Heterogeneity in Household Inflation Expectations and Monetary Policy

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KAEA Session
January 2025

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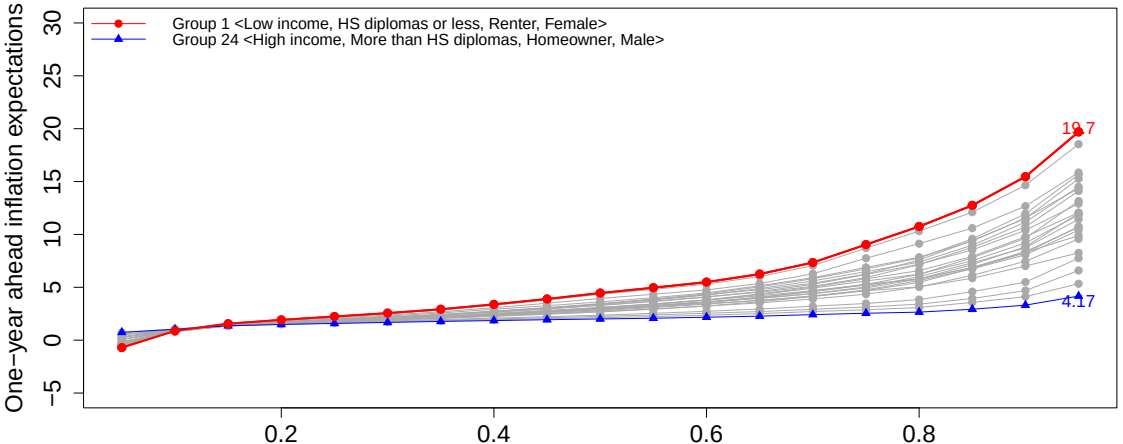
Heterogeneity in household inflation expectations

- Inflation expectations play a central role in the inflation dynamics and the transmission of monetary policy
- Household inflation expectations are quite heterogeneous across demographic (socio-economic) groups
- Some groups predict higher inflation than other groups
  - Low income households tend to predict higher inflation than high income households
  - Less-educated households tend to predict higher inflation than more-educated households
- Some groups exhibit fatter right tails
  - Low income households tend to have more extreme right tails than high income households
  - Less-educated households tend to have more extreme right tails than more-educated households
- Our work establishes empirical facts about the **whole** distribution of household inflation expectations conditional on observed characteristics

Illustration of heterogeneity by predicted conditional quantiles for young (<= 40 yr) households in the west region: Dec. 2019



What we do

- We ask:
  - What are the factors that characterize the distribution of household inflation expectations and how?
  - How does the distribution of household inflation expectations respond to a monetary policy shock?
- We estimate the conditional quantile regression (QR) of household inflation expectations on household characteristics and the macro variables including the monetary policy shock
  - NY Fed Survey of Consumer Expectations (SCE) - baseline
  - Michigan Survey of Consumers (MSC)
- We search for important characteristics generating the heterogeneity and compare our findings with the “randomized information treatment" literature

What we find

- Most of the heterogeneity in household inflation expectations across demographic groups arises in the upper quantiles

1. In the **lower** quantiles, inflation expectations are similar across demographic groups
   - All the groups have a peak of the distribution near 2%, the target by the Fed
2. In the **upper** quantiles, inflation expectations are very dispersed across demographic groups

- There is a large dispersion in the numeracy score within and between groups with the low numeracy score associated with the less well anchored inflation expectation.
- Inflation expectations respond **negatively** to a **contractionary** monetary policy shock across both the lower and upper quantiles, especially in the **upper** quantiles of the **low income** group
- **High income** group is relatively insensitive to a monetary policy shock but their inflation expectations are well anchored around 2% and closely related with the inflation compensation measure from TIPS.

Related literature

- Inflation expectations of households and firms: Weber, D'Acunto, Gorodnichenko, and Coibion (2022)
  - Demographic heterogeneity in household inflation expectations: de Bruin et al. (2010), Madeira and Zafar (2015)
  - Frictions in cognitive abilities and inflation expectations: Burke and Manz (2014), D'Acunto, Hoang, Paloviita, and Weber (2023)
  - Learning-through-survey effect: Kim and Binder (2023)
  - Consumption expenditures and inflation expectations: Johannsen (2014), Jaravel (2021)
- Effectiveness of monetary policy on inflation expectations
  - Coibion, Gorodnichenko, Kumar, and Pedemonte (2020), D'Acutno, Hoang, and Weber (2021), Coibion, Georgarakos, Gorodnichenko, and Weber (2023), Coibion, Gorodnichenko, and Weber (2022), Kostyshyna and Petersen (2024), Knotek et al. (2024)
- Conditional quantile regressions
  - Koenker and Basett (1978), Machado and Silva (2005), Adrian et al. (2019) , López-Salido and Loria (2020)

Empirical model

- Conditional quantile regression of inflation expectations (baseline)

$$Q_{y_{i,t}}(\tau|x_{i,t}, z_t, w_t) = \beta_{0,\tau} + x'_{i,t}\beta_{1,\tau} + z_t\delta_\tau + w'_t\gamma_\tau$$

  for $0 < \tau < 1$, where

  - $y_{i,t}$: **one-year ahead inflation expectations** for household i in period t
  - $x_{i,t}$: **income quartiles**; **education** (at most high school diplomas vs. more than high school diplomas); **gender** (male vs. female); **homeownership** (owners vs. renters); **number of kids and adults** in the household; **age** (young, middle-aged vs. old); **regions**; **survey tenure**; **numeracy score**
  - z_t: **monetary policy shock** (lagged)
  - w_t: YoY **CPI inflation** (lagged)and **unemployment rate gap** (lagged), **oil price inflation** (no lag)

- Extended version: allow the interaction of group characteristics with quantile-specific responses to the monetary policy shock

$$Q_{y_{it}}(\tau|x_{it}, z_t, w_t) = \beta^r_{0,\tau} + x'_{1,i,t}\beta^r_{1,\tau} + z_t x'_{2,i,t}\delta^r_\tau + w'_t\gamma^r_\tau$$

Data: NY Fed Survey of Consumer Expectations (SCE)

- Conducted every month; each month approximately 1,300 are surveyed through the Internet
  - Sample period: 2013m6 - 2019m12
- Rotating panel design
  - Respondents participate in the panel for up to 12 months, with a roughly equal number rotating in and out of the panel each month
  - Survey tenure ranges from 1 to 12
  - For now, we do not use the panel structure but treat the dataset as repeated cross-sections
- Winsorizing
  - Drop about 5% in the lower and upper tails, respectively ($\leq$ 3% quantiles or $\geq$ 97% quantiles by major characteristics)
- We do not use the survey on the subjective distribution of future inflation
- SCE asks numeracy questions to new respondents and counts the number of correct answers from 0 to 5

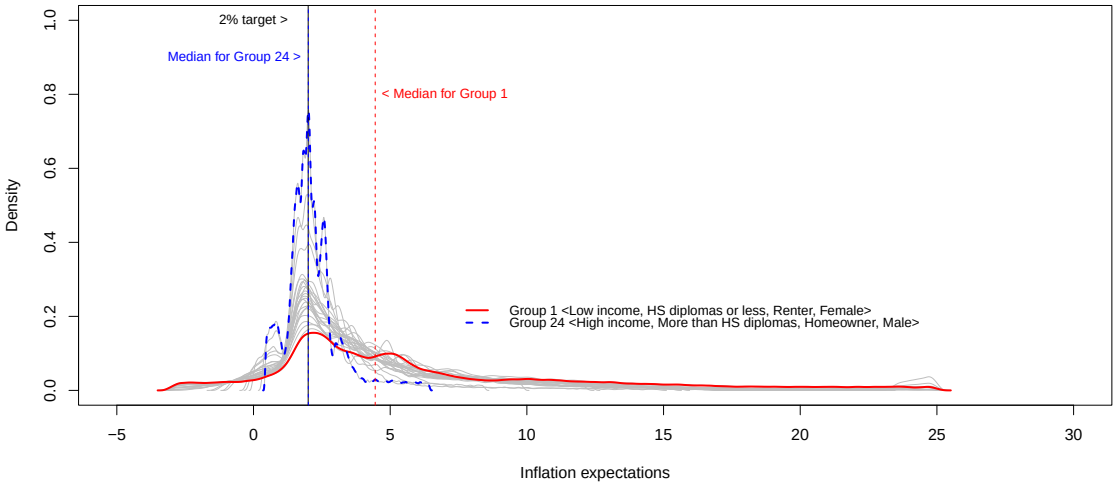
Monetary policy shocks

- Identified by Bauer and Swanson (2022) using high-frequency monetary policy surprises around the FOMC announcements
- Address two concerns on high-frequency identification
  - Exogeneity: monetary policy surprises are predictable with macroeconomic and financial data that pre-dates the FOMC announcement
  - Relevance: monetary policy surprises are a small fraction of interest rate changes each month
- Provide two sets of the shocks: unorthogonalized and **orthogonalized**

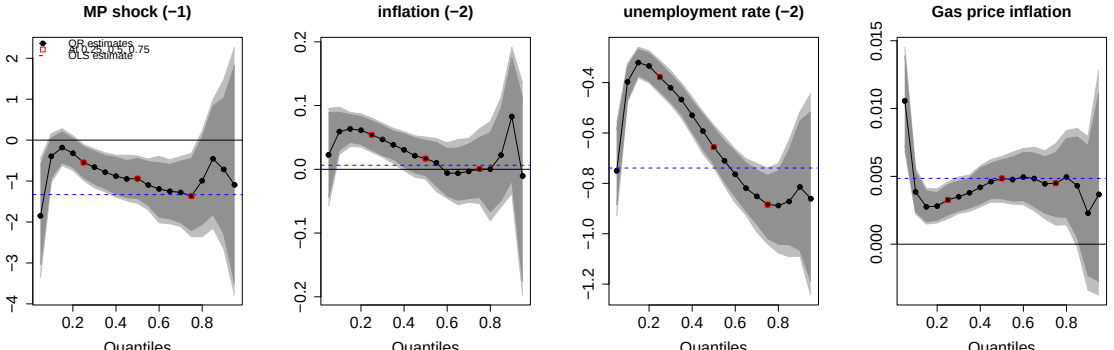
Jittering

- Individual inflation expectations are typically reported in integers
- Explicitly or implicitly, the respondents are likely to round their expectations to the nearest integer to answer
- We "jitter" integer answers and run the standard quantile regression on the jittered data
  - Add the random noise to the data and estimate the quantile regression on the jittered sample
  - Generate many jittered samples and take the average of the estimates across the jittered samples for efficiency
- $\widehat{y}_{i,t} = y_{i,t} + \epsilon_{i,t}$:Now the random noise ($\epsilon_{i,t}$) follows U[-0.5,0.5]
- Empirical results are robust to the group-specific (e.g., numeracy score) heteroskedasticity in the jittering noise
- SCE computes the median and the quantiles using linear interpolations
- Originally proposed by Machado and Silva (2005, JASA) to run the quantile regression on count data
- Standard errors by bootstrapping (xy-pair resampling)

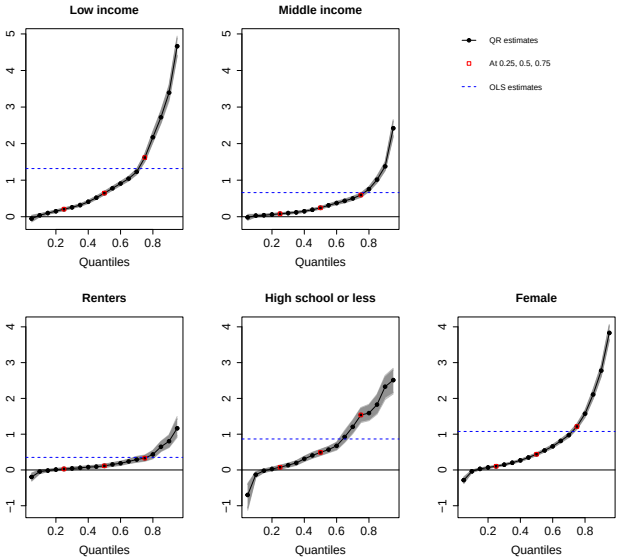
Predicted conditional distribution for young households (<=40yr) in west



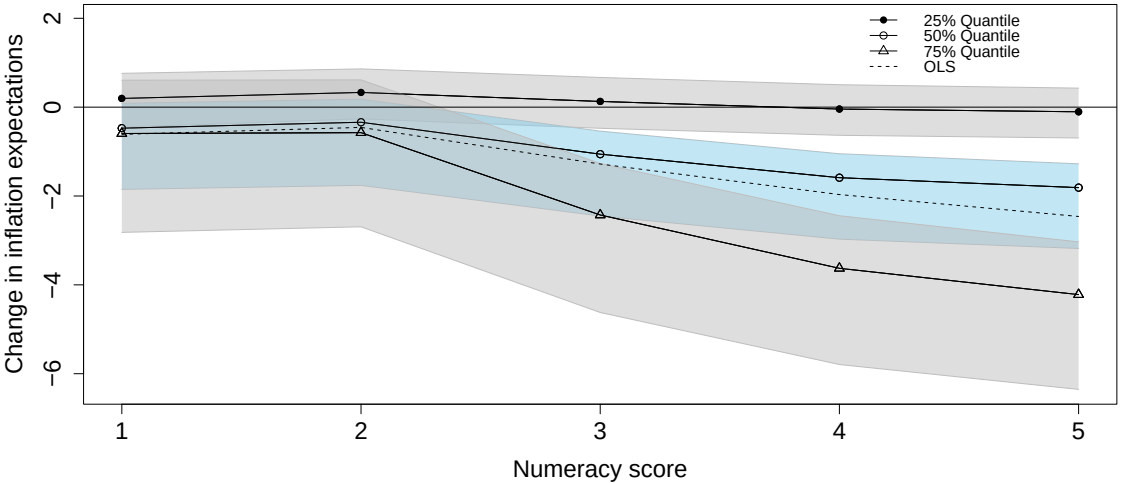
Estimated QR coefficients on **macro variables** (baseline)



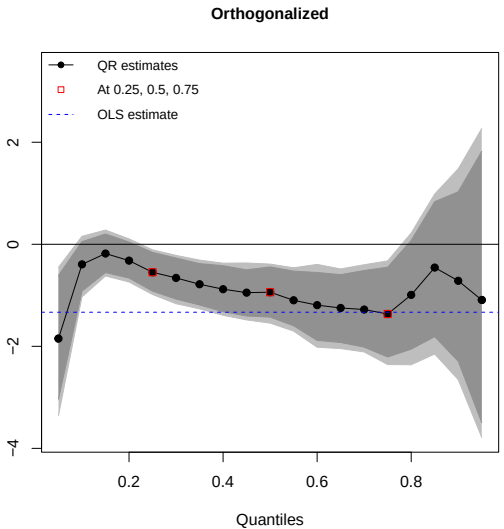
Estimated QR coefficients on **demographic characteristics** (baseline)

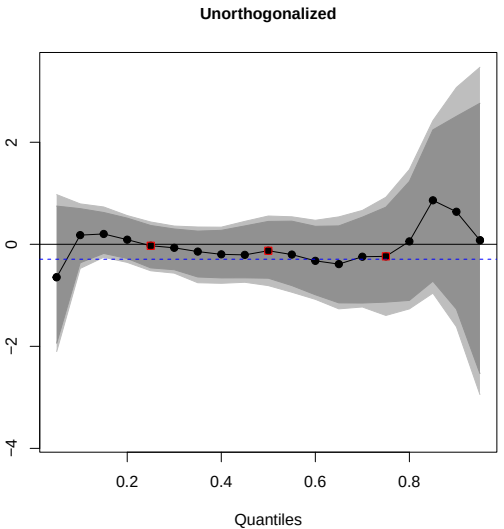


Estimated QR responses on **numeracy score** (baseline)



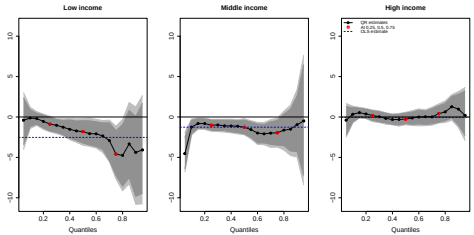
Orthogonalized vs. unorthogonalized monetary policy shock (baseline)



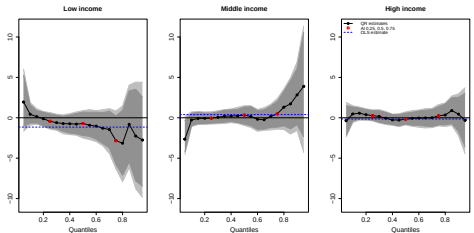


Orthogonalized vs. unorthogonalized monetary policy shock (extended)

(a) With the orthogonalized monetary policy shock



(b) With the unorthogonalized monetary policy shock



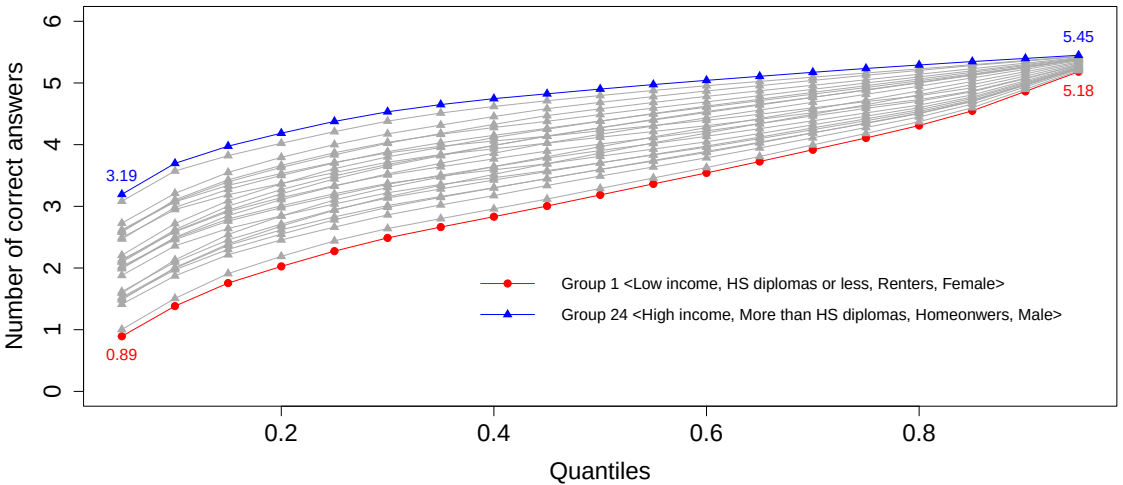
Summary of the empirical findings

- The distribution of inflation expectations has a short left tail and a long right tail
  - There is substantial heterogeneity across demographic groups in terms of the degree of right skewness
- In the lower quantiles, inflation expectations are similar across demographic groups
  - All the groups have a peak of the distribution near 2%, the target by the Fed
- In the upper quantiles, inflation expectations are very dispersed across demographic groups
- A contractionary monetary policy shock is estimated to stabilize household inflation expectations
- For high income group, inflation expectations are relatively insensitive to a monetary policy shock but is strongly correlated with the inflation compensation measure from TIPS (0.71 versus 0.32 in the low income group at the median)

What are the sources of the heterogeneity?

- **Economic literacy (numeracy)**
  - A very strong source of the heterogeneity in inflation expectations across groups
  - But even after controlling for the numeracy score, the pattern of the within-group and between-group heterogeneity still remains
- **Experienced inflation**
  - Heterogeneity in the consumption basket leads to heterogeneity in household-specific inflation, which may generate heterogeneity in inflation expectations
  - Some evidence that households with high (low) inflation experiences (e.g., different consumption baskets, age) expect high (low) inflation
  - It was found that groups with greater dispersion in experienced inflation also disagree more about future inflation (Johannsen, 2014)
  - But the difference in experience inflation is quantitatively small to the difference in inflation expectations
- **Skewed prediction of inflation**
  - Most of the households predict inflation and only around 5% of the households predict deflation
  - An effective lower bound at 0 or downward rigidity in inflation expectations (Gorodnichenko and Sergeyev 2021)
  - Not likely to be due to the inexperience of deflation (a similar pattern is observed in Japan)

Predicted conditional quantiles of the numeracy score



Implications for monetary policy

- Targeted communication, especially aimed at those in the vulnerable group, by the central bank may be helpful in improving the anchoring of household inflation expectations (consistent with findings from the “randomized information treatment" literature)
- Improving the awareness of inflation hedging through TIPS market and lowering the cost of access to it
- Nonetheless, our finding is encouraging in the sense that a monetary policy is **NOT** ineffective in lowering the inflation expectation of the vulnerable group

Appendix: Numeracy score in SCE

- Previous research finds that cognitive abilities or economic literacy affect household inflation expectations
  - Bruine de Bruin et al. (2010), Burke and Manz (2014), D'Acunto et al. (2022)
- MSC does not collect information on numeracy or economic literacy
- SCE asks some numeracy questions to new respondents. For example,

  QNUM1. *In a sale, a shop is selling all items at half price. Before the sale, a sofa costs $300. How much will it cost in the sale?*

  QNUM2. *Let's say you have $200 in a savings account. The account earns ten per cent interest per year. Interest accrues at each anniversary of the account. If you never withdraw money or interest payments, how much will you have in the account at the end of two years?*

- NY Fed classifies these questions for numeracy but the questions can be understood as testing economic or financial literacy
- The numeracy score is the number of correct answers (0 to 5)

Appendix: Numeracy questions in SCE

QNUM1. In a sale, a shop is selling all items at half price. Before the sale, a sofa costs $300. How much will it cost in the sale?

QNUM2. Let's say you have $200 in a savings account. The account earns ten per cent interest per year. Interest accrues at each anniversary of the account. If you never withdraw money or interest payments, how much will you have in the account at the end of two years?

QNUM3. In the BIG BUCKS LOTTERY, the chances of winning a $10.00 prize are 1%. What is your best guess about how many people would win a $10.00 prize if 1,000 people each buy a single ticket from BIG BUCKS?

QNUM5. If the chance of getting a disease is 10 percent, how many people out of 1,000 would be expected to get the disease?

QNUM6. The chance of getting a viral infection is 0.0005. Out of 10,000 people, about how many of them are expected to get infected?

QNUM8. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After one year, how much would you be able to buy with the money in this account? (1) More than today (2) Exactly the same (3) Less than today

QNUM9. Please tell me whether this statement is true or false: Buying a single company's stock usually provides a safer return than a stock mutual fund. (1) True (2) False

Appendix: Rounded responses

Questions on inflation expectations in SCE

Q8v2

The next few questions are about inflation. **Over the next 12 months**, do you think that there will be inflation or deflation? (Note: deflation is the opposite of inflation)

Instruction H8.

❍ Inflation (1)

❍ Deflation (the opposite of inflation) (2)

If no response: error E1

Q8v2part2

What do you expect the rate of [inflation (if Q8v2=inflation)/deflation (if Q8v2=deflation)] to be **over the next 12 months**? Please give your best guess.

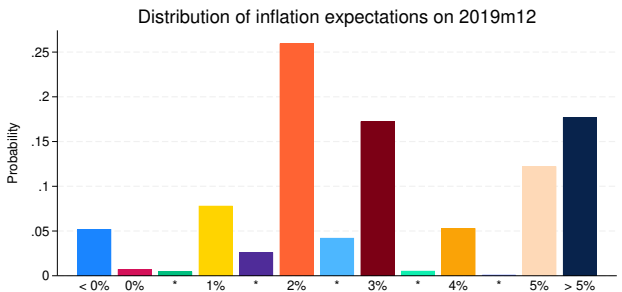
Instruction H9.

Over the next 12 months, I expect the rate of [inflation/deflation] to be __ %

If no response: error E1

Appendix: Rounded responses

- The expected rate of inflation or deflation can be a non-integer, but 93.2% of the answers are an integer



- Problematic in quantile regressions
  - Quantiles are also integers in the standard method so the quantiles do not vary much
  - It violates the sufficient condition for asymptotically valid inference of quantile regressions that the conditional prob density function be continuous

Appendix: Data: Michigan Survey of Consumers

- Conducted every month; each month approximately 500 are interviewed by telephone
- The core questions cover three broad areas of consumer sentiment: personal finances, business conditions, and buying conditions
- Rotating panel design: 40% of the total sample are re-interviewed six months after their first interviews
- Available since late 1970s but we use data since *1992m9* because of the availability of some data
- No information about economic literacy or numeracy of the respondents

Appendix: MSC Results: whole sample 1992m9 - 2019m12 (1)

Estimated QR coefficients

Appendix: MSC Results: whole sample 1992m9 - 2019m12 (2)

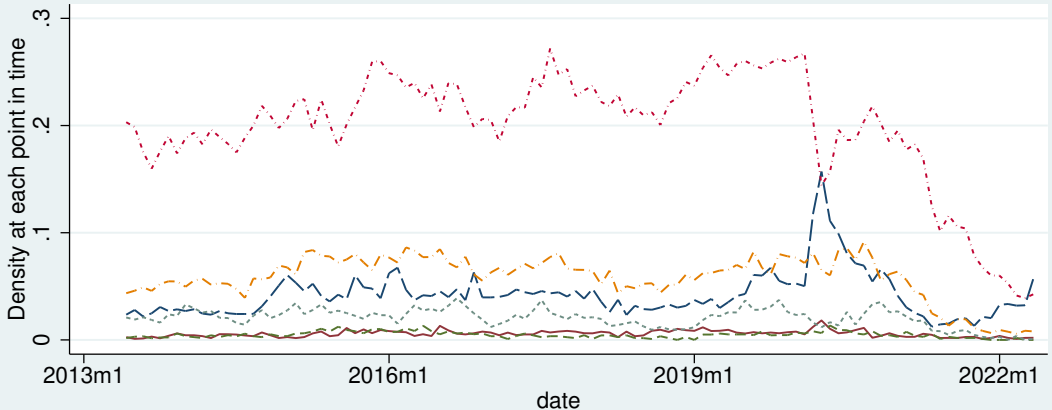
Estimated QR coefficients

Appendix: MSC Results: whole sample 1992m9 - 2019m12 (3)

Estimated QR coefficients

Small mass predicting deflation in SCE

One-year ahead inflation expectations

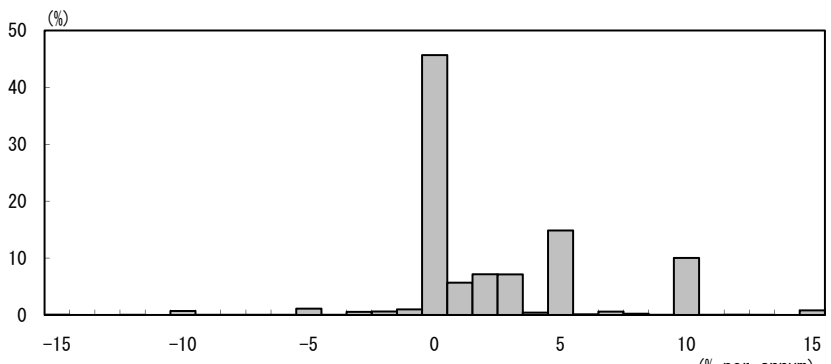


Small mass predicting deflation in BOJ Opinion Survey

One-year ahead inflation expectations

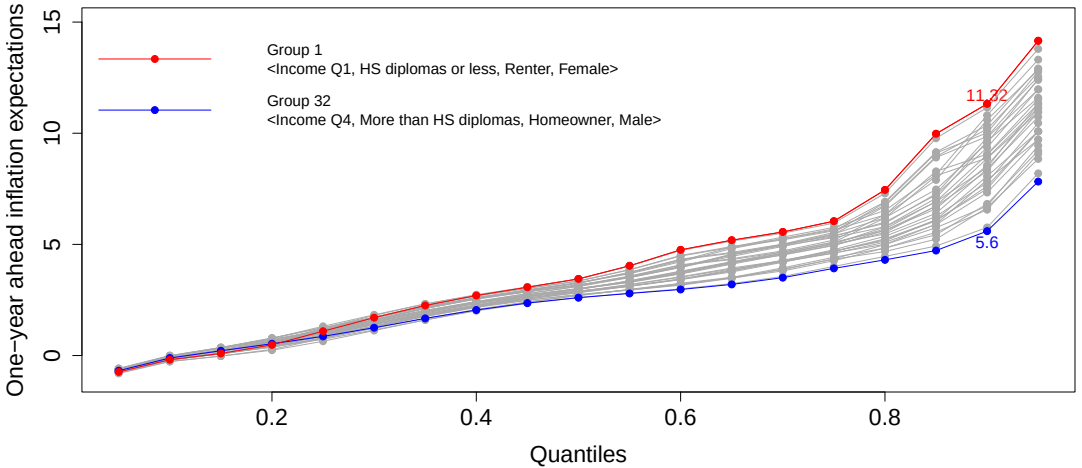
Figure 2. Distributions of Survey Answers on Inflation Expectations (All surveys averaged)

(a) 1 Year Expectations



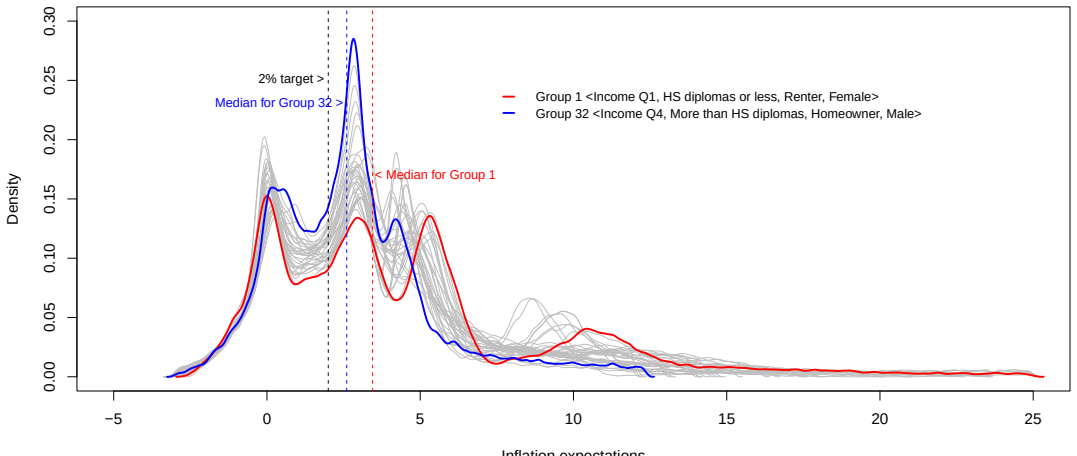
MSC: predicted conditional quantiles across groups

2019m12, Middle-aged ($40 \leq$ AGE < 60), first-time respondents, West



MSC: predicted conditional distributions across groups

2019m12, Middle-aged ($40 \leq$ AGE < 60), first-time respondents, West



MSC questions

MSC questions

Substantial mass at 0% inflation expectations in MSC

One-year ahead inflation expectations (2010m2, shortly after the GFC)

ECB Consumer Expectations Survey questions

Large mass at 0% in ECB Survey

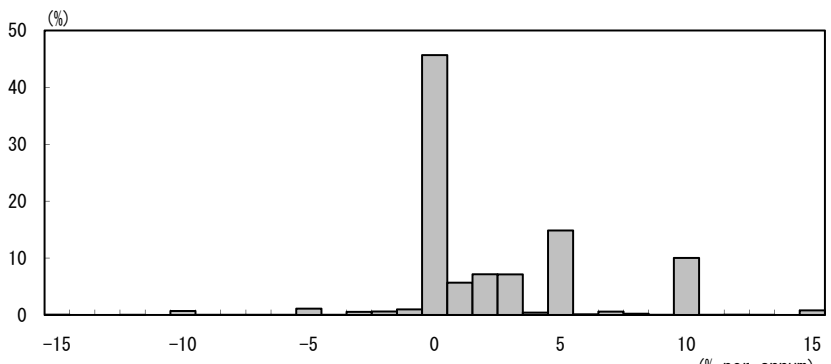
One-year ahead inflation expectations (2020m11). Prices will...

Large mass at 0% in BOJ Opinion Survey

One-year ahead inflation expectations

Figure 2. Distributions of Survey Answers on Inflation Expectations (All surveys averaged)

(a) 1 Year Expectations



TIPS expected inflation and median survey forecasts