Monetary policy in the face of supply shocks: the role of inflation expectations

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Abstract

How should monetary policy respond to a supply shock? How would that response change if supply shocks became more frequent? What role should inflation expectations play in the appraisal and calibration of that response? To seek answers to these perennial questions, we present new analysis and review recent developments in the academic literature, drawing on the main factors that should inform the monetary policy response, and highlighting some open questions concerning inflation expectations, how they form and how they influence pricing and economic activity.[6]

1 Response to a single supply shock

Supply shocks come in different shapes and sizes. Depending on the characteristics of the shock, and the nature and state of the affected economy, a supply shock may or may not require a monetary policy response, and may or may not induce a monetary policy trade-off. [7] This section discusses some important theoretical contributions on the monetary policy response to a specific type of supply shock – namely an increase in the global price of energy – in open, energy-importing economies such as the Euro Area or the United Kingdom.[8] The following section explores how a succession of supply or cost-push shocks could change the optimal policy response.

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7 We should be clear at the outset that there are better suited policies to address most supply shocks; in particular, monetary policy cannot substitute for a robust first-best policy designed to prevent and/or mitigate systemic shocks to energy provision. In this paper we are concerned with the residual volatility left to monetary policy, once more appropriate policies have been implemented. We come back to this point in Section 2.

8 Much of the intuition would carry over to a global food price shock or indeed a global good price shock; from the perspective of the UK economy, for example, as a net importer of goods, increases in goods' prices represent an adverse terms-of-trade shock.

1.1 The standard response: "looking through"

The orthodox monetary policy response to a global shock to energy prices is to "look through" them. For instance, in 2011 UK inflation rose above 5% largely due to a sharp increase in global energy prices. The Bank of England's Monetary Policy Committee (MPC) did not raise interest rates in response, and when the shock faded, inflation returned to the 2% target.[9] The rationale for looking through energy price shocks is that the main effects of monetary policy on the economy come through with some delay. Estimates of the speed of policy transmission vary, but the peak impact of policy on inflation typically comes sometime beyond the first year following a change in the policy rate.[10] That makes responding to short-lived price-level impacts of energy shocks counterproductive, since they drop out of the annual inflation calculation by the time the policy impact is at its peak. Trying to offset such shocks with an increase in the policy rate would cause more inflation volatility rather than less, making it more difficult to meet the inflation target in the medium term.

For concreteness, suppose that an unanticipated increase in global energy prices raises measured inflation in an energy-importing economy from 2% to 6%.[11] After twelve months, assuming energy prices remain at their new, higher level but do not experience another unanticipated shock, the energy contribution to headline inflation will disappear, and the headline inflation rate should fall back to target.[12]

Rather than "looking through" the shock (as illustrated by the solid blue line in Chart 1), the central bank could try to lean against the shock by tightening monetary policy (as illustrated by the dotted orange lines). However, monetary policy works with a lag, building towards peak effectiveness after 12-18 months. If, for example, the central bank wanted to achieve the inflation target 6 months after the shock, it could quickly tighten monetary policy when the shock hits. But because policy works with a lag, to hit the target after 6 months the central bank would need to be willing to undershoot the inflation target at 12 months, and subsequently bring inflation back to target from below by loosening monetary policy (as illustrated by the dashed orange line).[13] Many other paths are possible, but given the nature of this specific shock,

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9 See e.g. the Bank of England's May 2011 Inflation Report.

10 Cloyne and Hürtgen (2016) find that a one percentage point tightening leads to a maximum decline in industrial production of 0.6 percent and a fall in inflation of 1.0 percentage points after two to three years. In a shorter sample that starts in 1993, the peak effect from a change in Bank Rate on inflation occurs about twelve months after the change, with the peak impact on output somewhat later. Also in a more recent sample, Cesa-Bianchi et al (2020) use a high-frequency identification approach and find a peak effect on inflation at about 10 months and peak effect on unemployment (and monthly GDP) at about 20 months. Other studies, including many for the US, typically find the peak effect to occur somewhat later, at around 18-24 months (e.g. Christiano et al (1999), Romer and Romer (2004), Bernanke et al (2005)).

11 For a different argument that applies to economies that can influence energy prices, see e.g. Gornemann et al. (2022). Our analysis focuses on economies that are price takers in energy markets.

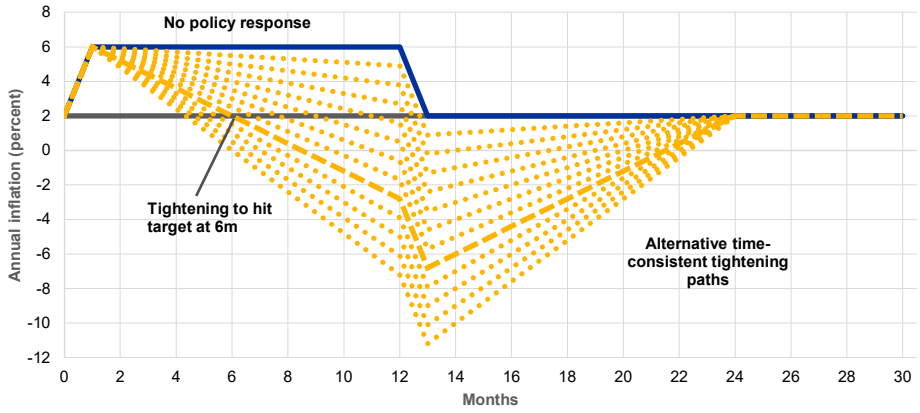
12 Alternatively, if the change in the relative price of energy turns out to be transitory rather than permanent, negative energy price inflation would pull aggregate inflation below target in the second year in the absence of a monetary policy response.

13 One might argue that after an initial sharp tightening, the central bank could loosen policy more aggressively at the 6-month point to avoid the inflation undershoot. But that only works if the central bank can repeatedly surprise firms and households. If the loosening after 6 months was pre-announced or anticipated, it would immediately reduce longer-term interest rates, preventing the central bank from setting a sufficiently tight policy stance to achieve the inflation target at 6 months. It is virtually impossible to formulate a credible, time-consistent (i.e., anticipated) policy path that returns inflation to target at 6 months without incurring an inflation undershoot further out.

any shortening of the period of above-target inflation will necessarily come at the cost of undershooting the inflation target for some period in the medium term.

Chart 1

Looking through an energy price shock



Sources: Authors' illustration.

For a central bank with a symmetric inflation target, it is not obvious that shortening the period of above-target inflation at the cost of incurring a period of below-target inflation is the optimal thing to do. If, moreover, the central bank has a secondary objective to limit output or employment volatility, it may indeed be a suboptimal path to follow.[14] In an open economy, leaning against the imported inflation stemming from an energy shock requires lowering domestic price and wage inflation. Monetary policy can achieve that with some lag, but only by lowering aggregate demand, which will reduce output and raise unemployment.[15]

1.2 Second-round and real-income effects

The previous considerations do not mean that monetary policy should always look through energy price shocks. When the shock fades, inflation will only fall back to target quickly if there are limited spillovers to, and inertia in, domestically set wages and prices. As it happens, such a lack of inflation inertia, that is, no inflation persistence beyond what is inherited from the output gap, is a well-known feature of the simple textbook New Keynesian model. However, in reality, binding nominal or real rigidities can give rise to inertia or "second-round effects". For instance, wages, benefits, or certain services prices such as rail fares, could be indexed to headline inflation, delaying the return of inflation to target.

[14] See e.g. the counterfactual exercises in Broadbent (2021) and Tenreyro (2022).

[15] In a world of low equilibrium real interest rates, the risk of hitting the effective lower bound on the policy rate must also be weighed up against potential risks to longer-term price stability from a period of above-target inflation (see e.g. Evans et al (2015)).

In an influential paper, Blanchard and Gali (2007) show how real-wage resistance can delay the return of inflation to target after a supply shock. From the perspective of an energy-importing economy, an increase in global energy prices is an adverse terms of trade shock. Real incomes and real wages fall on impact. But if workers try to resist a fall in their real income by making higher nominal pay demands, and firms try to defend their real profits by raising domestically set prices, real-income resistance can lead to nominal inertia and delay the return of inflation to target.[16]

In the presence of such real-wage or relative-price resistance combined with downward nominal rigidity, an energy price shock works much like a cost-push shock in the New Keynesian model. Abstracting from questions of timing and policy lags for a moment, the Phillips Curve "shifts inward," and the central bank faces a trade-off between stabilising inflation and stabilising the welfare-relevant output gap, as illustrated in Chart 2. In the chart, we assume the central bank seeks to minimise the sum of inflation deviations from target and output deviations from potential, subject to the aggregate supply constraint of the economy, represented by the New Keynesian Phillips Curve. The resulting monetary policy response curve (MR) depends on the relative weight the central bank places on stabilising output vis-a-vis stabilising inflation (represented by the parameter "lambda" in the canonical specification). The central bank will raise interest rates to reduce inflation, effectively leaning against the inertia that stems from real-wage or profit resistance. But it will not try to return inflation to target immediately, because that would be too costly in terms of output and employment volatility. Note that this is a different rationale for caution than the one discussed in Section 1.1: In that case, the central bank faced a trade-off between above-target inflation in the near term and below-target inflation in the medium term. In this case instead, the central bank faces a trade-off between stabilising inflation and stabilising output.

It is also possible for second-round effects to be state-contingent. For instance, high headline inflation would be more likely to lead to stronger nominal pay demands if the labour market were tight to begin with.[17] It is difficult, however, to disentangle these different drivers and their possible interaction quantitatively. In a recent contribution, Bernanke and Blanchard (2023) find that labour market tightness played only a minor role in driving US inflation over the past two years.[18]

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16 Lorenzoni and Werning (2023) study the role of distributional conflict in inflation dynamics in a general setting. A similar "battle of the mark-ups" mechanism is present in Layard and Nickell (1986).

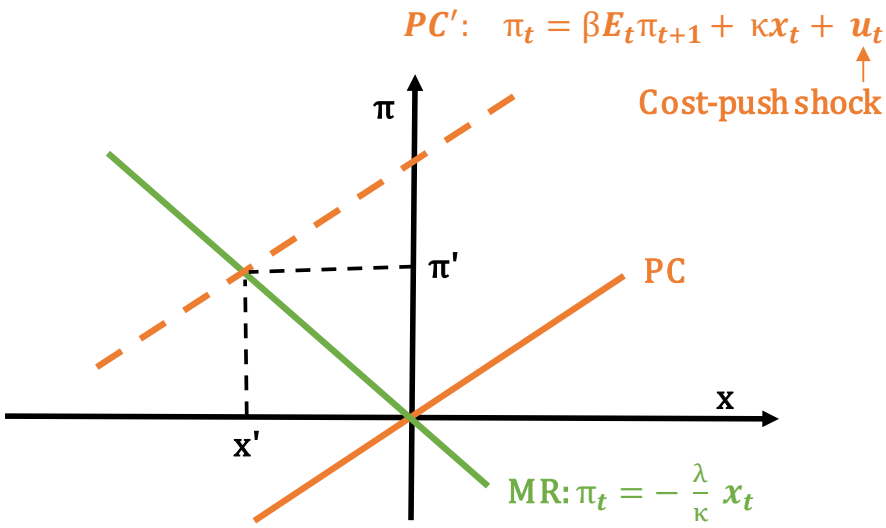
17 See e.g., Eggertsson and Benigno (2023).

18 Guerrieri et al. (2023) stress a similar point for the EA economy, highlighting the role of energy prices and their impact on relative prices as the main drivers of recent EA inflation.

Chart 2

With real wage resistance, an energy shock works much like a cost-push shock

A cost push shock in the standard New Keynesian model



Sources: Adapted from McLeay and Tenreyro (2020).

The bottom line is that in the presence of second-round effects, looking through energy shocks may no longer be optimal.[19] By tightening monetary policy somewhat, the central bank can bring inflation back to target more quickly without necessarily pushing inflation below target further out (Chart 3). There are however limits: Inertia from indexation is a mechanical consequence of shocks that push up on headline inflation; monetary policy can neither prevent the indexation mechanism nor, given lags, the initial direct inflationary effects of the shock. There is also evidence that the inflation perceptions of some households and firms are particularly influenced by highly visible prices, such as energy and food, rather than the aggregate inflation rate.[20] Since central banks in open economies have little control over these largely global prices, their ability to prevent indexation effects stemming from the impact of energy or food prices may be limited. This, along with the lags in monetary policy transmission, lends the rationale to mandates focused on medium-term inflation.

One consideration that may limit the extent of tightening, allowing for some more accommodation of short term inflation, arises from efficiency considerations in multi-sector settings a la Aoki (2001) or Woodford (2003). Rubbo (2020), Guerrieri et al (2022), Fornaro and Romei (2022) and Guerrieri et al (2023) point out that in settings with downward nominal rigidities, in which shock exposure varies across sectors, it is efficient for sectoral prices to move differentially, generating temporary dispersion in

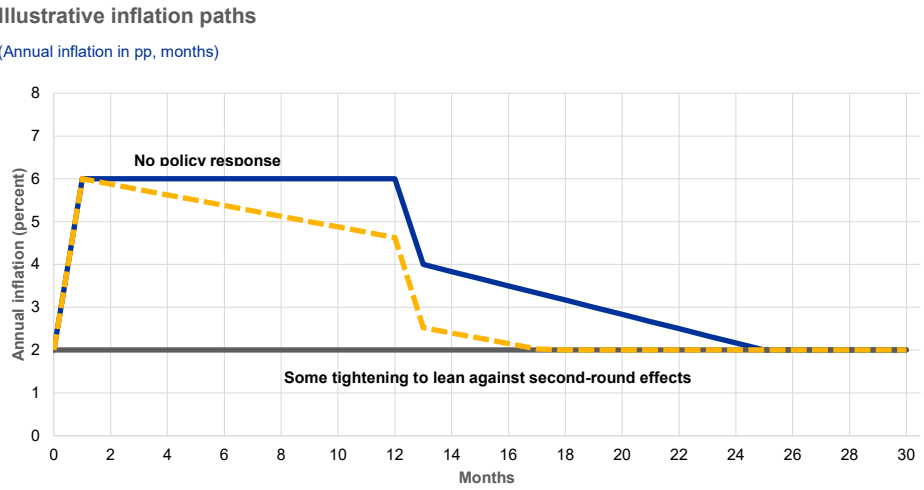
19 Note that Blanchard and Gali (2007) portray their contribution as providing a rationale for a trade-off compared to the baseline New Keynesian model in which divine coincidence holds, and hence the central bank fully offsets any inflation stemming from supply shocks by aggressively tightening monetary policy. This is because the baseline model does not feature monetary policy lags, and hence the central bank can immediately offset all inflation in the period the shock hits.

20 See e.g. Coibion and Gorodnichenko (2015) and D'Acunto et al. (2019).

sectoral inflation. Allowing for a temporarily higher rate of aggregate inflation can facilitate an efficiently swift relative-price adjustment.[21]

Chart 3

Leaning against second-round effects of an energy price shock



Sources: Authors' illustration.

The idea is illustrated in Chart 4, showing a stylised two-sector setting, with one sector that uses energy intensively and a second sector that features low use of energy. In response to the energy shock, the prices of energy and energy-intensive goods and services increase and their consumption falls. Households reallocate consumption towards relatively cheaper, less energy-intensive goods and services. In an energy-importing open economy, the former tend to be imported while the latter tend to be domestically produced. In such settings, sectoral supply constraints can lead to higher domestic inflation, and increased demand for domestic non-energy intensive sectors creating an expansion in *domestic* output and employment (as illustrated by the dashed orange line in Chart 4). Whether or not domestic demand increases depends on a number of considerations. An important one is the elasticity of substitution between energy-intensive and non-energy intensive goods and services.[22]

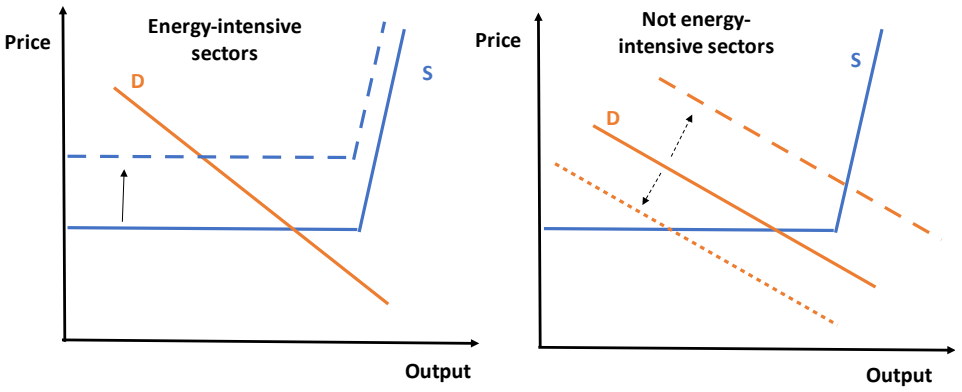
[21] This might indeed be a rationale for the flexibility embedded in most central bank mandates operating in flexible inflation-targeting regimes.

[22] See e.g. Bachmann et al. (2022).

Chart 4

Relative price and real income effects of an energy price shock

Illustrative diagram



Sources: Authors' illustration.

A second consideration is the response of real incomes and hence demand. The standard open-economy New Keynesian model assumes a representative household with unencumbered access to financial markets. This household behaves in accordance with the permanent income hypothesis; it takes a view on its lifetime income and smooths consumption over time by saving and borrowing. When the representative household is hit by an adverse terms-of-trade shock, its current real income falls. However, provided the shock eventually fades, the impact on the household's permanent income is small.[23] And because the household consumes out of permanent rather than current income, the effects of the terms-of-trade shock on demand are also small.

In practice, many households are financially constrained or for other reasons do not act in line with the permanent income hypothesis.[24] Auclert et al (2023) show in a recent paper that the real-income loss owing to an energy shock can lead to a reduction in aggregate demand, which endogenously reduces the persistent inflationary effects of the energy shock.[25] This channel, illustrated by the dotted orange line in the stylised Chart 4, can push inflation below target in the medium term.[26]

Chan et al. (2022) make a similar point in a more tractable two-agent New Keynesian (TANK) model. [27] Chart 5 shows the impulse responses of consumption,

[23] Alternatively, if the increase in the relative price of energy is permanent, the real income hit is permanent and hence larger relative to permanent income. A representative Ricardian household would then immediately cut consumption.

[24] Low-income households, which are more likely to be financially constrained, are also likely to be disproportionally affected by an adverse energy price shock. See e.g. Pieroni (2023).

[25] The idea builds on the Keynesian-supply shock of Guerrieri et al (2022); the authors highlight the role of financially constrained households in a real model and show how the initial supply shock can turn into a demand shock.

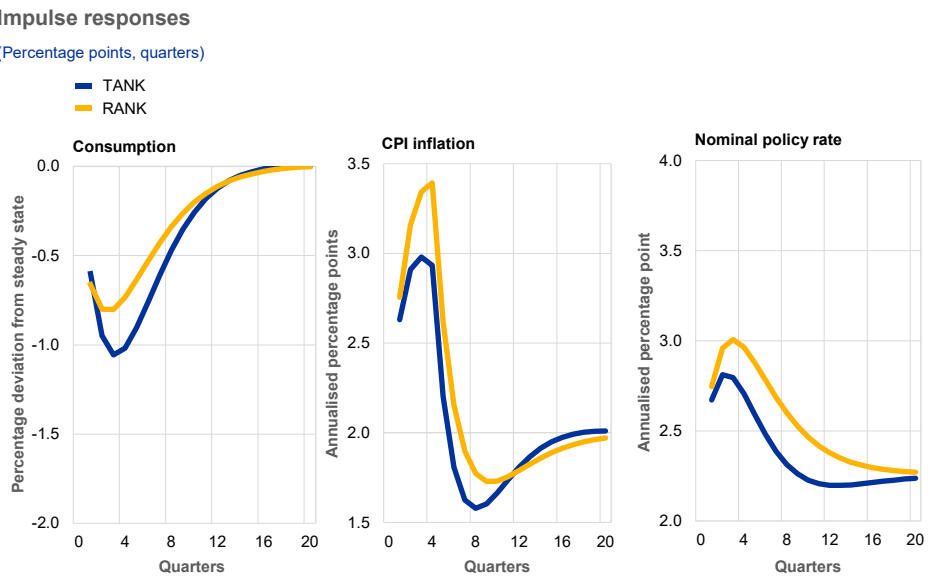
[26] See e.g. Tenreyro (2022).

[27] In contrast to Auclert et al. (2023), consumption falls instead of rising in Chan et al.'s (2022) RANK baseline. This is largely because the latter model's Taylor rule features a higher weight on inflation stabilisation. The recession in Chan et al.'s (2022) RANK model is induced by an active monetary policy maker, not by the energy shock itself.

inflation and the nominal policy rate to an energy-price shock in open-economy RANK and TANK models. The central bank leans against inflation by raising interest rates, which generates a decrease in aggregate consumption. But compared to the representative agent baseline, the TANK model with some constrained households generates a weaker path for both consumption and inflation in response to an energy shock, which requires a looser path for monetary policy to return inflation to target in the medium term (Chart 5). As Chan et al (2022) highlight, in line with Auclert et al (2023), for sufficiently severe financial constraints, the optimal monetary policy response could even be an outright loosening of the monetary policy stance.

Chart 5

An energy shock in RANK and TANK models



Sources: Chan, Diz and Kanngiesser (2022).
Notes: The steady-state CPI inflation rate is 2.0% and the steady-state nominal policy rate is 2.25% here.

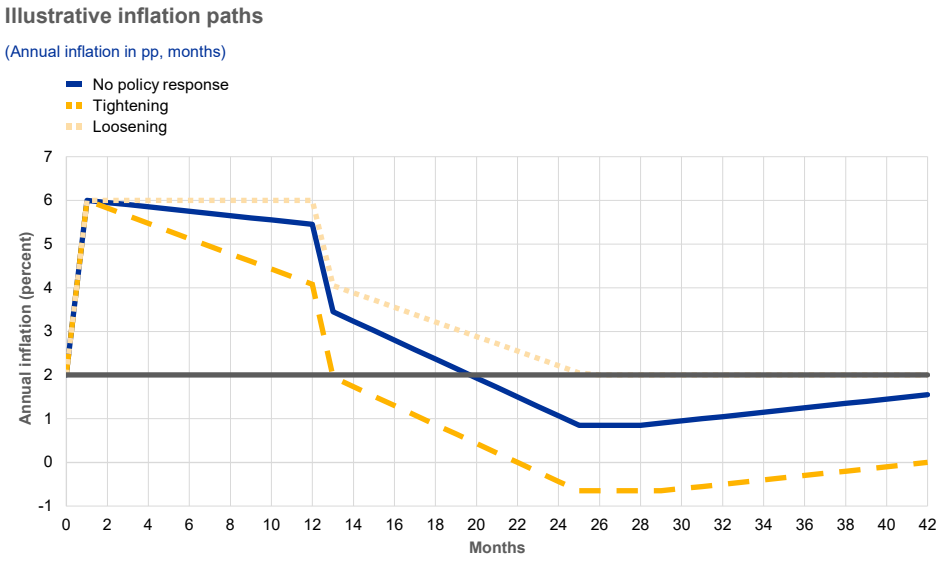
In an economy that exhibits both second-round effects and household or sectoral heterogeneity, the appropriate monetary policy response to an energy price shock is not a straightforward quantitative (or even qualitative) question. It is not obvious that the central bank can improve on the path for inflation that incorporates both second-round effects from the inflation overshoot and the demand weakness from the terms-of-trade shock weighing on inflation in the medium term (the solid blue line in Chart 6). Tightening policy helps reduce second-round effects, but risks pushing inflation below target (and output below potential) in the medium term (as illustrated by the dashed orange line). Loosening policy could help the medium-term outlook for both inflation and output, but would keep inflation higher in the near term and above-target for longer (as illustrated by the dotted orange line).[28] More research facilitating

[28] See Tenreyro (2022). Ideally, the central bank would at the same time lean against above-target inflation in the near term and against below-target inflation in the medium term. But because monetary policy works with a lag, and because financial markets form expectations about the central bank's actions based on the outlook for inflation, which affects medium and longer-term interest rates and hence financial conditions today, there is no time-consistent policy path that could credibly achieve this.

the quantification of these channels will help address the challenges monetary policy could face with similar shocks in the future.

Chart 6

Managing an energy price shock



Sources: Authors' illustration.

To summarise, in this section we have considered a number of deviations from the canonical New Keynesian model that can help rationalise recent central banks' responses to the global energy shock. Because monetary policy works with a lag, it is impossible to offset immediately and fully the first-round effects of an energy price shock on inflation. When frictions such as real-wage or relative-price resistance lead to second-round effects, monetary policy may need to tighten to lean against them. Efficiency considerations in multi-sector settings may suggest a less aggressive tightening. When some households are financially constrained, monetary policy may need to – at the margin – loosen to lean against demand weakness and a medium-term undershoot of the inflation target.

1.3 Other types of shocks and further considerations

Our focus in this section has been on a global shock to the price of energy, which, from the perspective of an energy-importing economy, represents a negative terms-of-trade shock. A similar set of considerations apply to other supply and cost-push shocks. In particular, the duration of the shock is important for whether or not monetary policy should seek to offset the *direct* effect of the shock on inflation – an intrinsically more persistent shock that increases inflation (rather than the price level) would necessitate a tighter stance.

The shock's duration, combined with the relative strength of second-round and income effects on demand, as well as efficiency considerations, would dictate the direction and size of the monetary policy response. Shocks to the prices of other

commodities that the country imports or, more generally, increases in the prices of other imported goods or services, would trigger similar channels; however, their duration and the impact of the shocks on wage-price dynamics and the real-income effects on demand might differ depending on the underlying factors driving them.

For example, changes in prices driven by climate-related events and/or policies taken in anticipation or in response to them may be more or less persistent, depending on how the policies are implemented. They may lead to changes in the demand for labour or other productive inputs via substitution or complementarity links. Shocks to productivity stemming from innovation might impact the economy differently depending on the effect on employment and incomes and the speed of diffusion of the productivity improvement. Changes in price markups may be more akin to price-level effects of more limited duration, while demographic changes in supply might be more drawn out.

Two key questions in all these instances are, first, how does private demand adjust in general equilibrium to the weaker supply trends? And second, how do other supply or demand policies respond to these shocks? We touch on these questions in the next section. While the conceptual framework we described can be used to identify the channels stemming from an individual shock, ultimately, an appropriate policy prescription will necessitate a quantitative analysis of the impact of the specific shock or set of shocks hitting the economy.

Throughout, we have maintained the assumption that households and firms form rational inflation expectations, anchored at the inflation target in the medium to long term. In particular, real-wage or profit resistance is driven by (backward-looking) households or firms attempting to catch-up with past real-income losses, not by households or firms acting based on expected inflation. The next section will consider whether this assumption can reasonably be maintained in the face of a succession of adverse supply shocks.

2 Response to multiple shocks

Over the past three years, rather than a single shock, economies around the world, including the United Kingdom and the Euro Area, have experienced an extraordinary succession of external shocks, which have pushed inflation very far above target. In 2021, strong global goods demand, stemming in particular from the United States, met lingering global supply-chain disruptions as the world economy emerged in uneven fashion from the various waves of the Covid-19 pandemic. The result was a large increase in global goods prices.[29] In 2022, the Russian invasion of Ukraine and the associated energy crisis exacerbated those global inflationary pressures.

These were shocks of exceptional magnitude in quick succession, which have pushed inflation to levels not seen in several decades in most advanced economies. We saw in Section 1 that the optimal monetary policy response to an energy shock is

[29] From the perspective of the UK economy, a net importer of goods, this represented a trade-off inducing cost-push shock.

ambiguous in theory: Depending on the nature of the shock and the nature of the economy hit, it could be optimal to look through the shock, tighten policy, or even loosen policy. But does it matter for monetary policy when there are multiple inflationary shocks in succession?

Some economists have argued that we should expect to experience more and larger adverse supply hits in coming decades. But more frequent and systematically adverse supply shocks could be seen as akin to a downward shift in trend growth, with a likely increase in volatility around the trend. Lower potential trend growth will endogenously lead to lower trend demand, and the result of those two forces might not necessarily be inflationary (unless private consumption and investment cannot foresee the effectively lower trend pattern). In other words, lower potential growth would not require a tighter monetary policy stance on average, unless households, firms and markets systematically overestimate trend supply over time, in which case monetary policy would be needed to close the demand-supply imbalance. Economies with frequent and systematically adverse supply hits (leading to lower and bumpier potential growth) will likely experience higher inflation volatility, but not higher average inflation (either because demand adjusts endogenously or because monetary policy closes any remaining gap).

It is pertinent to open a parenthesis here to stress that monetary policy is an aggregate demand tool and, as such, it cannot solve supply-side problems. The role of monetary policy is to return inflation to target once shocks hit the economy by slowing demand and increasing slack in the economy. In the presence of market imperfections, macroeconomic policy more broadly should be in charge of the prevention, mitigation and resolution of supply challenges. In particular, to address risks in energy supply (e.g., driven by climate-related or geopolitical events), private or public measures aimed at ensuring sufficient levels of inventory or technological diversification in production (Koren and Tenreyro 2013) or in trading partners' supplies (Caselli et al 2020) should be the first line of action to prevent or mitigate the impact of shocks on the economy.[30]

Nevertheless, let us assume that first-best policies are not enough to prevent or offset those shocks. And specifically, let us ask what happens when there is an unfortunate sequence of inflationary shocks, without any change to longer-term trends. In principle, monetary policy could operate as usual, responding to each shock as if it occurred in isolation. But responding to each shock individually, trading-off near-term against medium-term inflation, and inflation deviations from target with output deviations from potential, could result in a long period of above-target inflation prints. The models discussed in Section 1 all implicitly presuppose that household expectations remain well anchored at the target in the medium term. But can this assumption reasonably be maintained if inflation remains above target for multiple years?

Anchored expectations are a feature of rational-expectation models and are a useful benchmark because they impose discipline on economic theory. Models with rational agents are internally consistent and inflation expectations are straightforward to

[30] Fiscal policy, by virtue of being more targeted, should provide a second line of defence.

understand. Once we depart from the rational benchmark, there is an infinite variety of ways in which people could form expectations and in which those expectations could affect behaviour. Indeed, even within a rational setting, as Werning (2022) makes clear, deviations from the standard sticky-price Calvo (1983) model mean that inflation expectations would typically have a smaller effect on pricing than the nearly one-to-one relation implied by Calvo setting. (We return to this point in Section 3.)

Improving our understanding of the role of expectations in macroeconomics and monetary policy is an important area of research. But it also calls for humility: As economic researchers, we are on the edge of our area of expertise when it comes to expectations, veering into fields such as psychology and neuroscience. We are on somewhat firmer ground when discussing how monetary policy should take expectations into account, though mindful that, as Werning (2022) stresses, that depends on price and wage setting practices, amongst other factors.

In exploring deviations from standard models, two strands of the literature are worth highlighting.

First, there is a vast literature on learning models, which assume that firms or households do not fully understand the structure of the economy and hence do not have a clear idea of how it will respond to shocks. Instead, agents constantly update their mental model of the economy in response to events. When a cost-push shock occurs, they may not correctly identify it for what it is but interpret it as a general and persistent shift to a higher inflation environment, which can lead to self-confirming beliefs or "inflation scares.[31]

In practice, near-term (1-year and 2-year ahead) inflation expectations tend to be highly correlated with spot inflation, which could to some extent be a result of such learning effects. Because of this high correlation, it is difficult to tell apart backward-looking inertia caused by real-wage or profit resistance from inertia stemming from elevated near-term inflation expectations owing to adaptive expectations or learning effects in the data. But regardless of which channel is a better description of reality, the policy implication is similar: all else constant, monetary policy should lean against inertia with tighter policy relative to a benchmark without inertia.[32]

A second body of literature, building on a rational-inattention framework, assumes that agents – unable to pay attention and to act upon all available information – rationally choose the information they process.[33] When inflation has been low and stable for a long time, agents are likely to pay little attention to inflation. Inflation

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[31] See for example Orphanides and Williams (2005). For an introduction to the literature on learning models, see Evans and Honkapohja (2009) and Eusepi and Preston (2018) for an application to monetary policy. Recent contributions include Eusepi et al (2020) and Gati (2022).

[32] While directionally the same, optimal monetary policy is more nuanced in models of learning than in models with real-wage resistance. Learning models introduce a new inter-temporal trade-off not present in rational expectations models (Molnar, Santoro, 2014). Tighter policy in response to inflationary shocks eases future intra-temporal trade-offs by anchoring future expectations and enhancing agents' learning. However, given that inflation expectations might exhibit different degrees of de-anchoring, an aggressive monetary strategy might be a blunt response that risks introducing additional suboptimal volatility (Eusepi et al., 2020). On these grounds, a recent learning model by Gáti (2022) suggests that the optimal rate-setting is state dependent and the extent of tightening hinges on the degree of expectation de-anchoring.

[33] For a review of the literature on rational inattention, see Mackowiak et al. (2023).

expectations become de facto anchored, insulating inflation from cost-push shocks to some extent.[34] This makes it easier for a central bank to "look through" supply shocks that affect the price level. All else constant, less monetary tightening is required.[35] But if an unlucky succession of supply shocks pushes inflation far above target and/or keeps inflation above target for several years, rational inattention is likely to break down. The policy implication would again be similar to experiencing stronger real-wage and profit resistance: Monetary policy should lean against inertia by trying to return inflation to target more quickly.[36]

Beaudry et al. (2022) offer a way to integrate the ideas stemming from various models in a unified framework. Building on Farhi and Werning's (2019), they study optimal monetary policy under different inflation expectation formation processes. The setting they study suggests that under rational expectations, it is optimal for the central bank to look through supply-driven inflation shocks.[37] Under adaptive (backward-looking) expectations, it is optimal to lean against inflation to some extent by tightening monetary policy, in line with the previous discussion of the role of real-wage (or profit) resistance. But if boundedly rational agents use level-k-thinking, it can be optimal for the central bank to tighten policy more aggressively if supply shocks cumulate and push inflation above a certain threshold.[38]

As the possible deviations from rational expectations are legion, many other strands of the literature could be mentioned, such as sticky information models (e.g. Mankiw and Reis 2002; Ball, Mankiw and Reis 2005). These models can have different and interesting implications for the nuances of optimal monetary policy strategy. But the overarching take-away is that, much like in the case of real-wage or profit resistance, the more inflation expectations drift away from target following an inflationary shock, the more monetary policy would need to lean against inertia to return inflation to target.

3 Inflation expectations

To take the insights from the previous section to policy, we need answers to a number of empirical questions on inflation expectations. How do firms and

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34 Pfauti (2023) argues that this stabilisation effect is welfare enhancing but can be detrimental if the Effective Lower Bound becomes binding. This is because low attention makes changes in inflation and inflation expectation more persistent, hence a contractionary shock can generate a prolonged period of undershooting the inflation target and consequently "low for longer" monetary policy. This is the "inflation-attention trap", not present in RE models.

35 That said, when decision-makers in firms choose how much attention they devote to aggregate inflation based on how much inflation they experience, there is also an incentive for the central bank to remain in a rational-inattention equilibrium by leaning heavily against large inflationary shocks (e.g. Paciello and Wiederholt, 2014). In these models changes in relative prices are not efficient, which might not always be the case, e.g., if the underlying shock affects sectors differentially.

36 In the terminology of Chart 2, the central bank should operate with a lower lambda.

37 Benchimol and Bounader (2023) is another recent contribution to the literature on bounded rationality.

38 Intuitively, level-k thinking means that individuals start with a guess of other agents' macroeconomic expectations and compute aggregate outcomes under that guess. The initial guess is updated to reflect the aggregate outcome under the previous guess, and is then used as the guess for another iteration. This process is repeated a finite (k) number of times, reflecting bounded rationality. Note that the limiting cases are rational expectation when k goes to infinity, and adaptive expectations when k = 0 provided the initial guess is last period's realisation.

households really form expectations? How do these expectations affect economic decisions, in particular price and wage setting and overall activity? And beyond aiming for inflation at target and output at potential in the medium term, is there anything monetary policy could or should do to affect inflation expectations?

In this Section we take these questions in turn, starting with a brief review of the empirical literature on the determinants of inflation expectations, followed by a review of the empirical estimates of the impact of inflation expectations on pricing and activity. We conclude with a discussion of the main messages.

3.1 Inflation expectations formation and the role of monetary policy

We first discuss the factors influencing households' and firms' inflation expectations and then zoom in more specifically on the role of monetary policy in shaping those expectations.

3.1.1 Formation of Inflation Expectations: some key points

Households

In general, households' inflation expectations appear to be largely driven by idiosyncratic factors and perceptions of current inflation rather than by aggregate forward-looking factors.

In environments with low or moderate levels of inflation, knowledge of central banks' inflation targets or current levels of inflation or interest rates appears to be much more limited than in high-inflation countries (Coibion et al., 2018, 2021, 2020). Consistent with this limited knowledge, households' inflation expectations can also deviate substantially from the stated central bank target, even in contexts in which inflation is at or close to the target. This is documented, for example, by Coibion et al. (2020) for the United States and New Zealand, despite long-standing inflation targets and low and stable inflation records. Households' perceptions of current inflation can also significantly exceed actual inflation – including in Eurozone countries after the global financial crisis (GFC), when inflation was very low (Draeger and Nghiem, 2018; Duca et al., 2018) or Japan (Diamond, Watanabe and Watanabe, 2019).[39]

An immediate reason why inflation expectations and perceptions may deviate from targets is that households tend to rely on easily available and often noisy signals rather than seek out and process all the relevant information. In line with this, households' expectations are known to be affected by their individual shopping

[39] As illustration, Diamond et al (2019) document that two-thirds of survey respondents in 2014 expected inflation to be at least 2%, even though the official inflation rate at the time was only 1.5% and had exceeded this level only once (August–September 2008) during the previous 16 years. Most notably, 9% of respondents believed that the inflation rate of prices they faced would exceed 10%.

baskets, and the price of salient items such as petrol (Malmendier and Nagel 2016, D'Acunto et al, 2021, Coibion and Gorodnichenko, 2015b). More generally, households seem to base their shorter-term inflation expectations predominantly on the prices they observe, particularly prices of recently purchased goods. This relationship, however, may not be linear. In particular, households put more weight on price increases (rather than decreases) and on goods they purchase more frequently (Cavallo et al., 2017, D'Acunto et al, 2021).[40] The importance of individual consumption baskets also helps to explain why there is substantial disagreement across households not only about future inflation (Mankiw, Reis, and Wolfers 2004) but also current inflation (Jonung, 1981).

The limited attention or effort devoted to forming more accurate expectations of inflation may reflect the costs of collecting information relative to the benefits. This lack of attention seems to be particularly noticeable in contexts of low inflation; households might update their beliefs more frequently when there is a stronger benefit to do so.[41] Indeed, households in countries with higher and more volatile inflation tend to be more informed about inflation (Cavallo et al., 2017). The evidence within countries is, however, less straightforward: In the United States, the extent of disagreement across households *increases* when inflation is higher or more volatile (Mankiw, Reis, and Wolfers 2004). This might reflect an increase in dispersion in relative prices with high inflation (perhaps because the underlying demand or supply shock hits sectors differentially or because of staggered price adjustment in response to shocks) and hence differential exposure by households.

The cost of acquiring information may also change over time and across households, which in turn might reflect differential levels of media coverage around inflation and exposure to it. When inflation is low, media coverage may be low. In advanced economies, the level of education across households also seems to matter for the accuracy of inflation expectations, perhaps because it is easier for households with higher levels of education to acquire information.[42]

Firms

Although firms play a more direct role than households in setting prices, there is relatively less evidence about the formation of their expectations. In line with the 'shopping basket' effect observed for households, firms appear to base their inflation expectations on the price dynamics of products and inputs in their own industry, even when these are not correlated with aggregate inflation (Andrade et al, 2022, Albagli et al, 2022), as well as on the price of energy (Coibon et al., 2018). This appears to reflect incomplete knowledge of and limited attention to aggregate nominal factors, including monetary policy. For instance, less than half of surveyed New Zealand

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40 Particularly important are the prices of energy and unprocessed food, well known by households (also see Cœuré, 2019 for suggestive evidence for the Euro area) . In addition, women forecast higher inflation than men - perhaps because women tend do grocery shopping more often than men and that grocery prices tend to be volatile (D'Acunto et al., 2021).

41 This may also be due to limited news coverage in low inflation countries (Coibion et al, 2020), and a lack of motivation to follow monetary news (Kumar et al, 2015).

42 See Tenreyro, 2019.

firms actively track aggregate inflation, compared to around 80% of respondents tracking information on GDP, as documented by Coibion, Gorodnichenko and Kumar (2018). The authors also find that New Zealand firms systematically over-estimate future inflation. They attribute this to rational inattention: if competition is low or profit functions are flat, firms might not view aggregate inflation as key for their business. Idiosyncratic factors also helps to explain why firms appear to disagree substantially about current and future inflation (Coibon et al., 2022a).

3.1.2 The Role of Monetary Policy in Shaping Expectations

In the previous section, we have seen that in contexts of low and stable inflation, households' and firms' knowledge about aggregate factors and inflation is limited. In this section, we take a closer look at whether and how changes in monetary policy affect expectations. We start with a top-down empirical analysis, before reviewing the micro evidence.

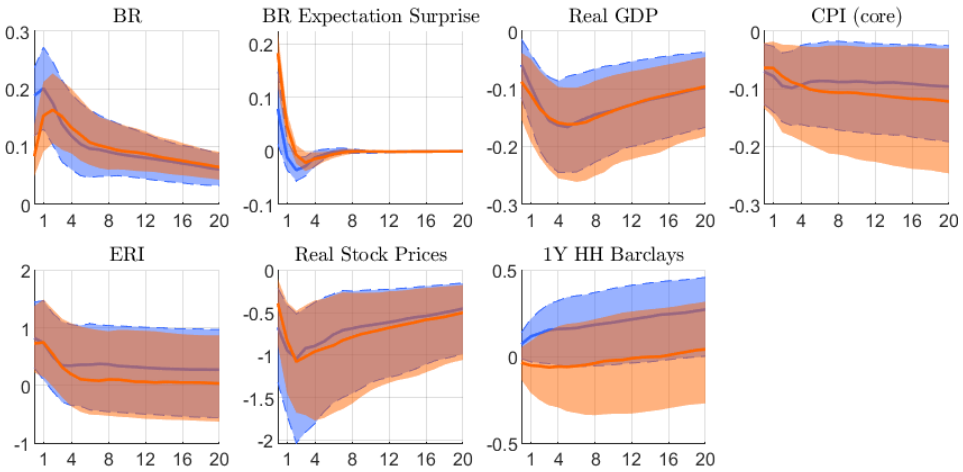
To assess the impact of monetary policy on expectations, we estimate a quarterly SVAR model based on Antolín-Díaz et al. (2021). The model contains several macroeconomic and financial variables for the United Kingdom, including the Consumer Price Index (CPI), a survey-based measure of household 1-year ahead expectations by Barclays and a time series of monetary policy surprises based on forecasts of the Bank of England's Bank Rate. Monetary policy shocks are identified with a narrative-sign restrictions strategy; this allows us to disentangle anticipated monetary policy shocks (those that generate changes in expected Bank Rate around specific events) from unanticipated ones. We leave the response of households' inflation expectations unrestricted (Diegel and Nautz, 2021).

The SVAR estimates displayed in Chart 7 indicate that an unanticipated tightening, that is, a positive shock to Bank Rate (blue line), affects inflation by slowing demand. The chart also shows estimates in response to an anticipated monetary policy shock (orange line). The policy tightening in both cases leads to a fall in activity and inflation, consistent with the demand channel embedded in New Keynesian models. In those models, falls in current and future demand lead to a fall in expected marginal costs, which in turn affect current pricing. The SVAR estimates suggest also that monetary policy does not directly affect household inflation expectations. As the last panel in Chart 7 shows, household inflation expectations initially increase following an unanticipated tightening, that is, a surprise increase in Bank Rate (blue line), and do not react to an anticipated monetary policy shock (orange line). In both cases, the response of expectations is not statistically significant.

Chart 7

Monetary policy shocks and household inflation expectations

(y axis: percentage change in the variable of interest, x axis: number of months after the shock)



Sources: Authors' calculations.

Notes: The charts show the SVAR estimates for the impact of an unanticipated (blue line) and anticipated (orange line) to the Bank of England's policy rate (Bank Rate ("BR")). The panel show the response to these shocks of the log change in: Bank Rate expectations ("BR expectations"), real GDP per capita, core inflation ("CPI (core)"), effective (trade-weighted) Sterling exchange rate ("ERI"), FTSE-all shares adjusted for GDP deflator ("Real Stock Prices"), and one-year ahead household inflation expectations ("1Y HH Barclays"). Bank Rate expectations are defined as average of three measures of Bank Rate expectations based on surveys of financial market participants and professional forecasters, and yield curve changes. The sample covers the 1990-2019 period. Bank Rate shocks are identified via a narrative approach exploiting four events: anticipated, expansionary shocks in Q1 2009 and Q3 2016, and expansionary unanticipated shocks in Q3/Q4 2002 and Q4 2008. In addition, we impose the following restrictions. First, monetary shocks must be associated with a rise in Bank Rate and the exchange rate, and with a fall in real GDP, the CPI, and real stock prices; the anticipated shock must also be associated with an immediate increase in the Bank Rate expectation series. Second, monetary policy shocks must be neutral for real GDP and stock prices in the long run. Third, for a given increase in Bank Rate, the effect of anticipated monetary policy shocks on the expectation variable must be larger than that of unanticipated monetary shocks.

The SVAR results are consistent with a vast literature on the effects of monetary policy on inflation and activity (see e.g. Christiano et al. (1999, 2005) and references therein), supporting the view that monetary policy operates through a demand channel, lowering inflation by slowing current or future demand. In section 3.1.1, we have seen that actual inflation or prices are a key factor in the formation of inflation expectations. Combined, these two research branches suggest that monetary policy tends to affect expectations of inflation via its impact on inflation, which in turn depends on current and future demand.

It is interesting to ask whether and how changes in monetary policy could directly affect inflation expectations, over and above their effect via (current or future) demand and actual inflation. The majority of the evidence, however, does not support this direct channel, in line with the SVAR estimates. As we review below, the response of expectations to monetary policy shocks is often limited or statistically insignificant, and when there is a significant response, it is more likely than not to go in the "wrong" direction. Indeed, a tightening often leads to a rise in expectations of future inflation.

Studies comparing surveys conducted shortly before and after policy announcements suggests that US households' expectations are unresponsive, unlike professional forecasters' or financial markets' (Lamla and Vinogradov, 2019; Fiore et al. 2022). Aggregate survey-based measures of inflation expectations also do not seem to change after major QE announcements in the UK and US (Coibion et al. 2020). German households are more likely to expect inflation to drop after a surprise

ECB tightening, though this effect is very small (Rast, 2022).[43] And while US homeowners' expectations are more sensitive to monetary policy news, they revise their expectation *upwards* when the Fed Funds Rate increases (Ahn et al, 2022).[44] These findings are broadly in line with our SVAR evidence for the UK. They could perhaps reflect an "information effect" whereby households infer from tighter monetary policy that the central bank sees rising inflationary pressure.

Another way of rationalising the lack of response of household inflation expectations to monetary policy shocks (or indeed, a response with the wrong sign) is that households have a different understanding of the effects of monetary policy. In line with this, most US households expect a rise in the Federal Funds rates to lead to *higher* inflation (Andre et al., 2022).[45] Similarly, less than forty percent of participants to the February Bank of England's Inflation Attitudes Survey thought that higher rates would slow prices in the next year or two. Around a fifth of respondents disagreed, and the remaining 45 percent did not know or neither agreed nor disagreed. Interestingly, the answers were broadly similar when respondents were asked about whether higher rates would slow prices in the next month or two, despite the lags with which monetary policy is expected to operate.[46] The unclear relation between movements in policy rates and expectations of inflation could perhaps reflect the fact that some households associate higher rates with higher borrowing costs, which could lead to an increase in their perceived inflation.

One way to test households' understanding of the impact of monetary policy is to randomly expose them to news about policy changes. The evidence from such randomised control trials (RCT) is mixed. When exposed to news about a policy tightening, US households revise their inflation expectations downwards (Coibion et al. 2022; Coibion et al., 2023).[47] In contrast, in a similar exercise, half of German firms do not adjust their expectations, and most firms that update their beliefs think inflation will be *higher in response to higher rates* (Conrad et al., 2022).

In general, the evidence for firms is sparser and more recent. Italian firms' pricing plans do not seem to be affected by monetary policy shocks (Bartiloro et al., 2019). Similarly, only 2% of respondents to the Bank of England's Decision Maker Panel survey over the past year reported that monetary policy was a relevant factor affecting their own-price expectations over the 12 months ahead.[48] Instead, German firms' own-price expectations shift in the expected direction after ECB policy shocks,

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[43] A surprise 25bps ECB tightening leads to a 2.7% reduction in the likelihood that households expect inflation to increase over the next year. One difficulty with interpreting survey-based evidence is that it's unclear whether households ignore monetary policy news, whether they think that monetary policy is not an important driver, or whether they disagree on whether a tightening lowers inflation, Another ambiguity is that, if households are inattentive to aggregate factors, testing households' response to measures of monetary policy surprises that net out confounding macroeconomic news might make less sense in the first place.

[44] A 100 bps increase in mortgage rates over a period of six months results in a 0.25pp reduction in 1-year ahead inflation expectations.

[45] This stands in contrast to two thirds of experts expecting a rise in the FFR to lead to lower inflation.

[46] Around one quarter of respondents cited interest rates as one of the "most important factors leading to changes in price expectations in the longer term".

[47] It is not clear from the exercise whether this results from a standard, aggregate demand channel or through a more direct mechanism.

[48] In the same survey, only 13% of firms thought monetary policy affected broader CPI expectations one year ahead (Thwaites et al., 2022).

although they remain unchanged for large unconventional policy announcements; puzzlingly, though, German firms' responses become smaller and even reverse as the size of the policy surprise increases (Enders et al. 2019).[49],[50] The direction of the effect might also depend on what firms associate higher rates with. When asked about how higher interest rates impact them, respondents to the Bank of England's Decision Maker Panel survey most frequently cite indirect effects on demand, which could work to lower their inflation expectations. That said, a small proportion of firms cited an impact via pass-through to higher prices, suggesting a cost-channel, whereby expectations of inflation increase in response to a policy tightening.

Another way in which monetary policy could more directly affect expectations is through communication about inflation forecasts or the inflation target, rather than by actual changes in policy rates or other policy tools. There is consistent evidence to suggest that in the US and in Euro Area countries, households' inflation expectations change significantly when households are provided with information about recent, current, or forecast inflation (Armantier et al., 2016; Binder and Rodrigue, 2018; Coibion et al., forth.) The evidence is also broadly consistent for firms in Italy and New Zealand (Coibion, Gorodnichenko and Ropele, 2018; Coibion, Gorodnichenko and Kumar, 2018). Respondents also significantly update their inflation expectations when they are exposed to information about the central bank's inflation target (e.g. Coibion et al. (2022) for the US and Bottone et al. (2022) for Italy), although this effect sometimes appears to be relatively short-lived (Coibion, Gorodnichenko and Kumar, 2018). This result underscores the potential importance of consistent (and constant) communication of the central bank's objectives.

Up to this point, our focus has been entirely on households' and firms' expectations, rather than that of experts or financial markets. A key motivation is that in most macroeconomic models, consumption and investment depend on the real interest rates faced by households and firms, and therefore on these agents' inflation expectations.

It is of interest of course to also understand how monetary policy may affect financial market expectations, as they are important for pricing and may be more forward looking than either households' or firms' expectations (Reis, 2023, Coibion et al., 2022). A seminal paper in this literature, written by Gürkaynak, Levin and Swanson (2010) suggests that in the United States, financial markets' long-term inflation expectations appear to be unresponsive to identified monetary policy shocks under inflation-targeting regimes. This could reflect the fact that markets believe that central banks are credibly committed to bring inflation back to target over this horizon. Our own empirical analysis for the UK also does not suggest a systematic

[49] Specifically, a surprise tightening of 5bps increases the probability that a firm reduces its inflation expectations by 0.25pp, but a surprise of 10bps, lowers the probability by 0.22pp.

[50] Di Pace, Mangiante and Masolo (2022) document that UK firms' price expectations do not respond to high-frequency monetary policy surprises, but they respond to three policy announcements included in their sample. It is less clear whether this reflects a direct effect or indirect expected changes in future demand as discussed above.

relationship between monetary policy surprises and medium-term inflation expectations.[51],[52]

3.2 How do inflation expectations affect households' and firms' economic decisions?

Macroeconomic models suggest three main channels through which an increase in inflation expectations could influence economic decisions affecting consumption, investment, and inflation. First, all else equal, higher inflation expectations should lower real interest rates and therefore encourage consumption and investment today ("real interest rate channel"). Second, higher inflation expectations may lead households to demand higher wages to avoid a loss in real income, and firms to offer higher wages to retain staff ("wage-setting channel"). Third, in the presence of price rigidities, it could be optimal for firms that can adjust prices to do so in response to expected inflation out to the horizon over which they expect their prices to remain fixed ("price-setting channel").

In this section, we review the evidence about the link between inflation and economic decisions for households and then firms.

Households

The standard Euler equation at the core of many modern macroeconomic models gives a key role to inflation expectations: When expected inflation rises, real interest rates fall. Through intertemporal substitution, when households anticipate higher prices in the future, they consume more today. This would be particularly the case for durable goods that can be more easily substituted across time. Overall, therefore, higher inflation expectations should boost aggregate demand, increasing inflation by reducing slack.

There are however questions about how the conceptual link performs empirically. If households are not well informed or misdiagnose inflation, perceived real interest rates might not change as in the theory. Furthermore, nominal illusion could lead households to misunderstand the difference between nominal and real interest rates altogether.[53] In line with this, Brunnermeier and Julliard (2008) show that decreases in inflation are associated with large increases in house price valuations, suggesting that households mostly respond to nominal rather than real interest rates. If households face credit constraints, they may also be limited in the degree to which

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51 We measure long-term market inflation expectations using 5-year 5-year inflation forwards. We include this variable in the SVAR described above.

52 In the US, markets' medium-term inflation expectations are generally thought to have remained anchored despite the surge in post-pandemic inflation (Bernanke and Blanchard, 2023).

53 For example, Fahri and Werning (2019) emphasize limited higher-order thinking by agents as a reason for a dampened response of consumption to news. Angeletos and Lian (2018) stress imperfect common knowledge as a related mechanism. D'Acunto et al (2021) refer to this 'human friction' as limiting the transmission of policy intervention through households' inflation expectations.

they can respond to changes in the real interest rate.[54] The driver of higher inflation expectations can also be crucial. If inflation stems from a negative supply shock, or if households expect their real income to fall (even if only in the short-run), then higher inflation expectations may be associated with a decrease in spending. In addition, if expected inflation is concentrated in goods that do not lend themselves to intertemporal substitution, like energy or food, the aggregate demand response is likely to be dampened.

What does the evidence suggest? In Table 1, we first review studies based on survey evidence. In line with the textbook model, a majority of these studies suggest that higher inflation expectations are associated with higher spending intentions – particularly for durable goods. When policy rates are at the effective lower bound, however, higher inflation expectations can be associated with either higher or lower consumption. This suggests that the impact of changes in expectations might be state-contingent, which makes it difficult to generalise from these studies to the present circumstances. Another common finding is that the strength of the association between expectations and consumption varies with cognitive abilities and other personal characteristics – possibly because these characteristics affect the degree of information or understanding of aggregate factors.

Table 1

Studies looking at the relationship between household inflation expectations and spending intentions

Study	Country / Period	Approach	Estimated impact of increase in inflation expectations on spending		Differences across sub-samples
			Normal times	At the ELB	
Bachmann et al. (2015)	US, 1984-2012	Probit model for the impact of inflation expectations on readiness to spend	Positive, but very small and insignificant	Negative, small and significant	A positive relationship is found mainly for households that are highly educated or good inflation forecasters.
Juster and Wachtel (1972)	US, 1960-71	Panel data models of consumer demand for durables and non-durables	Positive for spending on non-durables, and negative for spending on durables.	-	Some evidence that effects were larger during 1967-71 relative to other periods.
Duca et al. (2021)	Euro area, 2003-16	Probit model for the impact of inflation expectations on major purchases	Positive and significant	Larger positive impact	The positive effect is much smaller (or negative) for households that are less educated, have lower income, or are less optimistic about expected income.
Ichiue and Nishiguchi (2014)	Japan, 2006-2013	Probit models for the impact of inflation expectations on real spending.	-	Positive and significant for current spending. Negative for future spending.	Effects are relatively stronger for asset holders and older respondents. No discernible difference due to financial literacy.
Vellekoop and Wiederholt, (2019)	Netherlands, 2008-16	Panel data models linking survey data on inflation expectations to administrative data on income and wealth	Positive and significant, including for purchases of cars.	-	

[54] McKay, Nakamura and Steinsson (2016), for example, argue that incomplete markets imply heavier discounting in the Euler equation.

The main limitation of survey-based evidence is that isolating the causal effect of changes in inflation expectations from confounding factors is difficult. To address these shortcomings, another group of studies analyse the change in spending intentions when a randomly selected group of survey respondents is given information about current inflation. Although more convincing in terms of identification, these studies give contradictory results. Unlike in the standard Euler equation, spending intentions by Dutch households appear to fall when inflation expectations rise (Coibion et al., forth.) Further, this negative impact is even stronger for durables spending, whereas it reverses for services. In contrast, and in line with the standard Euler equation, when provided with information pointing to higher current or past inflation, US households adjust their inflation expectations upwards and they become more likely to report that now is a good time to purchase durables (Coibion et al, 2023). US households also seem to expect interest rates to go up less than one-for-one with inflation, meaning they expect real rates to fall.

Table 2

Randomised Control Trial studies examining the impact of an exogenous shock to household inflation expectations

Study	Country / Period	Approach to identify shock	Impact of exogenously higher inflation expectations on			Differences across sub-samples
			Income	Labour supply/wages	Spending	
Coibion et al. (forth.)	Netherlands, 2018	One group given latest CPI release.	Increases by much less than inflation expectations	Moderate increase in likelihood of applying for another job. No increase in likelihood of working more hours or asking for a raise.	Negative (mainly durable spending)	No systematic variation with households' cognitive ability or financial constraints.
Coibion et al (2023)	US, 2019	Subsets provided information about past, current, or future interest rates and inflation.	-	-	Positive, and large for durable goods	No systematic variation across demographic groups.
Hajdini et al (2022)	US, 2022		Increases by much less than inflation expectations (~20% pass-through)	Moderate increase in likelihood of applying for another job. No increase in likelihood of working more hours or asking for a raise.	-	Greater impact on income expectations for higher-income individuals

How could these results be reconciled? In the study of US households, respondents are given information about both inflation and interest rates. Therefore they may be more aware about the impact of changes in real interest rates rather than the effect of inflation in isolation. Instead in the study of Dutch households, respondents are asked about their income expectations; and as we discuss below, households generally do not expect income to keep pace with inflation. Relatedly, the perceived driver of inflation could differ across countries. For example, US households could associate higher inflation with a positive demand shock, while Dutch households could associate higher inflation with a hit to real income. These ambiguities make clear that drawing policy implications from these studies is not straightforward.

These seemingly conflicting results also raise a question about the link between inflation expectations and expected income. In theory, if households care about their real income and nominal wages are sticky, households may demand higher wages

today when they expect higher inflation in the future (Friedman, 1968). And if they do not expect wages to keep pace with inflation, households may choose to work more to compensate. Alternatively, households could choose to work less if lower real rates reduce the cost of future foregone consumption (Lucas and Rapping, 1969). These actions may in turn affect the decisions of firms, for example in granting higher wages, and choosing the optimal level of employment.

The studies reviewed in Table 2 generally find that households expect wages to increase by significantly less than inflation. In other words, households associate higher inflation with lower real income.[55] That is consistent with recent analysis of the Bank of England Inflation Attitudes Survey (IAS), which suggests that the link between inflation and earnings growth expectations is very small.[56]

One potential explanation for why households expect inflation to reduce real incomes is that they associate inflation to negative supply shocks rather than positive demand shocks. Moreover, households seem to be less prone to negotiate higher wages or seek alternative income sources. Both the literature and the IAS analysis suggest only a small increase in the likelihood that a worker would push for higher pay with their current employer. This could be due to a lack of structured wage negotiation, or to the cost of living not being a major concern for workers when inflation is low (Rudd, 2021).[57] In line with this, internal analysis based on recent IAS data suggests that the probability of searching for a new job or alternative sources of income increases with inflation, although this effect is small.[58] Coibion et al (2023) find a slightly larger effect for US households, but no impact on the likelihood of asking for a raise or working more hours.[59] This pattern may have changed in the recent post-Covid period, as inflation increased (although real wage growth remained subdued, despite the tight labour market).

Another potential explanation for the negative relation between expectations and activity is that, empirically, households often appear to associate higher inflation with a worse economic outlook (Kamdar, 2019; Candia et al., 2020; Weber et al., 2022). In line with this, the IAS suggests that when perceptions of inflation and actual inflation are above target, an increasing share of households report that a rise in the pace of price increases would leave the economy weaker (Chart 8). And while the share is closer to 50% when inflation is around or below target, less than 10% ever think that faster price rises will lead to a stronger economy, with the remainder either reporting that it will make little or no difference, or that they do not know.

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55 This is probably a key reason why households report to dislike inflation (Shiller, 1997).

56 A 1pp rise in inflation expectations is associated with a 0.02-0.05pp increase in earnings growth expectations.

57 In line with the first idea, a common theme in the literature is that higher-income, more educated households, generally expect larger pass-through from inflation to nominal income (Reference). These households are likely in a better position to negotiate higher wages with their employers, or alternatively to seek out a higher paid role elsewhere.

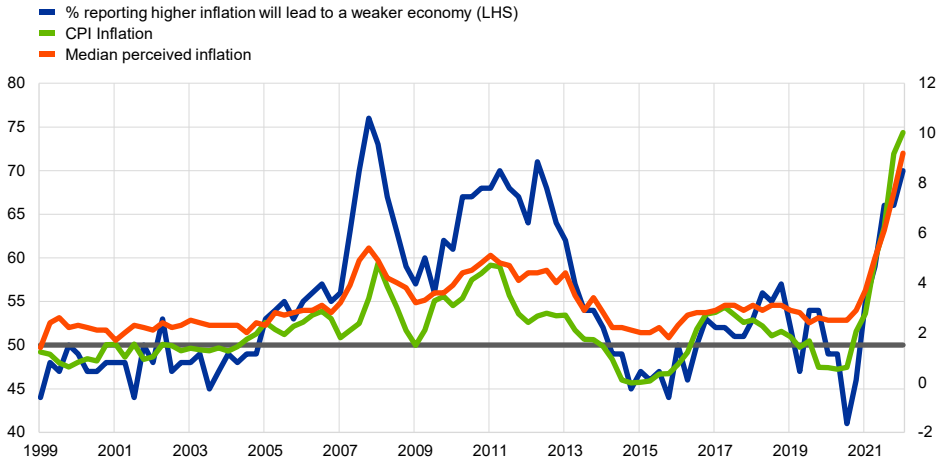
58 A 1pp increase in inflation perceptions or expectations leads to a 0.5-0.7% increase in the probability of seeking additional sources of income (new job, second job, extra hours, etc.).

59 A 1pp increase in inflation expectations leads to a 2% increase in the probability of searching for a new job.

Chart 8

Household perceptions of the impact of faster prices increases on the economy

(Percentage)



Sources: Bank of England calculations based on Inflation Attitudes Survey (IAS).

Firms

In standard models, all else equal, an increase in firms' inflation expectations would lead firms to increase their prices, raise wages, and increase investment and employment. We summarise empirical studies aiming to identify these ideas in Table 3 below. A majority of studies find that when firms receive information suggestive of a higher inflation level or target, they revise their expectations of aggregate inflation upwards. But there is less evidence that firms adjust their own-price expectations accordingly. And where there is an impact, it appears to be limited or transitory. Similarly, the relationship between inflation and wage expectations appears to be weak.

One way to interpret these findings relies on the observation that firm or industry-specific shocks may be more important in determining firms' prices than aggregate factors (see Section 3.1.1). Another explanation is that firms do not consider the wider consequences of higher inflation when responding to surveys. Indeed, there is almost no correlation between expected price and wage inflation in survey responses by French firms, despite the fact that wage contracts are commonly indexed to inflation in France (Savignac et al., 2021). More recently, Werning (2022) offered a new interpretation: most of our intuition on how expectations affects firms' pricing is based on Calvo's price setting model (Calvo, 1983); in a more general setting, however, the relation between inflation expectations and pricing behaviour is much more nuanced and it depends on whether firms follow time-dependent or state-dependent rules, and, within the former, on the frequency of price adjustment. In higher inflation periods, firms might switch to more frequent price or wage

changes, for which future inflation becomes less relevant.[60] In the limit in which prices and wages are fully flexible, inflation expectations become virtually irrelevant (that is, expectations only matter if there are price or wage rigidities).

How do theories of wage and price-setting translate into the real world when inflation is high? One limitation of the existing empirical literature is that it has typically examined periods and countries in which inflation was relatively low. But internal analysis of the Bank of England's Decision Maker Panel suggests the link between wages and price inflation has become stronger in the recent period of elevated inflation. And when asked about the factors affecting their wage expectations in the February 2023 survey wave, high inflation and the associated cost of living crisis were the most commonly cited factors. However, separating the role of expected and realised (or backward looking) inflation in these dynamics is difficult.

Academic studies are also inconclusive regarding the impact of inflation expectations on investment or employment decisions. For example, in New Zealand, when firms' inflation expectations increase, they expect to increase their investment and employment (Coibion et al., 2018). In contrast, in Italy, firms tend to reduce their employment and capital spending when they expect higher inflation (Coibion, Gorodchinenko, and Ropele 2020). This points to a "stagflationary" (or supply-driven) view where firms associate higher inflation with lower aggregate demand for their products. However, this effect seemed to disappear during the period in which interest rates were near the lower bound, when firms were arguably more likely to see inflationary or disinflationary pressures as demand-driven. This ambiguity suggests that the real consequences of a change in firms' expectations are likely to depend crucially on the drivers of inflation and the broader economic outlook.

[60] See for example Alvarez et al. (2018) and Nakamura et al. (2018). For the UK, Richard Davies' analysis also suggests that the share of prices increasing each month has increased recently, and has been correlated with the level of inflation in the past.

Table 3

Randomised Control Trial studies examining the impact of an exogenous shock to firm inflation expectations

Study	Country / Period	Approach to identify shock	Impact of exogenously higher inflation expectations on				
			Own prices (1yr ahead)	Aggregate prices	Wages	Employment	Investment
Coibion, Gorodnichenko and Kumar (2018)	New Zealand, 2013	One group given Reserve Bank of New Zealand inflation target	No change	-	No change	Significantly higher	Significantly higher
Coibion, Gorodnichenko and Ropele, (2018)	Italy, 2013-18	One group given latest CPI release.	Limited increase	-	-	Significantly lower	Significantly lower
Rosolia, Banca d'Italia (2021)	Italy, 2013-18		No change	Increase	No change	No change	No change
Savignac et al, (2021)	France, 2020-21	One group given latest inflation release.	No change	Increase	No change	-	-

3.3 Discussion

The evidence on inflation expectations and the more recent theoretical contributions reviewed in this section pose important challenges to common assumptions and priors about 1) the factors shaping inflation expectations and 2) the role of those expectations in standard macroeconomic models.

On the first point, the vast majority of the microeconomic evidence supports the idea that inflation expectations are mostly influenced by actual inflation or, indeed, by some of its volatile components, like petrol or food. The macroeconomic literature based on identified monetary policy shocks suggests that monetary policy can influence those expectations *indirectly* by reducing actual inflation via slower demand. In contrast, the bulk of the evidence does not support the notion that monetary policy innovations *directly* affect household or firm inflation expectations over and above any impact on actual inflation and activity (current or future). Survey evidence indicates that households and firms do not seem to systematically view tighter policy per se as pushing down on inflation; on the contrary, surveys often indicate that households and firms associate higher rates with increased price or cost inflation. This could be because households and firms have a limited understanding of the transmission mechanism and are unable to work out the general equilibrium effects of the policy or because they mix up the causal relation.[61]

[61] One possible counter to this argument is that the RCT evidence suggests that exposing households to news about interest rates seems to have strong effects on their inflation expectations. However it's not entirely clear how this evidence translates in the real world where, unlike econometricians, central banks cannot force agents to pay attention to monetary policy news.

Central bank communications, however, seem to have a more significant impact on expectations. RCT evidence suggests that exposing households to information about the inflation target or level can have strong (although sometimes short lived) effects; this would seem to call for consistent and repeated communication of the central bank's target.

On the second point, both empirically and theoretically, the impact of changes in inflation expectations on activity or pricing is not straightforward.

Concerning the impact of expectations on activity in particular, results from surveys and microeconomic studies on how inflation expectations affect household and firm behaviour suggests that the effect depends on whether inflation is demand or supply driven. More clarity in survey questions about the drivers of inflation could help better elucidate the effects. Since changes in inflation expectations affect expectations for real income, consumption and investment, the impact of inflation expectations on activity will depend on whether the underlying inflation driver is a demand or supply factor.

As concerns the impact of expectations on pricing, recent theoretical contributions shed new light on this relation within a standard New Keynesian setting. In particular, Werning (2022) stresses that short-term inflation expectations (or, more precisely, expectations at the horizon over which prices remain fixed) should be more relevant for pricing and wage-setting decisions. One important consideration stressed by Werning (2022) is that, paradoxically, in contexts of high inflation, inflation expectations might become less relevant, as firms increase the frequency of price adjustment and prices become less sticky. In the extreme in which firms are constantly adjusting prices, inflation expectations become irrelevant. In such contexts, spot or past inflation become more important in pricing decisions. That is consistent with work showing "backward-lookingness" may increase in periods of high inflation where forecast errors become larger (Cornea-Maderia et al, 2019).

More awareness about inflation might also shift behaviour from a starting point of systematic inattention to one in which inflation becomes both better understood and more relevant in households' and firms' decision making.

Another consideration that deserves more attention regards the relevant horizon of expectations when assessing de-anchoring. While in principle pricing- or wage-setting decisions should be more heavily influenced by firms' short-term inflation expectations, those short-term expectations are not a useful metric for an assessment of de-anchoring, as characterised by macroeconomic models, which should be based on long-term measures of expectations. Measures of firms' expectations, however, typically do not extend beyond two years. And while household survey measures of inflation expectations often extend to medium-term horizons, in reality, households tend to have little power in pricing or wage decisions. By virtue of their longer horizons, financial-market measures may be better at capturing the concept of de-anchoring. However, the mapping of financial market measures of expectations into standard New Keynesian models of firms' and households' pricing behaviour is more tenuous than those of firms or households.

Overall, the high sensitivity of household and firm inflation expectations to spot inflation and volatile components of the basket, their limited reaction to monetary policy (over and above the effects of policy on actual inflation), and their uncertain effects on the economy, call for caution in using measures of inflation expectations as intermediate targets to guide central banks' decisions.[62]

From the perspective of optimal monetary policy, returning inflation to the target following economic shocks appears to be the soundest strategy to secure inflation expectations remain anchored.

4 Concluding Remarks

We set out to answer three main questions: How should monetary policy respond to a supply shock? How would that response change if supply shocks became more frequent? And what role should inflation expectations play in the assessment and calibration of that response?

We started by reviewing the recent literature with a focus on a specific type of supply shock, a global increase in the price of energy, studying it from the perspective of energy-importing economies. We then discussed how a succession of supply shocks could change the optimal policy response. And finally, we explored the role that inflation expectations could or should play in shaping that response. For the latter, we revisited the growing literature on inflation expectations, the factors influencing those expectations – including the role of monetary policy, for which we provided new estimates – and the impact expectations have on pricing and activity.

We draw three broad take-aways from the analysis and broader literature:

First, the optimal monetary policy response to a single supply shock depends on the nature and duration of the shock, the strength of second-round effects and the impact of the shock on real incomes as well as efficiency considerations. The relative strengths of these factors determine whether monetary policy should look through, tighten, or loosen – and by how much.

Second, an unlucky sequence of inflationary supply shocks could result in a long period of above-target inflation prints if the central bank were to respond to each shock individually, trading off near-term against medium-term inflation deviations from target and inflation deviations from target with output deviations from potential. Drifting inflation expectations or backward-looking inertia in price setting would call for a tighter policy response in this case.

Third, despite their prominent role in economic models and policy thinking, our understanding of the formation and economic impact of inflation expectations remains limited and a large gap remains between standard model assumptions on

[62] Typically, an intermediate target must have a clear and systematic link to the final objective and monetary policy (inflation), as well as to the instrument of policy that is more directly controlled by the central bank (for instance the policy rate) – see e.g., the seminal contributions of Poole (1970) and Pindyck and Roberts (1976).

inflation expectations and their actual patterns of behaviour. This conclusion is based on the following considerations. Empirically, household and firm inflation expectations tend to move with actual inflation and are often highly sensitive to some volatile components of the basket (e.g., energy); identified monetary policy shocks appear to affect actual inflation, but do not seem to have a direct impact on households' or firms' inflation expectations, over and above their impact on inflation. Moreover, recent empirical and theoretical work has challenged existing priors and assumptions on how inflation expectations affect pricing, suggesting a weaker impact of expected inflation on prices than the nearly one-for-one link implied by standard Calvo models. In turn, when inflation is driven by a supply shock, higher inflation expectations can be associated with weaker consumption and investment, while the opposite is true when inflation is viewed as demand driven. Finally, given that financial-market measures of inflation expectations extend over longer horizons, they are more amenable to assessments of "de-anchoring"; however, their mapping into New Keynesian models of firms' and households' pricing behaviour is rather tenuous. From a modelling standpoint, it is a link in need of further development.

Overall, i) the high sensitivity of household and firm measures of inflation expectations to volatile components of inflation, ii) their limited reaction to monetary policy (over and above the effects of policy on actual inflation), and iii) their uncertain effects on the economy, call for caution in using measures of household or firm inflation expectations as intermediate targets to guide central banks' decisions.

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