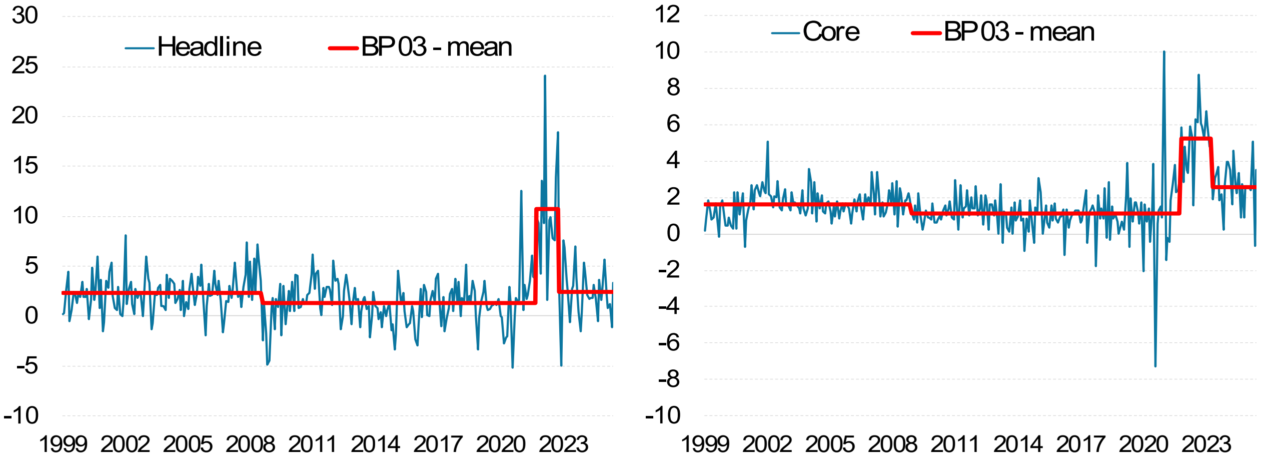
We begin by documenting stylised facts on euro-area inflation and the frequency of price adjustment, focusing on structural breaks in their mean. We then introduce the unemployment gap, which measures deviations of the unemployment rate from its natural (unobservable) level.

2.1. *Inflation and the frequency of change*

In the euro area, inflation began to rise rapidly in the second half of 2021 from the low levels observed during the initial phase of the pandemic. Headline inflation, measured by the Harmonized Index of Consumer Prices (HICP, henceforth) peaked at 10.6 per cent in October 2022, about six times its 1999-2019 average (1.7). In March 2023, core inflation was 5.7 per cent, around four times its 1999-2019 average (1.4), indicating that price pressures had become broad based across goods and services.

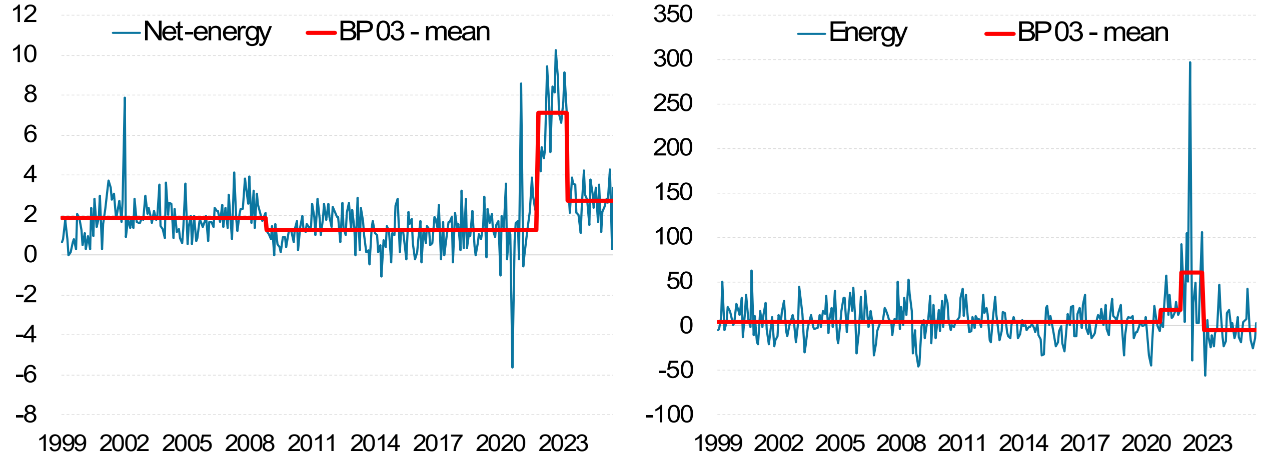
Figure 1. Inflation in the euro area

(*annualized monthly changes; percentage points*)



Headline

Core



Net-energy

Energy

Source: ECB. *Note*: annualized monthly percentage point changes of the seasonally adjusted series. Energy inflation is not seasonally adjusted. The dashed line represents the mean based on the Bai and Perron (2003) structural break test. Latest observation: July 2025.

Figure 1 plots the evolution of headline, core, net-energy, and energy inflation rates in the euro area from 1999 to 2025, together with regime-specific means estimated using the Bai and Perron (2003) methodology, which detects shifts in mean inflation without pre-specifying break dates.

Overall, four phases can be identified: (1) the pre-GFC; (2) the low-inflation period between 2008 and 2021; (3) the reopening after the most acute phase of the COVID -19 pandemic and the energy crisis; (4) the period after the energy crisis.

Between 1999 and 2008, inflation was stable, with similar means across measures except for energy inflation. The Bai and Perron (2003) methodology identifies a downward shift of (headline) inflation after the acute phase of the GFC in autumn 2008: average headline inflation fell from 2.33 to 1.26, reflecting the decline in core inflation from 1.63 to 1.11 (Figure 1 and Table 1). The dynamics of inflation changed markedly with the pandemic, the subsequent reopening of the economies and Russia's invasion of Ukraine. The shift to a regime of elevated inflation occurs in autumn 2021, driven by an unprecedented surge in energy inflation: the estimated mean rises to about 60 per cent, from 4.5 per cent before autumn 2020. Core inflation also moved from the low-inflation regime (mean 1.11 per cent) to a high-inflation regime (above 5 per cent), reflecting surging demand induced by the reopening of the economies, supply bottlenecks and especially the indirect effects of higher energy costs.

Table 1. Inflation and frequency of price adjustment: structural break tests

(*annualized monthly changes; percentage points*)

Inflation	*Regime*			
Energy	1999:01 – **2020:09**	2020:10 – **2021:09**	2021:10 – **2022:10**	2022:11 – 2025:06
	4.49	18.42	60.08	-4.32
Net-energy	1999:01 – **2008:10**	2008:11 – **2021:10**	2021:11 – **2023:03**	2023:04 – 2025:06
	1.87	1.24	7.11	2.71
Core	1999:01 – **2008:11**	2008:12 – **2021:10**	2021:11 – **2023:04**	2023:05 – 2025:06
	1.63	1.11	5.23	2.59
Headline	1999:01 – **2008:07**	2008:08 – **2021:09**	2021:10 – **2022:10**	2022:11 – 2025:06
	2.33	1.26	10.70	2.39
Frequency	2010:01 – **2013:11**	2013:12 – **2022:02**	2022:03 – **2023:04**	2023:05 – 2024:12
	8.37	7.78	11.90	8.63

Source: ECB and HICP micro data from Gautier et al. 2026. *Note*: annualized monthly percentage point changes of the HICP seasonally adjusted series. The regimes are identified using the Bai and Perron (2003) structural break test. Break dates are in bold. Latest observation: June 2025.

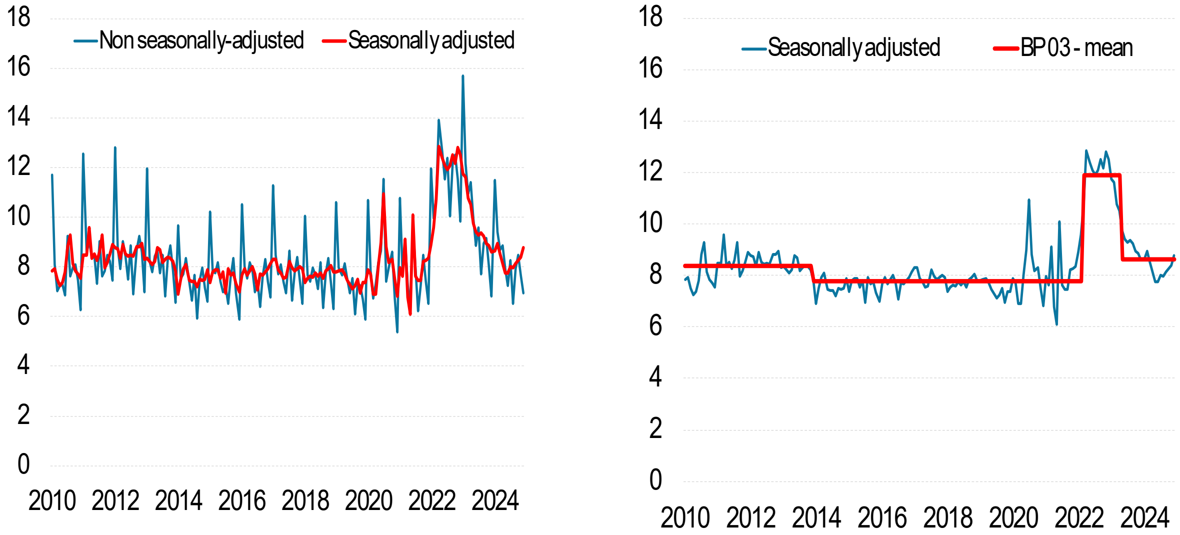
The high-inflation regime was temporary, lasting a little over a year. As supply bottlenecks eased and energy and food prices fell, inflation started declining (Neri, 2024). Core and net-energy inflation settled above their GFC-to-pandemic averages, while headline inflation returned close to its pre-GFC mean.

When large aggregate cost-push shocks occur, state-dependent models predict more frequent price adjustment: "*large shocks travel fast*" (Cavallo et al., 2024). Gauiter et al. (2026) show that repricing frequency in the euro area rose significantly as inflation reached double digits in 2022-23.

In 2022, the frequency was about four percentage points above its 2010-19 average (Figure 2), while the average size of price increases changed very little as inflation rose.[4]

Figure 2. Frequency of price changes in the euro area

(*per cent*)



Source: Gautier et al. (2026). *Note*: fraction of prices in the net-energy HICP basket changing in each month. Seasonal adjustment based on the X11 method. The dashed line represents the mean based on the Bai and Perron (2003) structural break test. Latest observation: December 2024.

Using the methodology in Bai and Perron (2003) three distinct breakpoints are detected — December 2013, March 2022 and May 2023 — corresponding to major macroeconomic phases. In the first regime, the average frequency of price changes was stable at about 8.4 per cent. This period was characterized by subdued inflationary pressures following the GFC and the euro area Sovereign Debt Crisis (SDC). Between late 2013 and early 2022, the frequency declined slightly, with the mean falling from 8.4 to 7.8 per cent. This regime coincides with the euro-area low inflation period, during which weak demand, low cost pressures, and a weakening of the anchoring of long-term inflation expectations exerted downward pressure on both headline and core inflation (Figure 1).

A sharp structural shift occurred in March 2022, after Russia's invasion of Ukraine. In this new regime, the average frequency of price changes increased by 4.1 percentage points above the previous regime to 11.90 per cent, as firms' pricing behaviour changed in response to large cost-push shocks. Price setting became much more flexible during the inflation surge. After April 2023, the frequency of price changes declined by about 3.3 percentage points, pointing to a normalization in firms' pricing behaviour (see Gautier et al. 2026 for more details).

Overall, the structural breaks in the frequency of price adjustment suggest that nominal rigidities vary over time. Firms adjust their pricing in response to macroeconomic shocks, especially large shocks to their costs. This evidence supports state-dependent pricing mechanisms in general

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[4] See also Dedola et al. 2024.

equilibrium models and cautions against treating the Calvo probabilities as time-invariant, particularly in periods that include large positive cost shocks.

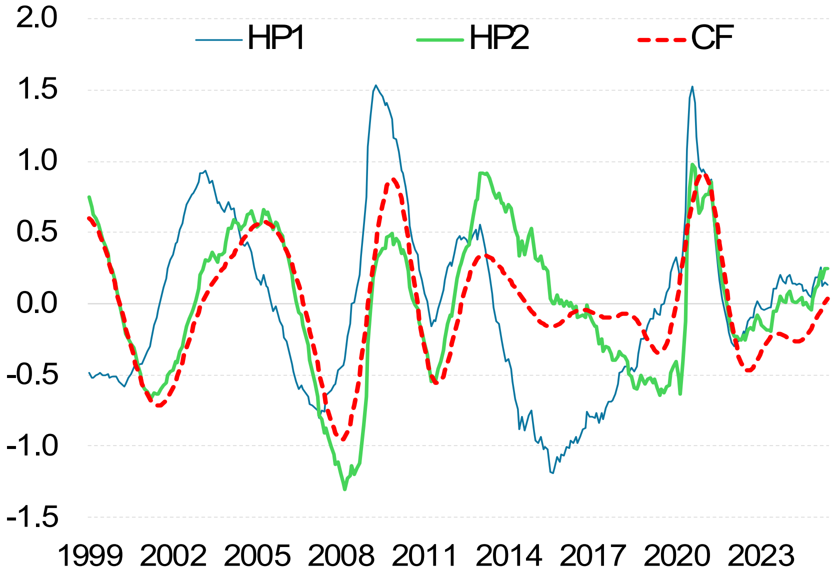
2.2. The unemployment gap

The unemployment gap represents the deviation of the actual unemployment rate from its trend or natural rate, and it is a central input in the analysis of the Phillips curve. Figure 3 compares three statistical methods for estimating the unemployment gap: the one-sided and two-sided Hodrick-Prescott (1997) filter and the Christiano-Fitzgerald (2003) band-pass filter.[5]

The series exhibit similar cyclical patterns, particularly during the GFC and the COVID -19 pandemic, but differ in amplitude and timing. The one-sided HP filter shows larger swings, especially around the 2008-09 Great Recession and the one that followed the outbreak of the pandemic and reaches a trough during the low-inflation period in 2015, about four years before the two-sided HP and CF filters. The two-sided filter yields a smoother, more symmetric cycle with smaller amplitude than the one-sided and the CF filters; the latter lies between the two HP versions.

Figure 3. Unemployment gap in the euro area

(*percentage points*)



Source: ECB. *Note*: unemployment gaps computed using the one-sided (HP1) and two-sided (HP2) Hodrick-Prescott (1997) and the Christiano-Fitzgerald (2003; CF) filters applied to the seasonally adjusted unemployment rate. Latest observation: June 2025.

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[5] The two-sided HP filter estimates a smooth trend using the whole sample; the one-sided version uses only past data. As such, it is more volatile and subject to revisions. The CF filter operates as a band-pass, extracting cycles of specified length and treating the remaining components as the trend; this feature makes the CF filter conceptually different from the HP. As we are agnostic about which method is the best, we estimate the unemployment gap with the three filters.

2.3. *Inflation and the unemployment gap*

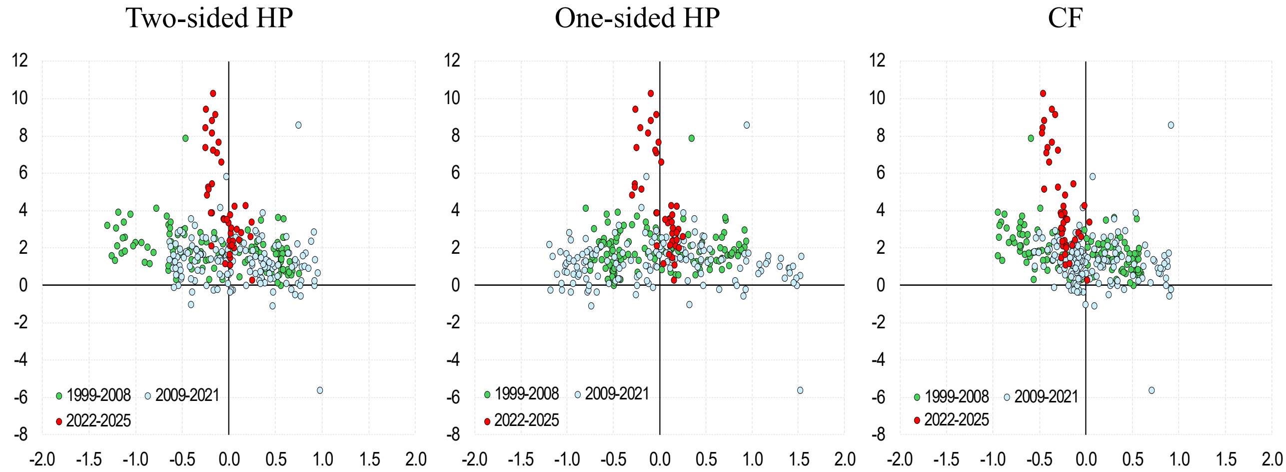
Considering the structural changes in the mean of net-energy inflation and the frequency of price adjustment, we examine the relationship between net-energy inflation and the unemployment gap over three distinct subperiods (Figure 4). These periods are chosen based on the results of the Bai and Perron (2003) methodology in Section 1; between the outbreak of the GFC and the energy crisis we consider a single period (2009-2021).

During the first period (1999-2008), observations cluster around moderate inflation rates and near-zero unemployment gaps, suggesting a weak link between inflation and cyclical conditions. This relationship is consistent with a flat Phillips curve, in a context of well-anchored inflation expectations and global disinflationary pressures that muted the pass-through from labor market conditions to consumer prices. In the second period (2009-2021), inflation remained persistently low even as the unemployment gap became increasingly negative, pointing to a puzzling lack of inflationary response to improving labour-market conditions. This decoupling may reflect structural changes in price-setting behaviour, a further flattening of the Phillips curve, or a weaker anchoring of inflation expectations.

The third subperiod (2022-2025) that followed the pandemic and the resulting supply bottlenecks includes the inflation surge which largely influenced by the energy crisis after Russia's invasion of Ukraine. Inflation rose sharply while the unemployment gap remained close to zero. This regime shift breaks the Phillips curve relationship, underscoring the dominant role of supply-side shocks and the limited explanatory power of slack-based models in this episode.

Figure 4. Net-energy inflation and the unemployment gap

(*per cent and percentage points*)



Source: ECB. *Note*: annualized monthly percentage point changes of net-energy inflation and unemployment gaps based on the HP and CF filters. Seasonally adjusted data. Latest observation: June 2025.

The graphical evidence suggests that the euro-area Phillips curve has undergone significant changes over the past two and a half decades, underscoring the importance of accounting for nonlinearities and regime changes in the relationship between inflation and economic slack.

3. The Phillips curve in the euro area

This section presents evidence on the time-varying slope of the Phillips curve in the euro area using both time series (Section 3.1) and panel (Section 3.2) methods.

3.1. Time series

In this section, we estimate the Phillips curve using a time-series approach. We consider three specifications: a static version, a dynamic one including lagged inflation, and an augmented dynamic specification that includes energy inflation:

$$\pi_t = \alpha + \gamma u_t + \varepsilon_t \tag{1a}$$

$$\pi_t = \alpha + \gamma u_t + \rho \pi_{t-1} + \varepsilon_t \tag{1b}$$

$$\pi_t = \alpha + \gamma u_t + \sum_{i=1}^{p} \beta_i \pi_{t-i}^{e} + \rho \pi_{t-1} + \varepsilon_t \tag{1c}$$

where π_t is inflation, u_t the unemployment gap, and π_t^e energy inflation. The backward-looking specification (see, among others, Ball and Mazumder, 2011 and 2019) is consistent with settings in which inflation expectations are adaptive. The results are robust to including the one-year inflation expectations from the ECB Survey of Professional Forecasters. We estimate the three specifications over the full sample and across subperiods and using the different measures of the unemployment gap (Section 2.3). This yields a comprehensive set of estimates for the slope parameter γ. A more negative slope implies that inflation responds more strongly to changes in the unemployment gap.

The estimates deliver three key insights (Figure 5). First, before the energy crisis the Phillips curve slope is stable and mildly negative across specifications and filtering methods, consistent with a modest sensitivity of inflation to slack. Second, between 2009 and 2021, which encompasses the aftermath of the GFC, the SDC, and the low-inflation period, the Phillips curve flattens further (see Figure 5), especially in the dynamic specifications. Third, in the post-pandemic period (2022-2025), the slope steepens sharply in all specifications, pointing to a regime change in the inflation-slack relationship in which inflation rises sharply despite only modest labour-market tightness.[6]

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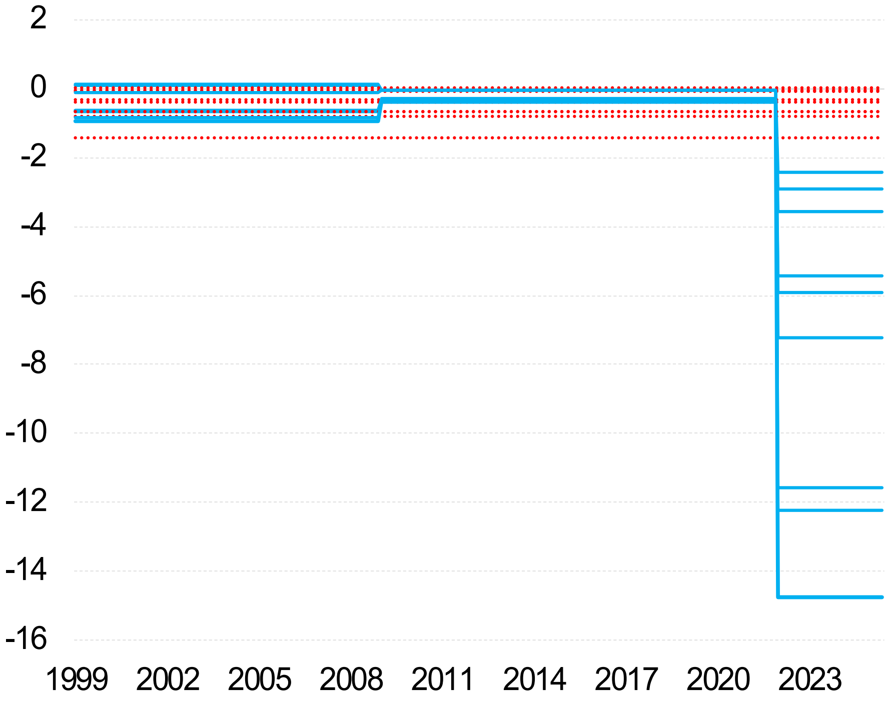
[6] We overcome the limitations of the size of the post-pandemic period estimating a panel model in Section 3.2.

Figure 5. Slope of the Phillips curve: time series approach



Note: annualized monthly percentage point changes of net-energy inflation and unemployment gaps based on the HP and CF filters. Seasonally adjusted data. Latest observation: June 2025.

The results are robust across measures of the unemployment gap. Although the three filters yield slightly different gaps, the time profile and magnitude of changes in the Phillips curve slope are remarkably similar across specifications. This suggests that the observed steepening is unlikely to be a mechanical artefact of a particular detrending method.

3.1.1. *The role of the frequency of price adjustments*

In this section, we assess whether fluctuations in firms' repricing behaviour can account for time variation in the slope of the Phillips curve. De Veirman (2023) adopts a similar approach for the United States. Motivated by the sharp increase in repricing frequency during the pandemic and the energy price shock, we estimate the following nonlinear extension of eq. (1c):

$$\pi_t = \alpha + \gamma u_t + \psi f_{t-1} + \theta f_{t-1} u_t + \sum_{i=1}^{p} \beta_i \pi_{t-i}^{e} + \sum_{i=1}^{p} \varphi_i f_{t-1} \pi_{t-i}^{e} + \rho \pi_{t-1} + \varepsilon_t \qquad (2)$$

where f_t denotes the (de-meaned) frequency of price adjustment and the other variable are defined above. The interaction coefficient θ captures whether fluctuations in the repricing frequency amplify or dampen the sensitivity of inflation to slack. The specification allows energy inflation to affect net-energy inflation directly, while permitting its impact to vary with the frequency of price adjustment. We set the number of lags p to 6 and estimate eq. (2) by OLS. Table 2 reports the results.

Two findings stand out. First, the baseline slope γ – evaluated at the sample mean of f_t – is negative and statistically significant, indicating that higher slack is associated with lower inflation when the repricing frequency is at its sample mean. Second, the interaction term is negative and precisely estimated, implying that a higher frequency of price adjustment makes the Phillips-curve slope more negative in absolute value. When firms reprice more often, changes in the unemployment gap transmit more strongly to inflation.

A higher frequency of price adjustments (ψ) exerts a positive and statistically significant impact on inflation. Periods in which firms reprice more often are associated with higher inflation. Indeed, inflation is the result of the share of prices changing (extensive margin, ψ) and the average size of price changes (intensive margin). The test that all the coefficients φ_i are jointly zero cannot be rejected at 1 per cent significant level. However, the contribution of the interaction between the frequency and energy inflation to net-energy inflation is small. Thus, for simplicity, we do not report the estimated parameters β_i and φ_i.

Table 2. Inflation, unemployment gap and the frequency of price adjustment

Parameter	One-sided HP filter			Two-sided HP filter			CF filter		
	Coeff.	Std. err.	*t*-stat	Coeff.	Std. err.	*t*-stat	Coeff.	Std. err.	*t*-stat
α	1.81	0.26	7.08	1.60	0.22	7.42	1.49	0.20	7.60
γ	-0.63	0.17	-2.88	-0.93	0.30	-3.06	-1.04	0.48	-2.16
ψ	0.66	0.17	3.92	0.53	0.16	3.29	0.34	0.17	2.09
θ	-1.61	0.42	-3.86	-1.72	0.56	-3.07	-2.08	0.63	-3.29
ρ	0.08	0.11	0.82	0.11	0.10	1.07	0.04	0.11	0.38

Note: coefficients estimated with OLS. Standard errors are corrected for heteroscedasticity. Net-energy inflation is measured as the annualized monthly percentage point change of the corresponding HICP seasonally adjusted series. Latest observation: December 2024.

The results of the estimation dovetail with the narrative evidence from the COVID-19 pandemic and the energy crisis, as in both episodes the repricing frequency increased sharply. The estimates imply that such increases amplify the pass-through from slack and energy prices to (net-energy) inflation. Accordingly, the steepening of the Phillips curve in those periods is not merely a level effect, possibly related to the increasing importance of inflation expectations, but rather the result of state dependent firms' pricing behaviour.[7]

Estimating the non-linear Phillips curve allows us to conduct a counterfactual simulation to assess the role of the different explanatory variables in eq. (2). A similar exercise is conducted in Beaudry et al. (2025), who assess the relative importance of the labour market tightness and inflation

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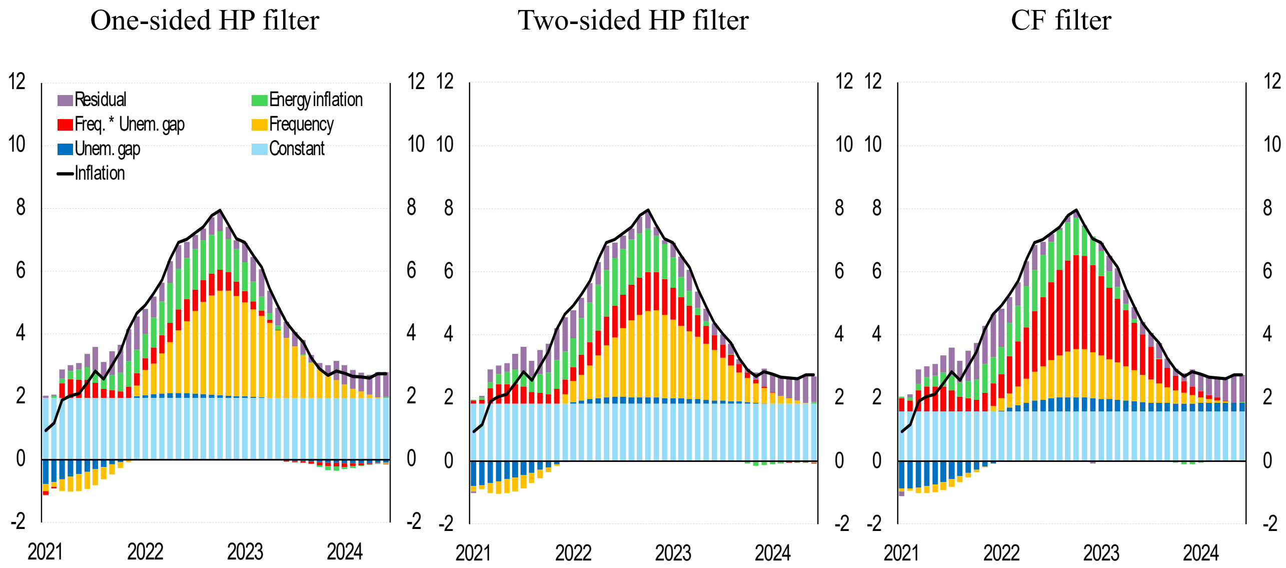
[7] In this regard, Beaudry et al. (2025) show that the weak relationship between inflation and labor market tightness in the U.S. appears primarily due to the elevated levels of inflation expectations.

expectations in accounting for both headline and core inflation in the U.S. To account for the contribution of each explanatory variable to net-energy inflation in eq. (2), we set to zero all the variables but the one for which we want to assess the contribution. We then simulate the equation dynamically. In this way, the sum of all the contribution and the residuals sum up to net-energy inflation.[8] We focus on the energy crisis and on the role of the frequency of price adjustments.

Figure 6. The role of the frequency of price adjustment

(*year-on-year percentage changes and percentage points*)



One-sided HP filter

Two-sided HP filter

CF filter

Note: contribution to y-on-y net-energy inflation. Latest observation: December 2024.

The simulations show that changes in the frequency of price adjustment, both directly (ψ) and indirectly through the slope of the Phillips curve (θ), played a key role in the rise of net-energy inflation (Figure 6). Indirect effects of energy prices explain between 1.1 and 1.3 percentage points of net-energy inflation between mid-2022 and mid-2023 (e.g. Neri et al. 2023, Lopez et al., 2024, Vlieghe, 2024). As shown in Figure 6, the direct contribution of energy inflation (green) is lower than that of the frequency of price changes (yellow). However, as discussed in Section 2.2, the temporary increase in the frequency during the energy crisis was due to the large shocks to firms' costs. Thus, the total contribution of energy prices is larger than that implied by their direct contribution.[9]

Overall, the time-series evidence provides evidence of a state-dependent Phillips curve in the euro area. Inflation becomes more sensitive to the unemployment gap in periods characterised by large cost-push shocks, when firms adjust prices more frequently, consistently with recent studies linking inflation dynamics to endogenous repricing behaviour (e.g. Cavallo et al., 2024). The result also aligns with Blanco et al. (2024), who model a feedback loop between inflation and repricing frequency that steepens the Phillips curve in periods of high inflation.

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[8] We set the coefficients φ_i to zero as their contribution to the fit of the model is negligible.

[9] See Neri et al. (2023) for the decomposition of contribution of energy and non-energy prices to euro area HICP.

3.2. Panel

To complement the time-series evidence, we exploit cross-country variation in the euro area countries in a panel setting, which permits more precise sub-sample estimates of the slope of the Phillips curve. The panel also provides a further check on state dependence by leveraging heterogeneity in labour-market conditions across euro-area countries, and it is particularly useful for short and atypical episodes such as the COVID-19 pandemic and the 2021-22 energy crisis.

We estimate the following equations:

$$\pi_{i,t} = \alpha_i + \gamma u_{t,i} + \varepsilon_{i,t} \tag{3a}$$

$$\pi_{i,t} = \alpha_i + \gamma u_{t,i} + \rho\pi_{i,t-1} + \varepsilon_{i,t} \tag{3b}$$

$$\pi_{i,t} = \alpha_i + \gamma u_{t,i} + \sum_{k=1}^{p} \beta_k \pi_{i,t-k}^{e} + \rho\pi_{i,t-1} + \varepsilon_{i,t} \tag{3c}$$

where $\pi_{i,t}$, $u_{t,i}$ and $\pi_{i,t}^{e}$ denote, respectively, net-energy inflation, the unemployment gap and energy inflation in country i; α_i is a country fixed effect and $\varepsilon_{i,t}$ is an idiosyncratic error term. The parameter γ measures the slope of the Phillips curve. We report the results of the estimation for the pre-SDC period (2000-2012), the low-inflation period (2013-2019), the COVID-19 pandemic (2020-2021), the energy crisis (2022-2023), and the post-energy-crisis period (2024-2025). We also consider the full 2000-2025 sample. Table 3 and Figure 7 summarise the estimated values of γ across specifications and measures of the unemployment gap.

Estimating over sub-sample periods provides compelling evidence of time variation in the slope of the Phillips curve in the euro area. During the pre-SDC period, the slope is negative and statistically significant across specifications, suggesting a relatively stable Phillips curve in a stable macroeconomic environment. By contrast, during the low-inflation period, the slope remains negative but becomes small in magnitude and, in some cases, statistically not significant, consistently with existing evidence for the euro area (Ciccarelli and Osbat, 2017 and Moretti et al. 2019).

During the pandemic, the slope steepens and becomes statistically significant, likely reflecting the strong disinflationary forces associated with the sharp collapse in aggregate demand and the rapid widening of the unemployment gap. During the energy crisis, the estimated slopes are large (in absolute value) suggesting the presence of non-linearities in inflation dynamics during a period of large cost-push shocks. The findings are consistent with the time-series results (Section 3.1).

After the energy-crisis, the slope declines and, in some specifications, becomes statistically not significantly different from zero. This result points to a partial reversion to a regime with a flat Phillips curve, like the one that prevailed before the GFC.

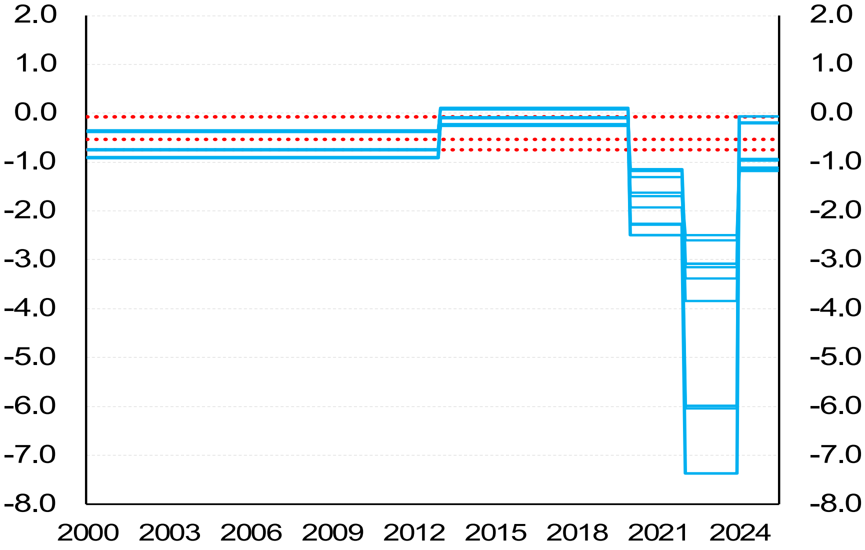
Table 3. Slope of the Phillips curve (γ) in the euro area

	Static			Dynamic			Dynamic + energy		
	HP1	HP2	CF	HP1	HP2	CF	HP1	HP2	CF
2000 - 2025	-0.08	-0.72***	-0.99***	-0.07	-0.57***	-0.78***	-0.07	-0.54***	-0.75***
2000 - 2012	-0.38***	-0.76***	-0.91***	-0.31***	-0.67***	-0.79***	-0.31***	-0.65***	-0.78***
2013 - 2019	0.11	-0.27***	-0.093	0.14	-0.31***	-0.11	0.13	-0.29***	-0.10
2020 - 2021	-1.93***	-1.30***	-2.49***	-2.47***	-1.59***	-3.15***	-2.32***	-1.51***	-2.99***
2022 - 2023	-3.38**	-3.85***	-7.37***	-2.17***	-2.40***	-4.84***	-1.76**	-2.08***	-4.01***
2024 - 2025	-1.18**	-0.94***	-0.068	-1.32*	-1.09***	-0.24	-1.31**	-1.11**	-0.36
# obs.	6120			6100			6100		

Note: the equations are estimated using country fixed effects. A * means statistical significance at 10 per cent, ** at 5 and *** at 1. Full sample: January 2000 – June 2025.

Across specifications, the estimated slope ranges from -0.54 to -0.99, depending on the slack measure and the specification of the equation. Over the full sample, we find a negative and statistically significant relationship between inflation and the unemployment gap except with the HP1 filter.

Figure 7. Slope of the Phillips curve in the euro area: panel approach



Note: point estimates of γ in eqs. (3a) to (3c). The light blue solid lines refer to the three equations in which the parameter differ across sub-samples (Table 4). Red dotted lines: full sample estimates. Latest observation: June 2025.

To sum up, the panel estimates corroborate the time-series evidence of a negative Phillips-curve in the euro area. The slope appears state-dependent: relatively stable before the GFC and SDC, flatter during the low-inflation regime, steeper during the COVID-19 pandemic and the energy crisis and then moderating again in the most recent period.

3.2.1. *The role of the frequency of price adjustments*

As discussed in Section 3.1.1, we assess the stability of the Phillips curve by exploiting panel data on the frequency of price adjustment. This approach captures cross-country heterogeneity in repricing frequency and tests whether its changes amplify or dampen the sensitivity of inflation to slack, in line with the time series evidence. Data on the frequency of price adjustments are available for eleven euro area countries for the period 2010-2019, and for nine until 2024. We estimate the equations:

$$\pi_{i,t} = \alpha_i + \gamma u_{t,i} + \psi f_{t-1,i} + \theta f_{t-1,i} u_{t,i} + \varepsilon_{i,t} \tag{4a}$$

$$\pi_{i,t} = \alpha_i + \gamma u_{t,i} + \psi f_{t-1,i} + \theta f_{t-1,i} u_{t,i} + \rho \pi_{i,t-1} + \varepsilon_{i,t} \tag{4b}$$

$$\pi_{i,t} = \alpha_i + \gamma u_{t,i} + \psi f_{t-1,i} + \theta f_{t-1,i} u_{t,i} + \sum_{k=1}^{p} \beta_k \pi^{e}_{i,t-k} + \sum_{k=1}^{p} \varphi_k f_{t-1,i} \pi^{e}_{t-k,i} + \rho \pi_{i,t-1} + \varepsilon_{i,t} \quad . \tag{4c}$$

where $f_{t,i}$ is the frequency of price adjustments in country i (expressed as deviation from the country sample mean) and the other variables are defined in the previous sections. A negative θ implies that a given change in the unemployment gap has an amplified impact on net-energy inflation, the higher is the frequency of price changes. A higher frequency makes the Phillips curve steeper.

Table 4 reports the results of the estimation. The coefficient on the frequency of price adjustment ψ is positive and highly significant across all the specifications, confirming that more frequent price changes are associated with higher inflation. The interaction term θ is negative and statistically significant, implying that a higher frequency of price changes steepens the Phillips curve: the marginal effect of slack in country i on inflation is: $\frac{\partial \pi_{i,t}}{\partial u_{i,t}} = \gamma + \theta f_{t-1,i}$.

Table 4. Inflation, unemployment gap and the frequency of price adjustment

	Static			*Dynamic*			*Dynamic- energy*		
	HP1	*HP2*	*CF*	*HP1*	*HP2*	*CF*	*HP1*	*HP2*	*CF*
α	2.500***	2.529***	2.330***	1.678***	1.774***	1.804***	1.631***	1.720***	1.713***
γ	-0.221***	-0.798***	-1.274***	-0.163**	-0.580***	-0.987***	-0.109*	-0.509**	-0.834***
ψ	0.429***	0.403***	0.322***	0.266***	0.260***	0.234***	0.182***	0.181***	0.188***
θ	-0.099***	-0.231***	-0.614***	-0.067**	-0.169***	-0.474***	-0.019	-0.101**	-0.348***
ρ	-	-	-	0.331***	0.302***	0.228***	0.180***	0.159***	0.125***

Note: the equations are estimated using country fixed effects. An * means statistical significance at 10 per cent, ** at 5 and *** at 1. Full sample: January 2010 – June 2025.

Importantly, the results of the panel confirm the time-series evidence and highlight the key role of the repricing frequency in shaping how changes in the unemployment gap translate into inflation.[10]

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[10] In the simple New Keynesian model, the Phillips curve in the inflation-unemployment space is given by: $\pi_t = \beta E_t \pi_{t+1} - k(\theta)\lambda(u_t - u_t^*) + u_t$ where λ relates output to employment and $k(\theta)$ is a nonlinear function of the probability of not resetting prices (i.e. the Calvo probability). If the frequency of price adjustements 1-θ increases, then

3.3. *Key findings on the slope of the Phillips curve in the euro area*

The slope of the Phillips curve in the euro area has changed over time since 2000. After remaining flat during the low inflation period that followed the GFC and the SDC, it steepened after the outbreak of the COVID -19 pandemic and during the 2021-22 energy crisis. The significant increase in the latter period, however, was very short-lived, reflecting the transitory nature of the supply-side shocks. Had the frequency of price adjustment not changed, inflation would have been substantially lower during the COVID-19 pandemic and the energy crisis.

4. The changing slope of the Phillips curve and monetary policy: a DSGE model

In this section, we study the monetary policy implications of endogenous changes in the frequency of price adjustment in a medium-scale DSGE model. We build on Gasteiger and Grimaud (2023), who extend an otherwise standard New Keynesian model by endogenizing the Calvo probability.

Our objective is twofold. First, we characterize the non-linear transmission of cost-push shocks and show that it depends on both their sign and size. Second, we analyse how these non-linearities shape the effectiveness of monetary policy and the associated inflation-output trade-off (the sacrifice ratio). We show that the endogenous frequency of price adjustment amplifies the effects of large inflationary cost-push shocks, while leaving the transmission of negative or small shocks largely unchanged. Therefore, the transmission of monetary policy becomes state-dependent, with a more favourable inflation-output trade-off following large inflationary cost-push shocks.

4.1. *Model structure*

We use the model in Gasteiger and Grimaud (2023), who augments a New-Keynesian model (Woodford, 2003 and Galì, 2015) with an endogenous price-adjustment choice for firms. Inflation Π_t is related to the optimal reset relative price p_t^*, and the share of firms that do not adjust their prices θ_t by the following equation: $1 = \theta_t {\Pi_t}^{\varepsilon-1} + (1-\theta_t)(p_t^*)^{1-\varepsilon}$, where ε is parameter governing substitution across products. Firms affect inflation through two margins: (*i*) the extensive margin, the fraction of firms that adjust their prices; and (*ii*) the intensive margin, the size of the optimal price change conditional on adjustment.

In the benchmark Calvo (1983) model, firms are selected to re-optimise with a constant probability, so only the intensive margin varies over the cycle. When choosing the price to set, firms internalize that their selling price will likely remain fixed for a few periods. Because the chosen reset price is expected to remain in place for several periods, pricing is forward-looking and delivers the New Keynesian Phillips curve, in which current inflation depends on expected future inflation and real marginal costs.

In Gasteiger and Grimaud (2023) the share of prices that are not adjusted (i.e. the Calvo probability) depends on the net-benefit of resetting the price, U_t^*, and the net-benefit of maintaining

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the slope of the Phillips curve $k(\theta)\lambda$ increases, making inflation more sensitive to the deviations of the unemployment rate from its natural level $(u_t - u_t^*)$.

the price fixed, U_t^f, each defined as the discounted value of real profits under the two options.[11] The Calvo probability is pinned down by a stochastic choice function:[12]

$$\theta_t = \frac{e^{\left(\omega U_t^f\right)}}{e^{\left(\omega U_t^f\right)} + e^{\left[\omega\left(U_t^* - \tau\right)\right]}} \quad . \tag{5}$$

where ω measures the intensity of choice and τ the re-optimising cost. For finite ω, both adjusting and non-adjusting firms coexist in equilibrium. When $\omega = 0$, the adjustment probability is constant (equal to 0.5), nesting a symmetric Calvo benchmark. Intuitively, higher incentives to re-optimise or lower adjustment costs increase the frequency of price adjustment, amplifying inflation dynamics. We return to this mechanism below.

The remainder of the model follows the representative-agent New Keynesian paradigm. We report only the equations affected by endogenous price adjustment and needed for our simulations.

Conditional on adjusting prices, the optimal relative price when a firms can adjust is:

$$\frac{P_t^*}{P_t} \equiv p_t^* = \frac{\varepsilon}{\varepsilon - 1}\frac{\psi_t}{\phi_t} \tag{6}$$

where ε is the elasticity of substitution across varieties, $\psi_t = w_t Y_t^{1-\sigma} + E_t \beta \theta_{t+1}\, \Pi_{t+1}^{\varepsilon} \psi_{t+1}$, and $\phi_t = Y_t^{1-\sigma} + E_t \beta \theta_{t+1}\, \Pi_{t+1}^{\varepsilon-1} \phi_{t+1}$ are recursively defined as functions of preference parameter (σ is the inverse elasticity of intertemporal substitution and β is the discount factor), the probability θ_t, output Y_t and the real wage w_t. The latter depends on output and labor supply N_t:

$$w_t = e^{\epsilon_t^s} \chi N_t^{\varphi} Y_t^{\sigma} \tag{7}$$

where ϵ_t^s is a labor supply. A positive shock decreases labour supply and increases firms' marginal cost, and we interpret it as cost-push shock. This is isomorphic to a shock to the price of energy in a version of the model in which intermediate goods are produced using a combination of labor and energy. In that case, assumptions would be required regarding, for instance the degree of labor-energy substitutability and the energy production function, the energy sector profits distribution. For parsimony, we treat ϵ_t^s as a cost-push shock.

Monetary policy follows a standard interest-rate rule. The central bank adjusts the policy rate in response to inflation and output, subject to an exogenous monetary policy shock:

$$\frac{1+i_t}{1+\bar{i}} = \left(\frac{1+i_{t-1}}{1+\bar{i}}\right)^{\phi_i} \left(\left(\frac{\Pi_t}{\bar{\Pi}}\right)^{\phi_\pi} \left(\frac{Y_t}{\bar{Y}}\right)^{\phi_x}\right)^{1-\phi_i} e^{\epsilon_t^r} \quad . \tag{8}$$

where i_t is the policy rate and ϵ_t^r an exogenous monetary policy shock.

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[11] The utility terms U_t^f and U_t^* are computed evaluating the firms' objective function, i.e. the discounted sum of real profits flows weighted by the corresponding Calvo probability, at the price level at time t-1 P_{t-1}, and the optimal reset price P_t^*, respectively. See Gasteiger and Grimaud (2023) for more details.

[12] In the New Keynesian model, the flow utility of maintaining price unchanged depends nonlinearly on the individual price in consideration $P_{i,t-1}$: in principle $\partial^2 U_t^f / \partial P_{i,t-1}^2 \neq 0$. This means that the average net-benefits of maintaining price fixed is different from the net-benefits of maintaining price fixed at the average level.

4.2. Calibration

We calibrate the model using standard values from the literature. Following Galì (2015), we set the discount factor to $\beta = 0.99$, the Calvo probability θ in steady state to 0.75, the inverse elasticity of intertemporal substitution to $\sigma = 1$, the Frisch elasticity to $\varphi = 1$, and the elasticity of demand for intermediate goods to $\varepsilon = 9$. The intensity parameter is set to $\omega = 10$ as in Gasteiger and Grimaud (2023). As for the parameters of the monetary policy rule, we set $\phi_\pi = 1.5$, $\phi_x = 0.25$, and $\phi_i = 0.75$. The monetary shocks are i.i.d. and cost-push shock follows an AR(1) process with persistence 0.75. Steady-state inflation is 2 per cent at an annual rate.

4.3. Non-linear effects of cost-push shocks

We first study the transmission of cost-push shocks of different signs and magnitudes. With a constant price-adjustment frequency, the responses of output and inflation are symmetric: a negative shock generates responses that mirror those of a positive shock of the same absolute size. The endogenous frequency adjustment breaks this symmetry. Figure 8 (panel a) reports the impulse responses of output, inflation, the policy rate, and the Calvo probability θ_t, to positive cost-push shocks of 1 and 5 per cent (dotted and solid blue), and to negative shocks of the same size (dotted and solid red). For readability, the responses to the negative shocks are sign inverted.

A large positive cost-push shock induces a sharp increase in the frequency of price adjustment: the share of firms keeping prices unchanged (i.e. the Calvo probability) fall by nine percentage points relative to its steady-state level. By contrast, a large negative cost-push shock produces only a moderate increase in the share of firms not resetting prices. As a result, inflation responds more strongly (in absolute value) to positive than to negative shocks of the same size. For small shocks, the asymmetries are negligible because the Calvo probability moves little.

Size dependency is equally pronounced. The response of inflation and output to a large positive shock exceeds the scaled-up response to a smaller shock, indicating amplification. This mechanism is largely absent for negative shocks. Similar asymmetries are documented by Ascari et al. (2025) and Kárádi et al. (2024).[13]

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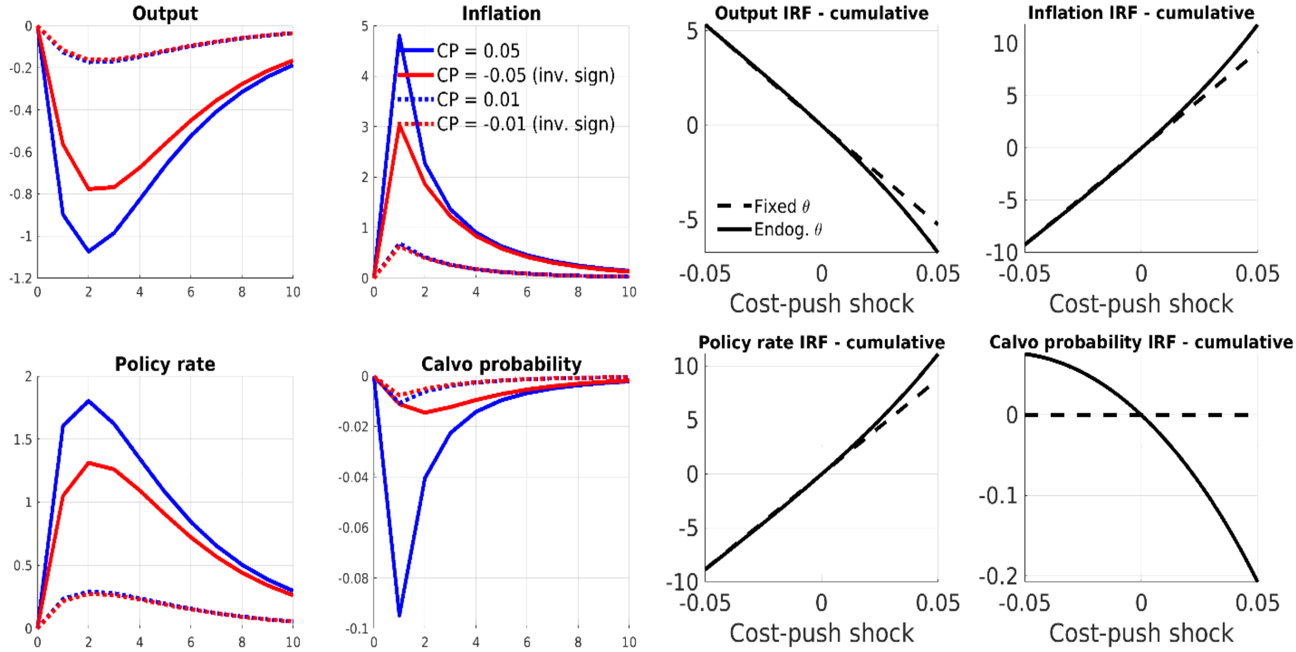
[13] Ascari et al. (2025) distinguish between shocks emerging from the workers side and those stemming from firms' market power. In Karadi et al. (2024), the shock is a wage subsidy.

Figure 8. Non-linear effects of cost-push shocks: sign and size dependence



a) Impulse responses

b) Cumulative impulse responses

Note: the left panel shows deviations from steady state for all variables expect output, which is expressed as percentage deviations. The sign of the responses to the negative cost-push shock is inverted for a comparison with those to a positive cost shock. The right panel shows the cumulative deviations as function of the size and sign of the cost-push shock. For a comparison, we report the cumulative deviations in a model with fixed Calvo probability (dashed lines).

Figure 8, panel b, further highlights this nonlinearity. It shows the cumulative responses of output, inflation, policy rate, and the Calvo probability as a function of the cost-push shock. Compared with a model with a fixed Calvo probability (dashed lines), the endogenous-adjustment model (solid lines) delivers substantially larger cumulative effects on inflation, output, and the policy rate for large positive shocks. In contrast, the cumulative responses to negative, of any size, or to small positive shocks are close to those in the model with constant probability, confirming that amplification only occurs with large and positive shocks.

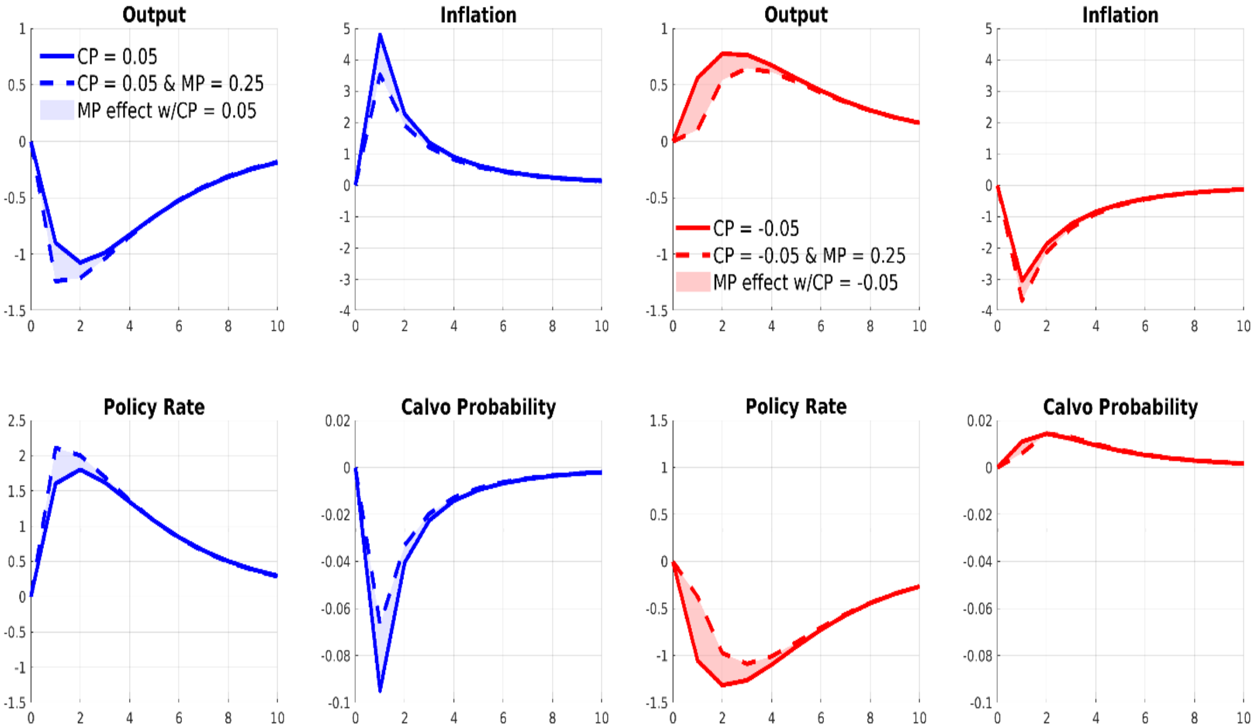
The mechanism originates in firms' pricing incentives. The profits function of intermediate producers is asymmetric around the optimal reset price: setting a price above the optimum is less costly than setting it below by the same amount. Consequently, following a negative cost-push shock firms face weaker incentives to cut prices, so the share of firms adjusting their prices decreases (larger θ_t). Following a positive cost-push shock, the incentive to increase prices is stronger, inducing many firms to re-optimize (smaller θ_t) and thereby amplifying inflation dynamics. We next show how these asymmetries translate into state-dependent monetary policy effects.

4.4. Monetary policy implications

We analyse the effects of a contractionary monetary policy shock conditional on positive and negative cost-push disturbances and compute the sacrifice ratios.

We consider a 25-basis-point contractionary monetary policy shock that occurs contemporaneously with positive and negative cost-push shocks. Figure 9 (panel a) compares: (*i*) the responses to the positive cost-push shock alone (solid blue); (*ii*) the responses to the combined cost-push and monetary policy shocks (dashed blue); and (*iii*) the marginal contribution of the monetary policy shock (shaded area). The contractionary monetary policy shock partly offsets the rise in the frequency of price adjustment and the increase in inflation but amplifies the contraction of output. At the peak response, the gains in inflation stabilization come at a one-to-four output cost.

Figure 9. The role of monetary policy in the transmission of cost-push shocks



a) Positive cost-push shock

b) Negative cost-push shock

Note: deviations from steady state for all variables except output, which is expressed as percentage deviations. The shaded areas measure the difference between the responses with and without the monetary policy shock.

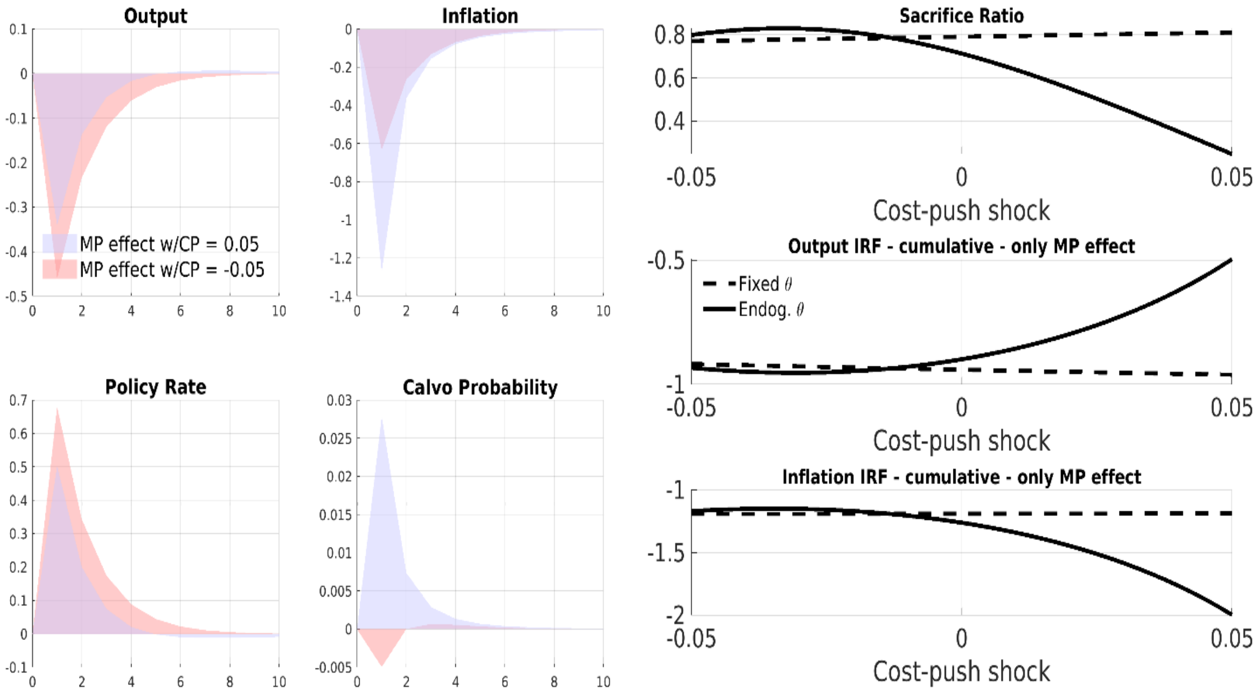
Figure 9 (panel b) shows the corresponding experiment under a negative cost-push shock. The contractionary monetary policy shock amplifies the fall of inflation and dampens the increase in output. The monetary policy shock has a much more limited impact on the frequency of price adjustment and does not significantly change the inertia of the inflation process. In net terms, output falls by 0.4% at its peak, while inflation decreases by 0.7 percentage points. The fall in inflation is associated with a 1-to-1.5 output cost.

To further highlight the differences in terms of the size and sign of the cost-push shocks, and the role of monetary policy, Figure 10 compares the effects of cost-push shocks with and without the monetary policy shock (panel a) and the corresponding cumulative effects (panel b). Under a positive cost-push shock, the cumulative effect on inflation (output) is larger (smaller) than with a negative shock (panel a).

The cumulated impact on inflation (output) is larger (smaller) with positive cost-push shocks than with the negative ones, and it increases with the size of the positive shocks. The sacrifice ratio declines with the size of inflationary cost-push shocks. Under a constant probability of price adjustment, by contrast, the sacrifice ratio is approximately invariant to the sign and size of the shock.

Overall, monetary policy is more effective at stabilizing inflation when inflationary cost-push shocks raise the frequency of price adjustment than when disinflationary shocks lower it. With inflationary shocks, inflation reacts more strongly while output respond less, improving the monetary policy trade-off. These state-dependent implications yield clear testable predictions, which we evaluate empirically in the next section using panel local projections.

Figure 10. State-dependency of monetary policy effects



(a) Endogenous frequency (b) Fixed frequency

Note: sacrifice ratios are computed as ratio between 1) the cumulative difference of impulse response of output in the model with cost-push only and that with both cost-push and monetary shocks, 2) the cumulative difference of impulse response function of inflation under the model with cost-push only and that with both cost-push and monetary shocks.

5. Back to the data: panel local projections

A key implication of the theoretical framework and descriptive evidence is that monetary policy is more effective at stabilizing inflation when inflationary cost-push shocks raise the frequency of price adjustment. In such states, inflation responds more strongly to monetary policy while output is less affected. This section tests empirically these predictions using panel local projections.

To this end, we estimate panel local projections (Jordà, 2005 and Jordà and Taylor, 2025) to assess whether, during periods characterized by large cost-push shocks such as during the 2021-22 energy crisis, monetary policy had a stronger impact on inflation and a milder effect on the unemployment gap than in other periods.

The estimated equation is:

$$y_{i,t,h} = \alpha_{i,h} + \beta_h S_t + \gamma_h \left(S_t * \sum_{k=0}^{5} \pi_{i,t-k}^{e}\right) + \varphi_h X_{i,t} + \varepsilon_{i,t,h} \tag{9}$$

where $y_{i,t,h}$ denotes the cumulative change in (net-energy) inflation or the unemployment gap at horizon h, $\alpha_{i,h}$ are country-horizon fixed effects, S_t is monetary policy shock (normalized to have unit standard deviation) from Jarocinski and Karadi (2020), $\sum_{k=0}^{5} \pi_{i,t-k}^{e}$ past energy inflation, which captures the size and sign of cost-push shocks. Energy inflation is standardized within each country to remove scale effects and make the coefficients γ_h comparable. The interaction term $S_t * \sum_{k=0}^{5} \pi_{i,t-k}^{e}$ captures state dependence, i.e. how the impact of a monetary policy shock varies with the magnitude of the cost-push shocks. The control vector $X_{i,t}$ includes lagged net energy inflation, energy inflation, the unemployment gap, and an indicator of supply bottlenecks, which captures the unprecedented supply-side pressures during the post-pandemic reopenings.[14]. We include twelve lags of inflation net energy and the control variables and six lag of the monetary policy shock. The error terms ε_{i,t_h} are i.i.d. Equation (9) is estimated using both the one- and two-sided HP-filtered unemployment gaps.[15] Figures 11 and 12 show the responses of inflation and the unemployment gap to a one-standard deviation monetary policy shock (β_h in blue, γ_h in green).

In line with the theoretical model, a contractionary monetary policy shock lowers inflation and increases the unemployment gap. The response of inflation is persistent, stabilizing after approximately 18 months, while the unemployment gap peaks after about one year before gradually reverting to zero (Figure 11, top panels). Crucially, the responses are strongly state-dependent (Figure 11, bottom panels). When energy inflation is elevated, such as in the late-2021 to early-2023 period, the disinflationary impact of monetary policy is significantly amplified, while the response of the unemployment gap is attenuated. These findings align closely with the model's predictions: a higher frequency of price adjustment strengthens the inflation response to monetary policy while dampening that of economic activity.

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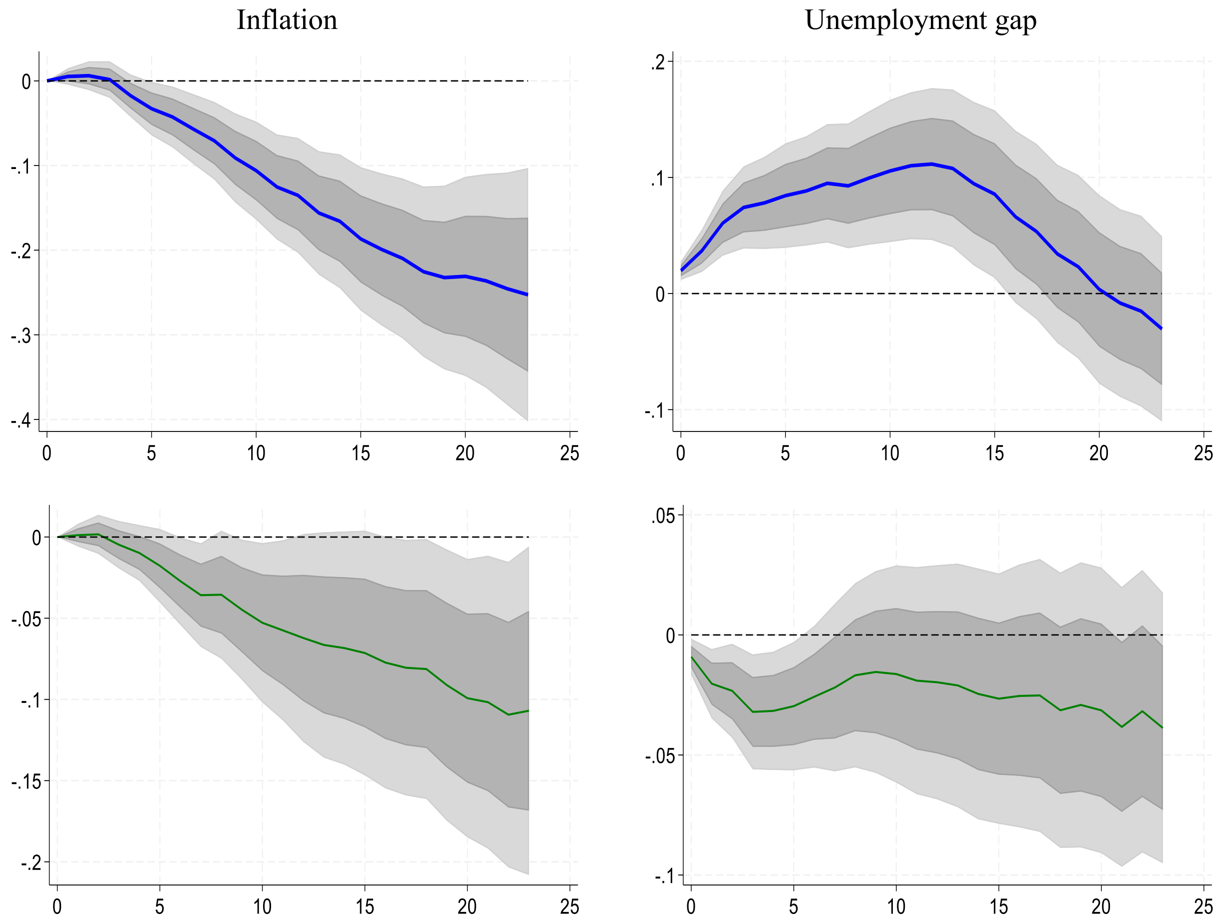
[14] We use the Global Supply Chain Pressure Index produced by the Federal Reserve Bank of New York that integrates several commonly used metrics with the aim of providing a comprehensive summary of potential supply chain disruptions. See https://www.newyorkfed.org/research/policy/gscpi.

[15] Estimation of eq. (9) with the CF-based unemployment gap led to explosive impulse responses, possibly related to the smoothness of the unemployment gap (Figure 2).

Figure 11. Response of inflation and the unemployment gap to a monetary policy shock: one-sided HP filtered unemployment gap

(*cumulated monthly changes; percentage points*)

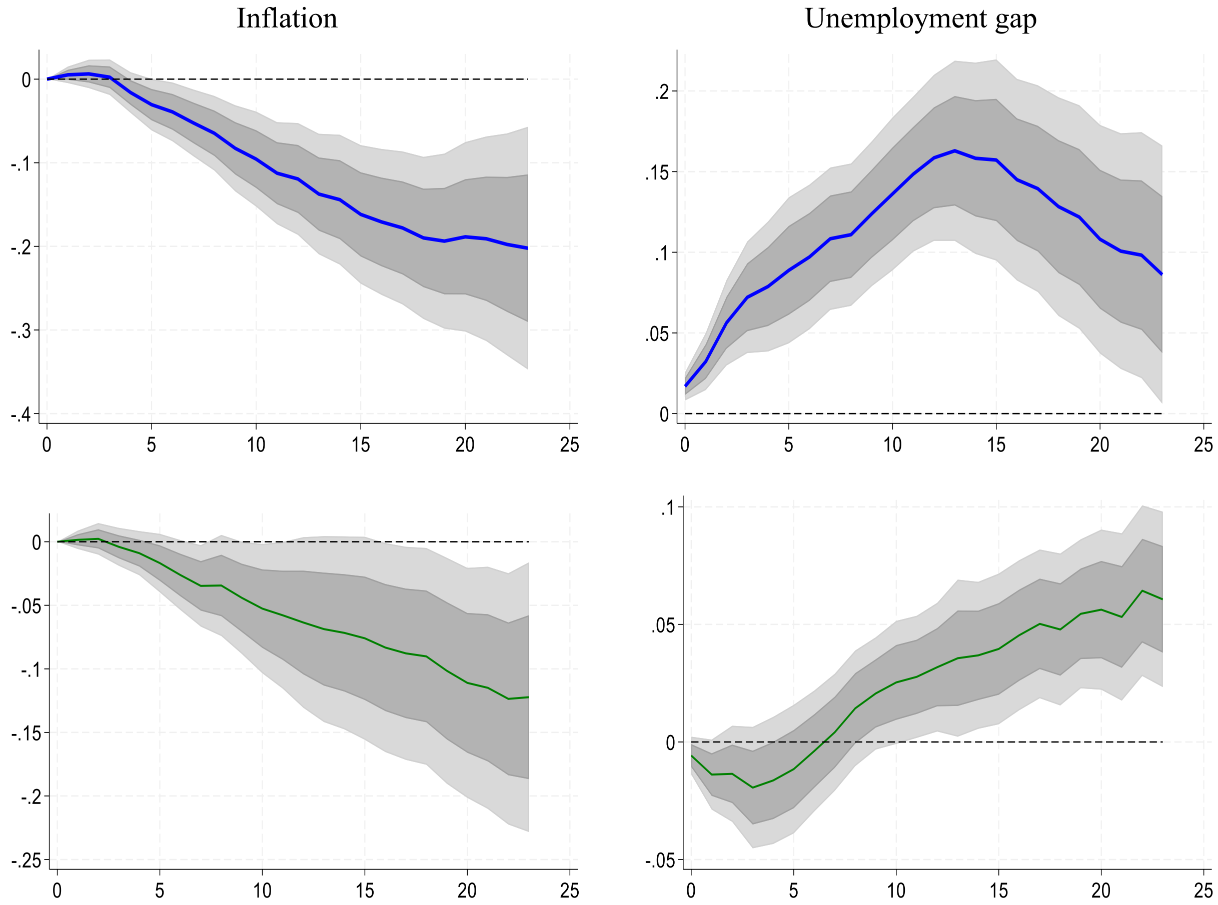


Note: First-row panels show unconditional responses; second-row panels show state-contingent responses. Responses are to a one-standard-deviation monetary policy shock. Shaded areas denote 0.68 and 0.90 confidence intervals. Estimates include country fixed effects; standard errors are robust.

The state-contingent responses of the unemployment gap differ across filtering methods). Under the one-sided HP filter, the attenuation of the effect of a monetary policy shock is highly persistent. In contrast, under the two-sided HP filter (Figure 12), the response is ambiguous attenuated, although statistically not significant, for roughly eight months and then is amplified. This discrepancy likely reflects the properties of the filters. The one-sided HP filter relies exclusively on past information, which can amplify persistence, whereas the two-sided HP filter uses information from the full sample, smoothing transitory fluctuations and reducing persistence.

Overall, the panel local projections provide strong evidence that the effectiveness of monetary policy in the euro area is state contingent. During periods of elevated cost-push pressures, a monetary policy tightening can achieve a larger disinflation at a smaller cost in terms of unemployment than during periods characterized by smaller shocks. Consistent with this evidence, the ECB’s restrictive stance during the 2021-22 energy crisis appears to have been particularly effective.

Figure 12. Response of inflation and the unemployment gap to a monetary policy shock: two-sided HP filtered unemployment gap
(*cumulated monthly changes; percentage points*)



Note: First-row panels show unconditional responses; second-row panels show state-contingent responses. Responses are to a one-standard-deviation monetary policy shock. Shaded areas denote 0.68 and 0.90 confidence intervals. Estimates include country fixed effects; standard errors are robust.

As a robustness check, we define regimes based on whether energy inflation is above or below the 75th percentile of its distribution (high vs. low inflation states).[16] Figure A1 shows that, during periods of elevated energy inflation, the response of inflation to a contractionary monetary policy shock is significantly stronger than in other periods. At the same time, the unemployment gap increases only modestly. When energy inflation is elevated, monetary policy transmits with lower real-side costs for each unit of inflation. When energy inflation is low and price adjustment is infrequent, the response of inflation is weaker and more gradual, while that of the unemployment gap is broadly similar to that observed during periods of elevated energy inflation.

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[16] We define a dummy variable, below and above the 75th percentile threshold, which identifies the state of the economy when the shock hits, see also (Ramey and Zubairy, 2018).

The results of the panel local projections reinforce the message of the paper: when inflation is high and price flexibility increases in response to shocks to firms' costs, monetary policy is more effective at stabilizing inflation and faces a more favourable inflation-unemployment trade-off.

6. Concluding remarks

This paper provides new evidence on the non-linear nature of inflation dynamics in the euro area, documenting the "awakening" of the Phillips curve during the 2021-22 inflationary surge. We show that the Phillips curve steepened markedly as the frequency of firms' price adjustments increased in the wake of the large energy-price shocks between late 2021 and mid-2022.

A New Keynesian model with endogenous repricing frequency (Gasteiger and Grimaud, 2023), rationalises these patterns: large cost-push shocks induce more frequent repricing, steepen the Phillips curve, and enhance the effectiveness of monetary policy in stabilising inflation, thereby lowering the sacrifice ratio. We test these predictions by means of panel local projections (Jordà and Taylor, 2025) and find that contractionary monetary policy shocks exert more pronounced downward pressure on inflation when large cost-push shocks occur – and price flexibility is high –, reducing the output cost of preserving price stability.

The main policy implication is that the effectiveness of monetary policy is state-contingent and varies with the inflation environment. When inflation is driven by large but transitory cost-push shocks, central banks may be able to curb inflation at a relatively limited output cost, as price adjustment becomes temporarily more frequent. As repricing normalises and the Phillips curve flattens, however, disinflation is likely to become more costly. Preserving well-anchored medium- to long-term inflation expectations remains essential to safeguard the effectiveness of monetary policy.

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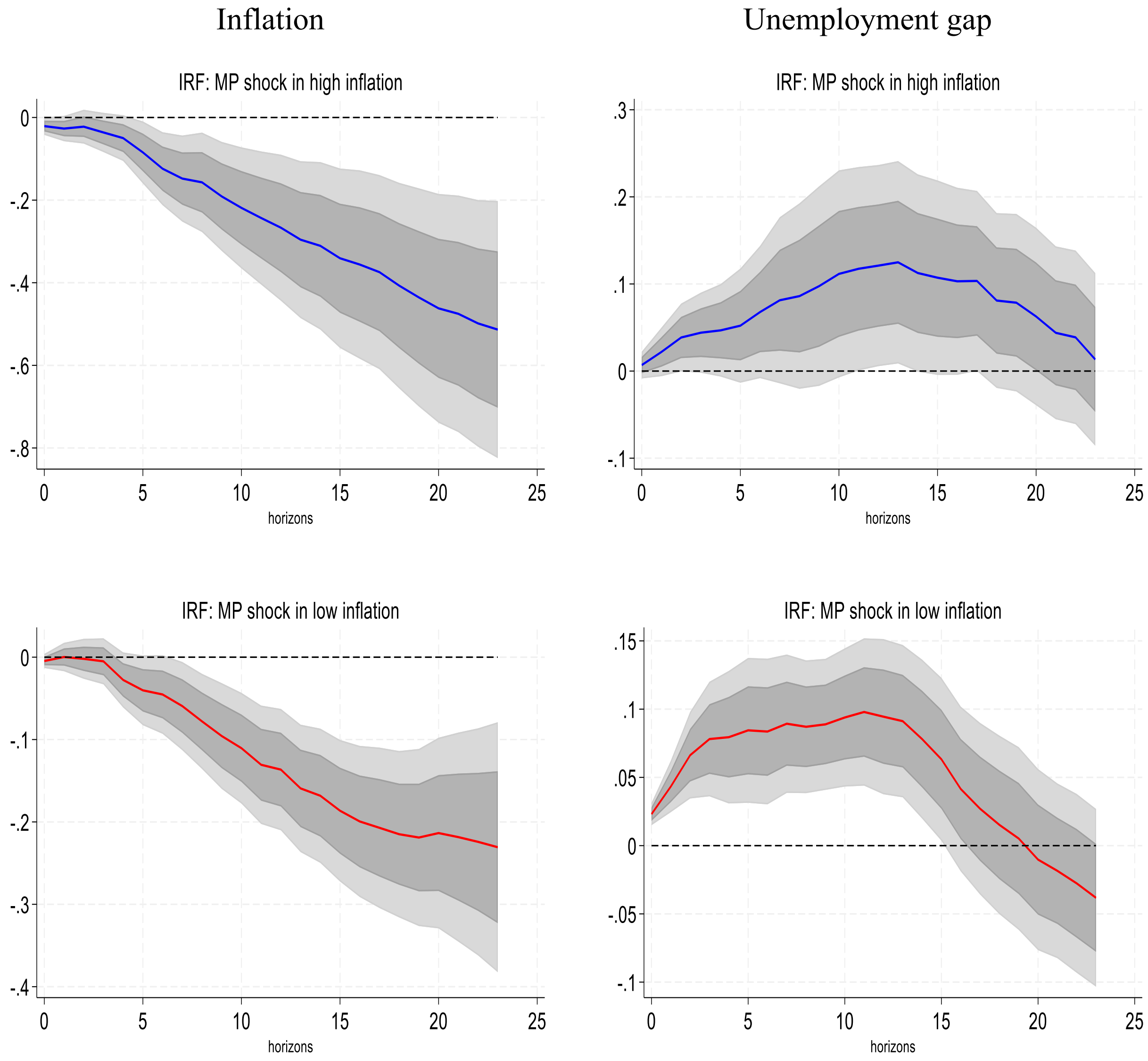
Appendix A

Figure A1. Response of inflation and the unemployment gap to a monetary policy shock: one-sided HP filter-based unemployment gap

(*cumulated monthly changes; percentage points*)



Note: We define the state of the economy when the shock hits: below and above the 75th percentile of energy inflation to identify low and high inflation. In the first-row graphs show the impact in high inflation, in the second-row graphs show the impact in low inflation. Response to a one-standard deviation monetary policy shock. Shaded are for confidence intervals at 0.68 and 0.90; country fixed effects and robust standard errors.