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

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What Inflation Measure Should the Central Bank Target?

Central Banks' price stability mandate: Which prices should the central bank stabilize?

- What is the optimal inflation measure to target?

New Keynesian perspective: **Core inflation** target optimal

- Exclude volatile food & energy prices with low nominal rigidities from inflation target

This paper: **Headline inflation** target optimal

- Food & energy prices are key determinants of household inflation expectations

This Paper

New **micro evidence** on consumer expectations

- Survey on inflation expectations for consumption categories (e.g., Dietrich et al., 2022)
- Disproportionate focus on food & energy components in inflation expectations

Explain findings by **sparsity-based rational inattention** model (Gabaix, 2014)

- Consumers pay more attention to volatile food & energy inflation expectations

Structural **multi-sector New Keynesian model** with rational inattention in expectations

- Expected food & energy inflation key source of demand volatility
- Quantitative welfare analysis: headline inflation target welfare maximizing

The Literature

Household inflation expectations

- Gas prices: Binder (2018), Coibion and Gorodnichenko (2015), Binder and Makridis (2022)
- Grocery prices: D'Accunto et al. (2020)
- Non-core prices: Arora et al. (2013), Trehan (2011)

This paper:

- Data on **inflation expectations for consumption categories**
- Estimate sensitivity of expectations to **full range of consumption categories**

The Literature

Optimal inflation target measure

- Core inflation target: Goodfriend and King (1997), Aoki (2001), Eusepi et al. (2011)
- Energy prices: Barnett et al. (2018), Bodenstein et al. (2008)
- Production networks: Huang and Liu (2005), La'O and Tahbaz-Salehi (2022), Rubbo (2022)

This paper:

- **Role of inflation expectations** for the optimal inflation target measure

Federal Reserve Bank of Cleveland's Daily Survey of Consumers

Module on inflation expectations from June, 2020 through July, 2021 (Dietrich et al., 2022)

- Representative of U.S. consumers, $N \approx 18,000$
  (age, gender, race, income, education and region)
- Survey weights to adjust for sampling inaccuracy
- Daily cross-section of ≈ 200 respondents, no panel structure

Survey Data

Elicit 12-months ahead inflation expectations as point forecasts

- **Headline** inflation expectations $\mathbb{E}_t^i \pi_{t+1}$
  - Similar to NY Fed SCE question format
- **Category** inflation expectations $\mathbb{E}_t^i \pi_{k,t+1}$
  - Split PCE consumption basket into 11 consumption categories
  - Question similar to headline expectation
- Personal **spending** patterns
  - S_k^i spending in dollars per category; construct category weights $\omega_k^i = S_k^i / \sum_{k=1}^{11} S_k^i$

Headline Question (NY Fed SCE) PCE categories Category Question Expenditure weights

Categories

Category	Example
Motor vehicles and parts	Cars and SUVs
Recreational goods and vehicles	Sports equipment and laptops
Other durable goods	Furniture, appliances, jewelry, luggage
Food and beverages	Food from grocery stores
Gasoline and other energy goods	
Other nondurable goods	Clothing, medicine and personal care products
Housing and utilities	Rent and utility bills
Health care	
Transportation services	Public transit tickets and airfare
Food services and accommodations	Restaurants and hotels
Other services	Internet/phone service, education, financial services

- Survey shows some examples for most product categories
- Categories similar to 3^{rd} level PCE disaggregation of BEA, combining some smaller categories for our survey

Category Inflation Expectation - Survey Question

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

	Increase/Decrease	By ____ %
the price of **motor vehicles and parts** (such as cars and SUVs) to ___ [increase/decrease] by ___ percent		
the price of **recreational goods and vehicles** (such as sports equipment and laptops) to ___ [increase/decrease] by ___ percent		
the price of **other durable goods** (such as furniture, appliances, jewelry, luggage) to ___ [increase/decrease] by ___ percent		

Internal Consistency of Expectations

Consistency between reported personal headline and category expectations

- Literature: consumers refer to their own consumption basket (e.g., Jonung, 1981, Weber et al., 2022) and rely on granular price information (e.g., D'Acunto et al., 2022, 2021)
- Aggregate category forecasts with personal expenditure weights

$$\underbrace{\mathbb{E}_t^i \pi_{t+1}}_{\text{Aggregate Forecast}} = \sum_{k=1}^{11} \overbrace{\omega_k^i}^{\text{Expend. Weight}} \underbrace{\mathbb{E}_t^i \pi_{k,t+1}}_{\text{Category Forecast}}$$

Deviations from Internal Consistency of Expectations

Large mental effort required to account for all components

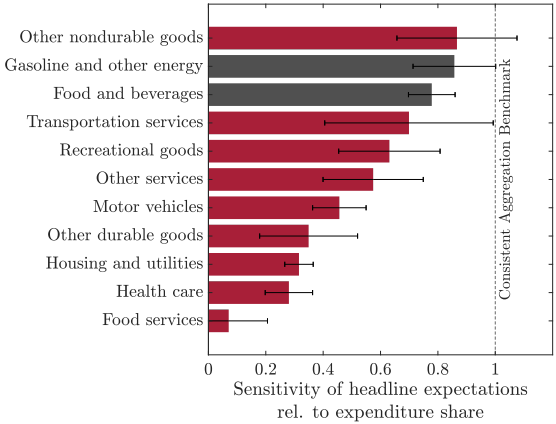
- Consumers rely on mental shortcuts (Tversky and Kahneman, 1974)

Estimate sensitivity m_k of headline forecast towards categories:

$$\underbrace{\mathbb{E}_t^i \pi_{t+1}}_{\text{Aggregate Forecast}} = \sum_{k=1}^{11} m_k \Big[\overbrace{\omega_k^i}^{\text{Expend. Weight}} \underbrace{\mathbb{E}_t^i \pi_{k,t+1}}_{\text{Category Forecast}} \Big] + D_i + \epsilon_i$$

- Consistent aggregation benchmark: $m_k = 1 \; \forall \; k$
- D_i controls for demographic fixed effects and personal expenditure weights

Estimated Sensitivity to Components of Consumption Basket



- Two sector estimation (agg. core and non-core forecast): Core 0.38, Non-core 0.80

Two sector estimation

Sparsity-based Rational Inattention (Gabaix, 2014)

Consumers form inflation expectations based on granular information about components

- Attention $m_k \in [0,1]$ towards category forecast is costly - default expectation is not

$$\underbrace{\mathbb{E}_t^B \, \pi_{t+1}(m)}_{\substack{\text{Behavioral Aggregate} \\ \text{Forecast}}} = \sum_{k=1}^{K} \omega_k [m_k \underbrace{\mathbb{E}_t \, \pi_{k,t+1}}_{\substack{\text{Categroy} \\ \text{Forecast}}} + (1 - m_k) \underbrace{\bar{\pi}_k}_{\substack{\text{Default} \\ \text{Expectation}}}]$$

- Utility loss from attention - attention cost $h(m)$: $m \uparrow \rightarrow h(m) \uparrow$
- Utility loss from forecast inaccuracy: $m \uparrow \rightarrow L(m) \downarrow$

$$L(m) = -\frac{1}{2} \mathbb{E} \left[\mathbb{E}_t^B \, \pi_{t+1}(m) - \mathbb{E}_t \, \pi_{t+1} \right]^2$$

Sparsity-based Rational Inattention (Gabaix, 2014)

Household optimization problem

$$m^* = \arg\max_m \quad \underbrace{-\frac{1}{2}\,\mathbb{E}\left[\mathbb{E}_t^B\,\pi_{t+1}(m) - \mathbb{E}_t\,\pi_{t+1}\right]^2}_{\text{Expected Inaccuracy Cost}} \quad - \quad \underbrace{h(m)}_{\text{Attention Cost}}$$

Sparse optimization (Gabaix, 2014)

- Substitute expected inaccuracy cost by second-order Taylor approximation
- Assume category inflation rates to be $\sim N(\bar{\pi}_k, \sigma_k)$ and uncorrelated

Optimal attention m_k^* increases in volatility of category inflation forecast $\sigma^2_{\mathbb{E}_t\,\pi_{k,t+1}}$

$$m_k^* \quad = \quad g(\sigma^2_{\mathbb{E}_t\,\pi_{k,t+1}}) = 1 - \frac{h_{m_k}(m_1, ..., m_k)}{\sigma^2_{\mathbb{E}_t\,\pi_{k,t+1}}}$$

Rational Inattention in Inflation Expectations Formation

Micro evidence from consumer survey:

- Headline expectations most sensitive to non-core inflation expectations, relative to personal expenditure shares

Model of rational inattention in expectations formation:

- More attention to food & energy due to highly volatile expectations
- Estimated attention (sensitivity) correlates with time-series volatility of expectations (Corr=0.57)

Correlation

Implications for Monetary Policy

Embed rational inattention model into New Keynesian general equilibrium framework:

- Multi-sector extension of canonical textbook model (Gali, 2015)
- Sparsity-based rational inattention to sector inflation forecasts (Gabaix, 2020)

New Keynesian model:

- Intertemporally optimizing households; firms face Calvo pricing frictions
- Monetary policy follows Taylor rule; defines inflation target

Monetary policy analysis:

- Compare welfare of different inflation targeting regimes
- Headline inflation target optimal

Households

Households maximize utility subject to budget constraint

$$\max \quad \mathbb{E}_0^B \sum_{t=0}^{\infty} \beta^t \left[\ln \prod_{k=1}^{K} \left(\frac{C_{k,t}}{\omega_k} \right)^{\omega_k} - \sum_{k=1}^{K} \zeta_k \frac{N_{k,t}^{1+\varphi}}{1+\varphi} \right] - h(m)$$

$$\text{s.t.} \quad \sum_{k=1}^{K} W_{k,t} N_{k,t} + L_t + B_{t-1} \geq \sum_{k=1}^{K} P_{k,t} C_{k,t} + \mathcal{Q}_t B_t$$

Rational inattention in formation of headline inflation expectations

$$\mathbb{E}_t^B \, \pi_{t+1} \quad = \quad \sum_{k}^{N} m_k \omega_k \, \mathbb{E}_t \, \pi_{k,t+1} \quad \text{with} \quad m_k^* = g(\sigma^2_{\mathbb{E}_t \, \pi_{k,t+1}})$$

Firms

Continuum of firms located in each sector k; produce output $Y_{k,t}(j)$

- Labor $N_{k,t}(j)$ and sectoral technology $A_{k,t}$ as inputs

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

- Calvo pricing: sector specific probability of price adjustment $1 - \theta_k$

$$\max_{P^*_{k,t}} \mathbb{E}_t \sum_{g=0}^{\infty} \theta_k^g \Lambda_{t,t+k} (1/P_{t+g}) \left[P^*_{k,t} Y_{t+g|t} - \mathcal{C}_{k,t+g|t}(Y_{t+g|t}) \right]$$

Monetary Policy – Taylor Rule

Adjust nominal interest rate i_t to inflation target $\tilde{\pi}_t$

$$i_t = \bar{i} + \underbrace{\phi_\pi \tilde{\pi}_t}_{\substack{\text{Reaction to} \\ \text{Inflation Target}}}$$

Define inflation target $\tilde{\pi}_t$ via sectoral weights η_k (Woodford, 2003)

$$\tilde{\pi}_t = \sum_k^N \eta_k \pi_{k,t} \quad \text{with} \quad \sum_k^N \eta_k = 1$$

Welfare

Average per-period welfare loss $\mathbb{L}$:

- Measured in equivalent steady state consumption
- 2^{nd}- order Taylor approximation of utility function (e.g., Gali, 2015, Woodford, 2003)

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

- Welfare loss increases in volatility of sectoral inflation and output gap

Attention Allocation and Model Solution

Optimal **attention allocation**

- Dynamics similar to partial equilibrium model
- Cost function $h(m) = \mathcal{K}/2 \sum m_k^2$
- Attention increases in the volatility of expected sectoral inflation rates

$$m_k^* = g(\sigma^2_{\mathbb{E}_t \pi_{k,t+1}})$$

Linearized model solution

- Fixed-point problem: attention $m_k^* = g(\sigma^2_{\mathbb{E}_t \pi_{k,t+1}})$ is function of linearized model solution
- Solve linearized model with attention functions as K additional equilibrium conditions

Attention and Model Solution

Calibration

Solve and calibrate linearized model with core/non-core sector

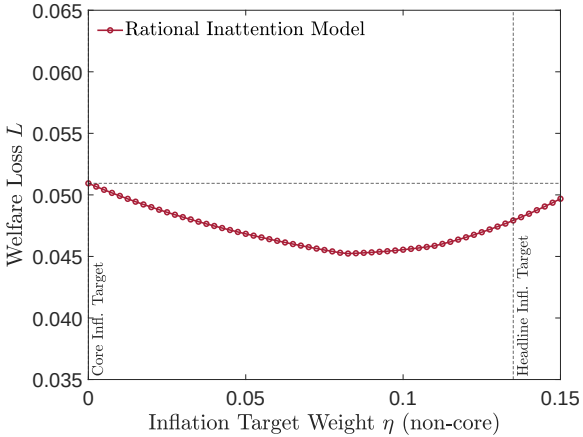
- Price rigidities: micro estimates from literature (Carvalho et al., 2021)
- Attention cost function: match estimated attention

	Data		Model	
	Std. dev.	Attention	Std. dev.	Attention
Core inflation	0.14	0.38	0.15	0.38
Non-core inflation	1.50	0.80	1.52	0.80

Notes: Standard Deviation: quarterly data, 1990Q1 to 2019Q4, Attention: Empirical estimates from survey

Model Calibration

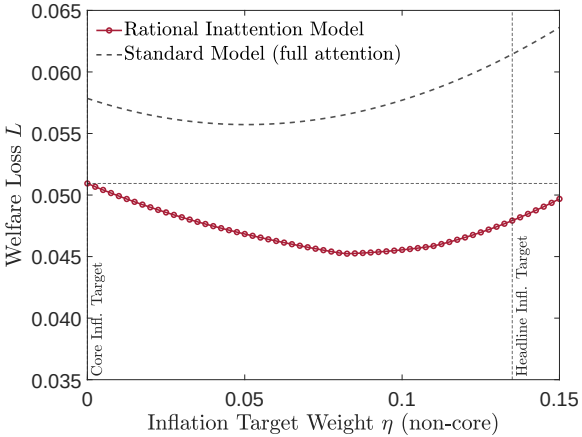
The Optimal Inflation Target Measure



- **Headline inflation** superior to core inflation target measure

Attention | Robustness: Price Rigidity

The Optimal Inflation Target Measure



- **Headline inflation** superior to core inflation target measure
- Standard, full attention model (no rational inattention): core inflation target optimal

Conclusion

Survey on inflation expectations in the US

- Inflation expectations for range of consumption categories

New micro evidence on consumer inflation expectations

- Food & energy inflation forecasts play disproportionate role in inflation expectations

Rationalize by sparsity-based rational inattention model

- Consumers optimally allocate more attention to volatile components - food & energy

Monetary policy analysis in multi-sector New Keynesian framework

- **Headline inflation target optimal**

Extra Slides

Extra Slides: Headline Inflation Expectation - Survey Question

Over the next 12 months do you think there will be inflation or deflation?

- O Inflation
- O Deflation (opposite of inflation)

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.

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Extra Slides: Category Inflation Expectation - Survey Question

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

	Increase/Decrease	By ____ %
the price of **motor vehicles and parts** (such as cars and SUVs) to ___ [increase/decrease] by ___ percent		
the price of **recreational goods and vehicles** (such as sports equipment and laptops) to ___ [increase/decrease] by ___ percent		
the price of **other durable goods** (such as furniture, appliances, jewelry, luggage) to ___ [increase/decrease] by ___ percent		

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Extra Slides: Expenditure Weights - Survey Question

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)	

Calculate relative expenditure weights $\omega_k^{exp,i}$ from category spending S_k^i:

$$\omega_k^{exp,i} = \frac{S_k^i}{\sum_{k=1}^{11} S_k^i}$$

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Extra Slides: Categories

Category	Example
Motor vehicles and parts	Cars and SUVs
Recreational goods and vehicles	Sports equipment and laptops
Other durable goods	Furniture, appliances, jewelry, luggage
Food and beverages	Food from grocery stores
Gasoline and other energy goods	
Other nondurable goods	Clothing, medicine and personal care products
Housing and utilities	Rent and utility bills
Health care	
Transportation services	Public transit tickets and airfare
Food services and accommodations	Restaurants and hotels
Other services	Internet/phone service, education, financial services

- Survey shows some examples for most product categories
- Categories similar to 3^{rd} level PCE disaggregation of BEA, combining some smaller categories for our survey

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Extra Slides: Estimated Sensitivity - Core/Non-core

	(1)	(2)	(3)
Exp. core inflation	0.404***	0.370***	0.375***
	(25.35)	(21.98)	(22.50)
Exp. non-core inflation	0.676***	0.785***	0.803***
	(21.70)	(22.09)	(22.34)
Constant	2.811***		
	(32.13)		
Demog. FE	no	no	yes
Expend. weight control	no	yes	yes
N	13828	13840	13812
r2	0.199	0.481	0.507

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

- Household inflation expectations relatively more sensitive to non-core expectations
- Sensitivity is lower than what rational model would suggest

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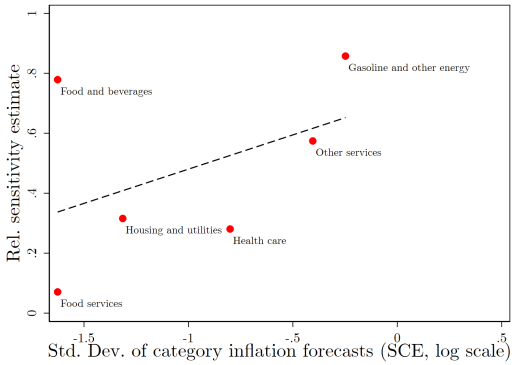
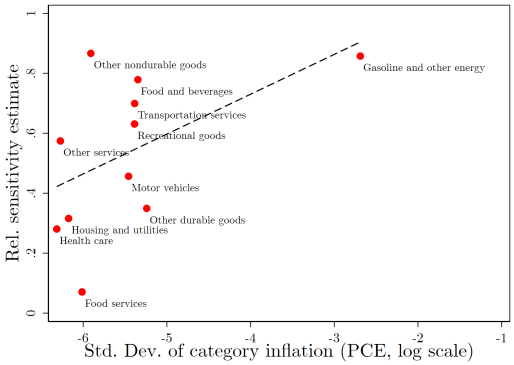
Extra Slides: Estimated Attention and Volatility

Volatility of inflation expectations (SCE)



Corr=0.53

Volatility of realized inflation



Corr=0.51 (w/o gas: 0.38)

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Extra Slides: Endogenous Attention - Details (Gabaix 2020)

- Replace utility losses by second-order Taylor approximation
- Cost function $h(m) = K/2 \sum m_k^2$

$$m_k^* = \max\left(m_d, \frac{\omega_k^2 var\left(\Theta_k\right)}{K + \omega_k^2 var\left(\Theta_k\right)} + \sum_{j \neq k}(1 - m_j^*)\frac{\omega_k \omega_j cov\left(\Theta_k, \Theta_j\right)}{K + \omega_k^2 var\left(\Theta_k\right)}\right)$$

with $\Theta_k = \sum_{i=1}^{\infty} \mathbb{E}_t \, \pi_{k,t+i}$

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Extra Slides: Endogenous Attention and Model Solution

Intuition similar to partial equilibrium model

- Attention increases in volatility of expected sector inflation rates
- Endogenous function of linearized model solution

Linearized model solution:

- Depends on level household attention m
- Find solution (Ψ_0, Ψ_1, Π) that also satisfies attention function $m = g(\Psi_0, \Psi_1, \Pi, \sigma_\epsilon)$

$$\begin{aligned} S_t &= \Psi_0(m) S_{t-1} + \Psi_1(m)\epsilon_t \\ X_t &= \Pi(m) S_t \\ m &= g(\Psi_0(m), \Psi_1(m), \Pi(m), \sigma_\epsilon) \end{aligned}$$

- Attention adjusts to policy changes endogenously!

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Extra Slides: Model Calibration

Homogeneous parameters

	Variable	Value	Target
Discount factor	β	0.999	$r_t \approx 1\%$ (annualized)
Inverse Frisch elasticity	φ	4	Chetty et al. (2011)
Labor share in production	α	1/5	Fernandez-Villaverde et al. (2015)
Elasticity of substitution	ϵ	10	Fernandez-Villaverde et al. (2015)
Taylor rule	ϕ_π	1.5	Gali (2015)
Inflation target	$\bar{\omega}$	ω	Headline inflation target

Sector specific parameters

	Variable	Core	Non-core	Target
Expenditure share	ω_k	0.865	0.135	BEA
Calvo	θ_k	0.6	0.3	Carvalho et al (2021)
Shock std. dev.	σ_k	0.0043	0.0216	Business cycle statistics
TFP persistence	ρ_k	0.9	0.6	Business cycle statistics

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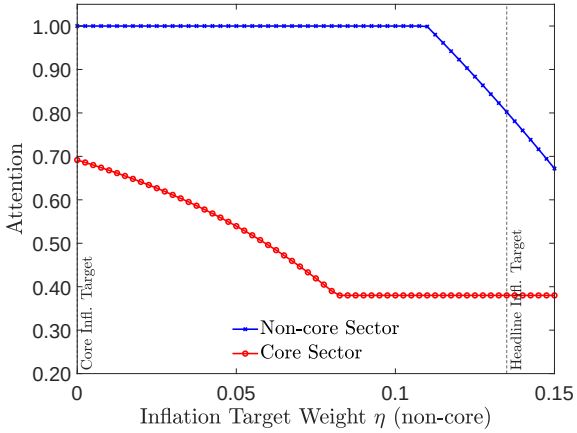
The Optimal Inflation Target Measure - Sectoral Attention



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