# Consumption Categories, Household Attention, and Inflation Expectations: Implications for Optimal Monetary Policy

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**Abstract**

What inflation measure should central banks target? This paper shows optimal monetary policy targets *headline* inflation if households pay limited attention to different consumption categories when forming inflation expectations. This result stands in contrast to standard rational expectations models, where optimal policy targets *core* inflation. The core inflation rate excludes volatile energy and food prices (non-core) from headline inflation. Using novel survey data on inflation expectations for disaggregated consumption categories, I find household expectations are disproportionately driven by beliefs about future non-core prices. I develop a sparsity-based rational inattention model to account for the empirical evidence. While forming inflation expectations, households pay attention to the volatile non-core components; the stable core inflation component receives little attention. Finally, I embed this framework into a multi-sector New Keynesian model to derive the optimal inflation target. In the model, targeting headline inflation is optimal, whereas a core inflation target would fail to stabilize the economy sufficiently.

*Keywords:* Households expectations, Survey, Monetary policy, Behavioral macroeconomics
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# 1 Introduction

What inflation measure should central banks target? The New Keynesian literature suggests monetary policy should target the core inflation rate (e.g., Aoki, 2001; Eusepi et al., 2011). Core inflation excludes volatile food and energy prices from measured headline inflation, which accounts for price changes of all goods and services within households' consumption basket. The argument for core inflation targeting is intuitive: in the canonical New Keynesian framework, monetary policy aims to stabilize real distortions arising from nominal price rigidities. Food and energy prices are relatively flexible and feature low nominal rigidities. Hence, monetary policy is most effective if it focuses stabilization efforts on the core inflation rate. Nevertheless, while actual monetary policy is a complicated decision process involving numerous gauges for the state of the economy, central banks place substantial emphasis on the headline inflation rate, contrary to the academic literature. Indeed, the U.S. Federal Reserve relies on a headline inflation rate based on the personal consumption expenditures price index to define its official price stability target (FOMC, 2022).[1]

This paper offers a New Keynesian rationale for targeting the headline inflation rate. I argue it is indeed the optimal policy strategy once households' inflation expectations are modelled in more detail: because consumers disproportionately focus on non-core prices to form inflation forecasts, volatile food and energy inflation expectations are a key driver of aggregate demand volatility, and much more so than accounted for in the standard multi-sector New Keynesian model. Consequently, the central bank can insulate the economy from fluctuations in expected inflation to a greater degree if it targets the headline inflation rate and does not exclude those prices that households' expectations eminently focus on. Results in this paper formally complement earlier considerations of policy makers that a core inflation target may have adverse effects on policy communication with the public and the anchoring of household inflation expectations (Bullard, 2011a; Cavallo, 2008; Harris et al., 2009; Powell, 2022; Yellen, 2012). Although those considerations are arguably outside the canonical New Keynesian welfare perspective with fully informed and rational agents, this paper internalizes them by explicitly modeling and providing evidence on households' expectations formation process.

I present the argument in favor of a headline inflation target in three steps. First, the paper quantifies how inflation expectations are influenced by different components of the consumption basket. Using novel survey data, I show households' headline inflation expectations are disproportionately driven by beliefs over future non-core prices, compared with expectations over core inflation. Second, I put forward a sparsity-based rational inattention model to account for the pattern in the data: forming inflation expectations, households find it optimal to pay attention to the volatile non-core components while the stable core inflation component receives little attention. Third, to perform a quantitative welfare analysis of inflation target measures, I embed this framework into a multi-sector New Keynesian model. The paper shows headline inflation targeting is the optimal policy strategy due to households' asymmetric attention to non-core

[1]The U.S. Federal Reserve moved from referencing core towards headline inflation as its official target during the Bernanke era (Coenen et al., 2017), referring to the PCE price index within the FOMC's statement on long-run goals since January 2012 (Bernanke, 2012). Other central banks, such as the European Central Bank (Harmonized Index of Consumer Prices) or Bank of England (Retailer Price Index), also target headline inflation rates.

prices in inflation expectations; targeting the core inflation rate, as suggested by previous literature, creates a welfare loss, even though food and energy prices feature only small nominal rigidities.

The empirical analysis builds on a novel dataset of household inflation expectations, elicited as part the Federal Reserve Bank of Cleveland Daily Survey of Consumer Expectations (Dietrich et al., 2022a; Knotek et al., 2020). This survey differs from previous household inflation surveys, in that it asks participants both about their headline inflation expectations as well as inflation forecasts for disaggregated product categories. Such granular inflation expectations are elicited for 11 distinct categories of consumption, reflecting the full range of personal consumption expenditures. In addition, the survey collects data on spending patterns of respondents, recording personal expenditure on each consumption category. The data were collected between June 2020 and July 2021 and are representative of the US population.

Based on this dataset, the paper first provides empirical evidence that household inflation expectations are disproportionately driven by beliefs about future non-core, food, and energy prices – relative to personal spending patterns. I quantify deviations in the expectations formation process from a model of expectations formation that uses individual expenditure weights and category inflation forecasts to construct headline inflation expectations. Specifically, I estimate the sensitivity of households' headline inflation expectations to each category-specific forecast, relative to the respective expenditure share. Empirical results document a *behavioral* element in household expectations. Although households do not *absolutely* overweight the non-core components in inflation expectations relative to the respective expenditure shares, they do so *relatively*. A large heterogeneity exists in the estimated sensitivity between consumption categories. Whereas headline expectations reflect variation in energy price inflation forecasts to 86 percent of what reported household expenditure on those goods would imply, the sensitivity is much lower for other categories, such as health care services (28 percent). On average, headline inflation is more sensitive to non-core (the sensitivity is at 80 percent of what the expenditure share on non-core goods would imply) compared with core inflation expectations (38 percent). The empirical result documents that households form their headline inflation expectations relying disproportionately on beliefs about future non-core inflation, compared with forecasts for core inflation.

To explain this behavioral element in household inflation expectations, I put forward a model of sparsity-based rational inattention, building on the framework by Gabaix (2014).[2] The key idea of sparsity-based rational inattention is that agents can in principle access any information relevant to a decision but first have to decide which components they should optimally pay costly attention to. The expectations formation model is described in partial equilibrium first, in order to develop the mechanism as transparently as possible.

Specifically, the intuition for the mechanics is as follows: households intend to form a headline inflation expectation containing as much information as possible about future price changes for each component of their consumption basket. However, paying full attention to specific

[2]Rational inattention models can be classified into two groups: entropy-based rational inattention (e.g., Maćkowiak et al., 2021; Sims, 2010) and sparsity-based rational inattention models (Gabaix, 2019). Although this paper relies on sparsity-based rational inattention, both frameworks can be described as a way to discipline behavioral models (Maćkowiak et al., 2021).

price changes for each product category is demanding in terms of mental resources; attention is costly by assumption. The agent will therefore need a rule toward which components of her consumption basket she optimally directs attention and which components she might neglect when forming headline expectations. Conceptually, the sparsity-based rational inattention framework assumes the agent *first* decides about the optimal allocation of attention and subsequently builds her inflation expectation in each period, based on the attention rule. In the model, the household optimally pays the most attention to those categories where expected inflation rates are most volatile over time. This behavior maximizes expected utility: in the most volatile categories, inattention creates the largest expected deviation of the headline inflation forecast from the full attention expectation. Thus, it is optimal to direct attention to volatile categories whereas for other components of the consumption basket with relatively stable expected inflation rates, it is sufficient to pay less attention and instead refer to a time-invariant default expectation that is free of mental cost.

Because inflation forecasts for the non-core components of headline inflation feature a higher volatility than the expected core inflation rate, the model suggests it is optimal for households to pay more attention to expected food and energy prices when forming inflation expectations. The empirical data match this model result: the estimated sensitivity of headline expectations toward a consumption category positively correlates with measures of category-specific forecast volatility.

To conduct a welfare analysis of different inflation target measures, I embed the sparsity-based rational inattention model of expectations formation into a general equilibrium, New Keynesian framework. The model is a multi-sector extension of the textbook framework by Galí (2015). Conceptually, I integrate sparsity-based rational inattention into the New Keynesian model following the approach by Gabaix (2020). For attention dynamics, the same intuition applies as in the partial equilibrium model: households endogenously divert more attention to sectors where inflation expectations are more volatile. Monetary policy follows a conventional Taylor rule and decides the weights of the core and non-core inflation rates in the inflation target measure. The model is calibrated to match estimated household attention as well as realized inflation statistics for a core and non-core sector. Because attention is endogenous in the model and adjusts to policy changes, welfare results are insensitive to the Lucas critique (Lucas, 1976). I find a headline inflation target significantly improves households' welfare in the model relative to a core inflation target. By contrast, when simulating an otherwise identical model but *without* the rational inattention in inflation expectations, policy implications are notably different. In that case, stabilizing only the core inflation rate would yield higher welfare than headline inflation targeting, as in standard multi-sector New Keynesian models (see, e.g., Aoki, 2001; Eusepi et al., 2011).

This earlier result is best understood through the lens of the *"stickiness principle"* (Eusepi et al., 2011): the welfare function of the representative household decreases in the sector-specific volatilities of the output gap and inflation rate; inflation volatility in more rigid sectors causes a larger marginal welfare loss, because price dispersion and thus real distortions are more pronounced. Hence, monetary policy optimally stabilizes the sectors where nominal rigidities are largest, to maximize welfare. Non-core, food, and energy prices are relatively flexible. Inflation volatility in those non-core sectors therefore creates only little marginal disutility in the welfare function. For the monetary policy, it is thus optimal to exclude non-core prices from the inflation target and instead focus stabilization efforts on sectors with higher price rigidities.

Once we account for households' disproportionate focus on the non-core components of inflation via the rational inattention framework developed in this paper, policy implications differ, even though the model is otherwise identical. Headline inflation targeting is the optimal strategy, despite the low nominal rigidity of non-core prices. Intuitively, this result can be explained by the relatively higher importance of non-core inflation expectations in households' intertemporal optimization. As households pay more attention to the non-core components of inflation, those components become a more important source of the volatility of headline inflation expectations and thus, via intertemporal optimization, a more significant determinant of aggregate demand fluctuations. Monetary policies' nominal interest rate instrument aims to align aggregate demand with its efficient level, because this stabilizes inflation rates. Hence, because non-core inflation expectations drive aggregate demand volatility to a greater degree than in the standard multi-sector model, monetary policy should focus relatively more on food and energy inflation: a higher inflation target weight on non-core inflation reduces the volatility of (expected) non-core inflation and shields the perceived real interest rate from fluctuations in non-core inflation forecasts. In the calibrated model, this mechanism dominates the stickiness principle, making a headline inflation target welfare maximizing.

My paper broadly relates to two lines of research: First, a number of papers study the formation of consumer inflation expectations and have documented the importance of non-core prices for inflation forecasts. Arora et al. (2013) and Trehan (2011) show consumer inflation expectations react excessively to observed non-core price changes. On a more disaggregated level, realized grocery (D'Acunto et al., 2020) and gasoline price changes (see, e.g., Binder and Makridis, 2022; Binder, 2018; Coibion and Gorodnichenko, 2015; Trehan, 2011) have been shown to play a crucial role for households' inflation expectations. Relating to these findings, the survey data in this paper allow me to revisit the issue by applying a more systematic approach: I estimate not only the relation between headline inflation expectations and specific product categories, but rather the disaggregated inflation expectations pertaining to the full range of categories in households' consumption basket. In addition, this paper differs from earlier work in that it relates headline inflation forecasts to disaggregated inflation *expectations* instead of realized or perceived inflation rates. Indeed, empirical results obtained from the new survey data corroborate earlier findings that consumers' headline inflation expectations are most sensitive to expected non-core price changes. In an experimental setup, Bruine de Bruin et al. (2011) show households focus on a subset of prices—those with especially extreme past changes—when forming their headline inflation forecasts. Also building on the Federal Reserve Bank of Cleveland Daily Survey of Consumer Expectations data, Dietrich et al. (2022b) specifically investigate the optimal elicitation as well as the relation between different measures of households' headline inflation expectations from a psychological point of view.

Second, this paper complements previous work on the optimal sectoral composition of the inflation target in New Keynesian models. Goodfriend and King (1997) argue in favor of targeting the sectors with sticky prices in the economy. Aoki (2001) formalizes this idea in a business cycle model with a rigid and flexible sector, showing monetary policy optimally only stabilizes the rigid sector. Several papers have revisited this question for common monetary policy in currency unions (Benigno, 2004), quantitative price rigidity estimates (Eusepi et al., 2011; Mankiw and Reis, 2003), online retail with more flexible prices (Glocker and Piribauer, 2021), production networks (Huang and Liu, 2005; La'O and Tahbaz-Salehi, 2022; Rubbo, 2022), and a model of the U.S. economy with a distinct energy sector (Barnett et al., 2018; Bodenstein et al., 2008). For open economies, Galí and Monacelli (2005) show the producer price index is the optimal inflation target measure, because import prices tend to be flexible due to nominal exchange rate adjustments.[3] This paper adds a new perspective to this literature by explicitly integrating the behavioral formation of household inflation expectations via rational inattention in an otherwise standard multi-sector New Keynesian model. The explicit modeling of households' expectations formation matters for policy: Whereas earlier work suggests core inflation targeting as the optimal policy, this paper finds welfare gains in stabilizing headline inflation.

The structure of the remainder of this paper is as follows: section 2 presents the survey dataset. Section 3 empirically analyzes the relation between headline and consumption category-specific inflation expectations. Section 4 presents the sparsity-based rational inattention model of headline expectations formation in partial equilibrium. Section 5 embeds the expectations formation model into a general equilibrium, multi-sector New Keynesian framework and derives welfare implications of different inflation target measure policies. Section 6 discusses results and concludes.

## 2 Survey

The data used in this paper were collected between June 2020 and July 2021 as a separate survey module within the Federal Reserve Bank of Cleveland Daily Survey of Consumer Expectations. Questions cover participants' economic expectations and current financial situation, as well as demographic and socioeconomic characteristics. The survey was administered by Qualtrics Research Services, which drew respondents from several actively managed, double-opt-in market research panels, complemented using social media (Qualtrics, 2019). Survey respondents are representative of the U.S. population along several dimensions. This paper relies on a subset of questions from the survey. Dietrich et al. (2022a,b) and Knotek et al. (2020) provide an overview of other elements, as well as the survey in general. The survey is unique in that it asks participants about disaggregated inflation expectations for a range of narrowly defined consumption categories. In addition, the data contains expectations over future headline inflation and respondents' reported personal consumption spending for each consumption category. I discuss the question design and the specific consumption categories in detail below.

[3] A separate literature discusses core inflation targeting from an empirical forecasting perspective. Monetary policy decisions affect the economy with a time lag; because food and energy price shocks are transitory, core inflation might be a better predictor of future, medium-term headline inflation than headline inflation (Bryan and Cecchetti, 1994; Mishkin, 2007). However, both the benefit of this policy as well as the empirical relevance of the argument is not unquestioned: Bullard (2011a,b) calls for an alignment of the inflation target with those prices households consume and care about. Verbrugge (2021) finds diverging trends of core and non-core prices, resulting in a significant downward bias of a core inflation target. Others show that, indeed, core inflation does not predict headline inflation better; see Crone et al. (2013) and Pincheira-Brown et al. (2019). As an alternative to core inflation, other measures of less volatile underlying inflation have been proposed (see, e.g., Bryan and Meyer, 2010; Dolmas and Koenig, 2019; Luciani and Trezzi, 2019).

Table 1: Survey Respondent Characteristics

| | Survey | U.S. population | | Survey | U.S. population |
|---|---|---|---|---|---|
| **Age** | | | **Race and Ethnicity** | | |
| 18-34 | 33.1% | 29.8% | non-Hispanic white | 72.7% | 60.1% |
| 35-55 | 33.8% | 32.4% | non-Hispanic black | 9.3% | 12.5% |
| >55 | 33.1% | 37.8% | Hispanic | 10.1% | 18.5% |
| | | | Asian or other | 7.9% | 8.9% |
| **Gender** | | | | | |
| Female | 49.9% | 50.8% | **Household Income** | | |
| Male | 49.7% | 49.2% | less than $50k | 47.8% | 37.8% |
| Other | 0.4% | -% | $50k - $100k | 29.5% | 28.6% |
| | | | more than $100k | 22.7% | 33.6% |
| **Region** | | | | | |
| Midwest | 20.6% | 20.7% | **Education** | | |
| Northeast | 21.9% | 17.3% | some college or less | 50.6% | 58.3% |
| South | 39.5% | 38.3% | bachelor's degree or more | 49.4% | 41.7% |
| West | 18.0% | 23.7% | | | |
| | | | **N=17,888** | | |

*Notes:* The "Survey" column represents the distribution in the survey; the "U.S. population" column gives the value for the U.S. population, obtained from the US Census Bureau (Household income: CPS ASEC, 2021; gender, education: ACS, 2019, age, race, region: National Population Estimate, 2019).

## 2.1 Sampling

Data were collected at a daily frequency, between June 2020 and July 2021; the survey follows a two-step approach to ensure the sample is representative of the U.S. population: First, via Qualtrics Research Services, the survey targets a sample that is reasonably representative of the US population according to age, gender, educational attainment, and regional distribution. Nevertheless, due to practical limitations, such as varying response rates among different socioeconomic groups or a limited sample size, securing a perfectly representative sample is difficult. Thus, in a second step, each respondent is assigned a survey weight, based on his socioeconomic and demographic characteristics, which allows me to compute exactly representative statistics, because the weighted sample perfectly matches the distribution of the U.S. population.

For the initial sampling by Qualtrics Research Services, the following targets were defined: respondents had to be male or female with around 50 percent probability; approximately one third were targeted to be between 18 and 34 years of age, another third between 35 and 55, and a final third older than age 55; 50 percent of respondents were required to hold at least a college degree. The geographic distribution of respondents corresponds to the proportional population size of U.S. census regions, drawing roughly 20 percent of the sample from the Midwest, 20 percent from the Northeast, 40 percent from the South, and 20 percent from the West. Table 1 compares the socioeconomic and demographic distribution of the sample with census data for the U.S. population; for most characteristics, initial sampling by Qualtrics Research Services already provides a distribution that is relatively similar to the U.S. population.

Following completion of the survey, I compute a survey weight for each respondent to improve the fit further, similar to the approach in Dietrich et al. (2022b); I apply iterative proportional fitting to create respondent weights, based on self-reported demographic and socioeconomic characteristics ("raking," see, e.g., Bishop et al., 1975; Idel, 2016). This approach ensures all statistics reported in the paper are *exactly* representative of the U.S. population according to age, gender, ethnicity, income, census region, and educational attainment–that is, the variables listed in Table 1. Targets are calibrated so that the weighted data match respective statistics from a number of U.S. Census Bureau sources; see the right-hand columns in Table 1.

Finally, to avoid participants in the sample that either do not understand the questions linguistically or do not pay attention, the survey required all respondents to be US residents and to speak English as their primary language, and included filters that eliminate respondents who enter gibberish for at least one response or who complete the survey in less (more) than five (30) minutes. In addition, CAPTCHA tests were used to reduce the likelihood that bots would interfere.[4]

## 2.2 Question Design

Several large surveys elicit inflation expectations of households, such as the *Survey of Consumer Expectations* (SCE) at the Federal Reserve Bank of New York or the University of Michigans' *Survey of Consumers* (SoC). Those surveys focus on households' expectations about future headline inflation. By contrast, this survey is unique because it takes a different approach, asking respondents not only to forecast headline, aggregate inflation, but also to predict future price changes within several distinct categories of consumption.[5] The survey is designed such that those categories cover the full range of personal consumption expenditures (PCE) of US households.

At the beginning of the survey, each participant is asked about the unconditional, 12-month-ahead expectation for headline inflation. The question is similar to the inflation point-forecast question within the SCE. Specifically, the survey asks the following question:

*Over the next 12 months, do you think that there will be inflation or deflation?*
◯ *Inflation*
◯ *Deflation*

Conditional on the answer given, the next question elicits the numerical expectation of the respondent. Depending on her answer to the last question, inflation or deflation appears in the brackets:

*What do you expect the rate of [inflation/deflation] to be over the next 12 months? Please give your best guess.*
*I expect the rate of [inflation/deflation] to be ___ percent over the next 12 months.*

This two-step procedure facilitates answering the question: if a decline in the price level is expected, no negative sign has to be entered (Armantier et al., 2017). Next, the survey asks

[4]Qualtrics Research Services provides the filtered data. The sample size in Table 1 refers to the number of respondents after filtering. Survey respondents are provided with fair monetary compensation for their time. To avoid results being driven by outliers in the survey data, I additionally drop the 1% largest and smallest responses for each series to ensure results are also not driven by formally correct but insensitive answers, such as, for example, an inflation rate of -1000%.

[5]The SCE also contains several category-specific inflation questions, but these do not cover the whole consumption basket of households.

Table 2: Personal Consumption Expenditures - Disaggregation

| Consumption Category | Core | Non-core | Example |
|---|---|---|---|
| *Goods* | | | |
| *Durable Goods* | | | |
| 1) Motor vehicles and parts | ■ | | Cars and SUVs |
| 2) Recreational goods and vehicles | ■ | | Sports equipment and laptops |
| 3) Other durable goods | ■ | | Furniture, appliances, jewelry, luggage |
| *Nondurable Goods* | | | |
| 4) Food and beverages for off-premises consumption | | ■ | Food from grocery stores |
| 5) Gasoline and other energy goods | | ■ | |
| 6) Other nondurable goods | ■ | | Clothing, medicine and personal care products |
| *Services* | | | |
| 7) Housing and utilities | ■ | | Rent and utility bills |
| 8) Health care | ■ | | |
| 9) Transportation services | ■ | | Public transit tickets and airfare |
| 10) Food services and accommodations | ■ | | Restaurants and hotels |
| 11) Other services | ■ | | Internet/phone service, education, financial services, hairdressers |

*Notes:* The table displays the disaggregation of personal consumption expenditures into consumption categories. The second column indicates if a specific category is part of core inflation. The third column shows examples of typical products within the category.

respondents about inflation expectations for 11 distinct categories, covering their whole consumption basket. To define categories, the survey design builds on the PCE classification by the Bureau of Economic Analysis, which classifies all consumption expenditures of U.S. households, both goods and services, into various categories, at different levels of disaggregation.[6] To obtain a granular view on expected inflation dynamics but also limit the mental burden for participants, the survey relies on the third level of disaggregation within the PCE, combining some smaller consumption categories.[7] Table 2 displays the 11 categories that this survey elicits expectations and spending data about. All 11 categories combined constitute the expenditure basis for measured headline inflation. Nine categories are part of core inflation and two—food and beverages as well as gasoline and energy—define non-core inflation. For each category, respondents are asked the following question, within a list of all categories:

*Twelve months from now, what do you think will have happened to the price of the following items?*
*I expect the price of* Category Name *(such as* Example) *to [Increase/Decrease] by ___ percent.*

[6] This expenditure classification constitutes the basis for the monthly calculation of the PCE price index (PCE-PI). This index is particularly suited to define consumption categories and elicit respective inflation rates from consumers, because the U.S. Federal Reserve relies on inflation rates based on the PCE-PI to measure price stability (FOMC, 2022).

[7] The first level splits consumption between goods and services. The second level of disaggregation additionally divides goods into durable and non-durable goods. Table B.1 in the Appendix describes the mapping of categories from the PCE to the Cleveland Fed survey.

Again, respondents can choose if they expect inflation or deflation and then assign a numerical value. The question format is largely similar to the previous question on headline inflation. The design is meant to elicit expectations for headline and category-specific forecasts that are comparable and to avoid potentially differential framing effects (see, e.g., Bertrand and Mullainathan, 2001). To facilitate participants answering the question as well as to ensure they refer to the correct set of products, the survey gives some examples of products contained in the respective category (see last column in Table 2). These examples might help some respondents answer the question correctly and thus improve data quality, especially in the more broadly defined consumption categories, such as "Other durable goods." All inflation expectations in this survey are elicited in the point-forecast format. Clements (2014) finds point-forecasts offer superior data quality over that obtained from probability distribution questions when one is concerned with the mean of expectations.

Apart from inflation expectations for each category, the survey collects personal consumption expenditure data from each respondent. Specifically, the following question asks survey participants to indicate expenditure during the last month for each category, in U.S. dollars:

*In terms of consumption spending, how much money did you spend on each of the following broad consumption categories during the last month? Please indicate an approximate dollar amount in each field.*
Category Name (such as Example) ___

The data on self-reported, category-specific spending allows me to construct a set of 11 expenditure shares $\omega_k^i \in [0, 1]$ for each respondent $i$, according to equation (2.1). In the notation that follows, superscript $i$ denotes a specific survey respondent, whereas the subscript $k \in \{1, ..., K\}$ identifies a consumption category. For each survey participant, the individual expenditure shares $\omega_k^i$ measure expenditure on products or services from category $k$, as a fraction of the respondents' total expenses:

$$\omega_k^i = S_k^i / \sum_{k=1}^{K} S_k^i, \tag{2.1}$$

where $S_k^i$ denotes the survey response, expenditure (in current U.S. dollars) of respondent $i$ on goods or services from consumption category $k$. Accordingly, the sum over spending for all categories, $\sum_{k=1}^{K} S_k^i$, represents the respondents' total nominal expenditures. By construction, it must hold that $\sum_{k=1}^{K} \omega_k^i = 1$; that is, expenditure shares of a given survey participant, for all categories, add up to unity. The survey follows a deliberate consecutive structure: participants are first asked about their headline inflation forecast before they are shown the questions on category-specific inflation expectations and expenditure. The particular ordering of questions allows me to elicit headline expectations without priming participants to think about either the relative importance of categories (expenditure) or category inflation forecasts, that is, the components of headline inflation.[8] A comprehensive list of all survey questions used, including demographic and socio-economic questions, can be found in Appendix A.

[8]Bruine de Bruin et al. (2011) find priming survey respondents in a similar way influences headline inflation expectations.

# 3 The Link between Headline and Category Inflation Expectations

To what extent do different components of the consumption basket influence households' headline inflation expectations? The survey data allows me to estimate this relationship empirically: I find consumer inflation expectations disproportionately reflect beliefs over future non-core inflation relative to core inflation expectations. In this section, I first describe a framework of theoretical consistency between disaggregated category and headline inflation expectations, based on personal spending patterns, as a benchmark for further analysis. Then, I empirically estimate the sensitivity of reported headline inflation expectations to inflation forecasts for the components of the consumption basket.

## 3.1 Headline and Category Inflation Expectations - Theoretical Connection

How do consumers' form inflation expectations, and which products do the refer to? Previous research suggests the reported inflation expectations in consumer surveys refer to respondents' inflation forecast for their *personal* consumption basket, rather than an official measure, such as the PCE-PI inflation rate (e.g., Jonung, 1981; Weber et al., 2022). Due to heterogeneous spending patterns among households, both concepts differ.[9] In addition, households build their inflation expectations mostly on granular personal experiences of price changes, such as exposure to prices while shopping, rather than (public) information about aggregate macroeconomic trends (Angelico and Di Giacomo, 2020; Cavallo et al., 2017; D'Acunto et al., 2022; D'Acunto et al., 2021). In this paper, I follow the notion that headline expectations reflect personal consumption baskets and are formed by consumers based on granular information about category- or product-specific prices. The headline inflation forecast on an individual survey participant should therefore reflect her internal expectations over granular price changes in the range of product categories she consumes, as well as her personal spending patterns.

As a benchmark for further analysis, I put forward a model that describes the *consistent* formation of headline expectations, based on category inflation expectations. Assume an agent $i$ has category-specific inflation expectations, denoted by $\mathbb{E}_t^i \pi_{k,t+1}$, as well as personal spending patterns that can be described by her set of expenditure shares $\omega_k^i$. It follows that her headline inflation expectation, $\mathbb{E}_t^i \pi_{t+1}$, is equal to the sum of her granular, category-specific inflation expectations, $\mathbb{E}_t^i \pi_{k,t+1}$, weighted with the respective personal expenditure shares, $\omega_k^i$.[10]

$$\mathbb{E}_t^i \pi_{t+1} = \sum_{k=1}^{K} \omega_k^i \, \mathbb{E}_t^i \pi_{k,t+1}. \tag{3.1}$$

[9] Most of the literature assumes survey respondents refer to their personal inflation rate, especially participants with lower socioeconomic status. D'Acunto et al. (2021), Jonung (1981), and Weber et al. (2022) show that demographic heterogeneity in inflation forecasts can be explained by spending patterns, in particular, household grocery-shopping responsibilities. Also, forecast errors are smaller when expectations are evaluated against realizations for the respective socioeconomic groups (Menz and Poppitz, 2013; Pfajfar and Santoro, 2009).

[10] Here, I assume both headline and category specific inflation expectations refer to the personal consumption basket. Her total consumption basket, in terms of categories, is described by her set of expenditure weights $\omega_k^i$. Similarly, her category specific baskets refer to the individual products she consumes within a category, say, the specific food and beverage items she regularly consumes for the "food and beverages" category.

Although equation (3.1) defines aggregation consistency from category to headline inflation expectations, a real-world agent is by no means bound to exactly follow equation (3.1) in his expectations formation process. Indeed, evidence suggests the link between headline inflation forecasts and category specific forecasts does not necessarily reflect personal expenditure shares (see, e.g., Dietrich et al., 2022b; Georganas et al., 2014). Note equation (3.1) defines internal consistency between category and headline inflation rates but is agnostic on the *rationality* of both aggregate and granular expectations, as evaluated against realizations of the data (see, e.g., Bordalo et al., 2020; Coibion and Gorodnichenko, 2012).

### 3.2 Headline and Category Inflation Expectations - Quantitative Analysis

The survey data allow me to explore the link described in equation (3.1), because it includes not only participants' headline inflation forecast, but also disaggregated inflation expectations for the full range of personal consumption expenditures as well as individual spending patterns. Empirically, I test whether households rely on their personal expenditure shares to weight category expectations within their headline expectations, by estimating the following relation, based on equation (3.1):

$$\mathbb{E}_t^i \, \pi_{t+1} = \gamma + \sum_{k=1}^{11} \beta_k \left[ \omega_k^i \, \mathbb{E}_t^i \, \pi_{k,t+1} \right] + D_i + \epsilon_i. \tag{3.2}$$

In equation (3.2), $\gamma$ is a constant term and $D_i$ is a vector collecting potential control variables specific to survey participant $i$. Expenditure shares of respondent $i$, $\omega_k^i$, are constructed as in equation (2.1). Coefficients $\beta_k$ measure the relative sensitivity of headline expectations to expectations in category $k$, compared with the respective expenditure share. It follows that if $\hat{\beta}_k = 1 \; \forall k$ and $\hat{\gamma} = 0$, survey participants would behave similarly to the consistent agent described in equation (3.1), aggregating category expectations weighted with their individual expenditure shares to their headline inflation expectations. By contrast, for any value of $\hat{\beta}_k < 1$ ($\hat{\beta}_k > 1$), headline expectations are less (more) sensitive to expectations in category $k$ than what the reported expenditure shares would imply.

I estimate equation (3.2) by a weighted OLS regression with fixed effects. Survey participants are weighted both with individual survey (see section 2 on the construction of survey weights) and Huber-robust weights. Huber-robust weights reduce the sensitivity of estimated coefficients to outliers in the data, an important property in survey data (Huber, 1964). I estimate the model in two layers of disaggregation: First, I use inflation expectations for two combined sectors. I aggregate all core inflation categories into one sector (using individual expenditure shares) and all non-core categories (food and energy) into a second sector. Second, I rely on the data for all PCE categories elicited in the survey. Although the second layer of disaggregation is more informative, I utilize the less granular disaggregation to calibrate the New Keynesian model in section 5 that allows me to study implications for monetary policy. Table 3 displays estimation results: the first three columns refer to the core/non-core disaggregation, and the latter three columns refer to the full disaggregation that the data allows, into 11 categories. Models (1) and (4) are estimated without control variables. Models (2), (3), (5), and (6) replace the constant term $\gamma$ by a vector of individual expenditure shares. Models (3) and (6) include demographic fixed effects.

Table 3: Headline Inflation Expectations: Relative Sensitivity to Categories

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Core inflation | 0.404*** | 0.370*** | 0.375*** | | | |
| | (25.35) | (21.98) | (22.50) | | | |
| Non-core inflation | 0.676*** | 0.785*** | 0.803*** | | | |
| | (21.70) | (22.09) | (22.34) | | | |
| Motor vehicles | | | | 0.570*** | 0.359*** | 0.456*** |
| | | | | (11.81) | (7.87) | (9.60) |
| Recreational goods | | | | 0.759*** | 0.511*** | 0.631*** |
| | | | | (8.55) | (5.63) | (7.00) |
| Other durable goods | | | | 0.550*** | 0.359*** | 0.349*** |
| | | | | (6.61) | (4.03) | (4.01) |
| Food and beverages | | | | 0.554*** | 0.793*** | 0.779*** |
| | | | | (15.05) | (18.99) | (18.77) |
| Gasoline and other energy | | | | 0.876*** | 0.858*** | 0.857*** |
| | | | | (12.64) | (11.71) | (11.67) |
| Other nondurable goods | | | | 0.943*** | 0.816*** | 0.866*** |
| | | | | (9.33) | (7.37) | (8.11) |
| Housing and utilities | | | | 0.312*** | 0.319*** | 0.316*** |
| | | | | (14.01) | (12.45) | (12.47) |
| Health care | | | | 0.276*** | 0.296*** | 0.281*** |
| | | | | (6.22) | (6.51) | (6.66) |
| Transportation services | | | | 0.976*** | 0.654*** | 0.699*** |
| | | | | (6.18) | (4.37) | (4.67) |
| Food services | | | | 0.166** | 0.070 | 0.071 |
| | | | | (2.64) | (1.03) | (1.02) |
| Other services | | | | 0.421*** | 0.578*** | 0.574*** |
| | | | | (5.37) | (6.64) | (6.44) |
| Constant | 2.811*** | | | 2.912*** | | |
| | (32.13) | | | (33.53) | | |
| Demog. FE | × | × | ✓ | × | × | ✓ |
| Expend. weight control | × | ✓ | ✓ | × | ✓ | ✓ |
| N | 13828 | 13840 | 13812 | 14554 | 14567 | 14525 |
| $R^2$ | 0.199 | 0.481 | 0.507 | 0.218 | 0.487 | 0.510 |

*Notes:* Table provides cross-sectional OLS estimates based on survey data. Observations are weighted with survey and Huber-robust weights. Standard errors computed as robust standard errors. $t$ statistics in parentheses; $*$ ($p < 0.05$), $**$ ($p < 0.01$), $***$ ($p < 0.001$);

Empirical results suggest households do not behave according to the benchmark model in equation (3.1), relying on personal expenditure to weight category inflation expectations. Although they do not *absolutely* overweight the non-core components in inflation expectations relative to their expenditure shares, they do so *relatively*. First, estimated coefficients $\hat{\beta}_k$ are smaller than unity across all model specifications and both levels of disaggregation but significantly larger than zero for most categories.[11] Thus, consumers are less sensitive in their headline inflation expectations to each category-specific expectation than what expenditure shares imply. For example, consider a consumer, representative of the survey population, who spends 10 percent of his income on energy. The consumer now updates his energy price expectation by 1 percentage point after observing a hike in energy prices, but keeps all other expectations constant. Aggregation consistency would require him to also update his headline inflation forecast by 0.1 percentage points (a 1 percentage point increase in energy inflation times an expenditure share of 0.1). Still, empirical results indicate he only updates his headline expectation by 0.086 percentage points, less than what his relative expenditure on energy would suggest. Nevertheless, coefficients significantly larger than zero corroborate the idea that headline inflation expectations are formed by consumers relying on granular information about several product or consumption category-specific price changes (see, e.g., D'Acunto et al., 2021; Weber et al., 2022).

Second, I find significant heterogeneity in estimated coefficients across categories: Whereas the relative sensitivity of headline expectations to non-core inflation is 0.803, it is only 0.375 for core inflation expectations (see column (3) of Table 3). The difference is highly significant (p-value$<$ 0.000). This finding indicates that although households' headline inflation expectations reflect almost consistently – relative to self-reported expenditure shares – cross-sectional variation in non-core inflation forecasts, they do not do so for core inflation expectations. The pattern is similar within the more granular level of disaggregation: the relative sensitivity is highest for non-durable and thus mostly non-core consumption categories: whereas the estimated coefficient is 0.857 for gasoline and other energy, 0.779 for food and beverages, and 0.866 for other nondurable goods inflation expectations, it is only 0.281 for health care and 0.071 for food services inflation forecasts. I can thus deduce that households' headline inflation forecast *disproportionately* reflects expectations over non-core price changes, relative to core inflation expectations.

Several potential concerns exist regarding the estimation of regression models relying on self reported survey measures as independent variables. The self-reported variables might either be biased relative to the true value or be subject to a white-nose reporting error (Mullainathan, 2002). The literature on consumer expenditure surveys suggests self-reported expenditure measures are potentially biased toward salient expenditures (see, e.g., Deaton, 2019; Hurd and Rohwedder, 2008; Winter, 2004).[12] Nevertheless, when testing the internal consistency between headline and category expectations, self-reported, potentially biased values of personal expenditure may be the appropriate measure to use. If households belief to have a set of expenditure weights, they use those—potentially biased—weights for their internal aggregation of category inflation expectations. If, for example, a consumer assumes she spends 10 percent of her income on gasoline and other energy, rather than 5 percent – her true expenditure share – she will assign

[11] Specifically, in model (6) in Table 3, estimated coefficients are smaller than unity for all categories and significantly so for all but "Gasoline and Energy" and "Other non-durable goods" at the 5% significance level. For the two-sector disaggregation (column (3)), both estimated coefficients are significantly smaller than 0, at the 0.1% significance level.

[12] For the survey used in this paper, Table 9 in the appendix confirms some discrepancies between official expenditure shares and the cross-sectional average of self-reported expenditure shares, comparing official PCE numbers from the BEA with mean self-reported numbers from the survey.

a weight of 0.1 to his energy price change expectations. This weight will subsequently be the one against which to measure the consumer's internal consistency in aggregation.[13] Concerning inflation expectations, the concept of bias in expectations is more complicated, because no *true expectation* exists against which it could be measured. Dietrich et al. (2022b) discuss this issue in greater detail.

White-noise reporting errors in survey responses constitute another potential concern, because they might cause regression attenuation, biasing estimated coefficients toward zero. For example, survey respondents are prone to enter rounded values rather than exact answers in the survey (see, e.g., Binder, 2017; Manski and Molinari, 2010). Regarding the personal expenditure weights, I can address the attenuation bias using an instrumental variable (IV) approach. To do so, I instrument individual expenditure weights $\omega_k^i$ with personal importance weights for the same category. Those weights are constructed similar to expenditure weights (see equation (2.1)) but build on a separate question asking survey participants how important a specific consumption category $k$ is in their daily life (for the wording of the question, see Appendix A). After running the first-stage regression, predicted values for spending shares are re-weighted such that they sum up to unity for each survey respondent. Table 7 in the Appendix compares IV regression results with OLS estimates. The last column shows F-statistics of the first-stage regression. Coefficients tend to be somewhat larger for the IV approach. Because no instruments are available for the 11 category inflation expectations in the survey, I can only rely on participants' reported values here. Still, the distorting impact of reporting noise in inflation expectations might be small: in a recent study, Crump et al. (2022) estimate the consumer Euler equation relying on inflation expectations from the SCE. Both OLS and IV regression approaches yield coefficients that differ only minimally in economic terms.

The wording of the question about reported spending raises another potential concern, because the survey asks about expenditure in the last month. Although those weights reflect the most recent spending pattern of households, they are possibly disturbed by large one-time purchases, such as a new car. Therefore, Table 8 repeats the estimations from Table 3 but relies on the relative importance weights instead. Arguably, the alternative question on importance weights is less comparable to expenditure weights but understands the weight of categories in current consumption in a broader sense, being more invariant to large one-time purchases. Estimation results are very similar.[14]

From an expectations formation perspective, the documented heterogeneity suggests households' headline inflation expectations reflects beliefs over non-core price changes to a much higher degree than core inflation expectations, relative to what the expenditure on core and non-core goods and services would suggest. This observation confirms earlier findings from the literature, but extends earlier results to a systematic analysis on the full range of categories in households consumption basket. For instance, Trehan (2011) shows households' update their inflation expectations following realized core and non-core price changes to a similar degree, even though non-core goods make up only a fifth of their consumption expenditures. D'Acunto et al. (2020)

[13] Biased expenditure shares are a potential additional source of bias in household inflation expectations, relative to actual realizations (see, e.g., Georganas et al., 2014). In this paper I only focus on aggregation inconsistency, relying on internally assumed expenditure weights.

[14] For the fully specified model in column (6), the correlation between expenditure and importance weight based estimates is 0.74.

finds price changes of grocery items purchased play a large role in consumers' headline inflation expectations. Binder (2018) provides evidence for the impact of gasoline prices.

The heterogeneity within the estimated relative sensitivity can be interpreted from a behavioral point of view: when mentally forming their headline expectations, consumers rely on their granular price change expectations but are not bound by a particular weighting scheme between consumption components. Kahneman (2003) notes intuitive judgements—such as inflation expectations—often rely on the most *accessible* characteristics. In the context of this analysis, a category inflation forecast is more accessable if it comes to mind more easily. The concept of *salience* (see, for a general discussion, Bordalo et al., 2013, 2022) further formalizes the accessibility of attributes. Price changes in one category might be less salient than in others, causing households to underrate their internal forecast for the specific category when they form headline expectations. Salience of a consumption category, can, for example, be related to the frequency of purchase (D'Acunto et al., 2020; Georganas et al., 2014) or the volatility of prices. In section 4, I develop a formal model of sparsity-based rational inattention in expectations formation where households consider it optimal to pay more attention to consumption categories where inflation expectations are more volatile. The model is able to account both for the disproportionate focus on non-core expectations, that is, the heterogeneity in estimated coefficients, as well as the relative sensitivity below one for all categories.

# 4 A Model of Headline Inflation Expectations Formation

How do consumers form *headline* expectations, based on their forecasts for granular, *category-specific* inflation rates? This section puts forward a formal rational inattention model to explain estimated deviations from a simple aggregation of category expectations to the headline inflation forecasts, relying on personal expenditure shares, as documented in section 3. Conceptually, the model is an application of the sparsity-based rational inattention framework by Gabaix (2014). The key idea in sparsity-based rational inattention models is the following: an agent wants to make a decision (e.g., form an expectation) that depends on information from a number of components, that is, input factors for the decision. Because paying attention to each component is costly, the agent allocates attention optimally; he first decides how much attention to devote to a component and subsequently, given his attention allocation, makes his decision.

## 4.1 Sparsity-based Rational Inattention in Headline Expectations Formation

To build some intuition for sparsity-based rational inattention in the formation of inflation expectations, consider a consumer in period $t$, forming his headline inflation forecast for the period $t+1$. The consumer wants to form his forecast based on his granular inflation expectations for product categories in his consumption bundle; he is aware of his relative expenditure shares. However, when tasked with forming his headline inflation expectation, taking into account inflation forecasts for every product category requires vast mental resources. The benefit of having an accurate inflation expectation reflecting as much information as possible about granular price changes might not be worth the cost; in the model attention to components is costly by assumption. To solve the problem, the consumer requires a rule regarding which components of headline inflation he should optimally allocate attention to. Intuitively, it is optimal to pay attention to the most important components. In the model, product categories are considered important for inflation expectations either because the consumer spends a large fraction of his income on the category or because inflation forecasts are relatively volatile over time. To the degree that the agent is inattentive to a consumption category, he will refer to a time-invariant default expectation that comes free of mental cost in the headline expectations formation process. The default expectation might, for example, be the long-run trend of price changes or the central bank inflation target. After deciding which components he should optimally allocate attention to, the consumer can apply this rule to form his headline inflation forecast. One might think of this rule as the consumer having an intuitive idea about which prices he should especially focus on, such as food and energy, whenever he considers inflation expectations.

In the model, the consumer partially trades off the expected accuracy of his headline inflation forecast—the resulting behavioral headline expectation will contain less information than he has about future price changes at a granular level—but can limit his mental burden. For most, this trade-off works well in everyday life: having a vague idea of future headline inflation might be sufficient to work with, for example, for intertemporal substitution. The additional benefit of a more refined understanding of future price changes is outweighed by the disutility connected to the effort required to form the more accurate forecast.

Whereas section 5 formally solves the model in a dynamic general equilibrium framework, this section considers the framework in partial equilibrium, to develop the model mechanism as transparently as possible. I make several simplifying assumptions, without loss of generality. First, I assume households expect all future inflation rates to be uncorrelated across categories. Second, the household faces a simplified utility function requiring her to align headline inflation expectations as closely as possible to a full attention benchmark.[15]

Assume households form their headline inflation forecast according to equation (4.1). For notational simplicity, I drop individual-specific superscripts and assume a representative agent:

$$\mathbb{E}_t^B \pi_{t+1} = \sum_{k=1}^{K} \omega_k \left[(1 - m_k)\bar{\pi}_k + m_k \, \mathbb{E}_t \, \pi_{k,t+1}\right]. \tag{4.1}$$

Notationwise, $\mathbb{E}_t^B \pi_{t+1}$ denotes the *behavioral* headline expectation, the inflation expectation of a rationally inattentive agent, as opposed to the *full attention* headline expectation, described in equation (3.1). Similar to the full attention headline expectation, the behavioral headline expectation is an expenditure weighted average of categories. However, when aggregating categories to his headline inflation expectation, the consumer relies on a blurred inflation forecast for each category as an input: depending on how much attention $m_k \in [0, 1]$ the consumer pays towards expected price changes within a category, this blurred category forecast is a weighted average $(1 - m_k)\bar{\pi}_k + m_k \, \mathbb{E}_t \, \pi_{k,t+1}$ of his full attention category inflation forecast $\mathbb{E}_t \, \pi_{k,t+1}$ for period $t + 1$ and the time-invariant default expectation $\bar{\pi}_k$. Note that if the consumer pays maximum attention to all categories, $m_k = 1 \; \forall \; k$, the behavioral headline expectation is equal to the full

[15]In the general equilibrium model in section 5.1.5, the representative household forms inflation expectations to optimize consumption and labor supply intertemporally. Here, I assume a simplified utility function that requires the agent to align the inflation expectation to the full attention benchmark.

attention headline expectation. The full attention expectation represents the most informative forecast the consumer can come up with, based on his granular price change expectations.[16]

It follows that the behavioral headline expectation is a function of $m$, the vector of category-specific attention levels $m_k$. To optimally decide how much attention to allocate to each category, the household minimizes the expected utility losses from inattention and the mental utility cost of attention:

$$\max_m - \mathbb{E}_t \left( \mathbb{E}_t^B \pi_{t+1} - \mathbb{E}_t \pi_{t+1} \right)^2 - h(m), \quad \text{s.t. (3.1) and (4.1).} \tag{4.2}$$

For analytical simplicity, in the optimization problem in equation (4.2), I assume the expected utility loss from deviating from the rational headline forecast to be quadratic. Following Gabaix (2014), the cost of attention $h(m)$ is measured in terms of utility and is a convex function of the attention vector $m$ with $h_{m_k}(m) > 0; h_{m_k m_k}(m) > 0;\ \forall\, k$. Intuitively, the agent wants to choose his attention $m_k$ to each category so that he minimizes the expected deviation of his behavioral headline expectation $\mathbb{E}_t^B \pi_{t+1}$ from the full attention headline forecast $\mathbb{E}_t \pi_{t+1}$ but at the same time also keeps attention at a minimum, because it is costly.

Solving the optimal attention problem in (4.2) is difficult for the consumer, as it potentially poses an "infinite regress" problem (see, e.g., Gabaix, 2014; Simon, 1955). I follow the approach by Gabaix (2014) and introduce a simplification of the original problem, which allows me to derive a closed-form solution that mimics the' mental optimization behavior of real-world agents arguably well. Specifically, the simplification rests on two assumptions. First, I assume the behavioral agent solves the problem in (4.2) by replacing the expected disutility from inattention by its second order Taylor approximation.[17] Second, I assume the agent perceives his category inflation expectations to be normally distributed $\mathbb{E}_t \pi_{k,t+1} \sim N(\bar{\pi}_k, \sigma_k^2)\ \forall\, k$ and uncorrelated $\mathbb{E}[\mathbb{E}_t \pi_{k,t+1} \mathbb{E}_t \pi_{l,t+1}] = 0\ \forall\, k \neq l\ \forall\, t$. The parameter $\sigma_k^2$ denotes the variance of the agents' inflation expectations for category $k$ over time. The agent is aware of the volatility of her expectations for each category.[18]

She now solves the following, simplified problem for the vector $m$:

$$\max_m -\frac{1}{2} \mathbb{E}_t \left[ \sum_{k=1}^{K} \sigma_k^2 (m_k - 1)^2 \omega_k^2 \right] - h(m). \tag{4.3}$$

Equation (4.4) displays first-order conditions. The optimal level of attention $m_k^*$ is a function of the volatility of inflation expectations $\sigma_k$ in category $k$, the expenditure share $\omega_k$, and the marginal cost of attention $h_{m_k}(m^*)$:

$$-(m_k^* - 1)\sigma_k^2 \omega_k^2 - h_{m_k}(m^*) = 0. \tag{4.4}$$

Given his optimal level of attention for each consumption category $m_k^*$, the consumer forms his

[16]Understanding the agent *could* potentially always obtain this forecast, based on his granular information about expected price changes, given that he pays full attention to each component, is important. Nevertheless, he optimally chooses not to do so, because fully considering each category forecast while forming his headline inflation expectation is too costly in terms of mental attention.

[17]Appendix C.1 formally derives the second-order Taylor approximation of $- \mathbb{E}_t \left( \mathbb{E}_t^B \pi_{t+1} - \mathbb{E}_t \pi_{t+1} \right)^2$ evaluated at $m_k = 0$ and $\mathbb{E}_t \pi_{k,t+1} = \bar{\pi}_k$.

[18]One might think of this assumption as the agent having an intuitive idea that their food price expectations change more often than their expectations about future healthcare prices.

headline forecast according to equation (4.1). The vector $m^*$ is constant over time, because by assumption, the expenditure weights $\omega_k$ and the volatility of expectations $\sigma_k^2$ do not change. It can be shown via the implicit function theorem that $m_k^*$ increases with $\sigma_k^2$ and $\omega_k^2$ as long as the attention cost function is convex, $h_{m_k m_k} > 0$:[19]

$$\frac{\partial m_k^*}{\partial \sigma_k^2} > 0; \qquad \frac{\partial m_k^*}{\partial \omega_k^2} > 0. \tag{4.5}$$

The rationally inattentive agent allocates more attention to those categories on which he either spends a large fraction of his income or for which inflation forecasts are relatively volatile over time. This finding is intuitive: as the agent spends a large fraction of his income on, say, food, inattention to food inflation forecasts greatly reduces the expected accuracy of the headline inflation forecasts, because food prices make up a large part of headline inflation. At the same time, when he knows his forecasts for, say, healthcare inflation are relatively stable around the default expectation, he does not have to devote many mental resources to think about his forecast. By contrast, knowing his energy price expectations are very volatile, paying considerable attention to them is optimal – the expected deviation from the default expectation is more prominent (as indicated by a high variance $\sigma_k^2$). Inattention therefore reduces the expected accuracy of the behavioral headline expectation more severely.

## 4.2 Model Predictions and Empirical Evidence

The specification of the regression model in equation (3.2) is similar to equation (4.1), describing the behavioral inflation expectations. Therefore, I interpret the estimated coefficients $\hat{\beta}_k$ from section 3 as the empirical equivalence of the attention levels $m_k$ from the model.[20] Empirically, I find survey participants' headline inflation expectations are less sensitive to category-specific forecasts than what expenditure shares imply; real-world households deviate from a benchmark model where category expectations are aggregated with personal expenditure weights. The model of rational inattention can explain this feature: households optimally choose to be partially inattentive to consumption categories when they form their headline inflation expectations, because attention is costly.

Table 3 documents a significant heterogeneity in the sensitivity across categories; the model is able to explain this asymmetry with category-specific optimal attention levels, due to varying expenditure shares and the volatilities of inflation expectations. This subsection presents evidence of the correlation between the estimated sensitivity and the volatility of inflation expectations, for specific categories. Because the Cleveland Fed Daily Survey of Consumer Expectations does not feature a time series for the consumption category inflation expectations long enough to com-

[19] Via the implicit function theorem, the first derivative of the optimal level of attention $m_k^*$ with respect to the expenditure share $\omega_k$ and the volatility of expectations $\sigma_k^2$ can be shown to be:

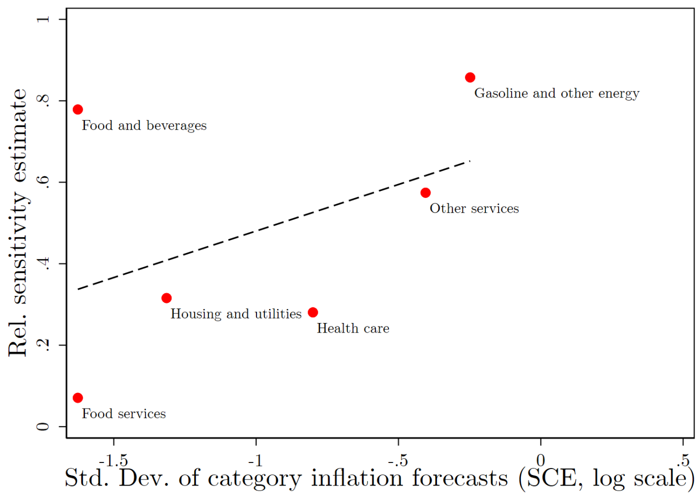
$$\frac{\partial m_k^*}{\partial \sigma_k^2} = \frac{\omega_k^2(1-m_k^*)}{\sigma_k^2\omega_k^2 + h_{m_k m_k}(m^*)} > 0; \qquad \frac{\partial m_k^*}{\partial \omega_k^2} = \frac{\sigma_k^2(1-m_k^*)}{\sigma_k^2\omega_k^2 + h_{m_k m_k}(m^*)} > 0.$$

Both terms are larger than 0 if the attention cost function is convex and $m_k^* < 1$.

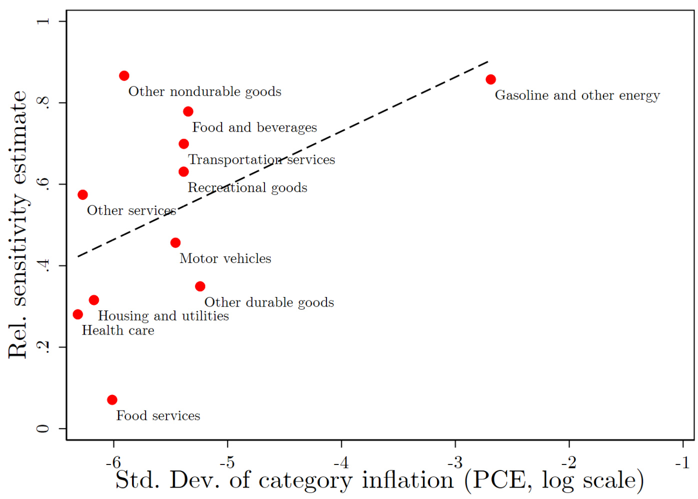
[20] In models (3) and (6) of Table 3, I control for the individual expenditure shares of all 11 PCE categories from the survey. Controlling for the expenditure shares makes the estimated model equivalent to equation 4.1. Estimated coefficients for the expenditure shares represent $(1 - m_k)\bar{\pi}_k$ in the model.

Figure 1: Estimated Attention and Volatility of Expected and Realized Inflation

(a) Forecast volatility




(b) Realized volatility




*Notes:* Panel (a): red dots show estimated coefficient per category on vertical axis and the log standard deviation of category inflation forecasts (monthly, SCE data) between 2013 and 2020 on the horizontal axis. Panel (b): red dots show estimated coefficient per category on vertical axis and the log standard deviation of realized category inflation on the horizontal axis (quarterly, PCE data).

pute meaningful estimates for the volatility of inflation forecasts, I rely on several alternative variables and data sources.

First, the SCE elicits one-year-ahead household inflation expectations for a limited set of specific product categories (gasoline, food, medical care, rent, housing, and college education). I use those monthly time series between 2013 and 2019 to compute volatility estimates for category inflation expectations. Categories from the SCE are matched as closely as possible to consumption categories from my survey.[21] Although not all estimated data points from Table 3

[21] The equal weighted average of SCE inflation forecasts for "Rent" and "Home prices" matches the "Housing and utilities" category in my survey. The SCE forecast for "College education" is used as an instrument for "Other services" and "Medical care" for "Health care." The SCE category expectation "Food" is both matched to the "Food and beverages" as well as the "Food services" consumption category. The SCE "Gas" category is equivalent to the "Gasoline" category.

can be matched to a forecast volatility estimate from the SCE, the correlation is 0.53. Figure 1 displays the relation between the estimated coefficients and the volatility of the respective SCE category inflation forecasts in panel (a) on the left side.

Second, I use realized inflation volatility for the respective PCE categories between 2010Q1 and 2019Q4. This approach rests on the assumption that household inflation expectations formation are at least partially adaptive or households perceive inflation to be highly autocorrelated. Toward that end, Jonung (1981) finds a strong impact of perceived current inflation of household inflation expectations. More recently, Weber et al. (2022) confirm this observation. Comparing the realized volatility with the SCE forecast volatility, I find a strong correlation across categories (0.67). The correlation between estimated coefficients and realized volatility is 0.43 (0.51 with log volatility).[22]

Third, the estimated attention correlates strongly with the frequency of price adjustment (based on estimates by Eusepi et al., 2011) across categories (correlation in levels 0.47; for log frequency of price adjustment, 0.58). The frequency of price adjustment consumers observe in their daily life might serve as a proxy for the volatility of prices and expectations for households.

Together, the data sources described above provide some correlational evidence for the mechanism proposed in the model. Previous literature also supports the findings. Regarding the link between headline inflation expectations and realizations, Cavallo et al. (2017) find households are more attentive—that is, exhibit a stronger link between realized and expected inflation—in countries with high inflation volatility, such as Argentina, than in countries with more stable prices, such as the U.S. This finding provides further evidence of the link between inflation volatility and households' mental attention. Bracha and Tang (2022) show similar evidence in household surveys for the U.S. and Europe - consumers are more attentive to price changes in times of higher inflation. In addition, products that historically show large movements in prices (i.e., feature a high price volatility) seem to play a significant role in household inflation expectations (Bruine de Bruin et al., 2011).

# 5 Limited Attention to Components of Headline Inflation - Implications for Monetary Policy

Does the documented higher attention of households to non-core components of headline inflation in the formation of expectations have implications for monetary policy, specifically, the optimal inflation target measure? Building on the previous empirical analysis, this section addresses the issue within a new Keynesian framework for monetary policy analysis. To do so, I embed the rational inattention model of inflation expectations into an otherwise standard multi-sector New Keynesian model. In the calibrated model, I find that due to households' rational inattention, headline inflation targeting is the superior strategy for monetary policy. To contrast this result with earlier findings from the literature, I also simulate an otherwise identical model without rational inattention in inflation expectations. In that case, stabilizing core inflation yields higher welfare than headline inflation targeting.

[22] Gasoline inflation is the most volatile and might be an outlier in the data. Without gasoline inflation, the correlation is somewhat lower but still positive, at 0.38.

The following section 5.1 outlines the multi-sector New Keynesian model with sparsity-based rational inattention in inflation expectations and solves the model. Section 5.2 numerically derives welfare implications of monetary policy alternatives regarding the inflation target measure.

## 5.1 New Keynesian Model Framework

The New Keynesian model is a multi-sector version of the canonical textbook framework by Galí (2015), augmented by sparsity-based rational inattention in inflation expectations formation. The mechanism for rational inattention is equal to the model developed in section 4, but within a dynamic general equilibrium framework with intertemporally optimizing households. Conceptually, sparsity-based rational inattention is integrated into the model following Gabaix (2019, 2020). In the model, household attention to inflation expectations of each sector is an endogenous function of the volatility of expected inflation, that is, the model solution, which in turn depends on exogenous model parameters and monetary policy decisions regarding the inflation target. Whereas previous models of sparsity-based rational inattention consider attention an exogenous parameter,[23] endogenizing households' attention allocation is crucial to my analysis, because it avoids the Lucas critique (Lucas, 1976) regarding welfare results. Any change in monetary policy decisions, such as a different inflation target measure, will ultimately alternate dynamics of expected future inflation and is thus relevant for households' attention allocation.

In the New Keynesian model, a continuum of firms within each sector use labor and technology to produce firm-specific, differentiated goods; firms are subject to sector-specific pricing frictions. Households supply labor to each sector and consume final products; they can save intertemporally via a riskless bond. The bond is in zero net supply. I abstract from capital and investment dynamics. Monetary policy follows a conventional Taylor rule, adjusting its policy instrument, namely the nominal interest rate, to inflation. In addition, monetary policy determines the sectoral composition of the inflation target measure. The remainder of this section is structured as follows: First, I describe households' optimization behavior in section 5.1.1. Section 5.1.2 discusses the firm problem, and section 5.1.3 outlines the role of monetary policy. Section 5.1.4 linearizes the model. In section 5.1.5, I endogenize households' attention to sector-specific inflation expectations. Section 5.1.6 derives the welfare criterion.

### 5.1.1 Households

Assume the representative, infinitely-lived household maximizes utility $U$:

$$U = \mathbb{E}_0^B \sum_{t=0}^{\infty} \beta^t \mathcal{W}_t. \tag{5.1}$$

The parameter $\beta$ is the discount factor. $\mathbb{E}_0^B$ is the bounded rational expectations operator, described in Definition 1 below. Period utility is denoted by $\mathcal{W}_t$:

$$\mathcal{W}_t = \ln \prod_{k=1}^{K} \left( \frac{C_{k,t}}{\omega_k} \right)^{\omega_k} - \sum_{k=1}^{K} \zeta_k \frac{N_{k,t}^{1+\varphi}}{1+\varphi}. \tag{5.2}$$

[23] Gabaix (2020) theoretically describes the endogenization of the attention parameter $m$ in New Keynesian models, but solves the model assuming $m$ to be endogenously set.

In equation (5.2), $C_{k,t}$ denotes consumption from sector $k \in \{1, . . ., K\}$, and $N_{k,t}$ denotes the households' labor supply to sector $k$.[24] The parameter $\omega_k$ is the household expenditure share of sector $k$. It holds that expenditure shares sum up to unity, $\sum_{k=1}^{K} \omega_k = 1$. The parameter $\varphi$ is the inverse Frisch elasticity of labor supply. In what follows, the variable $P_{k,t}$ denotes the price level in sector $k$ in period $t$.

Definition 1 introduces the bounded rational expectations operator, similar to Gabaix (2020).

**Definition 1** (Bounded rational expectations operator)**.** *Let $x$ be any variable that the household observes. If the household forms expectations over $x_{t+1}$, the bounded rational expectations operator $\mathbb{E}^B(\cdot)$ has the following properties:*

$$\begin{aligned} \mathbb{E}_t^B(x_{t+1}) &= \mathbb{E}_t(x_{t+1}) \quad \textit{if } x \neq P \\ \mathbb{E}_t^B(x_{t+1}) &= \mathbb{E}_t \left( x_t^{1-m_x} (1+g_x)^{1-m_x} x_{t+1}^{m_x} \right) \quad \textit{if } x = P, \end{aligned}$$

*where $P$ denotes a price level, $m_x \in [0,1]$ is the level of attention households pay to future values of variable $x$, and $g_x$ is the trend growth rate of $x$.* ■

The bounded rational expectations operator $\mathbb{E}^B(\cdot)$ is equal to the standard, rational expectations operator for all variables except the future price levels. Assuming no steady state trend inflation in the model ($\bar{\pi}_k = g_{P_k} = 0$), the household forms expectations over the future price level according to $\mathbb{E}_t^B(P_{k,t+1}) = \mathbb{E}_t \left[ P_{k,t}^{1-m_k} P_{k,t+1}^{m_k} \right]$. She thus perceives the future price in sector $k$ to be a combination of the rational expectation, $\mathbb{E}_t P_{k,t+1}$, and today's price level, $P_{k,t}$. The level of attention $m_k \in [0,1]$ governs how much she relies on the rational expectation. Similar to section 4, I denote $m$ as the $(1 \times K)$ vector of sector-specific attention levels. Households choose $m$ optimally, trading off utility gains from a more accurate forecast with the cost of attention. Section 5.1.5 endogenizes $m$ as a function of the linearized model solution.

The household maximizes utility (5.1) subject to the period budget constraint:

$$\sum_{k=1}^{K} W_{k,t} N_{k,t} + L_t + B_{t-1} \geq \sum_{k=1}^{K} P_{k,t} C_{k,t} + Q_t B_t. \tag{5.3}$$

Households receive labor income from each sector, $W_{k,t}N_{k,t}$, as well as lump-sum payment of profits from firms, $L_t$. The model allows for intertemporal savings via investment into holdings of a risk-free bond, $B_t$, that trades at price $Q_t$. The bond is in zero net supply, $B_t = 0 \; \forall t$. Nominal consumption expenditure on sector-$k$ products is denoted by $P_{k,t}C_{k,t}$. Households maximize utility in equation (5.1) subject to the budget constraint (5.3), over consumption $C_{k,t}$, labor supply $N_{k,t}$, and holdings of the risk-free bond $B_t$. In addition, households maximize utility over the level of attention $m$, subject to an attention cost function (for the endogenization of $m$, see section 5.1.5). However, regarding the optimization problem for consumption $C_{k,t}$, labor supply $N_{k,t}$, and the risk-free bond demand $B_t$, the household views his attention to future prices $m$ as given. The same applies to wages, the price of the risk-free bond, and current prices.[25]

[24]The parameters $\zeta_k$ measure the relative disutility of supplying labor to sector $k$. I set those parameters to ensure symmetric output in the steady state across firms; see Appendix C.2.

[25]For this assumption, see, for example, Galí (2015).

Optimal household behavior is characterized by a set of first-order conditions. Equation (5.4) defines demand for the sectoral consumption aggregate:

$$C_{k,t} = \omega_k C_t \left[\frac{P_{k,t}}{P_t}\right]^{-1}. \tag{5.4}$$

Here, the inter-sectoral elasticity of substitution is implicitly assumed to be 1. Equation (5.5) shows households' optimal labor supply to sector $k$:

$$\zeta_k N_{k,t}^{\varphi} C_t = \frac{W_{k,t}}{P_t}. \tag{5.5}$$

The sector-specific real wage is $W_{k,t}/P_t$. Equation (5.6) is the Euler equation for intertemporal optimization. Due to the log utility in consumption in equation (5.2), the intertemporal elasticity of substitution is unity:

$$\mathcal{Q}_t = \beta\, \mathbb{E}_t^B \left[\frac{C_t}{C_{t+1}} \frac{P_t}{P_{t+1}}\right]. \tag{5.6}$$

The price of the risk-free bond $\mathcal{Q}_t = -\exp(i_t)$ is defined by the nominal interest rate $i_t$, to be set by monetary policy.

Sectoral consumption baskets $C_{k,t}$ are CES aggregates of individual goods:

$$C_{k,t} \equiv \left[n_k^{-1/\epsilon} \int_{j\in k} C_{k,t}(j)^{\frac{\epsilon-1}{\epsilon}}\, dj\right]^{\frac{\epsilon}{\epsilon-1}}. \tag{5.7}$$

$C_{k,t}(j)$ denotes consumption of a good produced by firm $j$, located in sector $k$. The parameter $\epsilon$ is the intra-sectoral elasticity of substitution, assumed to be equal across all sectors. Firms are located on the unit interval, with each firm producing a single good. The fraction $n_k$ of firms operate in sector $k$. Corresponding sector-specific price indices are:

$$P_{k,t} = \left[n_k^{-1} \int_{j\in k} P_{k,t}(j)^{1-\epsilon}\, dj\right]^{\frac{1}{1-\epsilon}}. \tag{5.8}$$

$P_{k.t}(j)$ denotes the price in period $t$ for the good produced by firm $j$, located in sector $k$. The size of each sector is defined by $\omega_k = n_k$. Demand functions for firm-specific goods are obtained via cost minimization of the household:

$$C_{k,t}(j) = \frac{1}{n_k}\left[\frac{P_{k,t}(j)}{P_{k,t}}\right]^{-\epsilon} C_{k,t}. \tag{5.9}$$

Market clearing for each product implies $C_{k,t} = Y_{k,t}$. Nominal GDP is equal to $P_t Y_t = \sum_{k=1}^{K} P_{k,t} Y_{k,t}$. The aggregate price index $P_t$ is defined as a combination of sectoral price indices:

$$P_t = \prod_{k=1}^{K} P_{k,t}^{\omega_k}. \tag{5.10}$$

The gross inflation rate, the relation of the aggregate price level in period $t$ and $t-1$, is defined in equation (5.11):

$$\Pi_t = \frac{P_t}{P_{t-1}} = \prod_{k=1}^{K} \left( \frac{P_{k,t}}{P_{k,t-1}} \right)^{\omega_k}. \tag{5.11}$$

### 5.1.2 Production

A continuum of firms exists, indexed $j \in [0,1]$. Each firm $j$ is located in a single sector $k$ and produces a differentiated good, denoted by $Y_{k,t}(j)$. Firms in each sector produce using a sector-specific production function:

$$Y_{k,t}(j) = A_{k,t} N_{k,t}(j)^{1-\alpha}. \tag{5.12}$$

$A_{k,t}$ denotes the sector-specific technology and $N_{k,t}(j)$ is firm $j$'s input of labor, located in sector $k$. Due to similar production functions and price-setting constraints within a sector, the optimal price is identical for all firms within sector $k$. I subsequently drop the firm identifier $(j)$, for ease of notation. In the model, firms are not subject to sparsity-based rational inattention in expectations. The pricing problem of a representative firm maximizes real profits over the optimal price $P^*_{k,t}$ to be set in period $t$, taking into account that this price may be active for a number of periods, depending on the probability of possible price adjustment in subsequent periods. Equation (5.13) states the maximization problem of a firm:

$$\max_{P^*_{k,t}} \mathbb{E}_t \sum_{g=0}^{\infty} \theta_k^g \Lambda_{t,t+g} \left[ P^*_{k,t} Y_{k,t+g|t} - \mathcal{C}_{k,t+g|t}(Y_{k,t+g|t}) \right]. \tag{5.13}$$

$\theta_k \in [0,1]$ is the Calvo parameter in sector $k$, stating the probability that a firm may not adjust its price in a given period. $Y_{k,t+g|t}$ denotes total output of a firm in $t+g$, given that the price was last adjusted in period $t$. In equation (5.13), the variable $\Lambda_{t,t+g} = \beta^k (C_t/C_{t+g})(P_t/P_{t+g})$ is the stochastic discount factor between periods $t$ and $t+g$. $\mathcal{C}_{k,t+g|t}(\cdot)$ is the nominal cost function of the firm in $t+g$ if prices were last adjusted in $t$. Optimality, subject to households' demand function in equation (5.9), requires that

$$\mathbb{E}_t \sum_{g=0}^{\infty} \theta_k^g \Lambda_{t,t+g} Y_{k,t+g|t} \left[ P^*_{k,t} - \mathcal{M} \Xi_{k,t+g|t} \right] = 0. \tag{5.14}$$

$\mathcal{M} = \frac{\epsilon}{\epsilon-1}$ is the markup over nominal marginal costs in the absence of pricing constraints, that is, for $\theta_k = 0$. The nominal marginal costs are $\Xi_{k,t+g|t} = \frac{1}{1-\alpha} Y_{k,t+g|t}^{\frac{\alpha}{1-\alpha}} A_{k,t+g}^{\frac{1}{\alpha-1}} W_{k,t+g}$. Due the the Calvo pricing structure, the sectoral price index develops over time as:

$$P_{k,t} = \left[ (1-\theta_k) {P^*_{k,t}}^{1-\epsilon} + \theta_k P_{k,t-1}^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}}. \tag{5.15}$$

If prices are flexible in a sector, that is, if $\theta_k = 0$, equation (5.15) states the price index as $P_{k,t} = P^*_{k,t}$. In the case of full price flexibility, equation (5.14) implies the optimal price $P^*_{k,t}$ is equal to the markup $\mathcal{M}$ over nominal marginal costs $\Xi_{k,t|t}$.

### 5.1.3 Monetary Policy

Monetary policy sets the nominal interest rate $i_t$ in each period according to a Taylor rule. The parameter $\phi_\pi > 1$ governs the reaction of the nominal interest rate to the inflation target measure, $\tilde{\Pi}_t$:

$$1 + i_t = (1 + \bar{i})\tilde{\Pi}_t^{\phi_\pi}. \tag{5.16}$$

The parameter $\bar{i}$ denotes the steady state nominal interest rate. Similar to the gross inflation rate in equation (5.11), the inflation target measure is defined as

$$\tilde{\Pi}_t = \prod_{k=1}^{K} \left( \frac{P_{k,t}}{P_{k,t-1}} \right)^{\eta_k} \tag{5.17}$$

The central bank is free to set sectoral weights $\eta_k \in [0, 1]$, subject to $\sum_{k=1}^{K} \eta_k = 1$. When each sector's inflation target measure weight is set equal to its household expenditure share, $\eta_k = \omega_k$, monetary policy defines a headline inflation target. Appendix C.2 derives the steady state of the model.

### 5.1.4 Linearized Equilibrium

This section log-linearizes and derives the canonical representation of the model. Inflation is defined as the difference between log price levels, $\pi_{k,t} = p_{k,t} - p_{k,t-1}$, where $p = \log P$. From equation (5.11), it follows that aggregate inflation is linked to sectoral inflation rates, according to

$$\pi_t \quad = \quad \sum_{k=1}^{K} \omega_k \pi_{k,t}. \tag{5.18}$$

I define the terms of trade for a sector $k$, as the relative price of sector $k$ to the aggregate price index, $\tau_{k,t} = p_{k,t} - p_t$. It follows from equation (5.18) that $\sum_{k=1}^{K} \omega_k \tau_{k,t} = 0$. The log-linearized Euler equation, combined with the goods market equilibrium $y_t = c_t$, reads as

$$y_t = \mathbb{E}_t \, y_{t+1} - (i_t - \mathbb{E}_t^B \, \pi_{t+1} - \rho), \tag{5.19}$$

where $\rho = -\log \beta$, $i_t = -\log(Q_t)$ and $y_t$ ($c_t$) denotes the log deviation of output (consumption) from its steady state. Building on the definition of the bounded rational expectations operator and equation (5.18), I state the following expression for households' headline inflation expectations:

$$\mathbb{E}_t^B \, \pi_{t+1} \quad = \quad \sum_{k=1}^{K} \bar{m}_k \omega_k \, \mathbb{E}_t \, \pi_{k,t+1}. \tag{5.20}$$

Note equation (5.20) is identical to equation (4.1) in the partial equilibrium model, because the model contains no trend inflation. The derivation of the price-setting equations is standard, as outlined in Galí (2015). The sectoral Phillips curves are

$$\pi_{k,t} \quad = \quad \beta\,\mathbb{E}_t\,\pi_{k,t+1} - \lambda_k(p_{k,t} - \psi_{k,t} - \mu), \tag{5.21}$$

where $\lambda_k = \frac{(1-\theta_k)(1-\beta\theta_k)}{\theta_k}\frac{1-\alpha}{1-\alpha+\alpha\epsilon}$ and $\mu = \log\mathcal{M}$. The term $\psi_{k,t} - p_{k,t}$ gives log marginal costs, deflated with the sector price index. Using the log-linearized labor supply condition, $y_t + \varphi n_{i,t} = w_{i,t} - p_t$ and the log of production function $y_{i,t} = a_t + (1-\alpha)n_{k,t}$, I can write the marginal cost expression as

$$\psi_{k,t} - p_{k,t} \quad = \quad \Gamma y_{k,t} - \Gamma a_{k,t} - \log(1-\alpha), \tag{5.22}$$

where $\Gamma = \frac{1+\varphi}{1-\alpha} \geq 0$ and $a_{k,t} = \log A_{k,t}$ is the log level of technology in sector $k$. Appendix C.3 derives equation (5.22) formally. Next, I state the natural level of output $y_t^n$ as the economy-wide output level given flexible prices. For each sector, the log deviation of natural output from its steady state, $y_{k,t}^n$, is defined as the sector output given flexible prices in all sectors.[26] Equation (5.23) displays both the sector-specific and aggregate natural level of output, as functions of the exogenous technology level:

$$\begin{aligned} y_{k,t}^n &= \vartheta + a_{k,t} \\ y_t^n &= \vartheta + \sum_{k=1}^{K}\omega_k a_{k,t}, \end{aligned} \tag{5.23}$$

with $\vartheta = \Gamma^{-1}\left[\log(1-\alpha) - \mu\right]$. Because no rigidities exist in the flexible price economy, $y_{k,t}^n$ is independent of monetary policy. Using equation (5.23), I can rewrite the sectoral Phillips curves in its canonical form with $\tilde{y}_{k,t} = y_{k,t} - y_{k,t}^n$ as the sectoral output gap:

$$\pi_{k,t} \quad = \quad \beta\,\mathbb{E}_t\,\pi_{k,t+1} + \kappa_k\tilde{y}_{k,t}, \tag{5.24}$$

where $\kappa_k = \lambda_k\Gamma$ defines the slope of the Phillips curve. Equations (5.25) and (5.26) show the dynamic IS equation and natural rate of interest $r_t^n$:

$$\tilde{y}_t \quad = \quad \mathbb{E}_t\,\tilde{y}_{t+1} - (i_t - \mathbb{E}_t^B\,\pi_{t+1} - r_t^n) \tag{5.25}$$

$$r_t^n \quad = \quad \rho + \mathbb{E}_t\sum_{k=1}^{K}\omega_k\Delta a_{1,t+1}. \tag{5.26}$$

A log linearization of the sectoral demand (equation (5.4)) links the sectoral and economy wide output, $y_{k,t} = y_t - \tau_{k,t}$. Aggregate output is a linear combination of sectoral outputs, $y_t = \sum_{k=1}^{K}\omega_k y_{k,t}$. The sectoral output gap is connected to the economy wide output gap:

$$\tilde{y}_t \quad = \quad \tilde{y}_{k,t} - \tau_{k,t} - \sum_{k=1}^{K}\omega_k a_{k,t} + a_{k,t}, \tag{5.27}$$

The log of equation (5.16) defines the nominal interest rate policy of the central bank, $i_t =$

[26] This definition ensures the weighted sum of sectoral levels of natural output equals the economy wide level of natural output $y_t^n$.

$\rho + \phi_\pi \bar{\pi}$, where $\rho = \bar{i}$. The inflation target measure reads in log terms, $\tilde{\pi}_t = \sum_{k=1}^{K} \bar{\omega}_k \pi_{k,t}$, building on equation (5.17).

The solution to the linearized model is defined by the following transition and policy function:

$$S_t = \Psi_0 S_{t-1} + \Psi_1 \epsilon_t \tag{5.28}$$

$$X_t = \Pi S_t. \tag{5.29}$$

$S_t$ and $\epsilon_t$ denote the vector of state variables and exogenous innovations. $X_t$ is the vector of endogenous variables of the model. $\Psi_0(\mathcal{P}, m)$ and $\Psi_1(\mathcal{P}, m)$ are matrices that define the state variables' transition function, whereas $\Pi(\mathcal{P}, m)$ defines the policy function of the model. $\mathcal{P}$ is the vector of exogenous model parameters, and $m$ is the vector of sector specific attention levels. The model solution is a function of structural parameters and attention levels. The next section endogenizes attention levels.

### 5.1.5 Endogenous Attention

This section endogenizes the level of attention households allocate to future prices in each sector, $m(\mathcal{P})$, as a function of model parameters $\mathcal{P}$. Equation (5.20) derives that inattention to the future price level is equivalent to inattention to sector-specific inflation forecasts when forming headline inflation expectations. The intuitive dynamics of households' optimal attention allocation problem are similar to section 4: households wish to limit their attention because it is costly, but they also try to minimize utility losses that arise from a headline inflation forecast that deviates from the full attention headline expectation. Utility losses from expected inaccuracy of the headline expectation, caused by rational inattention, arise in the model because of subsequently imperfect intertemporal optimization.

To formally solve the optimization problem, I build on the integration of the sparsity-based rational inattention into New Keynesian models by Gabaix (2019, 2020). The formal derivation is in principle similar to section 4, but somewhat more complicated, due to the more complex utility structure of the dynamic general equilibrium model. The household faces the following optimization problem:

$$\max_m \mathbb{E}_t^B \, U\left(a(S_t, m), S_t, m\right) - h(m) \tag{5.30}$$

Here, utility—defined in equation (5.1)—depends on her economic actions $a_t$, her attention vector $m$, and the state of the economy $S_t$. The vector of economic actions $a = [C_k \; N_k \; B]'$ includes consumption and labor supply decisions, as well as bond holdings. The first-order conditions of the household problem, equations (5.4) to (5.6), constitute households' optimal decision function for each economic action. By assumption, disutility from attention costs is measured by the convex cost function $h(m)$.

Similar to section 4, I assume the optimization problem in equation (5.30) is difficult to solve for the household, and thus rely on a simplified version, following Gabaix (2019, 2020): the agent replaces expected utility $\mathbb{E}_t^B \, U\left(a(S_t, m), S_t, m\right)$ by a second-order Taylor approximation of utility losses from inattention.[27]

[27]Following the approach by Gabaix (2020), for the Taylor approximation, derivatives are evaluated at the

Equation (5.33) states the set of $k$ first-order conditions that can be solved for the optimal level of attention:

$$h(m)_{m_k} \quad = \quad (1-m_k)\omega_k^2\Theta_{k,k} + \sum_{l=1|l\neq k}^{K}(1-m_l)\omega_k\omega_l\Theta_{k,l} \quad \forall k. \tag{5.33}$$

The parameter $\Theta_{k,l}$ denotes the covariance between the sum of expected future inflation rates in sectors $k$ and $l$.[28] Endogenous optimal attention to each sector's inflation expectations depends on the sector's expenditure share, the variance of sectoral inflation expectations, and covariances of expected inflation with other sectors as well as the marginal cost of attention. Because those variance and covariance terms in the model are time invariant and depend on the exogenous model parameters, optimal attention $m$ is also time invariant, given constant parameter values. The system of equation in (5.33) can be solved for $m(\mathcal{P})$ as a function of the model parameters $\mathcal{P}$.

Proposition 1 considers a special case of equation (5.33) that aids in an understanding of the dynamics of household attention.

**Proposition 1** (Sector specific attention). *Assume covariances between sectoral expected inflation rates are small,* $\lim \Theta_{k,l} \to 0 \; \forall k,l$. *Then, it follows from equation* (5.33) *that attention to sector* $k$ *increases in the sector size of* $k$ *and the variance of expected inflation rates:*

$$\frac{\partial m_k}{\partial \Theta_{k,k}} \geq 0; \qquad \frac{\partial m_k}{\partial \omega_k} \geq 0. \tag{5.34}$$

■

Attention to sector $k$ increases in $\Theta_{k,k}$, the volatility of expected inflation rates in $k$. This finding is intuitive: if consumers know that on average over time, their inflation forecast for a sector differs largely from the steady state inflation rate, being inattentive to that future sector inflation creates large expected utility losses. Headline inflation expectations will deviate more from the full attention forecast. At the same time, attention also increases with the sector size

default attention $m^d \geq 0$, that comes free of mental cost (assumed to be equal for all sectors), and the steady state of of the model. Specifically, the household now maximizes equation (5.31):

$$\max_m -\frac{1}{2}(1-m)'\Lambda(1-m) - h(m), \tag{5.31}$$

with $\Lambda = -\mathbb{E}[S_t a'_{m,S}(m^d,0)\; \mathcal{W}_{aa}(a_{m,S}(\bar{S},m^d),\bar{x},1)\; a_{m,S}(m^d,0)S_t]$. $\mathcal{W}_{aa}$ denotes the second derivative of period utility to $a$. $a_{m,S}$ is the second derivation of $a$ subject to $m$ and the state variables $S$. Appendix C.5 derives (5.31) formally. Applying the period utility function (5.2) as well as first-order conditions ((5.4) and (5.5)) for consumption and labor, the maximization problem is equal to

$$\max_m \qquad -\frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K}(1-m_k)\Theta_{k,j}(1-m_l)\omega_k\omega_l - h(m), \tag{5.32}$$

where $\Theta_{l,k}$ is the covariance between the sum of expected future inflation in sectors $k$ and $l$.

[28] The term is additionally weighted by an utility constant $\tilde{u}_{aa}$. The covariance can be expressed in terms of the model solution:

$$\Theta_{k,l} \quad = \quad \mathbb{E}\left[\sum_{g=1}^{\infty}\pi_{k,t+g}\sum_{g=1}^{\infty}\pi_{l,t+g}\right]^2 \tilde{u}_{aa} = \left(\Pi_{\pi_k,\cdot}(I-\Psi_0)^{-1}\Psi_0\right)\tilde{u}_{aa}\Theta_S(\Pi_{\pi_l,\cdot}(I-\Psi_0)^{-1}\Psi_0)',$$

where $\Sigma_S$ defines the covariance matrix of state variables.

$\omega_k$: when expenditure on a sector is higher, inflation forecasts for the respective sector are a more important component of headline inflation.

The solution to the model is defined by the matrices $\Psi_0$, $\Psi_1$, and $\Pi$ in the transition function (5.28) and policy function (5.29) and has to satisfy both the models' linearized equilibrium conditions and the sector-specific attention functions. The model is solved numerically with the equations in (5.33) as additional constraints to the solution, apart from the linearized equilibrium conditions derived in section 5.1.4.[29] As a special case, the full attention model is nested: households pay full attention to each sector if the cost function $h(m)$ is zero irrespective of the level of $m$.

### 5.1.6 Welfare

Proposition 2 defines the welfare criterion of the model. Welfare losses are caused by economic volatility in the model and are measured as the equivalent consumption decline relative to steady state consumption (Galí, 2015; Woodford, 2003).

**Proposition 2** (Welfare)**.** *The variable $\mathbb{L}$ measures the average per-period welfare loss for a representative consumer, arising from volatility in the sector-specific output gaps $\tilde{y}_{k,t}$ and inflation rates $\pi_{k,t}$, in terms of relative steady state consumption:*

$$\mathbb{L} \;=\; \frac{1}{2}\left[\Gamma \sum_{k=1}^{K} \omega_k var(\tilde{y}_{k,t}) + \sum_{k=1}^{K} \omega_k \frac{\epsilon}{\lambda_k} var(\pi_{k,t})\right] + t.i.p. + ||\mathcal{O}^3||, \tag{5.35}$$

*where $\Gamma = \frac{1+\varphi}{1-\alpha} \geq 0$. t.i.p. denotes terms independent of monetary policy and $||\mathcal{O}^3||$ represents terms of third order or higher.*[30] ***Proof.*** *See Appendix C.6.* ■

Similar to the literature, I assume the *behavioral* agent has the same welfare criterion as a *rational* agent (Gabaix, 2020). In the model, the average per period welfare loss of households, $\mathbb{L}$, reflects inefficiencies, specifically monopolistic competition and price rigidities. Although monetary policy is unable to influence the former (some models address inefficiencies arising from monopolistic competition by assuming an optimal production subsidy), it has influence over the welfare loss caused by price rigidities. Sectoral price rigidities lead to the following distortions: First, because only a fraction of firms is able to adjust prices following a shock, price dispersion exists among firms with equal production technology. This price dispersion within a sector causes production to deviate from its efficient level, the natural level of output. Second, as price rigidities differ across sectors, shocks lead to an inefficient allocation of resources, that is, labor, between sectors, as the speed of price adjustment differs. In equation (5.35), the welfare loss is thus increasing in the variance of the sectoral output gaps and inflation rates.

[29] Solving the model creates a fixed-point problem: the optimal level of attention is an unknown combination of model parameters described by the set of equations in (5.33), that cannot be solved analytically. The model solution—based on the set of linearized equilibrium conditions—depends on the value of vector $m$, and has to satisfy equations (5.33). To solve the problem, I add equations (5.33) to the linearized model equilibrium conditions and solve numerically with a first-order perturbation approach.

[30] For the case in which price rigidities are equal across sectors, $\theta_k = \theta_l \; \forall k, l$, the welfare criterion simplifies to

$$\mathbb{L} \;=\; \frac{1}{2}\left[\Gamma var(\tilde{y}_t) + \frac{\epsilon}{\lambda} var(\pi_t)\right] + t.i.p. + ||\mathcal{O}^3||, \tag{5.36}$$

due to the relative price between sectors $\tau_{k,t}$ being independent of policy.

Table 4: Model Calibration

| | Variable | Value | Target |
|---|---|---|---|
| | | *Homogeneous Parameters* | |
| *Preferences and production* | | | |
| Discount factor | $\beta$ | 0.999 | $r_t \approx 1\%$ |
| Inverse Frisch elasticity | $\varphi$ | 4 | Chetty et al. (2011) |
| Labor share in production | $\alpha$ | 1/5 | Fernández-Villaverde et al. (2015) |
| Elasticity of substitution | $\epsilon$ | 10 | Fernández-Villaverde et al. (2015) |
| *Monetary policy* | | | |
| Taylor rule | $\phi_\pi$ | 1.5 | Galí (2015) |
| Inflation target | $\eta_k$ | $\omega_k$ | Headline inflation target |
| *Attention* | | | |
| Minimum, free attention | $m_d$ | 0.38 | see Table 5 |
| Cost function param. | $\mathcal{K}$ | 0.021 | see Table 5 |
| Cost function param. | $\varrho$ | 1 | see Table 5 |
| | | *Heterogeneous Parameters* | |
| *Sector size* | | | |
| Non-core expenditure | $\nu$ | 0.135 | PCE expenditure |
| *Pricing* | | | |
| Calvo core | $\theta_{core}$ | 0.60 | Carvalho et al. (2021) |
| Calvo non-core | $\theta_{non-core}$ | 0.30 | Carvalho et al. (2021) |
| *Technology process* | | | |
| Std. dev. core | $\sigma_{core}$ | 0.0043 | see Table 5 |
| Std. dev. non-core | $\sigma_{non-core}$ | 0.0216 | see Table 5 |
| Persistence core | $\rho_{core}$ | 0.90 | see Table 5 |
| Persistence non-core | $\rho_{non-core}$ | 0.60 | see Table 5 |

*Notes:* Parameter values used in model simulations.

## 5.2 Optimal Monetary Policy

Next, I analyze optimal monetary policy in the model developed above. In particular, I use the welfare criterion of households to derive the optimal weight for each sector in the inflation target measure of monetary policy. Section 5.2.1 calibrates the model to match core and non-core inflation moments, as well as empirical estimates from section 3. Section 5.2.2 analyzes optimal policy choices numerically.

### 5.2.1 Calibration

The model is calibrated to match dynamics of core and non-core inflation. Targets include the realized volatility of inflation and estimated household attention levels for core and non-core inflation expectations. Both core and non-core inflation encompass several consumption categories, that is, sectors, see Table 2. In the following, I assume all $K$ sectors in the economy are of equal size, $\omega = 1/K$. To match relative personal consumption expenditure of US households to core and non-core sectors, I assume a fraction of sectors, $\nu = 13.5$ percent, are part of non-

Table 5: Business Cycle and Sectoral Attention Statistics

| | Core inflation | | | Non-core inflation | | |
|---|---|---|---|---|---|---|
| | $\text{std}(\pi_{core})$ | $\nu_{core}$ | $m_{core}$ | $\text{std}(\pi_{non-core})$ | $\nu_{non-core}$ | $m_{non-core}$ |
| Data | 0.14 | 0.865 | 0.38 | 1.50 | 0.135 | 0.80 |
| Model | 0.15 | 0.865 | 0.38 | 1.52 | 0.135 | 0.80 |

*Notes:* Business Cycle Statistics for core and non-core inflation sectors and estimated attention levels (see section 3). Empirical data obtained via the St. Louis Fed's FRED database. Business cycle statistics rely on quarterly data between 1990Q1 and 2020Q1. Standard deviations are reported in percent.

core inflation, whereas $1 - \nu = 86.5$ percent are part of core inflation. All sectors that belong to core (non-core) inflation are similar with respect to their technology $A_{k,t}$ and price rigidity, $\theta_k$.[31] The model is calibrated at the quarterly frequency. Table 4 lists parameter values. The discount rate $\beta$ is set to 0.999, implying an annualized real interest rate of 1%. The intrasectoral elasticity of substitution $\epsilon$ equals 10, implying a steady state markup of 11%, as proposed by the model estimation in Fernández-Villaverde et al. (2015). The inverse Frisch elasticity of labor supply is $\varphi = 4$ (see, e.g., Chetty et al., 2011). The labor share in production is equal across both sectors, at $\alpha = 1/5$ (Fernández-Villaverde et al., 2015). Monetary policy reacts to changes in the inflation target measure via the Taylor rule, parameterized with $\phi_\pi = 1.5$ (see, e.g., Galí, 2015; Taylor, 1993). I set the relative weight of each sector within the central banks' inflation target measure equal to its expenditure share, implying monetary policy relies on a headline inflation target in the initial situation. In what follows, I relax the notation in that I refer to monetary policy's weight on non-core inflation by $\eta$ and the weight on core inflation by $1 - \eta$. In following section, I analyze the welfare consequences of deviations from that particular policy, such as a switch to core inflation targeting.

The literature has found the degree of price rigidities across different sectors plays a crucial role for welfare implications of inflation target alternatives (Aoki, 2001; Eusepi et al., 2011). I set those parameters in accordance with the literature, based on microeconomic estimates for the frequency of price adjustment: the Calvo parameter for core inflation sectors is $\theta_{core} = 0.6$, implying an average price spell of 7.5 months. To reflect the higher price flexibility, especially in the energy sector, I set $\theta_{non-core} = 0.3$, implying prices are reset every 4.3 months, on average. Numerical values are in line with recent estimates by Carvalho et al. (2021), who find that the price rigidity is lower in the non-core sector.

The remaining parameters, that is, parameters governing the sectoral TFP processes as well as the attention cost function, are calibrated to match the empirical volatility of quarterly inflation rates in both sectors as well as estimated household attention levels toward expected future inflation. Table 5 displays calibration targets and compares them with business cycle

[31] Appendix C.4 shows that for symmetric sectors $a$ and $b$, the relative price is constant, thus inflation and output gap dynamics are identical, $\tau_{a,t} = \tau_{b,t}; \pi_{a,t} = \pi_{b,t}; \tilde{y}_{a,t} = \tilde{y}_{b,t}$. If, in addition, as assumed by the calibration it holds that $\omega_a = \omega_b$, then due to similar inflation dynamics this implies that $m_a = m_b$. Thus, all core and, respectively, non-core sectors share the same inflation and output gap dynamics. Consequently, household attention is also equal across all sectors within core and, respectively, non-core. This allows me to solve the framework as a two sector model where the core sector has an household expenditure share of $1 - \nu = 0.865$. Still, attention towards core inflation assumes that there are $\nu K$ sectors of size $1/K$ that receive equal attention (as inflation dynamics are equal). the solution is independent of the value of $K$.

statistics in the model. Statistics in Table 5 are calculated at the quarterly frequency, relying on 30 years of data between 1990Q1 and the onset of the COVID-19 pandemic in 2020Q1. Non-core inflation rates have a standard deviation more than 11 times as high as core inflation rates (1.50 percent vs. 0.14 percent). The expenditure share of the non-core sector is set to $\nu = 0.135$, in line with combined relative personal consumption expenditures for energy and food between 1990Q1 and 2020Q1. To match targets, I set the persistence of log technology in the non-core sector to be smaller than in the core sector, accounting for the more transitory nature of shocks in the energy and food sectors. Further, I calibrate the standard deviation of shocks in the non-core sector to be larger than in the core sector. Although not a calibration target, the model turns out to match the persistence of both core and non-core inflation rates relatively well.

Finally, I assume attention costs $h(m)$ are separable in each sectoral attention level:

$$h(m) = \frac{\mathcal{K}}{2} \sum_{k=1}^{K} (m_k)^{\varrho}. \tag{5.37}$$

To match estimated attention level for core and non-core inflation, I set $\mathcal{K} = 0.021$ and $\varrho = 1$. Additionally a minimum level of attention $m_d = 0.38$ exists that is free of any mental cost.

### 5.2.2 The Optimal Inflation Target Measure under Limited Attention

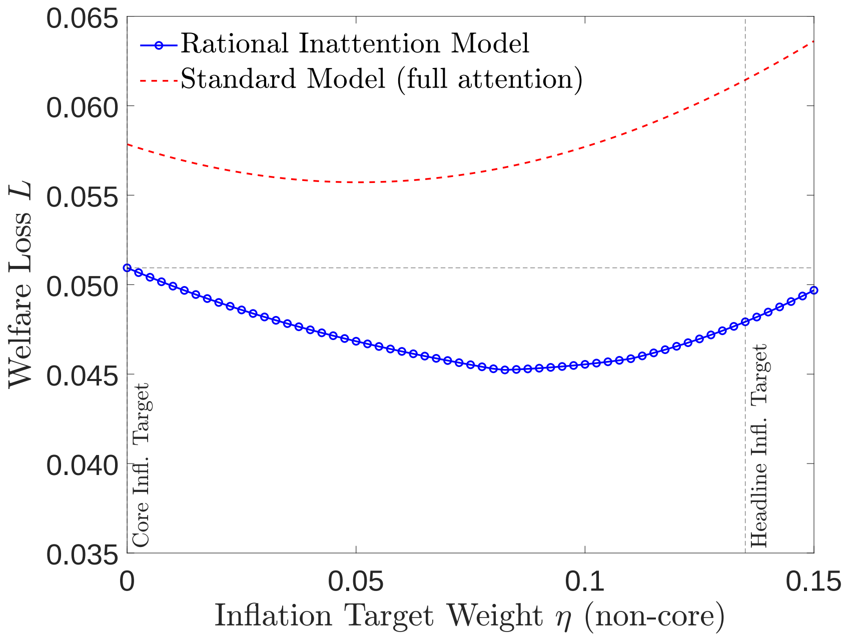
How much weight should monetary policy give to non-core inflation in its inflation target measure? In this section, I derive the optimal inflation target measure numerically. As consumers allocate relatively more attention to non-core inflation expectations, I find headline inflation targeting is the optimal policy.

Figure 2 displays the model's average per-period welfare loss for different values of $\eta$, the weight on non-core inflation, on the horizontal axis. The blue, dotted line represents the calibrated sparsity-based rational inattention model (henceforth, "rational inattention model"). The initial calibration, assuming a headline inflation target similar to the official U.S. Federal Reserve policy, is marked by the vertical line on the right. I obtain the welfare loss for each weight on non-core inflation $\eta$ by simulating the model with the respective policy choice for the inflation target (see equation (5.17)); other parameters are constant. For comparison, the figure also shows the welfare loss for an identical model, but assuming full household attention (i.e., "standard model (full attention)," red, dashed line).[32] This alternative is equivalent to a standard multi-sector New Keynesian model without rational inattention. The welfare loss $\mathbb{L}$ allows for a normative comparison of policy alternatives. A smaller $\mathbb{L}$ is equivalent to higher welfare of households. For central banks, the discrete choice between core ($\eta = 0$) and headline ($\eta = \nu$) inflation targeting is of particular interest. Additionally, the analysis enables me to derive the welfare-maximizing weight on non-core inflation.

In the rational inattention model, the headline inflation target results in a smaller welfare loss relative to a core inflation target. Quantitatively, the average welfare loss per period is 6.3 percent smaller under a headline inflation target than under to a core inflation target; monetary policy is thus more effective if it targets headline inflation. The welfare loss arising from nominal

[32] Formally, the calibration for the standard full attention model assumes $\mathcal{K} = 0$.

Figure 2: Welfare Loss for Varying Inflation Targets




*Notes:* The blue, dotted line shows welfare loss $\mathbb{L}$ for the calibrated rational inattention model. The dashed red line contrasts welfare loss for an otherwise identical model, but without rational inattention (full attention model). Welfare loss $\mathbb{L}$ in percentage points of steady state consumption.

rigidities would be significantly larger under core inflation targeting. The optimal weight on non-core inflation lies between both alternatives, at $\eta = 0.083$. By contrast, in the standard full attention model, the core inflation target represents a welfare loss reduction of 5.9 percent relative to the headline inflation target. The optimal welfare maximizing weight on non-core inflation is at $\eta = 0.05$. This result is consistent with earlier work (e.g., Aoki, 2001; Benigno, 2004; Eusepi et al., 2011). For both models, absolute welfare loss differentials between different inflation targets are small — a feature of multi-sector New Keynesian models well known in the literature (Matsumura, 2022).

In the standard New Keynesian model with full attention, monetary policy places increased emphasis on stabilizing inflation in the most rigid sectors of the economy (this result is described by the "stickiness principle"; see Eusepi et al. (2011)): the welfare loss of the representative household increases in the volatility of sector inflation rates. Inflation volatility in the most rigid sectors creates the largest marginal utility loss, because price dispersion and real distortions are more pronounced in those sectors. Hence, monetary policy optimally emphasizes stabilizing the sectors where nominal rigidities are largest, to maximize household welfare. Because non-core prices are relatively flexible compared with other parts of the economy, they receive little weight in the inflation target: non-core inflation volatility creates only minimal marginal disutility in the standard model.

Compared with this standard model, policy implications are notably different in the rational inattention model, which accounts for the documented focus of households' headline inflation expectations on the non-core components. Here, headline inflation targeting is the optimal strategy, despite the low nominal rigidity of non-core prices. Intuitively, this result can be explained by the relatively more important role of non-core inflation expectations in households' intertemporal optimization decision. In the model, the representative household allocates more attention to the non-core components of inflation, due to the higher volatility of her non-core inflation expectations. It follows that those components become a more important source of headline inflation expectations volatility. Because households rely on their inflation expectations to decide on their intertemporal optimization, non-core inflation expectations are a more significant determinant of aggregate demand fluctuations. Hence, it is optimal for monetary policy to focus more on food and energy inflation, compared with the standard model with full attention. A higher inflation target weight on non-core inflation helps to reduce the volatility of (expected) non-core inflation and shields the perceived real interest rate from fluctuations in non-core inflation forecasts.

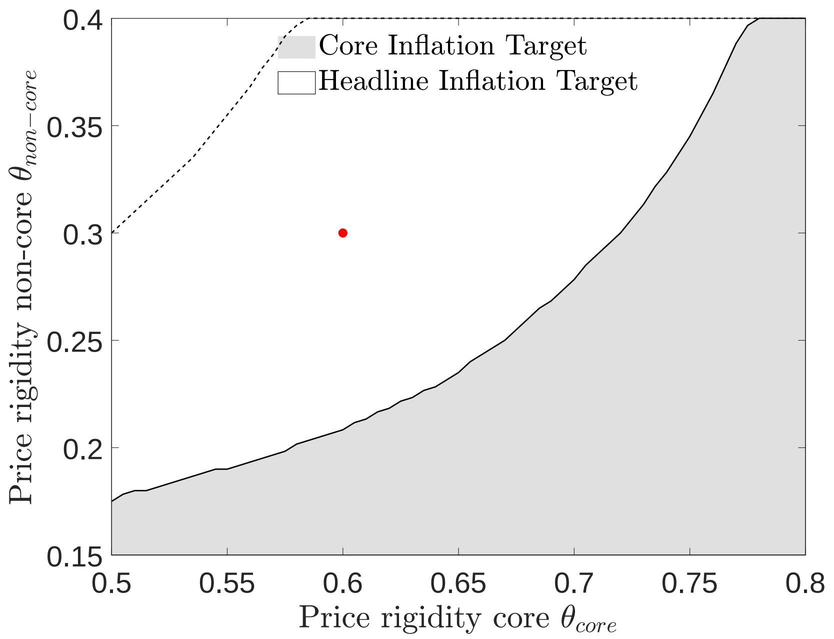
Note the welfare loss is smaller for the rational inattention model, compared with the standard model, for any value of $\eta$. As households pay less than full attention to any sector-specific inflation expectations, headline inflation expectations become less volatile than in the full attention scenario; it follows that the rational inattention has a stabilizing effect on the economy, because real interest rate fluctuations are dampened. Consequently, welfare losses are smaller.

Corresponding to Figure 2, Figure B.4.4 in the Appendix displays endogenous attention levels toward both core and non-core inflation, for values of $\eta$. For lower weights on non-core inflation, attention to the respective inflation expectations increases, as expectations become more volatile. Note that if the role of non-core inflation within the central banks' inflation target is low enough, attention to non-core reaches the upper bound, namely unity.[33]

As a robustness exercise, Figure 3 varies the price rigidities of core and non-core inflation and compares headline and core inflation targeting as policy alternatives: the regime with the lower welfare loss $\mathbb{L}$ is the preferred option for monetary policy. The red dot represents the initial calibration; see Table 4 and the welfare comparison in Figure 2. In the white area of the graph, headline inflation targeting results in a smaller welfare loss. Within the gray area, the core inflation target is superior: In the latter case, when rigidities are strongly asymmetric, with non-core sectors more flexible. By contrast, the dashed black line in the top-left corner shows the border between both areas for the full attention model: the headline inflation target is superior only for parameter combinations above that line. The graph shows an area where the rational inattention model put forward in this paper suggests welfare gains of headline inflation targeting, whereas the standard full attention model predicts welfare gains of a core inflation target. In that particular area, the effect of the heterogeneous attention of households on the optimal inflation target dominates the stickiness principle effect that works in the opposite direction, in favor of a core inflation target. As a further robustness exercise, Appendix B.4.4 assumes

[33]For core inflation, the figure shows that, somewhat surprisingly, if the weight on non-core inflation is below a threshold, the attention to core inflation starts to increase again. In that region, increasing non-core price volatility creates spillover effects into core inflation expectations, increasing the volatility of these expectations. The robustness analysis in Appendix B.4 shows the increase in attention to core inflation does not drive the main result of the paper. Rather, in a simulation where attention to core inflation is at a fixed, endogenous value, welfare implications remain the same. Figure 6 in the Appendix additionally assumes exogenous levels of attention to both sectors. Whereas in the baseline calibration, attention reacts strongly to changes in the forecast volatility, this policy exercises reflects either a borderline case where attention functions are not reactive to changes in inflation forecast volatility, or the case in which the level of attention depends on any other exogenous source. Again, policy implications remain the same.

Figure 3: Optimal Inflation Target Measure Regime for Values of Sectoral Price Rigidity




*Notes:* The figure compares welfare loss for core and headline inflation targeting in the model, for different values of sector-specific price rigidities. For combinations within the gray area, core inflation targeting is superior; for combinations within the white area, headline inflation targeting is superior. The dashed line represents the border between both areas for the standard full attention model: the headline inflation target is optimal in the upper left corner, above the line. The red dot represents initial calibration; see Table 4.

monetary policy targets core inflation in practice, despite the stated goal of headline inflation targeting (FOMC, 2022). The rational inattention model is again calibrated to match similar targets as in Table 5, but under the assumption that monetary policy places zero weight on non-core inflation in the initial situation. In that case, the rational inattention model predicts a small welfare gain from a switch in monetary policy toward a headline inflation target.

## 6 Conclusion

The U.S. Federal Reserve, among other central banks, places considerable emphasis on the headline inflation rate in its monetary policy decisions, even though previous New Keynesian literature has argued in favor of a core inflation target as the optimal policy approach, citing the low nominal rigidities of non core prices as the main reason. This paper offers a model-based rationale for targeting the headline inflation rate, arguing it is indeed the optimal policy strategy once the formation of consumers' inflation expectations is modeled in greater detail. Because consumers disproportionately focus on non-core prices to form inflation forecasts, volatile food and energy inflation expectations are a key driver of aggregate demand volatility. Consequently, the central bank can insulate the economy from fluctuations in expected inflation to a greater degree if it does not exclude those prices that households' expectations eminently focus on.

I first provide empirical evidence for households' disproportionate focus on non-core, food, and energy prices in the formation of inflation expectations. This result is based on a new survey eliciting disaggregated household inflation expectations for different components of the consumption basket. A sparsity-based rational inattention model can account for this pattern: households pay more attention to non-core components than to core prices when they form headline inflation expectations. This focus is optimal, because non-core inflation expectations are more volatile and attention is costly. The paper finally embeds this model of expectation formation into a multi-sector New Keynesian model. In a quantitative welfare analysis, I find that, because households allocate more attention to the non-core components of inflation, a core inflation target would fail to sufficiently stabilize the economy and lead to an increased welfare loss relative to a headline inflation target.

Although the stylized New Keynesian model used in this paper has the advantage of clear insights, several limitations are evident and call for future refinements of the analytical framework. First, the model does not feature capital and investment dynamics and is thus unable to produce hump-shaped inflation responses to shocks (Christiano et al., 2005). Second, the model is solved around a zero-inflation steady state, a possibly valid approximation, because estimation results from the survey were based on a period of moderate inflation expectations. Still, recent evidence suggests consumers pay more attention to inflation when the level of inflation is higher (Bracha and Tang, 2022; Cavallo et al., 2017). Thus, in a changed inflation regime with higher inflation rates, heterogeneous attention to non-core and core inflation forecasts might be considerably reduced, altering the welfare implications of the policy exercise. Third, standard new Keynesian models do not reflect the granular, decentralized information acquisition of households, which may play a role in asymmetries among sectors, because the frequency of price adjustment differs (see, e.g., L'Huillier, 2020).

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# A Survey Appendix

## A.1 Survey Overview and Sample

The survey was administered on the Qualtrics Research Core Platform, and Qualtrics Research Services recruited participants to provide responses. Survey data used in this paper spans the time from June 09, 2020 to July 07, 2021. Invitations went out to residents of the U.S. Respondents were pre-screened for residence-status, English language fluency, and age. All respondents who failed to meet the screening criteria were discontinued from the survey. Only respondents who confirmed residence in the U.S., who professed English language fluency, and who reported to be of ages above or 18, were brought on to the survey proper. Upon meetings these criteria, we screened responses by removing any participants who took less than five minutes to complete the survey or had at least one gibberish response (e.g., "$sd - \$rt2$").

## A.2 Inflation Expectations and Spending Patterns

### A.2.1 Headline Inflation Expectations

In order to learn on respondents' expectation about future headline inflation I use the following question:

***Q1: Inflation Point Prediction***
*The next few questions are about inflation. Over the next 12 months do you think there will be inflation or deflation?*

*O Inflation*
*O Deflation (opposite of inflation)*

Dependent on the answer given on the previous question, the participant is shown the next question:

*What do you expect the rate of* ***inflation/deflation*** *to be over the next 12 months? Please give your best guess.*
*I expect the rate of* ***inflation/deflation*** *to be _____ percent over the next 12 months.*We choose

to ask on point estimates in this twofold manner in order to avoid issues about the correct sign of the numerical answer, i.e. that respondents intend to answer $-3\%$ but just give 3 into the answer field.

### A.2.2 Category Expectations and Weights

In order to elicit participants category specific inflation expectations and expenditure weights, we ask the following questions:

***Q2: Importance weights***

*Which of the following broad consumption categories matter the most to you right now in your daily life? Please move the slider to indicate the importance for each of them, with 0 indicating no importance and 100 indicating highest importance.*

| | |
|---|---|
| Motor vehicles and parts (such as cars and SUVs) | 0_____\|_____100 |
| Recreational goods and vehicles (such as sports equipment and laptops) | 0_____\|_____100 |
| Other durable goods (such as furniture, appliances, jewelry, luggage) | 0_____\|_____100 |
| Food and beverages for off-premises consumption (such as food from grocery stores) | 0_____\|_____100 |
| Gasoline and other energy goods | 0_____\|_____100 |
| Other nondurable goods (such as clothing, medicine and personal care products) | 0_____\|_____100 |
| Housing and utilities (such as rent and utility bills) | 0_____\|_____100 |
| Health care | 0_____\|_____100 |
| Transportation services (such as public transit tickets and airfare) | 0_____\|_____100 |
| Food services and accommodations (such as restaurants and hotels) | 0_____\|_____100 |
| Other services (such as internet/phone service, education, financial services, hairdressers) | 0_____\|_____100 |

***Q3: Expenditure weights***

*In terms of consumption spending, how much money did you spend on each of the following broad consumption categories during the last month? Please indicate an approximate dollar amount in each field.*

| | |
|---|---|
| Motor vehicles and parts (such as cars and SUVs) | _____ |
| Recreational goods and vehicles (such as sports equipment and laptops) | _____ |
| Other durable goods (such as furniture, appliances, jewelry, luggage) | _____ |
| Food and beverages for off-premises consumption (such as food from grocery stores) | _____ |
| Gasoline and other energy goods | _____ |
| Other nondurable goods (such as clothing, medicine and personal care products) | _____ |
| Housing and utilities (such as rent and utility bills) | _____ |
| Health care | _____ |
| Transportation services (such as public transit tickets and airfare) | _____ |
| Food services and accommodations (such as restaurants and hotels) | _____ |
| Other services (such as internet/phone service, education, financial services, hairdressers) | _____ |

***Q4: Category Inflation***

*Twelve months from now, what do you think will have happened to the price of the following items? I expect the price of ...*

| | | | |
|---|---|---|---|
| Motor vehicles and parts (such as cars and SUVs) | to [increase/decrease] | by | ____ |
| Recreational goods and vehicles (such as sports equipment and laptops) | to [increase/decrease] | by | ____ |
| Other durable goods (such as furniture, appliances, jewelry, luggage) | to [increase/decrease] | by | ____ |
| Food and beverages for off-premises consumption (such as food from grocery stores) | to [increase/decrease] | by | ____ |
| Gasoline and other energy goods | to [increase/decrease] | by | ____ |
| Other nondurable goods (such as clothing, medicine and personal care products) | to [increase/decrease] | by | ____ |
| Housing and utilities (such as rent and utility bills) | to [increase/decrease] | by | ____ |
| Transportation services (such as public transit tickets and airfare) | to [increase/decrease] | by | ____ |
| Food services and accommodations (such as restaurants and hotels) | to [increase/decrease] | by | ____ |
| Other services (such as internet/phone service, education, financial services, hairdressers) | to [increase/decrease] | by | ____ |

## A.3 Demographics

To control for demographics and to make the survey representative, we checked for certain demographic characteristics. These include age, gender, ethnicity, state and postal code of residence, personal income and the highest educational level.

***D1: Age***

*Please enter your age.*

***D2: Gender***

*Please indicate your gender.*

*O Male*
*O Female*
*O Other*

***D3: Ethnicity***

*How would you identify your ethnicity? Please select all that apply.*

*O Asian/Asian American*
*O Black/African American*
*O White/Caucasian*
*O Other*
*O Prefer not to say*

***D4: Hispanic Origin***

*Do you consider yourself of Hispanic, Latino or Spanish origin?*

*O Yes*
*O No*

***D5: Income***

*Please indicate the range of your yearly net disposable income.*

*O Less than $10,000*
*O $10,000 - $19,999*
*O $20,000 - $34,999*
*O $35,000 - $49,999*
*O $50,000 - $99,999*
*O $100,000 - $199,999*
*O More than $200,000*

***D6: State of Residence***

*In which state do you currently reside?*

***D7: Postal Code***

*What is the postal (zip) code for the address of your permanent residence?*

***D8: Educational Attainment***

*What is the highest level of school you have completed, or the highest degree you have achieved?*

*O Less than high school*
*O High school diploma or equivalent*
*O Some college, but no degree*
*O Bachelor's degree*
*O Master's degree*
*O Doctorate or Professional Degree*

# B Additional Tables and Figures

## B.1 PCE Category Mapping

Table 6: PCE to Cleveland Fed Survey Category Mapping

| PCE | Cleveland Fed Survey | Example |
|---|---|---|
| Motor vehicles and parts | Motor vehicles and parts | cars and SUVs |
| Furnishings and durable household equipment | Other durable goods | furniture, appliances, jewelry, luggage |
| Recreational goods and vehicles | Recreational goods and vehicles | sports equipment and laptops |
| Other durable goods | Other durable goods | furniture, appliances, jewelry, luggage |
| Food and beverages purchased for off-premises consumption | Food and beverages for off-premises consumption | food from grocery stores |
| Clothing and footwear | Other nondurable goods | clothing, medicine and personal care products |
| Gasoline and other energy goods | Gasoline and other energy goods | |
| Other nondurable goods | Other nondurable goods | clothing, medicine and personal care products |
| Housing and utilities | Housing and utilities | rent and utility bills |
| Health care | Health care | |
| Transportation services | Transportation services | public transit tickets and airfare |
| Recreation services | Other services | internet/phone service, education, financial services, hairdressers |
| Food services and accommodations | Food services and accommodations | restaurants and hotels |
| Financial services and insurance | Other services | internet/phone service, education, financial services, hairdressers |
| Other services | Other services | internet/phone service, education, financial services, hairdressers |

*Notes:* The table maps the third level PCE disaggregation to the sectors used in the Cleveland Fed Daily Survey of Consumer Expectations and lists the examples given per category to participants. The PCE classification is based upon the U.S. national income and product accounts (NIPA) sector decomposition (”NIPA-PCE”).

## B.2 Robustness: Instrumental Variable Regression

Table 7: Expenditure Weights - Instrumental Variable Regression

| | (1)<br>OLS | (2)<br>IV | (3)<br>OLS | (4)<br>IV | F-stat (first stage) |
|---|---|---|---|---|---|
| Core inflation | 0.375*** | 0.502*** | | | |
| | (22.50) | (22.73) | | | |
| Non-core inflation | 0.803*** | 0.905*** | | | |
| | (22.34) | (18.52) | | | |
| Motor vehicles | | | 0.456*** | 1.127*** | 369 |
| | | | (9.60) | (9.06) | |
| Recreational goods | | | 0.631*** | 1.069*** | 937 |
| | | | (7.00) | (5.15) | |
| Other durable goods | | | 0.349*** | 0.788*** | 935 |
| | | | (4.01) | (2.23) | |
| Food and beverages | | | 0.779*** | 0.786*** | 721 |
| | | | (18.77) | (13.33) | |
| Gasoline and other energy | | | 0.857*** | 0.833*** | 342 |
| | | | (11.67) | (8.11) | |
| Other nondurable goods | | | 0.866*** | 1.570*** | 235 |
| | | | (8.11) | (6.77) | |
| Housing and utilities | | | 0.316*** | 0.217*** | 2268 |
| | | | (12.47) | (6.12) | |
| Health care | | | 0.281*** | 0.238** | 389 |
| | | | (6.66) | (1.92) | |
| Transportation services | | | 0.699*** | 2.270*** | 1194 |
| | | | (4.67) | (5.28) | |
| Food services | | | 0.0707 | 0.478*** | 810 |
| | | | (1.02) | (2.80) | |
| Other services | | | 0.574*** | 0.675*** | 299 |
| | | | (6.44) | (4.61) | |
| Demog. FE | ✓ | ✓ | ✓ | ✓ | |
| Expend. weight control | ✓ | ✓ | ✓ | ✓ | |
| N | 13812 | 14508 | 14525 | 14476 | |
| $R^2$ | 0.507 | 0.516 | 0.510 | 0.507 | |

*Notes:* The table provides cross-sectional OLS and IV estimates based on survey data. Observations are weighted with survey and Huber-robust weights. Standard errors computed as robust standard errors. $t$ statistics in parentheses; $*$ ($p < 0.05$), $**$ ($p < 0.01$), $***$ ($p < 0.001$);

## B.3 Robustness: Importance Weights

Table 8: Importance Weights - Impact of Categories

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Core inflation | 0.613*** | 0.578*** | 0.592*** | | | |
| | (30.22) | (28.05) | (28.66) | | | |
| Non-core inflation | 0.635*** | 0.757*** | 0.803*** | | | |
| | (13.50) | (15.02) | (15.81) | | | |
| Motor vehicles | | | | 0.935*** | 0.814*** | 0.801*** |
| | | | | (11.94) | (10.23) | (9.99) |
| Recreational goods | | | | 0.916*** | 0.803*** | 0.798*** |
| | | | | (7.85) | (6.59) | (6.45) |
| Other durable goods | | | | 0.799*** | 0.726*** | 0.785*** |
| | | | | (6.18) | (5.46) | (5.84) |
| Food and beverages | | | | 0.806*** | 1.019*** | 1.014*** |
| | | | | (12.22) | (14.41) | (14.09) |
| Gasoline and other energy | | | | 0.562*** | 0.593*** | 0.653*** |
| | | | | (9.13) | (9.19) | (10.21) |
| Other nondurable goods | | | | 1.097*** | 1.066*** | 1.060*** |
| | | | | (10.09) | (9.21) | (9.16) |
| Housing and utilities | | | | 0.336*** | 0.441*** | 0.423*** |
| | | | | (5.03) | (6.09) | (5.83) |
| Health care | | | | 0.219*** | 0.255*** | 0.267*** |
| | | | | (3.40) | (4.00) | (4.17) |
| Transportation services | | | | 1.281*** | 1.008*** | 1.029*** |
| | | | | (9.77) | (7.17) | (7.24) |
| Food services | | | | 0.358*** | 0.243* | 0.304** |
| | | | | (3.79) | (2.41) | (2.85) |
| Other services | | | | 0.333*** | 0.404*** | 0.423*** |
| | | | | (3.55) | (4.02) | (4.27) |
| Constant | 2.567*** | | | 2.497*** | | |
| | (29.65) | | | (28.90) | | |
| Demog. FE | × | × | ✓ | × | × | ✓ |
| Expend. weight control | × | ✓ | ✓ | × | ✓ | ✓ |
| N | 15808 | 15784 | 15804 | 15872 | 15857 | 15866 |
| $R^2$ | 0.225 | 0.478 | 0.498 | 0.247 | 0.496 | 0.512 |

*Notes:* The table provides cross-sectional OLS estimates based on survey data. Observations are weighted with survey and Huber-robust weights. Standard errors computed as robust standard errors. $t$ statistics in parentheses; $*$ ($p < 0.05$), $**$ ($p < 0.01$), $***$ ($p < 0.001$);

### B.3.1 Expenditure Shares

Table 9: Survey Expenditure Shares vs PCE

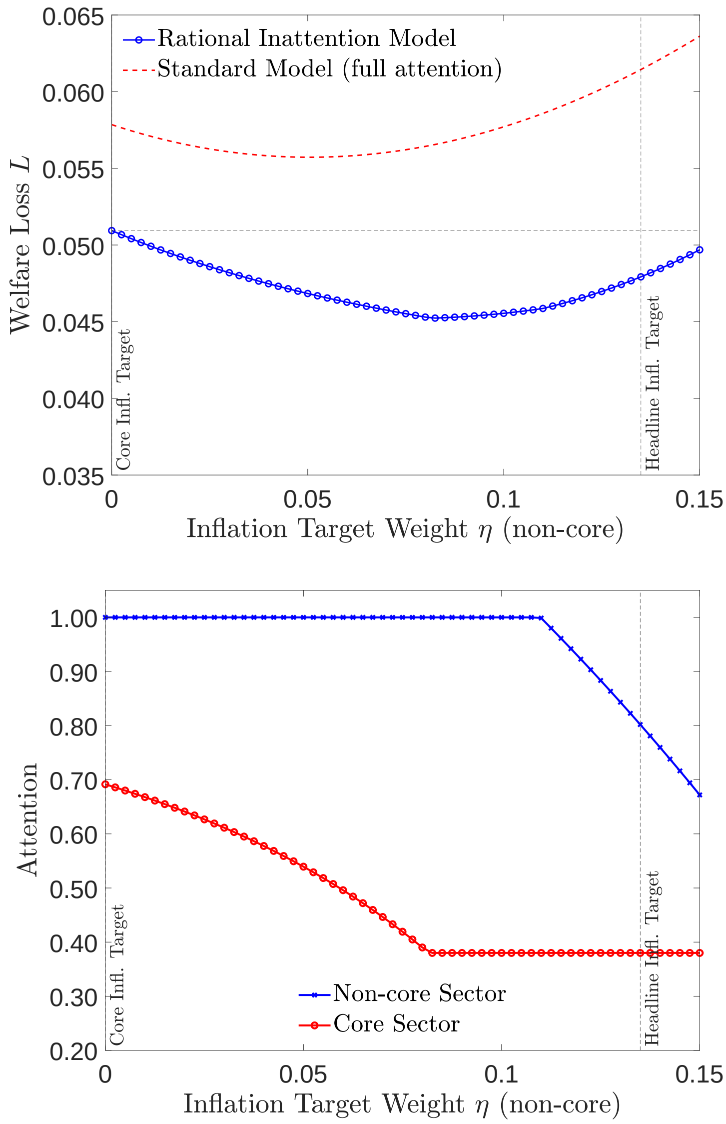
| Category | Survey | PCE (Q3:2020-Q3:2021) |
|---|---|---|
| Motor vehicles | 0.087 | 0.055 |
| | [0.084 0.090] | |
| Recreational goods | 0.045 | 0.046 |
| | [0.043 0.047] | |
| Other durable goods | 0.047 | 0.059 |
| | [0.045 0.049] | |
| Food and beverages | 0.192 | 0.100 |
| | [0.189 0.196] | |
| Gasoline and other energy | 0.073 | 0.025 |
| | [0.072 0.075] | |
| Other nondurable goods | 0.053 | 0.149 |
| | [0.051 0.054] | |
| Housing and utilities | 0.278 | 0.228 |
| | [0.273 0.283] | |
| Health care | 0.070 | 0.207 |
| | [0.068 0.073] | |
| Transportation services | 0.021 | 0.032 |
| | [0.020 0.022] | |
| Food services | 0.052 | 0.077 |
| | [0.051 0.054] | |
| Other services | 0.081 | 0.136 |
| | [0.080 0.083] | |

*Notes:* The table reports survey weighted expenditure shares from the Cleveland Fed Survey of Daily Consumer Expectations, as well as official PCE weights based on data from the Bureau of Economic Analysis (obtained via FRED Economic Data).

## B.4 Additional Figures - Model Analysis

### B.4.1 Baseline Calibration - Attention to Core and Non-core Inflation Expectations

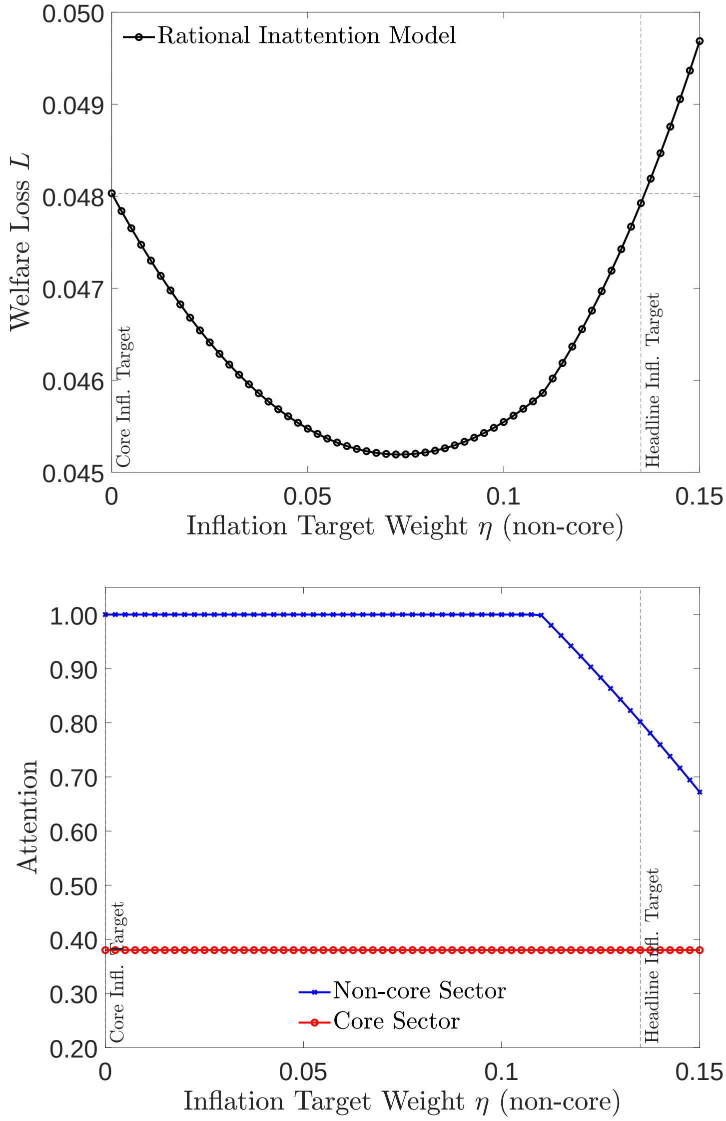
Figure 4: Welfare Loss $\mathbb{L}$ and Attention to Sector Inflation Expectations for Values of Non-core Inflation Weight in Inflation Target Measure




*Notes:* Top panel: blue, dotted line shows welfare loss $\mathbb{L}$ for the calibrated rational inattention model. Red, dashed line contrasts welfare loss for an otherwise identical model, but without rational inattention (full attention model). Welfare loss $\mathbb{L}$ in percentage points of steady state consumption. Bottom panel: red line shows endogenous household attention to core inflation expectations, blue line attention to non-core inflation expectations.

### B.4.2 Robustness - Fixed Attention to Core Inflation Expectations

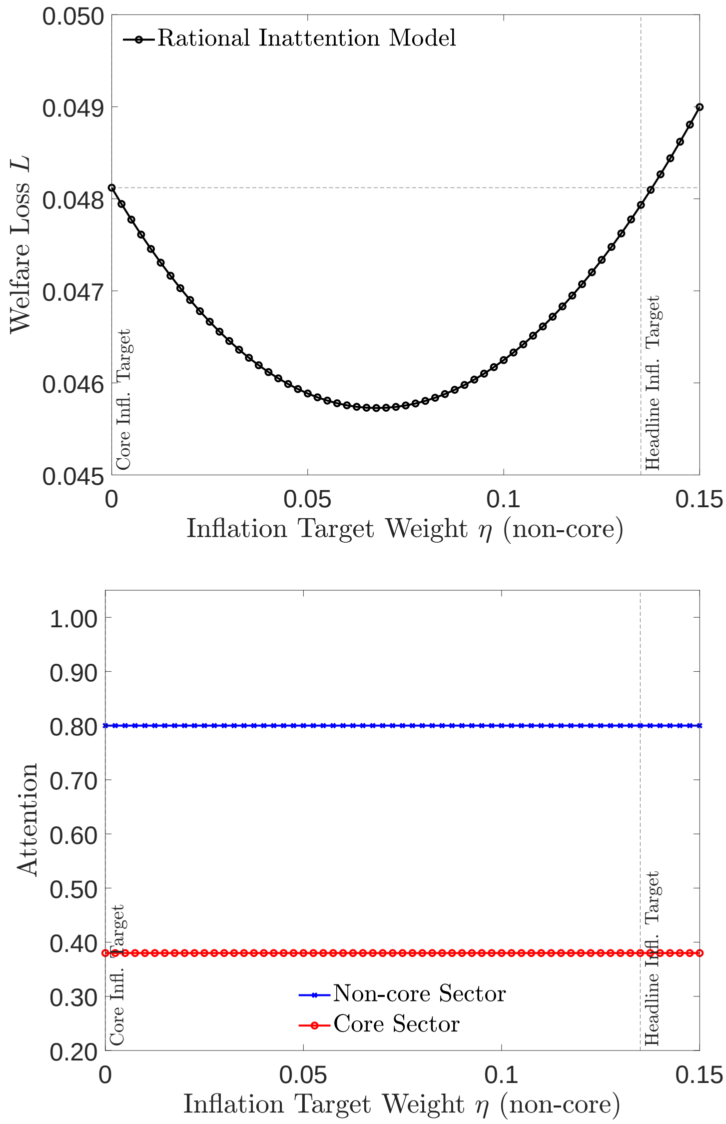
Figure 5: Welfare Loss $\mathbb{L}$ and Attention to Sector Inflation Expectations for Values of Non-core Inflation Weight in Inflation Target Measure - Fixed Attention to Core Inflation




*Notes:* The Figure replicates welfare analysis from figure 2 but keeps attention to core inflation fixed. Top panel: black, dotted line shows welfare loss $\mathbb{L}$ for the calibrated rational inattention model. Welfare loss $\mathbb{L}$ in percentage points of steady state consumption.Welfare losses are 0.21 percent smaller under a headline inflation target, compared to a core inflation target. Bottom panel: red line shows endogenous household attention to core inflation expectations, blue line attention to non-core inflation expectations.

### B.4.3 Robustness - Fixed Attention to Core and Non-core Inflation Expectations

Figure 6: Welfare Loss $\mathbb{L}$ and Attention to Sector Inflation Expectations for Values of Non-core Inflation Weight in Inflation Target - Fixed Attention to Core and Non-Core Inflation




*Notes:* The Figure replicates welfare analysis from figure 2 but keeps attention to core and non-core inflation fixed. Top panel: black, dotted line shows welfare loss $\mathbb{L}$ for the calibrated rational inattention model. Welfare losses are 0.42 percent smaller under a headline inflation target, compared to a core inflation target. Bottom panel: red line shows endogenous household attention to core inflation expectations, blue line attention to non-core inflation expectations.

### B.4.4 Robustness - Core Inflation Target Calibration

The following policy exercise assumes monetary policy follows a core inflation target, despite the stated headline inflation target FOMC (2022). The model is therefore re-calibrated to match inflation statistics and attention levels given that $\eta_{non-core} = 0$. Other parameters, deviation from Table 4 are $\sigma_{core} = 0.0069$ and $\sigma_{non-core} = 0.0177$.

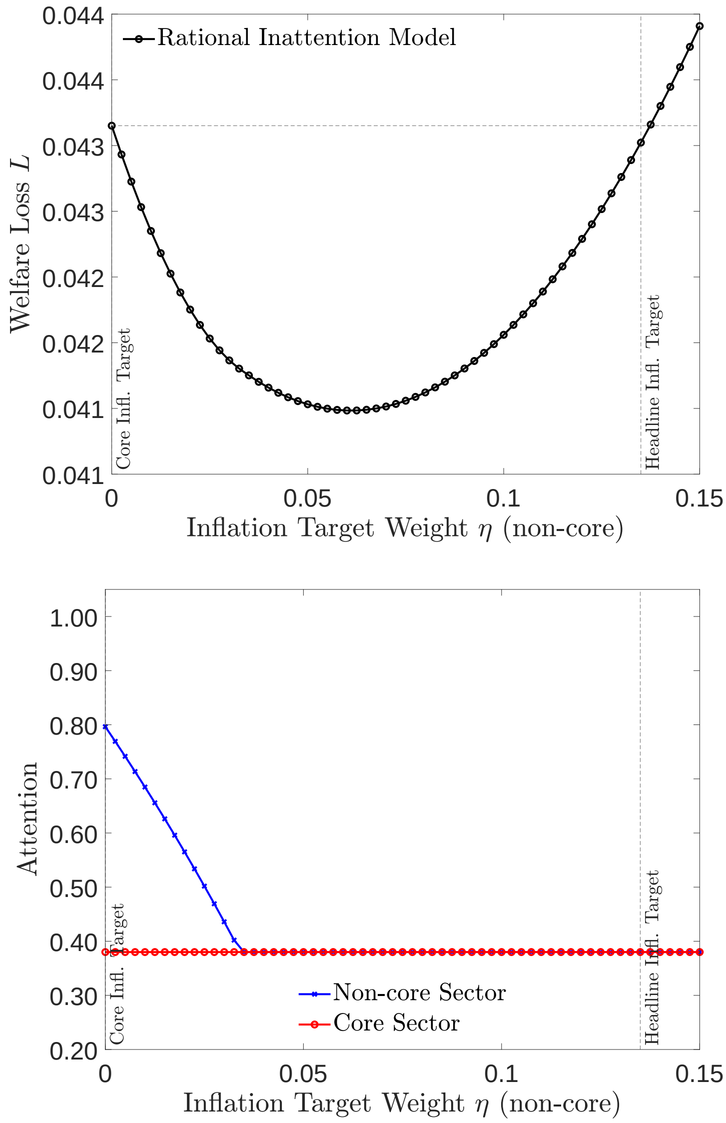
Table 10: Business Cycle and Sectoral Attention Statistics

| | Core inflation | | | Non-core inflation | | |
|---|---|---|---|---|---|---|
| | std($\pi_{core}$) | $\nu_{core}$ | $m_{core}$ | std($\pi_{non-core}$) | $\nu_{non-core}$ | $m_{non-core}$ |
| Data | 0.14 | 0.865 | 0.38 | 1.50 | 0.135 | 0.80 |
| Model | 0.14 | 0.865 | 0.38 | 1.47 | 0.135 | 0.80 |

*Notes:* Business Cycle Statistics for core and non-core inflation sectors and estimated attention levels (see section 3). Model calibration assumes a core inflation target, $\eta_{non-core} = 0$. Empirical data obtained via the St. Louis Fed's FRED database. Business cycle statistics rely on quarterly data between 1990Q1 and 2020Q1. Standard deviations are reported in percent.

Figure 7 shows switching to a headline inflation target, from the initial core inflation target, would reduce average per period welfare losses by 0.47 percent. Given fixed attention levels, similar to figure 6, the effect is larger, at 1.62 percent.

Figure 7: Welfare Loss $\mathbb{L}$ and Attention to Sector Inflation Expectations for Values of Non-core Inflation Weight in Inflation Target Measure - Initial Core Inflation Calibration




*Notes:* The figure replicates welfare analysis from figure 2 but keeps attention to core and non-core inflation fixed. Top panel: black, dotted line shows welfare loss $\mathbb{L}$ for the calibrated rational inattention model. Switching to a headline inflation target would reduce welfare losses by 0.47 percent, compared to the initial core inflation target. Bottom panel: red line shows endogenous household attention to core inflation expectations, blue line attention to non-core inflation expectations.

# C Further Proofs and Derivations

## C.1 Sparsity-based Rational Inattention in Headline Expectations Formation - Partial Equilibrium

This section derives the second order Taylor Approximation around small changes in $\Pi_{t+1}$, the $(K \times 1)$ vector of category inflation rates $\pi_{k,t+1}$. I denote the deviation of behavioral from full attention headline inflation expectations as

$$\Theta_{t+1}(m) = \mathbb{E}_t^B \pi_{t+1} - \mathbb{E}_t \pi_{t+1} \tag{C.1}$$

All subsequent derivatives are evaluated at the *default point*, that is zero attention, $m = \overrightarrow{0}_{K,1}$ and the default expectation, the expected value of category inflation rates, $\mathbb{E}\,\pi_{k,t+1} = \bar{\pi}_k$. In that case, it holds that $\Theta_{t+1} = 0$. In addition it set the default headline inflation expectation as $\mathbb{E}_t \pi_{t+1} = \sum_{k=1}^{K} \omega_k \bar{\pi}_k$. Following Gabaix (2014), I now define the utility differential between the behavioral and rational action:

$$V(\Pi_{t+1}) = u\left(\Theta(m, \Pi_{t+1})\right) \tag{C.2}$$

The *first derivative* with respect to $\Pi_{t+1}$ is:

$$V_{\Pi_{t+1}}(m, \Pi_{t+1}) \;\; = \;\; u_\Theta(\Theta)(\Theta_{\Pi_{t+1}}) \tag{C.3}$$

Evaluated at the default point this is equal to $V_{\Pi_{t+1}}(\overrightarrow{0}_{N,1}, \bar{\Pi}) = 0$. Next, I take the *second derivative*:

$$V_{\Pi_{t+1}\Pi_{t+1}}(m, \Pi_{t+1}) \;\; = \;\; (\Theta_{\Pi_{t+1}})' u_{\Theta\Theta}(\Theta)(\Theta_{\Pi_{t+1}}) + u_\Theta(\Theta)(\Theta_{\Pi_{t+1}\Pi_{t+1}})$$

Again evaluating at the default point, additionally using $u_{\Theta\Theta} = 1$, I arrive at

$$V_{\pi_{t+1}\Pi_{t+1}}(\overrightarrow{0}_{N,1}, \bar{\Pi}) \;\; = \;\; (\Theta_{\Pi_{t+1}})' u_{\Theta\Theta}(\Theta)(\Theta_{\Pi_{t+1}}) \tag{C.4}$$

Using these results, we can now define the Taylor approximation of the expected utility loss due to inattention, arising from small deviations of $\Pi_{t+1}$ from its mean $\bar{\Pi}$:

$$\begin{aligned}
\mathbb{E}[V] \;\; &\approx \;\; \mathbb{E}[V(m, \Pi_{t+1})] + \mathbb{E}[V_{\Pi_{t+1}}(m, \Pi_{t+1})(\Pi_{t+1} - \bar{\Pi})] \\
&\quad + \frac{1}{2}\,\mathbb{E}[(\Pi_{t+1} - \bar{\Pi}) V_{\Pi_{t+1}\Pi_{t+1}}(m, \Pi_{t+1})(\Pi_{t+1} - \bar{\Pi})] \\
&\approx \;\; \frac{1}{2}\,\mathbb{E}\left[(\Pi_{t+1} - \bar{\Pi})\Theta_{\Pi_{t+1}}(\Pi_{t+1})' u_{\Theta\Theta}(\Theta)\Theta_{\Pi_{t+1}}(\Pi_{t+1})(\Pi_{t+1} - \bar{\Pi})\right] \\
&\approx \;\; \left[\frac{1}{2}\sum_{k=1}^{K} \sigma_i (m_k - 1)^2 \omega_k^2\right]
\end{aligned}$$

The last step uses $u(\Theta) = \Theta^2$, $u_{\Theta\Theta} = 1$, the variance expression $E[(\pi_{k,t+1} - \bar{\pi}_k)^2] = \sigma_k$ as well as the agent assuming all covariances to be 0. Also, it replaces $\Theta_{\pi_{t+1}}$ by $\Theta_{\pi_{t+1}} = \omega_i(m_i - 1)$. The last line is then equal to the expression in the main text.

### C.2 New Keynesian Model Steady State

I consider a steady state that is symmetric across all sectors, that is, $P_k/P_l = 1\ \forall k, l$. This section derives a condition for the existence of the symmetric steady state. Relative prices in steady state are, assuming that the elasticity of substitution $\epsilon$ and labor share in production $\alpha$ is equal across all sectors:

$$\frac{P_k}{P_l} = \frac{W_k}{W_l}\left(\frac{N_k}{N_l}\right)^{\alpha} \tag{C.5}$$

I additionally scale the steady state level of technology in both sectors to $A_k = A_l = 1\ \forall k, l$. Relative labor supply is governed by

$$\frac{\xi_k}{\xi_l}\left(\frac{N_k}{N_l}\right)^{\varphi} = \frac{W_k}{W_l} \tag{C.6}$$

Relative consumption and output are defined by

$$\frac{C_k}{C_l} = \frac{\omega_k}{\omega_l}\frac{P_l}{P_k} \tag{C.7}$$

$$\frac{C_k}{C_l} = \frac{Y_k}{Y_l} = \left(\frac{N_k}{N_l}\right)^{1-\alpha} \tag{C.8}$$

Where the first line follows from demand equations (5.4) and the second line from the production function as well as the goods market clearing equation $Y_k = C_k\ \forall k$. Next, I combine the equation for relative prices (C.5) with the relative labor supply condition (C.6) to

$$\frac{P_1}{P_2} = \frac{\zeta_1}{\zeta_2}\left(\frac{N_1}{N_2}\right)^{\alpha+\varphi}$$

Relative consumption (C.7) and output (C.8) can be solved for an expression of relative labor supply:

$$\frac{N_k}{N_l} = \left(\frac{\omega_l}{\omega_k}\frac{P_k}{P_l}\right)^{1/(\alpha-1)}$$

Now, I can solve for the relative price level, combining the previous two lines:

$$\frac{P_k}{P_l} = \left[\left(\frac{\zeta_k}{\zeta_l}\right)^{1-\alpha}\left(\frac{\omega_k}{\omega_l}\right)^{\alpha+\varphi}\right]^{1/(1+\varphi)}$$

For a symmetric steady state with $P_l = P_l\ \forall k, l$ it is a sufficient condition that $\zeta_k = \omega_k^{-\frac{\varphi+\alpha}{1-\alpha}}\ \forall k$. Given this condition, I find that $C_k = \omega_k C$, due to $P = P_k$. It follows that $N_k = \omega_k^{1/(1-\alpha)} C^{1/(1-\alpha)}$. Further, as the real wage in each sector is equal to the marginal productivity $(1-\alpha)N_k^{-\alpha}$, I can show that:

$$N_k = \left[\frac{\epsilon(1-\alpha)}{\epsilon-1}\right]^{1/(1+\varphi)} \omega_k^{\frac{\varphi+\alpha}{(1+\varphi)(1-\alpha)}}$$

In turn, I can solve for aggregate output in steady state as:

$$C = \left[\frac{\epsilon(1-\alpha)}{\epsilon - 1}\right]^{\frac{1-\alpha}{1+\varphi}} \sum_{k=1}^{K} \omega_k^{\varphi-\alpha}$$

## C.3 Marginal Costs and Natural Level of Output

To derive an expression for the real marginal costs (marginal costs divided by sectoral price), I use

$$\psi_{k,t} - p_{k,t} \quad = \quad w_{k,t} - p_{k,t} - mpn_{k,t}.$$

Next, I substitute for the marginal productivity of labor $mpn_{k,t} = \log(1-\alpha) + a_{k,t} - \alpha n_{k,t}$

$$\psi_{k,t} - p_{k,t} \quad = \quad w_{k,t} - p_{k,t} - \log(1-\alpha) - a_{k,t} + \alpha n_{k,t}.$$

Prices in sector $k$ can be expressed as a function of the aggregate price level and the terms of trade $p_{1,k} = p_t + \tau_{k,t}$.

$$\psi_{k,t} - p_{k,t} \quad = \quad (w_{k,t} - p_t) - \tau_{k,t} - \log(1-\alpha) - a_{k,t} + \alpha n_{k,t}$$

This formulation now allows to substitute for the linearized labor supply decision of households $\varphi n_{k,t} + y_t = w_{k,t} - p_t$:

$$\psi_{k,t} - p_{k,t} \quad = \quad y_t - \tau_t - \log(1-\alpha) - a_{k,t} + (\varphi + \alpha) n_{k,t}.$$

Now, I use the households' sectoral demand function to link sectoral output to total output and the terms of trade.

$$y_{k,t} \quad = \quad y_t + p_t - p_{k,t} = y_t - \tau_{k,t}.$$

Inserting gives the following expression

$$\psi_{k,t} - p_{k,t} \quad = \quad y_{k,t} - \log(1-\alpha) - a_{k,t} + (\varphi + \alpha) n_{k,t}.$$

Labor input in each sector is linked to output via the production function $n_{k,t} = \frac{1}{1-\alpha} y_{k,t} - \frac{1}{1-\alpha} a_{k,t}$. Thus, the equation now reads

$$\psi_{k,t} - p_{k,t} \quad = \quad -\log(1-\alpha) + \frac{1+\varphi}{1-\alpha} y_{k,t} - \frac{1+\varphi}{1-\alpha} a_{k,t}.$$

In order to find the natural level of output, I assume prices are flexible, that is, $p_{k,t} = \mu + \psi_{k,t}$ for each period.

$$-\mu \quad = \quad -\log(1-\alpha) + \frac{1+\varphi}{1-\alpha} y^n_{k,t} - \frac{1+\varphi}{1-\alpha} a_{k,t}.$$

This then solves to

$$y^n_{k,t} \quad = \quad \vartheta + a_{k,t}.$$

With $\vartheta = \frac{(1-\alpha)[\log(1-\alpha)-\mu]}{1+\varphi}$. Note the natural level of output is thus a function of the (exogenous) level of technology and thus independent of monetary policy choices.

### C.4 Inflation Dynamics in Symmetric Sectors

Proposition 3 establishes the relative price between two sectors $k$ and $l$ is constant in the model if they share the same level of technology $A_{k,t} = A_{l,t}\ \forall t$, disutility of labor supply $\zeta_k = \zeta_l$ and pricing rigidities $\theta_k = \theta_l$. The relative price is then a function of relative sector size and disutility of labor supply.

**Proposition 3** (Symmetric Sectors)**.** *If two sectors $k$ and $l$ are symmetric in their production function, $A_{k,t} = A_{l,t}\ \forall t$ and have the same probability of price adjustment, $\theta_k = \theta_l$, as well as disutility of labor supply $\zeta_k = \zeta_l$ the relative price between sectors is constant.*

$$\frac{P_{k,t}}{P_{l,t}} = \frac{\omega_{k,t}}{\omega_{l,t}} \quad \forall\, t. \tag{C.9}$$

■

The relative price between sectors $k$ and $l$ is defined by the following equation:

$$\frac{P_{k,t}}{P_{l,t}} = \frac{\omega_{k,t}}{\omega_{l,t}} \frac{Y_{l,t}}{Y_{k,t}} \tag{C.10}$$

$$= \frac{\omega_{k,t}}{\omega_{l,t}} \left(\frac{N_{l,t}}{N_{k,t}}\right)^{1-\alpha} \left(\frac{D_{l,t}}{D_{k,t}}\right)^{\alpha-1}. \tag{C.11}$$

where the second line uses the sectoral production function. $D_{k,t} = \int_0^1 \left(\frac{Pk,t(j)}{P_{k,t}}\right)^{-\epsilon} dj$ is a measure of price dispersion in sector $k$. The third line follows from equation (5.5) and the equality of marginal productivity of labor and the real wage that $N_{k,t} = N_{l,t}$ if it holds that $A_{k,t} = A_{l,t}$. Appendix 3.3 in Galí (2015) discusses the price dispersion $D_t$. Intuitively, the price dispersion is equal in two symmetric sectors, when price rigidities are equal $\theta_k = \theta_l = \theta$ and both sectors face equal shocks. Thus,

$$\frac{P_{k,t}}{P_{l,t}} = \frac{\omega_{k,t}}{\omega_{l,t}}. \tag{C.12}$$

### C.5 Sparsity-based Rational Inattention in the New Keynesian Model

#### C.5.1 Endogenous Attention - General Result

In order to endogenize the level of attention of households, I rewrite utility $U$ as:

$$\nu(a_t, S_t, m) = \mathcal{W}_t(a_t) + \beta\,\mathbb{E}\,V(S_{t+1}, m),$$

where $S_t$ gives a vector of macro variables of the model, treated as given by the households optimization problem. $a$ denotes the action chosen (in this model, this corresponds to consumption choices and sectoral labor input) and $V$ the subjective households' value function. The expected value is dependent on this periods value of $S_t$ as well as future shocks $\epsilon_{t+1}$ and attention $m$. The household wants to maximize her utility - evaluated as the true model - given imperfect action $a_t(S_t, m)$ due to inattention:

$$\max_m \mathbb{E}\left[\nu(a_t(S_t, m), S_t, 1)\right] - \mathcal{K}g(m),$$

where $\mathcal{K}g(m)$ gives the mental disutility of attention: For a rational agent, I set the parameter $\mathcal{K}$ to 0.
As this problem is intractable, the household replaces it by a second order Taylor approximation of the utility losses of inattention.

$$\begin{aligned} L(S_t, m) &= \nu(a(S_t, m), S_t, 1) - \nu(a(S_t, 1), S_t, 1) \\ &= \nu(a(S_t, m) + \hat{a}(S_t, m), S_t, 1) - \nu(a(S_t, 1), S_t, 1) \\ &= \frac{1}{2}\left[\hat{a}'(S_t, m)\nu_{aa}(a(S_t, 1), S_t, 1)\hat{a}(S_t, m)\right]. \end{aligned} \tag{C.13}$$

Here, the variable $\hat{a}(S_t, m) = a(S_t, m) - a(S_t, 1)$ denotes the error due to inattention. The bounded rational action can be approximated by:

$$a(S_t, m) = a(0, 1) + \frac{\partial a(S_t, 1)}{\partial S_t} m S_t, \tag{C.14}$$

due to inattention entering the model linearly. I can thus write:

$$\hat{a}(S_t, m) = \frac{\partial a(S_t, 1)}{\partial S_t}(m - 1)S_t.$$

It also follows from (C.14) that $a_{m,x}(0, m^d) = \frac{\partial a(S_t,1)}{\partial S_t}$. Thus, I can write (C.13) as

$$L(S_t, m) = \frac{1}{2}\left[S_t'(m-1)a_{m,S}'(0, m^d)\nu_{aa}(a_t(S_t, 1), S_t, 1)a_{m,x}(0, m^d)(m-1)S_t\right]. \tag{C.15}$$

### C.5.2 Endogenous Attention - Model Application

I follow Gabaix (2020) and apply $\nu_{aa} = u_{aa}$ in the limit of small time intervals. For the utility function defined in (5.1), it holds

$$u_{aa} = \begin{bmatrix} -C^{-2} & 0 & 0 & 0 \\ 0 & \varphi\zeta_1 N_1^{\varphi-1} & 0 & 0 \\ 0 & 0 & ... & 0 \\ 0 & 0 & 0 & \varphi\zeta_K N_K^{\varphi-1} \end{bmatrix}.$$

Next, I define the bounded rational response of the household, for consumption as well as the labor supply decisions. Building on the log linearized Euler equation and using $c_t = \frac{C_t - C}{C}$

$$C_t = C - CE_t \sum_{g=0} \left[ \sum_{k=1}^{K} m_k \omega_k \pi_{k,t+1+g} \right].$$

For the labor supply decision, I can use:

$$N_{k,t} \quad = \quad \frac{1}{\varphi} N_k \left[ -\frac{C_t}{C} + w_{k,t} - p_t + 1 - \varphi \right].$$

Using those equations, I can derive $a_m$:

$$a_m = Z \left[ \omega_k E_t \sum\nolimits_{g=0} \pi_{k,t+1+g} \quad . \ . \ . \quad \omega_K E_t \sum\nolimits_{g=0} \pi_{K,t+1+g} \right], \tag{C.16}$$

where $Z = [C \quad -\frac{N_1}{\varphi} \quad . \ . \ . \quad -\frac{N_K}{\varphi}]'$ is a vector of steady state values. I can now proceed with

$$a_m(I - m) = \sum_{k=1}^{K} a_{m_k}(1 - m_k),$$

where each element $a_{m_k}$ on the right hand side is an $(K \times 1)$ matrix. Using the solution of the model in matrix notation, I write

$$\begin{aligned} E_t \sum_{g=0} \pi_{k,t+1+g} &= \Pi_{\pi_k,\cdot} \sum_{k=0} \Psi_0^k \Psi_0 S_t \\ &= \Pi_{\pi_k,\cdot}(I - \Psi_0)^{-1} \Psi_0 S_t. \end{aligned}$$

Using this result as well as equations (C.16) and (C.17), I can write $a_{m_k,S} = Z\omega_k \Pi_{\pi_k,\cdot}(I - \Psi_0)^{-1}\Psi_0$ with $a_{m_k,S}$ as a $(3 \times 3)$ matrix.

Applying these results to the general second order approximation in equation (C.15), I have

$$\begin{aligned} L(S_t, m) &= \frac{1}{2}\left[S_t'(m-1)a_{m,S}'(0, m^d)\nu_{aa}(a_t(S_t, 1), S_t, 1)a_{m,S}(0, m^d)(m-1)S_t\right] \quad \text{(C.17)} \\ &= \frac{1}{2}\left[S'\left(a_{m_1,S}(1-m_1) + a_{m_2,S}(1-m_2)\right)' \tilde{u}_{aa}a_{m,S}(0, m^d)(m-1)S_t\right] \\ &= \frac{1}{2}\sum_{k=1}^{2}\sum_{l=1}^{2}\left[S_t'\left(\Pi_{\pi_k,\cdot}(I-\Psi_0)^{-1}\Psi_0\right)' \tilde{u}_{aa}\Pi_{\pi_l,\cdot}(I-\Psi_0)^{-1}\Psi_0 S_t\right] \\ &= \frac{1}{2}\sum_{k=1}^{2}\sum_{l=1}^{2}\left[\Pi_{\pi_k,\cdot}(I-\Psi_0)^{-1}\Psi_0 S_t \tilde{u}_{aa} S_t'\left(\Pi_{\pi_l,\cdot}(I-\Psi_0)^{-1}\Psi_0\right)'\right] \\ &= \frac{1}{2}\sum_{k=1}^{2}\sum_{l=1}^{2}\Theta_{k,l}(1-m_k)(1-m_j)\omega_j\omega_k. \end{aligned}$$

with $\tilde{u}_{aa} = Z'u_{aa}Z = -C - \sum_{k=1}^{K}\zeta_k N_k^{\varphi+1}$ in the third line, which is a scalar. In line four I use that the termm $\Pi_{\pi_l,\cdot}(I-\Psi_0)^{-1}\Psi_0 S_t$ is also a scalar for which the commutative property applies. Thus, in the third line, I can use that the co-variance between the sum of future expected inflation in sector k and sector j is equal to $\Theta_{k,l} = \mathbb{E}\left[\Pi_{\pi_l,\cdot}(I-\Psi_0)^{-1}\Psi_0\Theta_S\left(\Pi_{\pi_k,\cdot}(I-\Psi_0)^{-1}\Psi_0\right)'\right]$. Here, $\Theta_S = \mathbb{E}(SS')$ gives the covariance matrix of the models state variables:

$$\begin{aligned} S_t &= \Psi_0 S_{t-1} + \Psi_1\epsilon_t \\ vec(\Theta_S) &= (I - \Psi_0 \otimes \Psi_0)^{-1} vec(\Psi_1\sigma_\epsilon\Psi_1'). \end{aligned}$$

## C.6 Welfare

I derive a welfare criterion via a second order Taylor approximation of the utility function around its steady state, following Galí (2015):

$$\frac{U_t - U}{U_C C} \approx \hat{y}_t + \sum_{k=1}^{K} \frac{U_{N_k} N_k}{U_C C} \left( \hat{n}_k + \frac{1+\varphi}{2} \hat{n}_k^2 \right) + t.i.p. + ||\mathcal{O}^3||,$$

where $t.i.p.$ gives terms independent of policy and moments in excess of the second are ignored. Variables with a hat notation denote log deviations from steady state, that is $\hat{x} = x_t - x$, with $x_t = log(X_t)$. Next, I insert an expression for the log deviation of sectoral labor supply $\hat{n}_k = \frac{1}{1-\alpha}(y_{k,t} - a_{k,t} + d_{k,t})$ that follows from production function and labor market aggregation. $d_{i,k} = \frac{\epsilon}{2\Theta_k} var(p_k)$ with $\Theta = \frac{1-\alpha}{1-\alpha+\alpha\epsilon}$ measures the price dispersion across firms in sector $k$ (see Galí (2015), appendix 3.3).

$$\frac{U_t - U}{U_C C} \approx \hat{y}_t + \sum_{k=1}^{K} \frac{U_{N_k} N_k}{U_C C} (1-\alpha)^{-1} \left( \hat{y}_1 + \frac{\epsilon}{2\Theta} var(p_k) + \frac{1}{2}\Gamma(\hat{y}_{k,t} - a_{k,t})^2 \right) + t.i.p. + ||\mathcal{O}^3||.$$

Then, I apply $\frac{U_{N_k} N_k}{U_C C} = \zeta_k N_k^{1-\varphi} = \frac{W_k}{P} \frac{N_k}{Y} = (1-\alpha)\frac{Y_k}{Y}$ which follows from equating the marginal productivity of labor in sector $k$ and the sector $k$ specific real wage rate. Finally, I use $\omega_k Y = Y_k$:

$$\frac{U_t - U}{U_C C} \approx \hat{y}_t - \sum_{k=1}^{K} \omega_k \left( \hat{y}_{k,t} + \frac{\epsilon}{2\Theta} var(p_1) + \frac{1}{2}\Gamma(\hat{y}_{k,t} - a_{k,t})^2 \right) + t.i.p. + ||\mathcal{O}^3||.$$

Applying $\hat{y}_t = \sum_{k=1}^{K} \omega_k \hat{y}_{k,t}$ simplifies to:

$$\frac{U_t - U}{U_C C} \approx -\sum_{k=1}^{K} \frac{\omega_k}{2} \left( \frac{\epsilon}{\Theta} var(p_k) + \Gamma(\hat{y}_{k,t} - a_{k,t})^2 \right) + t.i.p. + ||\mathcal{O}^3||.$$

We may proceed to:

$$\frac{U_t - U}{U_C C} \approx -\frac{\omega}{2} \left( \frac{\epsilon}{\Theta} var(p_1) + \Gamma \hat{y}_{k,t}^2 - 2\Gamma \hat{y}_{k,t} a_{k,t} \right) + t.i.p. + ||\mathcal{O}^3||.$$

Here, I use that $a_{k,t}^2$ is independent of policy, that is, formally part of $t.i.p.$. Next, $a_k$ is substituted by an expression for the log deviation of natural level of output from its steady state, $\hat{y}_{k,t}^n = y_{k,t}^n - y_k^n$. It holds that $\hat{y}_{k,t}^n = a_{k,t}$, as the log of the steady state level of technology is 0. Thus, it follows that

$$\frac{U_t - U}{U_C C} \approx -\sum_{k=1}^{K} \frac{\omega_k}{2} \left( \frac{\epsilon}{\Theta} var(p_k) + \Gamma(\hat{y}_{k,t}^2 - 2\hat{y}_{k,t}\hat{y}_{k,t}^n) \right) + t.i.p. + ||\mathcal{O}^3||.$$

Using the expression for the sectoral output gap $\tilde{y}_{k,t} = \hat{y}_{k,t} - \hat{y}^n_{k,t}$,[34] I find that $\tilde{y}^2_{k,t} = \hat{y}^2_{k,t} - 2\hat{y}_{k,t}\hat{y}^n_{k,t} + \hat{y}^{n^2}_{k,t}$.

$$\frac{U_t - U}{U_C C} \approx -\sum_{k=1}^{K} \frac{\omega_k}{2}\left(\frac{\epsilon}{\Theta} var(p_1) + \Gamma\tilde{y}^2_{k,t} - \Gamma\hat{y}^{n^2}_{k,t}\right) + t.i.p. + ||\mathcal{O}^3||.$$

As the natural level of output is independent of monetary policy it follows:

$$\frac{U_t - U}{U_C C} \approx -\sum_{k=1}^{K} \frac{\omega_k}{2}\left(\frac{\epsilon}{\Theta} var(p_k) + \Gamma\tilde{y}^2_{k,t}\right) + t.i.p. + ||\mathcal{O}^3||.$$

Next, similar to Woodford (2003), I apply $\sum_{t=0}^{\infty} \beta^t var(p_i) = \sum_{t=0}^{\infty} \beta^t \frac{\theta_i}{(1-\beta\theta_i)(1-\theta_i)} \pi^2_{i,t}$ and define the welfare function of a representative consumer as $\mathbb{W} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{U_t - U}{U_C C}$, such that

$$\mathbb{W} = -\frac{1}{2}\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\Gamma \sum_{k=1}^{K} \tilde{y}^2_{k,t} + \omega_k \sum_{k=1}^{K} \frac{\epsilon}{\lambda_k} \pi^2_{k,t}\right] + t.i.p + ||\mathcal{O}^3||, \quad \text{(C.18)}$$

where $\Gamma = \frac{1+\varphi}{1-\alpha} > 0$ and $\lambda_k = \frac{(1-\theta_k)(1-\beta\theta_k)}{\theta_k}\Theta$. Following Galí (2015), I rewrite the welfare function $\mathbb{W}$ as the average per period welfare loss for households, $\mathbb{L}$.

$$\mathbb{L} = \frac{1}{2}\left[\Gamma \sum_{k=1}^{K} var(\tilde{y}_{k,t}) + \omega_k \sum_{k=1}^{K} \frac{\epsilon}{\lambda_k} var(\pi_{k,t})\right] + t.i.p + ||\mathcal{O}^3||. \quad \text{(C.19)}$$

Equation (C.19) is then equal to equation (5.35) in Proposition 2.

[34] The steady state value of the output gap is zero by definition.