NBS Working paper
4/2025

Inflation Perceptions and Monetary Policy

Volker Hahn and Michal Marenčák

NATIONAL BANK OF SLOVAKIA
EUROSYSTEM

www.nbs.sk

research@nbs.sk

This publication is available on the NBS website
www.nbs.sk/en/publications-issued-by-the-nbs/research-publications

ISSN 2585-9269 (online)

Inflation Perceptions and Monetary Policy*

Volker Hahn[†]   Michal Marenčák[‡]

April 14, 2025

Abstract

Consumers' perceptions of current inflation rates depend disproportionately strongly on changes in food prices. We construct a new Keynesian model with bounded rationality that is compatible with this finding. We calibrate the model to the UK and show that, in combination with heterogeneity in sectoral price stickiness, bounded rationality leads to larger real effects of monetary-policy shocks. Moreover, price misperceptions make consumers overestimate the magnitude of aggregate real fluctuations. Consumer welfare is maximized by a central bank that takes core inflation and food prices into account in its monetary-policy making.

Keywords: bounded rationality, inflation perceptions, monetary-policy transmission, optimal monetary policy.

JEL: D01, E70, E52, E50.

*We would like to thank Alexander Dietrich, Jochen Mankart, Virgiliu Midrigan, Leonardo Melosi, Giang Nghiem, and an anonymous referee for the NBS working paper series for many valuable comments and suggestions. We also thank Rowan Kelsoe in the Prices Division at the Office for National Statistics for valuable feedback regarding the UK CPI data. This project was partially conducted during Michal Marenčák's Central Bank Research Fellowship at the BIS, whose hospitality is gratefully acknowledged. The views are those of the authors and do not necessarily reflect those of the National Bank of Slovakia.

[†]University of Konstanz; correspondence e-mail: volker.hahn@uni-konstanz.de.

[‡]National Bank of Slovakia; correspondence e-mail: michal.marencak@nbs.sk.

1. Introduction

Consumers' perceptions of current inflation are not fully rational. In the United Kingdom, inflation perceptions are disproportionately influenced by food prices compared to their actual weight in the CPI. This paper develops a new Keynesian model with bounded rationality (see Gabaix, 2014) that is in line with this observation.

Analyzing a model that focuses on the formation of inflation perceptions is potentially important for at least two reasons. First, while inflation expectations are widely recognized as critical to monetary policy-making, the role of inflation perceptions in the transmission of monetary policy has received far less attention. However, monetary policy may influence perceptions of current inflation as well as the current price level, which are plausible to affect perceived real wages and thus the labor supply. Moreover, these perceptions can affect consumption and savings decisions. Second, consumers' misperceptions of relative prices may lead to distortions in the quantities of goods that they buy. This also has potential implications for monetary-policy transmission as well as optimal monetary policy-making.

More specifically, our model implies that, while consumers correctly observe their own nominal incomes, the excessive attention to food prices compared to other prices causes them to overestimate changes in the aggregate price level whenever food prices fluctuate strongly. Consumers choose nominal consumption and nominal savings optimally but, as a consequence of misperceived prices, real consumption and savings differ from their intended values in general.

In particular, our model generates the following insights. Our main finding is that in the presence of heterogeneity in price rigidities across categories of goods, the different levels of attention that boundedly rational consumers pay to these categories entail larger effects of monetary-policy shocks on real output. This result is mainly driven by food prices, which are quite flexible and influence consumers' perceptions of the overall price level strongly. More specifically, because of the quick response of food prices to monetary-policy shocks, consumers tend to overestimate the quantitative impact of monetary policy on the overall price level for several quarters. A contractionary monetary-policy shock, for example, makes consumers wish to reduce consumption and thus induces them to lower nominal consumption expenditures. As consumers overestimate the drop in the price level, they end up buying even fewer consumption goods than intended.

Moreover, our analysis predicts that consumers overestimate the volatility of consumption. This is due to two properties of our calibrated model. First, aggregate fluctuations are mostly driven by productivity shocks. Second, as consumers pay a lot of attention to the comparably volatile food prices, they tend to overestimate fluctuations in the price level. Positive productivity shocks then lead to increases in consumption, drops in prices, and even larger drops in perceived prices. As a consequence of overly low price perceptions, consumers overestimate the quantities of consumption goods that a given amount of nominal consumption expenditures can purchase. Finally, we show that it is more beneficial for the central bank to target core inflation rather than headline inflation. We also consider energy prices in more detail. Energy prices are very flexible but, at the same time, hardly influence consumers' inflation perceptions in the UK. Our model implies that, compared to targeting core inflation, an even higher level of welfare can be achieved when monetary policy-makers ignore fluctuations in energy prices but not food prices when they set interest rates.

Our paper is connected to several strands of literature. First, several papers have examined people's perceptions about current inflation empirically. Using survey data, these papers find that perceptions of current inflation rates typically differ from the respective actual rates to a sizable extent (Lein and Maag, 2011; Detmeister et al., 2016; Abildgren and Kuchler, 2021). Georganas et al. (2014) establish in a lab setting that individuals' inflation perceptions are subject to a frequency bias in the sense that they are biased toward the inflation rates of frequently purchased items. This is also compatible with a finding by Jonung (1981), who explains gender differences in inflation perceptions by differences in consumption patterns between men and women. In line with this literature, we present empirical evidence for the UK that individuals' estimates of current inflation overweight food prices, which are plausible to be observed more frequently than other prices.

Second, several papers document that expectations about future inflation respond excessively to food prices (Trehan, 2011; D'Acunto et al., 2021; Bonciani et al., 2024) or energy prices (Trehan, 2011; Coibion and Gorodnichenko, 2015).[1] In contrast with the second set of papers, Binder (2018) finds no overweighting of gas prices. In a recent paper, Anesti et al. (2024) show that, in the UK, household inflation expectations as well as perceptions are very sensitive to food prices even compared to energy prices. A comprehensive overview over the literature on survey-based measures of expectations is given by D'Acunto and Weber (2024).

Third, we construct a model in which perceived inflation typically differs from actual inflation. This is also the case in models of incomplete information and rational inattention (Lucas, 1972; Mankiw and Reis, 2002; Maćkowiak and Wiederholt, 2015). In contrast with this literature, we consider agents that are not fully rational, which is in line with the empirical evidence presented in this paper as well as by Jonung (1981) and Lein and Maag (2011). An active and expanding body of research explores new Keynesian models with expectations or perceptions that deviate from full rationality. In a partial equilibrium framework, Montag (2024) analyzes the welfare consequences of a systematic upward bias in perceived inflation, which leads to distorted saving behavior. Dhamija et al. (2023) examine the link between house price inflation and inflation expectations. Like us, Dietrich (2024) studies boundedly rational agents in a new Keynesian framework. In contrast to us, he follows Gabaix (2020) and focuses on deviations of expectations from the rational benchmark rather than on possible misperceptions of current inflation and relative prices. These differences in modeling approaches lead to different results with respect to optimal monetary policy.

Dietrich (2024) finds that targeting headline inflation rather than core inflation is beneficial because it facilitates a more effective stabilization of inflation expectations, which are strongly influenced by volatile food prices. By contrast, we show that this result can be overturned if we put misperceptions of current prices center stage. On the one hand, fluctuations in food prices cause large fluctuations in the perceived aggregate price level and thus perceived consumption. This tends to suggest that the central bank should take food prices into account and thus target headline inflation. On the other hand, stabilizing the stickier

[1] Ahn et al. (2024) and Dhamija et al. (2023) examine the role of house prices for inflation expectations. Huber et al. (2023) analyze the link between perceptions of current inflation and inflation expectations.

prices in the core CPI is particularly desirable as this reduces socially inefficient price dispersion. In our model, the second effect dominates. Hence targeting core inflation is preferable to targeting headline inflation.

Benchimol and Bounader (2023) analyze the relative performance of price-level targeting and inflation targeting when agents display different types of myopia. Bonciani et al. (2024) consider a straightforward extension to a standard new Keynesian model where households overestimate the persistence of cost-push shocks to food prices. Our modeling approach is different from theirs as we explicitly formulate the households' optimization problem when households misperceive relative prices. This allows us to study misperceptions of current inflation, households' optimal consumption choices, the optimal pricing decisions of firms, and a welfare measure that takes households' misperceptions into account.

Fourth, as our model predicts that bounded rationality affects the transmission of monetary policy only in the presence of differences in price rigidity across sectors, it is related to papers that study such differences (Aoki, 2001; Eusepi et al., 2011). The general lesson from this literature is that central banks should concentrate on stabilizing the goods prices that are comparably sticky. As goods prices in the core CPI are typically stickier than the remaining prices, this implies that central banks should stabilize core inflation, not headline inflation. Our analysis shows that not only price stickiness but also the attention that consumers pay to different categories of goods determines which measure of inflation a central bank should focus on. Accordingly, while an analysis with fully rational consumers would suggest that central banks should not only ignore energy prices but also the rather flexible food prices, our main model with boundedly rational agents implies that central banks should not disregard food prices because they influence inflation perceptions to a large extent. Nakamura and Steinsson (2010) show that differences in price stickiness across sectors tend to amplify the real effects of nominal shocks. We show that the real effects of monetary policy are strengthened further when boundedly rational agents with different levels of attention are considered. This effect is a consequence of the fact that prices that adjust frequently tend to affect inflation perceptions more strongly than prices that adjust sluggishly.

Our paper is organized as follows. In the subsequent section, we present empirical evidence that consumers' perceptions of inflation are disproportionately strongly affected by food prices. Section 3 proposes a new Keynesian model with boundedly rational consumers. A few theoretical properties of this model are highlighted in Section 4. In Section 5, we explain how we calibrate the model. The simulation results from our calibrated model are presented in Section 6. Section 7 concludes.

2. Food Prices and Perceived Inflation

To motivate our structural model, this section provides empirical evidence that UK consumers' subjective inflation perceptions depend on changes in food prices more strongly than would be warranted by their contribution to CPI. To this end, we utilize two data sources on inflation perceptions in the UK. First, the monthly European Commission (EC) consumer survey provides information on households' qualitative perceptions of inflation. Second, the Bank of England's (BoE) quarterly survey on public attitudes toward inflation includes quantitative measures of perceived inflation.

In the first quarter of 2016, the BoE survey included a one-time question asking respondents about the most important factors influencing their perception of how prices had changed over the past 12 months. Figure 1 shows the distribution of answers, with roughly two thirds of the respondents indicating that the prices of food and drink were among the main four drivers of their perceptions. Perhaps surprisingly, a relatively small group of individuals answered that the level of current CPI inflation was a key driver of their inflation perceptions.

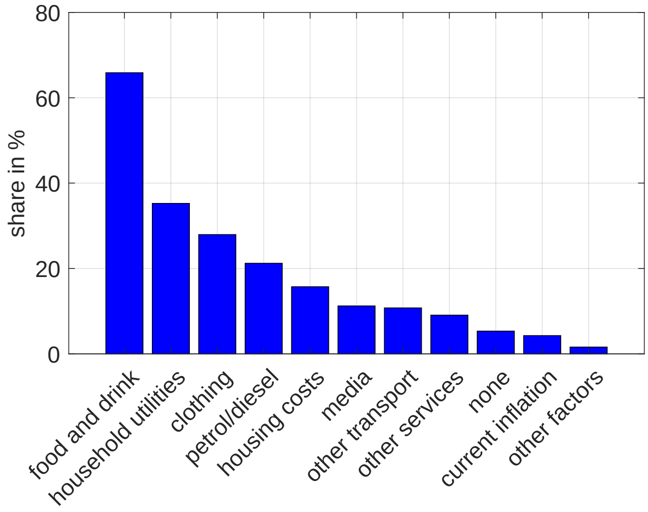

Figure 1: Survey evidence on the main drivers of households' inflation perceptions.

Notes: This figure shows the shares of respondents that state that a specific factor was important for their perceptions of overall price changes. Source: BoE's quarterly survey on public attitudes to inflation conducted in February 2016. Question: What were the most important factors in getting to your perception of how prices had changed over the past 12 months? Respondents could choose up to four options from the following ones: food and drink; clothing and footwear; household utilities e.g. gas, electricity and water; cost of housing e.g. mortgage payments, rent; petrol/diesel; other transport e.g. car servicing, air fares, rail fares, bus travel; other services e.g. restaurants, hotels, hairdressers; reports of inflation in the media; the current level of CPI inflation; other factors; none.

Further evidence can be inferred from the monthly EC consumer survey. We use the net balance of respondents reporting an overall increase in consumer prices over the previous 12 months as the dependent variable.[2] We then regress this measure on the year-on-year changes in the twelve CPI components over the period from January 1997 to November 2020. Figure 2 illustrates the contribution of covariates in explaining the variance of fitted values. The greatest explanatory power can be attributed to food and drink prices.

[2]The balance, B, is released by the European Commission and calculated as $B = (PP + P/2) - (M/2 + MM)$, where PP, P, M, and MM represent the shares of respondents who state that prices have risen a lot, risen moderately, stayed about the same, and fallen, respectively.

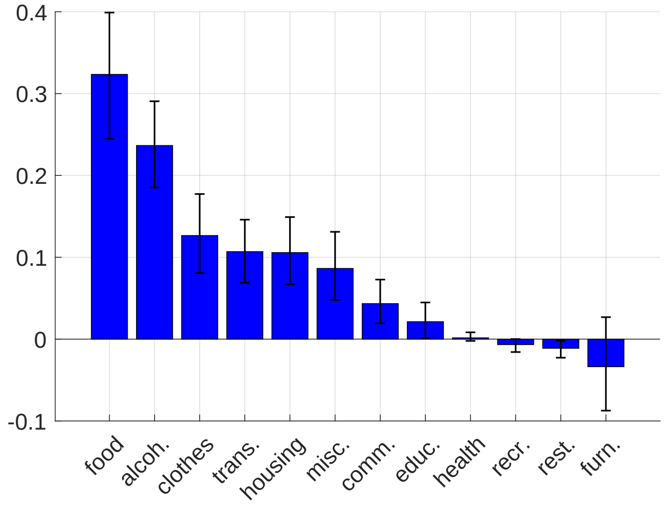

Figure 2: Qualitative inflation perceptions and changes in CPI subindices

Notes: This figure shows the results of regressing households' inflation perceptions in the UK on the y-o-y changes in the twelve CPI categories. The dependent variable is a monthly qualitative balance for perceived inflation as elicited in the EC consumer survey (see footnote 2). The twelve CPI categories correspond to the main twelve divisions of the Classification of Individual Consumption According to Purpose (COICOP): Food and non-alcoholic beverages; Alcohol and tobacco; Clothing and footwear; Housing and household services; Furniture and household goods; Health; Transport; Communication; Recreation and culture; Education; Restaurants and hotels; Miscellaneous goods and services. The bars represent the share of the variance in fitted values explained by each CPI category. Period: January 1997 - November 2020. Bootstrap 90% confidence intervals.

As a final motivating fact, we show that the disproportionate influence of food prices on inflation perceptions persists when we analyze quantitative data on perceived inflation. We focus on three conventional CPI components — food, energy, and core prices.[3] We then use the quarterly BoE survey, which provides the median perceived inflation by UK households over the past 12 months, and regress this measure on year-over-year changes in the three CPI aggregates from the last quarter of 1999 to the end of 2019. In Figure 3, we plot the resulting variance decomposition shares for the fitted values alongside those obtained by regressing official headline inflation on the same three categories. This allows us to compare the relevance of fluctuations in the three subindices for explaining variations in inflation expectations as opposed to those in actual inflation. As

[3]These CPI components are typically used to distinguish between core and headline inflation. The "food" category includes food, alcohol and tobacco, the "energy" category fuels and utilities, while "core" refers to the overall index excluding energy, food, alcohol and tobacco. For details on which components comprise these aggregates, see COICOP Special Aggregates and ONS Special Aggregates.

can be seen, food prices have a larger effect on inflation perceptions than on headline inflation, while, for energy prices, the opposite holds.

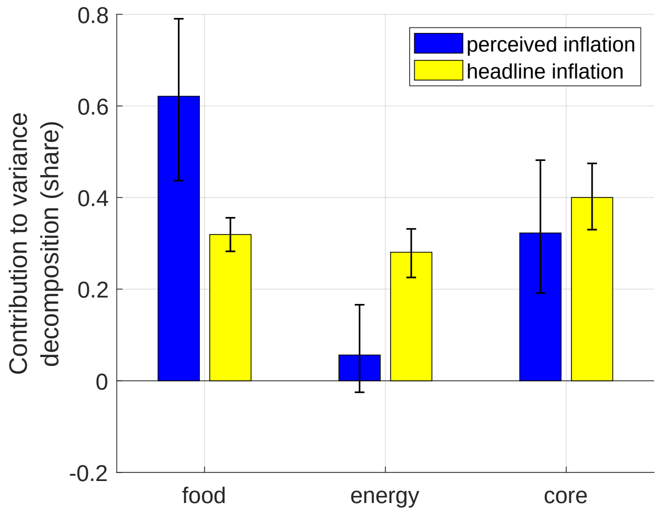

Figure 3: Quantitative inflation perceptions and changes in CPI subindices

Notes: This figure presents the results of regressing UK households' inflation perceptions on the year-over-year changes in three CPI aggregates — (1) food including alcohol and tobacco, (2) energy, and (3) core prices, i.e. overall index excluding the two previous categories. The dependent variable is the quarterly median quantitative inflation perception reported in the BoE's survey on public attitudes to inflation. The left bars show the shares of variance in the fitted values that are explained by each CPI category over the period from 1999Q4 to 2019Q4. The right bars display the shares of variance in the fitted values from a regression of official headline inflation on the same three categories. Bootstrap 90% confidence intervals.

These observations call for a model that includes an important role for food prices in driving households' inflation perceptions. At the same time, the model should involve only a minor influence of energy prices on perceived inflation. Such a framework will be developed in the next section.

3. Model

We extend a fairly standard New Keynesian model by introducing bounded rationality in the spirit of Gabaix (2019). The economy is populated by a continuum of monopolistically competitive producers, which is partitioned into n different sectors. The number of firms in sector $s = 1, 2, ..., n$ is α_s, where the total number of firms is normalized to one, i.e. $\sum_{s=1}^{n} \alpha_s = 1$. Firms are indexed by $i \in [0, 1)$. Firms in sector s are located on the interval $I_s := \left[\sum_{s'=1}^{s-1} \alpha_{s'}, \sum_{s'=1}^{s} \alpha_{s'}\right)$.

Labor is homogeneous, and the labor market is perfectly competitive. The nominal wage is denoted by W_t.

For each firm i, we use $s(i)$ to denote the sector to which the firm belongs. Firm i produces output with a linear technology

$$Y_{it} = A_{s(i)t} L_{it}, \tag{1}$$

where L_{it} is the amount of labor employed by the firm and $A_{s(i)t}$ is the common productivity of firms in sector $s(i)$ in period t, whose logarithm follows an $AR(1)$ process:

$$\ln A_{s(i)t} = \rho_{As(i)} \ln A_{s(i),t-1} + \epsilon_{As(i)t}. \tag{2}$$

The shocks $\epsilon_{As(i)t}$ are independent and normally distributed with mean zero and standard deviation $\sigma_{As(i)}$. Parameter $\rho_{As(i)}$ stands for the persistence of productivity shocks and satisfies $\rho_{As(i)} \in (-1, 1)$.

In every period t, the firm has to keep the nominal price $P_{i,t-1}$ from the previous period with probability $\delta_{s(i)} \in [0, 1)$. It can adjust the price P_{it} freely with probability $1 - \delta_{s(i)}$. It may be worth stressing that the degree of price stickiness varies across sectors.

A representative household consumes the different varieties of goods and supplies labor L_t. The corresponding utility function is

$$u(C_t) = \frac{C_t^{1-\gamma} - 1}{1-\gamma} - \frac{\omega}{\psi + 1} L_t^{\psi+1}, \tag{3}$$

where γ is the coefficient of relative risk aversion, ψ is the inverse of the Frisch elasticity of labor, and ω is a positive parameter. Future utilities are discounted by factor β ($\beta \in (0, 1)$). The consumption aggregate C_t is defined as

$$C_t = \left(\int_0^1 c_{it}^{\frac{\theta-1}{\theta}} \, di \right)^{\frac{\theta}{\theta-1}}, \tag{4}$$

where θ is a positive parameter. Households are boundedly rational and have biased perceptions of individual prices. In particular, they perceive that the price is P_{it}^B when the true price is P_{it}.

We introduce bounded rationality by making two assumptions. First, in line with a suggestion made in footnote 32 in Gabaix (2014) we assume that, for each good, the household's perceived price is a weighted geometric average of the true price and a default price, where we propose that the default price is the price that one would expect given the perceived price level P_t^B and the relative price of the good in the deterministic steady state, $Q_{s(i)}$. Formally, the perceived price is

$$P_{it}^B = P_{it}^{m_{s(i)}} \left(Q_{s(i)} P_t^B\right)^{1-m_{s(i)}}. \tag{5}$$

For each sector s, the positive parameter m_s describes the degree of attentiveness towards the prices. In particular, for $m_s = 1$, the perceived price is correct, i.e. $P_{it}^B = P_{it}$ for good i in sector s. For smaller values of m_s, the household does not take changes in P_{it} into account fully. We focus on values of m_s with $m_s \leq 1$. Higher values of m_s would suggest that, ceteris paribus, increases in the perceived price level would negatively affect perceived prices, which seems less plausible.

The second assumption addresses the following observation. The total cost of the optimal consumption bundle $\{c_{it}^B\}_{i=0}^1$, based on perceived prices $\{P_{it}^B\}_{i=0}^1$, is typically different from the true cost of the consumption bundle, i.e. $\int_0^1 P_{it}^B c_{it}^B \, di \neq \int_0^1 P_{it} c_{it}^B \, di$. As a consequence, it is not guaranteed that the household's budget constraint is satisfied. We address this problem by assuming that the household adjusts all quantities of goods i by a common factor B_t such that it spends exactly as much in every period as it anticipated. Thus if the optimal quantity is c_{it}^B, given perceived prices, the household will actually buy $c_{it} := B_t c_{it}^B$, where B_t is such that

$$\int_0^1 P_{it}^B c_{it}^B \, di = B_t \int_0^1 P_{it} c_{it}^B \, di. \tag{6}$$

In the following, we will call c_{it}^B the intended demand and c_{it} the household's actual demand for good i. To sum up, our approach implies that households decide on nominal spending on the different varieties of goods. Their choices are optimal, given the prices that they perceive. However, whenever price perceptions are not correct, the quantities of goods that the households buy are different from those that they perceive or intend to buy.

As shown in Section A, the household's intended demand for individual good i is

$$c_{it}^B = \left(\frac{P_{it}^B}{P_t^B}\right)^{-\theta} C_t^B, \tag{7}$$

where

$$C_t^B := \left(\int_0^1 \left(c_{it}^B\right)^{\frac{\theta-1}{\theta}} di\right)^{\frac{\theta}{\theta-1}}, \tag{8}$$

$$P_t^B := \left(\int_0^1 \left(P_{it}^B\right)^{-(\theta-1)} di\right)^{-\frac{1}{\theta-1}}. \tag{9}$$

Together with (5), we can rewrite (7) as

$$c_{it}^B = \left(\frac{P_{it}}{P_t^B}\right)^{-m_{s(i)}\theta} \left(Q_{s(i)}\right)^{-(1-m_{s(i)})\theta} C_t^B. \tag{10}$$

Because $c_{it} = B_t c_{it}^B$ and

$$C_t = B_t C_t^B, \tag{11}$$

the household's actual consumption bundle is $C_t := \left(\int_0^1 \left(c_{it}\right)^{\frac{\theta-1}{\theta}} di\right)^{\frac{\theta}{\theta-1}} = B_t C_t^B$. Thus the actual demand for good i is

$$c_{it} = \left(\frac{P_{it}}{P_t^B}\right)^{-m_{s(i)}\theta} \left(Q_{s(i)}\right)^{-(1-m_{s(i)})\theta} C_t. \tag{12}$$

According to (12), inattentiveness can be thought of as lowering the elasticity of demand. While the elasticity is θ for fully rational households, inattentiveness lowers it to $m_{s(i)}\theta$. As a consequence, a profit-maximizing firm operating under flexible prices would choose a markup of $m_{s(i)}\theta / \left(m_{s(i)}\theta - 1\right)$ over marginal cost. Therefore we have to impose the parameter restriction $m_{s(i)} > \frac{1}{\theta}$. Smaller values of $m_{s(i)}$ would imply that firms' profits increase with the price monotonically and the firms' profit maximization problems would not be well-defined.

We use P_t to denote the actual price of one unit of the consumption aggregate C_t. Because $P_t C_t = P_t^B C_t^B$, it satisfies

$$P_t = \frac{P_t^B}{B_t}. \tag{13}$$

Equation (13) implies that perceived inflation, $\Pi_t^B := P_t^B / P_{t-1}^B$ differs from actual inflation $\Pi_t := P_t / P_{t-1}$:

$$\Pi_t^B = \frac{B_t}{B_{t-1}} \Pi_t. \tag{14}$$

While we assume that the household believes that the price level is P_t^B and that its consumption is C_t^B rather than C_t, it correctly observes the nominal wage W_t and the gross nominal interest rate I_t between periods t and $t+1$. As a consequence, its optimal behavior under bounded rationality implies

$$\left(C_t^B\right)^{-\gamma} = \beta \mathbb{E}_t \left[\frac{I_t}{\Pi_{t+1}^B} \left(C_{t+1}^B\right)^{-\gamma} \right], \tag{15}$$

$$\frac{W_t}{P_t^B} = \omega L_t^{\psi} \left(C_t^B\right)^{\gamma}. \tag{16}$$

Please note that the household correctly anticipates its nominal income $W_t L_t$. As has been mentioned before, its perceived consumption expenditures equal the actual ones. Because it also correctly perceives nominal profits, its budget constraint is always satisfied.

While firms are assumed to be fully rational and thus use rational expectations as well as the correct prices and quantities of goods when determining optimal prices, they are assumed to discount future profits with the factor that households consider to be optimal, i.e. in period t, they discount future nominal profits in $\tau \geq t$ with the factor $\beta^{\tau-t} \frac{u'(c_\tau^B)}{u'(c_t^B)} \frac{1}{P_t^B}$. In Section A, we derive all remaining equilibrium conditions.

Monetary policy is described by a standard Taylor rule:

$$I_t = I_{t-1}^{\rho_i} \left[\Pi_t^{\phi_\pi} \left(\frac{Y_t}{Y_{ss}} \right)^{\phi_y} \right]^{1-\rho_i} \beta^{1-\rho_i} \epsilon_{mt}, \tag{17}$$

where ρ_i, ϕ_π, and ϕ_y are positive parameters and Y_t and Y_{ss} denote aggregate output in period t and in the steady state respectively. ϵ_{mt} captures monetary-policy shocks, whose logs are normally distributed with mean zero and standard deviation σ_m. The central bank thus targets a gross inflation rate of 1, which implies that the steady state gross nominal interest rate is equal to the steady-state gross real rate β^{-1}.

4. Implications of the Model

Before beginning with a quantitative analysis of our model, we highlight a few key findings about how inflation and perceived inflation are determined in our model. In Appendix B.2, we show

Proposition 1. *For a log-linear approximation around the zero-inflation steady state, inflation and perceived inflation are*

$$\pi_t = \sum_{s=1}^{n} \nu_s \pi_{st}, \tag{18}$$

$$\pi_t^B = \sum_{s=1}^{n} \mu_s \pi_{st}, \tag{19}$$

where the ν_s's are positive weights, defined in Appendix B.2, that satisfy $\sum_{s=1}^{n} \nu_s = 1$. The weights μ_s are defined as $\mu_s := \frac{m_s \nu_s}{\sum_{s'=1}^{n} \nu_{s'} m_{s'}}$. They are positive and satisfy $\sum_{s=1}^{n} \mu_s = 1$. π_{st} is sector-specific inflation, i.e. the average price increase in sector s.

Thus both inflation and perceived inflation are weighted sums of sector-specific inflation rates. Importantly, compared to actual inflation, perceived inflation is more strongly affected by sectors to which consumers attach a higher level of attentiveness. This can be seen by noting that the weights μ_s's and ν_s's are identical if all m_s's are identical and that, for each sector s, μ_s is an increasing function of m_s for given weights $\{\nu_{s'}\}_{s'=1}^{n}$.

We will see later that sector-specific inflation responds more strongly to aggregate shocks for sectors to which consumers pay more attention because such sectors typically have more flexible prices. As a result, an increase in inflation, for example, makes consumers overestimate the price level. As consumers in our model choose nominal spending in order to achieve intended levels of overall consumption, this implies that actual consumption exceeds the intended or perceived level. Therefore the actual volatility of consumption typically differs from the perceived one.

The next proposition examines perceived inflation both on the aggregate and the sectoral level more closely. For this purpose, we introduce π_{st}^B as the average change of perceived prices in sector s. We show in Appendix B.2:

Proposition 2. *For a log-linear approximation around the zero-inflation steady state, inflation and perceived inflation are*

$$\pi_t^B = \sum_{s=1}^{n} \nu_s \pi_{st}^B, \tag{20}$$

$$\pi_{st}^B = m_s \pi_{st} + (1 - m_s)\pi_t^B. \tag{21}$$

According to (20), perceived inflation is formed in exactly the same way as actual inflation in (18) with the notable difference that it is a weighted sum of perceived sector-specific inflation rather than actual sector-specific inflation rates. Equation (21) implies that perceived sectoral inflation is a weighted average of the actual sectoral inflation rate and perceived inflation, where the weight on the true inflation rate is m_s, the degree of attentiveness to sector s.

5. Calibration

This section introduces four different scenarios and describes how we select the numerical values for our model parameters. As we have shown in Section 2, food prices are key for understanding inflation perceptions. Thus we consider a separate sector for food. Because the prices for energy are typically volatile and hence excluded from core CPI, our model also contains a separate sector for energy. A third sector is introduced to capture all remaining items. Hence our calibrated model features three sectors: food (f), energy (e), and core (c). For the remainder of the paper, we will use the subscripts f, e, and c rather than numerical indices for sector-specific variables.

It will be instructive to explore key model mechanisms by distinguishing between a case with full rationality, i.e. where all m's are set to one (FR), and a case with bounded rationality where we allow for three different sector specific values of the attention parameters, m_f, m_e, and m_c (BR). Moreover, as heterogeneity with respect to price stickiness and attention interact in our model, we also distinguish between the case where all values of the Calvo parameter, δ, are identical and the one where price stickiness is heterogeneous across the three sectors (HET). The two possibilities along these two dimensions yield four scenarios in total (FR, BR, FR-HET, and BR-HET).

parameter	value
ν_f	0.15
ν_e	0.07
ν_c	0.77
δ_f	0.67
δ_e	0.33
δ_c	0.83
mean markup $\sum_{s\in\{f,e,c\}} \nu_s M_s - 1$	0.30

Table 1: Overview over parameters values chosen in line with ONS data

Notes: The values for δ_f, δ_e, and δ_c are for the HET scenarios. For the scenarios without heterogeneity with regard to price stickiness, the weighted mean $\delta = 0.77$ is used.

We choose one period to be one quarter and calibrate our model to the United Kingdom. We exclude the COVID-19 pandemic and thus consider the period from the fourth quarter of 1999 until the end of 2019.[4] Some parameters are chosen externally based on ONS data. For ν_f and ν_e, we select the mean of the respective yearly CPI weights for food and energy, respectively. For the remaining items, ν_c is set to $1 - \nu_f - \nu_e$. For the Calvo parameters, we compute the frequencies of prices not being adjusted in a quarter. For this purpose, we draw on the extensive ONS's price quote data underlying the UK CPI (see Appendix C for details). In the scenarios where we disregard differences in price stickiness, all values of δ are set to the respective mean for all items covered by the ONS data. We select parameter θ in the Dixit-Stiglitz aggregator such that the mean markup corresponds to 30.27%, which is the mean markup computed from another dataset released by ONS.[5] The parameter choices that are informed by ONS data are summarized in Table 1.

Other parameter values are chosen in line with the literature. For the parameters in the Taylor rule, we select estimates from Harrison and Oomen (2010): ρ_i = 0.87, ϕ_y = 0.11, and ϕ_π = 1.87. The parameters characterizing households' utility are set to standard values: $\psi = 5$, $\gamma = 2$, $\beta = 0.99$, and $\omega = 2$. Table 2 summarizes these parameter choices.

[4] We start in 1999Q4 due to the availability of quantitative data on inflation perceptions from the BoE's Inflation Attitudes Survey.

[5] The dataset "Experimental Statistics on markups, market power, productivity growth and business dynamism from the Annual Business Survey (ABS), 1997-2019, Great Britain" contains two different measures of markups, markups on labor costs and markups on intermediate consumption. We use the average of these two measures.

parameter	value
ρ_i	0.87
ϕ_y	0.11
ϕ_π	1.87
ψ	5
γ	2
β	0.99
ω	2

Table 2: Overview over parameters chosen in line with the literature

The remaining parameters are determined via the simulated method of moments, where we use a log-linear approximation of the equilibrium relationships.

We note that the overall level of the attention parameters m_f, m_e, and m_c is virtually impossible to identify in log-linearized versions of our model. This is suggested by the fact that the weights μ_f, μ_e, and μ_c that describe how strongly perceived inflation is affected by price changes in the three sectors depend only on the relative magnitudes of m_f, m_e, and m_c (see Proposition 1). As a consequence, we normalize one of these values while making sure that all parameters remain within the admissible set $(1/\theta, 1]$. Taking into account that food prices affect perceived inflation most strongly, we set $m_f = 1$. We have verified that this choice has no noticeable impact on our results. In particular, a scenario with bounded rationality but identical levels of m_f, m_e, and m_c generates almost identical results as the scenario with full rationality, where all attention parameters m are equal to one.

To pin down the parameters describing the three different productivity shocks, the remaining two m's in the BR scenarios, and the standard deviation of monetary-policy shocks σ_m, we select the following targets. In line with our motivating evidence presented in Section 2, we target the co-movement of perceived inflation with the changes of the CPI sub-indices. More specifically, we target the three coefficients resulting from regressing perceived inflation on the year-on-year change in the prices of food, energy, and the remaining items. Figure 4 shows the corresponding time series in our sample period.

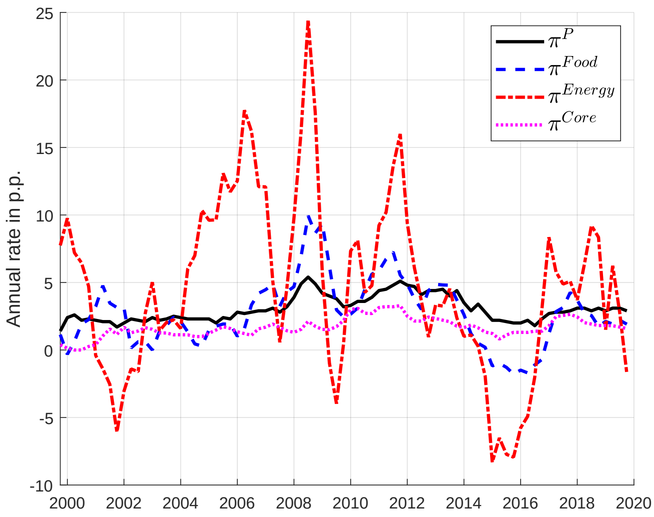

Figure 4: Time series evidence

Notes: The figure shows consumers' inflation perceptions and the year-on-year relative changes in the sectoral price levels from 1999Q4 until 2019Q4. Perceived inflation, π^P, is the median from the BoE's Inflation Attitudes Survey.

To identify the magnitude of monetary-policy shocks, we utilize the standard deviation of interest rates as a target, where we use the shadow rate to adequately capture the stance of monetary policy at the zero lower bound.[6] To determine the six parameters describing the three productivity shocks, we target the standard deviations and persistence levels of food inflation, energy inflation, and core inflation as well as the respective pairwise correlations. In addition, as non-targeted moments, we consider the standard deviation and persistence of the output gap, which we compute with the help of an HP filter with standard smoothing parameter 1600, the persistence and standard deviation of inflation perceptions, the correlation between expected and perceived inflation, and the volatility of inflation expectations.[7]

To make the effects of bounded rationality more easily comparable across scenarios, we only perform a full calibration of our model for scenario FR, which represents the standard case with full rationality and homogeneous degrees of price stickiness. For the remaining scenarios, we keep the parameters determining the magnitude and persistence of the sector-specific productivity shocks as

[6] The data are available at https://sites.google.com/view/jingcynthiawu/shadow-rates. See Wu and Xia (2016) for additional information.

[7] We use median inflation expectations from the BoE's Inflation Attitudes Survey and real GDP data from ONS.

parameter	FR	BR	FR-HET	BR-HET
m_f	1.000	1.000	1.000	1.000
m_e	1.000	0.064	1.000	0.064
m_c	1.000	0.339	1.000	0.324
σ_m	0.000	0.000	0.000	0.000
σ_{Af}	0.028	0.028	0.028	0.028
ρ_{Af}	0.975	0.975	0.975	0.975
σ_{Ae}	0.075	0.075	0.075	0.075
ρ_{Ae}	0.479	0.479	0.479	0.479
σ_{Ac}	0.018	0.018	0.018	0.018
ρ_{Ac}	0.000	0.000	0.000	0.000
θ	4.304	22.178	4.304	22.172

Table 3: Overview over estimated parameters values. Parameters σ_m, σ_{Af}, ρ_{Af}, σ_{Ae}, ρ_{Ae}, σ_{Ac}, and ρ_{Ac} are calibrated to scenario FR and not recalibrated in scenarios BR, FR-HET, and BR-HET.

well as the standard deviation of monetary-policy shocks unchanged. Moreover, we adjust parameter θ across scenarios in order to ensure identical mean markups across scenarios. The resulting parameters are displayed in Table 3 and the fit of moments across the four scenarios in Table 4.

Scenarios BR and BR-HET involve sizable differences in the attention parameters m_f, which was normalized to one, as well as m_e and m_c. This is in line with the evidence presented in Section 2, which has shown that perceived inflation is strongly influenced by changes in food prices. The first three lines of Table 4 show that, empirically, perceived inflation is disproportionately affected by food inflation as the regression coefficient of food inflation, 0.213, is larger compared to the weight of food in the CPI, which is $\nu_f = 0.153$ (compare Table 1). While scenarios FR and FR-HET are unable to replicate this pattern, the other scenarios with bounded rationality, i.e. BR and BR-HET are able to qualitatively reproduce it. It is noteworthy that the regression coefficients are too large, namely 0.333 and 0.317, respectively. This is due to the fact that the coefficients μ_f, μ_e, and μ_c have to sum up to one in our model, while the empirical coefficients sum up to approximately 0.7. To sum up, our model is broadly in line with the relative magnitudes of the regression coefficients considered in the first three lines but not in line with their absolute levels.

It may also be worth mentioning that the scenarios with bounded rationality involve much larger values for parameter θ from the Dixit-Stiglitz aggregator

moment	empirical	FR	BR	FR-HET	BR-HET
reg coeff perc infl, food infl	0.213	0.153	0.333	0.153	0.317
reg coeff perc infl, nrg infl	0.012	0.073	0.010	0.073	0.010
reg coeff perc infl, core infl	0.455	0.774	0.657	0.774	0.673
std i	0.011	0.003	0.002	0.003	0.001
std food infl	0.009	0.010	0.011	0.010	0.009
pers food infl	0.360	0.648	0.635	0.516	0.441
std nrg infl	0.027	0.009	0.019	0.034	0.038
pers nrg infl	0.224	0.264	0.237	0.071	0.032
std core infl	0.005	0.005	0.005	0.002	0.002
pers core infl	-0.451	0.107	-0.113	0.650	0.191
corr food infl, nrg infl	0.289	0.325	0.156	0.257	0.268
corr food infl, core infl	0.165	0.463	0.233	0.413	0.194
corr nrg infl, core infl	0.322	0.670	0.459	0.395	0.511

Table 4: Empirical moments and simulated moments. All interest rates and inflation rates refer to one quarter. The regression coefficients (reg coeff) are obtained by regressing perceived (quartilized) year-on-year changes in the overall price level on (quartilized) year-on-year changes in sector-specific price indices. Standard deviations (std) have to be multiplied by 100 to obtain values in percentage terms. Persistence (pers) corresponds to auto-correlation; corr stands for correlation.

(compare Table 3). This can be understood by noting that θ is chosen to match markups of 30%. In scenarios with bounded rationality, the low levels of attention for energy and core items increase the mean markup substantially such that a much larger value for θ is needed. Finally, we note that the standard deviation of monetary-policy shocks is small in all four scenarios.

6. Results

6.1. Monetary non-neutrality

In this section, we discuss the results of our model. In particular, we analyze the dynamic effects of monetary-policy shocks. Table 5 shows the cumulative impact of a positive one-percentage-point shock ε_{mt} in the Taylor rule (17) on inflation, output, perceived inflation, and perceived output. For all scenarios, the cumulative effects on actual inflation and perceived inflation are exactly identical. While this is unsurprising for the two scenarios with rational expectations, i.e. FR and FR-HET, it may be less obvious for the other two scenarios with boundedly rational agents, BR and BR-HET. In the latter cases, the identical cumulative responses of perceived and actual inflation are caused by the fact that consumers correctly perceive economic variables in the long run and only misperceive short-run deviations of variables from their steady-state variables. This entails that consumers always correctly perceive the long-term effects on the price level or, equivalently, the cumulative effects on inflation.

parameter	FR	BR	FR-HET	BR-HET
effect on output	-3.19	-3.19	-3.51	-4.78
effect on inflation	-3.23	-3.23	-3.17	-2.98
effect on perceived output	-3.19	-3.19	-3.51	-3.41
effect on perceived inflation	-3.23	-3.23	-3.17	-2.98

Table 5: Cumulative effects of a one-percentage point increase in nominal interest rates.

We also observe that the aggregate effects of monetary-policy shocks in the two scenarios FR and BR are exactly identical. This is due to the fact that in both scenarios prices are equally rigid for all goods. Consequently, they respond equally strongly to aggregate shocks. This implies that the fact that consumers pay more attention to some prices than to others has no effect on their perceptions of aggregate inflation.

The cumulative effects of monetary policy shocks on perceived and actual output are different only in scenario BR-HET. As we will see, this is mainly a consequence of two important properties of food prices. First, they are highly flexible and thus respond to monetary-policy shocks quickly. Second, consumers pay more attention to food prices than to other prices, which causes perceived inflation to respond particularly strongly in the periods after the shock has hit.

To visualize the dynamic effects and to clarify the particular role of food prices, we plot various impulse responses to monetary-policy shocks. As a benchmark, we first consider the scenario with perfect rationality and heterogeneous degrees of price stickiness, FR-HET, in Figure 5. The first panel shows the responses of the inflation rate for food (dotted line) and energy (gray solid line) as well as core inflation (dash-dotted line) to a monetary-policy shock. As energy prices are very flexible, the corresponding sector-specific inflation rate initially responds more strongly than core inflation. While food prices are stickier than energy prices, they are still considerably more flexible than the prices of items

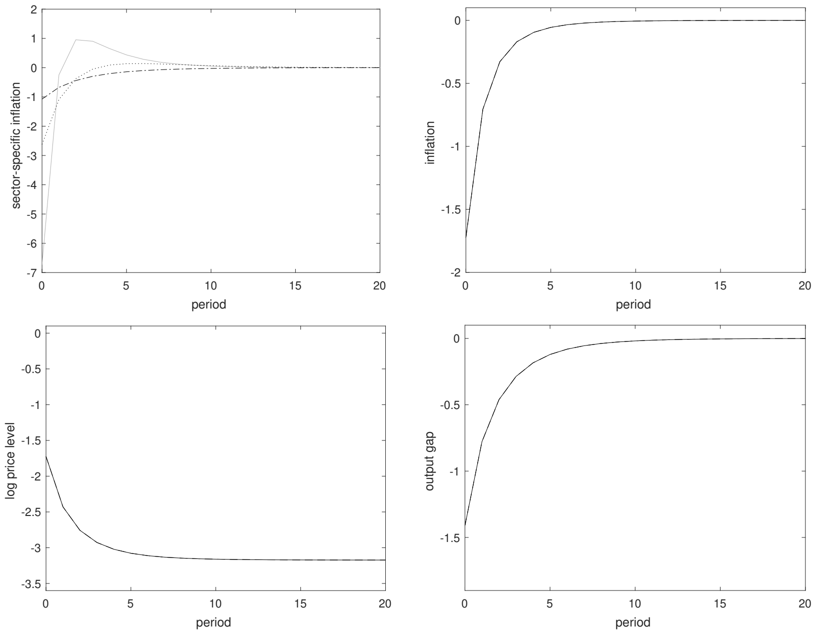

Figure 5: Benchmark scenario with full rationality and heterogeneous price stickiness (FR-HET). Impulse responses of food inflation (dotted line in the first panel), energy inflation (gray solid line), and core inflation (dash-dotted line), aggregate inflation (second panel), log price level (third panel), and output gap (fourth panel) to a one-percentage point increase in nominal interest rates. In panels 2-4, actual values and perceived values are identical.

in the core. Thus the initial response of food prices is weaker than for energy prices but larger than for core items.

The remaining three panels show the actual and perceived rates of inflation, the log price level, and the output gap. Because the benchmark scenario involves only fully rational agents, perceived and actual values are always identical. As is standard, the contractionary monetary-policy shock entails a temporary drop in inflation, a permanent drop in the price level, and a transitory reduction in output.

Having discussed the benchmark with fully rational agents, we now turn to the main case of interest, namely boundedly rational agents with heterogeneous degrees of attention regarding the different categories of goods (BR-HET). Figure 6 shows the dynamic evolution of economic variables after a monetary-policy shock. As in the benchmark case, the inflation rate for food (see the dotted line) responds more quickly to the contractionary monetary-policy shock than core inflation (the dash-dotted line). Importantly, scenario BR-HET involves that consumers pay more attention to food prices than to core inflation (and changes in energy prices). As a consequence, actual inflation (solid line) and perceived inflation (dashed line) differ (see the second panel in Figure 6). In particular, the initial response of inflation perceptions is dominated by the sizable changes in food prices and thus stronger than for actual inflation. After a few periods, this pattern is reversed and inflation perceptions are higher than actual inflation.

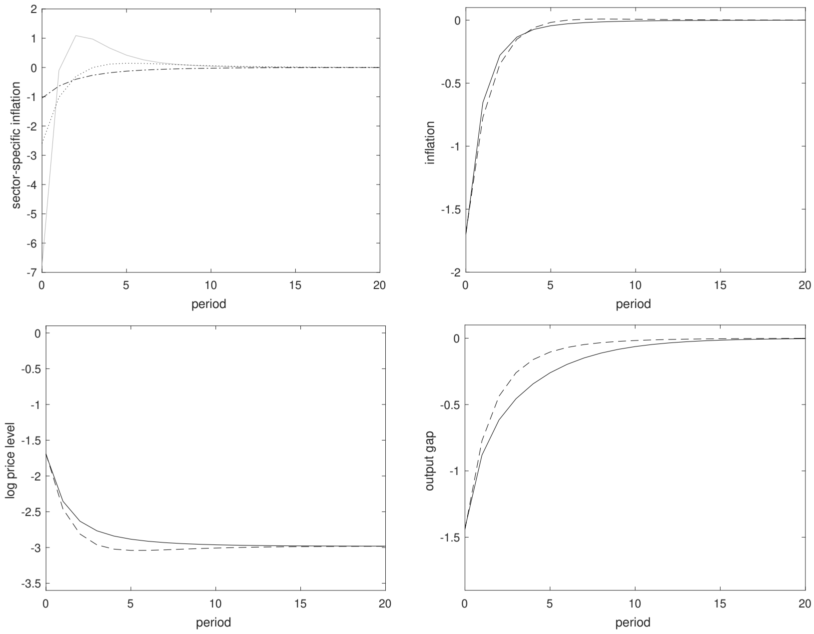

Figure 6: Main model with bounded rationality and heterogeneous price stickiness (BR-HET). Impulse responses of food inflation (dotted line in the first panel), energy inflation (gray solid line), and core inflation (dash-dotted line), aggregate inflation (second panel), log price level (third panel), and output gap (fourth panel) to a one-percentage point increase in nominal interest rates. In panels 2-4, black solid lines represent actual values, dashed lines perceived values.

The third panel of the figure illustrates the evolution of the perceived and the actual price level. The perceived price level, which is affected disproportionately strongly by the low food prices, is lower than the actual price level. As explained before, the perceived long-term effects on the price level are necessarily correct as consumers make only short-term mistakes. Thus both graphs in the third panel converge to identical values in the long-term.

In our model, a misperception of the price level necessarily renders a discrepancy between intended or perceived consumption and actual consumption. In particular, the fact that goods are typically more expensive than perceived by consumers results in a larger drop in consumption than intended (see the bottom-right panel). This explains the comparably large real effects of monetary policy in our main scenario.

In Appendix D, we also discuss the dynamic evolution of the economy following sector-specific productivity shocks. A major finding of this analysis is that, for shocks in the food sector, consumers overestimate the response of the aggregate price level, which is in line with the biased perceptions that they have after monetary-policy shocks. However, as, in contrast with monetary-policy shocks, productivity shocks tend to move output and prices in opposite directions, households tend to overestimate the response of consumption after productivity shocks in the food sector, whereas they underestimate this response after monetary-policy shocks.

6.2. Optimal monetary policy

In the following, we examine which inflation rate the central bank should target. We consider four different measures of inflation: core inflation, headline inflation, and measures of inflation that include all items contained in the CPI but exclude those related to food or those related to energy respectively. The latter two inflation rates are potentially interesting because food and energy prices have quite different properties. Energy prices are substantially more flexible than food prices (see Table 1). At the same time, energy prices are much less influential for consumers' inflation perceptions in our main scenario (see Table 3). In contrast with Section 6.1, we now recalibrate all parameters for scenarios BR, FR-HET, and BR-HET (for details see Appendix E).

We suppose that the central bank chooses a rule of the following form:

$$I_t = \left(\Pi_t^T\right)^{\phi_\pi^T} \beta^{-1}, \tag{22}$$

where Π_t^T represents the gross rate of inflation that the central bank uses as its target and ϕ_π^T (like ϕ_π) is a positive parameter that describes how strongly the central bank responds to changes in inflation. For each possible target rate, we compute the coefficient ϕ_π^T that maximizes welfare.

In principle, there are two different possible approaches to measuring welfare in our model. Welfare can either be evaluated using the perceived quantities of consumption goods or the actual quantities. We would argue that welfare should measure the subjective well-being of consumers. Thus we use the unconditional expectation of consumer's utility evaluated for perceived levels consumption as a welfare measure. However, we will show that our ranking of different monetary-policy strategies would be unaffected if we computed welfare based on actual levels of consumption.

A log-linear approximation around a deterministic steady state, which we used up to this point, would potentially lead to spurious findings with respect to welfare (see e.g. Kim and Kim, 2003). Thus we use second-order approximations of the representative household's utility function as well as the equilibrium relationships. We have verified that our findings continue to hold for an approximation that includes terms up to the third order.

target	highest welfare	std. dev. $\log C_t$	std. dev. $\log L_t$	mean C_t	mean L_t
headline	0.04%	1.56%	0.31%	+0.04%	+0.00%
no food	0.03%	1.54%	0.39%	+0.03%	+0.00%
no energy	0.04%	1.52%	0.25%	+0.05%	+0.00%
core	0.05%	1.48%	0.27%	+0.05%	+0.00%
benchmark	0.00%	1.32%	0.68%	+0.00%	+0.00%

Table 6: Scenario FR-HET. Columns from left to right: Highest levels of welfare that can be attained when the central bank uses different variants of inflation rates as a target, measured in consumption equivalents compared to the benchmark case; standard deviations of log consumption and log employment; mean consumption and mean employment measured as relative differences from the respective means in the case where the central bank follows the benchmark Taylor rule.

As a preliminary step, we turn to the scenario with heterogeneity with regard to price stickiness but where bounded rationality is absent (FR-HET). Table 6 considers the four different definitions of inflation that the central bank may target. In each case, the central bank selects the weight π_π^T on this target optimally. The bottom row concentrates on the benchmark case where the central bank applies the Taylor rule used in our calibration in Section 5.

The second column reports the highest attainable values for welfare. Welfare levels are reported in terms of consumption equivalents compared to the benchmark case with the Taylor rule described in Section 5. It is obvious that, in the scenario with fully rational consumers, perceived values always correspond to actual ones.

Importantly, the table shows that, with fully rational consumers, the highest level of welfare can be achieved by a central bank that focuses on core inflation.[8] This finding is in line with the literature discussed in the Introduction (Aoki, 2001; Eusepi et al., 2011), which shows that it is optimal for central banks to focus on stabilizing the changes of prices that are comparably sticky. We notice that the differences in welfare across the different targeting regimes are quite small. The finding of small welfare differences across policies is not a specific feature of our model but a typical implication of new Keynesian models.

According to Table 6, three factors contribute to the finding that targeting core inflation is desirable. First, targeting core inflation leads to small fluctuations in consumption and, second, to moderate fluctuations in employment. Third, it also entails an increase in mean consumption compared to the benchmark case. It may be worth mentioning that a log-linear approximation of our model around the deterministic steady state would imply that the value of mean consumption always corresponds to the one in the deterministic state, irrespective of the policy being used. However, our results about welfare are computed using an approximation of the equilibrium relationships that also features quadratic terms. In this case, the ergodic means are typically different from the values in the deterministic steady state.

Having discussed the scenario with fully rational consumers, we now turn to our main scenario BR-HET in Table **??**. The second column reports the highest attainable values for welfare, based on perceived values. The column on the right presents the highest possible values of welfare if the central bank chooses the coefficient in the Taylor rule to maximize welfare based on actual values.

For all four variants of the target measure as well as the benchmark case where the central bank follows the Taylor rule used for the calibration, welfare based on perceived levels is higher than for actual levels. These welfare differences

[8] In the case with homogeneous price stickiness and fully rational agents (FR), it is best for the central bank to stabilize headline inflation. This is plausible given that all goods are completely symmetric in this scenario.

target	highest welfare (perc.)	std. dev. $\log C_t^B$	std. dev. $\log C_t$	std. dev. $\log L_t$	mean C_t^B	mean C_t	mean L_t	highest welfare (actl.)
headline	0.03%	1.71%	0.99%	0.33%	+0.03%	-0.45%	+0.00%	-0.44%
no food	-0.00%	1.70%	1.04%	0.40%	+0.01%	-0.50%	+0.01%	-0.50%
no energy	0.06%	1.71%	0.90%	0.17%	+0.05%	-0.42%	-0.00%	-0.40%
core	0.05%	1.67%	0.90%	0.15%	+0.05%	-0.45%	+0.01%	-0.44%
benchmark	0.00%	1.54%	0.58%	0.68%	+0.00%	-0.48%	+0.00%	-0.47%

Table 7: Scenario BR-HET. Columns from left to right: Highest levels of welfare, based on perceived values, that can be attained when the central bank uses different variants of inflation rates as a target; standard deviations of log perceived consumption, log actual consumption, and log employment; mean perceived consumption and mean actual consumption measured as relative differences from mean perceived consumption when the central bank follows the benchmark Taylor rule; mean number of hours worked measured as a relative difference the respective level in the benchmark. The last column displays the highest levels of welfare, based on actual values, that can be attained when the central bank uses a specific definition of inflation as a target.

are determined by two factors. First, the standard deviations for perceived and actual consumption differ. Second, the households' mean perceived level of consumption is different from mean actual consumption. We discuss each of these factors in turn.

First, we notice that the standard deviation of perceived consumption is always higher than for actual consumption (see the second and third columns of Table **??**). The large perceived fluctuations can be explained by noting that aggregate fluctuations are dominated by sector-specific productivity shocks as opposed to the monetary-policy shocks that were studied in Section 6.1. As has been mentioned before, perceptions of nominal expenditures are always correct, i.e. $P_tC_t = P_t^BC_t^B$ (see (11) and (13)). Accordingly, perceived consumption can be written as

$$C_t^B = \left(\frac{P_t^B}{P_t}\right)^{-1} C_t. \tag{23}$$

Whether perceived consumption is more volatile than actual consumption thus depends on whether $\frac{P_t^B}{P_t}$, i.e. the degree of misperception of the price level, and consumption tend to co-move or tend to move in opposite directions. As discussed in Section 6.1 for monetary-policy shocks and in Appendix D for productivity shocks, perceived prices tend to respond more strongly to shocks than actual prices. Thus the price level P_t and price misperception $\frac{P_t^B}{P_t}$ co-move. As a consequence, demand shocks entail that consumption and price misperception tend to co-move whereas supply shocks make consumption and price misperception move in opposite directions. According to (23), fluctuations in consumption perceptions are thus dampened in the presence of demand shocks but amplified in the presence of supply shocks.

Second, we discuss the bias in the perceived level of consumption. Our simulations reveal that mean perceived consumption typically exceeds the mean level of actual consumption by half a percent. This as an effect that would not arise for a log-linear approximation of our model but does show up for an approximation that involves quadratic terms of equilibrium relationships as well.

For our main scenario, perceived welfare is higher when the central bank targets core inflation rather than headline inflation. This finding contrasts with Dietrich (2024) but is in line with Aoki (2001) and Eusepi et al. (2011). Irrespective of the welfare measure being used, the highest level of welfare can be achieved by targeting a measure of inflation that excludes energy. This conclusion differs from the one we obtained for fully rational consumers, where targeting core inflation was optimal. With boundedly rational consumers, taking food prices into account despite their comparably high degree of flexibility is desirable as they are an important determinant of price perceptions. To sum up, optimal monetary policy is not only affected by heterogeneity with respect to price rigidity but by bounded rationality as well.

7. Conclusion

This paper has presented empirical evidence in favor of a strong influence of food prices on perceived inflation rates. Motivated by this finding, we have proposed a new Keynesian model with boundedly rational consumers, which is consistent with this pattern. While it is known that heterogeneous price stickiness across sectors increases the real effects of monetary policy (Nakamura and Steinsson, 2010), our analysis has revealed that bounded rationality may lead to a sizable strengthening of this effect. Key to this finding is that food prices are quite flexible and thus adjust to monetary-policy shocks quickly. While consumers correctly perceive the long-term effects of aggregate shocks on the price level, the quick response of food prices induces them to overestimate the effects of monetary policy for the price level for some time. This causes them to underestimate the consequences for real variables.

However, perceived consumption is in general more volatile than actual consumption. This finding stems from the fact that, in our calibrated model, aggregate fluctuations are mostly driven by productivity shocks and not by monetary-policy shocks. Under monetary-policy shocks, changes in output and prices are positively correlated. By contrast, output and prices tend to move in opposite directions under productivity shocks. An increase in output, for example, then leads to an even larger increase in perceived output because consumers tend to overestimate the drop in prices and thus believe that, for given nominal expenditures, real consumption is higher than it actually is.

We have also shown that it is optimal for central banks to target core inflation rather than headline inflation. Monetary-policy performance can be improved further if the central bank targets a measure of inflation that includes food prices but excludes energy prices. By contrast, if the central bank ignores food prices but not energy prices when conducting monetary policy, this leads to low levels of welfare.

References

Abildgren, K. and A. Kuchler (2021). Revisiting the inflation perception conundrum. *Journal of Macroeconomics 67*, 1–19.

Adam, K. and H. Weber (2023). Estimating the optimal inflation target from trends in relative prices. *American Economic Journal: Macroeconomics 15*(3), 1–42.

Ahn, H. J., S. Xie, and C. Yang (2024). Effects of monetary policy on household expectations: The role of homeownership. *Journal of Monetary Economics*. forthcoming.

Anesti, N., V. Esady, and M. Naylor (2024, April). Food prices matter most: Sensitive household inflation expectations. Manuscript.

Aoki, K. (2001). Optimal monetary policy responses to relative-price changes. *Journal of Monetary Economics 48*(1), 55 – 80.

Benchimol, J. and L. Bounader (2023). Optimal monetary policy under bounded rationality. *Journal of Financial Stability 67*, 101151.

Binder, C. C. (2018). Inflation expectations and the price at the pump. *Journal of Macroeconomics 58*, 1–18.

Bonciani, D., R. M. Masolo, and S. Sarpietro (2024, October). How food prices shape inflation expectations and the monetary policy response. Bank of England Staff Working Paper No. 1,094.

Coibion, O. and Y. Gorodnichenko (2015). Is the Phillips curve alive and well after all? Inflation expectations and the missing disinflation. *American Economic Journal: Macroeconomics 7*(1), 197–232.

D'Acunto, F., U. Malmendier, J. Ospina, and M. Weber (2021). Exposure to grocery prices and inflation expectations. *Journal of Political Economy 129*(5), 1615–1639.

D'Acunto, F. and M. Weber (2024). Why survey-based subjective expectations are meaningful and important. *Annual Review of Economics 16*.

Detmeister, A., D. Lebow, E. Peneva, et al. (2016). Inflation perceptions and inflation expectations. *FEDS Notes 2016*(1882).

Dhamija, V., R. Nunes, and R. Tara (2023). House price expectations and inflation expectations: Evidence from survey data. Manuscript.

Dietrich, A. M. (2024). Consumption categories, household attention, and inflation expectations: Implications for optimal monetary policy. *Journal of Monetary Economics*. forthcoming.

Eusepi, S., B. Hobijn, and A. Tambalotti (2011). Condi: A cost-of-nominal-distortions index. *American Economic Journal: Macroeconomics 3*(3), 53–91.

Gabaix, X. (2014). A sparsity-based model of bounded rationality. *The Quarterly Journal of Economics 129*(4), 1661–1710.

Gabaix, X. (2019). Behavioral inattention. *Handbook of Behavioral Economics 2*, 261–343.

Gabaix, X. (2020). A behavioral new Keynesian model. *American Economic Review 110*(8), 2271–2327.

Georganas, S., P. J. Healy, and N. Li (2014). Frequency bias in consumers' perceptions of inflation: An experimental study. *European Economic Review 67*, 144–158.

Hahn, V. and M. Marenčák (2020). Price points and price dynamics. *Journal of Monetary Economics 115*, 127–144.

Harrison, R. and O. Oomen (2010). Evaluating and estimating a DSGE model for the United Kingdom. Bank of England working paper #380.

Huber, S. J., D. Minina, and T. Schmidt (2023). The pass-through from inflation perceptions to inflation expectations. Bundesbank Working Paper No 17/2023.

Jonung, L. (1981). Perceived and expected rates of inflation in Sweden. *The American Economic Review 71*(5), 961–968.

Kim, J. and S. H. Kim (2003). Spurious welfare reversals in international business cycle models. *Journal of International Economics 60*(2), 471–500.

Lein, S. M. and T. Maag (2011). The formation of inflation perceptions: Some empirical facts for European countries. *Scottish Journal of Political Economy 58*(2), 155–188.

Lucas, R. E. (1972, April). Expectations and the neutrality of money. *Journal of Economic Theory 4*(2), 103–124.

Maćkowiak, B. and M. Wiederholt (2015). Business cycle dynamics under rational inattention. *The Review of Economic Studies 82*(4), 1502–1532.

Mankiw, N. G. and R. Reis (2002, November). Sticky information versus sticky prices: A proposal to replace the New Keynesian Phillips curve. *Quarterly Journal of Economics 117*(4), 1295–1328.

Montag, H. (2024). On the welfare costs of perceptions biases. *Journal of Money, Credit and Banking*. forthcoming.

Nakamura, E. and J. Steinsson (2010). Monetary non-neutrality in a multisector menu cost model. *Quarterly Journal of Economics 125*(3), 961–1013.

Trehan, B. (2011). Household inflation expectations and the price of oil: It's déja vu all over again. *FRBSF Economic Letter 16*.

Wu, J. C. and F. D. Xia (2016). Measuring the macroeconomic impact of monetary policy at the zero lower bound. *Journal of Money, Credit and Banking 48*(2-3), 253–291.

A. Derivation of Equilibrium Conditions

The household's cost minimization problem The household's cost-minimization problem is

$$\begin{aligned} &\min_{\{c_{it}^B\}_{i=0}^1} \int_0^1 P_{it}^B c_{it}^B di \\ &s.t.\ C_t^B = \left(\int_0^1 \left(c_{it}^B\right)^{\frac{\theta-1}{\theta}} di \right)^{\frac{\theta}{\theta-1}}. \end{aligned} \tag{24}$$

With the Lagrange multiplier λ_t, we obtain the following first order condition:

$$c_{it}^B = \lambda_t^\theta (P_{it}^B)^{-\theta} C_t^B. \tag{25}$$

To determine λ_t, we can insert (25) into $C_t^B = \left(\int_0^1 \left(c_{it}^B\right)^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\theta}{\theta-1}}$, which results in

$$\lambda_t = \left(\int_0^1 \left(P_{it}^B\right)^{-(\theta-1)} di \right)^{-\frac{1}{\theta-1}}. \tag{26}$$

Using (9), we note that $\lambda_t = P_t^B$. Combining with (25), yields (7). By plugging (5) into (7), one obtains (10), which is the expression for intended demand stated in the main text.

Perceived price level as a function of actual prices In order to compute P_t^B as a function of actual prices $\{P_{it}\}_{i=0}^1$, one has to insert (5) into (9), which yields

$$\int_0^1 \left(\frac{P_{it}}{P_t^B} \right)^{-m_{s(i)}(\theta-1)} Q_{s(i)}^{-(\theta-1)(1-m_{s(i)})} di = 1. \tag{27}$$

For given $\{P_{it}\}_{i=0}^1$ and $\{Q_s\}_{s=1}^n$, the left-hand side of the equation is a strictly monotonically increasing function of P_t^B that is zero for $P_t^B = 0$ and goes to infinity for $P_t^B \to \infty$. Thus (27) involves a unique solution for P_t^B.

As a next step, we rewrite (27) to describe the dynamics of $\Pi_t^B = P_t^B / P_{t-1}^B$:

$$1 = \sum_{s=1}^n (Q_s)^{-(\theta-1)(1-m_s)} \int_{I_s} \left(\frac{P_{it}}{P_t^B} \right)^{-m_s(\theta-1)} di. \tag{28}$$

For each $s = 1, 2, ..., n$, we introduce J_{st} as

$$J_{st} := \frac{1}{\alpha_s}(Q_s)^{m_s(\theta-1)} \int_{I_s} \left(\frac{P_{it}}{P_t^B}\right)^{-m_s(\theta-1)} di. \tag{29}$$

With the help of (29), (28) can be formulated as

$$1 = \sum_{s=1}^{n} \alpha_s (Q_s)^{-(\theta-1)} J_{st}. \tag{30}$$

It can be easily shown that, for each sector s, J_{st} satisfies the following recursive equation:

$$J_{st} = \delta_s \left(\Pi_t^B\right)^{(\theta-1)m_s} J_{s,t-1} + (1-\delta_s)\left(\frac{Q_{st}^*}{Q_s B_t}\right)^{-(\theta-1)m_s}. \tag{31}$$

Q_{st}^* is the relative price P_{it}/P_t that firms in sector s choose when they are able to adjust the price in period t. Note that all firms in a sector select identical prices when they are able to adjust them because all firms in a sector have identical values of m_s.

Price level as a function of actual prices As a next step, we evaluate the condition $P_t C_t = \int_0^1 P_{it} c_{it}\, di$, which ensures that P_t corresponds to the expenditures for one unit of actual consumption. With the help of $P_t = P_t^B / B_t$, one obtains $1 = B_t \int_0^1 \frac{P_{it}}{P_t^B} \frac{c_{it}}{C_t}\, di$. Because of (12), this condition is equivalent to

$$1 = B_t \sum_{s=1}^{n} (Q_s)^{-\theta(1-m_s)} \int_{I_s} \left(\frac{P_{it}}{P_t^B}\right)^{-(m_s\theta-1)} di. \tag{32}$$

We have already explained that, for given $\{P_{it}\}_{i=0}^1$ and $\{Q_s\}_{s=1}^n$, (27) gives a unique value for P_t^B. For this value of P_t^B, (32) yields a unique value for B_t.

With the definition

$$H_{st} := \frac{1}{\alpha_s}(Q_s)^{m_s\theta-1} \int_{I_s} \left(\frac{P_{it}}{P_t^B}\right)^{-(m_s\theta-1)} di, \tag{33}$$

we can write (32) as

$$1 = B_t \sum_{s=1}^{n} \alpha_s (Q_s)^{-(\theta-1)} H_{st}. \tag{34}$$

One can show that, for each sector s, H_{st} is recursively given by

$$H_{st} = \delta_s \left(\Pi_t^B\right)^{\theta m_s - 1} H_{s,t-1} + (1-\delta_s)\left(\frac{Q_{st}^*}{Q_s B_t}\right)^{1-\theta m_s}. \tag{35}$$

Aggregate production function In the following, we derive the aggregate production function. It is straightforward to show that $L_t = \int_0^1 L_{it}\, di$, $L_{it} = c_{it}/A_{s(i)t}$, and the demand function (12) imply

$$C_t = A_t L_t, \tag{36}$$

where aggregate productivity A_t is given by

$$A_t = \left(\sum_{s=1}^{n} \alpha_s (Q_s)^{-\theta} \frac{S_{st}}{A_{st}}\right)^{-1} \tag{37}$$

and the sector-specific measures of price dispersion are

$$S_{st} := \frac{1}{\alpha_s}(Q_s)^{m_s\theta} \int_{I_s} \left(\frac{P_{it}}{P_t^B}\right)^{-m_s\theta} di. \tag{38}$$

These measures can be expressed recursively in the following way:

$$S_{st} = \delta_s \left(\Pi_t^B\right)^{\theta m_s} S_{s,t-1} + (1-\delta_s)\left(\frac{Q_{st}^*}{Q_s B_t}\right)^{-\theta m_s}. \tag{39}$$

Price setting Firm i's profit maximization problem is

$$\max_{P_{it}} \mathbb{E}_t \left[\sum_{\tau=t}^{\infty} (\beta\delta_{s(i)})^{\tau-t} u'(C_\tau^B) c_{i\tau} \left(\frac{P_{it} - \frac{W_\tau}{A_{s(i)\tau}}}{P_\tau^B}\right)\right], \tag{40}$$

where $c_{i\tau}$ in the above expression is the actual demand in period $\tau \geq t$, conditional on the firm's price still being P_{it}:

$$c_{i\tau} = \left(\frac{P_{it}}{P_\tau^B}\right)^{-m_{s(i)}\theta} \left(Q_{s(i)}\right)^{-(1-m_{s(i)})\theta} C_\tau. \tag{41}$$

With (41), $C_\tau/P_\tau^B = C_\tau^B/P_\tau$, and $u'(C_\tau^B) = (C_\tau^B)^{-\gamma}$ the maximization problem becomes:

$$\max_{P_{it}} \mathbb{E}_t \left[\sum_{\tau=t}^{\infty} (\beta\delta_{s(i)})^{\tau-t} (C_\tau^B)^{1-\gamma} \left(\frac{P_{it}}{P_\tau^B} \right)^{-m_{s(i)}\theta} \left(Q_{s(i)} \right)^{-(1-m_{s(i)})\theta} \left(\frac{P_{i\tau} - \frac{W_\tau}{A_{s(i)\tau}}}{P_\tau} \right) \right]. \tag{42}$$

It is straightforward to show that the optimal relative price chosen by a firm in sector s is

$$Q_{st}^* = M_s \frac{F_{st}}{G_{st}}, \tag{43}$$

where the markup M_s is

$$M_s = \frac{\theta m_s}{\theta m_s - 1}, \tag{44}$$

and

$$F_{st} := \mathbb{E}_t \sum_{\tau=t}^{\infty} (\beta\delta_s)^{\tau-t} (C_\tau^B)^{1-\gamma} \left(\frac{P_\tau^B}{P_t^B} \right)^{m_s\theta} \frac{w_\tau}{A_{s(i)\tau}}, \tag{45}$$

$$G_{st} := \mathbb{E}_t \sum_{\tau=t}^{\infty} (\beta\delta_s)^{\tau-t} (C_\tau^B)^{1-\gamma} \left(\frac{P_\tau^B}{P_t^B} \right)^{m_s\theta} \frac{P_t}{P_\tau}. \tag{46}$$

Variable

$$w_\tau := \frac{W_\tau}{P_\tau} \tag{47}$$

stands for the real wage. F_{st} and G_{st} can also be expressed recursively as follows

$$F_{st} := (C_t^B)^{1-\gamma} \frac{w_t}{A_{s(i)t}} + \beta\delta_s \mathbb{E}_t \left[(\Pi_{t+1}^B)^{m_s\theta} F_{s,t+1} \right], \tag{48}$$

$$G_{st} := (C_t^B)^{1-\gamma} + \beta\delta_s \mathbb{E}_t \left[(\Pi_{t+1}^B)^{m_s\theta} \Pi_{t+1}^{-1} G_{s,t+1} \right]. \tag{49}$$

Summary: Equilibrium conditions To sum up, the equilibrium corresponds to paths of A_{st}, ξ_t, Π_t, Π_t^B, I_t, C_t^B, J_t, J_{st}, Q_{st}^*, H_t, H_{st}, S_{st}, F_{st}, G_{st}, I_t, w_t that satisfy (2), the equation describing the relationship between perceived and actual inflation (14), the Euler equation (15), the labor supply condition (16), where W_t/P_t^B is replaced by w_t/B_t, the interest-rate rule (17), (30), (31), (34), (35), (36), (37), (39), (43), (48), and (49). Q_s corresponds to the steady-state level of Q_{st}^*.

Additional relationships Finally, we describe how sector-specific inflation can be computed. Although the equilibrium can be computed without these inflation rates, sector-specific inflation rates are required for the calibration of our model.

All goods in a sector receive the same weight when sector-specific inflation Π_{st} is computed. Thus we obtain

$$\Pi_{st} = \frac{\int_{I_s} P_{it} \, di}{\int_{I_s} P_{it-1} \, di}. \tag{50}$$

It will be useful to define the average relative price for sector s as

$$\overline{Q}_{st} = \frac{(\alpha_s)^{-1} \int_{I_s} P_{it} \, di}{P_t}. \tag{51}$$

It is now straightforward to see that

$$\overline{Q}_{st} = \delta_s \frac{\overline{Q}_{st-1}}{\Pi_t} + (1-\delta_s) Q^*_{st}, \tag{52}$$

$$\Pi_{st} = \frac{\overline{Q}_{st}}{\overline{Q}_{st-1}} \Pi_t. \tag{53}$$

In an equilibrium computed as described above, sector-specific inflation Π_{st} can be computed with the help of (52) and (53).

B. First-order Approximation Around the Steady State

In this appendix, we compute a few relationships that must hold in the zero-inflation steady state. As a next step, we derive first-order approximations for actual inflation and perceived inflation. These conditions can then be used to determine the levels of m_s for the different sectors from the observed relationship between sector-specific actual inflation rates and perceptions about aggregate inflation.

B.1. STEADY STATE

Finally, we compute the deterministic steady state with $\Pi = 1$. As, in the deterministic steady-state, all perceived prices correspond to the correct ones, $P_t^B = P_t$ and thus $B = 1$. Because of (14), we obtain $\Pi^B = 1$. Combining (43), (48), and (49) yields

$$Q_s = Q_s^* = M_s w, \tag{54}$$

where we have used that the marginal cost is identical across firms and equal to the steady-state real wage w. With the help of (31), we obtain

$$J_s = (Q_s)^{-(\theta-1)m_s}. \tag{55}$$

Inserting into (30) gives

$$1 = \sum_{s=1}^{n} \alpha_s (Q_s)^{-(\theta-1)}. \tag{56}$$

One can easily verify that (34) and (35) result in the same condition. (56) and (54) jointly determine w:

$$w = \left(\sum_{s=1}^{n} \alpha_s \left(\frac{1}{M_s} \right)^{\theta-1} \right)^{\frac{1}{\theta-1}}. \tag{57}$$

According to (39), S_s is given by

$$S_s = 1. \tag{58}$$

Thus, in line with (37), aggregate productivity is

$$A = \left(\sum_{s=1}^{n} \alpha_s (Q_s)^{-\theta} \right)^{-1}. \tag{59}$$

It may be noteworthy that, in contrast with a model with fully rational agents, our model implies $A < 1$ in general. This is a consequence of our finding that the elasticity of demand depends on the degree of attentiveness. Thus differences across m_s's lead to price dispersion and thus measures of aggregate productivity, A, smaller than one. If all m_s's are identical, $Q_s = 1$ holds for all sectors s and we obtain $A = 1$. In this case, labor is allocated efficiently across firms and $C = L$.

B.2. First-order Approximation for Perceived Inflation

We introduce b_t as the relative deviation of B_t from its steady-state level, $B = 1$. Moreover, let q_{it} be the relative deviation of P_{it}/P_t from its steady-state level Q_s and q_{st} be the average value of q_{it} for all firms i in s. Then it is straightforward to show that (27) can be approximated as

$$\left(\sum_{s=1}^{n} \nu_s m_s\right) b_t = \sum_{s=1}^{n} \nu_s m_s q_{st}, \tag{60}$$

where

$$\nu_s := \alpha_s (Q_s)^{-(\theta-1)} > 0. \tag{61}$$

According to (56), the ν_s's sum to one. With the help of

$$\mu_s := \frac{m_s \nu_s}{\sum_{s'=1}^{n} \nu_{s'} m_{s'}} > 0, \tag{62}$$

b_t can be written as

$$b_t = \sum_{s=1}^{n} \mu_s q_{st}. \tag{63}$$

It is clear that the μ_s's sum to one as well. The μ_s's can also be expressed as functions of markups M_s:

$$\mu_s := \frac{\nu_s \frac{M_s}{M_s - 1}}{\sum_{s'=1}^{n} \nu_{s'} \frac{M_{s'}}{M_{s'} - 1}} > 0. \tag{64}$$

Similarly, (32) can be approximated as

$$\left(\sum_{s=1}^{n} \nu_s m_s\right) b_t = \sum_{s=1}^{n} \left(m_s - \frac{1}{\theta}\right) \nu_s q_{st}. \tag{65}$$

Combining (60) and (65) yields

$$\sum_{s=1}^{n} \nu_s q_{st} = 0. \tag{66}$$

Let now π_t be the net inflation rate and π_{st} the average price change in sector s between periods $t-1$ and t. Then $q_{st} - q_{s,t-1} = \pi_{st} - \pi_t$. Together with (66), this gives

$$\pi_t = \sum_{s=1}^{n} \nu_s \pi_{st}. \tag{67}$$

Thus inflation is a weighted average of the sector-specific inflation rates where each sector s has weight ν_s.

Finally, we derive how perceived inflation π_t^B depends on the sector-specific inflation rates. With $\Delta b_t := b_t - b_{t-1}$, we can write

$$\pi_t^B = \pi_t + \Delta b_t. \tag{68}$$

Equation (65) and $q_{st} - q_{s,t-1} = \pi_{st} - \pi_t$ imply

$$\left(\sum_{s=1}^{n} \nu_s m_s\right) \Delta b_t = \sum_{s=1}^{n} \left(m_s - \frac{1}{\theta}\right) \nu_s (\pi_{st} - \pi_t). \tag{69}$$

In line with (67), (69) simplifies to

$$\left(\sum_{s=1}^{n} \nu_s m_s\right) \Delta b_t = \sum_{s=1}^{n} m_s \nu_s (\pi_{st} - \pi_t). \tag{70}$$

Together with (68) and (62), we obtain

$$\pi_t^B = \sum_{s=1}^{n} \mu_s \pi_{st}. \tag{71}$$

Thus, like actual inflation $\pi_t = \sum_{s=1}^{n} \nu_s \pi_{st}$, perceived inflation is a weighted measure of sector-specific inflation rates. The weights, however, are different. As the weights μ_s are increasing functions of m_s, the level of attention that the household pays to the prices in the respective sector, perceived inflation weights price changes in sectors to which consumers pay more intention more strongly than actual inflation.

Finally, we turn to the conditions stated in Proposition 2. Equation (21) is a direct consequence of (5). Multiplying both sides of (21) by ν_s, summing over s, and re-arranging yields (20). □

C. Sectoral frequencies of price adjustment

To determine the frequency of price adjustments across sectors in the UK, we utilize the micro price dataset underlying the UK CPI, as provided by the ONS. We follow the same data preparation process outlined in Hahn and Marenčák (2020), which prepared the ONS micro price dataset up to 2016. The following steps were undertaken to extend and refine the dataset for the period up to 2019:

1. Raw data
2. Establishing time series (removing duplicated items)
3. Validation of price quotes in line with the ONS methodology
4. Creation of unique weights per observation which combine three types of weights: shop weights, stratum weights, and COICOP item weights
5. Deleting prices in months with VAT changes (2008:12, 2010:03, 2011:03) and in 2005:05 due to data anomalies
6. Compute price changes
7. Remove price changes due to sales, comparable or non-comparable substitutions, and due to weight/quantity changes
8. Identify items in each category: Food, Energy, and Core
9. Loop over each quarter from 1999Q4 until 2019Q4 to compute the share of items that experienced at least one price change in a given quarter
10. Apply weights
11. Compute the mean of quarterly weighted shares of items with at least one price change in the given category

12. Probability of non price adjustment is given by one minus the average share from the previous step

Table 8 compares the price rigidity parameters estimated using our approach with those reported in other studies from the literature. The Calvo parameters used in this study are similar to those found in other studies for the UK. Dietrich (2024) uses the lower values of the Calvo parameter found by Eusepi et al. (2011) for the United States.

	Calvo parameters *(implied durations in quarters in parentheses)*				
	economy-wide	food	energy	non-core	core
This study	0.77 (4.35)	0.67 (3.03)	0.33 (1.49)	0.56 (2.28)	0.83 (5.88)
Adam and Weber (2023)	0.69 (3.23)				
Hahn and Marenčák (2020)	0.67 (3.03)				
Eusepi et al. (2011)				0.30 (1.43)	0.60 (2.50)

Table 8: Comparison of estimated price rigidity parameters to other studies

D. Sector-specific Productivity Shocks

This appendix discusses the consequences of the three different types of sector-specific productivity shocks that are considered in our analysis: shocks to productivity with regard to food, energy, and the remaining products. As suggested by Table 3, these shocks drive aggregate fluctuations as opposed to aggregate monetary-policy shocks, which have only a negligible size. Like in Section 6.1, we study a log-linear approximation around the deterministic steady state.

Figure 7 shows the actual and perceived responses of the price level and output (or consumption) to these types of shocks. Productivity shocks in the food sector are particularly important for understanding aggregate fluctuations as these shocks are comparably large and, at the same time, highly persistent (see

Table 3). According to the first panel of Figure 7, consumers overestimate the effects of productivity shocks in the food sector on the price level, which is a result of the high degree of attention that they pay to food prices. For positive productivity shocks in the food sector, aggregate real output increases. As households overestimate the drop in prices, they also overestimate the quantity of goods that they can purchase with a given nominal amount of funds. Thus perceived consumption fluctuates more strongly than actual consumption, which is a point that was highlighted in Section 6.2.

For completeness, we also discuss the remaining two types of productivity shocks. Shocks to energy prices have only small effects on the overall price level, as these prices represent only 7% of the consumer price index (see Table 1). As energy prices are very flexible, the price level also adjusts to these shocks rather quickly. Consumers largely ignore energy prices. Hence the perceived response of the price level is even weaker than the actual response. This result about perceived and actual responses of the aggregate price level contrasts with the findings for shocks in the food sector. This explains why, in response to food-price shocks, consumers underestimate the response of output, whereas perceived output overreacts to productivity shocks with respect to food. As a next step, we notice that productivity shocks in the core sector result in perceptions of price changes that are broadly correct. As a consequence, the perceived response of output is approximately correct as well.

Finally, it may be worth noting that, for three types of shocks, the perceived effect on the price level is correct in the long run. While this is obvious for shocks to the energy sector and core products, this may be less obvious from the first row of Figure 7, which illustrates shocks to food prices. In the latter case, the shocks are very persistent and the adjustment process takes more time than the 20 quarters displayed in the figure.

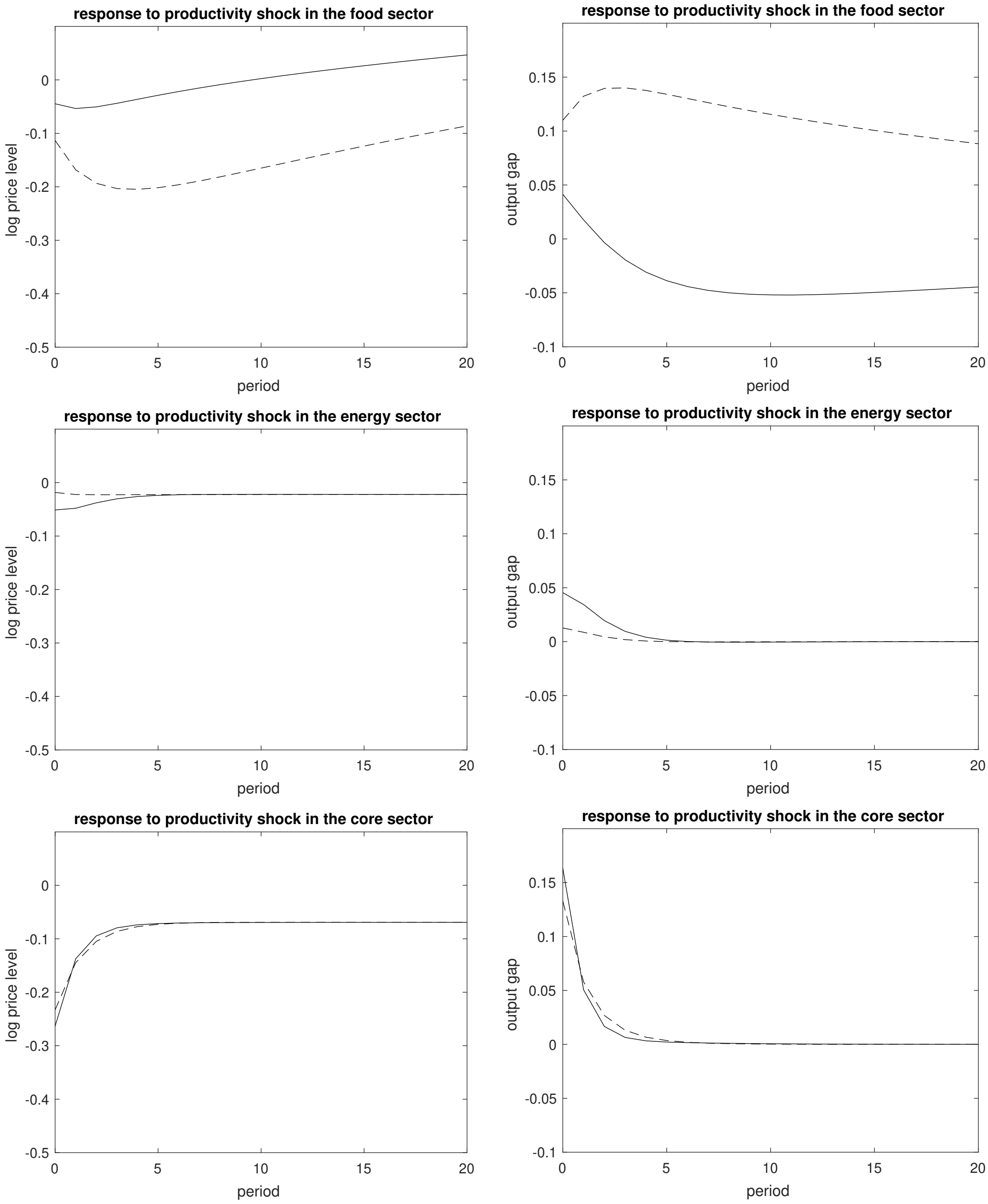

Figure 7: Scenario with bounded rationality and heterogeneous price stickiness (BR-HET). Impulse responses to a one-percentage point productivity shock in the sector for food (first row), energy (second row), and the remaining goods (last row). The panels on the left show the responses of the log price level, the panels on the right the responses of output. Black solid lines represent actual values, dashed lines perceived values.

E. CALIBRATION FOR OPTIMAL MONETARY POLICY ANALYSIS

parameter	FR	BR	FR-HET	BR-HET
m_f	1.000	1.000	1.000	1.000
m_e	1.000	0.065	1.000	0.069
m_c	1.000	0.390	1.000	0.419
σ_m	0.000	0.000	0.000	0.000
σ_{Af}	0.028	0.032	0.021	0.020
ρ_{Af}	0.975	0.990	0.975	0.984
σ_{Ae}	0.075	0.200	0.042	0.049
ρ_{Ae}	0.479	0.433	0.862	0.751
σ_{Ac}	0.018	0.019	0.010	0.010
ρ_{Ac}	0.000	0.000	0.027	0.000
θ	4.304	21.210	4.304	20.032

Table 9: Overview over estimated parameters values as used for optimal monetary policy analysis