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Guido Ascari, Volha Audzei, Gert Bijnens, Alina Bobasu, Andrea Colciago, Emmanuel Dhyne, Michaela Elfsbacka-Schmöller, Alex Grimaud, María Teresa Valderrama, Andrejs Zlobins

Monetary policy transmission and structural changes

No 393

Challenges for Monetary Policy Transmission in a Changing World (ChaMP) Research Network

This paper is one of five Occasional Papers (OPs; listed further below) summarising the strands of research conducted within the framework of the Challenges for Monetary Policy Transmission in a Changing World (ChaMP) Research Network, which was an initiative of the European System of Central Banks (ESCB) and brought together economists from the European Central Bank (ECB), the national central banks comprising the ESCB, the Bank of England and Norges Bank. Overall, it produced 168 individual papers and four papers on cross-country coordinated research projects.

ChaMP sought to revisit our knowledge of monetary transmission channels in the euro area and other European economies following a series of unprecedented shocks, and amid multiple ongoing structural changes and the extension of the monetary policy toolkit over the last decade and a half, including the 2021-23 inflation episode. The five OPs cover the main priorities of the network's two workstreams (WSs). WS1 focused on monetary transmission via the financial system, with OP No 389 covering transmission mechanisms from banks to non-financial corporations, OP No 390 examining mechanisms to households and OP No 391 looking at transmission via non-bank financial intermediation. Meanwhile, WS2 was dedicated to monetary transmission via the real economy, with OP No 392 summarising the network's research on transmission through input-output linkages among non-financial corporations and production sectors and OP No 393 examining how various structural changes interact with monetary policy transmission.

ChaMP was coordinated by a team chaired by Philipp Hartmann (ECB) and consisting of Diana Bonfim (Banco de Portugal), Margherita Bottero (Banca d'Italia), Emmanuel Dhyne (Nationale Bank van België/Banque Nationale de Belgique) and Maria T. Valderrama (Oesterreichische Nationalbank). This core team was supported by Melina Papoutsi, Gonzalo Paz-Pardo, Jean-David Sigaux, Raquel Gil-Antona, Clara Dolci and Simone de Luca (all ECB), along with seven central bank advisers and eight academic consultants. More information can be found on the ChaMP website.

Occasional Papers related to the ECB's ChaMP Research Network

No 389, "Monetary policy transmission via banks to firms"

No 390, "Monetary policy transmission through the financial system to households"

No 391, "Monetary policy transmission and non-bank financial intermediation"

No 392, "The propagation of shocks across the production network and implications for monetary policy"

No 393, "Monetary policy transmission and structural changes"

Contents

Abstract

This paper surveys research from the ESCB ChaMP Research Network on how ongoing structural change is affecting monetary policy transmission in the euro area. It shows that transmission is state-dependent and varies systematically with changes in the sectoral composition of the economy, in its international integration, in financial conditions and in inflation regimes. More service-intensive economies exhibit weaker real responses to monetary tightening, while high-inflation environments are associated with faster and stronger price pass-through, helping explain why the recent disinflation episode entailed relatively low output costs. The paper also shows that variations in leverage, supply shocks and energy-related disturbances alter the inflation-output trade-off and can make appropriate policy responses more contingent on the source and persistence of shocks. Finally, it reviews evidence that monetary policy can affect the supply side through innovation, reallocation and productivity, implying that structural change influences transmission and may itself be influenced by policy.

JEL codes: E52, O33, Q54

Keywords: monetary policy transmission, structural transformation, frictions, innovation, reallocation, climate and energy transition

Non-technical summary

This paper summarises the research of the ESCB ChaMP Research Network on how structural change interacts with monetary policy transmission in the euro area and derives the key messages emerging from it. Structural transformation is evolving rapidly – digitalisation, a long-term shift towards services, demographic pressures, geopolitical realignments and the climate transition are collectively reshaping production structures and the organisation of economic activity. These developments are not peripheral background conditions; they are shaping the channels through which monetary policy affects firms, households and prices.

The research generally suggests that monetary policy transmission in the euro area is effective and operates in line with monetary analysis. At the same time, key findings of this stream of work illustrate various novel ways in which the transmission of monetary policy is state-dependent. The response of output, prices and employment to a given change in interest rates differs substantially depending on structural features such as the share of services, firms' financial constraints, market competition or exposure to global value chains. Evidence suggests that service-intensive economies respond less to policy changes because, in contrast to manufacturing, services rely less on physical capital, which often has to be built up through borrowing, and are more subject to long-term contracts and relationships that react slower to interest rate changes. At the same time, high-inflation environments or periods of elevated financial leverage amplify transmission, making price and wage dynamics more responsive to monetary tightening.

The research also shows that firms do not adjust prices uniformly. Organisational differences, positions along the production network and exposures to global value chains influence how quickly and by how much firms change prices following a shock. Moreover, in high-inflation periods, firms' price-setting becomes more responsive, so that tighter monetary policy is transmitted more through faster price adjustment and less through quantities and disinflation can therefore be achieved with smaller output losses. This helps explain why the disinflation in the euro area following the high inflation in 2021 and 2022 occurred faster and with lower output costs than historical experience would have suggested.

Financial frictions naturally condition transmission, in interaction with the structural features of the economy. Transmission is amplified among small, bank-dependent and financially constrained firms, whose investment, hiring and entry respond more strongly to changes in borrowing costs and credit availability. It is dampened among larger firms and firms with limited external financing needs, which adjust investment and employment less for a given policy move. High corporate leverage can also strengthen the pass-through of tightening to domestic prices, even when aggregate output effects are partly cushioned by exports through improved price competitiveness. Production networks also matter: frictions at upstream suppliers amplify cost-push pressures, while frictions in downstream sectors strengthen demand-side propagation through final demand. When shocks originate abroad,

stabilising inflation may therefore mean tolerating some output volatility, because domestic and global value chain exposures shift the inflation-output trade-off.

This paper also presents ChaMP evidence and theory that monetary policy interacts with the supply side. Monetary policy affects investment in innovation and sectoral reallocation and thus, with some lags, total factor productivity (TFP) growth. Tighter (more accommodative) monetary policy weakens (strengthens) innovation activity by raising (lowering) financing costs and dampening (reinforcing) demand, which reduces (increases) firms' incentives to invest in R&D, technology adoption and other productivity-enhancing activities. It also affects how labour and capital are reallocated across sectors and firms: tightening shocks tend to shift activity away from more productive manufacturing sectors and can worsen misallocation, whereas easing can relax financial frictions and support more efficient allocation of resources, with implications for aggregate TFP. The analyses suggest similar effects for tightening and loosening monetary policy, but the degree of symmetry could still depend on the state of the economy – which would be a fruitful area for future research. In any case, they can induce shorter-term fluctuations in (forward-looking) supply indicators, so that a full assessment of demand-supply conditions for inflation assessments over the business cycle and therefore of optimal monetary policy would require taking them into account. Necessary interventions on the supply side of the economy, however, fall primarily within the realm of other policy authorities. As the primary objective of the ECB's monetary policy is price stability, any specific supply effects could only be pursued in support of the general economic policies of the European Union and only to the extent that they do not lead to deviations from the ECB's definition of price stability – which has a medium-term orientation.

Finally, ChaMP research further suggests that monetary policy transmission may differ across less and more carbon-intensive sectors and firms. When monetary policy tightens, "brown" and more energy-intensive activities tend to be more exposed to higher financing costs, fossil fuel price shocks and carbon-related cost increases, implying stronger short-run pressure on activity in these sectors. By contrast, when monetary policy loosens and financing constraints ease, "green" and more energy-efficient firms may be better placed to expand as relative prices adjust and investment is reallocated. At the same time, the transition is subject to important frictions. Tighter policy in response to transition-related inflationary pressures may weigh on "green" investment and slow reallocation towards cleaner technologies, while a more accommodative stance may support that reallocation when inflation expectations remain anchored. Overall, the evidence points to an inflation-output trade-off that depends not only on the size of the shock, but also on its nature, persistence and the way in which the green transition affects relative prices and financing conditions.

1 Introduction

This Occasional Paper summarises the main lessons from Workstream 2 of the ESCB Challenges for Monetary Policy Transmission in a Changing World (ChaMP) Research Network. The workstream focused on the interplay between some of those structural transformations and monetary policy transmission. The motivation of the ChaMP initiative was twofold: (1) structural changes alter the strength, speed and diversity of monetary policy transmission; and (2) monetary policy itself may affect structural changes. Hence, the paper also has something to contribute to the debate on the long-run neutrality of monetary policy.

1.1 Context and motivation

Structural transformations increasingly interact with and sometimes reshape the transmission of monetary policy.

The global and euro area economies are undergoing a period of unusually rapid and multifaceted structural transformation. Digitalisation, the long-term deepening of the service sector, demographic pressures, geopolitical realignments and the climate and energy transition are collectively reshaping production structures, competitive dynamics and the distribution of economic activity across firms, sectors and regions. These developments are not merely background conditions; they are increasingly interacting with and sometimes reshaping the transmission of monetary policy.

Monetary policy transmission is now best understood as a multi-dimensional, state-dependent process.

Evidence assembled over the two years of activity of the ChaMP network highlights that monetary policy transmission is now best understood as a multi-dimensional, state-dependent process, affected by the micro-level heterogeneity across firms, financial structures and pricing behaviour.

The recent inflation surge has highlighted the role of micro heterogeneity and state-dependent pricing. Firms with greater flexibility in adjusting prices respond differently to cost shocks and interest rate changes, implying that the frequency and size of price adjustments – and thus inflation dynamics – depend on the conjunctural state of the environment in which firms operate.

Structural shifts across sectors, particularly the long-run rise of services relative to manufacturing, have implications for monetary policy effectiveness. Service sectors generally rely less on physical capital and exhibit lower productivity growth; they also tend to respond less to changes in the cost of finance. As the service share increases, the aggregate sensitivity of output to monetary policy shocks mechanically declines. Empirical work confirms that the maximum impact of a monetary policy shock on output is substantially smaller in more service-intensive economies, indicating a gradual decline in the economy-wide potency of interest rate changes.

Globalisation and changing global value chains have introduced new non-linearities in the inflation-output trade-off. The rising use of foreign intermediates is increasing firms' exposure to international relative price movements, while global supply chain pressure shocks often resemble adverse supply shocks, tightening the policy trade-off.

Geopolitical fragmentation – manifested through industrial policies, reshoring and increased strategic trade interventions – adds another layer of complexity. Evidence suggests that while some industrial policies yield modest short-run effects on targeted sectors, they can induce more persistent changes downstream by altering input costs and competitiveness.

The climate and energy transition is yet another domain where structural change interacts with monetary policy. The transition requires large reallocation of capital, is shifting energy use patterns and exposing firms and households to relative price adjustments. Moreover, firms' expectations of rising input costs – linked to EU decarbonisation policies – affect pricing and investment decisions well in advance of actual regulatory changes. The energy price shock triggered by Russia's invasion of Ukraine demonstrated how natural gas supply shocks propagate more slowly and with different inflationary dynamics than oil shocks. These results could prove very insightful given the current geopolitical situation.

Monetary policy influences the long-run productive capacity of the economy, primarily through its impact on innovation, technology adoption and capital allocation.

Across these domains, the ChaMP network provides consistent evidence that monetary policy may influence the long-run productive capacity of the economy, primarily through its impacts on innovation, technology adoption and capital allocation. Results suggest that monetary policy transmits to innovation and thus potentially longer-term aggregate supply by influencing financing conditions and the demand for new technologies. Contractionary monetary policy is found to reduce innovation investment, while monetary expansions – especially when combined with forward guidance communication – is shown to boost investment in innovation. Further analysis suggests that monetary policy shocks may affect aggregate TFP through reallocation across or within sectors. Given that the primary goal of the ECB's monetary policy is price stability, these insights might enter monetary policy considerations only to the extent they do not lead to risks to price stability.

This calls for monetary policy analysis that moves beyond simple representative agent or low-dimensional models and accounts for the long-term structural implications of policy choices and state contingency in transmission.

1.2 Key mandate questions addressed

The ChaMP network was tasked with analysing several mandate-critical questions on the interplay between structural change and monetary policy. In the following sections, this Occasional Paper synthesises the findings around four overarching themes:

1. How do structural changes affect the strength, speed and heterogeneity of monetary policy transmission?
2. Can monetary policy itself influence long-run structural dynamics?
3. What do these findings imply for R* and long-run policy benchmarks?
4. How should monetary policy respond to structural shocks, supply disturbances and the green transition?

2 General transmission and state dependence

Monetary policy is continually evolving. It does not transmit uniformly across time, space or the sectors and agents of the economy. The ChaMP research has contributed to a growing literature showing that the effects of monetary policy depend on the structural characteristics of the economy. This implies that transmission is state-dependent, varying with structural conditions across regions, sectors and agents.[1] Moreover, because these characteristics evolve over time, the transmission mechanism is inherently time-varying and should not be treated as an immutable object. Recognising state dependence is therefore crucial, as it alters both the design and evaluation of monetary policy: optimal responses and simple linear models can easily mislead policymakers.

Transmission is state-dependent, varying with structural conditions across regions, sectors, and individuals.

2.1 Structural sources of state dependence

A first source of heterogeneity arises from the structural composition of the economy. Shifting towards a higher service intensity tends to dampen the overall effects of monetary policy on aggregate output, since the service sector is typically less responsive to policy changes than industry. Hauptmeier, Holm-Hadulla and Saporito (2025) use regional granular euro area data to quantify how the rising share of services influences the real effects of monetary policy. Consistent with lower capital intensity and lower interest sensitivity, services respond less than industry. A 100-basis-point monetary tightening reduces industrial output by around 4% within a year, whereas services fall by roughly 2.5%. Industry reacts quickly, with the maximum impact within the first year, while services respond and recover more slowly, reaching their trough a year later. The authors use a shift-share instrumental variable strategy to show that regions with higher service shares exhibit weaker output effects. They find that, while the transmission of monetary policy remains effective, the increase in the service share since the introduction of the euro has reduced the average output response to monetary policy by less than 10%, although cross-regional differences are substantial. Regions at the 75th percentile of the service share distribution are estimated to experience output contractions more than 40% weaker than regions at the 25th percentile following a monetary policy tightening. This result should be interpreted as heterogeneity associated with differences in service intensity, not as a statement that the effect is invariant to all other structural regional characteristics. These findings show that as economies become more service-oriented, the transmission of monetary policy to real activity becomes more muted, though still significant. Monetary authorities must therefore account for the geographic and

As economies become more service-oriented, the transmission of monetary policy to real activity becomes more muted, though still significant.

[1] While the research covered in this paper features some contributions related to the heterogeneous effect of monetary policy on households and firms, more ChaMP research in this area is summarised in Bonfim et al. (2026). Altavilla et al. (2026) cover the transmission of monetary policy to firms via the financial sector. Anyfantaki et al. (2026) explore the role of non-bank financial institutions, and, finally, Gebauer et al. (2026) summarise the work on the transmission of monetary policy through production networks.

sectoral composition of their jurisdictions: a homogeneous policy stance inevitably redistributes economic effects across regions and sectors.

The fact that monetary policy effects depend on the structure of the economy also has an important open economy dimension, which was particularly relevant during the recent inflation surge following the COVID-19 pandemic. As the global economy recovered from the disruption, a surge in consumer demand collided with unprecedented disruptions in global supply chains. Ascari, Bonam and Smadu (2024) analyse the central question facing policymakers in this context: how should monetary policy respond when inflation is driven primarily by global supply-side pressures? The main insight is that, for highly integrated economies, the optimal response is counter-intuitive. Empirically, the authors show that shocks to global supply chain pressures were a key driver of euro area inflation in 2022. The effects of these shocks on inflation are highly persistent and generate a hump-shaped response. The theoretical analysis builds a two-country New Keynesian model with international trade in intermediate goods. At low levels of global value chain integration, a supply chain shock behaves similarly to a domestic demand shock. By raising the price of foreign goods, it induces expenditure-switching towards domestic goods, thereby pushing both output and inflation higher. Under these conditions, optimal policy requires monetary tightening to stabilise prices. At high levels of participation, however, the same shock resembles an adverse domestic supply shock, driving output and inflation in opposite directions. The mechanism is straightforward: highly integrated economies face higher domestic production costs when foreign inputs are disrupted. As a result, the inflation-output trade-off deteriorates, and the optimal policy response becomes less aggressive. For economies with deep integration in global value chains – such as the euro area – the Ramsey optimal policy prescribes a milder monetary tightening in response to global supply shocks. Excessively aggressive tightening would amplify the contractionary impact on output, worsening the trade-off and reducing welfare. The key policy implication is that the optimal monetary response to global supply shocks is a non-linear function of a country's degree of global value chain participation. Economies with different levels of integration will experience these shocks in systematically different ways and therefore require differentiated, rather than uniform, policy reactions, which is not possible within a common currency area.

For economies with deep integration in global value chains—such as the euro area—the Ramsey optimal policy prescribes a milder monetary tightening in response to global supply shocks.

2.2 Granular transmission: consumption basket, activity and propagation

Understanding how prices of specific items react to monetary tightening is essential to identifying the granular effects of monetary policy and to assessing how these effects depend on the structural characteristics of the economy. Allayioti et al. (2024) examine this heterogeneity using 72 individual items from the core Harmonised Index of Consumer Prices (HICP) and document substantial dispersion in price sensitivities. Using local projections, each item is classified into one of three categories according to its estimated response to a contractionary monetary policy shock. The central finding of the paper is that monetary policy transmission within the core inflation basket is highly uneven. Highly sensitive items exhibit price responses roughly three times

Monetary policy transmission within the core inflation basket is highly uneven.

larger than moderately sensitive ones, and the adjustment occurs more quickly. Around 45% of the core HICP basket falls into the highly or moderately sensitive groups, consisting mainly of durable goods and services such as dwelling maintenance and transport. Interestingly, price flexibility matters less than demand characteristics. Using household budget survey data, the authors show a strong association between monetary policy sensitivity and household income: highly sensitive items account for a significantly larger share of consumption among high-income households. The sensitive categories are dominated by discretionary items such as durable goods, repair and maintenance services, and transport and recreation services. By contrast, the non-sensitive group comprises mostly non-discretionary or regulated items such as utilities, rents and medical services. This confirms that monetary policy primarily operates through postponing non-essential expenditure. This granular evidence highlights that monetary policy affects prices unevenly across the consumption basket and that this heterogeneity is itself time-varying. Aggregate price indices therefore conceal important distributional dynamics that may shift over time. Because 55% of the core basket is non-sensitive, core inflation remains persistent even under aggressive tightening. Many of these items represent necessities or are subject to regulated pricing, making them less responsive to interest rate-induced changes in demand. Finally, the authors show that impulse responses estimated over expanding windows show how pass-through has become faster and stronger in the most recent tightening cycle, and that a larger set of items has become sensitive to policy. This finding is particularly important, as past calibrations may underestimate monetary policy transmission strength in high-inflation regimes, as in the recent episode.

The rapid adjustment of output following a contractionary monetary policy is driven by downstream sectors linked to discretionary final consumption shock, while essential categories (food, utilities, communication) show minimal reaction.

Using high-frequency Spanish data, Buda et al. (2025) show that consumption and output respond significantly to monetary policy shocks within weeks, calling into question the traditional view of “long and variable lags”. They also document that the rapid adjustment of output is driven by downstream sectors linked to discretionary final consumption – particularly luxuries and durables – following a contractionary monetary policy shock, while essential categories (food, utilities, communication) show minimal reaction. Upstream intermediate input sectors respond more slowly but with more persistent declines, indicating that monetary policy effects propagate gradually through production networks. In contrast to these fast-moving real activity indicators, employment and consumer prices adjust only with long lags. This suggests that long policy lags originate not from inertia in demand but from the slow pass-through of early demand contractions to labour markets and pricing decisions.

Related euro area evidence is provided by Andreolli et al. (2026), who decompose consumption, inflation and employment into necessity and discretionary components. They show that, following a contractionary monetary policy shock, consumption and employment fall disproportionately in discretionary sectors, whereas prices respond more strongly in necessity sectors. They further document that discretionary industries employ a larger share of hand-to-mouth workers, implying that monetary tightening propagates especially strongly through the discretionary part of the economy. This reinforces the view that monetary policy transmission is highly uneven across the consumption basket and across sectors, and that the composition of inflation contains information that is masked in aggregate indices.

Core inflation is also not a pure gauge of domestic demand pressures. Bańbura, Bobeica and Martínez Hernández (2023) show, using a structural Bayesian vector autoregression that explicitly identifies new post-pandemic shocks (gas prices and global supply chain bottlenecks), that the surge in euro area core inflation was largely driven by supply-side forces, while monetary policy shocks played a limited role. They further construct an adjusted core measure net of energy and bottleneck-related shocks, which is more stable but still rises to record highs – highlighting both the value and limits of "looking through" specific supply shocks.

2.3 Pricing behaviour and non-linear pass-through

Pass-through from marginal costs to prices is central to understanding inflation responses to monetary policy and other shocks. However, the pass-through is not constant: it varies with the type and size of shocks, generating state dependence. Two recent papers, Ghassibe, Wanengkirtyo and Yotzov (2025) and Gagliardone et al. (2025), make important progress in advancing our understanding of these mechanisms.

Ghassibe, Wanengkirtyo and Yotzov (2025) analyse intertemporal pass-through (iPT), defined as the sensitivity of firms' desired prices to expected future marginal costs. A central empirical challenge in measuring forward-looking pricing is that plausibly exogenous shocks to firms' expectations about future costs are extremely rare. Most economic developments simultaneously affect both current and future conditions, making it difficult to isolate the effect of pure foresight. The authors overcome this obstacle by exploiting a unique natural experiment that occurred on March 13, 2019, when the UK Government unexpectedly announced a temporary reduced tariff schedule that would apply in the event of a "no-deal" Brexit. This created a clean news shock about future costs without altering contemporaneous costs. Using firm-level UK survey data, the authors estimate that iPT is largest among firms with low frequency of price adjustment and those expecting the cost shock to materialise sooner. The intuition is straightforward: firms that rarely change prices face stronger incentives to "get it right" when they do. A new price must embed expectations about cost conditions over a longer future horizon, making these firms inherently more forward-looking. Quantitatively, compared with firms with very flexible prices (duration of 0-5 months), iPT is substantially higher for firms with long price durations. A second key result concerns the state dependence of iPT. Firms that report adjusting prices only in response to specific events (state-dependent price setters) exhibit significantly lower iPT than firms adjusting prices at regular intervals (time-dependent price setters). State-dependent firms retain the valuable option to adjust prices if and when the future cost shock materialises. Moreover, as the expected future cost shock increases in size, the immediate pass-through into current prices grows less than proportionally. A central insight emerging from this framework is that iPT heterogeneity amplifies the forward-looking component of aggregate inflation. Announcements about future cost increases or future policy actions have stronger immediate effects when price adjustment is infrequent. This stands in marked contrast to the established literature on realised cost shocks, where heterogeneity in price stickiness typically dampens aggregate price movements. For anticipated shocks, the opposite holds: firm-level

heterogeneity strengthens the response of aggregate inflation to news about future costs. This result suggests that forward guidance will be more powerful in environments where firms have long price durations, but substantially less effective when state-dependent pricing dominates.

Gagliardone et al. (2025) study the pass-through from costs to prices using novel micro data from the universe of Belgian firms to construct a direct measure of the firm-level price gap – that is, the difference between a firm's current price and its optimal price. Their empirical analysis yields four main results. First, price adjustment frequency is not constant and follows a U-shape over price gaps. Second, expected price changes depend non-linearly on price gaps: linear for small gaps and much steeper for large ones. For firms with small price gaps, the relationship is approximately linear and resembles the behaviour implied by a Calvo model. For firms with large gaps, however, the slope becomes much steeper: the gradient linking price gaps to price changes increases by nearly 60%, revealing strong non-linearities in firm-level pricing behaviour. Third, while the distribution of firm-level price gaps was relatively stable during the pre-pandemic period of low inflation, the large aggregate cost shocks of the post-pandemic period caused a substantial rightward shift in the entire distribution. This pushed a large fraction of firms simultaneously into the tails of the distribution, where price gaps are large and adjustment is highly likely. The result was a sharp, synchronised increase in the frequency of price changes across firms, which contributed materially to the aggregate inflation surge. Fourth, aggregate inflation in the Belgian manufacturing sector was driven overwhelmingly by cost pass-through, particularly from shocks to intermediate input prices, rather than by changes in mark-ups. In normal times, the pass-through of cost shocks to prices is linear and relatively muted. During the inflation surge, pass-through more than tripled, revealing a strongly non-linear aggregate response.

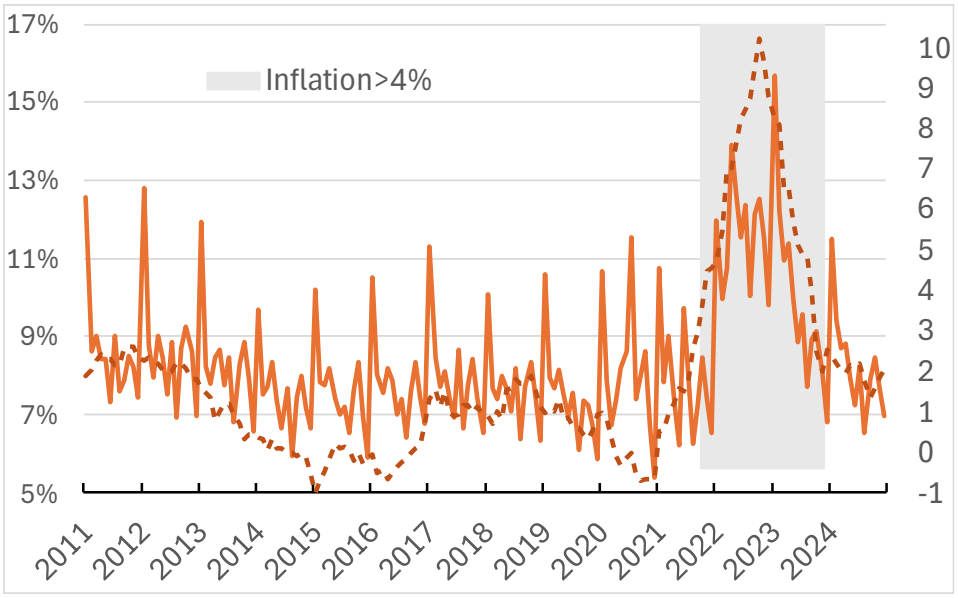
For firms with large gaps, the gradient linking price gaps to price changes increases, revealing strong non-linearities in firm-level pricing behaviour.

These empirical findings provide, for the first time, direct support for state-dependent pricing models in the euro area and contradict the flat adjustment probability assumed in time-dependent models. For small price gaps, expected price changes are nearly linear, resembling Calvo-style behaviour. For large gaps, pricing becomes highly non-linear: firms adjust much more frequently and close most of the gap. Large aggregate cost shocks shift the distribution of price gaps into this non-linear region, producing clustered and frequent adjustments across firms, which steepens the Phillips curve. The state-dependent model explains both low-inflation and high-inflation periods, while a Calvo model misses much of the post-pandemic surge.

For large gaps, pricing becomes highly non-linear: firms adjust much more frequently and close most of the gap.

Chart 1
Frequency of price changes

(percentage)



Source: Gautier et al. (2025).
Note: The chart shows the frequency of consumer prices changes in the euro area (plain line, left axis) and HICP inflation (dashed line, right axis).

Along similar lines, Gautier et al. (2025) provide a comprehensive analysis of how price-setting behaviour evolved during the significant inflation cycle of 2021-24, using euro area consumer price index micro data covering 190 million individual price quotes. The analysis concentrates on the frequency and size of price changes. Frequency rose sharply in 2022-23 before moving back toward its pre-pandemic average. The rise was broad-based across sectors and across the nine countries in the sample. Price change frequencies in services reacted less quickly but remained elevated until 2024, consistent with the well-documented lagged response of services inflation. The rise in average price changes reflected a shift towards more price increases, not larger individual adjustments. The second key finding concerns the magnitude of price changes. The observed increase in the average size of price changes was not the result of firms making larger individual adjustments. Instead, it was a compositional artefact arising from the dramatic shift in the mix of price increases versus decreases. In the high-inflation period, the share of increases rose sharply, mechanically pushing up the simple average of all price changes. When increases and decreases are examined separately, their average sizes changed only marginally. The average size of all price changes rose from 1.5% before 2020 to 5.5% in 2022, primarily because the share of increases rose from two-thirds to 82%. They show that the extensive margin (the frequency of price changes) contributed disproportionately to inflation variation during the surge, while the intensive margin (the size of individual changes) remained an important but secondary driver. Consistent with the findings of Gagliardone et al. (2025), both hazard rate estimates and local projection results reveal that the extensive margin becomes more responsive to energy shocks when inflation is high.

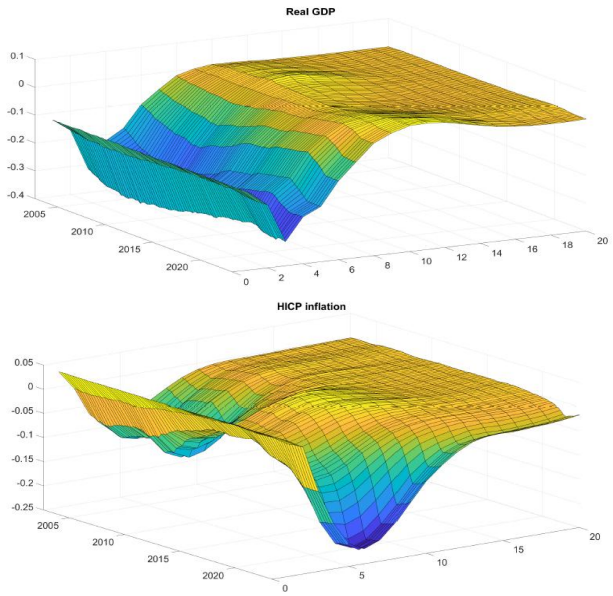
2.4 Time variation in transmission: macro evidence and structural interpretation

A conventional monetary policy shock takes roughly 12 to 18 months to fully transmit to real GDP and headline inflation. By contrast, the lags for core and services inflation are substantially longer.

While these papers all look at micro data, Zlobins (2025) provides complementary empirical evidence based on time series methods. First, the paper revisits the lags and strength of monetary policy transmission in the euro area. Estimates from a structural BVAR model show that a conventional monetary policy shock – obtained via a fusion of high-frequency identification with narrative sign restrictions – takes roughly 12 to 18 months to fully transmit to real GDP and headline inflation. By contrast, the lags for core and services inflation are substantially longer: full pass-through requires more than two years. Second, the paper employs a time-varying parameter, structural vector autoregression with stochastic volatility (TVP-SVAR-SV) model to show how transmission has changed over time. The results reveal a stark divergence between the 2022-23 tightening cycle and previous episodes. Recent hikes produced a stronger and more persistent inflation response than earlier cycles, while GDP reactions were similar. The critical implication of these findings is that the recent tightening cycle achieved substantial disinflation at unexpectedly low output cost. This unusually low sacrifice ratio is the central puzzle of the recent period. A standard structural dynamic stochastic general equilibrium (DSGE) model can explain the low sacrifice ratio as the combination of two factors: a more forceful monetary policy response and an increase in the frequency of price adjustments, which steepened the Phillips curve. These findings are consistent with state-dependent pricing models and suggest that central banks may face shorter transmission lags and lower output costs when inflation is high and firms adjust prices more frequently.

Chart 2

Time-varying impact of monetary policy in the euro area



Source: Zlobins (2025).
Notes: The chart shows impulse response functions from a time-varying parameter, structural vector autoregression with stochastic volatility to a conventional monetary policy shock over the period running from the third quarter of 2002 to the third quarter of 2023. The shock has been normalised to a 5-basis-point increase in the three-month EURIBOR in each period, allowing the estimated elasticities to be comparable over time.

The above empirical findings strongly support state-dependent pricing. A key implication is a non-linear Phillips curve that steepens in high-inflation periods. This makes inflation more sensitive to additional cost pressures and raises the risk that inflationary shocks become self-reinforcing, as firms are more likely to adjust prices frequently in such regimes. Ascari et al. (2025) take seriously the implications of empirical evidence in the above papers and develop a New Keynesian model in which both the price and wage Phillips curves exhibit genuine curvature. The key innovation is the introduction of a state-dependent mechanism in which the frequency with which firms and unions adjust prices and wages evolves endogenously. The state-dependent mechanism generates non-linear Phillips curves in both prices and wages, such that the inflation-output trade-off is no longer constant: the curves become steeper in high-inflation environments. As inflation rises, the cost of holding an outdated, relatively low price or wage becomes increasingly harmful for profits or surplus, while the cost of having a relatively high price or wage is comparatively modest. This asymmetry creates strong incentives for firms and unions to adjust more frequently in high-inflation periods, increasing overall nominal flexibility and amplifying the inflationary impact of subsequent shocks. By contrast, the standard Calvo model produces an almost linear Phillips curve, implying a stable and largely invariant trade-off between inflation and real activity. They estimate the fully non-linear model on euro area data for the 1999-2024 period. They show that the model with endogenous adjustment frequencies outperforms the standard time-dependent model on both Bayesian model comparison and forecasting accuracy – especially in high-inflation environments, where non-linearities become most relevant.

The state-dependent mechanism generates non-linear Phillips curves in both prices and wages, such that the inflation-output trade-off is no longer constant.

The model interprets the inflation surge as a period when higher adjustment frequencies steepened the Phillips curves, amplifying subsequent shocks. An initial supply-side (cost-push) shock did more than raise inflation; by increasing adjustment frequencies, it also steepened the Phillips curves. This increased nominal flexibility then amplified the inflationary impact of subsequent demand shocks. By contrast, the standard Calvo model cannot capture these non-linear interactions and therefore attributes the inflation surge almost entirely to a sequence of unusually large and persistent cost-push shocks. A key policy implication is that the inflation-output stabilisation trade-off becomes state-dependent. When the Phillips curve is steep – as in high-inflation environments – the cost of disinflation is lower. When inflation is low and adjustment frequencies are low, the Phillips curve is flat and disinflation is costly, implying that policy should be more cautious to avoid unnecessary recessions. Ignoring these non-linearities can lead to policy errors: early in the inflation surge, linear models would have overestimated the cost of tightening and advocated a “look-through” strategy; later in the cycle, they might underestimate the cost and recommend overly aggressive tightening.

When the Phillips curve is steep – as in high-inflation environments – the cost of disinflation is lower.

While the analysis of Ascari et al. (2025) is positive and empirically grounded, the natural next step is to ask what the normative implications are of state-dependent pricing and of a Phillips curve whose slope varies with economic conditions. Karadi et al. (2025) provide a first answer by studying optimal Ramsey policy in a state-dependent pricing framework à la Golosov and Lucas (2007). Their central result is that monetary policy should respond far more aggressively to large cost-push shocks. As discussed earlier, in state-dependent pricing models inflation raises the

When shocks are large and price adjustment becomes more frequent, the sacrifice ratio declines.

frequency of price changes, steepening the Phillips curve and increasing price flexibility. This non-linearity implies that the output cost of reducing inflation falls as inflation rises, in stark contrast to the nearly linear Phillips curve of the Calvo model. When shocks are large and price adjustment becomes more frequent, the sacrifice ratio declines, making strong anti-inflationary policy comparatively less costly.

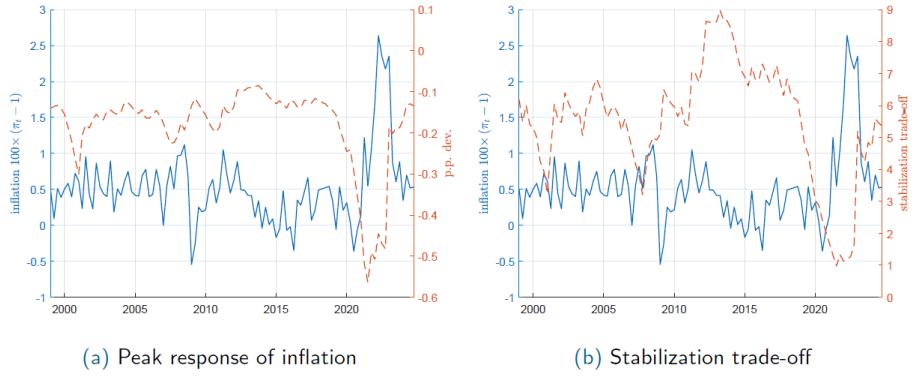
Another important insight is that the classic time inconsistency problem, while still present, is attenuated in the menu cost environment: unexpected monetary easing increases the frequency of price changes, raising price flexibility and dampening the output stimulus. This reduces the temptation to deviate from the Ramsey plan.

Overall, this work shows that endogenous variation in the frequency of price adjustment fundamentally reshapes optimal monetary policy. When inflation is high and prices become more flexible, central banks should lean more forcefully against inflation – an implication that resonates strongly with recent inflationary episodes.

Chart 3

Stabilisation trade-off of monetary policy in the euro area

(percentage)



Source: Ascari et al. (2025).
Note: Stabilisation trade-off is computed as the sum over 20 quarters of the ratio of the impulse response functions (IRFs) of output gap divided by the sum of the IRFs of inflation in response to a 0.25% monetary policy shock.

2.5 Additional transmission channels and distributional aspects

The transmission mechanism of monetary policy, however, depends not only on business cycle conditions, but on multiple real and financial states.

The transmission mechanism of monetary policy, however, depends not only on business cycle conditions, but also on multiple real and financial states. While existing studies often impose low-dimensional measures – such as distinguishing between high-inflation and low-inflation environments or separating recessions from expansions – to capture state dependence, the transmission of monetary policy is neither simple nor linear. Instead, it is shaped by multi-dimensional, state-dependent non-linearities.

Aydın Yakut, Byrne and Goodhead (2025) take on this challenge by systematically evaluating non-linearities arising from a large set of potential economic states. To do

that, the authors assemble a large mixed-frequency panel – 129 US real and financial variables and 126 euro area variables – from which they extract ten real and financial factors. A non-linear event study model interacts monetary surprises with these ten factors. This structure allows them to separate the direct effect – the average, state-independent impact of policy – from the indirect effect, which captures the contribution of state-dependent channels. The results confirm that monetary policy transmission is influenced by a small set of financially anchored state variables rather than a single factor.

In the United States, a subset of factors significantly affects transmission to long-term Treasury yields: transmission is weaker when interest rates are high and when debt is elevated, consistent with diminishing effectiveness over the course of a hiking cycle. While financial non-linearities are the primary drivers, the authors also find some evidence that transmission is weaker in strong phases of the business cycle. In the euro area, sovereign risk plays a prominent role in state-dependent pass-through along the transmission.

The key implication is that transmission depends on multiple real and financial conditions, not merely on broad business cycle indicators; relying on a single state variable risks misidentification. From a policy perspective, different channels appear dominant in the US and euro area cases. For the United States, policymakers should focus on the interest rate cycle, leverage and inflation when assessing the likely effectiveness of their measures. In the euro area, sovereign risk and uncertainty are most important.

Finally, monetary policy effects are not only heterogeneous across sectors or regions, but also across firms and households.

Regarding firms, Holm-Hadulla and Thürwächter (2024) show that corporate leverage conditions shape monetary policy transmission. The authors take advantage of a novel identification strategy to establish a causal link between firm-level debt dynamics and aggregate economic outcomes. The researchers first estimate firm-level regressions for each country to isolate idiosyncratic, unexplained changes in firm leverage. The authors then estimate local projections containing an interaction term between monetary policy shocks and these unexplained changes in firm leverage, allowing them to assess how monetary transmission varies with leverage conditions. The key finding is that transmission to prices strengthens in high-leverage states, while output responses remain unchanged. This reflects an internal devaluation channel. Economies experiencing rising corporate leverage undergo a sharper contraction in domestic demand following monetary tightening. However, this stronger contraction is partly offset by a smaller decline in exports, due to improved international price competitiveness. As a result, the price level falls more in high-leverage states, while output responds similarly to low-leverage conditions. Thus, corporate leverage amplifies the inflationary effects of policy tightening without generating greater output volatility. These findings carry important policy implications. Central banks should monitor leverage cycles, as elevated corporate debt increases the disinflationary effect of tightening. A single policy action aimed at achieving a particular average inflation outcome will have predictably different effects on national price levels depending on local corporate debt conditions.

Central banks should monitor leverage cycles, as elevated corporate debt increases the disinflationary effect of tightening.

Regarding households, Meriküll and Rottner (2025) use high-frequency administrative tax data from Estonia to study how monetary policy affects earnings inequality. The richness and granularity of these administrative records are essential to analysing the short-lived but intense recent inflation surge, and to distinguishing between employment adjustments (the extensive margin) and wage changes (the intensive margin). To examine how these labour market responses translate into household-level consumption effects, the authors merge the administrative labour data with marginal-propensity-to-consume estimates from the 2021 Estonian Household Finance and Consumption Survey. The first main finding is that contractionary monetary policy shocks reduce labour income across the entire distribution, but the effects are highly unequal. Low-income workers experience the largest adverse impact of tightening. For these groups, the decline in earnings is driven primarily by the extensive margin – that is, employment losses or reductions in hours. By contrast, for higher-income workers, the adjustment occurs mainly through changes in real wages, reflecting the intensive margin. The second result of the paper is that monetary policy shocks have different effects depending on the inflation level. The impact of monetary policy on labour earnings and inequality is substantially amplified during high-inflation periods, while the effects are much weaker during low-inflation regimes. A one-standard-deviation contractionary monetary policy shock has an approximately eightfold larger impact on aggregate consumption in the high-inflation regime. Consequently, both consumption and earnings inequality responses intensify when inflation is high.

2.6 Concluding remarks and implications for policy analysis

Cross-sectional heterogeneity, structural composition, global integration, price-setting behaviour and the distribution of leverage all shape how interest rate changes propagate through the economy.

The papers considered in this section collectively underscore that monetary policy transmission is neither uniform nor linear. Cross-sectional heterogeneity, structural composition, global integration, price-setting behaviour and the distribution of leverage all shape how interest rate changes propagate through the economy. These factors are dynamic and state-dependent, implying that a one-size-fits-all policy can lead to inefficient or uneven outcomes. The recent inflation surge has exposed these non-linearities, revealing that the potency and lags of monetary policy vary dramatically across regimes and sectors. The challenge for central banks is to recognise this complexity and adjust both their analytical frameworks and policy strategies accordingly.

It is particularly crucial to recognise regime shifts in price dynamics.

Some clear policy recommendations follow immediately from these results. Models for policymaking should integrate non-linear, time-varying and state-dependent transmission mechanisms. The structural composition of output (services versus industry), the degree of global value chain integration and the leverage cycle should all inform the stance and timing of policy. The recent inflation surge demonstrated that is particularly crucial to recognise regime shifts in price dynamics. During high-inflation episodes, the Phillips curve steepens, allowing policy to stabilise inflation at lower output loss, but also requiring timely action to prevent self-reinforcing inflationary forces. In low-inflation regimes, the curve flattens, necessitating a similarly forceful action to avert deflationary spirals as prices become more inertial to changes in economic activity.

In sum, the evidence assembled here points to a need to review the way monetary policy is analysed and designed, with some of the findings already being used in the ECB's 2025 strategy review.

Transmission mechanisms are state-dependent, multi-dimensional and non-linear, and they can change rapidly when the economy transitions from low-inflation to high-inflation regimes. Policymakers who ignore this complexity risk miscalibrating their response.

3 Market dynamics, competition and financial frictions

This section reviews evidence on how market structure and financial frictions shape the transmission of monetary policy. It focuses on the interaction between financing conditions, competitive dynamics and firms' pricing and production decisions, and on how these interactions can alter both the strength and incidence of policy across firms and sectors.

The contributions summarised highlight two broad mechanisms. First, when external finance is bank-based and constraints are heterogeneous, changes in policy rates and credit supply can affect investment, employment and entry in a heterogeneous manner, with implications for market dynamics and competition. Second, supply-side frictions and heterogeneous price rigidities can generate state-dependent pass-through, particularly in high-inflation environments, thereby influencing the inflation-output trade-off faced by policymakers.

3.1 Financial frictions

European firms rely heavily on banking credit for external financing, making the bank lending channel an important transmission mechanism to real investment.

Monetary policy transmission to the real economy is affected by firms' financial conditions, their position in the supply chain and market concentration. At the same time, monetary policy affects the financial conditions of economic agents through the cost of borrowing and availability of credit. European firms rely heavily on banking credit for external financing, making the bank lending channel an important transmission mechanism to real investment. Furthermore, more favourable credit conditions for small enterprises stimulate firm entry and market competition.

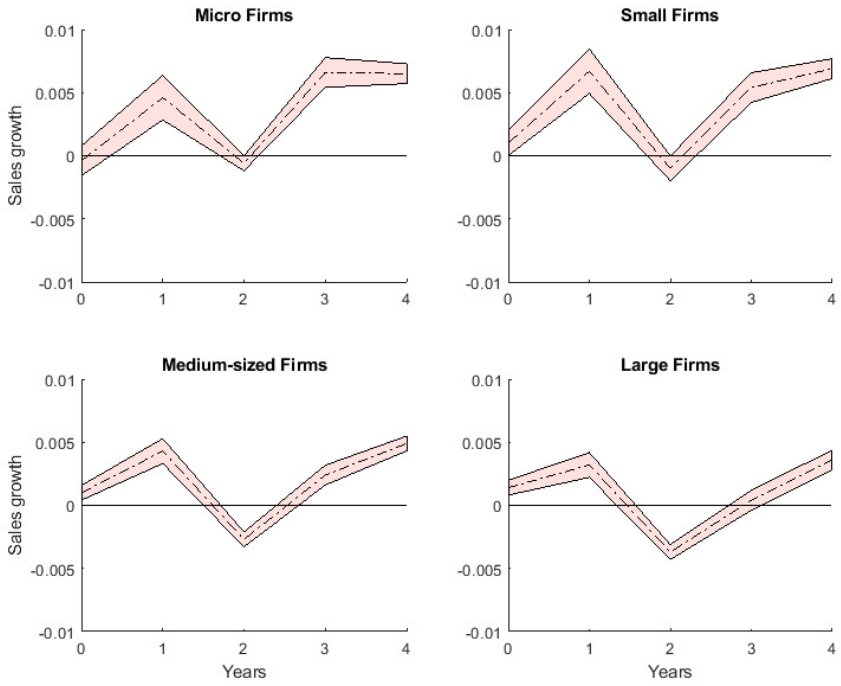
Accommodative monetary policy boosts market competition through better credit conditions for small firms, supporting a reduction in industrial market concentration.

The literature aims to connect market concentration in the European Union and monetary policy. Popov and Steininger (2023) examine how accommodative monetary policy influences market concentration using a sample of over 1.4 million firms. The authors study how monetary policy shocks affect firms' sales and profit margins through firms' financial conditions. The channel through which monetary policy is found to more heavily influence the growth of small firms is the bank lending channel. Small firms, which are more dependent on bank credit than medium and large firms, increase their long-term debt in a more accommodative environment. The opposite holds for restrictive monetary policy shocks. As such, more accommodative monetary policy boosts market competition through better credit conditions for small firms. A recent period of accommodative monetary policy is further associated with a non-negligible reduction in industrial market concentration in Europe.

Chart 4

Firm-level sales growth response to monetary easing

(percentage)



Source: Popov and Steininger (2023).
Notes: The chart shows the different responses to a one-standard-deviation monetary policy tightening shock in sales growth at firm level. The authors plot 95% pink confidence bands calculated from standard errors clustered at the industry and country level.

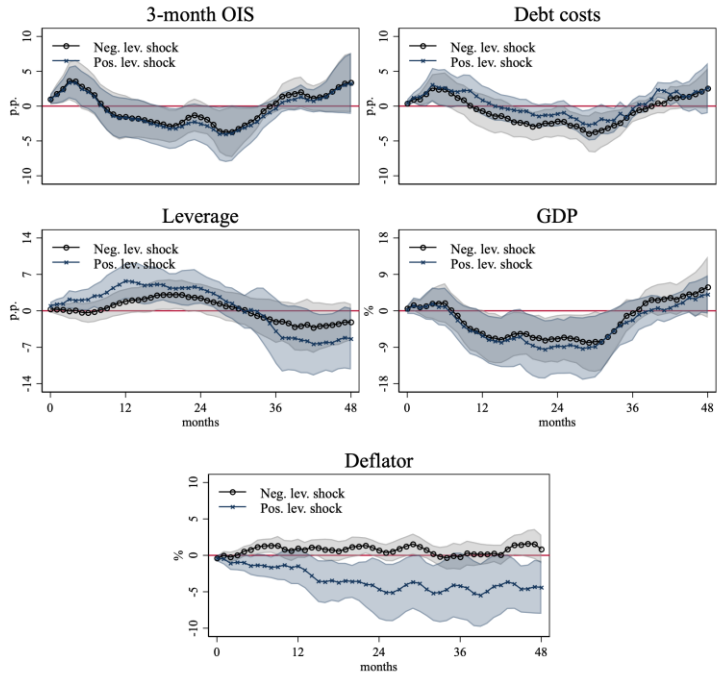
Corporate leverage amplifies monetary policy's effect on prices but has little impact on GDP due to an "internal devaluation" channel that cushions exports.

Firms' financial constraints per se are a relevant factor for monetary policy transmission to the real economy. In line with vast theoretical literature (e.g. Bernanke, Gertler and Gilchrist, 1999), corporate leverage is found to amplify monetary policy transmission to the real economy. While corporate leverage in many European economies remains high by historical standards, Holm-Hadulla and Thürwächter (2024) find that it amplifies monetary policy's effect on prices but, surprisingly, has little to no impact on GDP. Subdividing GDP into key components, the authors explain this disconnect with the "internal devaluation" channel: higher leverage tightens firms' domestic demand responses but improves relative price competitiveness, cushioning exports. Economies experiencing an increase in leverage exhibit a stronger monetary policy-induced contraction in domestic demand than those experiencing a decline. However, in the former case, this is counteracted by a milder drop in exports, facilitated by the competitiveness gains resulting from their stronger price-level response. In view of the pronounced variation in corporate leverage, these findings point to another relevant source of heterogeneity in monetary policy transmission across the euro area countries and over time. From the point of view of a policymaker, this creates heterogeneity in inflation responses across small open economies depending on leverage conditions. A given monetary policy stance can thus induce stronger price effects in highly leveraged economies.

Chart 5

Response of GDP and GDP deflators to a monetary policy shock depending on leverage shock

(percentage points and percentage)



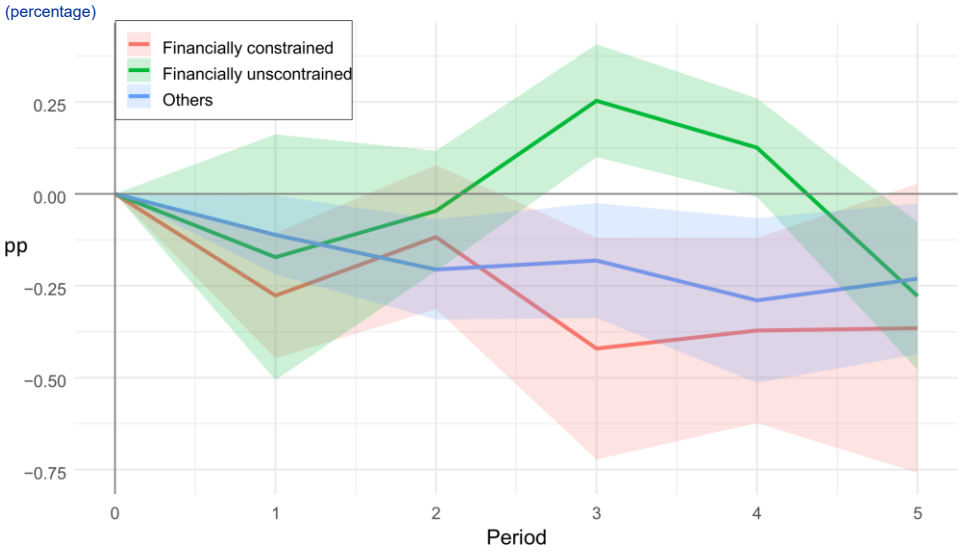
Source: Holm-Hadulla and Thürwächter (2024), Figure 5.
Notes: The IRFs are evaluated at the 10th percentile (negative leverage shock) and 90th percentile (positive leverage shock) of the granular instrumental variable (GIV). The IRFs are normalised to a 100-basis-point impact response in the three-month overnight index swap (OIS) rate at the respective GIV value. The line with circles (x-markers) shows the IRF from the 10th (90th) percentile of the GIV. The grey (blue) area is the corresponding 90% confidence interval using Driscoll and Kraay standard errors. The IRFs for debt costs are estimated from a shorter sample starting in 2004 due to missing data.

Financially constrained firms respond more strongly to monetary policy, whereas firms with smaller needs for external financing adjust investment less.

Among others, empirical evidence to support the presence of the credit channel of monetary policy transmission to investment is provided by Ferrando, Lamboglia and Offner (2025). While controlling for firms' investment opportunities or fundamentals, they show that financially constrained firms respond more strongly to monetary policy. Firms with a smaller need for external financing adjust their investment less when interest rates change. Firms' fundamentals play an important role too. There is a small effect on investment when their fundamentals are weak, and a large effect when firms' fundamentals are strong.

Chart 6

Response of investment to a 1-basis-point surprise increase in monetary policy



Source: Ferrando, Lamboglia and Offner (2025), Figure 4.
Notes: Local projection estimates of the effects of monetary policy on investment, conditional on whether a firm is classified as "financially constrained", "unconstrained" or "others". The regression includes sector and country fixed effects, and controls for past investment, leverage, return on equity (ROE), sales growth, internal funding, liquidity and past funding needs and availability. Observations are weighted by their economic significance. 90% confidence intervals are shown in blue, red and green and are calculated using Driscoll-Kraay standard errors clustered at the firm and time levels. Sample period: April 2010 to January 2023.

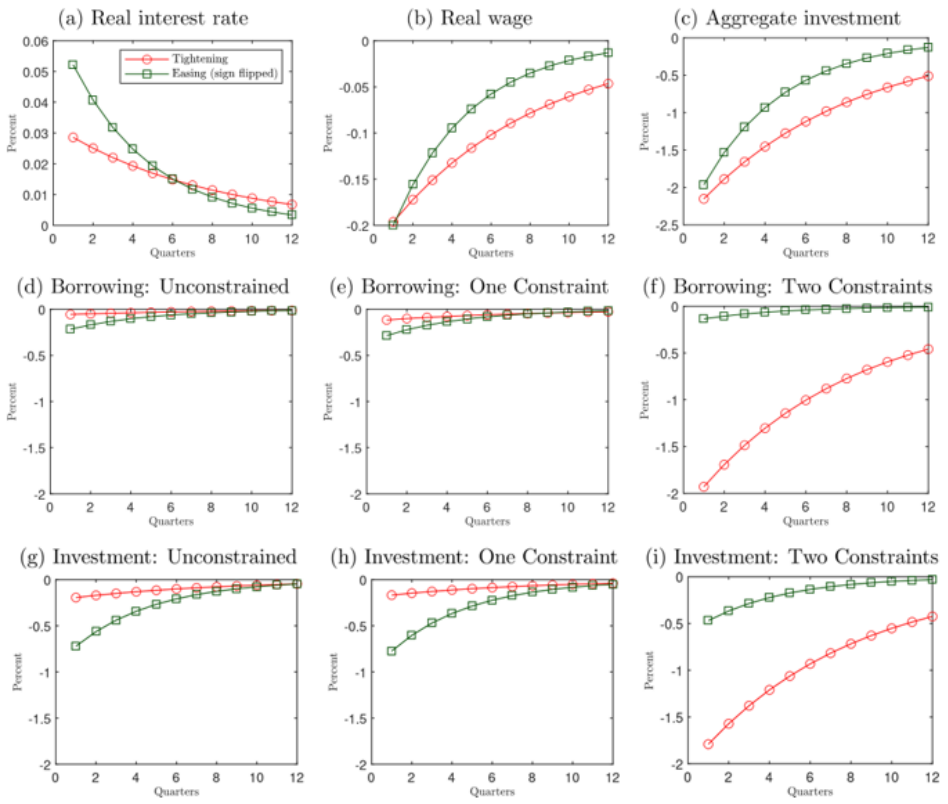
Contractionary monetary policy triggers strong reactions by making financial constraints binding, while accommodative policy generates weaker expansionary effects.

The impact of firms' financial constraints on asymmetry in monetary policy transmission is generalised by Perez-Orive, Timmer and van der Ghote (2026). In a quantitative New Keynesian model supported by empirical analysis, the authors show that asymmetry arises from multiple financial constraints. As firms have multiple financial constraints, a contractionary monetary policy makes the tightest constraints binding. An accommodative monetary policy relieves the constraints, but the constraint relieved the least becomes binding, preventing the firms from expanding their credit and investment. As a result, under multiple financial constraints, accommodative monetary policy has smaller expansionary effects on firms' investment, while contractionary monetary policy generates a larger drop in investment.

Chart 7

Schematic of the impact of multiple financial constraints

(percentage)



Source: Perez-Orive, Timmer and van der Ghote. (2026), Figure 8.

Moreover, during periods of high financial volatility, firms' need for external financing can alter their pricing and output decisions. Based on Swedish firm-level data, Ahlander, Klein and Pappa (2024) show that the slope of firm-level supply curves flattens (or even turns negative) during times of financial stress. Firms decrease their prices after a rise in global demand. This effect is explained by firms' motivation to increase their internal liquidity to avoid external financing during high financial volatility.

Tighter constraints on upstream suppliers amplify cost-push effects, while constraints on downstream sectors strengthen demand-side propagation within production networks.

De Sanctis et al. (2023) add a production network dimension to the role of financial frictions in monetary policy transmission. They show that the location of financially constrained firms within supply chains matters: tighter constraints on upstream suppliers amplify cost-push effects, while constraints on downstream sectors strengthen demand-side propagation. This dual channel implies that the macroeconomic transmission of monetary shocks depends not only on the intensity of frictions but also on their position in the network.

Restrictive policy reduces firms' ability to "hoard" labour in downturns two to three times more than accommodative policy increases it.

Finally, regarding employment, Bijnens, Hutchinson and Saint Guilhem (2026) show that monetary policy influences firms' ability to "hoard" labour in downturns, and this effect is asymmetric. For central banks with a dual mandate, it is indeed important to understand how firms' employment decisions react to monetary policy depending on their financial conditions. Restrictive policy reduces labour hoarding two to three times more than accommodative policy increases it. Financing constraints are found to

amplify employment cuts following output shocks. The mechanism underscores how balance sheet conditions shape employment dynamics. This result highlights a stabilisation role for monetary policy via labour demand: accommodative policy can cushion job losses when financing frictions are binding. But it also suggests that fragmented financial conditions weaken the transmission of stabilising policies and risk asymmetric labour market outcomes. Complementary macroprudential and targeted credit policies can therefore enhance the effectiveness of monetary policy and protect employment.

To sum up, the bank credit channel of monetary policy is found to affect market competition in the euro area by stimulating or suppressing the growth of small firms relative to large firms. Firms' financial constraints and fundamentals affect the strength of monetary policy propagation to investment, pricing and employment decisions. When firms are highly leveraged or financially constrained, monetary policy has a more pronounced effect on their decisions. Strong firm fundamentals are found to amplify firms' investment response to monetary policy shocks.

3.2 Supply frictions and price rigidities

Besides financial frictions, other frictions are found to amplify or dampen firms' response to monetary policy shocks and other types of shock. These micro-level supply frictions can scale up to generate non-negligible macroeconomic effects. The interaction of these frictions with the inflationary environment is of interest to policymakers after the recent long period of low inflation followed by a dramatic inflation surge.

During episodes of high inflation, firm-level supply curves become steeper and firms are more inclined to raise prices in response to demand shocks.

Evidence from micro data suggests that during episodes of high inflation, firms adjust prices and quantities differently in response to demand shocks. Ahlander, Klein and Pappa (2024) show that when inflation spikes, firm-level supply curves become steeper and firms are more inclined to raise prices. This aligns with recent literature on the non-linearity of the aggregate Phillips curve[2] as well as the evidence provided in Sections 2.4 and 2.5 about the increase in the frequency of price adjustment during episodes of high inflation.

Heterogeneous price rigidities among firms and industries play an important role in shock propagation to consumer price inflation (Ahlander, Carlsson and Klein, 2023). Propagation of producer price changes to consumer prices is of interest because it reflects the speed of shock propagation through the economy and to a policymaker's variable of interest – consumer price inflation. Policymakers can expect faster shock propagation to consumer prices in more flexible industries, such as food processing or fuel for transportation, where the pass-through is almost immediate. In more rigid industries, such as production of durables, the pass-through is slower and more gradual. Interestingly, there is no evidence that pass-through to consumer prices was affected by the COVID-19 pandemic or by the recent period of high inflation.

[2] For a recent literature review on the non-linearity of the Phillips curve, see Audzei, V. and Babecky, J. (2024), "The Phillips curve: A new era of non-linearity?", *cnBlog*, Česká národní banka, 29 October.

When it comes to producer price responses to input cost shocks, Duprez and Magerman (2018) document large heterogeneity in producer price changes and incomplete pass-through of input costs, with an average cost pass-through of only 0.44. Firms react to both cost shocks and the prices of other firms in their environment. Common shocks are passed through much more strongly than idiosyncratic shocks. These findings imply that monetary and supply shocks propagate through networks in a non-linear way, with strategic pricing margins dampening or amplifying transmission. For policymakers, this suggests caution in assuming constant mark-ups in structural models and highlights the value of firm-level data in real-time policy assessment. It also implies that competition policy and monetary policy interact and that stronger competitive pressure can affect the degree of pass-through and hence macro persistence.

Supply shocks have gained an elevated interest recently, after the Suez Canal blockage, pandemic-related and geopolitical supply disruptions. Besides raising input prices, losing or gaining a supplier itself has been found to affect firms' marginal costs. Baqaee et al. (2023) show that when firms gain or lose suppliers, their marginal costs respond strongly, reflecting substantial "inframarginal surplus" created by supplier relationships. A 1-percentage-point gain or loss in supplier cost share changes marginal costs by about 0.3 percentage points, and supplier churn plausibly accounts for around half of aggregate productivity growth in Belgium. The mechanism works through love-of-variety effects and imperfect appropriability of surplus by producers. From a policy perspective, this implies that disruptions to supplier networks – whether financial, regulatory or geopolitical – can have lasting productivity consequences.

Production networks substantially amplify and prolong inflation, breaking the "divine coincidence" and requiring a tolerance for non-zero output gaps.

Rich production networks amplify propagation of foreign shocks, such as energy price shocks, to inflation. Aguilar et al. (2026) develop a multi-country New Keynesian model with rich national and international production networks. Energy price shocks propagate through input-output linkages, generating feedback between costs and prices that substantially amplifies and prolongs inflation; cumulative inflation would be roughly 40% smaller without production networks. Heterogeneous production structures create pronounced cross-country differences in inflation persistence. The policy implication is that production networks break the "divine coincidence": stabilising inflation requires tolerating non-zero output gaps when shocks originate abroad and propagate through supply chains. Moreover, the amplification of supply shocks increases the premium on credible and systematic monetary policy responses, while highlighting the value of coordinated energy and structural policies to reduce exposure.

3.3 Concluding remarks

This section highlights that monetary policy transmission in the euro area is shaped by firm-level heterogeneity, financial frictions and supply-side networks. On the financial side, firms' reliance on bank credit and their financial constraints condition how monetary policy affects their investment, pricing and employment. Accommodative monetary policy benefits small and bank-dependent firms, supporting entry and competition, while restrictive policy tightens financial constraints and

amplifies asymmetries across firms. Corporate leverage further introduces cross-country heterogeneity: highly leveraged economies experience stronger price responses to monetary policy, even when aggregate output responses remain muted. The findings suggest that further research is needed to understand how countries' heterogeneity transmits into area-wide policy calibration and its implications for interaction between monetary and macroprudential policies.

Beyond financial frictions, the transmission of shocks to inflation is affected by supply-side frictions, pricing rigidities and production networks. Firm-level evidence shows that inflationary regimes matter: in high-inflation environments, supply curves steepen and price adjustments become more aggressive, intensifying policy trade-offs. Heterogeneous price rigidities and incomplete, shock-dependent cost pass-through imply that inflation dynamics are non-linear and state-dependent, shaped by market structure, competition and strategic pricing. At the same time, dense domestic and international production networks amplify and prolong the effects of supply shocks, generating persistent inflationary pressures and cross-country differences in outcomes.

Taken together, these findings suggest that monetary policy transmission is affected by firms' balance sheets, market structure and supply chain configurations. Further research is needed to understand the implications of this heterogeneity for euro area monetary policy.

4 Productivity, innovation and reallocation

Recent literature – including analyses from the ChaMP research network – provides important evidence on monetary policy transmission through the real economy, notably via sectoral reallocation, innovation and technology growth, as well as through the labour market and inequality. These insights are very important for central banks. Understanding the drivers behind investment and productivity, as well as the implications for economic growth and employment, is an important element of monetary policy preparation. While these factors have long-run dynamics often outside the monetary policy horizon, studies have shown that monetary policy contributes to sectoral reallocation influencing productivity and stimulating innovation. Resource reallocation and monetary policy trade-offs are intensified during recessions, high inflationary environments and supply disruptions (e.g. energy price shocks). Reallocation of labour is of particular interest for policymakers, as it affects employment dynamics and aggregate demand. A non-negligible role is played by distributional effects of monetary policy in a high-inflation environment. The poorest consumers suffer more from inflation than richer ones, and monetary policy can intensify or mitigate this inequality though its direct and indirect channels.

4.1 Transmission through innovation and TFP

Recessions can significantly affect investment in innovation and technology growth, manifesting demand shocks as persistent technology shocks that reduce TFP.

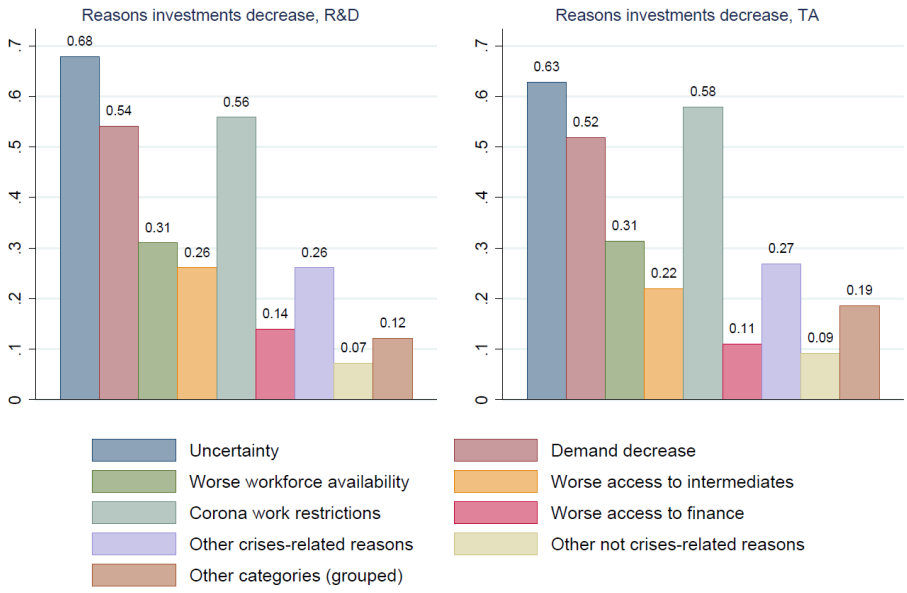
To what extent do short-run shocks transmit via technology-enhancing investment to longer-term aggregate supply? The traditional view, reflected in standard monetary policy models, assumes that long-term growth and supply-side dynamics are only structurally determined and unaffected by cyclical factors. However, an emerging literature has started documenting potential long-run effects of monetary policy (see, for example, Jordà, Singh and Taylor, 2024, or Ma and Zimmerman, 2023, for the United States). Elfsbacka-Schmöller, Goldfayn-Frank and Schmidt (2024) show that recessions significantly affect investment in innovation and technology growth, exerting persistent effects on TFP and aggregate output. Using unique, granular data on technology-enhancing investment in R&D and technology adoption from a representative survey of German firms (Bundesbank Online Panel of Firms), they identify pronounced, crisis-induced cuts to firms' innovation spending: 20% and 25% of firms cut spending on R&D and technology adoption respectively due to the COVID-19 pandemic, with sizeable average innovation cuts by innovation-active firms. A 1% recession-induced firm-level output drop is estimated to result in a 0.3% drop in innovation investment. Crucially, demand shocks emerge as a main driver of the

innovation cuts[3], supporting the view that demand shocks can manifest as persistent technology shocks.[4] Firm-level financial constraints amplify the innovation reduction.

Chart 8

Reasons for firms increasing investments in R&D and technology adoption, by investment type

(percentage)



Source: Elfsbacka-Schmöller, Goldfayn-Frank and Schmidt (2024), Figure 3.

These results are rationalised by means of a New Keynesian model with endogenous technology growth through R&D and technology adoption, demonstrating that contractionary demand shocks transmit through innovation, causing a persistent slowdown in TFP and aggregate output. These findings indicate that short-term shocks transmit to TFP and aggregate output over at least the medium term.[5] Recessions can lead to large and highly persistent output losses under an inflation-targeting central bank which does not account for the endogenous TFP adjustment. The view of a fixed, purely structural output trend may from this perspective not be appropriate and, as a result, measures which build on this assumption, notably traditional potential output and output gap measures, may give biased signals to policymakers. Finally, disentangling demand from supply shocks may be more challenging in practice than assumed, as demand shocks simultaneously affect the technology stock.

3 These results echo the broader insights from an emerging literature in this field. Ilzetzki (2024) demonstrates that aggregate demand shift can raise firm-level technology growth, notably in an environment of binding capacity constraints. Antolin-Diaz and Surico (2025) and Cloyne et al. (2022) show that short-run government spending and corporate tax cut shocks have long-lasting effects by raising R&D investment. Elfsbacka-Schmöller and Spitzer (2021) demonstrate that demand shocks played an essential role in explaining the slowdown in TFP growth in the euro area, as well as for the slow recoveries from the Great Recession and the euro area sovereign debt crisis.

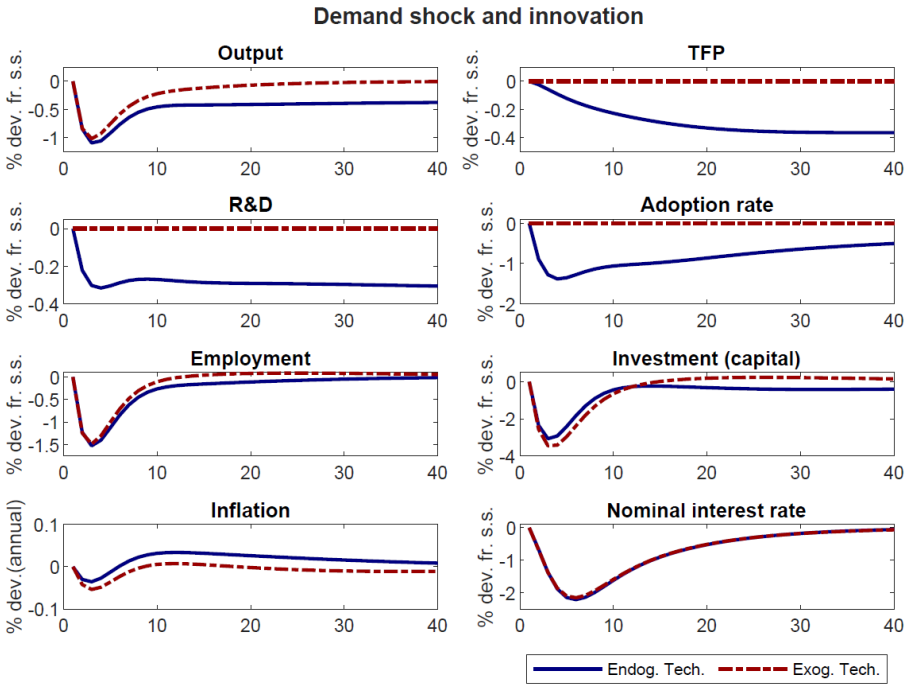
4 See also Bai, Ríos-Rull and Storesletten (2026) for an additional mechanism underscoring this view.

5 See, among others, Anzoategui and Comin (2019), Bianchi et al. (2019), Garga and Singh (2021) and Elfsbacka-Schmöller and Spitzer (2021).

Chart 9

Macroeconomic dynamics under a contractionary demand shock

(percentage deviations from steady state)



Source: Elfsbacka-Schmöller, Goldfayn-Frank and Schmidt (2024), Figure 9.

What role does monetary policy play in innovation and technology growth? There is an emerging empirical literature which, using time series data, suggests that monetary policy may transmit to innovation [6] and exert more persistent effects than conventionally assumed.[7]

Systematic monetary tightening during the 2022-23 period induced an average 20% reduction in firm-level innovation spending, which persisted over the medium term.

Elfsbacka-Schmöller, Goldfayn-Frank and Schmidt (2025) present firm-level evidence on the effect of monetary policy shifts on innovation activities using novel data from the Bundesbank Online Survey of Firms. They first document how a systematic monetary tightening (euro area policy rate hikes from 0% to 4.5% during the 2022-23 period) affected firms' innovation investment. They estimate that the euro area induced a substantial – on average 20% – reduction in firm-level innovation spending among innovation-active firms, with nearly half of these firms completely suspending such activities. Importantly, these cuts persisted over the medium term, indicating a sustained slowdown in innovation activity.

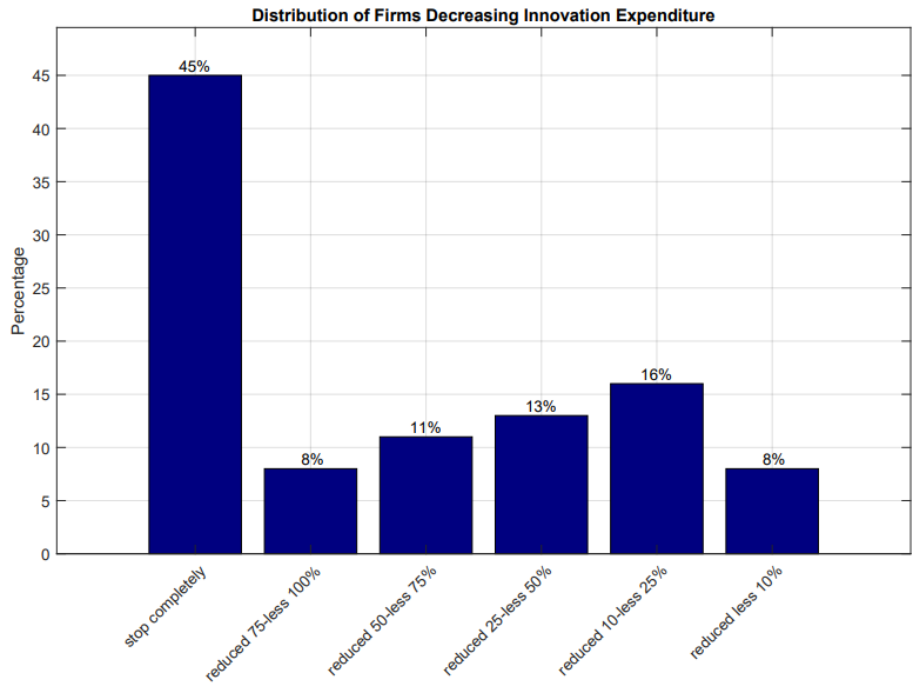
6 See Ma and Zimmermann (2023) and Moran and Queralto (2018).

7 See Jordà, Singh and Taylor (2024).

Chart 10

Distribution of intensity of innovation investment cuts (2022-23)

(percentage)



Source: Elfsbacka-Schmöller, Goldfayn-Frank and Schmidt (2025), Figure 1.

Both rate hikes and cuts transmit to innovation investment via the demand and financial channel. Forward guidance provides additional stimulus for innovation by reducing ambiguity about future policy paths.

Second, using a survey-based scenario analysis, they assess firms' responses to exogenous policy rate changes ("monetary policy shocks"): both hikes and cuts are found to significantly influence innovation investment. At the baseline interest rate of 4.5%, firms' responses to policy rate increases and decreases are largely symmetric. However, the degree of symmetry of these responses may be state-dependent, i.e. vary depending on the prevailing level of the policy rate, as an increasing share of firms exit from innovation activities in a high-rate environment. As to the underlying channels, the authors show that a key transmission mechanism from monetary policy to innovation is aggregate demand, with stronger responses in firms with pessimistic demand expectations. Moreover, the financing channel emerges as one of the transmission channels, with stronger innovation effects among firms with higher shares of bank loans and variable rate loans. Finally, forward guidance ("low-for-longer") is found to provide additional stimulus beyond stand-alone rate cuts, suggesting long-term, supply-side effects of monetary policy communication. It is particularly effective for firms reliant on bank loans and those facing high uncertainty, as forward guidance reduces ambiguity about future policy paths and encourages innovation investment.

Table 1

Effect of policy rate changes on planned innovation

Monetary policy response	Scen 1.: hike 1 pp.	Scen 2.: hike 0.5 pp.	Scen 3: cut 0.5 pp.	Scen 4: cut 1 pp.	Scen. 5: cut 1 pp. (long)	N
Baseline	-0.094*** [0.007]	-0.060*** [0.006]	0.043*** [0.006]	0.109*** [0.007]	0.164*** [0.009]	14,485
Heterogeneity dimensions						
Scenario x exp. inflation, 12m.	0.009** [0.004]	0.007** [0.004]	0.004 [0.004]	0.010*** [0.004]	0.013*** [0.005]	14,485
Scenario x loan share, pp.	-0.001*** [0.000]	-0.001*** [0.000]	0.001*** [0.000]	0.003*** [0.000]	0.004*** [0.000]	14,325
Scenario x labour prod., lg.	-0.013 [0.012]	-0.003 [0.011]	0.001 [0.011]	-0.002 [0.013]	-0.014 [0.017]	6,095
Scenario x size (empl. high)	0.043*** [0.014]	0.038*** [0.013]	0.014 [0.013]	0.017 [0.014]	0.016 [0.019]	14,456
Scenario x uncertainty key rate (high)	0.014 [0.013]	0.012 [0.012]	0.008 [0.012]	0.026* [0.014]	0.065*** [0.018]	14,258

Source: Elfsbacka-Schmöller, Goldfayn-Frank and Schmidt (2025), Table 6.
Notes: BOP-F October-December 2023. Results based on ordinary least squares regression. The outcome variables are the midpoint of the interval representing the change in plans for 2024 to 2025, recorded to range between -1 (reduced completely) and 1.1 (increase by more than 100%). Reference category for scenarios: actual change due to the past interest rate hike of 4.5%. Labour productivity measure is log-transformed and is based on the survey responses about number of employees and turnover in 2022, truncated at the 1% lowest and 5% highest end of the distribution. Inflation expectation represents the 12-month point prediction, truncated at 1%. Standard errors are clustered at the firm level (in brackets). Controls include survey wave, share of bank loans and firm size. Significance levels: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. For details, see source.

Klieber, Sigmund and Valderrama (2026) focus on the role of financial frictions in monetary policy effects on TFP using a dynamic optimisation model calibrated to Austrian non-financial corporations. They find that tighter financial conditions – resulting from both contractionary monetary policy and binding financial frictions – negatively affect TFP. Their model incorporates monetary policy through two components that influence the cost of capital: the policy stance, proxied by deviations from a country-specific Taylor rule, and exogenous policy shocks. Higher financing costs, particularly in the presence of financial frictions, reduce firms' incentives to invest in productivity-enhancing technologies, ultimately depressing TFP. In particular, tighter monetary policy and binding financial frictions can dampen productivity-enhancing investment, potentially slowing structural transformation. However, symmetric effects are observed when monetary policy is loosened.

4.2 Transmission through reallocation

Contractionary shocks act as accelerators of structural change, reallocating activity from high-productivity manufacturing to lower-productivity services.

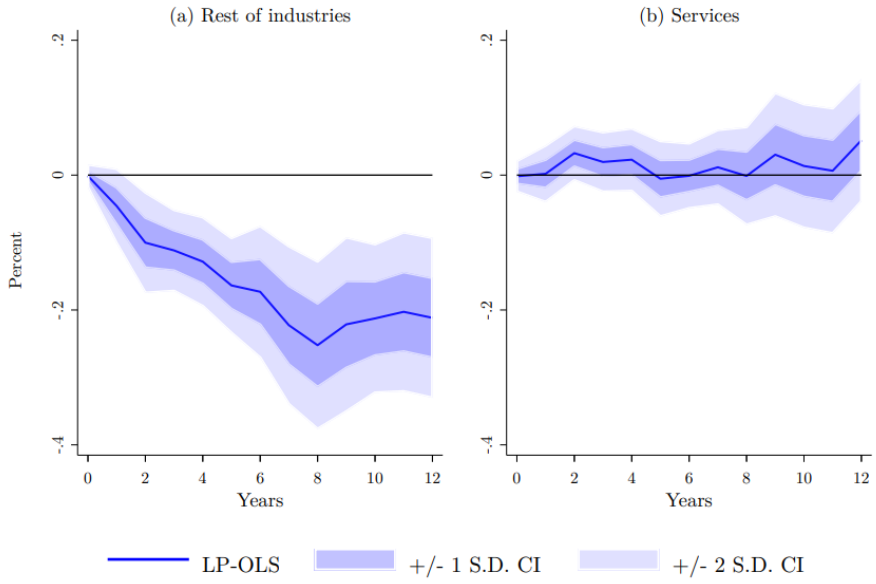
Several central results emerge from ChaMP Workstream 2 as to the role of reallocation in the transmission of monetary policy to the real economy. A stream of studies is dedicated to the analysis of the interaction between aggregate TFP and monetary policy based on granular empirical evidence and New Keynesian general equilibrium models. Amador and Elfsbacka-Schmöller (2024) study the sectoral reallocation effects of monetary policy shocks and their transmission to TFP. Using local projections on US data covering 65 industries from 1948-2014, contractionary monetary policy shocks are shown to shift resources from manufacturing to services, exerting a long-lasting negative effect on TFP by contracting activity more strongly in high-productivity versus low-productivity industries. Through a multi-sector New

Keynesian model with endogenous growth and heterogeneous sectoral contributions to TFP growth, they examine the role of nominal rigidities under frictional reallocation, investigate the heterogeneous monetary policy transmission to manufacturing versus services and study the long-run impact of monetary policy on aggregate productivity through sectoral reallocation. The results suggest monetary policy affects TFP and output through this reallocation mechanism, with monetary contractions acting as accelerators of the ongoing structural change from manufacturing to services.

Chart 11

Impulse response function estimates of industry-level Domar weight to monetary policy shock

(percentage)

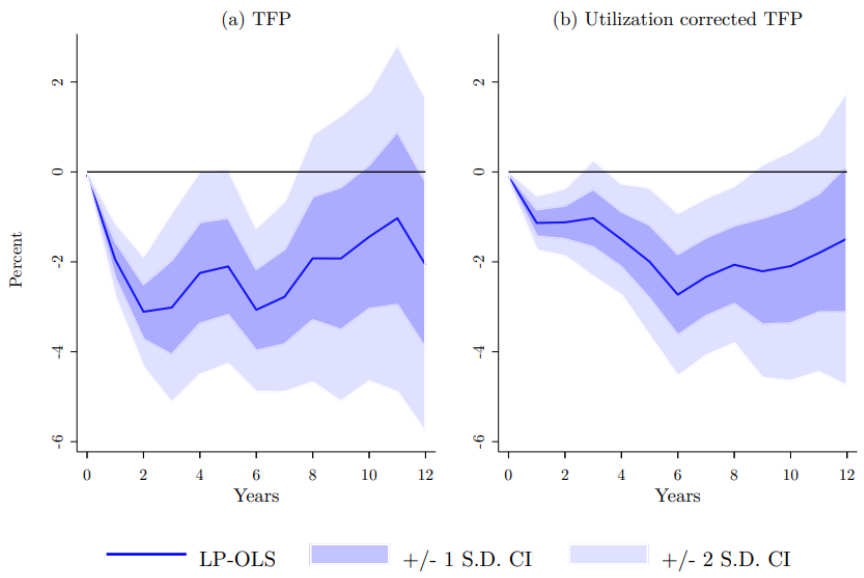


Source: Amador and Elfsbacka-Schmöller (2024), Figure 4.
Notes: The figure shows cumulative impulse response estimates of a contractionary monetary policy shock. The dependent variables are the Domar weights. The shaded areas show one and two Newey-West standard error confidence bands. The monetary shock series can be found in Table 2 of Romer and Romer (2023).

Chart 12

Response of productivity variables to a monetary policy shock

(percentage)



Source: Amador and Elfsbacka-Schmöller (2024), Figure 16.
Notes: The figure shows cumulative impulse response estimates of a contractionary monetary policy shock. The dependent variables are (a) TFP and (b) TFP, corrected by factor utilisation, from https://www.johnfernald.net/TFP based on Fernald (2014) following Basu, Fernald and Kimball (2006). The shaded areas show one and two Newey-West standard error confidence bands. The monetary shock series can be found in Table 2 of Romer and Romer (2023). Estimates use annualised quarterly frequency data, and only the horizons corresponding to years after the shock are shown.

For expansionary monetary policy shocks, González et al. (2024) find, using granular Spanish firm-level data and a New Keynesian model with heterogeneous firms and financial frictions, that monetary policy can affect aggregate TFP through its impact on capital misallocation. In the model, an expansionary shock relaxes financial frictions and induces firms with a higher marginal return on capital to raise investment more strongly than firms with a lower marginal return, improving the allocation of capital and raising TFP over the medium term. The empirical evidence supports this mechanism: firms with a high marginal return on capital increase investment relatively more after an easing than firms with a low marginal return, consistent with a reallocation of capital towards more productive uses. The model implies the symmetric opposite for a monetary tightening, which tends to worsen capital allocation and reduce TFP. González et al. (2024) further analyse the optimal monetary policy problem and show that the misallocation channel creates a time inconsistency motive in the model: in the short run, a central bank would be tempted to engineer an unexpected monetary expansion to improve TFP temporarily. However, the optimal systematic response to demand, financial and TFP shocks remains price stability. The main implication is therefore not that monetary policy should seek to exploit this channel on a sustained basis, but that structural change and financial frictions can alter the way policy transmits to productivity and the supply side of the economy.

4.3 Labour market and income distribution channels

Another key way in which monetary policy transmits to the real economy is through its effect on the labour market and inequality.

Meriküll and Rottner (2025) address the distributional effects of monetary policy in high-inflation environments. They study how the entire distribution of earnings shifts after a monetary shock and complement this evidence with a heterogeneous agent New Keynesian model embedding inflation-dependent earnings responses. They find state dependence in the distributional effects of monetary policy: contractionary monetary policy increases earnings inequality, but only under high inflation. In low-inflation environments, inequality effects are small. The mechanism operates through stronger employment and wage adjustments at the bottom of the distribution during periods of high inflation. This highlights the need for joint evaluation of monetary and fiscal measures: targeted fiscal support can help mitigate inequality effects while allowing monetary policy to focus on stabilising prices. The study also stresses the importance of communication, since distributional concerns are more salient in high-inflation periods.

Monetary policy trade-off during an energy crisis is studied by Chafwehé, Colciago and Priftis (2024) and Audzei and Sutóris (2024), who show that the trade-off is intensified when energy prices are high. In Chafwehé, Colciago and Priftis (2024), monetary policy tightening reduces inflation but also weakens business creation and productivity-enhancing reallocation. Since energy intensity differs across sectors, the real effects of monetary policy become highly uneven. This suggests that complementary fiscal or credit policies may be needed to preserve business dynamism when interest rates remain high to maintain price stability. In Audzei and Sutóris (2024), monetary policy affects households' energy intensity of consumption through its impact on unemployment, precautionary motives and nominal asset return. Thus, it can stimulate or dampen households' incentives to invest in energy conservation and build resilience to energy price fluctuations. The policies stabilising inflation weaken investment into abatement and thus increase output volatility. The trade-off between output stabilisation and inflation stabilisation becomes more pronounced.

Several studies address monetary policy transmission to the real economy through the labour market. Ascari, Colciago and Membretti (2026) focus on monetary policy effects on the distribution of employment across firms of different sizes. Using US business dynamics statistics data linked to macro data through a mixed-frequency BVAR model, the authors estimate the response of job creation, job destruction, firm entry and firm exit to a contractionary monetary policy shock. They find that unemployment rises, firm entry falls and firm exit increases. Importantly, employment becomes more concentrated in large firms because small firms sharply reduce job creation and exit at higher rates. To interpret these patterns, the authors build a quantitative dynamic industry model with heterogeneous productivity, multi-worker firms, decreasing marginal returns, nominal rigidities and labour market frictions. The model embeds endogenous entry and exit and realistically matches the size

distribution of firms and employment concentration. Parameters are estimated by matching model impulse responses to those from the BVAR.

Monetary policy has significant reallocation effects across firms, where contractionary shocks disproportionately cause small firms to reduce job creation or exit.

Ascari, Colciago and Membretti (2026) show that monetary policy has significant reallocation effects across firms. A contractionary shock disproportionately affects small firms through lower job creation and higher exit, while large incumbents stabilise employment. This raises the employment share of large firms, increasing concentration. These dynamics matter for monetary policy because they shape the output-inflation trade-off. When concentration is realistic and exit is endogenous and size-dependent, the model generates a Phillips multiplier that matches the data. Therefore, the structure of firm dynamics, especially employment concentration and exit behaviour, is crucial for understanding the real effects of monetary policy. The results imply that monetary policy affects not only aggregate activity but also business dynamism, firm turnover and the composition of employment. For central banks, this highlights the importance of monitoring firm-level indicators and incorporating firm heterogeneity into models used for policy analysis.

The shift towards non-routine work increases labour market fluidity, which weakens the sensitivity of inflation to economic activity and flattens the Phillips curve.

Siena and Zago (2024) link job polarisation to the flattening of the Phillips curve in the euro area. Using micro data on employment by occupation, they document that the shift from routine to non-routine work increases labour market fluidity, measured by hiring and separation rates. Embedding these features in a New Keynesian model with search frictions, they show that greater fluidity weakens the response of unemployment to demand shocks and reduces the sensitivity of inflation to economic activity. These findings offer a structural explanation for a potentially weakened Phillips curve relationship: as labour markets become more fluid and dominated by non-routine jobs, inflation responds less to changes in unemployment. Consequently, larger movements in interest rates may be required to stabilise inflation, while the importance of labour market composition for inflation forecasting and policy design is underscored.

The findings above imply that the monetary policy authority should be aware of the effect of monetary policy decisions on the long-run dynamics of productivity and innovation, and their impact on resource allocation among different economic sectors. The real effects of monetary policy are shown to be state-dependent and to interact strongly with the economic structure. Sectoral composition, inflation regimes, labour market characteristics, firm dynamics and energy intensity all modify how policy transmits to the real economy. For central banks, the key message is that structural analysis must complement standard cyclical frameworks. Incorporating such information improves policy calibration and enhances the ability of monetary authorities to achieve price stability in a changing economic environment.

4.4 Concluding remarks and implications for policy analysis

The evidence reviewed in this section points to a set of transmission channels that operate through the supply side and through the allocation of resources across firms, sectors and workers. In particular, monetary policy affects innovation and technology adoption by shaping financing conditions and aggregate demand, with effects that can

persist beyond the immediate business cycle. At the same time, monetary shocks can trigger sectoral and firm-level reallocation, influencing measured aggregate productivity and the composition of output, while labour market adjustments and distributional responses condition how these mechanisms translate into consumption and inflation dynamics.

For policy analysis, these results suggest that assessments of the stance and of the inflation-output trade-off may be sensitive to how innovation, reallocation frictions and labour market heterogeneity are represented in the baseline and in scenarios. Empirical work documenting persistent effects of downturns and tightening on firms' innovation spending implies that potential output and productivity trends may be less exogenous than typically assumed over a policy-relevant horizon. Likewise, reallocation mechanisms – across sectors and across the firm-size distribution – can change concentration, employment composition and the propagation of shocks, affecting both the timing and incidence of monetary policy.

More broadly, the evidence suggests that monetary policy may matter for outcomes beyond short-run demand management through supply-side margins that remain relevant over a policy-relevant horizon. Tighter financial and demand conditions as well as downturns can weaken innovation investment and induce adverse reallocation, creating medium-run "scarring" effects on productivity and output, while easing that relaxes binding constraints may mitigate these dynamics by supporting productivity-enhancing investment and reducing misallocation. This does not imply that monetary policy determines the long-run steady-state growth rate of the economy. It does imply, however, that the policy path becomes one of the many factors that can influence the medium-run trajectory of the economy through innovation and allocation, so that stance assessment becomes less robust when it relies on time-invariant benchmarks for potential growth, the natural rate or r* in environments where these margins are active. Incorporating these channels in a disciplined way can therefore improve the interpretation of observed productivity movements, strengthen scenario design around supply-side disturbances and support a more robust evaluation of the medium-run feedback from monetary policy to the economy's supply side.

5 Climate change, energy transition and supply shocks

Energy shocks originate largely from the supply side and involve persistent structural adjustments rather than temporary disturbances.

Energy prices have emerged as a key driver of macroeconomic fluctuations in recent years. The post-pandemic recovery, Russia's invasion of Ukraine and increasingly binding climate policies have all contributed to pronounced volatility in oil, gas and electricity prices, while the transition towards net zero is generating persistent changes in relative prices, production structures and investment patterns. Unlike standard demand-driven inflationary episodes, energy shocks are largely supply-driven, propagate unevenly across sectors and households, and often involve persistent structural adjustments rather than temporary disturbances.

These features raise fundamental questions for the conduct of monetary policy. Should central banks tighten aggressively in response to energy-related inflation? To what extent might such tightening amplify reallocation frictions, dampen investment in energy-saving or green technologies, or prolong productivity losses? How do expectations about future energy prices and climate policies shape current pricing behaviour and inflation dynamics? And how does the uneven burden of energy shocks across households and firms affect monetary policy transmission and overall welfare?

Recent research provides new insights into these questions using a wide range of approaches, including multi-sector DSGE models with explicit energy inputs, heterogeneous agent models, empirical identification of energy and climate shocks and survey-based evidence on firms' and households' expectations. Despite differing methodologies, this literature conveys a clear and coherent message: energy shocks fundamentally alter the nature of the inflation-output trade-off, calling for a more state-contingent, forward-looking and context-sensitive monetary policy response.

The green transition can generate both inflationary and disinflationary forces, fundamentally altering the nature of the inflation-output trade-off.

The emerging picture is that energy shocks are not merely transitory cost-push disturbances but often reflect deeper structural forces linked to geopolitical developments, technological progress and the green transition. From a central bank's perspective, this alters the policy landscape in several important ways. First, as predominantly supply-side shocks, energy price increases are less amenable to standard demand management tools. Second, they create complex reallocation pressures, shifting resources away from energy-intensive sectors and potentially reducing aggregate productivity during the adjustment. Third, the effects are strongly distributional, disproportionately weighing on lower-income households and more energy-dependent firms, thereby influencing both the strength and the channels of monetary policy transmission. Moreover, the green transition itself – through climate policy, carbon pricing and the diffusion of green technologies – can generate both inflationary pressures and disinflationary forces, depending on whether the shock raises current production costs or improves future energy efficiency.

Against this backdrop, this section summarises the main findings of recent analytical contributions along three key dimensions: (i) energy shocks via reallocation,

productivity and climate transition; (ii) heterogeneity and inequality; and (iii) the implications for climate-conscious monetary policy.

Together, these areas illustrate how energy and climate change-related shocks reshape the macroeconomic environment in which monetary policy operates, requiring a careful balance between short-term stabilisation objectives and longer-term structural transformation.

5.1 Energy shocks, reallocation, productivity and climate transition

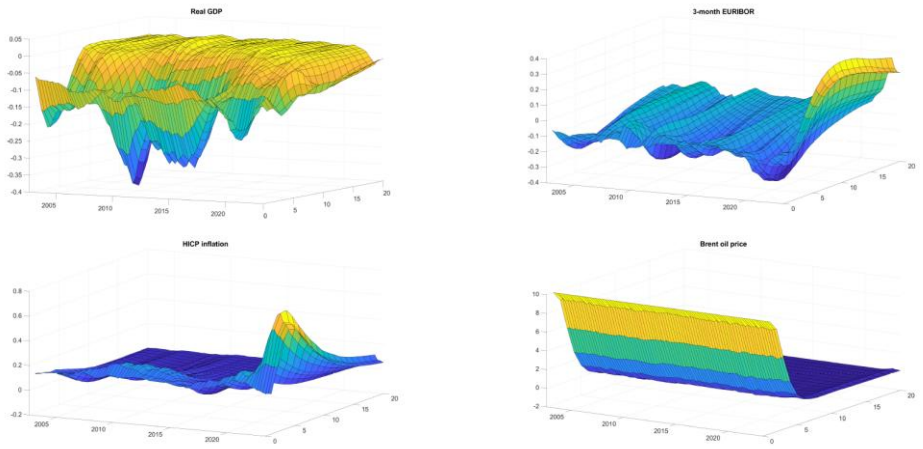
Monetary policy is generally expected to follow a "look-through" approach in response to inflationary energy price shocks – here proxied by oil supply shocks – as long as such shocks are assessed to be transitory and predominantly supply-driven (Zlobins, 2026). This prescription, however, is not unconditional. When rising energy prices give rise to a broad-based and persistent increase in inflation expectations, monetary policy may need to respond more forcefully to prevent second-round effects and safeguard price stability. The case for a stronger reaction becomes even clearer when the energy shock is large. In addition, the transmission of energy shocks depends on the prevailing inflation environment, as elevated inflation tends to increase the frequency of price adjustment, amplifying the pass-through of cost shocks to headline inflation.

The policy response to the large energy cost-push disturbances observed in 2021–22 illustrates this point. During this episode, the sharp increase in the pass-through of energy prices to headline inflation – associated with a de-anchoring of short-term inflation expectations and a temporary rise in aggregate profits – raised the risk that short-run inflation dynamics could spill over into longer-term inflation beliefs. Against this backdrop, a decisive monetary policy tightening was warranted to contain inflation persistence and prevent a de-anchoring of long-run inflation expectations.

Chart 13

The effects of energy price shocks in the euro area over time

(deviation from pre-shock level)



Source: Zlobins (2026).
Notes: The chart shows IRFs from the TVP-SVAR-SV to an oil supply shock, identified via sign and zero restrictions. The shock has been normalised to lead to a 10-percentage-point peak increase in the Brent oil price in each period, allowing the estimated elasticities to be comparable over time.

Energy price shocks primarily propagate through reallocation and supply-side channels, rather than through a uniform contraction in aggregate demand. In energy-importing economies, a persistent increase in fossil fuel prices raises production costs unevenly across sectors, triggering a gradual reallocation of labour and capital away from energy-intensive activities towards less energy-dependent production (Chafwehé, Colciago and Priftis, 2024). This adjustment process is inherently frictional, reflecting financial constraints and adjustment costs that limit firms' ability to reorganise production rapidly.

In the short run, these frictions lead to a decline in aggregate productivity and output, alongside rising inflation, giving rise to stagflationary dynamics. At the same time, higher energy costs induce a selection mechanism among firms: less productive and more energy-intensive firms are more likely to exit, while entry increasingly favours more productive and energy-efficient firms. As the reallocation unfolds, the competitive structure of the economy is reshaped, generating medium-term productivity gains across both manufacturing and services.

Supply-driven energy price increases generate stagflationary dynamics, whereas demand-driven increases resemble more standard cyclical expansions.

The importance of reallocation mechanisms also highlights that energy shocks are not homogeneous and that their macroeconomic consequences depend crucially on their underlying source (Alessandri and Gazzani, 2025). Energy price increases driven by supply disruptions – such as geopolitical events or constraints in energy infrastructure – differ markedly from those driven by stronger global demand. Supply-driven shocks primarily reflect an adverse terms-of-trade movement for energy-importing economies such as the euro area, raising production costs and compressing real incomes, while simultaneously reducing productive capacity. As a result, they generate pronounced stagflationary dynamics, with inflation rising alongside a contraction in output. By contrast, energy price increases driven by stronger global demand reflect stronger global economic activity and tend to co-move with broader expansions in output and

trade. In these cases, higher energy prices are less indicative of a binding supply constraint and are more a by-product of cyclical demand pressures, implying a more conventional inflation-output trade-off. The distinction between supply-driven and demand-driven energy shocks therefore has first-order implications for monetary policy. Responding aggressively to inflation arising from supply-driven energy shocks risks amplifying the associated output losses and delaying the reallocation of resources, while a more standard policy response may be appropriate when higher energy prices reflect demand-side pressures.

Taken together, these mechanisms reinforce that aggressive tightening when the energy shock is coupled with a strong de-anchoring of inflation expectations can be particularly costly in real terms, underscoring the importance of conditioning the monetary policy response on the nature and origin of the underlying energy shock rather than on observed inflation alone.

Finally, not all energy-related shocks are inflationary. Some shocks, particularly those associated with technological progress and energy efficiency improvements, can operate via deflationary supply-side disturbances, while others – such as transitory climate-related shocks due to extreme weather events – introduce additional, often temporary, sources of volatility that require a careful monetary policy framework.

Green technology shocks improve the inflation-output trade-off, allowing central banks to stabilise inflation with lower output costs.

Improvements in green technology alter the economy's energy intensity and production structure by reducing reliance on fossil fuels and lowering marginal costs over time (Ferriani, Gazzani and Natoli, 2025). These shocks stimulate investment and raise productive capacity, supporting output growth while gradually easing inflationary pressures. Although the initial investment response may generate short-run demand pressures, the medium-term effects tend to be disinflationary as production becomes more energy-efficient. As a result, green technology shocks improve the inflation-output trade-off faced by monetary policy, allowing central banks to stabilise inflation with comparatively lower output costs than in the case of adverse energy supply shocks.

Transitory climate-related shocks – such as unexpected temperature fluctuations – introduce additional supply-side disturbances. These shocks affect production conditions unevenly across sectors and regions, particularly in activities that are more climate-sensitive. In the short run, they can raise prices and depress output by disrupting labour productivity, energy demand and supply chains (Natoli, 2023). However, their effects are typically transitory and largely independent of domestic demand conditions.

The coexistence of these two types of shock has important implications for monetary policy. While green technology shocks tend to support both price stability and output over the medium term, transitory climate-related supply disturbances resemble temporary energy supply disruptions, for which aggressive monetary tightening might amplify output volatility without meaningfully addressing the source of inflation.

Moreover, beyond short-run reallocation and climate-related supply disturbances, energy shocks also propagate through investment decisions and expectations, creating inflationary pressures that are inherently forward-looking. During the energy

transition, firms' perceptions of future energy prices, regulation and carbon costs play a central role in shaping current pricing and investment behaviour, even in the absence of immediate changes in energy costs (Henriet, Lisack and Turunen, 2026). Consistent with this expectations-based transmission, Degasperi et al. (2026) show that climate policy announcements which primarily shift the expected pace of the transition ("path shocks") propagate empirically like negative demand shocks: industrial production contracts, unemployment rises and both headline and energy inflation decline. In their estimates, the deflationary effect reflects a broad-based downward revision in expected growth and sentiment, alongside heightened uncertainty, even as emissions fall and portfolio allocations tilt towards greener assets.

Anticipation of tighter climate policies can raise current marginal costs through higher investment spending and forward-looking pricing ahead of realised cost increases.

Anticipation effects are central to this mechanism. Expectations of higher future energy prices or tighter climate policies induce firms and households to reorient investment towards cleaner and more energy-efficient capital. Audzei and Sutóris (2024) show that a strong and persistent energy price shock generates a pronounced increase in energy-saving capital, driven by higher expected returns on energy-saving investment for unconstrained agents. This reallocation leads to a sustained decline in energy intensity, reflecting more efficient use of raw energy in consumption and production. At the same time, strong endogenous monetary policy response dampens these incentives through labour market outcomes and precautionary saving motives. These mechanisms introduce a dynamic trade-off for monetary policy. Tightening in response to green transition-related inflation may contain price pressures in the short run but risks slowing capital reallocation and delaying productivity gains associated with cleaner technologies (Degasperi et al., 2026). By increasing financing costs, restrictive policy can raise the overall cost of the transition and prolong reliance on energy-intensive capital, ultimately reducing long-run welfare. Conversely, a more accommodative stance – when inflation expectations remain anchored – can facilitate investment in green capital and support a smoother adjustment path.

Survey-based evidence reinforces the importance of expectations in this process (Angelico, 2024). Firms that anticipate higher future energy prices or more stringent environmental regulation tend to adjust prices earlier and plan larger investment shifts, indicating that beliefs about the transition translate directly into current inflation dynamics. This expectation-driven channel amplifies the impact of energy and climate policies on inflation and underscores the need for monetary authorities to distinguish between demand-driven price pressures and transition-induced inflation rooted in structural change.

Taken together, these dynamics link naturally with the role of green technology and climate shocks discussed above. While green technological progress ultimately alleviates inflationary pressures by improving energy efficiency, the investment and adjustment phase of the transition can be inflationary in the short run.

5.2 Heterogeneity, inequality and monetary policy transmission when energy shocks hit

Energy price shocks not only affect the economy through aggregate reallocation and productivity channels; they also propagate through heterogeneous household responses, with important implications for both aggregate dynamics and the transmission of monetary policy.

Less wealthy households experience consumption declines roughly three times larger than wealthier households following energy price shocks.

Because energy is both a necessity in consumption and a key input in production, increases in energy prices translate into uneven changes in real incomes, consumption possibilities and welfare across households. Bobasu, Dobrev and Repele (2025) use a heterogenous agent New Keynesian model and find pronounced distributional effects of energy price shocks and the associated monetary policy response. Households with limited wealth are disproportionately affected by increases in energy prices, reflecting their greater exposure to energy costs and their reliance on labour income. Under a passive monetary policy response, the decline in consumption among less wealthy households is around three times larger than that observed for wealthier households, whose consumption is only marginally affected. An active policy response amplifies these effects and causes a further reduction in consumption across all households. Notably, as policy rates increase more sharply, the relative reduction in consumption among wealthier households becomes even smaller compared with that of less wealthy households.

Nevertheless, the underlying drivers of these consumption responses differ markedly across household groups. For less wealthy households, the contraction in consumption is largely driven by indirect effects operating through labour income. Energy price shocks weaken economic activity and employment prospects, and an active monetary policy response deepens the downturn, thereby exacerbating income losses and amplifying the consumption decline for these households.

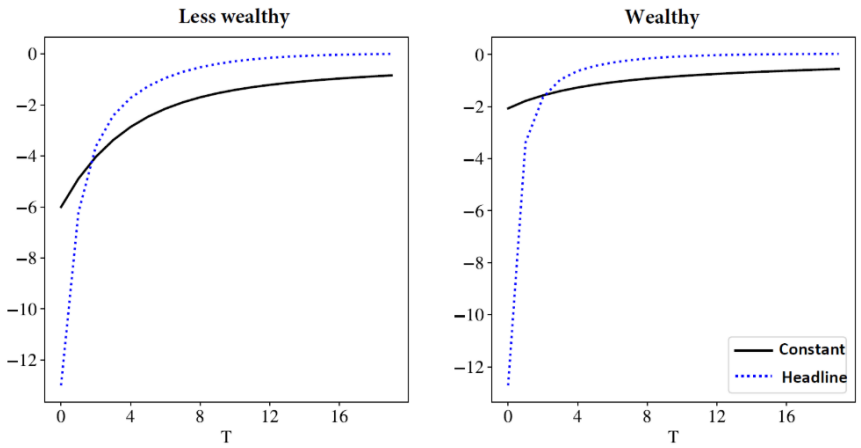
By contrast, the consumption response of wealthier households is primarily driven by the direct real interest rate channel. Facing higher real returns, these households choose to postpone consumption and increase savings. Indirect labour income effects play a limited role, as wealthier households rely less on labour income and are less exposed to energy price increases in their consumption basket.

Chart 14

Consumption response and its breakdown for wealthy and less wealth households

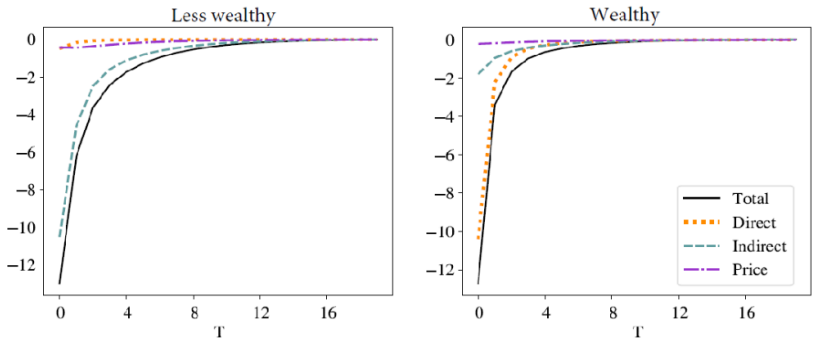
a) Consumption response under a policy rule keeping the real rate fixed and a rule reacting to headline inflation

(percentage deviation from steady state)



b) Breakdown of the consumption response into drivers for the policy rule reacting to headline inflation

(percentage deviation from steady state)



Source: Bobasu, Dobrev and Repele (2024).
Notes: in panel a), we plot a comparison of the consumption response of less wealthy and wealthy households under a policy rule that keeps the real interest rate fixed (labelled "constant") with a policy rule reacting to contemporaneous headline inflation (labelled "headline") for a 30% increase in foreign energy prices. In panel b), we plot a comparison of the decomposition of the consumption response of wealthy and less wealthy households under the policy rule reacting to contemporaneous headline inflation. The "direct" effect captures the contribution from a change in the real interest rate, the "indirect" effect captures income effects, and the "price" effect captures relative price changes as described in Appendix B in Bobasu, Dobrev and Repele (2024). "Less wealthy" refers to households in the lowest wealth quintile, whereas "wealthy" refers to households in the second highest wealth quintile. The Y axis denotes percentage deviations from steady state; the X axis refers to quarters following the shock.

Monetary policy influences agents' incentives to build resilience against energy price shocks; this influence is intensified by household heterogeneity.

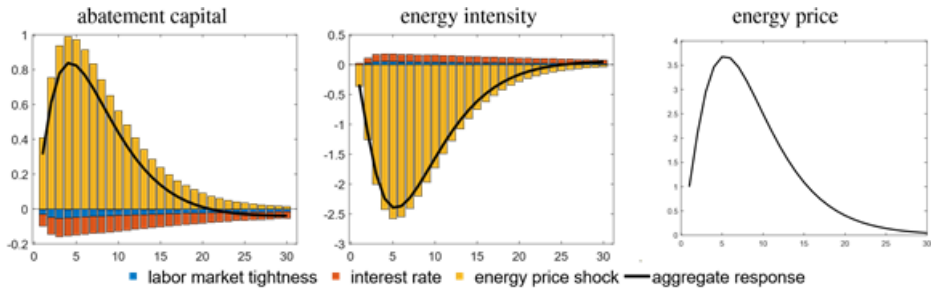
A role of household heterogeneity for monetary policy transmission when energy prices shock hits is addressed by Audzei and Sutóris (2024), who introduce energy conservation technology into a tractable heterogeneous agent New Keynesian model with energy in consumption and production. However, investment in this technology is unaffordable for poor and unemployed households. The agents in the model have different levels of energy intensity, and thus poorer households are more affected by the energy price shock. Monetary policy influences agents' incentives to invest in energy-saving capital through labour market outcomes, such as precautionary motives, share of constraint agents and nominal asset returns. The presence of energy conservation technology implies that the trade-off between output stabilisation and inflation stabilisation becomes more pronounced. The presence of heterogeneous

agents dampens households' incentives to invest in energy-saving capital even when facing rising energy prices through the labour market outcomes and investment-saving decisions.

Chart 15

IRFs to an energy shock: a decomposition

(percentage deviations from steady state)



Source: Audzei and Sutóris (2024);
Notes: The chart shows model-generated impulse responses to an unexpected 1% exogenous energy price shock, which is expected to peak in five quarters at 3.5%. The response is decomposed into the effect of energy prices, labour market tightness and interest rate. The labour market tightness reflects both agents' precautionary motives and a share of constrained agents; the interest rate is a return on nominal assets, which increases the debt burden for debtors and saving motives for unconstrained households. Both of these channels underline the role of household heterogeneity.

Besides aggregate implications, energy price shocks and the following monetary policy response can affect distributional outcomes. Energy price increases disproportionately affect lower-income and liquidity-constrained households, which devote a larger share of their expenditure to energy and have limited scope to smooth consumption. As a result, aggregate consumption declines not only because average real income falls, but also because marginal propensities to consume are higher among the households most exposed to the shock. In this context, monetary tightening in response to energy-driven inflation can exacerbate the initial contraction by further compressing labour income and limiting access to credit, even if it supports a faster recovery for wealthier households through higher returns on savings.

These mechanisms also translate into distinct and uneven adjustment patterns across households. Higher energy prices encourage both reductions in energy consumption and investment in energy-saving technologies, but the ability to adjust along these margins is highly unequal. Better-off households are more capable of financing energy efficiency improvements, whereas constrained households adjust primarily by cutting consumption, often at significant welfare cost. Monetary policy can reinforce these asymmetries: tighter policy raises borrowing costs and weakens labour income prospects, further delaying investment in energy-saving technologies for constrained households. As a result, the adjustment process becomes not only slower but also more regressive.

5.3 Climate-conscious monetary policy

The transmission channels discussed above point to a broader implication for the conduct of monetary policy in an economy increasingly affected by green transition

and climate change shocks. While central banks are not tasked with achieving climate objectives per se, the growing importance of energy price volatility, climate risks and the green transition requires monetary policy to become climate-conscious in its assessment of inflation dynamics and macro-financial conditions. This is also consistent with the ECB's 2021 strategy review, which explicitly recognised that climate change has implications for price stability and committed the ECB to incorporate climate change considerations into its monetary policy framework within its mandate.

A climate-conscious approach to monetary policy does not imply that central banks should directly target emissions or steer the transition through interest rate policy, but it does require energy and climate considerations to be incorporated into forecasting frameworks, scenario analysis and risk assessment.

A climate-conscious approach therefore does not imply that central banks should directly target emissions or steer the transition through interest rate policy (Nakov and Thomas, 2023). Rather, it requires energy and climate considerations to be incorporated into forecasting frameworks, scenario analysis and risk assessment, and the policy response to be adjusted accordingly. This entails greater tolerance of supply-driven inflation when it reflects necessary structural reallocation, alongside vigilance against second-round effects on wages and inflation expectations that could undermine price stability.

Furthermore, the large economic damages associated with greenhouse gas emissions and their procyclicality imply that the natural output gap does not necessarily coincide with the welfare-relevant output gap. Giovanardi and Kaldorf (2025) show how this affects the optimal monetary policy response to business cycle shocks in a small-scale New Keynesian DSGE model. They find that monetary policy can be conducted as usual if climate policy takes the procyclicality of emissions into account, for example by adjusting carbon taxes or the amount of emission allowances appropriately over the business cycle. If climate policy fails to account for such cyclical variations, the optimal interest rate is slightly less responsive to productivity shocks, although its effects are quantitatively small.

5.4 Concluding remarks and implications for policy analysis

This section has shown that energy price shocks fundamentally reshape the environment in which monetary policy operates. Unlike conventional demand-driven fluctuations, energy shocks predominantly reflect supply-side disturbances and structural transformation, altering relative prices, production structures and income distribution. Crucially, however, the policy implications differ depending on whether the shock is a conventional fossil energy supply disruption, a structural price shift associated with the green transition or a transitory climate-related disturbance. Recognising these distinctions is essential for calibrating the appropriate monetary policy response.

First, energy shocks operate largely through reallocation and productivity channels. Higher energy prices force resources away from energy-intensive activities and trigger firm exit and capital restructuring. While these processes can generate medium-term productivity gains, they are slow and costly in the short run, producing stagflationary dynamics.

Second, the macroeconomic effects of energy shocks depend critically on their source. Supply-driven energy price increases compress real incomes and productive capacity, creating sharp policy trade-offs, whereas demand-driven price increases resemble more standard cyclical expansions.

Third, heterogeneity and inequality are central to understanding energy shocks and monetary policy transmission in response to these shocks. Energy price increases disproportionately affect lower-income and liquidity-constrained households, whose consumption responses affect aggregate demand more strongly through higher marginal propensity to consume. Monetary tightening amplifies these effects, shifting the burden of adjustment towards more vulnerable households, while wealthier households respond primarily through intertemporal substitution and higher savings.

Fourth, energy shocks interact with investment decisions and expectations, particularly during the green transition. Anticipation of higher future energy prices or stricter climate policies can raise current inflation through forward-looking pricing and capital adjustment, even before energy costs materialise. Such transition-driven inflation reflects structural change rather than cyclical overheating. The policy challenge here is distinct from that posed by transitory disturbances: premature tightening may slow capital reallocation towards cleaner technologies and reduce long-run welfare, yet prolonged accommodation risks de-anchoring inflation expectations if the transition proves uneven or protracted.

Fifth, not all energy-related shocks are inflationary. Green technology shocks may improve energy efficiency and productive capacity, easing inflationary pressures over time. By contrast, transitory climate-related supply disturbances – such as temperature shocks or extreme weather events – tend to be short-lived and self-correcting, calling for a look-through approach rather than aggressive stabilisation. It is important to note, however, that a policy of looking through such transitory shocks does not automatically extend to the structural price pressures of the green transition, which operate over longer horizons and through fundamentally different channels.

Taken together, these findings point to the need for a climate-conscious and state-dependent monetary policy framework. Such an approach does not entail targeting climate outcomes directly but rather integrating energy and climate considerations into the assessment of inflation dynamics, expectations and real adjustment costs. State dependence is essential precisely because the optimal response varies across shock types: conventional supply disruptions may warrant measured tightening to contain second-round effects, transitory climate disturbances are best looked through, and transition-related structural pressures require a careful balancing of accommodation to support reallocation against the imperative of keeping expectations well anchored.

6 Cross-cutting policy implications and conclusions

Much of the analytical framework implicitly underpinning the 2020 strategy review was built for a low-inflation environment characterised by persistent slack, a flat Phillips curve and repeated inflation undershooting. In that context, linearised representative agent models provided a workable approximation: the effective lower bound and episodic financial amplification were the main non-linearities, supply shocks were typically treated as transitory, and transmission was assumed broadly stable across states.

The post-2021 environment assessed in the 2025 strategy assessment differs materially. The evidence reviewed in this Occasional Paper indicates that the euro area has faced repeated cost and supply disturbances, a sustained shift towards services, heterogeneous balance sheets and state-dependent price-setting. Transmission is therefore neither linear nor uniform across sectors, regions, firms and households, but monetary policy remains effective and consistent with monetary analysis. However, the central implication is that policy assessment should no longer rely on a time-invariant mapping from monetary policy to inflation and activity. Echoing Friedman's "long and variable lags", the evidence points to a framework in which diagnosis of the state of the economy and the nature of the shocks is explicit, and in which the expected lags, pass-through and incidence of policy are treated as state-contingent objects.

6.1 Transmission is not a constant

The evidence reviewed in this Occasional Paper documents systematic heterogeneity in transmission across sectors, firms and households, with three conditioning dimensions that are particularly relevant for euro area policy.

First, economic structure matters. A more services-intensive economy is associated with different real effects of monetary policy, and changes in sectoral composition can shift aggregate transmission and its incidence across regions and sectors (Hauptmeier, Holm-Hadulla and Saporito, 2025). Evidence at the level of consumption items likewise points to substantial dispersion in price sensitivities to monetary policy (Allayioti et al., 2024).

Second, financial constraints generate asymmetries. When multiple financing constraints bind, tightening can be amplified while easing can be dampened, and leverage conditions can strengthen the transmission of monetary policy to prices even when output responses are broadly unchanged (Holm-Hadulla and Thürwächter, 2024; Perez-Orive, Timmer and van der Ghote, 2026). Related evidence suggests that financing conditions can also affect firm dynamics and competitive pressures,

providing an additional source of time variation in pass-through (Popov and Steininger, 2023).

The frequency of price adjustment increased sharply during the inflation surge, resulting in an unusually low sacrifice ratio during disinflation.

Third, pricing is regime-dependent. Micro evidence shows that the frequency of price adjustment increased sharply during the inflation surge, with the extensive margin playing an important role (Gagliardone et al., 2025; Gautier et al., 2025). Macro evidence points to time variation in the strength and lags of transmission and to a low sacrifice ratio during the recent tightening cycle, consistent with a steepening Phillips curve when prices adjust more frequently (Zlobins, 2025; Ascari et al., 2025). The implication is not that standard benchmarks become uninformative, but that lags, pass-through and sacrifice ratios should be treated as state-contingent rather than fixed (Zlobins, 2025).

6.2 Not all inflation is the same: supply shocks and response calibration

The recent period has shown that supply shocks are not rare events that can simply be "looked through".

The recent period has shown that supply shocks are not rare events that can simply be "looked through". The euro area faces a broader set of disturbances – including global value chain bottlenecks, energy price shocks, climate policy shocks and temperature shocks – whose persistence and incidence depend on structural exposure (Natoli, 2023). Network evidence underscores that shocks can propagate through production linkages and generate uneven sectoral and regional effects, altering aggregate trade-offs (Aguilar et al., 2026; Duprez and Magerman, 2018).

Energy shocks illustrate why diagnosis is essential. The paper documents that energy price shocks propagate importantly through reallocation and supply-side channels (Chafwehé, Colciago and Priftis, 2024; Ascari et al., forthcoming), and that macroeconomic consequences depend on whether energy price movements are supply-driven or demand-driven (Alessandri and Gazzani, 2025). Heterogeneity is central: energy price increases disproportionately affect lower-income and liquidity-constrained households, and policy responses can shift the burden of adjustment through labour income and credit channels (Bobasu, Dobrev and Repele, 2024; Audzei and Sutóris, 2024).

Calibration should be guided by shock source and persistence, by the degree of propagation through production linkages and energy exposure, and by the prevailing pricing regime.

These insights support a conditional principle: "looking through" is generally appropriate for transitory, predominantly supply-driven shocks, but it is not unconditional when broader price-setting dynamics and risks of second-round effects become salient (Zlobins, forthcoming; Burban, De Backer and Vladu, 2024; Audzei and Sutóris, 2024). This shock-contingent approach is also consistent with the ECB's 2021 monetary policy strategy, which reaffirmed a medium-term orientation for monetary policy, implying that policy should respond to shocks according to their implications for the medium-term inflation outlook rather than to short-run price movements alone. In practice, calibration should therefore be guided by shock source and persistence, by the degree of propagation through production linkages and energy exposure, and by the prevailing pricing regime that shapes pass-through and persistence (Aguilar et al., 2026; Gagliardone et al., 2025; Zlobins, 2025; Karadi et al., 2025).

6.3 Monetary policy in an economy undergoing structural transition: why the mapping to inflation changes

This Occasional Paper documents that the ongoing structural transitions in the euro area – sectoral rebalancing towards services, reorganisation of global value chains, evolving market structure, and the climate and energy transition – are reshaping inflation dynamics and transmission (Hauptmeier, Holm-Hadulla and Saporito, 2025; Popov and Steininger, 2023). Two implications stand out.

First, structural policies set the direction of these transitions, while monetary policy shapes the macro-financial conditions under which they unfold. Monetary policy cannot deliver structural objectives such as higher productivity or decarbonisation, but it can influence the timing and resilience of transition-related investment when adjustment margins are constrained (Henriet, Lisack and Turunen, 2026; Nakov and Thomas, 2023).

Parts of the structural transition are forward-looking, meaning measured inflation may reflect adjustment costs rather than purely cyclical overheating.

Second, parts of the transition are forward-looking: anticipation of higher future energy prices or stricter climate policies can affect current pricing and investment, so that measured inflation may partly reflect adjustment costs and re-optimisation rather than purely cyclical overheating (Henriet, Lisack and Turunen, 2026).

6.4 Overall policy implications

Against this backdrop, the ChaMP network was tasked with analysing mandate-critical questions on the interplay between structural change and monetary policy. This Occasional Paper synthesises the evidence around four questions.

First, how does structural change affect the strength, speed and heterogeneity of transmission? Transmission varies systematically with structural states and cannot be summarised by time-invariant mapping: it is dampened in more services-intensive economies, becomes more asymmetric when multiple financial constraints bind and differs across inflation regimes as price-setting adjusts endogenously.

Second, can monetary policy influence structural dynamics? The evidence reviewed suggests that a strict separation between short-run stabilisation and supply-side outcomes may not be possible. At the same time, the available evidence does not imply that such supply-side effects necessarily dominate over a full business cycle, as several ChaMP contributions point to broadly similar effects of monetary tightening and loosening on innovation investment and reallocation. The state dependence of the degree of such symmetry would be a fruitful area for future research.

Third, what are the implications for the natural rate and long-run benchmarks? If innovation, productivity and allocation respond to monetary conditions, then the natural rate may possibly not be invariant to monetary history. This strengthens the case for avoiding purely time-invariant benchmarks in stance assessment and for using scenarios under which medium-run supply effects feed back into the policy-relevant trade-offs.

Fourth, how should policy respond to structural shocks, recurrent supply disturbances and the green transition? Appropriate calibration depends on the nature of innovation (source and persistence) and on structural propagation (networks, energy exposure and constraints). A “look-through” approach to supply-driven inflation is therefore conditional, and transition dynamics can shift pricing and investment in a forward-looking way that matters for inflation persistence and policy trade-offs.

Baseline analysis should integrate state-contingent transmission mechanisms – such as sectoral composition and inflation regimes – rather than fixed lags.

Taken together, these findings point to priorities for the analytical framework used in policy assessment. Baseline analysis should integrate state-contingent transmission mechanisms – sectoral composition, balance sheet constraints and inflation regimes – rather than relying on fixed lags. Scenario design should incorporate recurrent supply disturbances and their propagation through production linkages and energy exposure, alongside heterogeneity in household and firm responses. Finally, given the evidence and theory on innovation, reallocation and scarring, medium-run supply channels should be represented symmetrically between loosening and tightening and in a way that allows policy paths to influence the evolution of potential and the assessment of R*, while transition dynamics should be treated consistently in baseline and scenario exercises, including forward-looking investment and pricing responses to climate and energy policies.

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Guido Ascari
De Nederlandsche Bank, Amsterdam, The Netherlands; email: g.ascari@dnb.nl

Volha Audzei
Ceska Narodni Banka, Prague, Czech Republic; email: volha.audzei@cnb.cz

Gert Bijnens
Nationale Bank van België/Banque Nationale de Belgique, Brussels, Belgium; email: gert.bijnens@nbb.be

Alina Bobasu
European Central Bank, Frankfurt am Main, Germany; email: alina.bobasu@ecb.europa.eu

Andrea Colciago
De Nederlandsche Bank, Amsterdam, The Netherlands; email: a.colciago@dnb.nl

Emmanuel Dhyne
Nationale Bank van België/Banque Nationale de Belgique, Brussels, Belgium; email: emmanuel.dhyne@nbb.be

Michaela Elfsbacka-Schmöller
European Central Bank, Frankfurt am Main, Germany; email: michaela.elfsbacka_schmoller@ecb.europa.eu

Alex Grimaud
Oesterreichische Nationalbank, Vienna, Austria; email: alex.grimaud@oenb.at

María Teresa Valderrama
Oesterreichische Nationalbank, Vienna, Austria; email: maria.valderrama@oenb.at

Andrejs Zlobins
Latvijas Banka, Riga, Latvia; email: andrejs.zlobins@bank.lv

Postal address 60640 Frankfurt am Main, Germany
Telephone +49 69 1344 0
Website www.ecb.europa.eu

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