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On looking through sectoral shocks: The role of (de-)anchored inflation expectations[*]

Rafael Gerke[†] Joost Röttger[‡]

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Abstract

How does a possible de-anchoring of inflation expectations alter the conventional monetary policy prescription of looking through sectoral shocks? To answer this question, we study optimal monetary policy in a multisector New Keynesian model extended to allow for endogenous long-run inflation expectations. We find that the risk of de-anchoring does not change the key policy trade-offs. It remains optimal for monetary policy to stabilise the output gap and inflation in sectors with stickier prices, confirming previous findings in the literature. Moreover, output and inflation dynamics are both hardly affected by a possible de-anchoring. This contrasts with the nominal interest rate response required to achieve these outcomes, which is more aggressive when there is a risk of de-anchoring. These findings reflect an asymmetry in the pass-through of inflation expectations to firms' price-setting and households' consumption decisions, with the latter being stronger than the former.

Keywords: Multisector economy, New Keynesian model, optimal monetary policy, de-anchored inflation expectations

JEL classification: C67, E31, E52, E70

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1 Introduction

In recent years, supply chain disruptions, changes in the relative demand for goods and services, as well as increases in the prices of energy and other commodities have contributed to a sharp rise in inflation and led to sizeable relative price movements. Key drivers of these developments have been shocks that affected economic sectors differently, such as the COVID-19 pandemic and the Russian invasion of Ukraine (see e.g. Guerrieri et al., 2023). Ongoing developments – including climate change, measures to contain it, rising geopolitical tensions, and the potential fragmentation of the global trading system – suggest that asymmetric and inflationary supply shocks are also likely to play an important role in the years ahead.

How should central banks respond to such inflationary and "uneven" shocks? Since monetary policy does not have the tools to effectively target price changes in different sectors, the literature usually argues that monetary policy should look through sectoral shocks.[1] Specifically, it should refrain from stabilising headline inflation and instead prioritise the stabilisation of the output gap and inflation in sectors with stickier prices (Aoki, 2001; Huang and Liu, 2005; Bodenstein et al., 2008; La'O and Tahbaz-Salehi, 2022; Rubbo, 2023; Qiu et al., 2026).[2] However, the literature assumes that inflation expectations of households and firms are always perfectly anchored. Therefore, it is silent about the possibility that periods of high and persistent inflation may lead to upward revisions in long-run inflation expectations. The need to contain de-anchoring risks and to stop inflation from becoming entrenched is prominently featured in policy discussions (see e.g. Adrian, 2023; Maechler, 2024). This view is also supported by normative studies that allow for de-anchoring in the textbook one-sector New Keynesian model (see e.g. Gáti, 2023; Dupraz and Marx, 2024; Gust et al., 2025).[3] In this paper, we study whether the looking-through recommendation of the multisector literature remains valid in the presence of de-anchoring risks. To do so, we extend a New Keynesian multisector model as in Pasten et al. (2020) or Rubbo (2023), featuring a network production structure and sectoral heterogeneity in price stickiness, by endogenising long-run inflation expectations via adaptive infinite-horizon learning (see Preston, 2005).

Compared to a benchmark with perfectly anchored expectations, we find that the optimal nominal interest rate response to an adverse, inflationary sectoral shock is more aggressive if inflation expectations can de-anchor. However, the shock induces very similar output (gap) and inflation dynamics with and without a possible de-anchoring. The trade-offs faced by the policymaker, namely whether to stabilise the output gap or inflation in specific sectors, are not materially affected by the threat of de-anchoring. It remains optimal to prioritise stabilisation of the output gap, explaining similar output gap dynamics with and without de-anchoring risk. Conditional on similar output gap dynamics, inflation hardly behaves differently when long-run inflation expectations of firms are endogenous because the pass-through of firms' relevant inflation expectations to price setting is limited in a multisector economy, which contrasts with the textbook one-sector case (see Werning, 2022). However, the pass-through of households' inflation expectations to their consumption is quite high, reflecting a high elasticity of consumption-saving decisions to expected real interest rate changes. As a result, the nominal interest rate response needs to be much more aggressive to move output in the desired direction if households' inflation expectations can de-anchor.[4]

In our multisector model economy, there is a fraction of agents that forms expectations in a forward-looking manner. The remaining fraction of agents is naive and forms long-run expectations via adaptive learning, leading inflation ex-

[1] Nelson (2025) discusses the history of the term "looking through". In the context of a temporary, inflationary supply shock, looking through is typically understood to mean that monetary policy refrains from strictly targeting (short-term) headline inflation and at least partially accommodates the overall price increase. Importantly, it does not necessarily mean that monetary policy does not respond to the shock at all, i.e. keeps interest rates unchanged. A looking-through approach can be operationalised in two main ways. One operationalisation focuses on stabilising core rather than headline inflation, highlighting the sectoral origins and implications of the shock (see e.g. Huang and Liu, 2005; Bodenstein et al., 2008; Rubbo, 2023). The other operationalisation focuses on stabilising inflation forecasts instead of current inflation, emphasising the temporary impact of the shock on inflation dynamics (see e.g. Erceg et al., 2024; Conrad et al., 2025). In this paper, when using the term looking through, we refer to the former operationalisation, as it is more relevant in the context of sectoral shocks, such as an energy price shock.

[2] Ou et al. (2026) show that this result can be overturned under rational inattention if it is sufficiently costly for firms to acquire information.

[3] Anchored inflation expectations are also often mentioned as a pre-condition for a looking-through policy (Nelson, 2025).

[4] The learning literature usually does not distinguish inflation expectations of firms and households (see e.g. Molnár and Santoro, 2014; Gáti, 2023; Eusepi et al., 2026).

pectations to have a backward-looking element. On average, expectations of households and firms in the economy are therefore partially forward-looking *and* backward-looking. These two features have recently been shown to be crucial in explaining biases documented in expectations data (see e.g. Angeletos et al., 2021, 2025; Gust et al., 2026), as they can generate an underreaction to macroeconomic news that is followed by a subsequent overreaction. Moreover, having forward-looking agents in the model implies that monetary policy can influence the economy via announcements about future interest rates (see Woodford, 2018; Dupraz and Marx, 2024). By contrast, the learning literature usually assumes that all agents are adaptive learners, rendering such policy communication ineffective. Following Carvalho et al. (2023) and Gáti (2023), we not only allow the level but also the sensitivity of long-run inflation expectations to vary endogenously over time, thus capturing nonlinearities in expectation formation.[5] Typically ignored by the learning literature (see e.g. Eusepi and Preston, 2018), such nonlinearities are important in the context of high-inflation episodes as witnessed in the 1970s or the past few years (see e.g. Harding et al., 2023; Blanco et al., 2024).

As our baseline calibration, we consider a stylised 4-sector version of our model, which features a manufacturing sector, a service sector and an energy sector. In addition, there is also a "union sector", which is introduced to allow for sticky nominal wages (see Rubbo, 2023). Although the production network structure of this calibration is highly stylised, it is able to capture key properties of sectoral inflation dynamics as observed during the recent inflationary surge (see e.g. Guerrieri et al., 2023). Furthermore, we show that our key results also apply for a more granular model calibration with 72 sectors, which comes at the cost of making the underlying channels at work less transparent. As our key experiment, we look at the optimal monetary policy response to an adverse productivity shock to the energy sector ("energy shock").[6] Since energy prices respond flexibly, firms in this sector immediately pass on the increase in their marginal costs to consumers and firms by raising the price of energy. Firms in different sectors of the economy differ in their exposure to energy as a production input and their degree of price stickiness. Whereas manufacturing firms directly rely on energy as a production input, we assume for the sake of illustration that firms in the service sector are only indirectly impacted by the energy price increase, as they use manufactured goods (in addition to labour) as a production input. Prices thus adjust differently across sectors, leading to different waves of sectoral inflation adjustments until the impact of the shock fades out eventually (see Guerrieri et al., 2023). As shown by Rubbo (2023), the micro-founded loss function for the multisector model implies that there is a motive for stabilising (*i*) the output gap to avoid distortions in the labour market, (*ii*) sectoral inflation rates, weighted by sectoral size and the sectoral degree of price stickiness, to reduce misallocation within sectors due to sectoral price dispersion, and (*iii*) sectoral price wedges to reduce the misallocation of resources across sectors due to inefficient relative prices. Importantly, headline inflation does not enter the loss function, only its (sectoral) elements.[7]

For the micro-founded loss function, we find that optimal monetary policy looks through an energy shock in the sense that it stabilises the output gap rather than headline (CPI) inflation. In the multisector model, the output gap is even slightly positive in the first periods of the shock, i.e. optimal monetary policy is slightly expansionary, to reduce distortions on the labour market due to sticky nominal wages (similar to Bodenstein et al., 2008). Importantly, these findings hold regardless of our assumptions about agents' expectation formation. That is, the share of agents with forward-looking expectations and the sensitivity of naive agents' long-run expectations to sectoral shocks do not qualitatively affect these policy conclusions and do not matter much quantitatively. By controlling aggregate demand via the nominal interest rate, monetary policy can directly implement its desired path for the output gap. In a one-sector economy, controlling aggregate demand is enough to also control prices because there is no difference between sectoral and aggregate inflation. However, with multiple sectors, it is not possible to control sectoral inflation rates and prices with aggregate demand management only. This observation holds already under rational expectations and is at the heart of

[5]See Kim (2025) for another recent example using endogenous-gain learning.

[6]Our model features a closed economy and is calibrated to the United States. For economies that rely on energy imports, like the euro area, an open-economy model would be the more appropriate setting for an optimal policy analysis (see e.g. Aguilar et al., 2026; Qiu et al., 2026).

[7]In the textbook one-sector model (Galí, 2015), headline inflation enters the micro-founded loss function only because sectoral and aggregate inflation coincide by construction.

the monetary policy trade-off in a multisector environment (see Rubbo, 2023).[8] Since monetary policy cannot fine-tune sectoral price setting, it is optimal to mostly keep its focus on stabilising the output gap and reduce misallocation in particularly sticky segments of the economy and the labour market in particular. When long-run inflation expectations are endogenous, monetary policy can affect outcomes by changing these expectations through changes in outcomes observed by naive agents, which they use to form expectations about the future in the future. However, the ability to use this channel and affect actual sectoral inflation rates by changing long-run expectations of sectoral inflation and prices also ultimately relies on aggregate demand management. Moreover, as we show in the paper, the pass-through of inflation expectations to inflation is limited in a multisector economy compared to a one-sector economy, extending results by Werning (2022). Taken together, the policymaker does not have an incentive to actively manage long-run inflation expectations to change sectoral inflation dynamics.

In the model, the demand side is not a constraint on what monetary policy can achieve.[9] As a result, the way households form their expectations does not matter for the findings regarding macroeconomic dynamics described in the previous paragraph. However, it does matter for the nominal interest rate path that monetary policy has to set in order to implement its desired movements in economic activity and prices. Therefore, it is relevant for monetary policy in practice. In line with Gáti (2023) and Dupraz and Marx (2024), we find that a possible de-anchoring of inflation expectations requires a more forceful and/or persistent response of interest rate policy to implement similar outcomes as under rational expectations. If elevated long-run inflation expectations cause (some) households to permanently expect lower real rates, monetary policy must raise nominal rates sufficiently to counter the expansionary effect of this development. Remarkably, the *simultaneous* presence of households with forward-looking expectations and households with backward-looking expectations implies that the optimal interest rate response in the impact period of an inflationary energy shock is subdued. To affect the consumption behaviour of naive agents, who only respond to observed actual interest rate changes and not to announced future ones, the optimal interest rate path is persistently higher than under rational expectations. However, households with forward-looking expectations anticipate this restrictive future interest rate path and respond to it already in the period of its announcement. To counter the strong contractionary effect that this policy has on the demand of households with forward-looking expectations, the policymaker does not hike interest rates as strongly on the impact of the energy shock compared to a scenario where such households are absent.[10]

We also look at optimal policy under an ad-hoc loss function for the policymaker. If we assume that the policymaker cares about stabilising the output gap and headline (CPI) inflation, it faces a trade-off similar to that present in the textbook one-sector New Keynesian model under a cost-push shock. As a result, the policymaker stabilises headline inflation more than under the micro-founded loss function, leading to a negative output gap response. Yet, the impact that a potential de-anchoring has on interest rate, inflation and output dynamics is the same as for the micro-founded loss function. The same is true if we assume a loss function that features so-called divine coincidence (DC) inflation, which, following Rubbo (2023), puts higher weights on inflation in larger and stickier sectors and thus resembles core inflation. As in Rubbo (2023), the optimal policy response derived under this DC loss function and the micro-founded loss function are very close. Finally, we demonstrate the robustness of our results by increasing the number of sectors, allowing for flexible wages, considering shocks to different sectors and by assuming that firms form inflation expectations based on aggregate rather than sectoral information.

[8] Antonova and Müller (2026) show how tax policy can be used to implement the first-best allocation in a multisector economy by manipulating sectoral price movements.

[9] An effective lower bound on the policy rate is not relevant for the experiment that we consider. Moreover, we abstract from endogenous movements in long-run nominal rate expectations due to learning, which may otherwise constrain interest rate policy (see Eusepi et al., 2026)

[10] It is worth pointing out that, in principle, our demand side suffers from shortcomings of representative-agent New Keynesian models criticised in the literature, in particular an unrealistically high sensitivity of household consumption to changes in current and expected future interest rates (see e.g. Vissing-Jørgensen, 2002). To attenuate these shortcomings, we assume that, along the lines of Gabaix (2020), agents with forward-looking expectations correctly understand long-run relationships in the economy but "cognitively discount" expected future short-run deviations from the long run.

Related literature This paper contributes to two strands of literature. First, it contributes to the literature that studies optimal monetary policy in multisector models (see e.g. Aoki, 2001; Huang and Liu, 2005; Bodenstein et al., 2008; La'O and Tahbaz-Salehi, 2022; Rubbo, 2023; Qiu et al., 2026). This literature shows that stabilising headline (CPI) inflation is usually not recommended, which can be interpreted as suggesting a "looking-through" policy is favourable in response to inflationary and trade-off-inducing supply shocks. We clarify this finding and show that it also remains true if long-run inflation expectations of households and firms can de-anchor. In doing so, our paper also relates to recent literature that studies optimal monetary policy when inflation expectations are not necessarily anchored (see e.g. Molnár and Santoro, 2014; Gáti, 2023; Dupraz and Marx, 2024; Gust et al., 2025; Eusepi et al., 2026). In line with (most of) this literature, we find that endogenous long-run inflation expectations lead to an optimal policy response to trade-off-inducing shocks that is stronger than under rational expectations.[11] However, we show that in a multisector environment this only applies to the response of the policy rate. When looking at actual outcomes, e.g. at inflation, output or the output gap, we find that they do not differ much under the optimal policy for different assumptions about expectation formation and long-run expectations in particular. Ultimately, the optimal policy trade-offs are not affected by the threat of de-anchoring. Finally, our paper relates to Werning (2022), who derives the pass-through of inflation expectations to inflation for the one-sector New Keynesian model under different pricing assumptions. We extend his findings for Calvo pricing to a multisector environment, showing the existence of a novel indirect pass-through channel that reflects interactions between firm pricing in different sectors.

Layout The remainder of this paper is organised as follows. Section 2 introduces our model. Section 3 presents and discusses our main quantitative results. Section 4 provides some sensitivity analyses. Section 5 discusses the pass-through of inflation expectations. Section 6 concludes.

2 Model

The model extends the textbook New Keynesian model (see Galí, 2015) by allowing for multiple goods, a network production structure (see Pasten et al., 2020; Rubbo, 2023) and endogenous long-run expectations (see Evans et al., 2009; Woodford, 2018; Carvalho et al., 2023; Gáti, 2023).

Households There is a unit-mass continuum of households, indexed with $i \in [0,1]$, who have access to a nominal one-period bond that offers a gross return of R_t. Households choose a sequence for consumption, labour supply and bond holdings, $\left\{C_{i,t}, N_{i,t}, B_{i,t}\right\}_{t=0}^{\infty}$, that maximises expected lifetime utility, $\mathbb{E}_t^i\left[\sum_{s=0}^{\infty}\beta^s\left\{u\left(C_{i,t+s}\right)-v\left(N_{i,t+s}\right)\right\}\right]$, with $u(C)=\left(C^{1-\sigma}-1\right)/(1-\sigma)$ and $v(N)=N^{1+\varphi}/(1+\varphi)$, subject to the period budget constraint, $P_t^h C_{i,t}+B_{i,t}=B_{i,t-1}R_{t-1}+W_tN_{i,t}+D_t-T_t$. Note that the subjective expectation operator $\mathbb{E}_t^i[\cdot]$ is specific to household i and must not coincide with the objective (model-consistent) expectation operator, $\mathbb{E}_t[\cdot]$.

Households earn the nominal wage W_t per unit of labour supplied, receive nominal profits D_t due to ownership of firms in the economy and pay lump-sum taxes T_t to the government. Household consumption $C_{i,t}=Q\left(C_{1,i,t},\ldots,C_{K,i,t}\right)$ is a composite good, where $C_{k,i,t}$ denotes the quantity of goods produced by sector $k\in\{1,2,\ldots,K\}$ that are consumed by household i in period t. We assume that preferences are homothetic, such that all households choose the same consumption bundle composition. We refer to the price of this consumption bundle, P_t^h, as the consumer price index (CPI). The optimal consumption-savings decision of household i satisfies the Euler equation $C_{i,t}^{-\sigma}=\beta\mathbb{E}_t^i\left[C_{i,t+1}^{-\sigma}\left(P_t^h/P_{t+1}^h\right)\right]$,

[11] Bocola et al. (2025) and Christoffel and Farkas (2025) model de-anchored inflation expectations by assuming that the private sector has imperfect knowledge about the central bank's objective and updates its prior about it based on observed policy actions. Under the optimal monetary policy, the policymaker takes into account this asymmetry and the signalling effect of its actions. Unlike the adaptive-learning approach of modelling de-anchoring adopted in this paper, their approach does not assume bounded rationality. However, their "asymmetric-information approach" assumes *(i)* a central bank that cares about stabilising headline inflation and *(ii)* a central bank objective that is subject to persistent shocks. The optimal policy studied in these papers thus deviates from the welfare-maximising policy by construction. Moreover, it is not clear how this approach can be adopted in a multisector setting when the (micro-founded) objective of the central bank does not feature only one (headline) inflation term.

whereas the optimal labour supply decision satisfies $C_{i,t}^{-\sigma}\left(W_t/P_t^h\right) = N_{i,t}^{\varphi}$. The household budget constraint then determines individual household savings $B_{i,t}$.

Firms In the economy, there are K sectors, indexed with $k \in \{1, 2, \dots, K\}$. In each sector, there is a unit-mass continuum of monopolistic firms, indexed with $j \in [0, 1]$, who produce differentiated goods that are used by a sector-level final good firm to produce the good $Y_{k,t}$, using a CES technology, $Y_{k,t} = \left(\int_j Y_{k,j,t}^{(\epsilon_k-1)/\epsilon_k} dj\right)^{\epsilon_k/(\epsilon_k-1)}$. Firm profit maximisation then implies that $Y_{k,j,t+s} = \left(P_{k,j,t+s}/P_{k,t+s}\right)^{-\epsilon_k} Y_{k,t+s}$ is the demand function for intermediate good j in sector k. The price of the sectoral (final) good is $P_{k,t} = \left(\int_j P_{k,j,t}{}^{1-\epsilon_k} dj\right)^{1/(1-\epsilon_k)}$, with $P_{k,j,t}$ denoting the price of input $Y_{k,j,t}$ set by intermediate good firm j in sector k. The intermediate good $Y_{k,j,t}$ is produced with a constant-returns-to-scale production function. Specifically, firm j in sector k uses the function $Y_{k,j,t} = A_{k,t} F_k\big(N_{k,j,t}, \{X_{k,k',j,t}\}_{k' \in \{1,2,\dots,K\}}\big)$, where $A_{k,t}$ denotes exogenous sectoral (Hicks-neutral) productivity, $N_{k,j,t}$ labour input, and $X_{k,k',j,t}$ intermediate goods from sector k'. As in Rubbo (2023), we define aggregate real GDP by using the consumption aggregator of households, $Y_t^r = Q\left(C_{1,t}, \dots, C_{K,t}\right)$, where $C_{k,t}$ denotes total household consumption for sector k.

Intermediate good firms face nominal price rigidity in the form of a Calvo-type friction. In each sector, only a randomly selected fraction $1 - \delta_k$ of firms is therefore able to reset its price $P_{k,j,t}$ in a given period t, taking into account the possibility of future price stickiness. For the remaining fraction of firms that cannot optimally reset their prices, δ_k, the intermediate good price is given as $P_{k,j,t} = P_{k,j,t-1}$. An intermediate good firm j that can reset its price solves

$$\max_{P_{k,j,t}} \mathbb{E}_t^{k,j}\left[\sum_{s=0}^{\infty} M_{t+s}\delta_k^s \left\{(P_{k,j,t+s} - (1-\tau_k)\, MC_{k,t+s})Y_{k,j,t+s}\right\}\right] \text{ s.t. } Y_{k,j,t+s} = \left(P_{k,j,t+s}/P_{k,t+s}\right)^{-\epsilon_k} Y_{k,t+s},$$

where $M_{t+s} = \beta^s (C_{t+s}/C_t)^{-\sigma}\left(P_t^h/P_{t+s}^h\right)$ is the stochastic discount factor between periods t and $t+s$, and $MC_{k,t}$ denotes nominal marginal costs of firms in sector k.[12] The expectation operator $\mathbb{E}_t^{k,j}[\cdot]$ is specific to firm j in sector k and need not coincide with the objective (model-consistent) expectation operator, $\mathbb{E}_t[\cdot]$.

To eliminate (steady-state) inefficiencies due to monopolistic competition, we assume that the government pays a sector-specific and constant input subsidy τ_k to firms. Pre-subsidy, sectoral marginal costs satisfy

$$MC_{k,t} = \min_{N_{k,t}, \{X_{k,k',t}\}_{k'=1}^K} W_t N_{k,t} + \sum_{k'=1}^{K} P_{k',t} X_{k,k',t} \text{ s.t. } A_{k,t} F\Big(N_{k,t}, \left\{X_{k,k',t}\right\}_{k'=1}^{K}\Big) = 1.$$

Given that all firms that can reset their price do so in the same way, we refer to $P_{k,t}^*$ as the sectoral reset price. The first-order condition that solves the firm profit maximisation problem is

$$P_{k,t}^* = (1+\tau_k)\frac{\epsilon_k}{\epsilon_k - 1}\frac{\mathbb{E}_t^{k,j}\left[\sum_{s=0}^{\infty} M_{t+s}\delta_k^s Y_{k,j,t+s} MC_{k,t+s}\right]}{\mathbb{E}_t^{k,j}\left[\sum_{s=0}^{\infty} M_{t+s}\delta_k^s Y_{k,j,t+s}\right]}.$$

Government The fiscal authority finances firm subsidies by levying lump-sum taxes T_t on households, such that $T_t = \sum_{k\in\{1,2,\dots,K\}} \tau_k MC_{k,t}$. The monetary authority sets the nominal interest rate R_t.

Market clearing Bonds are in zero net supply, such that $\int_i B_{i,t} di = 0$ holds. The labour market clearing condition is $\int_i N_{i,t} di = \sum_{k\in\{1,2,\dots,K\}} \int_j N_{k,j,t} dj$. For each sector k, the sectoral goods market clearing condition is $Y_{k,t}/\nu_{k,t} = C_{k,t} + \sum_{k'\in\{1,2,\dots,K\}} X_{k',k,t}$, where $C_{k,t} = \int_i C_{k,i,t} di$ and $\nu_{k,t}$ is sectoral price dispersion, which follows the law of motion $\nu_{k,t} = \delta_k\left(P_{k,t-1}/P_{k,t}\right)^{-\epsilon_k}\nu_{k,t-1} + (1-\delta_k)\left(P_{k,t}^*/P_{k,t}\right)^{-\epsilon_k}$ with $P_{k,t}^{1-\epsilon_k} = \delta_k\left(P_{k,t-1}\right)^{1-\epsilon_k} + (1-\delta_k)\left(P_{k,t}^*\right)^{1-\epsilon_k}$. Total firm profits are $D_t = \sum_{k\in\{1,2,\dots,K\}} D_{k,t}$, with $D_{k,t} = (P_{k,t} - MC_{k,t})Y_{k,t}$.

[12] As in Preston (2005), our choice for the firm discount factor is not important for our analysis since we will ultimately look at a log-linear model approximation. Only the steady-state value for the household discount factor β, which everyone in the economy knows, will matter in this case.

Temporary equilibrium We now define the temporary equilibrium for the model (see Preston, 2005; Farhi and Werning, 2019; García-Schmidt and Woodford, 2019; Werning, 2022), which describes how outcomes in a given period are determined, taking expectations as given. To do so, let the tuple $\Xi = \left(\{\mu_k\}, \{B_i\}, C, \{C_i\}, D, \{D_k\}, M, \{MC_k\}, N, \{N_i\}, \{N_{k,j}\}, P^h,\right.$ $\left.\{P_k\}, \{P_k^*\}, R, T, W, \{X_{k,k',j}\}, \{Y_k\}\right)$ collect all relevant endogenous variables and $S = (\{A_k\})$ all exogenous ones. Given beginning-of-period values for endogenous variables, Ξ_{t-1}, current-period values for exogenous variables, S_t, as well as current household and firm expectations about $\{\Xi_{t+s+1}, S_{t+s+1}\}_{s=0}^{\infty}$, a temporary equilibrium for period t consists of outcomes Ξ_t, such that households and firms solve their respective optimisation problems and markets clear.

Production network For the remainder, it is convenient to introduce notation commonly used in the production network literature (see e.g. Baqaee and Farhi, 2020; Rubbo, 2023). First, define nominal GDP as total expenditure on final goods, $Y_t^n = \sum_{k\in\{1,2,\dots,K\}} P_{k,t} C_{k,t}$. Second, define the vector of consumption expenditure shares, $b_t = \left(b_{1,t}, \dots, b_{K,t}\right)'$, with $b_{k,t} = P_{k,t} C_{k,t} / Y_t^n$, $k \in \{1, 2, \dots, K\}$, such that the CPI satisfies $P_t^h = \sum_{k\in\{1,2,\dots,K\}} b_{k,t} P_{k,t}$. Third, the vector of revenue-based Domar weights (or sectoral sales shares) $\lambda_t = \left(\lambda_{1,t}, \dots, \lambda_{K,t}\right)'$, with $\lambda_{k,t} = P_{k,t} Y_{k,t} / Y_t^n$, satisfies $\lambda_t = \Psi_t' b_t$, where $\Psi_t = (I_K - \Omega_t)^{-1}$ is the revenue-based Leontief inverse matrix and Ω_t the revenue-based input-output matrix, with entries $\Omega_{k,k',t} = \left(P_{k',t} X_{k,k',t}\right) / \left(P_{k,t} Y_{k,t}\right)$. Fourth, cost-based versions of the Domar weights and the Leontief inverse matrix are given as $\tilde{\lambda}_{k,t} = \tilde{\Psi}_t' b_t$ and $\tilde{\Psi}_t = \left(I_K - \tilde{\Omega}_t\right)^{-1}$, respectively, with associated input-output matrix $\tilde{\Omega}_{k,k',t} = \left(P_{k',t} X_{k,k',t}\right) / \left(MC_{k,t} Y_{k,t}\right)$. Finally, define the vector of sectoral labour shares $\alpha_t = \left(\alpha_{1,t}, \dots, \alpha_{K,t}\right)'$, with $\alpha_{k,t} = \left(W_t N_{k,t}\right) / \left(MC_{k,t} Y_{k,t}\right)$, $k \in \{1, 2, \dots, K\}$.

In the next section, we consider a log-linear approximation of the model around the efficient steady state. Since markups are zero in this steady state due to the input subsidies, the revenue-based and cost-based input-output matrices coincide, i.e. $\Omega = \tilde{\Omega}$ (see Baqaee and Farhi, 2020). As a result, the same holds true for the Leontief inverse matrix and the Domar weights, i.e. $\Psi = \tilde{\Psi}$ and $\lambda = \tilde{\lambda}$.

One can view the Domar weights λ as a measure of sectoral size, input-output matrix Ω as a measure of direct sectoral exposure to production inputs, and the Leontief inverse matrix $\Psi = I_K + \Omega + \Omega^2 + \dots$ as a measure of total, i.e. direct and indirect, sectoral exposure due to the production network (see Baqaee and Farhi, 2020).

Log-linear model approximation Assuming rational expectations, Rubbo (2023) shows that the log-linear approximation of the multisector New Keynesian model around the efficient steady state reduces to a straightforward extension of the linearised textbook model representation à la Galí (2015). Applying these insights to the temporary-equilibrium formulation of the multisector model above, we can similarly write its log-linear approximation at either the sectoral or aggregate level as

$$
\begin{aligned}
\widehat{Y}_t &= \sum_{s=0}^{\infty} \beta^s \mathbb{E}_t^h \left[(1-\beta)\, \widehat{Y}_{t+s} - \beta\sigma^{-1} \left(\widehat{R}_{t+s} - \widehat{\Pi}_{t+s+1}^h - \widehat{r}_{t+s} \right) \right], && (1)\\
\widehat{\Pi}_{k,t} &= \frac{(1-\beta\delta_k)(1-\delta_k)}{\delta_k} \sum_{s=0}^{\infty} (\beta\delta_k)^s \mathbb{E}_t^f \left[\widehat{MC}_{k,t+s} - \widehat{P}_{k,t+s} \right] + \frac{1-\delta_k}{\delta_k} \sum_{s=1}^{\infty} (\beta\delta_k)^s \mathbb{E}_t^f \left[\widehat{\Pi}_{k,t+s} \right], && (2)\\
\widehat{MC}_{k,t} &= \alpha_k \left[(\varphi+\sigma)\, \widehat{Y}_t + \sum_{k'=1}^{K} \left(\lambda_{k'} \widehat{A}_{k',t} + b_{k'} \widehat{P}_{k',t} \right) \right] + \sum_{k'=1}^{K} \Omega_{k,k'} \widehat{P}_{k',t} - \widehat{A}_{k,t}, && (3)\\
\widehat{P}_{k,t} &= \widehat{P}_{k,t-1} + \widehat{\Pi}_{k,t}, && (4)\\
\widehat{\Pi}_t^h &= \sum_{k=1}^{K} b_k \widehat{\Pi}_{k,t}, && (5)
\end{aligned}
$$

with $\widehat{X}_t$ denoting that variable X_t is expressed in log-deviations from its value in the efficient steady state. The expectation operator $\mathbb{E}_t^m[\cdot]$, $m \in \{h, f\}$, captures the average expectation of agent type m. The next section will cover its specification in detail.

Equation (1) is the infinite-horizon version of the IS curve, as first derived by Preston (2005), with $\widehat{Y}_t$ denoting the (aggregate) output gap and $\widehat{r}_t$ the natural rate of interest, satisfying

$$\widehat{r}_t = \sigma\left[(\varphi+1)/(\varphi+\sigma)\right]\sum\nolimits_{k\in\{1,2,\ldots,K\}}\lambda_k\widehat{A}_{k,t}\left(\rho_{A,k}-1\right).$$

This IS curve is derived in three steps. First, one needs to obtain (log-linearised) individual decision rules for household consumption that apply for arbitrary beliefs about the future, using the individual Euler equation and the household's intertemporal budget constraint. Second, one aggregates these decision rules across households. Third, the resulting condition is reformulated in terms of the aggregate output gap and the natural rate. This version of the IS curve reflects that, different from the rational-expectations case, current household demand depends on current beliefs about the output gap, the interest rate, consumer price inflation and the natural rate in all future periods. Only after imposing rational expectations, Equation (1) reduces to the standard (recursive) IS curve, $\widehat{Y}_t = \mathbb{E}_t\left[\widehat{Y}_{t+1} - \sigma^{-1}\left(\widehat{R}_t - \widehat{\Pi}^h_{t+1} - \widehat{r}_t\right)\right]$.

Equation (2) is the sectoral version of the infinite-horizon New Keynesian Phillips curve (NKPC) first derived by Preston (2005) for the standard textbook model. It shows that inflation in sector k, $\widehat{\Pi}_{k,t}$, depends on the period-t mark-up in the same sector, $\widehat{\mu}_{k,t} \equiv \widehat{P}_{k,t} - \widehat{MC}_{k,t}$, as well as period-$t$ expectations about all future mark-ups and inflation in sector k. Under rational expectations, Equation (2) reduces to $\widehat{\Pi}_{k,t} = \left[(1-\beta\delta_k)(1-\delta_k)/\delta_k\right]\left[\widehat{MC}_{k,t} - \widehat{P}_{k,t}\right] + \beta\mathbb{E}^f_t\left[\widehat{\Pi}_{k,t+1}\right]$ via the law of iterated expectations (see e.g. Preston, 2005), similar to Pasten et al. (2020) and Rubbo (2023). Additionally assuming that there is only one sector in the economy ($K = 1$), we arrive at the standard textbook NKPC, $\widehat{\Pi}_t = \left[(1-\beta\delta)(1-\delta)/\delta\right]\left[\widehat{MC}_t - \widehat{P}_t\right] + \beta\mathbb{E}_t\left[\widehat{\Pi}_{t+1}\right]$.

Equation (3) describes how sectoral marginal costs are determined. It applies to all firms in the same sector k due to the assumption of a sector-specific and constant-returns-to-scale production technology. The expression on the RHS consists of three terms. The first term measures marginal costs due to labour expenses, which depend on the output gap as a measure of economic slack and the sum of size-adjusted sectoral productivities. The second term captures marginal costs due to inputs from different sectors. The third term measures the effect of within-sector productivity on marginal costs. The first and the third term are also present in the standard one-sector textbook model ($K = 1$), in which case the equation reduces to $\widehat{MC}_t = (\varphi+\sigma)\widehat{Y}_t + \widehat{P}_t$ since $\alpha_1 = \lambda_1 = b_1 = 1$. Importantly, exogenous productivity does not affect marginal costs in this case anymore because its positive indirect effect on marginal costs via nominal wages and its negative direct effect exactly cancel each other out (see Rubbo, 2023). By contrast, sectoral productivity $\widehat{A}_{k,t}$ will not generally be neutralised this way in the multisector case. Moreover, input-output linkages, captured by $\Omega_{k,k'}$ in the second term on the right-hand side (RHS) of Equation (3), will lead to interactions between sectoral inflation rates, each governed by one of K sectoral NKPCs, by changing the cost of inputs via Equation (4).

Equation (4) is the law of motion for sectoral price $\widehat{P}_{k,t}$, linking it to its value in the previous period, $\widehat{P}_{k,t-1}$, and current sectoral inflation, $\widehat{\Pi}_{k,t}$, as determined by the sectoral Phillips curve for sector k. Equation (5) simply pins down CPI inflation $\widehat{\Pi}^h_t$ as a consumption-share weighted average of sectoral inflation rates.

Expectation formation Having derived the temporary equilibrium conditions, i.e. how outcomes are determined for *given* expectations, we now turn to the way agents form these expectations and how they interact with outcomes. We assume that a share of households s_h and a share of (intermediate good) firms s_f has forward-looking and potentially rational expectations, whereas the remainder of households and firms form expectations in a naive and potentially backward-looking way.[13] [14] Agents with forward-looking expectations are modelled in the spirit of Gabaix (2020).

[13] As in Brassil et al. (2025), we assume that households and firms (at the sectoral level) are ultimately governed by a representative agent who makes decisions based on expectations that are a population-share weighted average of forward-looking and backward-looking expectations. This assumption implies that we can abstract from distributional effects due to heterogeneous expectations, which would have to be taken into account for welfare and optimal policy. See Di Bartolomeo et al. (2016) for an application that considers the distributional consequences in the context of the textbook New Keynesian model.

[14] This share is assumed to be constant in the model. This assumption is consistent with findings by D'Acunto et al. (2023), who document a close relationship between innate cognitive ability, as measured by IQ scores, and inflation expectation formation. High-IQ men are found to form consistent expectations and act in ways that are in line with behaviour predicted by standard consumption-savings models. The observations are not explained by socio-economic factors, such as income, education and status.

Their expectations are anchored around the deterministic steady state of the model but expected fluctuations around this steady state are "discounted cognitively" relative to rational expectations by the factor $0 \leq \eta_m \leq 1$. Specifically, the s-period ahead expectation of variable X in period t for agent type $m \in \{f, h\}$ is $\eta_m^s \mathbb{E}_t\left[\widehat{X}_{t+s}\right]$, with $\mathbb{E}_t\left[\,\cdot\,\right]$ denoting the rational (model-consistent) expectation operator in period t. For $\eta_m = 1$, this formulation nests rational expectations. For $\eta_m < 1$, it captures inattention towards future macroeconomic developments. As a result, although agents take into account monetary policy announcements about the future, inattention towards them implies that the model is not subject to the forward guidance puzzle (see Del Negro et al., 2023). Moreover, the further future deviations from the steady state are away, the more they are discounted cognitively.

Naive agents expect macroeconomic variables to remain at the steady state in all future periods. That is, these agents do not take into account future fluctuations around this steady state at all and can only observe the current (actual) outcome.[15] Importantly, what naive agents perceive to be the steady state is endogenous and can change over time. Following the adaptive learning literature, we adopt an anticipated utility approach (see Kreps, 1998), which implies that naive agents do not take into account future revisions of long-run values when they optimise. We also assume that all agents in the economy can observe the current values for exogenous variables and know their laws of motion as well.[16]

Under these assumptions, the period-t expectation of endogenous variable X in period $t+s$, $\mathbb{E}_t^m\left[\widehat{X}_{t+s}\right]$, $m \in \{h, f\}$, which appears in Equations (1) and (2), can be interpreted as the average expectation of agent type m,

$$\mathbb{E}_t^m\left[\widehat{X}_{t+s}\right] = (1 - s_m)\,\overline{X}_{m,t-1} + s_m \eta_m^s \mathbb{E}_t\left[\widehat{X}_{t+s}\right], \tag{6}$$

with $\overline{X}_{m,t-1}$ denoting the time-varying and backward-looking long-run (or steady-state) expectation of variable X held by the naive fraction of agent type m in period t.

To form long-run expectations, we assume that naive agents apply adaptive steady-state learning as in Evans et al. (2009),

$$\overline{X}_{m,t} = \overline{X}_{m,t-1} + \omega_{m,x,t} f_{x,t|t-1}^m, \tag{7}$$

with forecast error

$$f_{x,t|t-1}^m = \widehat{X}_t - \overline{X}_{m,t-1}. \tag{8}$$

The long-run expectation updated in period t and used to forecast macroeconomic variables in period $t+1$ thus is effectively a weighted average of its current "estimate", $\overline{X}_{m,t-1}$, and the latest available data point, $\widehat{X}_t$,

$$\overline{X}_{m,t} = \left(1 - \omega_{m,x,t}\right)\overline{X}_{m,t-1} + \omega_{m,x,t}\widehat{X}_t,$$

where the weight is based on the learning gain $\omega_{m,x,t}$.

According to this learning rule, long-run expectations for variable X are updated solely based on observations for this particular variable. This assumption is in line with Evans et al. (2009) and fits our characterisation of these agent types as naive, lacking the ability or incentives for sophisticated reasoning. However, in the context of a model with sectoral heterogeneity, one could argue that naive firms may find it difficult to perfectly observe sectoral variables in practice. We will revisit this criticism in Section 4.2, showing that it is not crucial for our main results.[17]

Our expectation formation process shares similarities with other approaches in the literature. For instance, one can effectively view it as a version of "shallow reasoning", as proposed by Angeletos and Sastry (2021), that allows long-run

[15] Effectively, these agents fully discount future short-run developments.

[16] This is in contrast to Gabaix (2020), who assumes that future short-run fluctuations of exogenous variables are discounted cognitively as well. However, it is in line with the adaptive learning literature, arguing that the law of motion for exogenous variables is easily learned by agents (see e.g. Gáti, 2023).

[17] On the other hand, Minton and Monnery (2025) show that firms' expectations about their costs are driven by their own costs and disconnected from (CPI) inflation expectations, supporting our baseline modelling assumption about expectation formation of naive firms.

expectations to vary over time rather than remain at the (actual) deterministic steady state. In line with their approach, assuming a non-zero share of naive agents alone already implies that rational expectations are "cognitively discounted", i.e. even for $\eta_m = 1$. Unlike the cognitive discounting proposed by Gabaix (2020), the discounting of future rational expectations via the share s_m does not increase with horizon s (see Equation (6)). As shown later, the strength of the "discounting" via s_m is not strong enough to reasonably attenuate the power of forward guidance in our model, leading to implausible implications for optimal interest rate policy. Additionally assuming $\eta_m < 1$ attenuates this issue.

Our expectations process also shares similarities with the finite-horizon planning approach introduced by Woodford (2018). According to this approach, agents optimise in a forward-looking fashion only over a finite horizon and use experience-based, i.e. backward-looking, forecasts beyond it. The agents' forecasting approach is similar to constant-gain adaptive learning, introducing a backward-looking element into the expectation formation that our approach shares. As in Woodford (2018), our expectations process thus features forward-looking and backward-looking elements. This property is relevant since recent research highlights the importance of these two elements in replicating empirically observed time-series properties of macroeconomic variables (Gust et al., 2022) as well as evidence on expectation formation (Gust et al., 2026).[18] It is also relevant for monetary policymakers since they can affect outcomes directly by shaping expectations via announcements understood by forward-looking agents and indirectly by changing long-run expectations of naive agents via actual interest rate changes and their macroeconomic consequences for the present.

The learning gain $\omega_{m,x,t}$ provides a measure of how well expectations are anchored. The higher it is, the more sensitive long-run expectations are to forecast errors. In contrast to Woodford (2018) and recent applications of the finite-planning approach (see Gust et al., 2022; Dupraz and Marx, 2024), we follow Carvalho et al. (2023) and Gáti (2023) by considering an endogenous learning gain. By allowing the gain to vary endogenously over time, the degree of (de-)anchoring becomes endogenous and depends on the actions of monetary policymakers (see Gáti, 2023). Moreover, the more flexible endogenous-gain approach outperforms the standard constant-gain one by capturing periods of low and high (de-)anchoring, which is in line with the data (see Carvalho et al., 2023).

To capture these insights in a parsimonious way, we follow Gáti (2023) and assume that the learning gain depends on the forecast error, $\omega_{m,x,t} = \omega_{m,x}\left(f^m_{x,t|t-1}\right)$.[19] However, we assume a linear-quadratic function for the learning gain instead of her piecewise linear function,

$$\omega_{m,x}\left(f^m_{x,t|t-1}\right) = \omega_{m,x} + \frac{\psi_{m,x}}{2}\left(f^m_{x,t|t-1}\right)^2 . \tag{9}$$

For $\psi_{m,x} = 0$, we obtain the commonly used constant-gain learning formulation, providing an important benchmark. For $\psi_{m,x} > 0$, we have an endogenous learning gain (see Carvalho et al., 2023; Gáti, 2023). The learning gain is quadratic in the forecast error. Positive and negative forecast errors of the same size thus have the same effect on it.

Recursive model formulation In this section, we derive a recursive formulation of the forward-looking infinite-horizon equations (1) and (2). This formulation will allow us to use standard methods to solve the model, facilitating its quantitative evaluation and the study of optimal policy.

First, consider the infinite-horizon IS curve. After applying Equation (6) to replace the expectation operator $\mathbb{E}^h_t[\cdot]$ in Equation (1), using Equation (5) to replace CPI inflation and simplifying terms, we obtain

$$\begin{aligned}\widehat{Y}_t &= (1-\beta)\widehat{Y}_t - \beta\sigma^{-1}\left(\widehat{R}_t - \widehat{r}_t\right) \\ &\quad + (1-s_h)\frac{\beta}{1-\beta}\left[(1-\beta)\overline{Y}_{h,t-1} - \beta\sigma^{-1}\overline{R}_{h,t-1} + \sigma^{-1}\sum\nolimits_{k=1}^{K} b_k\overline{\Pi}_{k,h,t-1}\right] \\ &\quad + s_h\sum\nolimits_{s=1}^{\infty}(\eta_h\beta)^s\mathbb{E}_t\left[(1-\beta)\widehat{Y}_{t+s} - \beta\sigma^{-1}\widehat{R}_{t+s} + \sigma^{-1}\sum\nolimits_{k=1}^{K} b_k\widehat{\Pi}_{k,t+s}\right] \\ &\quad + \beta\sigma^{-1}\sum\nolimits_{s=1}^{\infty}\beta^s\mathbb{E}_t\left[\widehat{r}_{t+s}\right].\end{aligned} \tag{10}$$

[18] See also Angeletos et al. (2025).

[19] See also Milani (2014, 2025) for evidence that the learning gain varies with the forecast error.

This equation differs from those in Preston (2005) or Gáti (2023) because we allow some households to form expectations in a forward-looking manner. This assumption introduces a forward-looking element into the expectation formation, as captured by the third term on the RHS, which depends on the population share s_h. The second term on the RHS only depends on current long-run expectations, thus collapsing the infinite sum related to naive households into a simple backward-looking expression. By contrast, the forward-looking third term related to forward-looking households still depends on their period-t expectations for all future periods. Finally, the fact that the last term on the RHS does not depend on the household population share shows that all agents forecast exogenous variables in the same way, as everyone in the economy can observe these variables' current values and knows their laws of motion. The same applies to the first term on the RHS, which only includes values in the current period that are observable to all households.

To write the IS curve recursively, we define the auxiliary variables

$$F_{h,t} \equiv \beta\sigma^{-1} \sum_{s=0}^{\infty} \beta^s \mathbb{E}_t \left[\widehat{r}_{t+s}\right],$$

and

$$G_{h,t} \equiv \sum_{s=0}^{\infty} (\eta_h\beta)^s \mathbb{E}_t \left[(1-\beta)\,\widehat{Y}_{t+s} - \beta\sigma^{-1}\widehat{R}_{t+s} + \sigma^{-1} \sum_{k=1}^{K} b_k \widehat{\Pi}_{k,t+s}\right],$$

capturing forward-looking infinite-horizon expectations of exogenous and endogenous variables, respectively. We can express the infinite sums defined by $F_{h,t}$ and $G_{h,t}$ in a recursive way as

$$F_{h,t} = \beta\sigma^{-1}\widehat{r}_t + \beta\mathbb{E}_t\left[F_{h,t+1}\right], \tag{11}$$

and

$$G_{h,t} = (1-\beta)\,\widehat{Y}_t - \beta\sigma^{-1}\widehat{R}_t + \sigma^{-1}\sum_{k=1}^{K} b_k\widehat{\Pi}_{k,t} + \eta_h\beta\mathbb{E}_t\left[G_{h,t+1}\right]. \tag{12}$$

To summarise terms involving long-run expectations of naive households in the IS curve, we define

$$H_{h,t} \equiv (1-\beta)^{-1}\left[(1-\beta)\,\overline{Y}_{h,t} - \beta\sigma^{-1}\overline{R}_{h,t} + \sigma^{-1}\sum_{k=1}^{K} b_k\overline{\Pi}_{k,h,t}\right]. \tag{13}$$

We can then write the IS curve conveniently as

$$\widehat{Y}_t = (1-\beta)\widehat{Y}_t - \beta\sigma^{-1}\left(\widehat{R}_t - \widehat{r}_t\right) + \beta\mathbb{E}_t\left[F_{h,t+1}\right] + s_h\eta_h\beta\mathbb{E}_t\left[G_{h,t+1}\right] + (1-s_h)\,\beta H_{h,t-1}. \tag{14}$$

To express the sectoral NKPCs recursively, we proceed in a similar way. First, we replace marginal costs in the sectoral NKPC (2) via Equation (3),

$$\begin{aligned}\widehat{\Pi}_{k,t} = \kappa_k\alpha_k\widehat{Y}_t &+ \sum_{s=0}^{\infty}\beta\delta_k{}^s\mathbb{E}_t^f\left[\beta\delta_k\kappa_k\alpha_k\widehat{Y}_{t+s+1} + \beta(1-\delta_k)\,\widehat{\Pi}_{k,t+s+1}\right]\\ &+ \gamma_k\sum_{s=0}^{\infty}\beta\delta_k{}^s\mathbb{E}_t^f\left[\sum_{k'=1}^{K}\left\{\alpha_k\left(\lambda_{k'}\widehat{A}_{k',t+s} + b_{k'}\widehat{P}_{k',t+s}\right) + \Omega_{k,k'}\widehat{P}_{k',t+s}\right\} - \widehat{A}_{k,t+s} - \widehat{P}_{k,t+s}\right],\end{aligned}$$

with $\gamma_k \equiv (1-\beta\delta_k)(1-\delta_k)/\delta_k$ and $\kappa_k \equiv \gamma_k(\varphi+\sigma)$.

Then, we apply the expectation operator from Equation (6) and write the infinite sums

$$F_{k,t} \equiv \beta\delta_k\gamma_k\sum_{s=0}^{\infty}\beta\delta_k{}^s\mathbb{E}_t\left[\sum_{k'=1}^{K}\alpha_k\lambda_{k'}\widehat{A}_{k',t+s} - \widehat{A}_{k,t+s}\right],$$

and

$$G_{k,t} \equiv \sum_{s=0}^{\infty}\beta\delta_k{}^s\mathbb{E}_t\left[\beta\delta_k\kappa_k\alpha_k\widehat{Y}_{t+s} + \beta(1-\delta_k)\,\widehat{\Pi}_{k,t+s} + \beta\delta_k\gamma_k\left\{\sum_{k'=1}^{K}\left(\alpha_k b_{k'}\widehat{P}_{k',t+s} + \Omega_{k,k'}\widehat{P}_{k',t+s}\right) - \widehat{P}_{k,t+s}\right\}\right],$$

recursively as

$$F_{k,t} = \beta\delta_k\gamma_k\left[\sum_{k'=1}^{K}\alpha_k\lambda_{k'}\widehat{A}_{k',t} - \widehat{A}_{k,t}\right] + \beta\delta_k\mathbb{E}_t\left[F_{k,t+1}\right], \tag{15}$$

and

$$G_{k,t} = \eta_f\beta\delta_k\kappa_k\alpha_k\widehat{Y}_t + \eta_f\beta\left(1-\delta_k\right)\widehat{\Pi}_{k,t} + \eta_f\beta\delta_k\gamma_k\left\{\sum_{k'=1}^{K}\left(\alpha_k b_{k'}\widehat{P}_{k',t} + \Omega_{k,k'}\widehat{P}_{k',t}\right) - \widehat{P}_{k,t}\right\} + \eta_f\beta\delta_k\mathbb{E}_t\left[G_{k,t+1}\right]. \tag{16}$$

Finally, after defining

$$H_{k,t} \equiv \left(1-\beta\delta_k\right)^{-1}\left[\beta\delta_k\kappa_k\alpha_k\overline{Y}_{f,t} + \beta\left(1-\delta_k\right)\overline{\Pi}_{k,f,t} + \beta\delta_k\gamma_k\left\{\sum_{k'=1}^{K}\left(\alpha_k b_{k'} + \Omega_{k,k'}\right)\overline{P}_{k',f,t} - \overline{P}_{k,f,t}\right\}\right], \tag{17}$$

to summarise infinite-horizon expressions related to long-run expectations of naive firms, we obtain the following recursive representation of the sectoral NKPC,

$$\begin{aligned}\widehat{\Pi}_{k,t} = \kappa_k\alpha_k\widehat{Y}_t + \gamma_k\left[\sum_{k'=1}^{K}\left\{\alpha_k\left(\lambda_{k'}\widehat{A}_{k',t} + b_{k'}\widehat{P}_{k',t}\right) + \Omega_{k,k'}\widehat{P}_{k',t}\right\} - \widehat{A}_{k,t} - \widehat{P}_{k,t}\right] \\ + \mathbb{E}_t\left[F_{k,t+1}\right] + s_f\mathbb{E}_t\left[G_{k,t+1}\right] + \left(1-s_f\right)H_{k,t-1}.\end{aligned} \tag{18}$$

Together with the law of motion for sectoral prices, given by Equation (4), and the equations related to long-run expectation formation, given by Equations (7)-(9), Equations (11)-(18) characterise the model dynamics in the remainder.

Welfare To analyse the optimal monetary policy response to sectoral shocks under the threat of de-anchored inflation expectations, we need to specify an objective function for the policymaker. Following Rubbo (2023), we can write the second-order approximation of household utility in the multisector model around the efficient steady state as

$$\begin{aligned}\mathbb{W}_t = \frac{1}{2}\sum_{s=0}^{\infty}\beta^s\mathbb{E}_t\Big[(\varphi+\sigma)\widehat{Y}_{t+s}^2 + \sum_{k=1}^{K}\lambda_k\gamma_k^{-1}\epsilon_k\widehat{\Pi}_{k,t+s}^2 \\ +\frac{1}{2}\sum_{k'=1}^{K}\sum_{k''=1}^{K}\left\{b_{k'}b_{k''}\sigma_h + \sum_{k=1}^{K}\lambda_k\Omega_{k,k'}\Omega_{k,k''}\sigma_k\right\}\left(\widehat{\chi}_{k',t+s} - \widehat{\chi}_{k'',t+s}\right)^2\Big].\end{aligned} \tag{19}$$

The vector $\widehat{\chi}_t = (\widehat{\chi}_{k,t}, \dots, \widehat{\chi}_{K,t})$ collects sectoral price gaps $\widehat{\chi}_{k,t} \equiv \widehat{P}_{k,t} - \widehat{P}_{k,t}^*$, which – analogous to the output gap – measure the difference between actual sectoral prices, $\widehat{P}_{k,t}$, and their respective flex-price counterparts, $\widehat{P}_{k,t}^* = -\sum_{k'=1}^{K}\Psi_{k,k'}\widehat{A}_{k',t}$.[20]

Period welfare depends on three terms. The first term involves the squared output gap. It is present in the standard one-sector model as well and captures deviations of labour supply from its efficient (flex-price) level. The second term, which is the weighted sum of squared sectoral inflation rates, measures price dispersion within sectors. As in the standard one-sector model, the weight on each of the sectoral inflation terms increases with the elasticity of substitution, ϵ_k, and the degree of price stickiness in the sector, measured by γ_k^{-1}. In addition, welfare related to within-sector price dispersion also positively depends on a sector's size, measured by Domar weight λ_k. The third term is not present in the one-sector model, as it captures misallocation between sectors due to distorted relative sectoral prices (see Rubbo, 2023). This misallocation concerns the demand for sectoral goods by households (first term in curly brackets) and firms (second term in curly brackets). As in La'O and Tahbaz-Salehi (2022) and Rubbo (2023), using the definition $\mathrm{Var}_a\left(\widehat{\chi}_t\right) \equiv \sum_{k'=1}^{K}a_{k'}\widehat{\chi}_{k',t}^2 - \left(\sum_{k'=1}^{K}, a_{k'}\widehat{\chi}_{k',t}\right)^2$, we can also write the third term as $\sigma_h\mathrm{Var}_b\left(\widehat{\chi}_t\right) + \sum_{k=1}^{K}\lambda_k\sigma_k\mathrm{Var}_{\Omega_{k,\cdot}}\left(\widehat{\chi}_t\right)$, where $\Omega_{k,\cdot}$ denotes row number k of matrix Ω. Intuitively, the cost of across-sector misallocation increases with the substitution elasticities σ_h and σ_k, respectively.

[20] Deviations from rational expectations do not affect the form of the loss function (see e.g. Eusepi and Preston, 2018; Gabaix, 2020). By contrast, heterogeneous expectations can affect the loss function (see e.g. Di Bartolomeo et al., 2016) but do not affect it in our case due to our representative-agent assumption (see Brassil et al., 2025).

As a useful reference, we also consider an ad-hoc loss function given by

$$\mathbb{W}_t = \frac{1}{2} \sum_{s=0}^{\infty} \beta^s \mathbb{E}_t \Big[w_Y \widehat{Y}_{t+s}^2 + w_\Pi \Big(\sum_{k=1}^{K} w_k \widehat{\Pi}_{k,t+s} \Big)^2 \Big]. \tag{20}$$

This loss function only depends on two elements. In addition to the squared output gap deviations, it features squared inflation deviations for a price index with weights $(w_1, \ldots, w_K)$. For $w_k = b_k$, the loss function targets stable CPI inflation. This variant provides a useful reference since the associated loss function is consistent with a dual mandate objective for the central bank. Another useful reference case is nested for $w_k = \lambda_k \gamma_k^{-1} / \sum_{k' \in \{1,2,\ldots,K\}} \lambda_{k'} \gamma_{k'}^{-1}$. These weights define an inflation target based on the so-called "divine coincidence" (DC) price index derived in Rubbo (2023). For this price index, Rubbo (2023) provides two interesting results, assuming rational expectations. First, it is possible to write down a New Keynesian Phillips curve that is in terms of current and expected future DC inflation. Like the Phillips curve in the textbook model, it is unaffected by sectoral productivity shocks. As a result, the divine coincidence result known from the one-sector model (see Galí, 2015) applies for this price index as well, i.e. there is no trade-off between stabilising the output gap and DC inflation for a productivity shock. Importantly, this result does not hold for CPI inflation, such that sectoral productivity shocks effectively act like cost-push shocks, introducing a trade-off between output gap and CPI inflation stabilisation. Second, Rubbo (2023) shows that the optimal policy for the micro-founded loss function (19) can be approximated by an interest rate feedback rule that targets DC inflation.[21] We will return to this result in the next section.

Policy problem For the optimal policy problem, we focus on endogenous long-run inflation expectations.[22] As a result, demand-side conditions, which can be a constraint on monetary policy if households also learn about long-run nominal interest rates (see Eusepi et al., 2026), can be omitted from the policy problem. However, the household conditions are still relevant, as they determine the nominal interest rate path once the policymaker decided which outcomes to implement.

Before formulating the policy problem, we re-write some model equations by expressing sectoral prices in real terms, normalising them via the consumer price index, i.e. $\widehat{p}_{k,t} \equiv \widehat{P}_{k,t} - \sum_{k'=1}^{K} b_{k'} \widehat{P}_{k',t}$. With this normalisation, the affected sectoral equilibrium conditions are

$$\begin{aligned}
\widehat{\Pi}_{k,t} &= \alpha_k \kappa_k \widehat{Y}_t + \gamma_k \Big(\alpha_k \sum_{k'=1}^{K} \lambda'_k \widehat{A}_{k',t} + \sum_{k'=1}^{K} \Omega_{k,k'} \widehat{p}_{k',t} - \widehat{A}_{k,t} - \widehat{p}_{k,t} \Big) + \mathbb{E}_t \left[F_{k,t+1} \right] + s_f \mathbb{E}_t \left[G_{k,t+1} \right] + (1 - s_f) H_{k,t-1}, \\
G_{k,t} &= \eta_f \Big(\beta \delta_k \alpha_k \kappa_k \widehat{Y}_t + \beta \delta_k \gamma_k \Big(\sum_{k'=1}^{K} \Omega_{k,k'} \widehat{p}_{k',t} - \widehat{p}_{k,t} \Big) + \beta (1 - \delta_k) \widehat{\Pi}_{k,t} \Big) + \eta_f \beta \delta_k \mathbb{E}_t \left[G_{k,t+1} \right], \\
H_{k,t} &= (1 - \beta \delta_k)^{-1} \Big(\beta \delta_k \gamma_k \Big(\sum_{k'=1}^{K} \Omega_{k,k'} \bar{p}_{f,k',t} - \bar{p}_{f,k,t} \Big) + \beta (1 - \delta_k) \overline{\Pi}_{f,k,t} \Big), \\
\widehat{p}_{k,t} &= \widehat{p}_{k,t-1} + \widehat{\Pi}_{k,t} - \sum_{k'=1}^{K} b_{k'} \widehat{\Pi}_{k',t}.
\end{aligned}$$

If long-run inflation expectations can move away from zero, expected nominal prices are no longer bounded for naive agents anymore, which can cause numerical instability. Our normalisation avoids this.

In our model, firm expectations enter the NKPC in three ways. First, expectations about future sectoral productivities are captured by the term $\mathbb{E}_t \left[F_{k,t+1} \right]$. They are formed in a rational way by all firms, reflecting that they observe the current productivity values and know the correct law of motion for $A_{k,t}$. Second, the term $s_f \mathbb{E}_t \left[G_{k,t+1} \right]$ captures that the fraction s_f of firms forms expectations about relevant future endogenous variables in a forward-looking manner. However, the equation for $G_{k,t}$, which governs how expectations of endogenous variables affect firm price setting, takes into account that expectations are cognitively discounted if $\eta_f < 1$. Third, the term $H_{k,t-1}$ captures that the fraction $1 - s_f$ of firms is naive and forms expectations in a backward-looking way. $H_{k,t}$ reflects how long-run expectations

[21] Without discounting, it is even possible to exactly implement the optimal policy with such an interest rate rule.

[22] Long-run price expectations are ultimately a function of long-run inflation expectations via the law of motion for sectoral prices. When referring to long-run inflation expectations, we thus usually mean long-run expectations for sectoral inflation and prices.

are transmitted to firm price setting. Naive firms expect future values for $p_{k,t}$ and $\Pi_{k,t}$ to be at their current estimate for the long run. As illustrated by the term $(1-\beta\delta_k)^{-1}$ in the equation for $H_{k,t}$, changes in long-run expectations for these variables can thus have a strong impact on firm price setting. Specifically, the higher their discounting factor β and/or the lower their price-setting probability $1-\delta_k$, the stronger the direct pass-through of long-run inflation and price expectations to sectoral inflation $\Pi_{k,t}$.

Let $\mathbb{U}_t \equiv \mathbb{U}\big(\widehat{Y}_t, \{\widehat{\Pi}_{k,t}, \widehat{p}_{k,t}\}\big)$ denote the period loss function of the policymaker, nesting the micro-founded and the ad-hoc specifications. The optimal monetary policy under commitment sets the path of nominal interest rates to minimise the loss function $\mathbb{W}_t$ subject to the equilibrium conditions for the recursive model formulation. As is common in the literature, we assume that the policymaker has rational expectations when setting its policy (see e.g. Gaspar et al., 2010; Bersson et al., 2024). The Lagrangian for the monetary policy problem under commitment can then be written as

$$
\begin{aligned}
\mathcal{L}_0 = \sum_{t=0}^{\infty} \beta^t \mathbb{E}_0 \Bigg[& \mathbb{U}\left(\widehat{Y}_t, \left\{\widehat{\Pi}_{k,t}, \widehat{p}_{k,t}\right\}_{k=1}^{K}\right) \\
& + \sum_k \mu^1_{k,t} \left(\begin{array}{l} \widehat{\Pi}_{k,t} - \alpha_k \kappa_k \widehat{Y}_t - \gamma_k \left(\alpha_k \sum_{k'=1}^{K} \lambda'_k \widehat{A}_{k',t} + \sum_{k'=1}^{K} \Omega_{k,k'} \widehat{p}_{k',t} - \widehat{A}_{k,t} - \widehat{p}_{k,t}\right) \\ -\mathbb{E}_t\left[F_{k,t+1}\right] - s_f \mathbb{E}_t\left[G_{k,t+1}\right] - (1-s_f) H_{k,t-1} \end{array} \right) \\
& + \sum_k \mu^2_{k,t} \left(G_{k,t} - \eta_f \left(\beta\delta_k \alpha_k \kappa_k \widehat{Y}_t + \beta\delta_k \gamma_k \left(\sum_{k'=1}^{K} \Omega_{k,k'} \widehat{p}_{k',t} - \widehat{p}_{k,t} \right) + \beta(1-\delta_k)\widehat{\Pi}_{k,t} \right) - \eta_f \beta \delta_k \mathbb{E}_t\left[G_{k,t+1}\right] \right) \\
& + \sum_k \mu^3_{k,t} \left(H_{k,t} - (1-\beta\delta_k)^{-1} \left(\beta\delta_k\gamma_k \left(\sum_{k'=1}^{K} \Omega_{k,k'} \bar{p}_{f,k',t} - \bar{p}_{f,k,t} \right) + \beta(1-\delta_k)\overline{\Pi}_{f,k,t} \right) \right) \\
& + \sum_k \mu^4_{k,t} \left(\overline{\Pi}_{f,k,t} - \overline{\Pi}_{f,k,t-1} - \omega_{\Pi_k,f,t} \left(\widehat{\Pi}_{k,t} - \overline{\Pi}_{f,k,t-1} \right) \right) \\
& + \sum_k \mu^5_{k,t} \left(\bar{p}_{f,k,t} - \bar{p}_{f,k,t-1} - \omega_{p_k,f,t} \left(\widehat{p}_{k,t} - \bar{p}_{f,k,t-1} \right) \right) \\
& + \sum_k \mu^6_{k,t} \left(\widehat{p}_{k,t} - \widehat{p}_{k,t-1} - \widehat{\Pi}_{k,t} + \sum_{k'=1}^{K} b_{k'} \widehat{\Pi}_{k',t} \right) \Bigg].
\end{aligned}
$$

The first-order conditions for $\{\widehat{Y}_t, \widehat{\Pi}_{k,t}, \widehat{p}_{k,t}, G_{k,t}, H_{k,t}, \overline{\Pi}_{f,k,t}, \bar{p}_{f,k,t}\}$ are (in that order):

$$
\begin{aligned}
0 &= \mathbb{U}_{Y,t} - \sum_{k'} \mu^1_{k',t} \alpha_{k'} \kappa_{k'} - \sum_{k'} \mu^2_{k',t} \eta_f \beta \delta_{k'} \alpha'_k \kappa_{k'}, \\
0 &= \mathbb{U}_{\Pi_k,t} + \mu^1_{k,t} - \eta_f \beta (1-\delta_k) \mu^2_{k,t} - \mu^4_{\Pi_k,f,t} (\omega_{\Pi_k,f,t} + (\partial \omega_{\Pi_k,f,t} / \partial \widehat{\Pi}_{k,t})(\widehat{\Pi}_{k,t} - \overline{\Pi}_{f,k,t-1})) + b_k \sum_{k'} \mu^6_{k',t} - \mu^6_{k,t}, \\
0 &= \mathbb{U}_{p_k,t} - \sum_{k'} \gamma_{k'} \Omega_{k',k} \mu^1_{k',t} + \gamma_k \mu^1_{k,t} - \sum_{k'} \eta_f \beta \alpha_{k'} \gamma_{k'} \Omega_{k',k} \mu^2_{k',t} + \eta_f \beta \alpha_k \gamma_k \mu^2_{k,t} \\
&\quad - \mu^5_{p_k,f,t} (\omega_{p_k,f,t} + (\partial \omega_{p_k,t} / \partial \widehat{p}_{k,t})(\widehat{p}_{k,t} - \bar{p}_{f,k,t-1})) + \mu^6_{k,t} - \beta \mathbb{E}_t\left[\mu^6_{k,t+1}\right], \\
0 &= \mu^2_{k,t} - s_f \beta^{-1} \mu^1_{k,t-1} - \eta_f \delta_k \mu^2_{k,t-1}, \\
0 &= \mu^3_{k,t} - (1-s_f) \beta \mathbb{E}_t\left[\mu^1_{k,t+1}\right], \\
0 &= -(1-\beta\delta_k)^{-1} \beta (1-\delta_k) \mu^3_{k,t} + \mu^4_{k,t} + \beta \mathbb{E}_t\left[\mu^4_{\Pi_k,f,t+1}(-1 + \omega_{\Pi_k,t+1} + (\partial \omega_{\Pi_k,f,t+1} / \partial \overline{\Pi}_{k,t})(\widehat{\Pi}_{k,t+1} - \overline{\Pi}_{f,k,t}))\right], \\
0 &= -\sum_{k'} (1-\beta\delta_{k'})^{-1} \mu^3_{k',t} \beta \delta_{k'} \gamma_{k'} \Omega_{k',k} + (1-\beta\delta_k)^{-1} \mu^3_{k,t} \beta \delta_k \gamma_k \\
&\quad + \mu^5_{k,t} + \beta \mathbb{E}_t\left[\mu^5_{k,t+1}(-1 + \omega_{p_k,f,t+1} + (\partial \omega_{p_k,f,t+1} / \partial \bar{p}_{f,k,t})(\widehat{p}_{k,t+1} - \bar{p}_{f,k,t}))\right] + \mu^6_{k,t},
\end{aligned}
$$

with $\mathbb{U}_{x,t} \equiv \partial \mathbb{U}_t / \partial \widehat{x}_t$.

To illustrate the policy trade-offs, we proceed step by step. As the first step, we follow Rubbo (2023) and eliminate the relevance of expectations and intertemporal policy considerations by assuming full discounting ($\beta = 0$). In this case, the relevant policy choices involve only $\{\widehat{Y}_t, \widehat{\Pi}_{k,t}, \widehat{p}_{k,t}\}$ and the constraints related to long-run expectation formation become irrelevant ($\mu^4_{k,t} = \mu^5_{k,t} = 0$). The respective first-order conditions then are:

$$
\begin{aligned}
0 &= \mathbb{U}_{Y,t} - \sum\nolimits_{k'} \mu^1_{k',t}\alpha_{k'}\kappa_{k'}, \\
0 &= \mathbb{U}_{\Pi_k,t} + \mu^1_{k,t} + b_k \sum\nolimits_{k'} \mu^6_{k',t} - \mu^6_{k,t}, \\
0 &= \mathbb{U}_{p_k,t} - \sum\nolimits_{k'} \gamma_{k'}\Omega_{k',k}\mu^1_{k',t} + \gamma_k\mu^1_{k,t} + \mu^6_{k,t}.
\end{aligned}
$$

These conditions show how the policymaker trades off different intratemporal distortions in a multisector economy. To establish a benchmark, consider the one-sector version ($K = 1$), in which case the third condition becomes irrelevant ($\mu^6_{k',t} = 0$ for all k'), the labour share α equals one and the first two conditions can be combined to $-\mathbb{U}_{Y,t}/\mathbb{U}_{\Pi,t} = \kappa$ by eliminating the multiplier attached to the Phillips curve, μ^1_t. The policymaker would like to equalise the ratio of marginal losses for Y_t and Π_t to the slope of the Phillips curve, κ, which matters for the cost of bringing down inflation in terms of the output gap. In response to a productivity shock A_t, it is well known that the policymaker can perfectly stabilise Y_t and Π_t in the one-sector model, whereas it faces a trade-off under a cost-push shock because it moves Y_t and Π_t in opposite directions.

In the multisector case ($K > 1$), the intratemporal trade-off between output gap and inflation stabilisation is complicated by the fact that there are now as many inflation rates as there are sectors, causing misallocation within K sectors, measured by $\mathbb{U}_{\Pi_k,t}$, and across sectors, measured by $\mathbb{U}_{p_k,t}$.[23] In contrast to the one-sector case, even under a sectoral productivity shock, the policymaker trades off stabilising the output gap against stabilising sectoral inflation rates and prices. How this trade-off is resolved depends on how costly inflation and price distortions are in specific sectors and the policymaker's ability to move sectoral inflation into the desired direction, which crucially depends on the sectoral labour shares, α_k, the slopes of the sectoral Phillips curves, κ_k, and the entries of the input-output matrix Ω. As discussed by Rubbo (2023), for the micro-founded loss function, the optimal policy under full discounting is to close the output gap, which implies that within-sector price distortions are minimised. Across-sector price distortions, while costly, cannot be avoided by the optimal policy in response to productivity shocks in a multisector economy. Since the ability of the policymaker to fine-tune prices in specific sectors via aggregate demand management is limited, it effectively refrains from doing so.

We now turn to the intertemporal dimension of the policy problem by assuming $\beta > 0$. First, consider the first-order condition for $G_{k,t}$,

$$\mu^2_{k,t} = s_f\beta^{-1}\mu^1_{k,t-1} + \eta_f\delta_k\mu^2_{k,t-1}.$$

The sectoral multipliers $\mu^1_{k,t-1}$ and $\mu^2_{k,t-1}$ capture the history dependence of optimal policy under commitment in the presence of Phillips curves with forward-looking expectation formation. A change in $G_{k,t}$ not only affects outcomes in period t but also those in the previous period $t-1$ by changing expectations of firms in that period. Under commitment, this effect is internalised by the policymaker and the lagged multipliers enforce promises made in the past, preserving a recursive model structure despite the presence of a time-inconsistency problem. Note that the policymaker's ability to change outcomes via expectations management depends on how forward-looking firm expectations are. This is highlighted by the firm population share, s_f, and the degree of cognitive discounting, η_f, in the first-order condition. As shown by Rubbo (2023) for $s_f = \eta_f = 1$, the intertemporal dimension of the optimal commitment policy does not affect the main optimal policy predictions obtained under full discounting. Monetary policy will still prioritise stabilising the output gap. However, as will be shown later as part of the quantitative model analysis, the optimal policy under the micro-founded loss function will deviate from full output gap stabilisation to address distortions in sectors with particularly sticky inflation.

[23]Note that, via the law of motion for sectoral prices, sectoral inflation $\Pi_{k,t}$ has a direct effect on sectoral price $p_{k,t}$.

The first-order condition for $H_{k,t}$ illustrates how endogenous long-run expectations affect the policy trade-off,

$$\mu^3_{k,t} = (1 - s_f)\beta\mathbb{E}_t\left[\mu^1_{k,t+1}\right].$$

In contrast to the forward-looking firms, period-t expectations of naive firms are tied to their long-run inflation and price expectations, which in turn evolve in a backward-looking fashion and are linked to actual inflation and prices in the previous period, $t-1$. Current distortions, captured by the multiplier $\mu^3_{k,t}$, thus are now weighted against expected future distortions, captured by $(1-s_f)\beta\mathbb{E}_t\left[\mu^1_{k,t+1}\right]$. As previously shown in Molnár and Santoro (2014) for $K = 1$ and $s_f = 0$, with adaptive learning about long-run inflation expectations, the policymaker's ability to influence firm behaviour through backward-looking expectation formation allows it to trade off distortions today against expected distortions tomorrow and thus, depending on its patience, to optimally delay distortions into the future.

To further illustrate the policy trade-off related to long-run expectations, we focus on long-run sectoral inflation expectations $\overline{\Pi}_{k,t}$. We write the first-order condition for $\overline{\Pi}_{k,t}$ as

$$\mu^4_{k,t} = \beta\mathbb{E}_t\left[\mu^4_{k,t+1}(1-\omega_{\Pi_k,f,t+1} - (\partial\omega_{\Pi_k,f,t+1}/\partial\overline{\Pi}_{k,t})(\widehat{\Pi}_{k,t+1} - \overline{\Pi}_{f,k,t}))\right] + (1-s_f)(1-\beta\delta_k)^{-1}\beta(1-\delta_k)\beta\mathbb{E}_t\left[\mu^1_{k,t+1}\right],$$

by combining it with the first-order condition for $H_{k,t}$. The multiplier $\mu^4_{k,t}$ is associated with the law of motion for $\overline{\Pi}_{f,k,t}$. The optimal policy choice for $\overline{\Pi}_{f,k,t,}$ equates $\mu^4_{k,t}$ to the sum of the expected marginal effect it has on the evolution of long-run expectations in the subsequent period (first term on the RHS) and the expected distortion it causes via the Phillips curve for sector k in period $t+1$ (second term on the RHS).

To change long-run expectations of naive agents, monetary policy needs to move actual outcomes. For inflation, this can be seen in the first-order condition for $\Pi_{k,t}$, which links the multiplier attached to the Phillips curve, $\mu^1_{k,t}$, and the multiplier on the law of motion for $\overline{\Pi}_{f,k,t}$, $\mu^4_{k,t}$. Distortions caused today by changing long-run expectations are thus tied to the intratemporal trade-off between stabilising Y_t, $\Pi_{k,t}$ and $p_{k,t}$. The incentive to change long-run sectoral inflation expectations in a multisector economy is rather low for the same reasons fine-tuning actual sectoral inflation and price movements is not attractive: a mismatch between multiple sectoral variables and one policy instrument, the nominal rate, which allows the policymaker to affect aggregate demand.

As in Carvalho et al. (2023) and Gáti (2023), we allow the learning gain to change endogenously. The resulting impact on the optimal policy trade-off is captured by the partial derivatives $\partial\omega_{X,f,t}/\partial\widehat{X}_t$ and $\partial\omega_{X,f,t}/\partial\overline{X}_{t-1}$. They enter the first-order conditions only in combination with forecasting error $\widehat{X}_{k,t} - \overline{X}_{f,k,t-1}$. The signs of the errors today and tomorrow thus determine whether an endogenous learning gain dampens or amplifies the incentive to change long-run expectations.

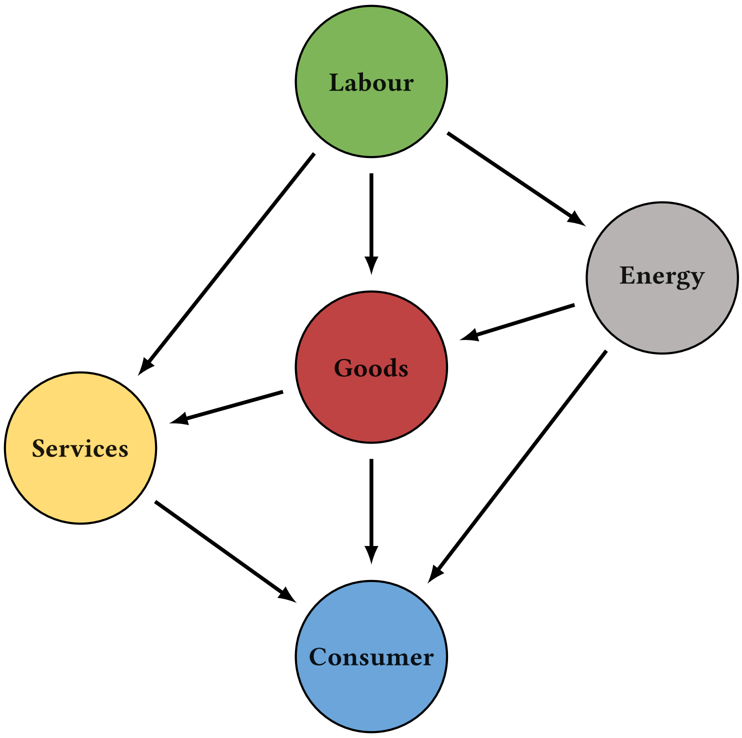
Finally, note that the intratemporal and intertemporal policy trade-offs related to forward-looking and backward-looking expectations interact in our model for $s_f \in (0,1)$.[24] The consequences of this interaction for optimal policy are difficult to assess based only on the first-order conditions. In the next section, we perform a quantitative analysis of optimal policy under different assumptions for s_f and s_h, showing how the policy trade-offs are resolved when both types of agents are present in the economy and what this implies for the optimal interest rate path.

3 Quantitative analysis

In this section, we provide a quantitative analysis of the multisector model presented in the previous section. First, we present the model calibration. Second, we evaluate the effects of sectoral shocks in the multisector model for an interest rate feedback rule. Third, we look at the optimal monetary policy under commitment for different assumptions about

[24] This property is shared with the optimal policy analysis of Dupraz and Marx (2024) based on Woodford (2018)'s model with finite-horizon planning.

Figure 1: Production network in the stylised economy



expectation formation.

3.1 Calibration

For the quantitative model analysis, we consider a calibration that is motivated by the stylised model presented in Guerrieri et al. (2023). Despite its parsimonious structure, the stylised model is capable of capturing various observations related to the inflation surge in the aftermath of the COVID-19 pandemic and the Russian invasion of Ukraine in 2022. Moreover, the stylised model will allow us to analyse the monetary policy trade-offs in a transparent way.[25]

We consider a production network that features four sectors ($K = 4$). The network structure is illustrated in Figure 1. Firms in the first sector, labelled the union (or labour) sector and indexed as $k = L$, hire labour supplied by households on the competitive market and transform it into the intermediate good "labour". This good is then sold to firms in the three remaining sectors, making the union sector the most upstream sector. Importantly, the union sector sets the price of labour subject to the same nominal rigidity that the other sectors face. As in Rubbo (2023), modelling unions as firms within a particular sector enables us to introduce sticky nominal wages in the spirit of Erceg et al. (2000) without altering the model structure by including unions as an additional and distinct agent type. Firms in the union sector use labour supplied by households as the only variable production input and exhibit the degree of price stickiness $\delta_L = 0.85$. Moreover, since firms in this sector are the only ones that use labour supplied directly by households, the union sector has a labour share of one ($\alpha_L = 1$), whereas the other three sectors have a labour share of zero. However, their exposure to labour offered by the union sector shows up in the input-output matrix Ω.

The second sector in the economy is the energy sector ($k = E$). Using labour supplied by the union sector as the only variable production input, firms in this sector manufacture the good "energy". As is common in the literature, we model price-setting in this sector as effectively being flexible ($\delta_E = 0.003$).[26] Energy is consumed directly by households

[25]While we motivate our analysis with this time episode, our goal is not to fully explain inflation dynamics during that episode and provide a rationale for the observed monetary policy response. See Erceg et al. (2024) for an attempt to jointly explain the inflation dynamics and the monetary policy response during this episode in the context of a one-sector New Keynesian model.

[26]This assumption is also consistent with the data, see e.g. Carvalho et al. (2021).

($b_E = 0.1$) as well as by firms in the third sector, the goods sector $k = G$. Firms in this sector manufacture goods and can substitute between the two production inputs labour and energy. The labour cost share of this sector is $\Omega_{G,L} = 0.6$. Manufactured goods are consumed by households directly ($b_G = 0.5$) and are used as a production input by firms in the service sector, $k = S$. The labour cost share in the service sector is $\Omega_{S,L} = 0.8$ and thus higher compared to the goods sector. For the degree of price stickiness, we also assume that it is higher in the service sector ($\delta_S = 0.75$) than in the goods sector ($\delta_G = 0.65$) (see Guerrieri et al., 2023). Given that $b_L = 0$, the consumption expenditure share for services is given as $b_S = 0.4$. This calibration of the production network implies that the input-output matrix Ω is quite sparse,

$$\begin{bmatrix} \Omega_{L,L} & \Omega_{L,S} & \Omega_{L,G} & \Omega_{L,E} \\ \Omega_{S,L} & \Omega_{S,S} & \Omega_{S,G} & \Omega_{S,E} \\ \Omega_{G,L} & \Omega_{G,S} & \Omega_{G,G} & \Omega_{G,E} \\ \Omega_{E,L} & \Omega_{E,S} & \Omega_{E,G} & \Omega_{E,E} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ \Omega_{S,L} & 0 & 1-\Omega_{S,L} & 0 \\ \Omega_{G,L} & 0 & 0 & 1-\Omega_{G,L} \\ 1 & 0 & 0 & 0 \end{bmatrix},$$

and together with the household expenditure share b, it implies that the Domar weights are given as $\left(\lambda_L, \lambda_S, \lambda_G, \lambda_E\right)' = \left(1, 0.1, 0.52, 0.608\right)'$.

For the preference and technology parameters, we mostly follow Rubbo (2023). For the household, we set the discount factor to $\beta = 0.99$, the intertemporal elasticity of substitution to $1/\sigma = 1$ and the Frisch elasticity to $\varphi = 2$. For the demand-related elasticities, we use $\sigma_h = 0.9$, $\sigma_k = 0.1$ and $\epsilon_k = 8$, $\forall k$. Finally, we assume that sectoral productivities $\widehat{A}_{k,t}$ follow AR(1) processes, with persistence parameters $\rho_{A,k} = 0.85$, $\forall k$, and i.i.d. normally distributed shocks $\varepsilon_{k,t}$.

For the parameters related to agents' expectation formation, we set $\omega_{m,x} = \psi_{m,x} = 0$ for $m \in \{h, f\}$ and $x \in \{R, Y\}$, thus focusing on the de-anchoring of inflation expectations. Only long-run expectations related to inflation can thus potentially move around. For our baseline parameterisation, we consider a learning gain value of $\omega_{m,x} = 0.02$ for households and firms, consistent with the value estimated by Milani (2004) for a New Keynesian model with infinite-horizon learning. For the endogenous-gain parameters, we cannot rely on values from the literature and therefore experimented with a range of different values.

3.2 Inflation dynamics

In this section, we assume rational expectations and illustrate some key properties of inflation in the multisector model by considering a sectoral productivity shock. For this exercise, we assume that monetary policy follows a standard Taylor rule, $\widehat{R}_t = \rho_R \widehat{R}_{t-1} + (1-\rho_R)(\phi_\Pi \widehat{\Pi}_t^h + \phi_Y \widehat{Y}_t)$.[27] Motivated by the experiences following the Russian invasion of Ukraine in February 2022, we consider a negative shock to productivity in the energy sector, $\widehat{A}_{E,t}$.[28] This shock directly raises marginal costs for firms in the energy sector, who immediately pass on these costs to households and firms in other sectors, as energy prices are (almost) fully flexible. In the remainder, we therefore also refer to this particular shock as an energy (price) shock. We set the size of the shock to obtain an annualised energy inflation rate of 25% on shock impact ($\varepsilon_{E,t} = -0.0625$), which is in line with the 2022 value observed for the United States on average in 2022.

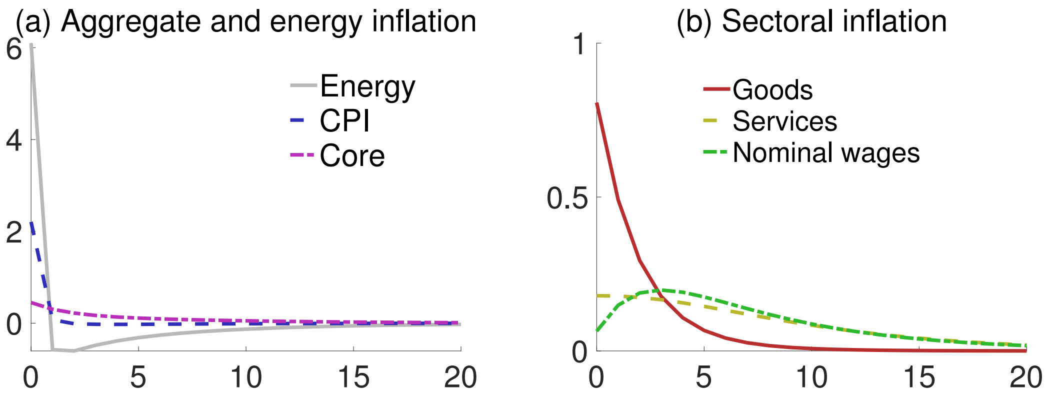
Figure 2 displays inflation dynamics in the multisector model for a large negative shock to productivity in the energy sector ($\varepsilon_{E,t} = -0.0625$). The increase in energy inflation (Panel (a), solid grey line) is strong and immediate but it also dissipates quickly. Since energy is partly consumed by households, the price increase is directly passed on to CPI inflation (Panel (a), dashed blue line). However, CPI inflation is more persistent than energy inflation, reflecting that prices for goods and services, which are the other two CPI components, adjust only gradually.[29] The dashed-dotted magenta line

[27] The parameter values are $\rho_R = 0.7$, $\phi_\Pi = 1.5$ and $\phi_Y = 0.25$.

[28] Alessandri and Gazzani (2025) show that shocks to the supply of natural gas have stronger aggregate effects than shocks to the oil supply. In this paper, we look at shocks to the energy sector, abstracting from the exact source of the shocks within this sector.

[29] While CPI inflation is more persistent than energy inflation, its persistence is nevertheless quite low. This observation reflects the absence of model features that are usually considered in macroeconomic models to make inflation dynamics more persistent, for example indexation (see e.g. Guerrieri et al., 2023).

Figure 2: Inflation dynamics following an energy shock



Notes: IRFs are in percentage deviations from steady state. The underlying model version assumes rational expectations ($s_h = s_f = \eta_h = \eta_f = 1$) and an interest rate rule.

in Panel (a) of Figure 2 illustrates this by displaying core inflation, which we define as DC inflation excluding nominal wage inflation, i.e. $\widehat{\Pi}_t^c \equiv \sum_{k\in\{2,\ldots,K\}} w_k^c \widehat{\Pi}_{k,t}$, with $w_k^c = \lambda_k \gamma_k^{-1} / \sum_{k'\in\{2,\ldots,K\}} \lambda_{k'} \gamma_{k'}^{-1}$. Core inflation, which effectively does not (directly) contain energy inflation, does not increase as much as energy and CPI inflation but is notably more persistent. The inflation dynamics for goods and services, which drive core inflation, are shown in Panel (b) of Figure 2 – together with nominal wage inflation. Inflation in the goods sector (solid red line) increases notably upon shock impact. By contrast, the increase in service inflation is subdued and more gradual (dashed yellow line). Differences in the inflation responses of these two sectors are driven by differences in their exposure to the price of energy, their degree of price stickiness and their labour intensity. Compared to firms in the goods sector, firms in the service sector increase their prices more gradually, as the energy price increase is already passed on to the service sector only partially and with a delay due to price stickiness. Moreover, service prices are stickier than goods prices, further attenuating the immediate response of service inflation but also making it more persistent. Lastly, the service sector is also more exposed to changes in the cost of labour, which is responding slowly to the energy shock due to nominal wage rigidity (dashed-dotted green line), making service inflation additionally more gradual compared to goods inflation. As documented empirically by Guerrieri et al. (2023), these heterogeneous responses of sectoral inflation to an energy shock are in line with experiences since 2022. Given the prominent role that this type of shock played in discussions about the recent inflation surge and the appropriate monetary policy response, we will investigate it from a normative perspective in the next section.

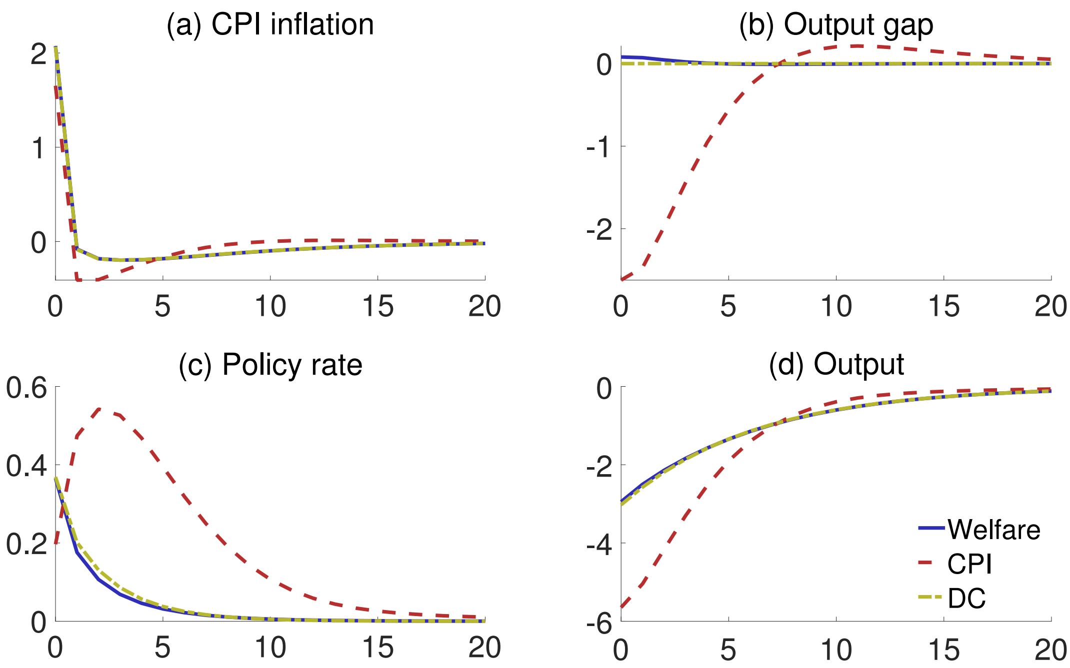
3.3 Optimal monetary policy

We analyse the optimal policy in five steps, adding a new element to the model in each step. First, as the reference case, we consider the optimal monetary policy response to an energy price shock under rational expectations, i.e. for $s_h = s_f = 1$ and $\eta_f = \eta_h = 1$. Second, we assume agents are forward-looking but subject to cognitive discounting ($s_h = s_f = 1$ and $\eta_f = \eta_h < 1$). Third, we introduce naive agents ($s_h = s_f < 1$) but keep long-run inflation expectations anchored at the deterministic steady state. Fourth, we endogenise long-run inflation expectations by letting naive agents use constant-gain learning. Fifth, we allow the learning gain to move endogenously over time.[30]

Rational expectations Figure 3 depicts the response of selected variables to an energy price shock under the optimal commitment policy if all agents are fully rational. As discussed in Section 2, the welfare-maximising commitment policy

[30]We solve the model numerically using a nonlinear perfect foresight solver, as implemented in Dynare (see Adjemian et al., 2024). Except in the last case with endogenous-gain learning, the model is linear and the solver delivers the same results as standard solution methods for multivariate linear rational expectations models (see e.g. Klein, 2000; Sims, 2002).

Figure 3: Responses to an energy shock with rational agents ($s_h = s_f = 1$)



Notes: IRFs are in percentage deviations from steady state. "Welfare": micro-founded loss function. "CPI": ad-hoc loss function with CPI inflation target. "DC": ad-hoc loss function with DC inflation target.

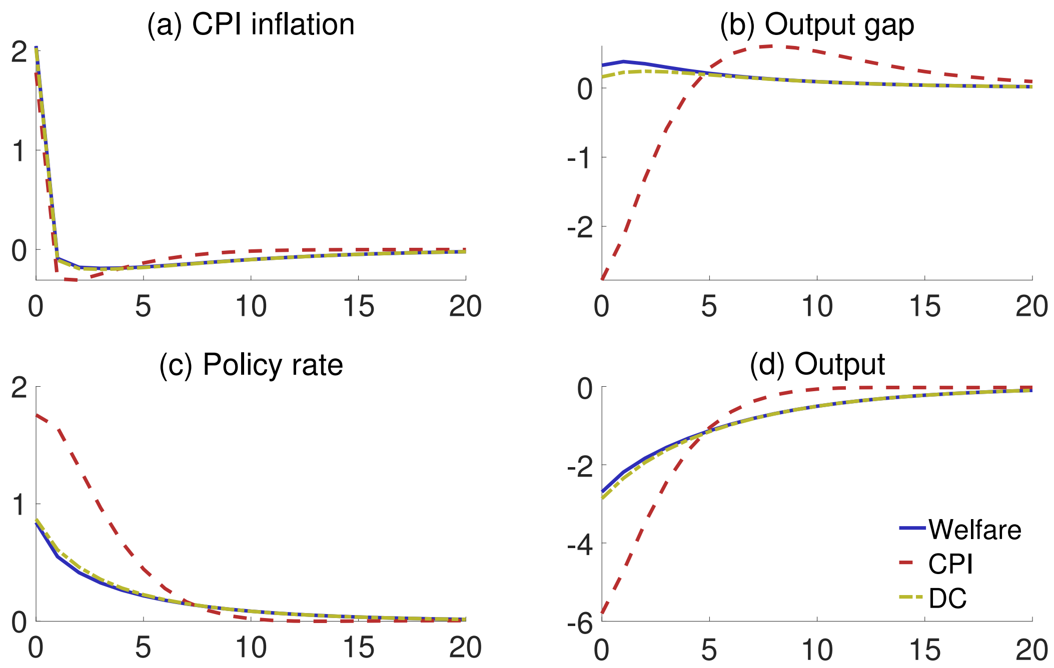
in a multisector economy tends to stabilise the output gap in response to sectoral productivity shocks.[31] Therefore, it does not lean against the increase in CPI inflation and in that sense "looks through" the negative productivity shock in the energy sector, see Figure 3 (solid blue lines). The output gap is slightly positive in the first periods after the energy price shock, in line with Bodenstein et al. (2008). Although the nominal interest rate goes up, monetary policy is therefore slightly expansionary by letting output move above its flex-price level. The positive output gap indicates that the monetary policymaker tries to trade off a stable output gap against reductions in price distortions within (and across) the different sectors. Given that energy prices are effectively flexible, γ_E^{-1} is approximately zero, energy inflation does not (directly) enter welfare as an argument. By contrast, wages are quite sticky, such that squared wage inflation receives a relatively high weight in the objective. Moreover, labour supplied by unions is a direct input for the energy, goods and service sectors. By having a positive output gap, real wages do not fully adjust downward to reflect the fall in productivity, reducing price dispersion within sectors. However, this policy entails welfare losses due to misallocation across sectors, since sectoral prices are distorted. Yet, due to our sparse input-output matrix, this misallocation is rather limited.

Figure 3 also shows optimal policy results based on the ad-hoc loss function (20).[32] For the CPI inflation target, the energy shock acts like a cost-push shock, forcing the policymaker to trade off output gap against CPI inflation stabilisation (dashed red lines). Importantly, the associated policy is more contractionary than the welfare-maximising one since it (successfully) brings down CPI inflation by implementing a negative output gap, whereas this is not a concern for the welfare-maximising policymaker. Looking at the optimal policy based on the ad-hoc loss function that targets DC inflation, we observe that it closely aligns with the welfare-maximising policy (dashed-dotted yellow lines). This finding

[31]For different but related models, the finding that it is not desirable to stabilise CPI inflation in multisector economies has been established in previous studies as well (see e.g. Erceg et al., 2000; Aoki, 2001; Huang and Liu, 2005; La'O and Tahbaz-Salehi, 2022).

[32]For the ad-hoc loss function, the weights on the output gap and the inflation index are set to $w_Y = \varphi + \sigma$ and $w_\Pi = \left[\sum_{k\in\{1,2,\ldots,K\}} \lambda_k \gamma_k^{-1} \epsilon_k\right] / \sum_{k\in\{1,2,\ldots,K\}} \lambda_k$, respectively. Our calibration then implies a relative weight on the output gap of $w_Y / w_\Pi = 0.021$.

Figure 4: Responses to an energy shock with cognitive discounting ($s_h = s_f = 1$, $\eta_h = \eta_f = 0.8$)



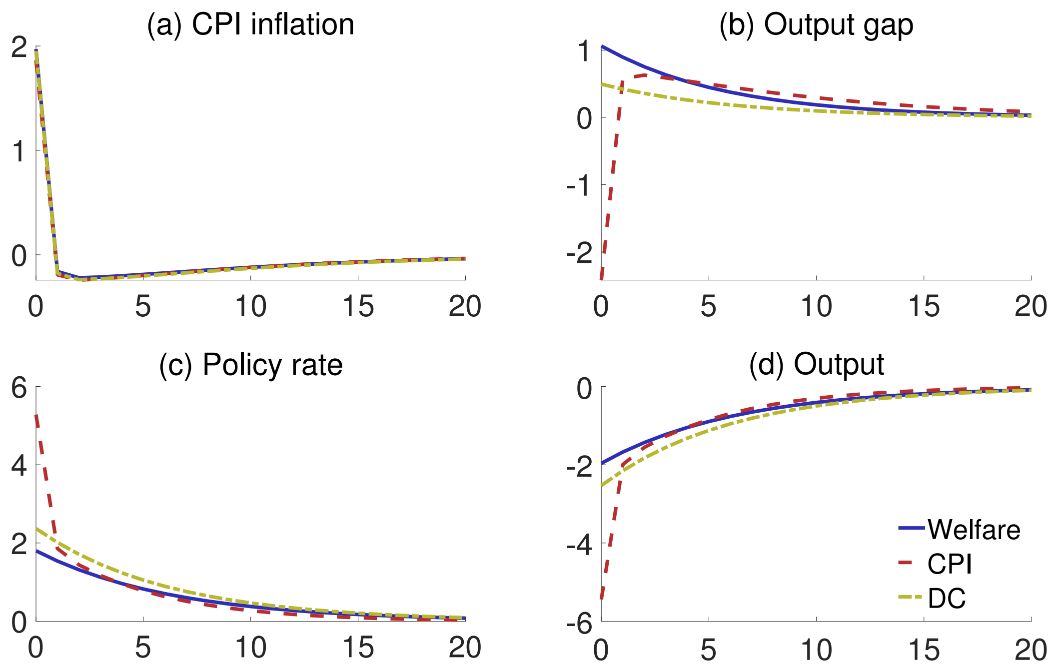
Notes: IRFs are in percentage deviations from steady state. "Welfare": micro-founded loss function. "CPI": ad-hoc loss function with CPI inflation target. "DC": ad-hoc loss function with DC inflation target.

demonstrates that DC inflation targeting provides a good approximation of the welfare-maximising policy (see Rubbo, 2023). By construction, the DC index puts higher weights on inflation in sectors that are larger and stickier, similar to how the micro-founded loss function discounts squared inflation more for sectors that are flexible. Flexibly targeting DC inflation, which closely resembles core inflation, produces an optimal policy response that also "looks through" the energy price shock by not stabilising CPI inflation.[33] However, unlike the welfare-maximising policy, this policy does not implement a slightly positive output gap in the first few periods, reflecting that wage inflation only enters the objective via DC inflation and not as a separate argument.

Cognitive discounting In Figure 4, we document the impact that cognitive discounting has on optimal policy. It shows responses for a model version with forward-looking agents that are subject to cognitive discounting ($\eta_f = \eta_h = 0.8$).[34] Under this assumption, the policymaker's ability to control outcomes by managing agents' forward-looking expectations is diminished, which requires stronger and front-loaded interest hikes to implement the desired outcomes. This finding holds regardless of the policymaker's objective. Qualitatively, but also mostly quantitatively, the responses of inflation and output do not change under the welfare-maximising policy compared to the rational-expectations case. For the optimal policies with ad-hoc loss functions, differences are more notable. If the policymaker is concerned with stabilising DC inflation, the output gap now is positive at first, as in the welfare-maximising case. If the policymaker's concern is stabilising CPI inflation, the inflation response becomes close to that in the other two cases, even though the interest rate hike is much stronger. This finding arises because price-setting by firms is less forward-looking under cognitive discounting. As a result, the sacrifice ratio for stabilising CPI inflation (the output loss needed to cut inflation) becomes less favourable. Therefore, bringing down inflation as much as in the rational-expectations case is not optimal anymore as it would require a much stronger decline in the output gap.

[33] An important difference between DC and core inflation is that the latter does not include wage inflation.
[34] This value is in line with those used in Gabaix (2020).

Figure 5: Responses to an energy shock with naive agents and anchored expectations ($s_h = s_f = 0$)



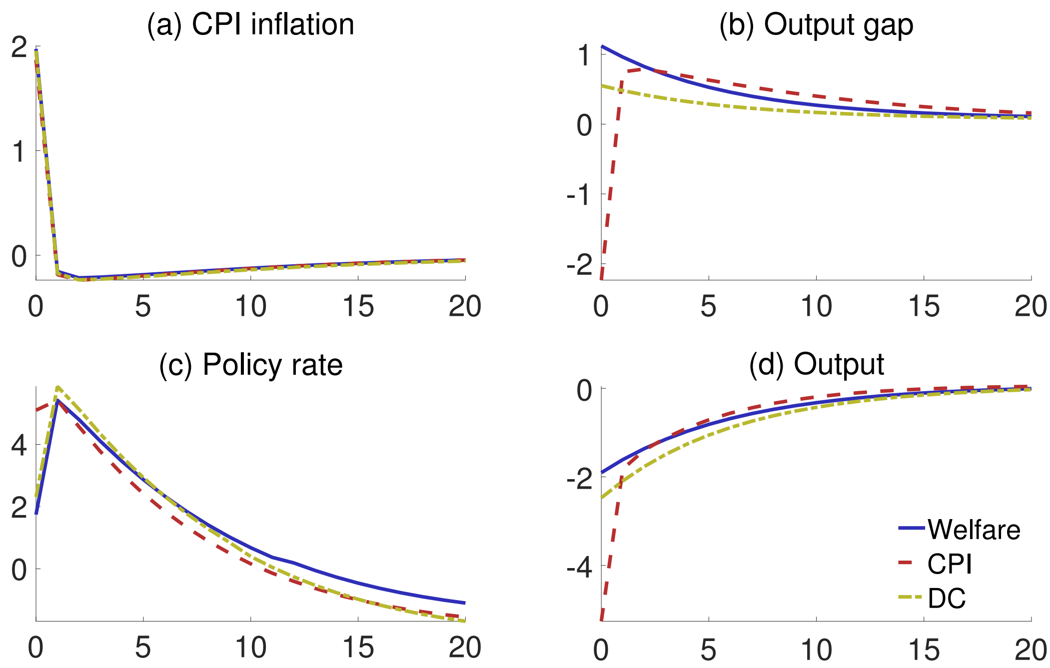
Notes: IRFs are in percentage deviations from steady state. "Welfare": micro-founded loss function. "CPI": ad-hoc loss function with CPI inflation target. "DC": ad-hoc loss function with DC inflation target.

Naive expectations In Figure 5, we show the responses under the optimal policy for a model version without forward-looking agents but fully anchored inflation expectations ($s_h = s_f = 0$). This case can be seen as an extreme form of cognitive discounting ($\eta_f = \eta_h = 0$). Households and firms only correctly observe the current value of an endogenous macroeconomic variable. They naively assume it will be equal to its deterministic steady-state value in all future periods. Qualitatively, the results are in line with the previous case. Since the policymaker's ability to manage agents' forward-looking expectations is not possible anymore at all, interest rate hikes have to be even more front-loaded and stronger than with a moderate degree of cognitive discounting.

Constant-gain learning Figures 6 and 7 plot the responses if the naive agents in the economy adjust their long-run expectations over time via constant-gain learning. The main observation for these model versions is that remarkably little changes for inflation and output compared to the case with naive agents that have anchored long-run expectations, whereas the interest rate responses change visibly. These results, which apply to all three loss functions, demonstrate that long-run inflation expectations matter much more for household than firm behaviour in the multisector model. The reason for this is as follows. Ceteris paribus, even small changes in long-run inflation expectations have a strong impact on the consumption-savings decisions of naive households. While naive households are backward-looking when it comes to forming expectations, their behaviour is forward-looking and optimal given their expectations, responding to changes in expected real rates far ahead in the future. Upward shifts in long-run inflation expectations thus cause naive households to expect permanently lower real rates, which in turn leads to strong positive adjustments in their current demand (see third term on the RHS of Equation (10)). All else equal, the policymaker then has to strongly hike nominal rates to implement a given outcome, offsetting the expansionary effect of higher long-run inflation expectations. This is indeed what we see in Figure 6, which assumes that all agents are naive ($s_h = s_f = 0$).[35]

[35] The observation that, due to adaptive infinite-horizon learning, small changes in long-run inflation expectations can already have strong effects on outcomes is related to the origins of the forward guidance puzzle (see Del Negro et al., 2023). The puzzle states that in full-information rational-

Figure 6: Responses to an energy shock with naive agents and constant-gain learning ($s_h = s_f = 0$)



Notes: IRFs are in percentage deviations from steady state. "Welfare": micro-founded loss function. "CPI": ad-hoc loss function with CPI inflation target. "DC": ad-hoc loss function with DC inflation target.

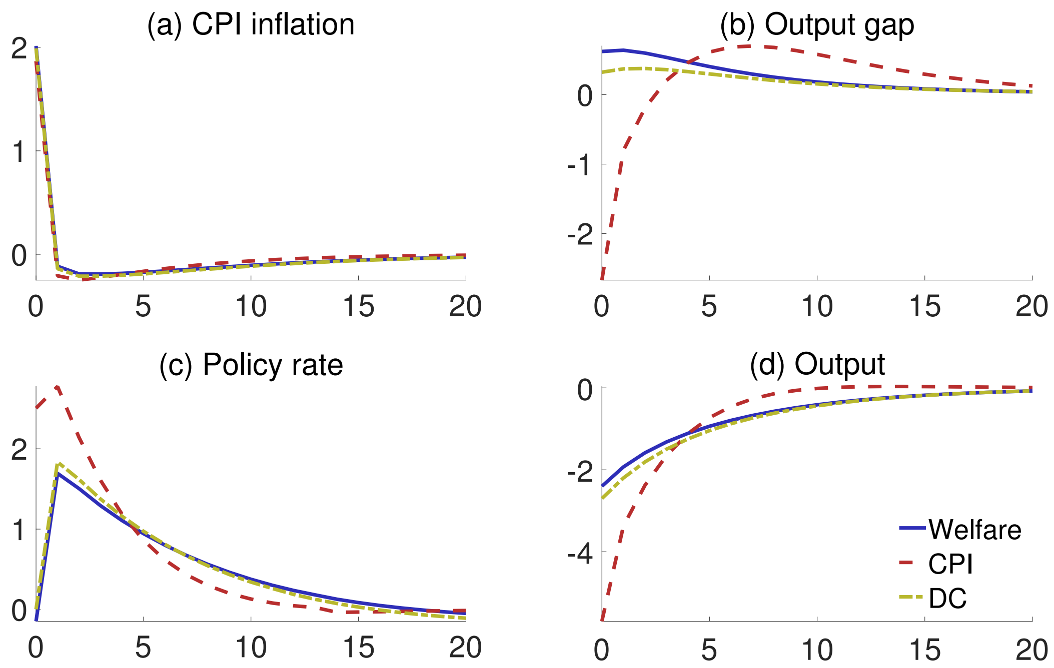
With respect to the initial interest rate response, we observe notable differences in the first period depending on whether we allow for agents with forward-looking expectation formation or not. If 50% of agents have forward-looking expectations (see Figure 7), interest rates do not increase in the impact period of the shock. This response shows that the policymaker attenuates the contractionary effect that higher rates in future periods have on the demand by households who form expectations in a forward-looking way. Accordingly, this effect is absent if the share of these households is zero (see Figure 6). It is also worth emphasising again that the IS curve pins down the nominal rate path that the policymaker implements to achieve specific outcomes. It does not pose a constraint on what outcomes the policymaker can implement.[36] The paths for inflation and (to a lesser extent) output under the optimal policy therefore do not depend on household expectation formation in our case.

Turning to inflation and output, the reason why endogenous long-run inflation expectations hardly affect the optimal responses of these variables in the multisector model is a mismatch between the number of tools monetary policy has at its disposal (one) and the heterogeneity of sectoral price-setting. Monetary policy can directly implement its desired output gap path by controlling aggregate demand via the policy rate. However, with multiple sectors, it is not possible to control heterogeneous sectoral inflation rates and prices with only this one blunt tool. This is already the case under rational expectations and is at the heart of the monetary policy trade-off in a multisector environment (see

expectations (FIRE) representative-agent New Keynesian (RANK) models, expected interest rate changes in periods far ahead in the future have implausibly large effects on outcomes in earlier periods. However, approaches that address this puzzle by deviating from FIRE, e.g. by introducing some form of naivety or inattention to expected future short-run fluctuations (see Angeletos and Lian, 2018; Woodford, 2018; Farhi and Werning, 2019; García-Schmidt and Woodford, 2019; Gabaix, 2020; Angeletos and Sastry, 2021), do not attenuate the strong sensitivity of aggregate demand to changes in expected long-run real rates in our model, as the forward guidance puzzle arises – among other things – from the assumption of rational expectations. By contrast, in our case, moving away from rational expectations, which keep long-run expectations anchored, introduces the strong propagation of changes in expected long-run real rates (see Equation (10)). Moreover, in our case, it is long-run expectations that matter. Approaches such as the one proposed by Gabaix (2020), which are designed to attenuate the effects of short-run fluctuations around a deterministic steady state, do not dampen the strong propagation in our case.

[36] This can be different if there is an effective lower bound on the policy rate or learning about the long-run nominal rate (see Eusepi et al., 2026), which can both cause the interest rate path that is consistent with the desired outcome to be infeasible.

Figure 7: Responses to an energy shock with naive agents and constant-gain learning ($s_h = s_f = 0.5$)



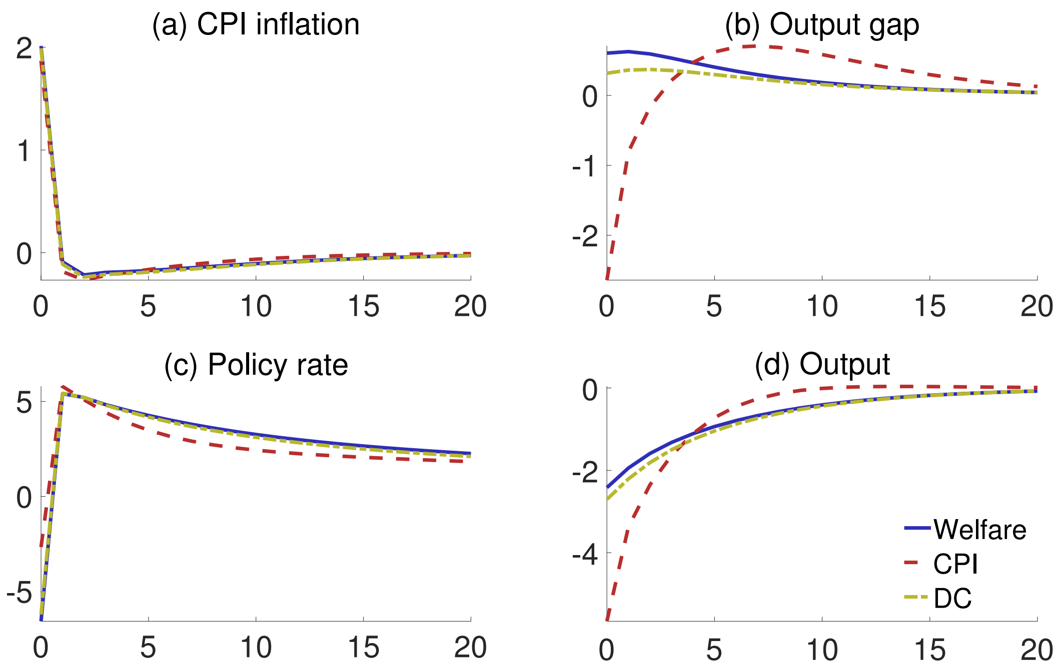
Notes: IRFs are in percentage deviations from steady state. "Welfare": micro-founded loss function. "CPI": ad-hoc loss function with CPI inflation target. "DC": ad-hoc loss function with DC inflation target.

Rubbo, 2023). Since monetary policy is not good at fine-tuning sectoral price-setting, it is optimal to mostly keep its focus on stabilising the output gap and reduce misallocation in particularly sticky sectors, namely the union sector. When long-run inflation expectations are endogenous and backward-looking, monetary policy can affect outcomes by changing these expectations via actual outcomes. However, the ability to affect actual sectoral inflation by changing long-run expectations of sectoral inflation and prices also ultimately relies on aggregate demand management. This makes managing long-run *sectoral* inflation expectations just as ineffective as managing actual *sectoral* inflation rates. This finding is in contrast to the textbook one-sector model, where there is more scope for guiding the economy via backward-looking expectations due to *(i)* a higher pass-through of inflation expectations to actual inflation and *(ii)* the close link between inflation and real activity via the (unique) NKPC (see Gaspar et al., 2010; Molnár and Santoro, 2014).[37]

As in the textbook one-sector model, we could drop the IS curve from the optimal policy problem, as it does not constrain the policymaker's choice set for outcomes.[38] Once an optimal path for the output gap, inflation rates and prices is found, the IS curve "only" residually pins down the nominal rate path consistent with these outcomes, reflecting household inflation expectations. If all households are completely rational but firms are boundedly rational, the outcomes would not change relative to a scenario in which households and firms are both boundedly rational. However, the interest rate path that is consistent with these outcomes would differ in this case, reflecting a change in household expectation formation. By contrast, the reverse does not hold. Changing how firms form expectations alters the paths of the output gap, inflation and prices under the optimal policy. It also changes the optimal interest rate path that is consistent with those paths.

[37] We return to the pass-through in the one-sector model vs. the multisector model in Section 5.
[38] Furthermore, interest rate fluctuations do not enter the loss function as an argument.

Figure 8: Responses to an energy shock with naive agents and endogenous-gain learning ($s_h = s_f = 0.5$)



Notes: IRFs are in percentage deviations from steady state. "Welfare": micro-founded loss function. "CPI": ad-hoc loss function with CPI inflation target. "DC": ad-hoc loss function with DC inflation target.

Endogenous-gain learning As highlighted by Gáti (2023) and discussed in Section 2, endogenous-gain learning provides policymakers with an additional channel to influence the economy. Compared to constant-gain learning, the size of forecast errors now matters for how sensitive long-run expectations are to a shock. While the endogeneity of the gain can cause de-anchoring to occur more quickly and be stronger, it also gives policymakers' actions more bite. By responding more aggressively, a policymaker can lean against a potential de-anchoring and prevent – or at least attenuate – it immediately. Figure 8 shows IRFs for the optimal policy response in our model with endogenous-gain learning and 50% rational agents ($s_h = s_f = 0.5$). The endogenous-gain learning parameter is set to $\psi_{m,x} = 490$.[39] To counter the additional effect of the shock on the gain, the policymaker adjusts interest rates to agreater extent and also more persistently. Again, due to the presence of rational households, this response does not apply to the first period, in which the policy rate is now *cut* and thus lower than under constant-gain learning (see Figure 7).[40] For inflation and output, we again observe only small differences compared with constant-gain learning. This shows that inflation expectations are unimportant for firms' behaviour. They are also difficult to take advantage of by the policymaker to affect firm behaviour in a multisector economy.

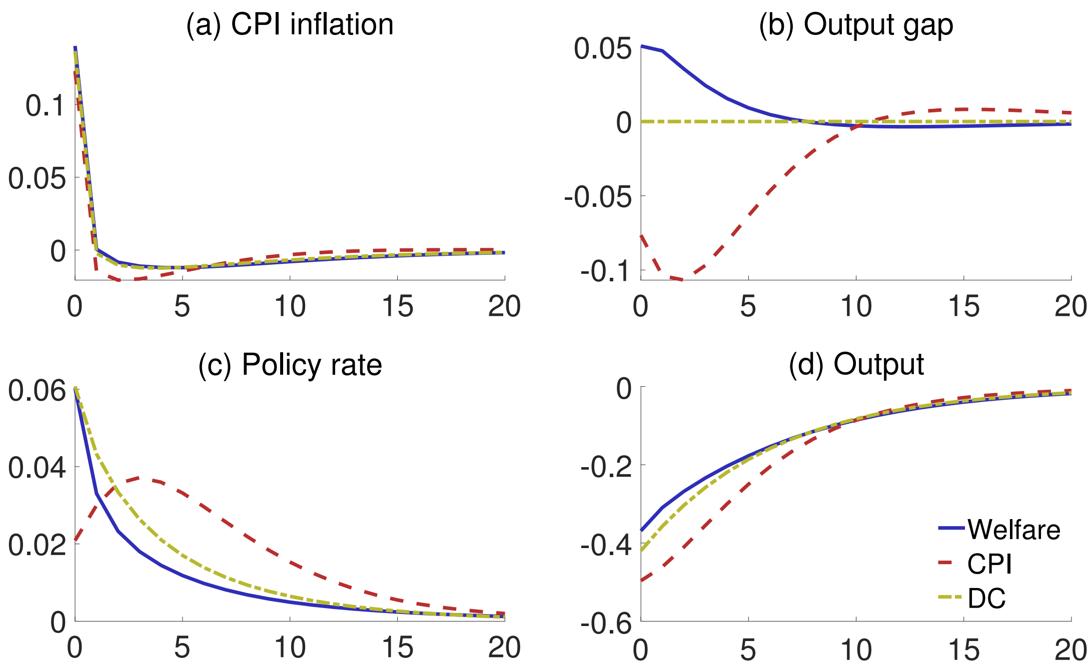
4 Robustness

In this section, we consider different versions of the model to highlight the relevance of individual channels and modelling assumptions. Second, we assume naive firms form their sectoral inflation expectations based on observed aggregate inflation. Third, we consider shocks to sectors other than the energy-producing one. Fourth, we allow for flexible

[39]We experimented with different parameter values, finding that our (qualitative) results for endogenous-gain learning are not sensitive to the specific parameter value. The chosen value for $\psi_{m,x}$ implies that the learning gain for energy inflation increases to almost one upon shock impact. Larger values can lead to numerical instabilities when calculating model solutions for specific model cases.

[40]Note that it is difficult to disentangle the effect that the endogenous gain has due to a larger total gain compared to constant-gain learning ($\omega_{m,x,t} \geq \omega_{m,x}$) from the sensitivity of the gain that is absent under constant-gain learning.

Figure 9: Responses to an energy shock with rational agents ($s_h = s_f = 1$) and 72 sectors



Notes: IRFs are in percentage deviations from steady state. "Welfare": micro-founded loss function. "CPI": ad-hoc loss function with CPI inflation target. "DC": ad-hoc loss function with DC inflation target.

nominal wages.

4.1 Many sectors

So far, our quantitative model evaluation used a stylised production network with only four sectors and simple input-output linkages. While this calibration allowed us to understand the different forces driving our results, one might wonder to what extent our findings apply in a more realistic setting, featuring a richer sectoral structure.[41] In this section, we therefore consider a model calibration with 72 sectors, capturing the 2012 production structure in the United States based on the 3-digit NAICS code classification (see Rubbo, 2023).[42] Except for supply-side parameters contained in Ω, b, δ and λ, we keep the parameter values from Section 3.1. Again, we look at the optimal policy response to an energy shock, which we now identify as a negative productivity shock in the oil and gas extraction (sub)sector (NAICS code 211).

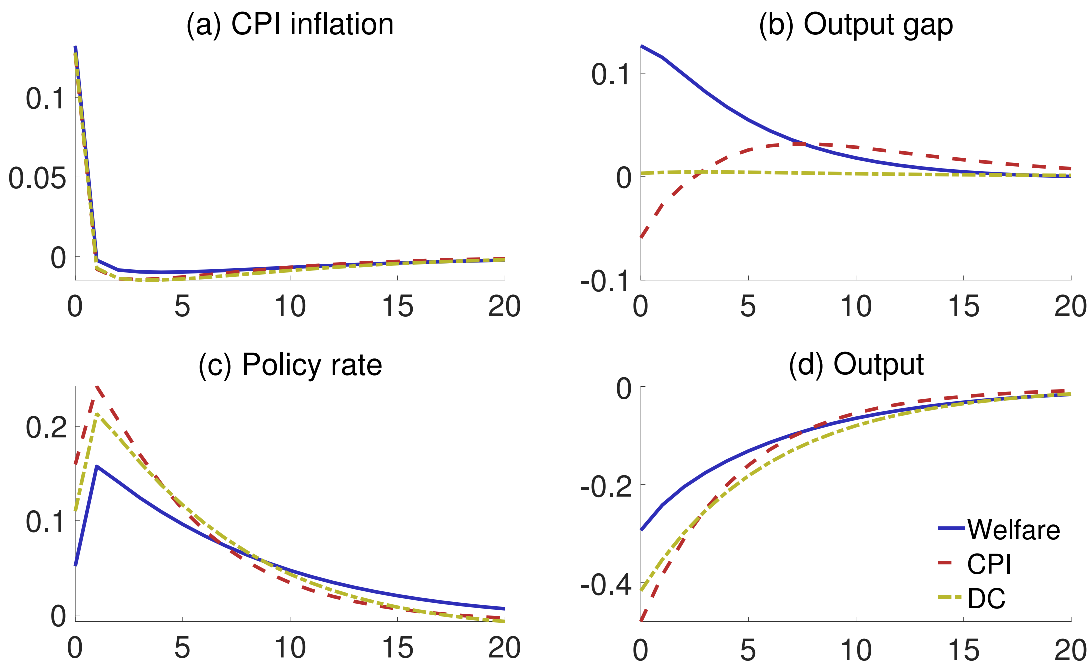
Our results obtained for the stylised 4-sector economy also hold for the 72-sector economy. Under rational expectations, the welfare-based policy is close to that under an ad-hoc objective with a DC inflation target (see Figure 9). As before, the former policy implements a slightly positive output gap to support the labour market and reduce misallocation on it, whereas the latter stabilises the output gap. When the ad-hoc objective features a CPI inflation target, optimal monetary policy is more contractionary than for the other two cases – as before.[43] While the results do not change qualitatively relative to the 4-sector economy, quantitative differences can be observed. This is true especially for the contractionary

[41] Pasten et al. (2020) show that the transmission of monetary policy depends on the level of sectoral (dis)aggregation. Specifically, they find that the cumulative real effect of monetary policy shocks in a New Keynesian multisector model is almost 50% higher in a 341-sector economy compared to a 7-sector economy. By contrast, it is only 6% higher compared to a 58-sector economy. The effect on inflation is similar at these different aggregation levels.

[42] This number already includes the union sector introduced for the purpose of modelling nominal wage rigidities.

[43] We use the same relative weights for the ad-hoc loss function as in the 4-sector case.

Figure 10: Responses to an energy shock with naive agents and constant-gain learning ($s_h = s_f = 0.5$) and 72 sectors



Notes: IRFs are in percentage deviations from steady state. "Welfare": micro-founded loss function. "CPI": ad-hoc loss function with CPI inflation target. "DC": ad-hoc loss function with DC inflation target.

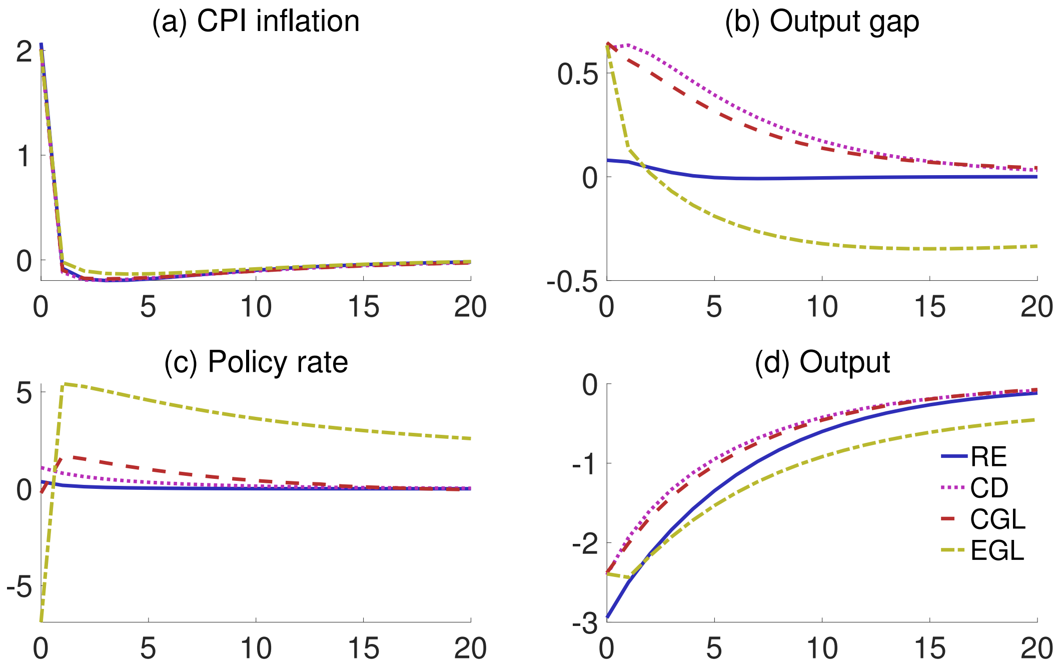
effect under the CPI target, which is weaker in the 72-sector economy. The reason is that, although energy inflation (not shown) goes up by the same magnitude in the 4-sector and 72-sector economies following a negative energy shock, the pass-through of energy inflation in the 72-sector economy is dampened compared to the 4-sector economy. As a result, reducing inflation under the CPI target is both less urgent but more costly, explaining a less forceful monetary policy response.

When introducing a fraction of naive agents with backward-looking expectation formation, we again observe only small changes for inflation, output and the output gap compared to rational expectations (see Figure 10). By contrast, the optimal interest rate path differs (again) notably, albeit less so than in the 4-sector economy. As before, going from constant-gain learning to endogenous-gain learning hardly changes the results. Indeed, although the learning gain for energy inflation roughly doubles compared with the 4-sector economy, the differences in CPI inflation, output gap and interest rate become even less visible. We therefore conclude from this analysis that the 4-sector model version already captures the relevant forces governing the optimal monetary policy response to an energy shock in a multisector economy reasonably well.

4.2 Firms and aggregate inflation expectations

The IS curve features expectations about aggregate (CPI) inflation because households care about its future evolution when making their consumption-saving decisions. By contrast, aggregate inflation expectations do not enter the sectoral Phillips curves, only expectations about sectoral inflation. This is because sectoral inflation, rather than aggregate inflation, captures the pricing behaviour of firms' sectoral competitors and thus enters firms' expectations. It then follows naturally that naive firms use observed sectoral inflation, not aggregate inflation, to update their long-run expectations about sectoral inflation. However, one could argue that in practice firms usually do not learn (only) from

Figure 11: Responses to an energy shock for micro-founded loss function if firms learn from aggregate inflation



Notes: IRFs are in percentage deviations from steady state. "RE": rational expectations. "CD": cognitive discounting. "CGL": 50% constant-gain learning. "EGL": 50% endogenous-gain learning.

observations about sectoral inflation but (also) from observed aggregate inflation to form sectoral inflation expectations. For instance, information about the former might be simply more readily available.

If expectation formation of naive firms were to depend on aggregate inflation, this could increase the policymaker's ability and incentive to manage inflation expectations of naive firms. In this case, long-run expectations of all firms would be informed by aggregate inflation and therefore be at least partially synchronised across sectors. As a result, one might expect our optimal policy results for the multisector model to get closer to those in the textbook model, in which case firms' inflation expectations are perfectly aligned (see Gáti, 2023). To investigate whether this is indeed the case, we change the learning rule for firms' long-run sectoral inflation expectations to

$$\overline{\Pi}_{k,f,t} = \left(1 - \omega_{\Pi_k,f,t}\right) \times \overline{\Pi}_{k,f,t-1} + \omega_{\Pi_k,f,t} \times \left(e_f \widehat{\Pi}_{k,t} + (1-e_f)\widehat{\Pi}^h_t\right),$$

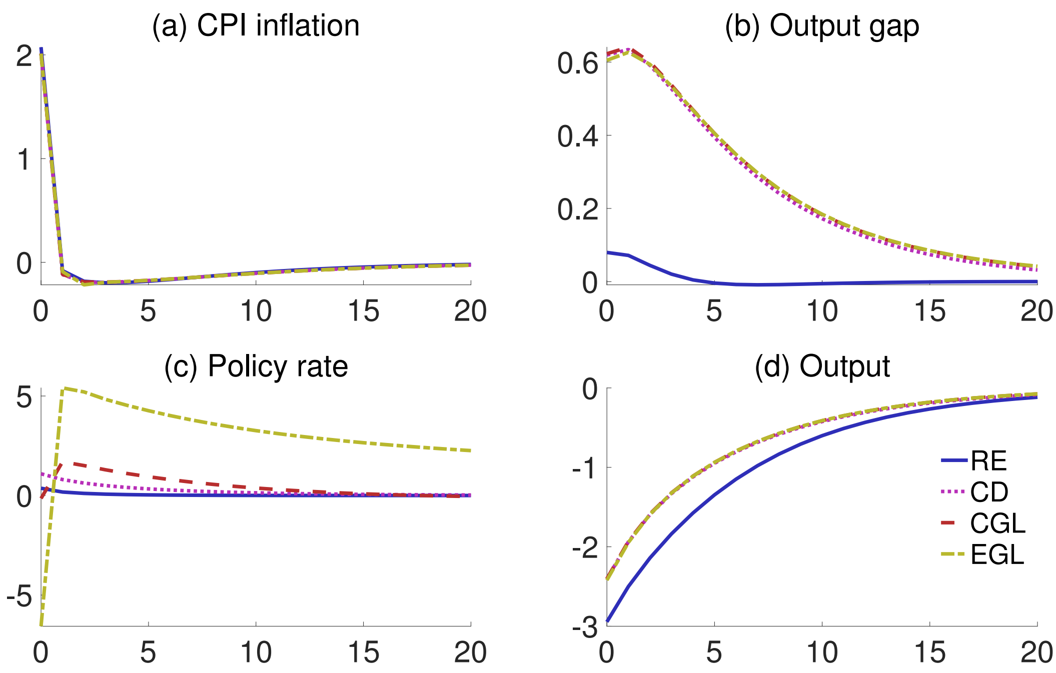
with $\omega_{\Pi_k,f,t}$ now being a function of forecast error $e_f\widehat{\Pi}_{k,t} + (1-e_f)\widehat{\Pi}^h_t - \overline{\Pi}_{k,f,t-1}$ and parameter e_f measuring the relative importance of sectoral inflation observations for updating long-run sectoral inflation expectations. The case previously studied is nested by this learning rule for $e_f = 1$.[44]

For the sake of illustration, we assume that long-run sectoral inflation expectations of naive firms are updated only via observed CPI inflation, i.e. $e_f = 0$. For the remaining parameters, we keep the values from Section 3.1. Figure 11 shows the optimal policy response to an energy shock for the micro-founded loss function under different assumptions about expectation formation if $e_f = 0$. As a benchmark, Figure 12 shows the respective experiment for $e_f = 1$, which is the case analysed in the previous sections.[45] Qualitatively, the responses do not change for $e_f = 0$. However, differences

[44]Similarly, firms also update their long-run exectations about (normalised) sectoral prices using observed aggregate inflation, $\bar{p}_{k,f,t} = \left(1-\omega_{p_k,f,t}\right)\times \bar{p}_{k,f,t-1} + \omega_{p_k,f,t} \times \left(\widehat{p}_{k,f,t-1} + e_f\widehat{\Pi}_{k,t} + (1-e_f)\widehat{\Pi}^h_t - \widehat{\Pi}^h_t\right)$.

[45]Although we plot rational expectations as a useful reference case, the model version featuring 50% naive agents with anchored expectations

Figure 12: Responses to an energy shock for micro-founded loss function in baseline model



Notes: IRFs are in percentage deviations from steady state. "RE": rational expectations. "CD": cognitive discounting. "CGL": 50% constant-gain learning. "EGL": 50% endogenous-gain learning.

between the output (gap) responses become more notable relative to $e_f = 1$. By contrast, the dynamics of aggregate inflation hardly change at all.

These findings demonstrate that a key result of this paper, namely that output (gap) and inflation dynamics hardly change under the optimal policy if inflation expectations can de-anchor, is robust to making long-run inflation expectations of firms more aligned. Although this enhances the policymaker's ability to use long-run inflation expectation to affect firms' behaviour, it remains sub-optimal to make prominent use of this channel due to the sectoral origin of the shock, heterogeneous price stickiness and input-output linkages.[46]

4.3 Other sectoral shocks

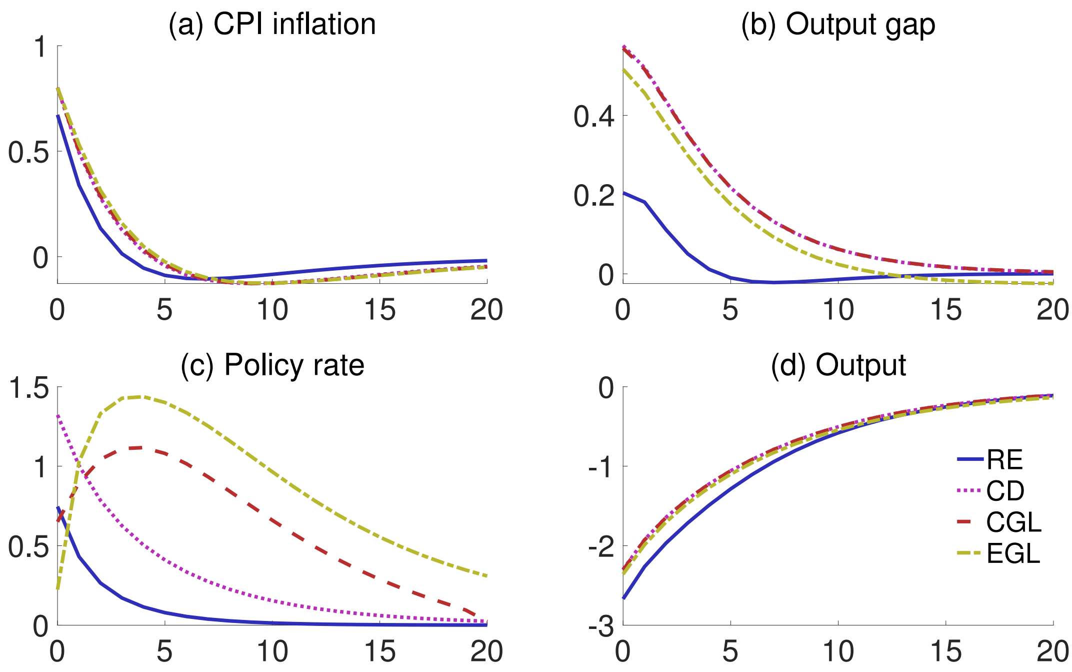
Until now, a negative productivity shock in the energy sector was the only sectoral shock we analysed. To see whether our results also apply to other sectoral shocks, we consider the optimal policy response to negative productivity shocks in the goods and the services sectors. We assume that the size of the shock is the same as in the case of the energy shock ($\varepsilon_{G,t} = \varepsilon_{S,t} = -0.1$). Figures 13 and 14 show the results.

Qualitatively, we observe that the responses do not differ compared to the energy shock (see Figure 12). Quantitatively, inflation increases less strongly and more persistently after a goods sector shock (see Figure 13) than after an energy shock, reflecting a higher degree of stickiness. Since service inflation is even stickier than goods inflation, the overall inflation reponse is even more subdued (see Figure 14). Moreover, services have a lower CPI weight and are not used as intermediate production inputs by other sectors, further attenuating the pass-through of a shock in this sector to overall

(magenta-coloured lines) is the appropriate baseline to assess the impact of de-anchoring risk because the model versions with constant-gain learning and endogenous-gain learning feature 50% naive agents as well.

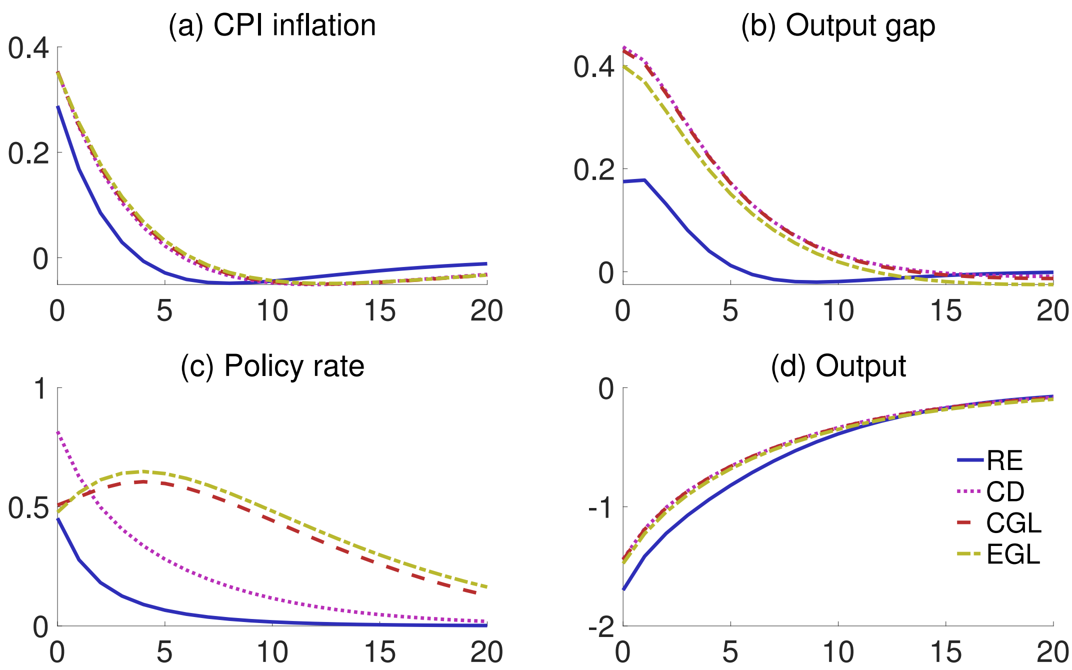
[46] Moreover, Minton and Monnery (2025) find that firms' expectations about their costs are governed by their own costs, not (CPI) inflation, which supports how naive firms form expectations in our baseline case ($e_f = 1$).

Figure 13: Responses to a goods sector shock for micro-founded loss function in baseline model



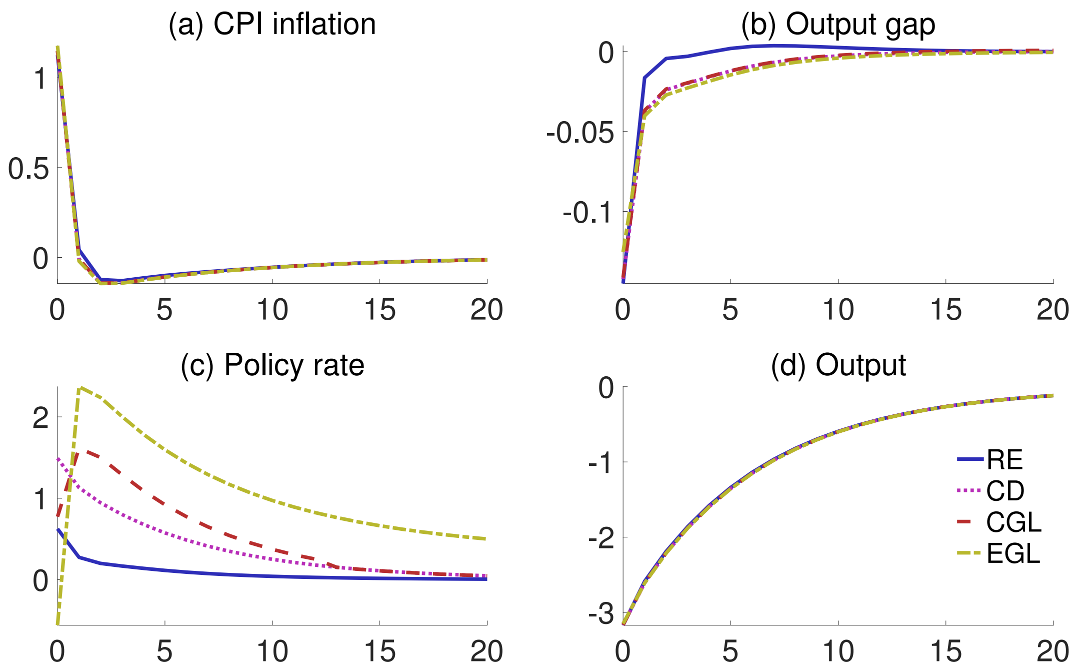
Notes: IRFs are in percentage deviations from steady state. "RE": rational expectations. "CD": cognitive discounting. "CGL": 50% constant-gain learning. "EGL": 50% endogenous-gain learning.

Figure 14: Responses to a service sector shock for micro-founded loss function in baseline model



Notes: IRFs are in percentage deviations from steady state. "RE": rational expectations. "CD": cognitive discounting. "CGL": 50% constant-gain learning. "EGL": 50% endogenous-gain learning.

Figure 15: Responses to an energy shock for micro-founded loss function with flexible nominal wages ($\delta_L = 0$)



Notes: IRFs are in percentage deviations from steady state. "RE": rational expectations. "CD": cognitive discounting. "CGL": 50% constant-gain learning. "EGL": 50% endogenous-gain learning.

inflation.

4.4 Flexible nominal wages

The union sector plays a special role in the economy. It is the most upstream sector, providing labour as a production input to all other sectors. In addition, it is also the sector with the highest degree of price stickiness. Both factors matter for the policymaker's incentive to implement a positive output gap after a negative energy (productivity) shock, in line with Bodenstein et al. (2008) and Rubbo (2023). Figure 15 shows the optimal policy response to an energy shock for the micro-founded loss function if nominal wages are flexible ($\delta_L = 0$). The output gap now turns negative after the shock hits the economy. However, the magnitude of output gap fluctuations is rather small, remaining almost flat overall. Inflation again does not differ much for different types of expectation formation. In that sense, the optimal policy looks through the energy shock under flexible wages, too. As before, to implement these outcomes, monetary policy needs to raise the nominal rate more aggressively if some households are naive and if their inflation expectations can change over time.

5 Pass-through of firms' sectoral inflation expectations

The optimal monetary policy in the multisector economy prioritises stabilisation of the output gap regardless of assumptions made about the formation of expectations. This finding, shown to be robust in the previous section, shows that the policymaker does not, in effect, use aggregate demand management to affect inflation dynamics by moving long-run inflation expectations of firms. But why do inflation dynamics not differ more with the type of expectation formation? Inflation expectations enter the sectoral Phillips curves and one might expect shifts in long-run inflation expectations to imply notably different inflation dynamics – conditional on similar or even identical output gap behaviour. To understand why this is not the case in our model, this section looks at the pass-through of firms' inflation expectations to inflation.

As pointed out by Werning (2022), the rational-expectations NKPC, which links current inflation to expected inflation in the next period, is not useful in assessing the pass-through of inflation expectations to actual inflation. It is not possible to *exogenously* vary inflation expectations in this case. Instead, the Phillips curve needs to be derived for arbitrary expectations, using the concept of a temporary equilibrium. For the resulting infinite-horizon version of the NKPC, it is then straightforward to derive the pass-through of an exogenous change in inflation expectations to inflation.

Having already derived such temporary-equilibrium expressions for our multisector model, we now proceed as in Werning (2022), generalising his results derived for the textbook New Keynesian model to a multisector model. Using Equations (3) and (4) to replace sectoral nominal marginal costs and prices in Equation (2), we can write

$$\widehat{\Pi}_{k,t} = \frac{1-\delta_k}{\delta_k}\left[\sum\nolimits_{k'=1}^{K}\left(\alpha_k b_{k'} + \Omega_{k,k'}\right)\widehat{\Pi}_{k',t} - \widehat{\Pi}_{k,t}\right] + \frac{1-\delta_k}{\delta_k}\sum\nolimits_{s=1}^{\infty}(\beta\delta_k)^s \mathbb{E}_t^f\left[\sum\nolimits_{k'=1}^{K}\left(\alpha_k b_{k'} + \Omega_{k,k'}\right)\widehat{\Pi}_{k',t+s}\right] + a_{k,t}^1 + a_{k,t-1}^2,$$

with

$$a_{k,t}^1 \equiv \frac{(1-\beta\delta_k)(1-\delta_k)}{\delta_k}\sum\nolimits_{s=0}^{\infty}(\beta\delta_k)^s \mathbb{E}_t^f\left[\alpha_k\left((\varphi+\sigma)\widehat{Y}_{t+s} + \sum\nolimits_{k'=1}^{K}\lambda_{k'}\widehat{A}_{k',t+s}\right) - \widehat{A}_{k,t+s}\right],$$

and

$$a_{k,t-1}^2 \equiv \frac{1-\delta_k}{\delta_k}\left[\sum\nolimits_{k'=1}^{K}\left(\alpha_k b_{k'} + \Omega_{k,k'}\right)\widehat{P}_{k',t-1} - \widehat{P}_{k,t-1}\right].$$

Following Werning (2022), we define a_t^1 and a_{t-1}^2 to collect terms not related to inflation and inflation expectations of firms. To further simplify the analysis, we assume that firms' sectoral inflation expectations are given as $\mathbb{E}_t^f\left[\widehat{\Pi}_{k,t+s}\right] = \Pi_k^e$, with constant Π_k^e. The sectoral infinite-horizon NKPC can then be written as

$$\widehat{\Pi}_{k,t} = \phi_k \sum\nolimits_{k'=1}^{K}\left(\alpha_k b_{k'} + \Omega_{k,k'}\right)\Pi_{k'}^e + \tilde{\delta}\left[\sum\nolimits_{k'=1}^{K}\left(\alpha_k b_{k'} + \Omega_{k,k'}\right)\widehat{\Pi}_{k',t} - \widehat{\Pi}_{k,t}\right] + a_{k,t}^1 + a_{k,t-1}^2 \tag{21}$$

with $\phi_k \equiv \beta(1-\delta_k)/(1-\beta\delta_k)$ and $\tilde{\delta}_k \equiv (1-\delta_k)/\delta_k$.

To understand the pass-through of Π_k^e to $\widehat{\Pi}_{k,t}$, it is helpful to first consider the textbook model version with one sector,

$$\widehat{\Pi}_t = \phi\Pi^e + \kappa\sum\nolimits_{s=0}^{\infty}(\beta\delta_k)^s \mathbb{E}_t^f\left[\widehat{Y}_{t+s}\right].$$

The pass-through of inflation expectations to actual inflation is given by $\phi = \beta(1-\delta)/(1-\beta\delta)$, which is equal to one for $\beta \to 1$ and close to one for standard calibrations (see Werning, 2022).[47]

In the multisector case, given by Equation (21), the first term on the RHS also captures this direct effect of inflation expectations on inflation. However, in this case, there is an additional effect, captured by the second term on the RHS, which is absent in the one-sector case, showing that changes in sectoral inflation expectations will indirectly affect actual inflation via the production network. Specifically, if firms in sector k raise their prices due to higher expected inflation in one or more sectors that produce inputs they rely on, this will in turn cause firms that use inputs from sector k to raise their prices as well. This in turn leads firms in sector k to raise their prices and so on.

[47]Different from Werning (2022), but consistent with Preston (2005), firms can observe current aggregate outcomes when making their pricing decisions and do not need to form expectations about them based on information in period $t-1$. As a result, "our" ϕ for the one-sector case differs from the one in Werning (2022), which equals $(1-\delta)/(1-\beta\delta)$, by the factor β. This assumption does not matter much in the one-sector case, but will be relevant in the multisector case, as it enables the propagation of sectoral inflation expectations via the production network. Since this propagation channel is relevant for our quantitative model analysis, we consider it helpful to also allow for it when deriving the pass-through of inflation expectations to inflation.

To obtain the total pass-through of Π^e_k on $\widehat{\Pi}_{k,t}$, we write the system of infinite-horizon NKPCs in matrix notation,

$$\widehat{\Pi}_t = \text{diag}(\phi)\,(\text{diag}(\alpha)B + \Omega)\,\Pi^e + \text{diag}(\tilde{\delta})\,(\text{diag}(\alpha)B + \Omega - I_K)\,\widehat{\Pi}_t + a^1_t + a^2_{t-1},$$

with $\Pi_t \equiv \left(\Pi_{1,t}, \ldots, \Pi_{K,t}\right)'$, $\Pi^e \equiv \left(\Pi^e_1, \ldots, \Pi^e_K\right)'$ and $B \equiv (b, \ldots, b)'$. The column vectors α, $\tilde{\delta}$ and ϕ contain the sectoral parameters α_k, δ_k and ϕ_k in stacked form, respectively. With this notation, it is straightforward to solve for the sectoral inflation rates,

$$\widehat{\Pi}_t = \Theta\Pi^e + \tilde{a}^1_t + \tilde{a}^2_{t-1}, \tag{22}$$

with $\Theta \equiv \Delta\Phi$, $\Delta \equiv \left(I_K - \text{diag}(\tilde{\delta})\,(\text{diag}(\alpha)B + \Omega - I_K)\right)^{-1}$, $\Phi \equiv \text{diag}(\phi)\,(\text{diag}(\alpha)B + \Omega)$, $\tilde{a}^1_t \equiv \Delta a^1_t$ and $\tilde{a}^2_{t-1} \equiv \Delta a^2_{t-1}$.

Equation (22) shows that the total pass-through of inflation expectations to inflation in a multisector economy, given by Θ, is a combination of direct effects, captured by Φ, and indirect (IO) effects, captured by Δ. The direct effects reflect how the initial impulse of higher inflation expectations affects firm price setting in different sectors in period t. Specifically, entry $\Phi_{k,k'}$ is the elasticity of inflation in sector k with respect to expected inflation for goods produced in sector k'. Similar to the Leontief inverse matrix, Δ captures how the initial impulse is propagated through the production network, i.e. $\Theta = \Phi + \tilde{\Delta}\Phi + \tilde{\Delta}^2\Phi + \ldots$, with $\tilde{\Delta} \equiv \text{diag}(\tilde{\delta})\,(\text{diag}(\alpha)B + \Omega - I_K)$.[48]

The total elasticity of CPI inflation with respect to sectoral inflation expectation Π^e_k is $b'\theta_k$, where θ_k denotes column k of matrix Θ. For our stylised 4-sector calibration, the pass-through of energy inflation expectations, which are driving CPI inflation expectations after an energy shock, to CPI inflation is 0.24, whereas it is only 0.003 for the 72-sector calibration. If inflation expectations for all sectors with positive CPI weights increase simultaneously and uniformly, the pass-through to CPI inflation is 0.59 in the 4-sector case and 0.56 in the 72-sector case.[49] Overall, changes in firms' inflation expectations thus have a limited effect on actual inflation in a multisector economy. In the full model, inflation expectations of naive firms change because actually observed inflation moves. Since those expectations change by (much) less than one for one, the overall impact that endogenous shifts in long-run inflation expectations have is rather low, explaining the small differences in inflation dynamics for model versions with and without endogenous long-run inflation expectations.

6 Conclusion

How should monetary policy respond to inflationary sectoral shocks in the presence of de-anchoring risks? To answer this question, this paper has analysed optimal monetary policy under commitment for a New Keynesian multisector model with endogenous long-run inflation expectations. Relative to an economy with perfectly anchored inflation expectations, the nominal interest rate response to an inflationary sectoral shock is more aggressive if inflation expectations can de-anchor. This policy response reflects that the expansionary effect of upward movements in long-run inflation expectations of households following such a shock needs to be countered by stronger nominal rate hikes to achieve the desired outcomes. However, the sectoral shock induces quite similar inflation and output dynamics under the optimal monetary policy regardless of whether inflation expectations can de-anchor or not. This finding shows that the limited ability to control price setting of firms in different sectors via interest rate policy leads the policymaker to effectively refrain not only from fine-tuning actual sectoral price movements but also from actively attempting to change firms' long-run expectations of sectoral prices and inflation. Moreover, similar inflation dynamics with and without de-anchoring risks reflect that the pass-through of inflation expectations to inflation is limited in a multisector

[48] The matrix $\tilde{\Delta}$ contains the (absolute value of the) elasticities of period-t inflation in sector k with respect to nominal mark-up growth, $(\text{diag}(\alpha)B + \Omega - I_K)\,\Pi_t$.

[49] Note that the pass-through of firms' CPI inflation expectations to CPI inflation is indeterminate in the multisector model because it differs with the sectoral composition of the CPI inflation expectations change. For example, increasing energy inflation expectations by $1/b_E$, thus raising CPI inflation expectations by one, increases CPI inflation by 0.80 in the 4-sector case and by 0.87 in the 72-sector case.

economy, such that inflation dynamics are hardly affected by the possibility of a de-anchoring.

While this paper has analysed two aspects frequently mentioned in discussions about a looking-through policy, de-anchoring risks and multisectoral relationships, it is important to point out that there are other aspects that are missing in our model and that are relevant for policymakers in practice (see e.g. Bullard, 2011; Workstream 1: Changing Economic and Inflation Environment, 2025). For example, when analysing an energy price shock, a closed-economy setting as used in this paper is a reasonable approximation for an application to the United States, but not when analysing optimal policy for economies that rely on energy imports, like the euro area (see e.g. Aguilar et al., 2026; Qiu et al., 2026).

References

Adjemian, S., M. Juillard, F. Karamé, W. Mutschler, J. Pfeifer, M. Ratto, N. Rion, and S. Villemot (2024): "Dynare: Reference Manual, Version 6," Dynare Working Papers 80, CEPREMAP.

Adrian, T. (2023): "The Role of Inflation Expectations in Monetary Policy," Speech, IBF/Deutsche Bundesbank Symposium, May 15, 2023.

Aguilar, P., R. Domínguez-Díaz, J.-E. Gallegos, and J. Quintana (2026): "The Transmission of Foreign Shocks in a Networked Economy," Mimeo.

Alessandri, P. and A. Gazzani (2025): "Natural Gas and the Macroeconomy: Not All Energy Shocks Are Alike," *Journal of Monetary Economics*, 151, 103749.

Angeletos, G.-M., J. Guerreiro, and D. Zhang (2025): "From RANK to HANK, without FIRE," NBER Working Paper No. 34596.

Angeletos, G.-M., Z. Huo, and K. Sastry (2021): "Imperfect Macroeconomic Expectations: Evidence and Theory," *NBER Macroeconomics Annual*, 35, 1–86.

Angeletos, G.-M. and C. Lian (2018): "Forward Guidance without Common Knowledge," *American Economic Review*, 108, 2477–2512.

Angeletos, G.-M. and A. Sastry (2021): "Managing Expectations: Instruments vs. Targets," *Quarterly Journal of Economics*, 136, 2467–2532.

Antonova, A. and G. Müller (2026): "Distorted Prices and Targeted Taxes in the New Keynesian Network Model," *Journal of Monetary Economics*, 158, 103904.

Aoki, K. (2001): "Optimal Monetary Policy Responses to Relative-Price Changes," *Journal of Monetary Economics*, 48, 55–80.

Baqaee, D. and E. Farhi (2020): "Productivity and Misallocation in General Equilibrium," *Quarterly Journal of Economics*, 135, 105–163.

Bersson, B., P. Hürtgen, and M. Paustian (2024): "Expectations Formation, Sticky Prices, and the ZLB," *Journal of Money, Credit and Banking*, 56, 365–393.

Blanco, A., C. Boar, C. Jones, and V. Midrigan (2024): "The Inflation Accelerator," NBER Working Paper No. 32531.

Bocola, L., A. Dovis, K. Jørgensen, and R. Kirpalani (2025): "Monetary Policy without an Anchor," NBER Working Paper No. 34436.

Bodenstein, M., C. Erceg, and L. Guerrieri (2008): "Optimal Monetary Policy with Distinct Core and Headline Inflation Rates," *Journal of Monetary Economics*, 55, S18–S33.

Brassil, A., C. Gibbs, and C. Ryan (2025): "Boundedly Rational Expectations and the Optimality of Flexible Average Inflation Targeting," Mimeo.

Bullard, J. (2011): "Measuring Inflation: The Core Is Rotten," *Federal Reserve Bank St. Louis Review*, 93, 223–233.

Carvalho, C., S. Eusepi, E. Moench, and B. Preston (2023): "Anchored Inflation Expectations," *American Economic Journal: Macroeconomics*, 15, 1–47.

Carvalho, C., J. Lee, and W. Park (2021): "Sectoral Price Facts in a Sticky-Price Model," *American Economic Journal: Macroeconomics*, 13, 216–256.

Christoffel, K. and M. Farkas (2025): "Managing the Risks of Inflation Expectation De-anchoring," Mimeo.

Conrad, C., Z. Enders, and G. Müller (2025): "Inflation Forecast Targeting Revisited," CEPR Discussion Paper DP20467.

D'Acunto, F., D. Hoang, M. Paloviita, and M. Weber (2023): "IQ, Expectations, and Choice," *Review of Economic Studies*, 90, 2292–2325.

Del Negro, M., M. Giannoni, and C. Patterson (2023): "The Forward Guidance Puzzle," *Journal of Political Economy: Macroeconomics*, 1, 43–79.

Di Bartolomeo, G., M. Di Pietro, and B. Giannini (2016): "Optimal Monetary Policy in a New Keynesian Model with Heterogeneous Expectations," *Journal of Economic Dynamics and Control*, 73, 373–387.

Dupraz, S. and M. Marx (2024): "Keeping Control Over Boundedly Rational Expectations," Mimeo.

Erceg, C., D. Henderson, and A. Levin (2000): "Optimal Monetary Policy with Staggered Wage and Price Contracts," *Journal of Monetary Economics*, 46, 281–313.

Erceg, C., J. Lindé, and M. Trabandt (2024): "Monetary Policy and Inflation Scares," IMF Working Paper No. 2024/260.

Eusepi, S., M. Giannoni, and B. Preston (2026): "The Short-Run Policy Constraints of Long-Run Expectations," *Journal of Political Economy*, 134, 525–569.

Eusepi, S. and B. Preston (2018): "The Science of Monetary Policy: An Imperfect Knowledge Perspective," *Journal of Economic Literature*, 56, 3–59.

Evans, G., S. Honkapohja, and K. Mitra (2009): "Anticipated Fiscal Policy and Learning," *Journal of Monetary Economics*, 56, 930–953.

Farhi, E. and I. Werning (2019): "Monetary Policy, Bounded Rationality, and Incomplete Markets," *American Economic Review*, 109, 3887–3928.

Gabaix, X. (2020): "A Behavioral New Keynesian Model," *American Economic Review*, 110, 2271–2327.

Galí, J. (2015): *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework and its Applications*, Princeton, NJ: Princeton University Press.

García-Schmidt, M. and M. Woodford (2019): "Are Low Interest Rates Deflationary? A Paradox of Perfect-Foresight Analysis," *American Economic Review*, 109, 86–120.

Gaspar, V., F. Smets, and D. Vestin (2010): "Inflation Expectations, Adaptive Learning and Optimal Monetary Policy," in *Handbook of Monetary Economics*, ed. by Friedman, B. and M. Woodford, Amsterdam: Elsevier, vol. 3, chap. 19, 1055–1095.

Gáti, L. (2023): "Monetary Policy & Anchored Expectations – An Endogenous Gain Learning Model," *Journal of Monetary Economics*, 140, S37–S47.

Guerrieri, V., M. Marcussen, L. Reichlin, and S. Tenreyro (2023): *Geneva 26: The Art and Science of Patience: Relative Prices and Inflation*, Paris & London: CEPR Press.

Gust, C., E. Herbst, and D. López-Salido (2022): "Short-Term Planning, Monetary Policy, and Macroeconomic Persistence," *American Economic Journal: Macroeconomics*, 14, 174–209.

——— (2025): "Optimal Monetary Policy with Uncertain Private Sector Foresight," *Journal of Monetary Economics*, 155, 103826.

——— (2026): "Inflation Expectations with Finite Horizon Planning," *Jounal of Economic Dynamics and Control*, 182, 105222.

Harding, M., J. Lindé, and M. Trabandt (2023): "Understanding Post-COVID Inflation Dynamics," *Journal of Monetary Economics*, 140, S101–S118.

Huang, K. and Z. Liu (2005): "Inflation Targeting: What Inflation Rate to Target?" *Journal of Monetary Economics*, 52, 1435–1462.

Kim, J. (2025): "Learning from Surprises: Monetary Policy Shocks and Endogenous Gain Learning," Mimeo.

Klein, P. (2000): "Using the Generalized Schur Form to Solve a Multivariate Linear Rational Expectations Models," *Journal of Economic Dynamics and Control*, 24, 1405–1423.

Kreps, D. (1998): "Anticipated Utility and Dynamic Choice," *Econometric Society Monographs*, 29, 242–274.

La'O, J. and A. Tahbaz-Salehi (2022): "Optimal Monetary Policy in Production Networks," *Econometrica*, 90, 1295–1336.

Maechler, A. (2024): "Monetary Policy in an Era of Supply Headwinds – Do the Old Principles Still Stand?" Speech, London School of Economics, October 2, 2024.

Milani, F. (2004): "Expectations, Learning and Macroeconomic Persistence," Mimeo.

——— (2014): "Learning and Time-Varying Macroeconomic Volatility," *Journal of Economic Dynamics and Control*, 47, 94–114.

——— (2025): "Expectations, Learning Gains, and Forecast Errors: Assessing Nonlinearities With a Functional Coefficient Approach," *Economics Letters*, 256, 112612.

Minton, R. and H. Monnery (2025): "How Firms Form Beliefs and the Implications for Inflation," Mimeo.

Molnár, K. and S. Santoro (2014): "Optimal Monetary Policy When Agents Are Learning," *European Economic Review*, 66, 39–62.

Nelson, E. (2025): "A Look Back at "Look Through"," Finance and Economics Discussion Series 2025-037.

Ou, S., P. Yin, D. Zhang, and R. Zhang (2026): "Nominal Rigidities, Rational Inattention, and the Optimal Monetary Policy," *Journal of Economic Theory*, 232, 106129.

Pasten, E., R. Schoenle, and M. Weber (2020): "The Propagation of Monetary Shocks in a Heterogeneous Production Economy," *Journal of Monetary Economics*, 116, 1–22.

Preston, B. (2005): "Learning About Monetary Policy Rules When Long-Horizon Expectations Matter," *International Journal of Central Banking*, 1, 81–126.

Qiu, Z., Y. Wang, L. Xu, and F. Zanetti (2026): "Monetary Policy in Open Economies with Production Networks," *Journal of Monetary Economics*, 159, 103918.

Rubbo, E. (2023): "Networks, Phillips Curves, and Monetary Policy," *Econometrica*, 91, 1417–1455.

Sims, C. (2002): "Solving Linear Rational Expectations Models," *Computational Economics*, 20, 1–20.

Vissing-Jørgensen, A. (2002): "Limited Asset Market Participation and the Elasticity of Intertemporal Substitution," *Journal of Political Economy*, 110, 825–853.

Werning, I. (2022): "Expectations and the Rate of Inflation," NBER Working Paper No. 30260.

Woodford, M. (2018): "Monetary Policy Analysis When Planning Horizons Are Finite," in *NBER Macroeconomics Annual*, ed. by Eichenbaum, M. and J. Parker, Cambridge, MA: MIT Press, vol. 33, 1–50.

Workstream 1: Changing Economic and Inflation Environment (2025): "A Strategic View on the Economic and Inflation Environment in the Euro Area," Occasional Paper Series 371, European Central Bank.