Expectations for Gasoline Prices and Inflation: Evidence from Households

Constantin Bürgi* Prachi Srivastava† Karl Whelan‡

University College Dublin

December 2024

Abstract

Gasoline prices are highly salient to consumers and, for this reason, they may have an outsized influence on their thinking about inflation. We examine how people's expectations about gasoline prices influence their expectations for overall inflation. We find little evidence from two US household surveys that people over-react to their beliefs about expected gasoline prices when formulating their expectations about overall inflation.

JEL Codes: E31, E52, D84

*constantin.burgi@ucd.ie

†prachi.srivastava@ucdconnect.ie

‡karl.whelan@ucd.ie. Thanks to Mengdi Song for comments on a previous draft. Thanks also to the editor, Pok-sang Lam and two referees for comments that greatly helped improve the paper.

1. Introduction

Recent global events have reminded economists and policy-makers of the continuing potential for supply shocks to have a profound influence on inflation. The surge in energy prices over this period has concerned central bankers not just because of its direct impact on inflation but also because it could cause overall inflation expectations to become de-anchored from the low levels that have prevailed in recent decades. One specific concern has been that high gasoline prices could have a particularly strong impact in raising inflation expectations. Most people drive cars and regularly go to filling stations, so this gives gasoline prices a particular salience that could lead to people placing an unwarranted emphasis on this component of the consumer price index when formulating expectations for overall inflation.

In previous research on this topic, Coibion et al. (2020) have argued that household inflation expectations are particularly sensitive to gasoline prices and presented evidence that almost all of the short-run volatility in inflation expectations could be explained by fluctuations in oil prices. However, Kilian and Zhou (2022b) use variance decompositions from a VAR framework to show that gasoline prices account for about 40% of the short-run variance in inflation expectations. Also, Kilian and Zhou (2022a) address the relationship between gasoline prices, headline inflation and core inflation using the Michigan consumer survey and find no evidence that gasoline price shocks move long-run household inflation expectations. Binder (2018) models inflation and inflation expectations for both gasoline and non-gasoline prices. After disentangling the indirect effects of gasoline prices on non-gasoline prices, she concludes that the response of household inflation expectations to changes in gasoline prices is roughly consistent with the weight of gasoline in the CPI.

In this paper, we assess the potential impact of the salience of gasoline prices by asking a slightly different question to previous work: When people change their expectations for gasoline price inflation, does this have an outsized impact on the change in their overall inflation expectations? If gasoline prices are particularly salient, then people may over-estimate the weight of gasoline in the overall consumer price index. Alternatively, people could overstate the influence of gasoline prices on prices for other goods or mis-apprehend the extent to which gasoline price inflation is a useful proxy for price inflation for other components of the index. Each of these factors could lead them to translate their beliefs about changes in gasoline prices into a larger-than-warranted change in their beliefs about non-gasoline prices.[1]

To answer this question, we use two US household panel data sets, the University of Michigan's Survey of Consumers and the New York Fed's Survey of Consumer Expectations (SCE), both of which track people's changing expectations over time for total consumer price inflation and its gaso-

[1]We note, of course, that much of the recent surge in energy prices around the world related to natural gas and that other products such as coal can influence the CPI via electricity prices. Given our focus on the issue of salience, we keep our focus on gasoline prices. Kilian and Zhou (2023) provide an analysis of the role of a range of different energy prices on the CPI.

line sub-component. We find the impact of people's expectations for gasoline price inflation on their expectations for total inflation is modest. From the Michigan survey, our preferred estimate is that a 1 percentage point increase in inflation expectations for gasoline is associated with an increase of 0.025 percentage points in total inflation expectations. From the SCE, we estimate that a 1 percentage point increase in inflation expectations for gasoline is associated with an increase of 0.037 percentage points in total inflation expectations. With a typical weight for gasoline in the CPI of about 4% and gasoline being a common input into the production of other goods and services, these estimates point against the hypothesis of an out-sized influence of gasoline price expectations.

The paper is organized as follows. Section 2 presents a simple model to motivate the use of microeconomic panel data regressions with individual-specific fixed effects to answer our question about the relationship between gasoline inflation expectations and total inflation expectations. Section 3 describes the data used and presents our results. Section 4 concludes.

2. A Simple Model of Gas and Non-Gas Expectations

We start with a simple model to motivate our panel regressions. We first model person i's inflation expectations at time t for inflation at time $t+1$ for the non-gas component of consumer price index ($E_{it}\pi^N_{t+1}$) as determined by

$$E_{it}\pi^N_{t+1} = \mu^N_i + \beta_N z_t + \sigma E_{it}\pi^G_{t+1} + \epsilon^N_{it} \tag{1}$$

where μ^N_i is an individual fixed effect, z_t is a vector of macroeconomic variables, $E_{it}\pi^G_{t+1}$ is person i's gas price inflation expectations and ϵ^N_{it} is a zero-mean random component. Gas-related inflation expectations are included as a direct determinant of non-gas inflation expectations to allow for people factoring in the indirect effect gas prices have on prices of other goods and services. The individual fixed effect allows for some people being systematically optimistic or pessimistic about non-gas price inflation.

Next, we assume that person i's gas price inflation expectations are determined as

$$E_{it}\pi^G_{t+1} = \mu^G_i + \beta_G z_t + \epsilon^G_{it} \tag{2}$$

where μ^G_i is a separate fixed effect reflecting systematic optimism or pessimism about gas-related inflation and ϵ^G_{it} is a mean-zero random component. Note that we are assuming here a causal structure such that people assume gas prices have an impact on non-gas prices but not vice versa. We will discuss the possibility of causality in both directions and also more complex dynamics below.

Finally, we assume that people formulate their expectations for aggregate inflation as a weighted average of these two components, with ω being their perceived weight on gasoline-price inflation in total inflation. Individual i's total inflation expectations are thus

$$E_{it}\pi_{t+1} = (1-\omega)\, E_{it}\pi^N_{t+1} + \omega E_{it}\pi^G_{t+1} \tag{3}$$

Inserting the two earlier equations and re-arranging we get an expression for inflation of the form

$$E_{it}\pi_{t+1} = (1-\omega)\,\mu^N_i + (1-\omega)\,\beta_N z_t + \psi E_i \pi^G_{t+1} + (1-\omega)\,\epsilon^N_{it} \tag{4}$$

where the coefficient

$$\psi = \omega + (1-\omega)\,\sigma \tag{5}$$

captures both the direct and indirect effects of gas-related inflation expectations on total inflation expectations.

One approach to estimating ψ would be to estimate a cross-sectional regression of the form

$$E_{it}\pi_{t+1} = \alpha + \kappa z_t + \psi E_{it}\pi^G_{t+1} + \epsilon_{it} \tag{6}$$

In this case, the estimated constant term α will be determined by the weight of gasoline and the average value of the non-gas fixed effect, $(1-\omega)\,\bar{\mu}^N_i$, and the residual will contain a term in the individual deviations from this average, $(1-\omega)\left(\mu^N_i - \bar{\mu}^N_i\right)$. It is likely, however, that the two sets of fixed effects, μ^N_i and μ^G_i are positively correlated. In other words, people who tend to be pessimistic about gasoline inflation are probably also likely to be pessimistic about non-gas price inflation. If this correlation is positive, then estimates of ψ from the cross-sectional regression in equation 6 will will be biased upwards because the term $(1-\omega)\left(\mu^N_i - \bar{\mu}^N_i\right)$ in the residual will be positively correlated with $E_i\pi^G_t$. This calls for the use of panel data. Specifically, with a panel, we can estimate a fixed effects regression of the form

$$E_{it}\pi_{t+1} = \alpha_i + \kappa z_t + \psi E_{it}\pi^G_{t+1} + \epsilon_{it} \tag{7}$$

where the introduction of individual-level fixed effects allows for the unbiased estimation of ψ because the residual no longer contains a fixed effect correlated with $E_{it}\pi^G_{t+1}$.

3. Evidence

Here, we describe our data sources and present the results.

3.1. Data Sources

Michigan Survey
The monthly Michigan Survey of Consumers covers around 500 households asking questions about attitudes and expectations. The survey includes questions about inflation expectations and gasoline price expectations. We use the answers to the following questions:

i) *"By about what percent do you expect prices to go (up/down) on the average during the next 12 months?*
ii) *"About how many cents per gallon do you think gasoline prices will (increase/decrease) during the next twelve months compared to now?"*

While most of the survey is a repeated cross-section, a subset of participants contribute a second time to the survey six months after their initial response. We use this subset for our analysis. The data are from January 1982 to December 1992 and also from October 2005 to December 2022 because the question about gasoline price expectations was not asked from 1993 to 2004. During the periods when the question was generally asked, there were also various months in which the question was omitted, which further restricts the panel dimension of the data.

Because the survey asks about inflation expectations as a percentage but asks about gasoline price expectations in terms of cents, we need to adapt the responses about gasoline to obtain a variable comparable to the response on inflation expectations. To do this, we used gasoline price data from the Energy Information Administration (EIA) to obtain the average national gasoline price corresponding to the respective survey wave and then combined this with the survey answers and the historical CPI for gasoline to calculate a series on the expected percentage change in the gasoline price for each respondent in the sample.[2]

Survey of Consumer Expectations
The Federal Reserve Bank of New York launched an online monthly Survey of Consumer Expectations (SCE) in 2013, typically covering about 1,300 households. We examine data from January 2013 to December 2022. The SCE covers a broader range of questions than the Michigan survey including more detailed questions about expectations. As discussed by Armantier et al. (2017), new respondents are drawn each month to match various demographic targets from the American Community Survey and participants stay on the panel for up to twelve months.

The questions from the SCE that we use are:

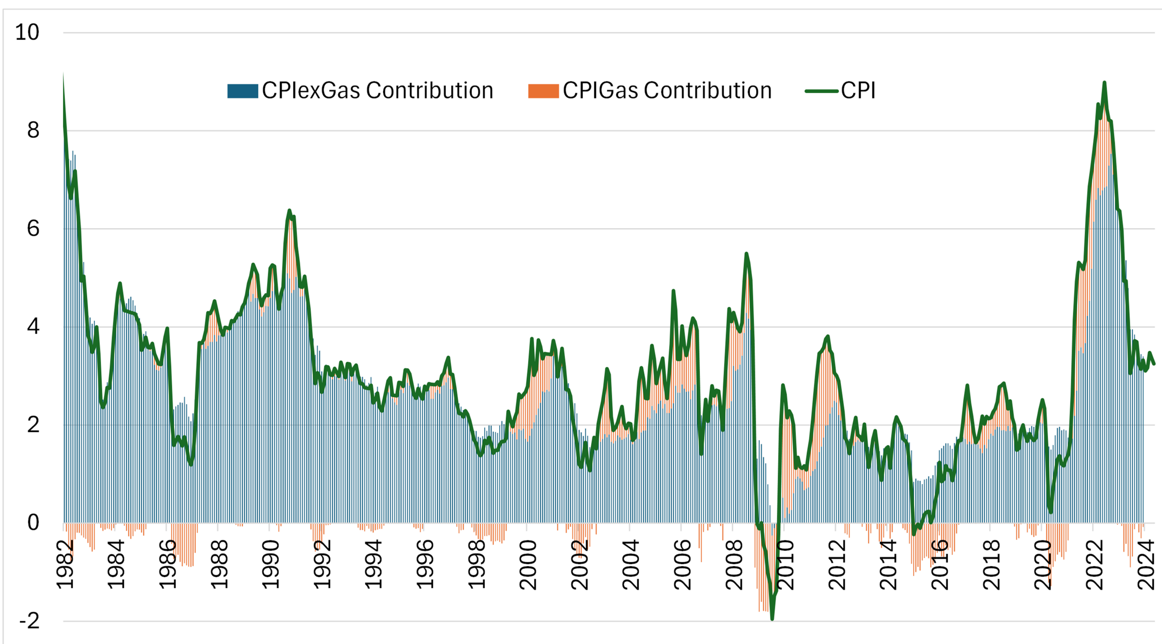
[2] We also used regional gasoline prices from the EIA which produced very similar results.

i) "What do you expect the rate of [inflation/deflation] to be over the next 12 months?"
ii) "Twelve months from now, what do you think will have happened to the price of the following items? ... "I expect ... The price of a gallon of gas to have increased by ... or decreased by"

where the second question asks for a percentage increase or decrease.

The two datasets both have strengths and weaknesses for addressing our question. The SCE has the advantage of being specifically designed to focus carefully on inflation expectations. It also has a longer panel component and provides more directly comparable data on total inflation and gasoline inflation expectations because both questions are framed in percentage terms. However, it has a short time dimension with relatively little variation in either inflation or the contribution to inflation of of gasoline until near the end of the sample. In contrast, the Michigan survey, while having a limited panel dimension and a gasoline question that does not have an ideal wording, is available over a long time horizon covering a wider variation in both inflation and the contribution of gasoline (see Figure 1). This makes the use of both datasets complementary.

Figure 1: CPI inflation and the contribution of gasoline and non-gasoline components



3.2. Results

Our empirical approach is to estimate regressions of the form

$$E_{it}\pi_{t+1} = \alpha_i + \gamma_t + \psi E_{it}\pi^G_{t+1} + \epsilon_{it} \tag{8}$$

where $E_{it}\pi_{t+1}$ is the consumer price inflation rate forecasted by participant i to occur over the next 12 months and $E_{it}\pi^G_{t+1}$ is their forecast for gasoline price inflation over the same horizon. We use the time effect γ_t to estimate the impact of all macro variables rather than relying on specifying a subset of potentially relevant variables.

Table 1 presents the estimated $\hat{\psi}$ coefficients from estimation of equation 8 using the two datasets and various time samples. One concern with these datasets is the possibility that a small number of outliers could have a big influence on the estimated coefficients. Some of the participants in the surveys have relatively little knowledge of economics and provide extreme answers. To address this issue, the results in Table 1 are from trimmed versions of the datasets that exclude observations with entries in the top and bottom 5% of values for the two variables. The estimates are not particularly sensitive to the extent of trimming. Results using 1/99 and 10/90 trimming are similar as are results based on winsorized samples.

For the SCE sample of June 2013 to December 2022, the estimated $\hat{\psi}$ coefficient is 0.0371. For the full Michigan survey time period, the estimated coefficient is 0.0254 while the estimate from the Michigan survey restricted to the same time frame as available for SCE is 0.0206. Estimates from various other sample splits from the Michigan survey are within a similar range.

Results for the full datasets including outliers are reported in Table 2. The coefficient estimates for the Michigan survey are generally bigger than for the trimmed sample but they are relatively similar in magnitude. However, outliers are a bigger issue in the SCE and the $\hat{\psi}$ coefficient from the full dataset is only 0.0012 and the fit of the regression is much lower. This estimate appears to reflect undue influence of a small number of outliers. Overall, we view the evidence as pointing to a ψ coefficient of between 0.02 and 0.04.

Table 1: Estimates of ψ from equation 8 from different samples with 5%-95% trimming

	$\hat{\psi}$	Std Error	N	R^2
Michigan Consumer Survey				
Apr 1982:Dec 1992; Oct 2005:Dec 2022	0.0254***	0.0024	95,658	0.75
Apr 1982:Dec 1992; Oct 2005:May 2013	0.0291***	0.0033	60,694	0.76
Apr 1982:Dec 1992	0.0285***	0.0050	33,570	0.75
Oct 2005:May 2013	0.0298***	0.0043	27,124	0.77
Oct 2005:Dec 2022	0.0241***	0.0027	75,006	0.75
Jun 2013:Dec 2022	0.0206***	0.0034	34,964	0.73
Survey of Consumer Expectations				
Jun 2013:Dec 2022	0.0371***	0.0020	104,652	0.68

Notes: The regressions were estimated using individual fixed effects and time effects. N refers to the total sample size. Michigan survey regressions do not include all months because of missing values for gasoline price expectations.

Table 2: Estimates of ψ from equation 8 from different samples including outliers

	$\hat{\psi}$	Std Error	N	R^2
Michigan Consumer Survey				
Apr 1982:Dec 1992; Oct 2005:Dec 2022	0.0314***	0.0023	115,105	0.71
Apr 1982:Dec 1992; Oct 2005:May 2013	0.0302***	0.0031	73,180	0.72
Oct 1982:Dec 1992	0.0260***	0.0050	40,091	0.72
Oct 2005:May 2013	0.0348***	0.0037	33,089	0.71
Jan 2005:Dec 2022	0.0338***	0.0024	75,014	0.71
Jun 2013:Dec 2022	0.0336***	0.0033	41,925	0.71
Survey of Consumer Expectations				
Jun 2013:Dec 2022	0.0012	0.0039	129,338	0.19

Notes: The regressions were estimated using individual fixed effects and time effects. N refers to the total sample size. Michigan survey regressions do not include all months because of missing values for gasoline price expectations.

3.3. Discussion

To address the question as to whether the salience of gasoline prices leads to expectations about these prices having an unwarranted large influence on people's expectations for total inflation, we need to answer an empirical question: What does the evidence suggest is the typical co-movement of CPI inflation over a one-year horizon associated with a 1 percent increase in gasoline prices? Here we discuss some ways to answer this question.

A starting point to answer this question is the simple model described in Section 2, in which there is a direct contemporanous causal effect of gasoline prices on non-gasoline prices, no causality in the other direction and no other dynamics. In this case, the correct answer for the impact of gasoline inflation on total inflation—what is being captured in the surveys by the ψ coefficient—should equal the sum of ω, the perceived weight of gasoline in the CPI, plus another positive term representing the perceived indirect effect of gasoline prices on other items in the CPI bundle. The weight for gasoline over our sample period is shown in Figure 2. For the full sample used here for the Michigan survey, 1982-1992 and 2005-2022, the average weight was 0.042. For the SCE sample of 2013-2022, the average weight was 0.038. The estimated $\hat{\psi}$ coefficients in Table 1 are generally below these values. Indeed, the CPI weight for the various samples generally lies outside the conventional confidence intervals associated with the estimated coefficients.

In relation to the indirect effects, gasoline prices clearly have an impact on the cost of other items in the index. Input-output tables from the Bureau of Economic Analysis show that transportation costs account for almost 1 percent of the total value of the personal consumption expenditures bundle, with gasoline likely accounting for a large fraction of these costs.[3] Gasoline costs likely also influence the costs of many goods in the CPI bundle. For example, gasoline prices will impact food costs because farmers need to run tractors and other types of equipment that run off gasoline. These considerations suggest that the impact of an increase in gasoline on total CPI inflation is likely a bit higher than the typical 4% average weight of gasoline in the CPI.

Some straightforward calculations provide confirmation for this idea that gasoline prices have a larger effect on total inflation than both the weight of gasoline in the CPI and our reported $\hat{\psi}$ coefficients. In the simplest case, under the assumptions of the model in Section 2 above, in which there is a causal effect of gasoline prices on non-gasoline prices and no reverse effect and this impact occurs immediately without any lagged dynamics, if gasoline price inflation is exogenous to other macro determinants of inflation, then a simple way to estimate the impact of gas inflation on total inflation is to use an OLS regression of CPI inflation on gasoline inflation.

The top panel of Table 3 reports estimates of this regression and 10th and 90th percent confidence intervals (using Newey-West robust standard errors) for a range of samples corresponding to those used in our household survey regressions. For each of these sample periods, our estimated $\hat{\psi}$

[3] Available at https://www.bea.gov/products/industry-economic-accounts/underlying-estimates

coefficients lie below the estimated confidence intervals for these OLS estimates.

The survey respondents, however, may use a more sophisticated model than the one in Section 2 to formulate their expectations. One such model is a Vector Autoregression with causality running in both directions, i.e. from gasoline prices to non-gasoline prices but also from non-gasoline prices to gasoline prices. The latter causality may matter, for example, if the cost of gasoline tends to keep up with the overall price level so that the cost of gas does not fall in real terms during periods of high inflation. To estimate the appropriate relationship between one-year inflation rate forecasts for the full CPI and for gasoline under models of this type, we estimated monthly VARs using gasoline and non-gasoline price inflation specified as follows:

$$\pi_t^N = \alpha^N + \beta_{NN}(L)\,\pi_{t-1}^N + \beta_{NG}(L)\,\pi_{t-1}^G + \epsilon_t^N \quad (9)$$

$$\pi_t^G = \alpha^G + \beta_{GN}(L)\,\pi_{t-1}^N + \beta_{GG}(L)\,\pi_{t-1}^G + \epsilon_t^G \quad (10)$$

One approach to assessing the relationships between VAR-based forecasts would be to construct two time series of the historical one-year-ahead forecasts for total inflation and gasoline inflation and regression the total series on the gasoline series. Standard errors from these regressions, however, would not be correct because the series are both generated regressors. This means the coefficient from this regression would itself be a complex function of all of the coefficients of the underlying VAR and the standard errors would underestimate the sampling uncertainty associated with the VAR coefficients.

Instead, our approach was to use bootstrapped one-year ahead forecasts based on the estimated VARs. Specifically, we used the historical reduced-form shocks ϵ_t^N and ϵ_t^G from these VARs to estimate the relationship between one-year gasoline inflation and one-year non-gasoline inflation that are implied by these models. We did this by constructing 1,000 alternative histories for π_t^N and π_t^G using bootstrapped residuals and the estimated VAR models.[4] We then constructed the implied one-year inflation rates for total CPI inflation (using the relevant historical CPI weights for gasoline) and regressed this on the simulated one-year gasoline inflation series. The lower panels of Table 3 report the median, 10% and 90% values of these coefficients for various samples and for different choices of lag length. The coefficients with double stars correspond to the median estimates from the VARs with lag lengths chosen as optimal according to the Bayesian Information Criterion (BIC).

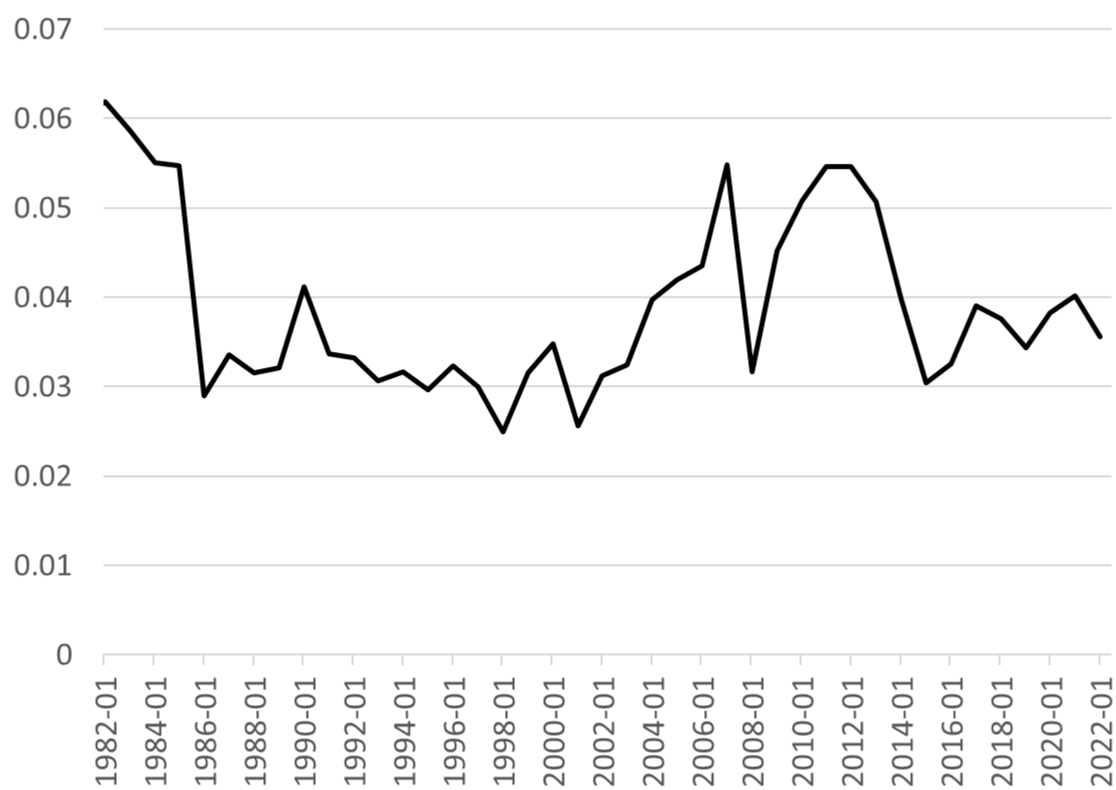
These estimates tell us about the range of values for the co-movement of total inflation and gasoline inflation that are consistent with these VAR models with causality running in both directions. As would be expected due to the existence of indirect effects, these coefficients are higher than the weight of gasoline in the corresponding samples, with the typical point estimates from the models preferred by the BIC being in the range of 0.06 to 0.07. As with the simple OLS estimates, our

[4]Since we use error pairs (gasoline and non-gasoline inflation) to construct the bootstrapped series, whether we use structural or reduced form errors does not change our results.

estimated $\hat{\psi}$ coefficients lie below the bootstrap-constructed confidence intervals. We also obtained similar results using larger VARs that incorporated additional variables. In particular, we obtain similar results (though for shorter samples) using VARs including the measures of global oil production and monthly global real economic activity used in Killian (2009) and Baumeister and Killian (2016) which have been made available for longer samples by Lutz Kilian on his website.[5]

Overall, we believe this evidence points against the hypothesis that the salience of gasoline prices leads to expectations about these prices having an unwarranted large influence on people's expectations for total inflation.

Figure 2: The weight of gasoline in the US CPI



[5]We obtained these data from https://sites.google.com/site/lkilian2019/research/data-sets

Table 3: Coefficients from projections of π on π^G from an OLS regression of π on π^G and from simulated data from VAR models in π on π^G with various lag lengths

	Percentile	2013-2022	1982-1992	2005-2013	2005-2022	1982-2022
	0.1	0.057	0.030	0.036	0.048	0.029
OLS	0.5	0.085	0.065	0.059	0.071	0.055
	0.9	0.112	0.099	0.082	0.093	0.081
	0.1	0.039	0.028	0.046	0.042	0.046
VAR1	0.5	0.055	0.059	0.059	0.054	0.056
	0.9	0.074	0.092	0.072	0.068	0.068
	0.1	0.046	0.051	0.051	0.052	0.048
VAR2	0.5	0.065**	0.073**	0.060**	0.063**	0.057
	0.9	0.090	0.094	0.069	0.075	0.066
	0.1	0.037	0.053	0.050	0.046	0.048
VAR3	0.5	0.057	0.076	0.060	0.058	0.058**
	0.9	0.086	0.100	0.068	0.071	0.068
	0.1	0.045	0.078	0.052	0.051	0.044
VAR12	0.5	0.063	0.091	0.059	0.063	0.052
	0.9	0.075	0.103	0.065	0.077	0.061

Notes: The coefficients reported here for the VAR analysis are based on bootstrap simulations for each model with randomly drawn innovations with replacements and 1000 replications, from which the simulated total CPI inflation series was regressed on the simulated gasoline inflation series. *For OLS, 50 represents the estimated coefficient and 10/90 figures are the coefficient $\pm$ 1.285 the Newey-West robust standard errors are used for the percentiles. **Best model according to BIC.

4. Conclusion

Most people drive cars and regularly have to go the filling station. This makes gasoline prices highly salient to consumers. For this reason, there has been concern that rising gasoline prices can contribute to consumers raising their expectations of future inflation, thus making it harder for central banks to return inflation to its credit after a supply shock has increased it to above target levels.

To address this issue, we have examined the relationship between people's expectations for gasoline price inflation and their expectation for total inflation. If people over-estimate the importance of gasoline to overall inflation or misunderstand the association between gasoline prices and other prices, then changes in gasoline inflation expectations may translate into larger-than-warranted changes in overall inflation expectations. As expected, we find a positive relationship at the individual level between these two sets of expectations but we do not find that people over-react in the sense that the positive coefficients we report tend to be less than both the weight for gasoline in the CPI and our estimates of the joint relationship between total inflation and gasoline inflation consistent with a range of VAR models incorporating these variables.

Given the attractiveness of the salience hypothesis, these results may seem surprising. However, we believe they are entirely consistent with the existing evidence presented by Kilian and Zhou (2022a) and Kilian and Zhou (2022b), which pointed to a limited influence on inflation expectations of the recent surge in gasoline prices and Binder (2018), who showed that the response of household inflation expectations to changes in gasoline prices is roughly consistent with the weight of gasoline in the CPI.

References

Armantier, O., Topa, G., Van der Klaauw, W., and Zafar, B. (2017). An overview of the survey of consumer expectations. *Economic Policy Review*, (23-2):51–72.

Baumeister, C. and Killian, L. (2016). Forty years of oil price fluctuations: Why the price of oil may still surprise us. *Journal of Economic Perspectives*, 30:139–160.

Binder, C. C. (2018). Inflation expectations and the price at the pump. *Journal of Macroeconomics*, 58:1–18.

Coibion, O., Gorodnichenko, Y., Kumar, S., and Pedemonte, M. (2020). Inflation expectations as a policy tool? *Journal of International Economics*, 124(103297).

Kilian, L. and Zhou, X. (2022a). The impact of rising oil prices on US inflation and inflation expectations in 2020–23. *Energy Economics*, 113(106228).

Kilian, L. and Zhou, X. (2022b). Oil prices, gasoline prices and inflation expectations. *Journal of Applied Econometrics*, 37:867–881.

Kilian, L. and Zhou, X. (2023). A broader perspective on the inflationary effects of energy price shocks. *Energy Economics*, 125(106893).

Killian, L. (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review*, 99:1053–1068.