Consumer Inflation Expectations and Regional Price Changes*

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Abstract

We analyze the extent to which US consumers are affected by regional price swings when reporting their inflation expectations. The aggregate data analysis based on a generalized sticky information model indicates that regional differences in inflation exert a statistically significant, albeit quantitatively modest, impact on disagreement in inflation expectations among consumers. This result is confirmed by the micro-level analysis, conducted within a framework in which information is sticky and consumer's experience of inflation matters when forming expectations. The results suggest that regional rather than national inflation rates affect consumers' views on inflation in short- and medium-term horizon.

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I. Introduction

For the conduct of economic policies, expectations of economic agents are important inputs that must be considered. Academic researchers (e.g., Sargent, 1982; Blinder, 2000; Woodford, 2003) have recognized this and so have monetary policy makers (e.g., Bernanke, 2007; Yellen, 2015; Draghi, 2018). As expressed by Bernanke (2013): '*... expectations matter so much that a central bank may be able to help make policy more effective by working to shape those expectations.'* and Yellen (2016): '*... many central banks have sought additional ways to stimulate their economies, including adopting policies that are directly aimed at influencing expectations of future interest rates and inflation.'*

The analysis in the study at hand focuses on consumers' inflation expectations, which are likely to affect their decisions to consume and thereby the output growth and aggregate price developments. We employ the Survey of Consumer Expectations (SCE) conducted by the Federal Reserve Bank of New York (FRBNY) and the Survey of Consumers made by the University of Michigan (MSC) to explore which factors affect the way households form inflation expectations and thereby to get a better understanding of the household-expectation channel in the monetary transmission mechanism. Particularly we are interested in how developments of local prices affect consumer views on future developments of the inflation rate.

Despite the important role of consumers' inflation expectations for actual inflation developments (e.g., Coibion and Gorodnichenko, 2015; Friedrich, 2016), the knowledge of the formation process is still limited. Some studies (e.g., Johannsen, 2014; Malmendier and Nagel, 2016) focus on the role of life-time experienced inflation in the expectation formation process, but with the development of detailed surveys of households' expectations, and the publication of micro-level data, it has become possible for researchers to investigate the impact of heterogeneity on expectations. The literature in this respect is scarce, even though the issue is addressed in a couple of recently published papers. Diamond et al. (2020) apply data from a Japanese consumer survey and argue that inflation expectations increase with age, while Bachmann et al. (2021) document the presence of partisan bias in US inflation expectations.

Our analysis suggests that regional differences in inflation rates affect the formation of consumers' inflation expectations. The results based on a generalized version of the sticky-information model estimated on aggregate MSC data indicate that disagreement among consumers, given by cross-sectional variance of their inflation expectations, can be partially attributed to differences in inflation rates across US regions. Additionally, using micro data from the CSE we find that the regional inflation rates, as opposed to country-wide observations, affect consumer inflation expectations.

Relation to existing literature. The present analysis builds mainly on two observations in the expectation-formation literature. One demonstrates how consumers' personal experiences matter for how they answer questions with respect to the future inflation rate

and another argues that information is sticky. We employ these observations and argue that consumers form their inflation expectations based on the prices they observe locally.[1]

Sticky information models, discussed by e.g., Mankiw and Reis (2002, 2006), where agents do not update their information instantaneously, have been successful in explaining the dynamics of output and inflation. The microeconomic foundations for these models have been elaborated by Carroll (2003, 2006), in his epidemiological model of expectations. He argues that US survey data on inflation expectations are consistent with a model where only some of the households use the expectations of experts. The rest of them use past expectations as they find it costly to update their information.

Using the inflation expectations of MSC, Branch (2007) claims that the formation of these expectations is consistent with a sticky information model with a time-varying distribution structure. Lanne et al. (2009) show that these expectations are consistent with a simpler model of the same type, when a large part of the households form their opinions using the most recent inflation rate and not the expert forecast. The sticky information model has also shown to be consistent with inflation expectations outside the US, e.g., by Döpke et al. (2008), who find support for this model with European data (France, Germany, Italy, and UK).

Mankiw et al. (2003) explore disagreement about inflation expectations and find that a sticky information model, where some agents employ outdated information to form

[1] Interestingly, Fielding and Shields (2011) argue that differences in economic and demographic characteristics imply that price responses to monetary policy shocks vary across US cities.

expectations, can explain central tendency and dispersion of US inflation expectations. In the present study we also explore the disagreement dimension by adopting the framework of Łyziak and Sheng (2022), which allows for analyzing several sources of disagreement in inflation expectations.

As a part of our analysis, we also explore how consumers' personal experiences affect their inflation expectations. Johannsen (2014) constructs household specific inflation rates by calculating separate consumption bundles with data from the Consumer Expenditure Survey (CES) conducted by the Bureau of Labor Statistics (BLS). Employing survey data on inflation expectations from the MSC, he shows that demographic groups with higher dispersion in experienced inflation also disagree more about the future rate. Also applying the MSC, Madeira and Zafar (2015) argue that life-time experience of inflation has impact on one-year-ahead expectations, while public information is more relevant for those of longer horizons. Malmendier and Nagel (2016) also find evidence that life-time inflation experience mattes for the formation of inflation expectations. With 57 years of individual MSC expectations, they find significant differences across consumers with different age in periods with high inflation volatility. The experienced inflation seems to have a persistent role in the formation of expectation. In the recent study, Goldfayn-Frank and Wohlfart (2020) document that East Germans expect higher rates than West Germans long time after the German reunification, which, they argue, is due to the experienced inflation shock after the reunion.

Another type of experience, which has attracted less attention in the literature, regards what agents feel in the everyday life. Bruine de Bruin et al. (2011) present two studies, where they ask participants to form inflation expectations under different scenarios. The results show that individuals asked to recall a specific price change reported more extreme one-year-ahead inflation expectation, and more disagreement, than those who were asked to recall average changes. It also turned out that, even when individuals were asked not to recall any specific price changes, more than half of them did so anyway when forming their one-year-ahead inflation expectations. Employing Swedish data, Dräger (2015) argues that there is a strong relation between perceived and expected inflation, while the role of actual inflation in determining expectations is weaker. D'Acunto et al. (2019) analyze US grocery shopping observations and find that consumers rely on these prices when forming the inflation expectations.

The rest of the study. The remainder of the study is structured as follows. Section II describes the data employed in the empirical analysis. Section III presents the analysis of disagreement made with aggregated data, while section IV discusses the extent to which regional price changes matter for the formation of consumers' inflation expectations. The latter analysis is based on observations of individual expectations. Final comments are included in section V.

II. Data and descriptive statistics

There are four main sources of the data employed in the empirical analysis. Time series observations of inflation rates, national and regional, are from the BLS, and expert forecast are from the Survey of Professional Forecasters (SPF) conducted by the Federal Reserve Bank of Philadelphia. For the analysis of disagreement, which is made with aggregated observations, we use MSC data from the University of Michigan, while panel observations are from SCE of the FRBNY. The reason for applying survey data from different sources is that the MSC is available for a longer period, while SCE has a rotating panel structure and provides more details on characteristics of respondents. Appendix A presents a brief description of SCE.

Time series observations. To measure national and regional price changes, we employ BLS data for headline and core inflation as well as food and gasoline prices. Descriptive statistics are reported in Tables B2 and B3 in Appendix B. The times series show some heterogeneity across regions, but without statistically significant differences in the averages. From MSC and SPF we utilize quarterly averages calculated with individual replies to the one-year-ahead inflation expectations. The sample period starts in 1981Q3 and ends in 2021Q1. For dispersions we employ variances. Descriptive statistics are shown in Table B4 in Appendix B.

Panel observations. We apply individual observations from FRBNY SCE, and our database contains observations from June 2013 to December 2019, a total of more than

100,000 observations. The questions of interest are inflation expectations twelve and 36 months ahead[2] and Table 1 reports some descriptive statistics on the replies across months.

TABLE 1

Descriptive statistics on inflation expectations, SCE survey (2013M6 – 2019M12)

				One-year-ahead			
	#obs	*Min*	*P10*	*P25*	*P50*	*P75*	*P90*	*Max*
p50	1,308	-100.0	2.0	2.0	3.0	5.0	10.0	65.0
avg	1,313	-77.6	0.6	2.0	3.1	5.4	12.7	281.6
sd	79	16.5	0.7	0.0	0.3	0.8	2.2	1,267.5
min	1,171	-100.0	-2.0	2.0	3.0	5.0	10.0	65.0
max	1,758	-50.0	1.5	2.0	4.0	8.0	20.0	11,200.0
mode	1,306	-100.0	1.0	2.0	3.0	5.0	15.0	100.0
				Three-years-ahead			
	#obs	*Min*	*p10*	*p25*	*p50*	*p75*	*p90*	*Max*
p50	1,311	-200.0	-2.0	2.0	3.0	5.0	10.0	75.0
avg	1,315	-88.9	0.1	2.0	3.2	5.7	13.4	123.5
sd	79	21.0	0.9	0.1	0.4	1.0	1.8	119.8
min	1,174	-200.0	-2.0	2.0	3.0	5.0	10.0	75.0
max	1,759	-50.0	1.2	2.5	4.0	8.0	15.0	1,000.0
mode	1,325	-100.0	1.0	2.0	3.0	5.0	15.0	100.0

Notes: The table shows median (p50), average (avg), standard deviation (sd), minimum (min), maximum (max), and mode (mode) for the following statistics calculated across months: number of observations (#obs), minimum (min), percentiles 10th, 25th, 50th, 75th and 90th (p10, p25, p50, p75, p90), and maximum (max). For example, the cell (p50, #obs) shows the median of the number of monthly observations.

Source: Federal Reserve Bank of New York and own calculations.

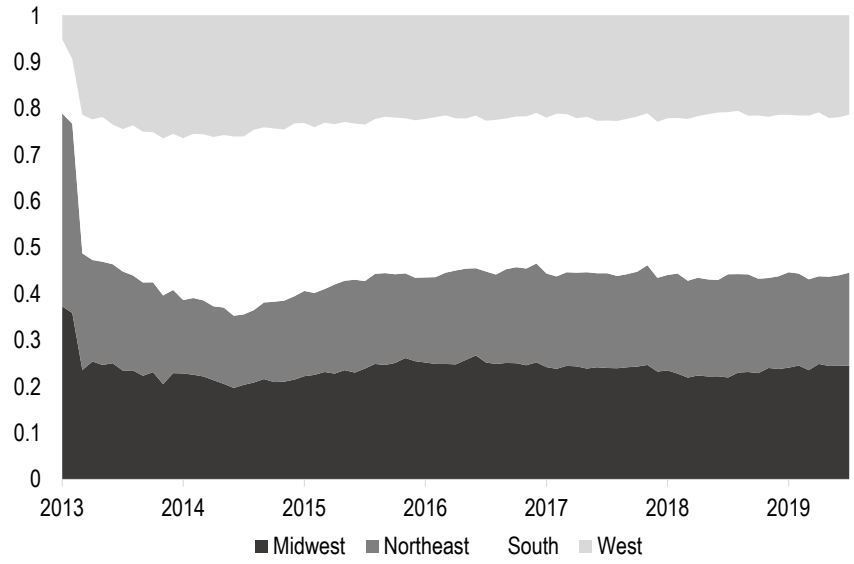
There are some striking outcomes in Table 1. Firstly, the number of observations per survey is quite constant with between 1,200 and 1,400 respondents. Only seven of the

[2] The formulations of the questions are: *'Over the next 12 months, I expect the rate of [inflation/deflation] to be __%'* and *'Over the 12-month period between [Month, Year - 24 months from survey date] and [Month, Year - 36 months from survey date], I expect the rate of [inflation/deflation] to be ___ %.'*

surveys are outside this range. Except for the two first months, the distribution across regions is also relatively stable with 24% of the observation from Midwest, 19% from Northeast, 34% from South and 23% from West (Fig. 1). Secondly, there are some large outliers with exceptionally low and high responses. For this reason, we winsorize the data prior to estimations. Thirdly, the 25th percentile for the question on the one-year-ahead inflation rate is 2% in all surveys (there are only few exceptions for the three-months-ahead question), while the median is close to 3% in the majority of them.

FIGURE 1

Percentages of answers across regions and months



Source: Federal Reserve Bank of New York and own calculations.

Table B1 in Appendix B shows descriptive statistics across regions. There are some differences, but the averages do not deviate significantly from each other. The table also shows statistics for the probability distributions across bins, which are supplied by the

consumers and included in the micro-observations of SCE. The medians and means of these distributions do not contain the same extreme values. To measure uncertainty in the price expectations, the table reports the variance and the difference between the percentile 75 and 25 calculated by FRBNY with the bin distributions.

III. Regional inflation and disagreement in consumer inflation expectations

We start the analysis with testing whether regional differences in inflation rates drive differences in consumer views on future inflation. For this purpose, we refer to the sticky information (epidemiological) framework (Mankiw and Reis, 2002; Carroll, 2003, 2006). The version of the epidemiological model applied is based on the generalization of the original Carroll (2003, 2006) model, presented by Łyziak and Sheng (2022).

Let us assume that the consumer *i*'s inflation expectation at time *t*, denoted as $c_{i,t}$, evolves according to the following formula:

$$c_{i,t} = \mu_i + \lambda_i p_{i,t} + \beta_i c_{i,t-1} + \gamma_i r_{i,t-1} + e_{i,t}, \quad (1)$$

where $p_{i,t}$ is the publicly available inflation forecast by the expert, whose opinions the individual *i* is following[3], $r_{i,t-1}$ is the most recent inflation rate observed by the individual *i* in his or her location, μ_i is individual-specific intercept capturing consumer *i*'s time-

[3] With MSC micro-observations, Dräger and Lamla (2017) find that a rising volatility in the inflation predictions of professional forecasters triggers an update of consumer inflations expectations.

invariant belief on the long-run level of inflation ("fundamental inflation"), λ_i is consumer *i*'s propensity to learn from expert forecasts, β_i is the weight on consumer *i*'s previous inflation expectations, γ_i is consumer *i*'s propensity to adjust expectations on the basis of current inflation in his/her location, while $e_{i,t}$ is the random shock. The fundamental inflation of consumer *i*, c_i^*, can be calculated based on eq. (1) as $c_i^* = \mu_i/(1-\lambda_i-\beta_i-\gamma_i)$.

We denote $\bar{x}_t$ as the cross-sectional average of $x_{i,t}$ and $\sigma_{x,t}^2$ as the cross-sectional variance of $x_{i,t}$. The dynamics of mean inflation expectation, $\bar{c}_t$, is given by:

$$\bar{c}_t = \bar{\mu} + \bar{\lambda}\bar{p}_t + \bar{\beta}\bar{c}_{t-1} + \bar{\gamma}\bar{r}_{t-1} + \bar{e}_t. \tag{2}$$

Under the assumption that μ_i, $c_{i,t-1}$, λ_i, β_i, $p_{i,t}$, γ_i and $r_{i,t-1}$ are orthogonal to each other[4], we obtain consumer forecast disagreement as follows:

$$\sigma_{c,t}^2 = \sigma_\mu^2 + \left(\sigma_\beta^2 + \bar{\beta}^2\right)\sigma_{c,t-1}^2 + \left(\sigma_\lambda^2 + \bar{\lambda}^2\right)\sigma_{p,t}^2 +$$
$$+\left(\sigma_\gamma^2 + \bar{\gamma}^2\right)\sigma_{r,t-1}^2 + \sigma_\lambda^2\bar{p}_t^2 + \sigma_\beta^2\bar{c}_{t-1}^2 + \sigma_\gamma^2\bar{r}_{t-1}^2 + \sigma_{e,t}^2. \tag{3}$$

[4] This assumption seems plausible and is not very restrictive given that μ_i, λ_i, β_i and γ_i are constant over time – hence they are independent of $c_{i,t-1}$, $p_{i,t}$ and $r_{i,t-1}$, $p_{i,t}$ and $c_{i,t-1}$ are independent since consumers are assumed to learn from experts, but not vice versa, $p_{i,t}$ and $r_{i,t-1}$ are independent because of the assumption that experts forecasting US inflation do not pay attention to regional inflation developments and $c_{i,t-1}$ and $r_{i,t-1}$ are independent due to publication lags.

According to equation (3), disagreement among consumers in assessing future inflation comes from eight sources:

(i) heterogeneity in fundamental inflation, σ_{μ}^{2};

(ii) consumers' divergent past expectations, $\sigma_{c,t-1}^{2}$,

(iii) experts' different views about future inflation, $\sigma_{p,t}^{2}$,

(iv) differences in regional inflation, $\sigma_{r,t-1}^{2}$,

(v) differences in the weights placed on consumers' own past forecasts, σ_{β}^{2},

(vi) differences in consumers' propensities to learn from experts, σ_{λ}^{2},

(vii) differences in consumers' propensities to adjust expectations based on current regional inflation, σ_{γ}^{2}, and

(viii) heterogeneity due to random shocks, $\sigma_{e,t}^{2}$.

We estimate equations (2) and (3) as a system using the Seemingly Unrelated Regression (SUR) method and rely on MSC data. As far as regional inflation rates are concerned, we apply BLS data for inflation in the four US regions (Midwest, Northeast, South and West). The estimated model is very general, and all the parameters are assumed to be heterogenous among the agents.

Estimation results suggest that the average regional inflation is statistically significant in the equation for the level of inflation expectations (Table 2). More specifically, in a given quarter there are approx. 52% of consumers, who do not modify their previous expectations, 14% of consumers following expert forecasts regarding US inflation and 12% of consumers observing and making use of inflation rates in their locations. The remaining part of consumers (approx. 22%) hold constant expectations, equal to 5% on average. A statistically significant role of average regional inflation in the equation for the level of consumer inflation expectations – in line with the logic of the model (3) – implies that regional differences have impact on disagreement in consumer inflation expectations. Estimation results of the equation for cross-sectional variance of inflation expectations reveal that the propensities of consumers to learn from experts and to follow either consumers' previous expectations or regional inflation are statistically significant, which suggests that these propensities are heterogenous among consumers. This heterogeneity seems quantitatively large, especially in the case of the propensity of consumers to learn from experts and to follow previously set expectations (Fig. 2). Hence, it seems to constitute a relevant driver of cross-sectional divergences in consumer expectations.

Interestingly, among consumers updating their expectations based on expert forecasts, 58% of individuals change their expectations in the direction consistent with experts, while 42% of individuals display a negative propensity to learn, i.e., they modify their expectations in the direction opposite to experts. The above finding is largely in line with

Pfajfar and Santoro (2013) and Łyziak and Sheng (2022). In the case of consumers following regional inflation or previous expectations, the percentage of individuals modifying their expectations in the direction opposite to changes of the above benchmarks is somewhat smaller, equal to 38% and 22%, respectively.

The above results imply that a part of cross-sectional differences in inflation expectations formed by consumers is likely to be related to regional differences in inflation. However, in quantitative terms the importance of this factor is limited as the differences in regional inflation explain approx. 5% of the cross-sectional variance of inflation expectations.[5] It is not very surprising given that heterogeneity of regional inflation rates is rather small (see Table B4 in Appendix B).

[5] Our results suggest that factors related to previous expectations and expert forecasts explain 75% and 16% of cross-sectional variance of consumer expectations respectively, while factors related to regional inflation and to fundamental inflation explain approx. 5% of disagreement each.

TABLE 2

Sticky-information model with regional inflation rates, 12-month-ahead inflation expectations, aggregate data

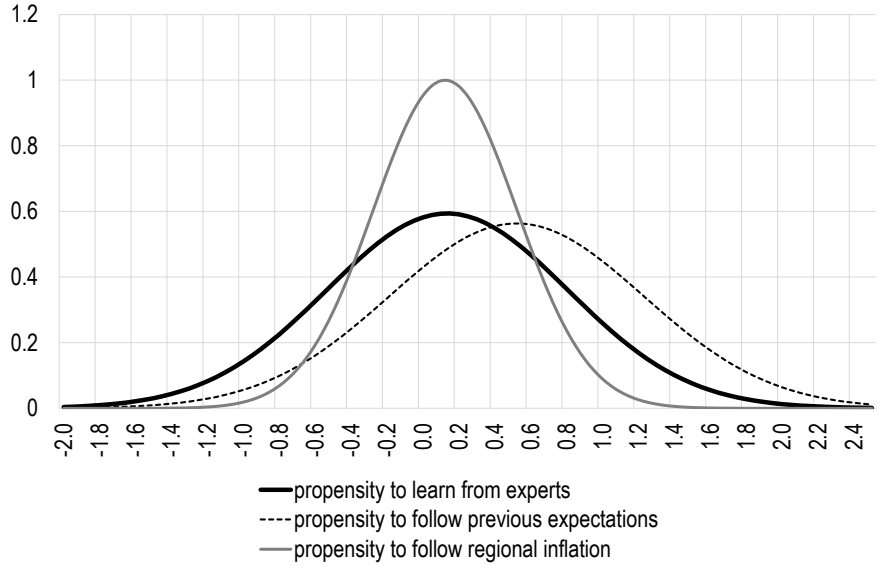
	Eq. (2)/ (3)		*Eq. (3)*
$\bar{\lambda}$	0.137* (0.074)	σ_λ	0.672*** (0.105)
$\bar{\beta}$	0.522*** (0.096)	σ_β	0.708*** (0.037)
$\bar{\gamma}$	0.124** (0.058)	σ_γ	0.399*** (0.039)
$\bar{\mu}$	1.085*** (0.242)	σ_μ	1.006 (0.619)
Adj. R^2	0.81	Adj. R^2	0.70

Notes: Estimated as a system with Seemingly Unrelated Regression (SUR) method. Sample: 1981Q3-2021Q1. Standard errors in parentheses. * p<.1; ** p<.05; *** p<.01.

Source: own calculations.

FIGURE 2

Distributions of propensities to learn from experts and to follow previous expectations or regional inflation



Source: own calculations.

IV. Regional inflation and the level of inflation expectations

In this section we take advantage of the micro-level data from SCE to investigate importance of national and regional price developments in shaping consumer inflation expectations. In the empirical analysis we refer to two theoretical frameworks: sticky information model and learning-from-experience model.

Sticky information model

We employ FRBNY SCE data to estimate a version of the sticky-information model of inflation expectations formation at the micro level. The model—which allows both, regional and national, inflation rates to affect inflation views— is as follows:

$$c_{i,t} = \beta_{i,0} + \beta_1 c_{i,t-1} + \beta_2 r_{i,t} + \beta_3 n_t + \beta_4 p_t + \Pi^T X_{i,t} + e_{it}, \quad (4)$$

where $c_{i,t}$ denotes 12-month-ahead or 36-month-ahead inflation expectations of consumer *i* in period *t*, $r_{i,t}$ is the regional inflation rate in period *t* specific to the place of residence of consumer *i*, n_t is the national inflation rate and p_t is the consensus expert forecast. We account for individual heterogeneity by including in $X_{i,t}$ a wide set of demographic characteristics of the consumer (gender, age, age squared, income, number of children in household, education level, race, numeracy score[6]) and a set of dummy variables related to the number of surveys already answered by the respondent

[6] The numeracy score measures ability to use numbers is everyday life. It is based on five test questions referring to calculating price after discount, familiarity with compound interest rate, and using percentages.

(tenure) in order to account for the panel conditioning effect (Kim and Binder, 2020).[7] We prefer this specification over individual fixed effects, because we want to exploit cross-sectional variability, which is especially important in a situation when respondents stay in the panel for a relatively short time span.[8] Alternatively, national inflation rate and SPF forecast might be replaced with a set of time dummies (T_t) which account for all kind of information available to all respondents in period *t*, including national inflation rate and recent expert inflation forecasts.

Estimation results presented in Table 3 and 4 reveal that the regional inflation rate provides an important input to consumers' expectation formation, while no strong evidence suggest that the national inflation rate does. This holds for both horizons of inflation expectations, short- and medium-term. Specifications with time dummies confirm that regional inflation rates affect consumer inflation opinions significantly. Surprisingly, we get counter-intuitive (negative) estimate of the parameter related to expert forecast, suggesting that consumers revise their inflation expectations in the opposite direction of experts' prediction. Even if researchers typically find a positive relation between mean consumer inflation expectations and consensus expert forecast, Pfajfar and Santoro (2013) show that on micro-level as much as half of the consumers revise their inflation expectations in the opposite direction than consensus forecast. This result is also broadly consistent with the heterogeneity of propensity of consumers to learn

[7] Kim and Binder (2020) show that consumers with more survey experience have lower inflation expectations and they find larger panel conditioning effects in SCE survey than MSC, probably due to longer time between interviews in the latter.
[8] The same approach for modelling SCE panel data is taken by Kuchler and Zafar (2019).

from experts, as presented in the previous section. Another explanation is that the period under consideration is relatively short and characterized by very stable SPF forecasts (about 2%), which makes it difficult to identify a robust relationship between consumer inflation expectations and expert forecasts.

Next, we disaggregate regional inflation rate into three components: core inflation, food inflation, gasoline inflation. The results suggest that for short-term inflation expectations, the regional differences in food inflation play the most important role. This is different for the medium-term inflation expectations, for which differences in the core inflation is the only regional variable that matters. In both cases, regional gasoline prices do not affect inflation expectations.

TABLE 3

Sticky-information model with regional inflation rates, 12-month-ahead inflation expectations

	(1)	*(2)*	*(3)*
Lagged expectations	0.374***	0.378***	0.377***
Regional CPI inflation rate	0.129***	0.121***	-
National CPI inflation rate	-0.036	-	-
Regional core inflation	-	-	0.085*
Regional food inflation	-	-	0.113**
Regional gasoline inflation	-	-	0.003
SPF inflation forecast	-0.634***	-	-
Personal characteristics	Yes	Yes	Yes
Tenure dummy	Yes	Yes	Yes
Time dummy	No	Yes	Yes
#obs	79,308	79,308	79,308
R^2 (overall)	0.343	0.344	0.344

Notes: Inflation expectations are measured as mean of the subjective forecast distribution. Random effects estimator with robust standard errors. * p<.1; ** p<.05; *** p<.01.

Source: own calculations.

TABLE 4

Sticky-information model with regional inflation rates, 36-month-ahead inflation expectations

	(1)	*(2)*	*(3)*
Lagged expectations	0.326***	0.328***	0.328***
Regional CPI inflation rate	0.120***	0.110**	-
National CPI inflation rate	-0.026	-	-
Regional core inflation	-	-	0.113**
Regional food inflation	-	-	0.072
Regional gasoline inflation	-	-	-0.002
SPF inflation forecast	-0.788***	-	-
Personal characteristics	Yes	Yes	Yes
Tenure dummy	Yes	Yes	Yes
Time dummy	No	Yes	Yes
#obs	79,461	79,461	79,461
R^2 (overall)	0.320	0.320	0.320

Notes: Inflation expectations are measured as mean of the subjective forecast distribution. Random effects estimator with robust standard errors. * p<.1; ** p<.05; *** p<.01.

Source: own calculations.

Learning-from-experience model

The learning-from-experience model refers to a constant gain adaptive learning model of expectation formation, which stresses the role of inflation experienced over lifetime (Malmendier and Nagel, 2016). According to this approach, consumers form inflation expectations based on an autoregressive model of inflation with unknown parameter values, which they try to infer recursively. The important assumption is that more recent data affect expectations more strongly than more distant data. Apart from inflation experienced by consumers during their lifetime, other common factors (like professional inflation forecasts) might affect consumers' inflation expectations. We modify the

learning-from-experience model by allowing consumers to learn from national and local inflation rates.

We use the empirical specification like the one employed by Goldfayn-Frank and Wohlfart (2020) and Kuchler and Zafar (2019):

$$c_{i,t} = \beta_{i,0} + \beta_1 \tilde{r}_{i,t} + \beta_2 \tilde{n}_{i,t} + \beta_3 p_t \ + \Pi^T X_{it} + \epsilon_{it}, \quad (5)$$

where: $\tilde{r}_{i,t}$ is inflation experienced by the respondent *i* over some period based on local price developments and assuming weighting of past data with parameter λ, while $\tilde{n}_{i,t}$ is the corresponding inflation experience based on national-level inflation rate. As previously, $X_{i,t}$ includes personal characteristics of respondent and the number of SCE surveys already taken.

The formula for constructing average inflation rates based on regional data is the following:

$$\tilde{r}_{i,t} = \sum_{k=0}^{K} w_{it}(k,\lambda) r_{t-k}, \quad (6)$$

$$w_{it}(k,\lambda) = \frac{(K-k)^{\lambda}}{\sum_{k=0}^{K}(K-k)^{\lambda}}, \quad (7)$$

where K is the number of months and λ is the weighting parameter. In the case of the average inflation rates based on country-wide data we use an analogous formula.

To construct historical inflation rates experienced by respondents, we consider a period of the past one to five years. For each time span, we consider weighting parameters ranging from zero to five (with a step of 0.1). If λ equals zero, we get simple averages; higher values of λ correspond to higher weights of more recent observations. We choose K and λ to which maximize the overall R^2 of the model. We choose it separately for the model explaining short- and medium-term inflation expectations. For models with time effects, we use the same weighted averages of past inflation as for the baseline model. It turns out that US consumers take into consideration about 4 years of historical inflation rates, and that they put only slightly larger weight on more recent observations or, in the case of medium-term inflation expectations, use simple average.

Estimation results of model (5) are presented in Table 5 and Table 6. Like in the sticky information framework, we find that regional inflation rates affect one-year ahead consumer inflation expectations, while national inflation rates are statistically insignificant. The learning-from-experience model points to a positive and statistically significant role of expert forecasts in shaping one-year ahead consumer inflation expectations. In the case of medium-term inflation expectations, the evidence in favors of importance of regional inflation rates is weaker, as this variable is statistically significant only in the model without time dummies.

Finally, we disaggregate the overall inflation rate into three components: core inflation, food inflation, and gas price inflation. Such a disaggregation does not give us more insight

into drivers of consumer inflation expectations as for most of parametrizations the experienced inflation is statistically insignificant.

TABLE 5

Learning-from-experience model with regional inflation rates, 12-month-ahead inflation expectations

	(1)	*(2)*	*(3)*
Regional CPI inflation rate	0.320***	0.269***	-
National CPI inflation rate	0.182	-	-
Regional core inflation	-	-	0.116
Regional food inflation	-	-	0.186
Regional gasoline inflation	-	-	0.010
SPF inflation forecast	0.302**	-	-
Personal characteristics	Yes	Yes	Yes
Tenure dummy	Yes	Yes	Yes
Time dummy	No	Yes	Yes
#obs	100,499	100,499	100,499
R^2 (overall)	0.029	0.0335	0.0334

Notes: Inflation expectations are measured as mean of subjective forecast distribution. SFP forecast is CPI inflation forecast 4-quarters ahead. Random effects estimator with robust standard errors. * p<.1; ** p<.05; *** p<.01.

Source: own calculations.

TABLE 6

Learning-from-experience model with regional inflation rates, 36-month-ahead inflation expectations

	(1)	*(2)*	*(3)*
Regional CPI inflation rate	0.205**	0.143	-
National CPI inflation rate	0.224*	-	-
Regional core inflation	-	-	0.040
Regional food inflation	-	-	0.170
Regional gasoline inflation	-	-	-0.010
SPF inflation forecast	0.055	-	-
Personal characteristics	Yes	Yes	Yes
Tenure dummy	Yes	Yes	Yes
Time dummy	No	Yes	Yes
#obs	100,740	100,740	100,740
R^2 (overall)	0.0227	0.0267	0.0267

Notes: Inflation expectations are measured as mean of subjective forecast distribution. SFP forecast is CPI inflation forecast 4-quarters ahead. Random effects estimator with robust standard errors. * p<.1; ** p<.05; *** p<.01.

Source: own calculations.

V. Final comments

To what extent do consumers consider regional price development when forming their inflation expectations? In the study at hand, we address this question by analyzing, firstly, how disagreement in inflation expectations can be explained by regional factors and, secondly, by exploring the extent to which regional price swings have an impact on consumer inflation expectations. We find that regional differences in inflation rates exert a statistically significant impact on disagreement in inflation expectations among consumers, even though the quantitative importance of this effect is small. Evidence from micro-level analysis suggests that regional differences in inflation rates matter for short- and medium-term inflation expectations. It seems that in the former case differences in food inflation particularly matter, while in the latter case differences in core inflation play an important role.

The fact that regional factors influence how consumers form expectations implies that policy makers must pay attention to both national and local news when extracting information from consumers' economic expectations. This may be particularly important when there are substantial differences across the regions.

The present analysis was made with regional observations, and it would be interesting to explore if the results are robust to an application with observations with a higher degree of disaggregation, e.g., state-level observations. Another area where there is scope for future research is with respect to the New Keynesian Phillips Curve. Estimations of this

relationship with regional inflation expectations may expand our knowledge of the inflation-unemployment dynamics. Finally, a forecast horse race may reveal whether consumers' expectations are more accurate with respect to regional rates rather than with the national ones. Maybe survey questions to consumers should be more related to local developments rather than the national one. Future investigations may shed more light upon these important questions.

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Appendix A: SCE survey

The SCE survey has a rotating panel structure, where a representative sample of about 1,300 household heads are interviewed every month for a period of up to 12 months (Armantier et al., 2017). Micro data are available from June 2013 and are published with a delay of nine months. Participants are paid an amount of 20 USD for completing the questionnaire, which includes questions on the financial situation of the household as well as macroeconomic variables such as employment, stock market performance, growth, and inflation. Furthermore, it includes questions to define characteristic of the respondents, such as geographical location, age, education, and income, as well as questions to clarify how they use numbers in everyday life.[9]

[9] Recent studies that employ data from the survey include those of Ben-David et al. (2018), Crump et al. (2019), Kuchler and Zafar (2019), Bachmann et al. (2021), and Mueller et al. (2021).

Appendix B: Descriptive statistics

TABLE B1

Inflation expectations across regions, panel observations (2013M3 – 2019M12)

	area	*min*	*p10*	*p50*	*p90*	*max*	*avg*	*sd*	*#obs*
Inflation (12m)	MW	-100.0	1.0	3.0	10.0	2,025.0	4.8	16.6	24,757
	NE	-100.0	1.0	3.0	10.0	100.0	4.9	11.6	20,797
	S	-100.0	0.7	3.0	15.0	1,000.0	5.7	14.4	34,947
	W	-100.0	1.0	3.0	12.0	11,200.0	5.8	74.4	23,189
Dist. Answers									
P50	MW	-27.6	0.0	2.8	7.9	29.2	3.5	4.6	24,304
	NE	-25.0	0.0	2.7	7.7	36.3	3.4	4.8	20,470
	S	-36.3	0.0	2.9	9.4	36.3	3.7	5.1	34,244
	W	-25.0	0.4	3.0	8.7	36.3	3.8	4.9	22,822
Avg	MW	-25.0	0.0	2.8	8.0	28.0	3.5	4.5	24,304
	NE	-25.0	0.0	2.8	7.9	36.3	3.5	4.7	20,470
	S	-36.3	0.0	2.9	9.0	36.3	3.7	5.0	34,244
	W	-25.0	0.4	3.0	8.6	36.3	3.9	4.8	22,822
Var	MW	0.2	0.3	2.2	41.7	463.7	14.3	35.4	24,304
	NE	0.2	0.3	1.9	45.3	480.3	13.7	34.8	20,470
	S	0.2	0.3	2.7	61.1	481.0	19.6	43.9	34,244
	W	0.1	0.3	2.2	42.5	449.3	13.7	33.0	22,822
Iqr	MW	0.5	1.0	2.1	9.5	37.0	3.8	4.3	24,304
	NE	0.5	1.0	2.0	9.8	37.9	3.7	4.4	20,470
	S	0.6	1.0	2.3	12.2	38.0	4.5	5.1	34,244
	W	0.5	1.0	2.1	9.6	36.0	3.8	4.2	22,822
Inflation (36m)	MW	-100.0	1.0	3.0	12.0	115.0	5.0	11.0	24,757
	NE	-100.0	1.0	3.0	10.0	555.0	5.0	12.8	20,823
	S	-200.0	-1.0	3.0	15.0	420.0	5.7	14.0	34,985
	W	-144.0	1.0	3.0	12.0	1,000.0	5.3	12.9	23,215
Dist. Answers									
P50	MW	-31.4	0.0	2.3	6.5	36.3	2.9	4.5	16,782
	NE	-25.7	0.0	2.3	7.1	36.3	3.0	4.8	13,845
	S	-27.9	0.0	2.4	8.1	36.3	3.2	5.1	23,329
	W	-25.0	0.0	2.5	8.0	36.3	3.2	4.8	15,034
Avg	MW	-26.6	0.0	2.9	8.5	28.0	3.6	4.8	24,370
	NE	-25.0	0.0	2.9	8.0	36.3	3.5	4.8	20,529
	S	-26.7	0.0	3.0	9.3	36.3	3.7	5.3	34,320
	W	-27.5	0.0	3.0	9.0	36.3	3.9	5.0	22,864
Var	MW	0.2	0.4	2.4	45.1	481.0	14.6	35.3	24,370
	NE	0.2	0.3	2.1	45.0	481.0	13.8	34.3	20,529
	S	0.2	0.4	2.9	61.2	477.0	19.8	43.6	34,320
	W	0.1	0.4	2.4	42.6	458.5	14.0	32.8	22,864
Iqr	MW	0.5	1.0	2.2	9.9	38.0	4.0	4.4	24,370
	NE	0.6	1.0	2.1	9.7	38.0	3.8	4.3	20,529
	S	0.6	1.0	2.5	12.2	37.7	4.6	5.1	34,320
	W	0.5	1.0	2.2	9.7	36.6	3.9	4.2	22,864

Notes: The regions are Midwest (MW), Northeast (NE), South (S), and West (W). Inflation (12m) and Inflation (36m) are point expectations of the inflation rates 12 and 36 months ahead. Dist. Answers show moments of the probability distributions that are supplied by the respondents: median (P50), average (Avg), variance (Var) and differences between the percentiles 75 and 25 (Iqr). The columns report minimum (min), percentiles 10, 50 and 90 (p10, p50, p90), maximum (max), average (avg), standard deviation (sd) and number of observations (#obs).

Source: Federal Reserve Bank of New York and own calculations.

TABLE B2

Descriptive statistics on CPI and core inflation (2013M3 – 2019M12)

	area	*min*	*p10*	*p50*	*p90*	*max*	*avg*	*sd*
CPI y/y	Country	-0.20	0.17	1.70	2.46	2.95	1.55	0.78
	MW	-1.07	-0.33	1.39	2.17	2.47	1.15	0.87
	NE	-0.41	-0.09	1.50	2.24	2.70	1.32	0.78
	S	-0.60	-0.13	1.56	2.40	2.88	1.42	0.85
	W	0.68	1.12	2.33	3.24	3.64	2.23	0.79
CPI m/m	Country	-0.57	-0.25	0.12	0.51	0.64	0.12	0.28
	MW	-0.70	-0.46	0.11	0.56	0.89	0.09	0.35
	NE	-0.50	-0.20	0.09	0.44	0.64	0.11	0.24
	S	-0.70	-0.27	0.12	0.54	0.74	0.11	0.32
	W	-0.59	-0.20	0.16	0.52	0.81	0.18	0.29
CORE y/y	Country	1.57	1.68	1.96	2.27	2.39	1.97	0.24
	MW	1.05	1.24	1.63	1.95	2.19	1.59	0.27
	NE	0.91	1.10	1.71	2.07	2.36	1.66	0.33
	S	1.51	1.62	1.89	2.20	2.39	1.91	0.21
	W	1.61	1.78	2.77	3.02	3.18	2.58	0.45
CORE m/m	Country	-0.20	-0.03	0.16	0.38	0.47	0.16	0.15
	MW	-0.27	-0.11	0.11	0.37	0.47	0.13	0.17
	NE	-0.28	-0.12	0.16	0.33	0.54	0.13	0.17
	S	-0.21	-0.08	0.13	0.39	0.57	0.15	0.17
	W	-0.09	0.01	0.22	0.42	0.56	0.21	0.15

Notes: See Table B1. The table reports statistics for annual (y/y) and monthly (m/m) inflation rates for headline (CPI) and headline excluding food and energy (CORE) prices. The rows "Country" show the statistics for the US economy.

Source: Bureau of Labor Statistics and own calculation.

TABLE B3

Descriptive statistics on inflation rate for price groups (2013M3 – 2019M12)

	area	*min*	*p10*	*p50*	*p90*	*max*	*avg*	*sd*
Food (y/y)	Country	-0.39	0.22	1.40	2.55	3.41	1.43	0.83
	MW	-0.60	-0.03	1.13	2.60	3.56	1.20	0.92
	NE	-0.22	0.07	1.43	2.30	3.11	1.39	0.78
	S	-0.70	-0.02	1.46	2.49	3.22	1.34	0.88
	W	-0.43	0.90	1.66	2.90	3.82	1.78	0.92
Food (m/m)	Country	-0.33	-0.15	0.13	0.34	0.47	0.12	0.18
	MW	-0.42	-0.25	0.11	0.46	0.58	0.10	0.26
	NE	-0.44	-0.20	0.10	0.48	0.65	0.12	0.25
	S	-0.34	-0.18	0.14	0.36	0.56	0.11	0.20
	W	-0.43	-0.21	0.20	0.46	0.65	0.15	0.25
Energy (y/y)	Country	-19.59	-15.02	-0.34	10.14	15.19	-1.53	8.94
	MW	-22.25	-15.60	-1.50	9.63	17.67	-2.07	9.23
	NE	-19.73	-17.85	-0.45	11.81	15.83	-1.57	9.84
	S	-21.14	-17.07	-0.26	10.08	15.42	-2.04	9.20
	W	-18.66	-12.73	1.08	10.82	14.91	-0.10	8.28
Gas (y/y)	Country	-35.40	-24.08	-2.14	19.28	30.66	-2.99	15.26
	MW	-38.94	-25.46	-4.64	17.57	38.53	-3.51	16.13
	NE	-34.42	-26.93	-2.08	19.74	30.11	-3.09	15.86
	S	-36.38	-27.78	-2.96	18.90	32.52	-3.75	16.23
	W	-32.73	-22.59	0.40	17.29	25.86	-1.14	14.18
Gas (m/m)	Country	-17.13	-6.29	-0.20	6.57	10.61	-0.24	5.39
	MW	-19.88	-10.35	-0.35	8.39	20.44	-0.28	6.81
	NE	-16.03	-6.01	-0.03	6.39	12.73	-0.24	4.83
	S	-17.13	-8.19	-0.08	7.36	15.81	-0.29	5.76
	W	-15.70	-6.75	-0.08	6.29	19.41	-0.03	5.80

Notes: See Table B2. The table reports statistics for annual and monthly inflation rates for food, energy, and gas prices.

Source: Bureau of Labor Statistics and own calculation.

TABLE B4

Descriptive statistics on Michigan Survey and Survey of Professional Forecasters (1981Q3 – 2021Q1)

	Michigan Survey						
	min	*p10*	*p50*	*p90*	*max*	*avg*	*sd*
P50	1.07	2.56	3.00	3.81	6.50	3.11	0.67
Avg	1.50	2.99	3.83	5.07	8.03	3.92	0.92
Var	9.33	10.67	18.67	48.87	84.00	26.22	16.65
	Survey of Professional Forecasters						
	min	*p10*	*p50*	*p90*	*max*	*avg*	*sd*
P50	1.80	2.04	2.50	4.70	8.00	3.07	1.23
Avg	1.83	2.04	2.46	4.68	7.93	3.06	1.19
Var	0.08	0.19	0.39	1.27	7.99	0.70	0.91

Notes: See Table B1. The table reports statistics across quarterly individual answers (averages of the monthly statistics in the case of the Michigan Survey).

Sources: University of Michigan, Federal Reserve Bank of Philadelphia, and own calculations.