

Mental models of the macroeconomy

Johannes Wohlfart¹

¹University of Copenhagen, CEBI, and CESifo

15th March 2023

PhD Course on Subjective Beliefs, Attention and Economic Behavior

Motivation

- Well-documented empirical fact: Substantial **disagreement** in survey expectations about the macroeconomy (Coibion and Gorodnichenko, 2012; Mankiw et al., 2003).
 - Holds true for households, firms and professional forecasters.
 - Disagreement matters for the transmission of policies.
- Heterogeneity in survey expectations is often attributed to **differences in information** about the current state of the economy across economic agents (Carroll, 2003; Coibion and Gorodnichenko, 2012; Link et al., 2023).
- Alternative driver of disagreement in survey expectations: heterogeneity in **subjective models of the macroeconomy**.

Motivation

- Most of this lecture is based on the paper “*Subjective Models of the Macroeconomy: Evidence from Experts and Representative Samples*” by Peter Andre, Carlo Pizzinelli, Chris Roth and Johannes Wohlfart (2022, *Review of Economic Studies*).
- Focus of this lecture on both:
 - i) **findings** related to expectation formation.
 - ii) **methods** we use to measure mental models of the economy (including respondents’ thoughts / associations when thinking about macroeconomic shocks).
- If enough time we will also briefly discuss the paper “*The Effects of Monetary Policy: Theory with Measured Expectations*” by Chris Roth, Mirko Wiederholt and Johannes Wohlfart (2023).

Research questions

- 1 How do households and experts predict unemployment and inflation to respond to macroeconomic shocks?

Research questions

- 1 How do households and experts predict unemployment and inflation to respond to macroeconomic shocks?
- 2 How much heterogeneity is there i) within and ii) between households and experts?

Research questions

- 1 How do households and experts predict unemployment and inflation to respond to macroeconomic shocks?
- 2 How much heterogeneity is there i) within and ii) between households and experts?
- 3 What is the role of associations and memory in driving heterogeneity in predictions?

Challenges

- Response of survey expectations to actual macroeconomic shocks is **uninformative**, as fractions of the population will be inattentive to these shocks (Coibion and Gorodnichenko, 2012).
- People's beliefs should be measured in a way that enables a **comparison** with benchmarks from the theoretical and empirical literature.
- Beliefs should be measured using survey questions that are **comprehensible** to individuals without an economics education.

This paper

Samples

Representative samples of the **US population** ($n \approx 6,500$) and a set of leading **experts** ($n \approx 1,300$).

Methods

Hypothetical vignettes in which respondents predict future unemployment and inflation under different macroeconomic shocks, holding constant information about the state of the economy.

- oil price
- government spending
- monetary policy
- income taxes

In mechanism experiments we measure **associations** respondents have while making their predictions.

Outline of Lecture

- ① Data and Vignette Design
- ② Heterogeneity in Subjective Models
- ③ The Role of Selective Recall
- ④ The Role of Associative Memory
- ⑤ Conclusion and Implications
- ⑥ Methods application: Predicting effects of monetary policy on consumption

Data

Online samples of the US population ($n \approx 6,500$), representative in terms of age, gender, region, income and education:

- Wave 1 ($n=1,085$): February and March 2019, *Research Now*.
- Wave 2 ($n=1,151$): July 2019, *Lucid*.
- Wave 3 ($n=2,126$): February 2021, *Lucid*.
- Wave 4 ($n=1,521$): February 2021, *Lucid*.
- Wave 5 ($n=486$): June 2021, *Lucid*.

Expert samples ($n \approx 1,500$):

- Wave 1 ($n=179$): February 2019: participants at major macro conferences, experts in policy institutions and PhD students.
- Wave 2 ($n=908$): July 2019, ifo World Economic Survey.
- Wave 3 ($n=375$): February 2021, invited authors of published macro papers and PhD students at leading departments.

Vignettes

Two variables are predicted ...

- unemployment u
- inflation π

... in four vignettes

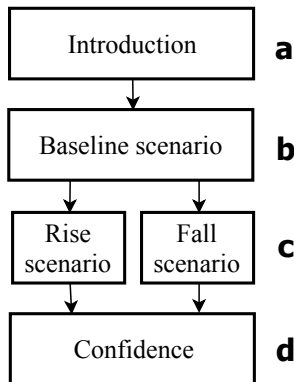
- price of crude oil, total government spending, federal funds target rate, income tax rates.

Goals

- identical for general population and expert sample
- accessible for the general population, but comparable to benchmarks from macroeconomic models and empirical estimates
- fix beliefs about current levels of u and π
- *exogenous* shocks to identify perceived effects of shock on u and π

Vignettes: Structure

Vignette Structure



Belief measurement

Use difference in predictions as outcome variable.

- **Perceived inflation response**
$$\Delta\pi_{i,r/f} = \pi_{i,r/f} - \pi_{i,baseline}$$
- **Perceived unemployment response**
$$\Delta u_{i,r/f} = u_{i,r/f} - u_{i,baseline}$$

Example: Government spending constant scenario

We would like you to think about the following hypothetical scenario.

Scenario: Government spending grows as usual

Imagine **federal government spending grows as usual** over the next 12 months. That is, it grows at a rate that equals the usual growth that took place in the previous years.

Inflation rate

Under this scenario, what do you think the US **inflation rate** will be over the next 12 months?

Note: The default position of the slider is the current level of the inflation rate: 1.6%



Unemployment rate

Under this scenario, what do you think the US **unemployment rate** will be 12 months from now?

Note: The default position of the slider is the current level of the unemployment rate: 4.0%



Example: Government spending increase scenario

Scenario: Government spending grows more

Imagine **federal government spending** unexpectedly **grows to a larger extent** than usual over the next 12 months due to a newly announced **spending program** on defense. In particular, it grows by 2.4 percentage points more than the usual growth that took place in the previous years.

The government announces: The change is temporary and occurs despite no changes in the government's assessment of national security or economic conditions. Moreover, federal taxes do not change in response to the spending program.

Example: Tax increase scenario

Scenario: Income tax rates increase

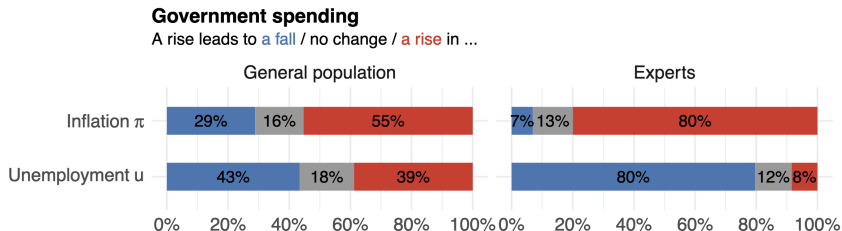
Imagine that **income tax rates** are unexpectedly **1 percentage point higher** for all households in the US over the next 12 months. This means that the typical US household would **pay about \$400 more in taxes**.

The government announces: The tax change is temporary and occurs despite no changes in the government's assessment of the economic conditions. Moreover, government spending does not change in response to the tax increase.

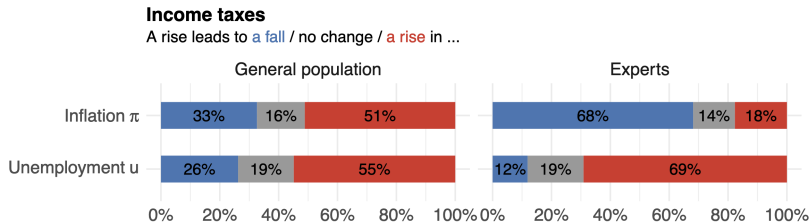
Outline of Lecture

- ① Data and Vignette Design
- ② Heterogeneity in Subjective Models
- ③ The Role of Selective Recall
- ④ The Role of Associative Memory
- ⑤ Conclusion and Implications
- ⑥ Methods application: Predicting effects of monetary policy on consumption

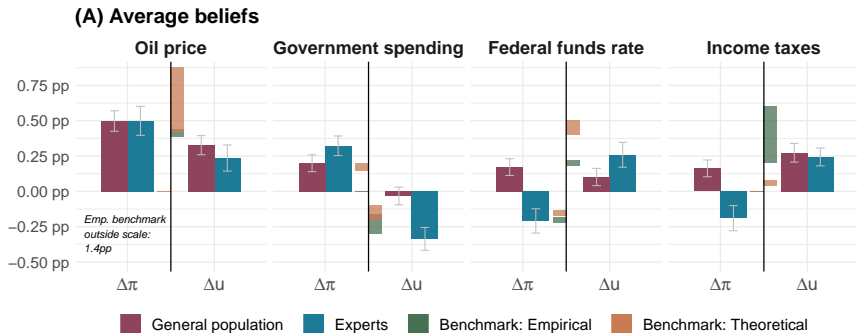
Main results: Government spending shock - directional effects



Main results: Tax shock - directional effects



Main results: Heterogeneity in subjective models - quantitative



Summary

- There is substantial **heterogeneity in forecasts** of the **directional effects** of macroeconomic shocks, among experts and among households.
- Average predictions of households and experts differ substantially for...
 - the inflation response to monetary policy shocks
 - the inflation response to income tax shocks and
 - the unemployment response to government spending shocks.
- Disagreement in forecasts suggests an important role for **heterogeneity in subjective models** in expectation formation.

Outline of Lecture

- ① Data and Vignette Design
- ② Heterogeneity in Subjective Models
- ③ The Role of Selective Recall**
- ④ The Role of Associative Memory
- ⑤ Conclusion and Implications
- ⑥ Methods application: Predicting effects of monetary policy on consumption

Sources of heterogeneity: Role of associations

- What drives heterogeneity in predictions within and between households and experts?
- One potential explanation: differences in **associations** that come to respondents' minds.
 - Experts may think of **textbook models**.
 - Households selectively think of **specific propagation mechanisms** and may not account for the full general equilibrium effects of a shock.
- To shed light on the role of the associations, we directly measure respondents' **thoughts** while they make their predictions.

Measuring thoughts: Dual approach

Design similar to main experiment, but measuring **associations** using a dual approach:

- 1 Elicitation of thoughts in **open-ended text responses** on prediction screen:
 - No priming and immune to ex-post rationalization.
 - But necessarily noisy and incomplete.
- 2 **Structured question** on a list of 6-7 vignette-specific propagation channels on the next screens:
 - Measure attention to specific channels for which open-text responses are not sufficiently nuanced.
 - Easy to compare across respondents (no judgment calls in coding necessary).
 - But may be subject to ex-post rationalization.
 - Address ex-post rationalization with an experiment shifting attention.

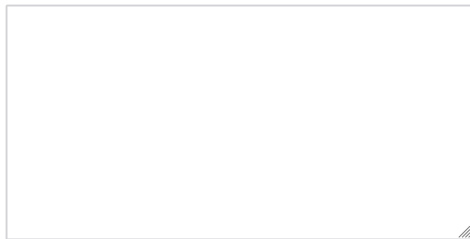
Measuring thoughts: Prediction screen

Your thoughts

Above, you predict how the change in the alternative scenario affects the US economy.
Please tell us how you come up with your predictions.

What are your main considerations in making those predictions?

Please respond in 2-3 sentences.



- Analyze this data using text-analysis tools and hand-coding of responses.

Measuring thoughts: Structured question on propagation channels: government spending vignette

How did you come up with your predictions?

The following statements describe different thoughts you might have had on your mind while making your predictions for the alternative scenario. **Did you have any of these thoughts on your mind?** Please tick all that you had on your mind.

- Because of higher incomes, households increase their spending.
- Because there is more demand for their products, businesses increase their product prices.
- Businesses face lower demand for their products, so they increase their product prices to keep profits at the same level.
- Households expect to pay higher taxes in the future, which may be needed to pay back the new government debt. Therefore, households work more.
- Households expect to pay higher taxes in the future, which may be needed to pay back the new government debt. Therefore, households cut back on their spending.
- Because there is more demand for their products, businesses increase their workforce.
- To help the government finance the additional spending, the central bank prints money.
- None of the above.*

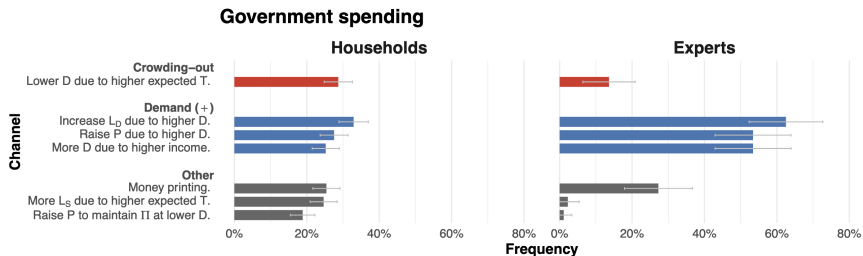
Measuring thoughts: Structured question on propagation channels: tax vignette

How did you come up with your predictions?

The following statements describe different thoughts you might have had on your mind while making your predictions for the alternative scenario. **Did you have any of these thoughts on your mind?** Please tick all that you had on your mind.

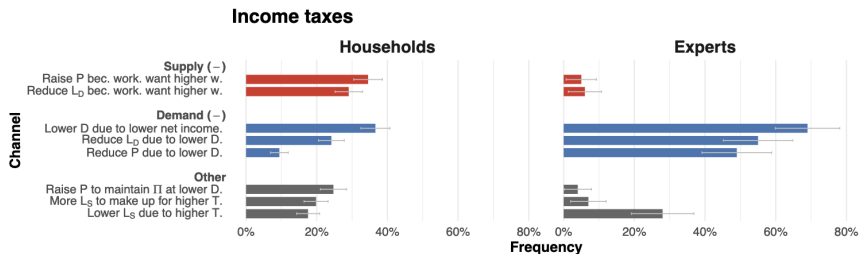
- Because workers demand higher wages to make up for the higher income taxes, businesses reduce their workforce.
- Because workers demand higher wages to make up for the higher income taxes, businesses increase their product prices.
- Because there is less demand for their products, businesses reduce their product prices.
- Because of lower disposable incomes, households cut back on their spending.
- Because higher taxes make it less attractive to work, households work less.
- Because there is less demand for their products, businesses reduce their workforce.
- Businesses face lower demand for their products, so they increase their product prices to keep profits at the same level.
- To make up for their reduced disposable incomes, households work more.
- None of the above.*

Thoughts about propagation channels (structured question): Government spending shock



We find similar patterns based on hand-coded text-data.

Thoughts about propagation channels (structured question): Tax shock



We find similar patterns based on hand-coded text-data.

Summary

- The propagation channels that are on top of respondents' minds vary **systematically** within and across our samples of households and experts.
- Experts tend to recall channels that are central in **textbook models**.
 - Open-ended data suggest that experts engage in **general equilibrium thinking**.
- Households in many cases **neglect** these channels and think of channels that are conventionally seen as less important by textbooks.
 - Households seem to take a **partial equilibrium** view of the world.

Summary

- The propagation channels that are on top of respondents' minds vary **systematically** within and across our samples of households and experts.
- Experts tend to recall channels that are central in **textbook models**.
 - Open-ended data suggest that experts engage in **general equilibrium thinking**.
- Households in many cases **neglect** these channels and think of channels that are conventionally seen as less important by textbooks.
 - Households seem to take a **partial equilibrium** view of the world.

Next step: Is the data on thoughts **correlated** with predictions respondents make in vignettes?

Correlations between Associations and Predictions: Government Spending

	Households		Experts	
	$\Delta\pi$ (1)	Δu (2)	$\Delta\pi$ (3)	Δu (4)
Crowding-out	0.140*** (0.050)	0.236*** (0.055)	-0.036 (0.071)	0.057 (0.046)
Demand (+)	-0.067 (0.045)	-0.249*** (0.047)	0.076 (0.076)	-0.299*** (0.057)
Constant	0.329*** (0.038)	0.080** (0.037)	0.195*** (0.067)	0.009 (0.051)
Observations	519	519	88	88
R ²	0.023	0.102	0.014	0.266
R ² (all 7 channel indicators)	0.062	0.180	0.178	0.438

- Disclaimer: **descriptive evidence** only.
- Similar patterns with hand-coded data based on unstructured text.

Correlations between Associations and Predictions: Income Taxes

	Households		Experts	
	$\Delta\pi$	Δu	$\Delta\pi$	Δu
	(1)	(2)	(3)	(4)
Supply (-)	0.217*** (0.041)	0.188*** (0.044)	0.018 (0.074)	0.004 (0.074)
Demand (-)	0.024 (0.041)	0.054 (0.043)	-0.150*** (0.046)	0.212*** (0.038)
Constant	0.254*** (0.032)	0.130*** (0.034)	-0.035 (0.041)	0.041 (0.030)
Observations	530	530	100	100
R ²	0.053	0.039	0.095	0.169
R ² (all 8 channel indicators)	0.128	0.129	0.375	0.277

Thoughts account for differences between experts and households

	Government spending Unemployment Δu		Federal funds rate Inflation $\Delta \pi$		Income taxes Inflation $\Delta \pi$	
	(1)	(2)	(3)	(4)	(5)	(6)
Expert	-0.215*** (0.036)	-0.003 (0.035)	-0.462*** (0.037)	-0.323*** (0.048)	-0.517*** (0.030)	-0.347*** (0.041)
Constant	0.013 (0.025)	0.040 (0.035)	0.297*** (0.020)	0.207*** (0.030)	0.368*** (0.021)	0.248*** (0.030)
p_F : Expert coeff. equal	<0.001		<0.001		<0.001	
Channels	-	✓	-	✓	-	✓
Observations	608	607	614	612	631	630
R ²	0.020	0.203	0.127	0.199	0.152	0.258

Summary

- Thoughts of specific propagation channels are correlated with forecasts of the effects of macroeconomic shocks on inflation and unemployment in the expected directions.
- Thoughts account for part of the differences in forecasts between households and experts.

Outline of Lecture

- ① Data and Vignette Design
- ② Heterogeneity in Subjective Models
- ③ The Role of Selective Recall
- ④ The Role of Associative Memory**
- ⑤ Conclusion and Implications
- ⑥ Methods application: Predicting effects of monetary policy on consumption

Associative Memory

- Human memory is known to be associative, selective, and to draw on personal experiences (Kahana, 2012).
- Theories of associative memory predict that
 - **contextual cues** affect the forecasts people make by changing the associations that come to their minds.
 - **different personal experiences** in the memory database should be reflected in differences in associations and forecasts.

Contextual cues

- To shed light on the role of contextual cues, we conduct a simple experiment.
- Proof of concept that an exogenous change in contextual cues can change people's selective retrieval of propagation mechanisms and, thereby, **causally** affect their forecasts.
- **Priming exercise** in Wave 4 of the household survey:
 - Focus on **monetary policy vignette** and **inflation forecast**.
 - Ask subgroups to predict effects on production **costs** or product **demand** before forecasting inflation on the survey screen.
 - Pure control group forecasting inflation only.
 - Elicitation of thoughts using **open-ended question** on prediction screen to measure the first stage.

Causal effect of mechanism associations

	Word usage (open-text data)		Inflation prediction
	Cost-related words	Demand-related words	$\Delta\pi$
	(1)	(2)	(3)
Costs prime	0.086*** (0.023)	0.007 (0.020)	0.021 (0.031)
Demand prime	-0.021 (0.017)	0.077*** (0.023)	-0.057** (0.029)
Constant	0.093*** (0.010)	0.106*** (0.011)	0.366*** (0.017)
p : Costs = Demand	<0.001	0.007	0.028
Observations	1,521	1,521	1,521
R ²	0.017	0.010	0.004

Notes: Robust standard errors are in parentheses. * denotes significance at 10 pct., ** at 5 pct., and *** at 1 pct. level.

Experiences and associations

- Moreover, **personal experiences** are correlated with selective recall of specific propagation mechanisms
 - **Oil Price shock:** Individuals born before 1962 are more likely to ...
 - ... choose propagation channels related to the supply side
 - ... use words related to costs when making predictions in the oil vignette.
 - **Government spending shock** (which focuses on an increase in defense spending):
 - previous employment by (suppliers of) the military is associated with a greater tendency to think of mechanisms related to increases in product demand and labor demand.
 - We find similar patterns for a more general question on experiences with different propagation mechanisms.
- Experiences also **correlated with predictions** in the vignettes (in a way that is consistent with the effects on associations).

Summary

- We provide evidence on the role of **associative memory** in driving heterogeneity in thoughts and forecasts.
- **Contextual cues and prior experiences** shape which propagation channels individuals retrieve and thereby which forecasts they make.

Other evidence in the paper

- **Symmetry** of forecasts to positive vs negative shocks.
- Predictions about the **joint response** of unemployment and inflation to shocks.
- Alternative/additional **mechanisms** driving forecasts:
 - Perceived past correlations between macroeconomic variables.
 - Rational inattention.
 - Numeracy.
 - ...
- Relative importance of different mechanisms.
- Extensive **robustness** checks:
 - Dropping inattentive respondents.
 - Dropping extreme predictions in baseline scenarios.
 - Focusing on assistant/associate/full professors in expert sample.
 - ...

Outline of Lecture

- ① Data and Vignette Design
- ② Heterogeneity in Subjective Models
- ③ The Role of Selective Recall
- ④ The Role of Associative Memory
- ⑤ Conclusion and Implications**
- ⑥ Methods application: Predicting effects of monetary policy on consumption

Summary and implications I

- Substantial **heterogeneity** in beliefs about response of economy to shocks, among experts and even more so among households.
- Households' beliefs on average aligned with experts in many cases, with some exceptions:
 - Opposite beliefs about inflation response to monetary policy and tax shocks.
 - Households on average see no effect of government spending shocks on unemployment.
- **Associations** and thoughts about differential propagation channels seem to be an important driver of forecasts.
- Priming evidence suggests that households' subjective models are **not fixed**.
 - These models may be formed "on the fly", depending on the **associations triggered by the context**.

Summary and implications II

- New perspective on the strong heterogeneity in macroeconomic expectations (Coibion and Gorodnichenko, 2012).
- Even if agents hold comparable information about previous realizations of macroeconomic variables, **associative recall** of different economic mechanisms generates strong heterogeneity.

Take-away: Methods

- Use of **hypothetical vignettes** to study expectation formation holding constant beliefs about state of the economy.
- Use of open-ended questions and text data to study associations and thoughts.
- Combining priming and text data to study the **causal effect** of changes in attention to particular mechanisms.

Outline of Lecture

- ① Data and Vignette Design
- ② Heterogeneity in Subjective Models
- ③ The Role of Selective Recall
- ④ The Role of Associative Memory
- ⑤ Conclusion and Implications
- ⑥ **Methods application: Predicting effects of monetary policy on consumption**

Predicting effects of monetary policy on consumption

- Hypothetical vignettes can be used to **predict consumption effects** of different policy options ex-ante.
- In “*The Effects of Monetary Policy: Theory with Measured Expectations*” (Roth, Wiederholt and Wohlfart, 2023) we do this for both conventional and unconventional monetary policy.
- Key idea:
 - Theory: Use a heterogeneous agent New-Keynesian model to express consumption of (non-hand-to-mouth) households as a function of expectations only.
 - Measured Expectations: Elicit all expectations appearing in the consumption functions for alternative policy scenarios with a tailored survey.

Example: Consumption function of PIH households

- The log-linearized consumption function of an unconstrained household expecting no constraints in the future:

$$c_{it} = \frac{1}{\bar{c}_i} (1 - \beta) E_{it} \left[\sum_{s=t}^{\infty} \beta^{s-t} \tilde{y}_{i,s} \right] - \frac{1}{\bar{y}_i} \beta E_{it} \left[\sum_{s=t}^{\infty} \beta^{s-t} (r_s - \pi_{s+1}) \right] + \frac{1}{\bar{c}_i} (1 - \beta) \frac{1}{\bar{\beta}} E_{it} \left[\tilde{b}_{i,t-1} \right]$$

- Difference in consumption across policies

$$(\Delta c_{it} = c_{it}^{PolicyA} - c_{it}^{PolicyB}):$$

$$\Delta c_{it} = \frac{1}{\bar{c}_i} (1 - \beta) \Delta E_{it} \left[\sum_{s=t}^{\infty} \beta^{s-t} \tilde{y}_{i,s} \right] - \frac{1}{\bar{y}_i} \beta \Delta E_{it} \left[\sum_{s=t}^{\infty} \beta^{s-t} (r_s - \pi_{s+1}) \right] + \frac{1}{\bar{c}_i} (1 - \beta) \frac{1}{\bar{\beta}} \Delta E_{it} \left[\tilde{b}_{i,t-1} \right]$$

- Note: Expectation differences across policies are sufficient statistics for consumption differences across policies.

Eliciting expectation differences in a survey: Baseline scenario

In our survey on **unconventional monetary policy**, respondents first complete the baseline scenario, where they receive the following instructions:

Please imagine that at the next meeting of the Fed on March 16/17 2021, the Fed announces that the current federal funds rate will remain unchanged at 0.1 percent. Moreover, the Fed announces that its projection about the future federal funds rate at the end of 2023 remains unchanged at 0.1 percent.

Note: Further, imagine that the Fed's projection of the federal funds rate in 2030 remains unchanged at 2.5 percent.

Subsequently we elicit expectations of federal funds rate, inflation and own income.

Eliciting expectation differences in a survey: Alternative scenario

In the subsequent alternative scenario, respondents receive the following instructions:

We will now ask you to consider the following alternative hypothetical scenario. Please imagine that at their next meeting on March 16/17 2021, the Fed announces that the current federal funds rate will remain unchanged at 0.1 percent. However, the Fed announces that its projection about the future federal funds rate at the end of 2023 increases from 0.1 percent to 0.5 percent.

Note: Further, imagine that the Fed's projection of the federal funds rate in 2030 remains unchanged at 2.5 percent.

Subsequently we elicit expectations of federal funds rate, inflation and own income.

The effect of forward guidance on aggregate consumption

- Assumption parameters: $\beta = 0.99, \gamma = 2$
- Assumption attention: All households hear policy announcement.
- Assumption hand-to-mouth households: Reductions in income occur later.
- Substituting each agent's subjective beliefs into her consumption function and aggregating yields

$$\begin{aligned} \Delta c_0 = & \underbrace{0.21}_{\substack{\text{Weighted} \\ \text{fraction} \\ \text{HTM}}} \times 0 + \underbrace{0.52}_{\substack{\text{Weighted} \\ \text{fraction} \\ \text{non-HTM} \\ 0\% \text{ constr.}}} \times (-0.475) \\ & + \underbrace{0.22}_{\substack{\text{Weighted} \\ \text{fraction} \\ \text{non-HTM} \\ 0\% < \text{constr.} \leq 50\%}} \times 0.313 + \underbrace{0.06}_{\substack{\text{Weighted} \\ \text{fraction} \\ \text{non-HTM} \\ > 50\% \text{ constr.}}} \times 0.508 = -0.148 \end{aligned}$$

The effect of forward guidance on aggregate consumption

- For **conventional monetary policy**, we find a stronger consumption response of -0.883 to a hypothetical increase in the actual federal funds rate from zero to 0.5%.
- We also **validate** our approach by asking respondents directly about how they would adjust their spending (difficult due to differences in expected inflation across scenarios).
- Advantages of our approach:
 - No assumptions about expectation formation.
 - No assumptions about monetary policy and inflation.
 - Counterfactual is fully state contingent.

- Carroll, Christopher D**, “Macroeconomic Expectations of Households and Professional Forecasters,” *The Quarterly Journal of Economics*, 2003, 118 (1), 269–298.
- Coibion, Olivier and Yuriy Gorodnichenko**, “What Can Survey Forecasts Tell us about Information Rigidities?,” *Journal of Political Economy*, 2012, 120 (1), 116–159.
- Kahana, Michael Jacob**, *Foundations of Human Memory*, Oxford University Press, 2012.
- Link, Sebastian, Andreas Peichl, Christopher Roth, and Johannes Wohlfart**, “Information frictions among firms and households,” *Journal of Monetary Economics*, 2023.
- Mankiw, N Gregory, Ricardo Reis, and Justin Wolfers**, “Disagreement About Inflation Expectations,” *NBER Macroeconomics Annual*, 2003, 18, 209–248.