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# Failure at the Fed: A Study of the Determinants of Consumers' Inflation Expectations

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# Failure at the Fed: A Study of the Determinants of Consumers' Inflation Expectations

By

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# Abstract

This paper utilizes data from Federal Reserve Economic Data (FRED) to investigate the determinants of consumers' inflation expectations. I employ a series of OLS models to test the effect of various goods' prices on consumers' inflation expectations, as measured by the Michigan Survey of Consumers, as well as the effects of monetary policy and previously observed inflation. My results indicate that energy prices have a positive statistically significant effect on consumers' inflation expectations, while previously observed inflation has no statistically significant effect. Furthermore, I find that adjustments to the federal funds rate and the recent implementation of inflation targeting do not appear to anchor consumers' inflation expectations. These findings suggest that the theory of rational expectations cannot be applied to consumers' inflation expectations.

## Introduction

Managing inflation is one of the Federal Reserve's most important goals. This is done through control of the money supply and managing inflation expectations throughout the economy. But how should members of the Federal Open Market Committee (FOMC) quantify these expectations? For decades, the Federal Reserve and other central banks have relied upon an adaptive expectations model to quantify inflation expectations. But in recent years, organizations in a variety of countries have begun to survey economic agents of all sorts, quantifying these agents' inflation expectations. These agents range from professional inflation forecasters to the average consumer. The question is, whose inflation expectations should economists be measuring? Economists are typically interested in the expectations of firms, as they set the prices that drive inflation. Sadly, as there is no perfect dataset available for American firms' inflation expectations, economists must establish an adequate proxy for firms' expectations.

Economists Olivier Coibion and Yuriy Gorodnichenko argue that consumers' inflation expectations are the best proxy for firms' inflation expectations. If we accept this argument, as I argue we can, we must endeavor to discover what drives consumers' inflation expectations. Rational expectations theory tells us that if consumers are rational actors, the Federal Reserve can use monetary policy to shape consumers' inflation expectations. Coibion and Gorodnichenko argue that consumers are not rational actors and therefore their expectations are unaffected by monetary policy. They suggest that consumers are rationally inattentive, which makes their expectations sensitive to the prices of frequently purchased goods.

My paper builds upon the literature in a number of ways. Firstly, it tests to see if previously observed inflation has a significant effect on inflation expectations when they are quantified with consumers' inflation expectations as measured. Secondly, it explores the primary

determinants of consumers' inflation expectations. Thirdly, it studies whether these effects remain significant when controlling for wage levels. Finally, it provides empirical results on the effects of monetary policy on consumers' inflation expectations. I use an OLS model to test the effects of the index values of various CPI Stratums on consumers' inflation expectations as measured by the Michigan Survey of Consumers in order to observe the effects of different prices on consumers' inflation expectations; my model also includes controls for monetary policy and wage. My paper makes two significant contributions to the literature. Firstly, it finds that consumers are rationally inattentive, as their behavior does not adhere to rational expectations theory. This is demonstrated by my duel findings that monetary policy is unable to anchor inflation expectations and the fact that consumers' expectations are unaffected by previously observed inflation. Secondly, it finds that the price of energy has a large significant effect on consumers' inflation expectations, with an average 3.14% increase in consumers' inflation expectations, supporting Coibion and Gorodnichenko's (2013) findings on the effect of oil prices on consumers' inflation expectations.

The rest of the paper is organized as follows. Section 1 discusses background theory. Section 2 reviews the previous literature on inflation expectations. Section 3 discusses data and methodology. Section 4 outlines my empirical results. Section 5 outlines my findings. Section 6 includes concluding remarks on policy implications and future research opportunities.

**Section 1: Background Theory**

The Federal Reserve and other central banks rely on the Neo-Keynesian Phillips Curve, which is outlined below, to define inflation:

$$\pi_t = E_{t-1}\pi + \theta\left(Y_t - \overline{Y_t}\right) + \mu_t \ (1)$$

Where $\pi_t$ represents inflation in period t, $E_{t-1}\pi$ represents inflation expectations in period t-1, $\theta\left(Y_t - \overline{Y_t}\right)$ represents the output gap in period t (often characterized by the difference between the unemployment rate and the natural rate of unemployment), and $\mu_t$ represents an exogenous supply shock. The Neo-Keynesian Phillips Curve uses the following adaptive expectations model to define inflation expectations:

$$E_{t+1}\pi = \pi_t \ (2)$$

Where $E_{t+1}\pi$ represents expected inflation in the next period, and $\pi_t$ is inflation in period t. This model conveys that economic agents expect inflation in the next period to be the same as inflation observed in the previous period. The adaptive expectations hypothesis was first put forth by Milton Friedman, who argued that inflation expectations can be determined by averaging inflation from the past four quarters (Mankiw 2012, 432-3).

In short, inflation is partially driven by inflation expectations, which are driven by previously observed inflation. The question that remains is, can the Federal Reserve affect inflation expectations? Rational expectations theory argues that it can. The theory states that economic agents optimally use all information that is available to them, including fiscal and monetary policy. Rational expectations theory states that any monetary policy must account for the effects it will have on inflation expectations. If this theory holds true, the Federal Reserve should be able to signal economic agents to shape their inflation expectations via changes in monetary policy (Mankiw 2012, 415).

**Section 2: Literature Review**

This literature review is broken down into four sections. Section 2A discusses the traditional measurement of inflation expectations given the assumption of adaptive or rational

expectations, as well as the implications these models have on determining the effectiveness of monetary policy. Section 2B establishes the validity of the recent use of survey data for quantifying inflation expectations based on recent papers which find that the inclusion of survey data increases the forecasting accuracy of Neo-Keynesian economic models. Section 2C discusses the implications of using data from surveys of consumers as opposed to surveys of forecasters when determining the effectiveness of monetary policy. Section 2D discusses this paper's original contributions to the literature.

**Section 2A**: **Adaptive and Rational Expectations**

Friedman (1968) outlines what he believes monetary policy can and cannot do. His paper is quite extensive, and discusses a broad range of monetary policy topics. As this paper's focus is inflation expectations, this review of Friedman (1968) will focus solely on his opinions on the effects of adaptive expectations. The importance of adaptive expectations is discussed in his section outlining the limits of Keynesian monetary policy. Friedman argues that adaptive expectations prevent central banks from accomplishing two of their primary policy goals: pegging interest rates and the unemployment rate. Friedman believes that the predominant Keynesian economic theory is wrong and that monetary policy can only accomplish these goals in the short run.

Friedman begins by critiquing the Keynesian view that central banks can peg interest rates. The traditional Keynesian logic, as Friedman understands it, is as follows: if banks want to keep interest rates down, they will make large open market purchases of treasury securities. This raises the securities' price, lowers their yield, and increases the quantity of money in the economy, pushing interest rates down. But Friedman says this decrease in interest rates is only temporary. He argues that an increase in the money supply will lead to higher incomes, which

will inflate prices. Due to adaptive expectations, the public will expect prices to continue to rise. This means that borrowers will be more willing to pay higher interest rates. Friedman argues that the short term decrease in interest rates will actually be followed by an increase to an interest rate that is greater than the one before the open market purchase was conducted. That being said, interest rates will eventually return to the level they otherwise would have maintained. Because of this, Friedman argues that it is impossible for central banks to keep interest rates low in the long run.

At the time Friedman wrote this essay, mainstream economists still relied upon the original Phillips Curve, which shows a simple inverse relationship between unemployment and inflation. However, Friedman argues that monetary policy can only temporarily lower unemployment. This is due to the combination of adaptive expectations and the natural rate of unemployment. He assumes that the economy starts at the natural rate of unemployment, with a stable inflation rate. Workers and employers have written their contracts, and have adjusted their wages in pace with observed inflation. The central bank then implements a policy of monetary growth, increasing aggregate demand, which in turn leads to an increase in prices greater than in previous periods. Firms, now making more money, hire more workers, and the unemployment rate dips. However, since inflation was greater than anticipated, workers' nominal wages have risen but their real wages have fallen. Since workers only care about their purchasing power, they will negotiate for higher wages, which will result in firms laying off the new workers that they had just hired, and unemployment rises back to its natural rate. This reasoning leads Friedman to argue that central banks are incapable of lowering unemployment in the long run.

As demonstrated in Section 1, mainstream economists incorporated Friedman's theories into the Neo-Keynesian Phillips Curve. That being said, not all economists consider this model

to be valid. Farmer (2013) discounts the Neo-Keynesian Phillips Curve. He lists a variety of concerns, but his main problem with the model is its reliance on Friedman's natural rate hypothesis. He argues that central bankers relying on this model believe that there is no way to curb persistently high unemployment, as they believe this unemployment to be the result of structural changes that cannot be affected by monetary policy. Farmer (2013) believes that equilibrium in the labor market can be reached at any unemployment rate via the matching of workers and firms using modified search theory; standard search theory uses a Cobb-Douglas function where employment is a factor of the number of people looking for work and the number of vacancies firms are looking to fill, with the assumption that firms will produce enough goods to meet aggregate demand in the economy. He argues that once aggregate demand is determined, profit maximization will dictate the equilibrium level of unemployment. He closes his model with the following equation:

$$E_t[\pi_{t+1}] + (E_t[Y_{t+1}] - Y_t) = \pi_t + (y_t - Y_{t-1}) + z_t^s \quad (3)$$

Where $E_t[\pi_{t+1}]$ represents expected inflation, $(E_t[Y_{t+1}] - Y_t)$ represents expected GDP growth, $\pi_t$ represents inflation in the current period, $(y_t - Y_{t-1})$ represents GDP growth, and $z_t^s$ representss a belief shock. This equation states that expected inflation and GDP growth are determined by observed inflation and GDP growth, as well as irrational changes in expectations, which Farmer equates to Keynes' concept of the 'animal spirits.' These expectations translate into actual economic growth through the optimized IS curve. In this way, expectations become self-fulfilling prophecies.

Farmer (2013) characterizes his model as an adapted rational expectations model which allows for monetary policy to shape inflation expectations. Farmer (2012) examines the ways in which conventional and unconventional monetary policy can affect inflation expectations. He

begins by outlining the arc of monetary policy from 1960 through 2011. He argues that up until 1979, the Federal Reserve allowed the federal funds rate to be relatively insensitive to variation in the inflation rate. This resulted in a broad range of inflation rates. However, after 1979, the Federal Reserve increased the federal funds rate's sensitivity to variation in inflation. This reigned in inflation to a narrow range of lower values. This also had the effect of curbing inflation expectations, as market participants knew that inflation would be curtailed much more aggressively than in the past. The issue that arose during the Great Recession, when the Federal Reserve dropped interest rates to zero, was that the FOMC had no way of signaling future policy changes using conventional monetary policy. Farmer (2012) argues that the Federal Reserve circumvented this problem by employing Quantitative Easing. His argument is based on trends in one year expected inflation in the swaps market. These expectations dropped during the recession, but quickly recovered. This recovery after the Great Recession corresponded with the Federal Reserve's purchase of mortgage-backed securities and other types of securities. Farmer (2012) believes that the purchasing and corresponding stabilizing of the prices of these long-term assets reinforced medium and long term inflation expectations and prevented disinflation.

**Section 2B: The Introduction of Survey Data into Neo-Keynesian Models**

While rational expectations models are still relied upon, economists have recently started to use survey data to test their models. Two such economists are Coibion and Gorodnichenko (2013), who set out to answer the same question as Farmer (2012): why didn't the United States' economy experience disinflation after the Great Recession? The Phillips Curve tells us that the massive increases in unemployment during the Great Recession should have led to similarly massive disinflation. In reality, inflation was more or less constant before, during, and immediately after the Great Recession. Explanations for this so-called missing disinflation

included increases in the natural rate of unemployment, shifts in marginal costs characterized by a lack of wage disinflation, or the flattening of the Phillips Curve. But upon delving into these explanations, Coibion and Gorodnichenko find that each of them is unable to explain the data. They instead put forth the hypothesis that an increase in inflation expectations can explain this missing disinflation.

Coibion and Gorodnichenko (2013) believe that Friedman's measure of adaptive expectations would not be a sufficient measure of inflation expectations, as the Neo-Keynesian Phillips Curve forecasted disinflation. This required Coibion and Gorodnichenko to find a more accurate measure of inflation expectations. They argue that since firms are the price setters in the economy, a survey of firms' inflation expectations would have been ideal. However, since no such survey exists in the United States, Coibion and Gorodnichenko needed to find an appropriate proxy for firms' inflation expectations. They theorize two possible proxies; the Survey of Professional Forecasters (SPF) and the Michigan Survey of Consumers (MSC). The SPF is considered a good proxy because large firms are likely to have a professional forecaster on staff or hire a forecasting firm. However, they theorize that small to medium sized firms would be unlikely to receive considerable gains from precise information about aggregate conditions in the economy and would instead track idiosyncratic factors within their own industry due to rational inattention. This review will make a brief digression to outline the theory behind rational inattention.

Sims (2003) is widely credited as the originator of the theory of rational inattention. He argues that the rational expectation theory's assumption that all agents employ perfect forecasting based on expectations formed via an analysis of aggregate economic information is incorrect. He argues that many agents have constraints on their ability to gather information,

which forces them to rely on incomplete sources of information. This leaves agents vulnerable to idiosyncratic shocks to their beliefs. He compares these agents to a casual reader of the *New York Times.* The *Times* publishes the federal funds rate every day in the back of the business section, but not all readers have the time or agency to obtain this information. Thusly, it will be a shock to the casual reader if one day the *Times* publishes a bolded headline declaring that the Federal Reserve has pushed forward an increase to the federal funds rate. In the same way that there would be no shocks if all readers read the *Times* in its entirety, there would be no shocks if there were no constraints on economic agents' ability to gather information.

The effects of these constraints worsen if one assumes a variable inflation rate, and that all firms seek to maximize their profits. If the variance of the inflation rate is low, the marginal return of accurately tracking the inflation rate is low. This will lead agents to allocate more resources to take in more aggregate economic information. However, if variance of inflation rate is high, then the marginal return of accurately predicting the inflation rate increases. This will lead agents to allocate more of their resources towards tracking their specific inflation rate at the expense of searching for other economic information. He argues that this is why there is an increase of inflation-indexation clauses when the inflation rate becomes variable, as well as why economic efficiency decreases in the presence of variable inflation.

The theory of rational inattention is what leads Coibion and Gordonichenko (2013) to suggest that the MSC would serve as a better proxy for firm expectations, as the average consumer is also not likely to track aggregate conditions in the economy. To determine which survey is a better proxy, Coibion and Gorodnichenko develop a nested Phillips Curve that includes both the SPF and the MSC as dependent variables, predicting that if the MSC is the better proxy it will be significant and SPF will not. Their model proves this to be the case. But

what drives consumer inflation expectations? Coibion and Gorodnichenko theorize that oil and commodity prices increase consumers' inflation expectations. They test this by running the following regressions:

$$E_t^{MSC}\pi_{t+1,t+4}E_t^{SPF}\pi_{t+1,t+4} = \beta_0 + \beta OilP_t + \beta PriceAgro_t + \varepsilon_t \text{ (4)}$$

$$E_t^{MSC}\pi_{t+1,t+4}E_t^{SPF}\pi_{t+1,t+4} = \beta_0 + \beta \log\left(\frac{OilP_t}{OilP_{t-1}}\right) + \beta\, log\left(\frac{PriceAgro_t}{PriceAgro_{t-1}}\right) + \varepsilon_t \text{ (5)}$$

Where $E_t^{MSC}\pi_{t+1,t+4}E_t^{SPF}\pi_{t+1,t+4}$ represents the difference between the MSC and the SPF's expected inflation over the coming year, *OilP* represents the real price of oil, as taken from West Texas Intermediate, *PriceAgro* represents the food index price produced by the World Bank, and $\beta \log\left(\frac{OilP_t}{OilP_{t-1}}\right) / \beta\, log\left(\frac{PriceAgro_t}{PriceAgro_{t-1}}\right)$ represents these prices' respective growth rates. These regressions show that the difference between household and professional inflation expectations can be explained by consumers' increased sensitivity to changes in the price of oil and food, with consumers being particularly sensitive to changes in oil price. They run an additional regression, using just the MSC, in order to test this:

$$E_t^i\pi_{t,t+12} - E_{t-6}^i\pi_{t-6,t+6} = \beta_0 + \beta \log\left(\frac{OilP_t}{OilP_{t-6}}\right)x100 + \varepsilon_t \text{ (7)}$$

Where $E_t^i\pi_{t,t+12} - E_{t-6}^i\pi_{t-6,t+6}$ represnts the difference between inflation expectations when *t=12* and inflation expectations when *t=6*; this is done to eliminate potential individual fixed effects, as the MSC cycles to survey the same people every six months. $\beta \log\left(\frac{OilP_t}{OilP_{t-1}}\right)x100$ represents the percent change in the price of oil. Coibion and Gorodnichenko find that for every 1% increase in the real price of oil, there is a 1.6% increase in consumers' inflation expectations. They theorize that this effect is transmuted through gas prices, which consumers are exposed to

every day. Their findings suggest that increases in oil prices that occurred during the Great Recession led to increased inflation expectations that offset disinflation. This is based on their belief that consumer inflation expectations are the best proxy for firm inflation expectations, as consumers' expectations best capture small to medium size firms' rational inattention.

Łyziak (2016) also tests to see if survey data of inflation expectations can be used to improve the forecasting accuracy of Neo-Keynesian economic models. All of his data comes from the Polish Central Statistical Office (GUS)'s survey of inflation expectations from 2001-2014. This survey is significant because it measures the inflation expectations of firms, financial analysts, and consumers. Łyziak (2016) introduces these expectations in the open market IS Curve and the Neo-Keynesian Phillips Curve. He defines each group's inflation expectations with the following equation:

$$\pi^{e}_{t,t+4} = \tau\pi_{t-1} + (1-\tau)\pi_{t+4} + \varepsilon_t^{\pi^e} (8)$$

Where $\pi^{e}_{t,t+4}$ represents that particular group's inflation expectations, $\tau$ is a factor that represents the number of economic agents who use solely backwards-looking expectations, and $(1-\tau)\pi_{t+4}$ represents the amount of expectations defined by rational forward-looking expectations. He then runs counterfactuals to see if using these survey results of inflation expectations improved Neo-Keynesian models' accuracy. He makes two significant observations. The first is that survey measures of inflation expectations, particularly those results taken from firms, improved the accuracy of Neo-Keynesian models. This is in line with traditional economic theory, which tells us that firms are price-setters. The second observation is that firms' inflation expectations are more similar to those of professional forecasters, not to those of consumers. This puts Łyziak (2016) at odds with Coibion and Gorodnichenko (2013).

While he uses data from Poland, Łyziak (2016) does cite a working paper which reports that firm expectations are closer to forecasters' expectations using data from a survey of businesses conducted by the Federal Reserve of Atlanta. This suggests that his conclusion can be applied to data from the United States. Unfortunately, the sample only has three years' worth of data and is from a limited number of states; in comparison, the MSC uses data from 48 states and has been conducted for decades. This difference suggests that Łyziak's (2016) conclusions are not necessarily applicable to the United States.

**Section 2C: Survey Data's Implications for Monetary Policy**

While quantifying inflation expectations is important, monetary policymakers' goal is ultimately to manage these expectations in order to prevent economic crisis. Gaballo (2016) argues that theoretically forward guidance can have a significant effect on private inflation expectations. He defines private inflation expectations as a factor of the current price level, forward guidance from the Federal Reserve, and an error term representing further private information. He argues that forward guidance's effect is tempered by variable $K$. $K$ can range anywhere from 0, implying that forward guidance has no effect, to $\infty$, implying that all information is perfectly conveyed from the Federal Reserve to the private entities. $K$'s value greatly tempers how much forward guidance affects private inflation expectations. If $K$'s value is high, then forward guidance will largely drive private inflation expectations, whereas market prices and private sources of information will not. Conversely, if $K$ is low, private inflation expectations will be driven either by market prices or private information. If private expectations are determined largely by monetary policy this would imply rational expectations, whereas if private expectations are determined largely by private information then it would imply rational inattention. While this paper lays out extensive theoretical work, it does not provide empirical

evidence. However, it does raise an important question on the strength of the transmission mechanism. Rational expectations theory tells us that the transmission mechanism is strong, but can economists use survey data to support this hypothesis? I find that there is a difference of opinion amongst those authors who quantify inflation expectations using surveys of professional forecasters and those who quantify inflation expectations using surveys of consumers.

Tsenova (2012) argues that long term inflation expectations are well anchored by monetary policy. He uses survey data of professional forecasters from both the Eurozone and the United States. The survey from the Eurozone asks about expected inflation for the Harmonized Index of Consumer Prices (HCIP), while the SPF in the United States asks about expected inflation in CPI. In order to standardize the sample of years, as the United States survey started in 1994 while the Eurozone survey started in 1999, the sample is restricted from 1999 to 2009. Using this dataset, he constructs the following three-equation model:

$$\Delta\pi_{i,t}^{e\ long} = \beta^{\Delta\pi}\Delta\pi_t + \Delta\epsilon_{i,t}^{\Delta\pi} \quad (9)$$

$$\Delta\pi_{i,t}^{e\ long} = \beta^{\Delta\pi NewsS}\Delta{\pi_t}^{eNewsS} + \Delta\epsilon_{i,t}^{\pi^{eNewsS}} \quad (10)$$

$$\Delta\pi_{i,t}^{e\ long} = \beta^{\Delta\pi NewsM}\Delta{\pi_t}^{eNewsS} + \Delta\epsilon_{i,t}^{\pi^{eNewsM}} \quad (11)$$

Where $\Delta\pi_{i,t}^{e\ long}$ represents changes in long term inflation expectations, $\Delta\pi_t$ represents current change in inflation, $\Delta{\pi_t}^{eNewsS}$ represents changes in short term news, and $\Delta{\pi_t}^{eNewsS}$ represents changes in medium term news. Changes due to short term news are defined by forecasts of inflation 1 to 4 quarters in the future; he theorizes that this would capture the effect of short term shocks in the economy. Changes due to medium term news are defined by forecasts of inflation 5 to 8 quarters in the future, as he believes this capture changes due to announced monetary policy.

He finds that long term inflation expectations in the Eurozone are insensitive in all three equations, making them perfectly anchored. Expectations in the United States are slightly less well-anchored. Long term inflation expectations are sensitive to current inflation and short term news at the 1% level, and sensitive to medium term news at the 5% level; despite this, neither of these coefficients are particularly high. These results show that American forecasters' expectations are more sensitive to current inflation and shocks as compared to their European counterparts, but are ultimately anchored by monetary policy.

Coibion et al (2015), who use the MSC to quantify inflation expectations, come to a different conclusion. They argue that inflation expectations are not anchored by forward guidance. Their argument hinges upon five points. The first is that consumer inflation expectations, as measured by the MSC, hover between 3.1% and 4.4%. These values are considerably higher than the Federal Reserve's stated goal of 2% inflation; in comparison, professional forecasters' expectations are closer to the Federal Reserve's target. The second point is that variability of expectations is high amongst consumers. While the dispersion amongst professional forecasters is 0.4%, the dispersion amongst consumers is 4%. The third point is that consumers are highly uncertain of their inflation expectations. The Survey of Consumer Expectations asks respondents to assign a probability to 10 inflation baskets; the mean standard deviation is 3 percentage points, showing a high degree of uncertainty. The fourth point is the high level of revision for inflation forecasts. Between 70 and 80% of MSC respondents revise their forecast, with an average revision of 5%. The fifth point is that consumers' long run inflation expectations are highly sensitive to their short run inflation expectations.

Coibion et al (2015) attribute this failure to anchor inflation expectations largely to a lack of knowledge of monetary policy. As a crude proxy for knowledge of monetary policy they cite a

survey which finds that only 25% of those asked could identify Janet Yellen as the chair of the Federal Reserve. They also noted that the entire Federal Reserve System only has a total of 702,955 Twitter followers, which is far fewer followers than a pop star or even an economist such as Paul Krugman. By analyzing Google Trends data, they find that people are 3 to 4 times as likely to search for "puppies" than they are to search for "inflation" or even "unemployment." While consumers didn't appear to know much about monetary policy, an Opinion Research Corporation finds that 68% of respondents rated inflation as extremely important to them. This led Coibion et al (2015) to hypothesize that this lack of knowledge of monetary policy came from consumers' inability to understand it. They cite an Associated Press poll which finds that 70% of respondents said monetary policy is "difficult to understand" and 25% said it is "very hard to understand." This lack of understanding leads to an inability on the part of the Federal Reserve to anchor inflation expectations.

As outlined above, Coibion et al (2015) argue that consumer inflation expectations are highly variable. One must turn to micro-level data to understand why. Kaplan and Schulhofer-Wohl (2016) find that there is large heterogeneity amongst household inflation rates. They draw this conclusion using data from the Kilts-Nielson Consumer Panel (KNCP), a dataset that uses barcodes to determine the specific goods consumers purchased as well as the price they paid and quantity they purchased; this data is collected from over 500 million purchases made by 50,000 U.S. households over the course of a decade. Kaplan and Schulhofer-Wohl (2016) measure inflation using the Laspeyres, Paasche, and Fisher indexes, and make a number of alterations to isolate various effects. Their first alteration is to replace individual unit price with the average price for that item across households. This is done to isolate the effect of the contents of a household's specific basket from the price of those items. Their second alteration is to replace

unit price with the average price of goods within its stratum, the category that the item would fall under in the aggregate CPI, in order to observe the inflation of different categories of goods. Their third alteration is to assign prices from the aggregate CPI to each household's basket to see if they can recreate the aggregate CPI used in macroeconomic data. All four indexes produce a wide distribution of inflation rates that are clustered around the aggregate inflation rate in the economy. This implies that all households are not subject to the same inflation rate, as most macroeconomic models would suggest. Kaplan and Schulhofer-Wohl (2016) theorize that heterogeneity of inflation rates would not necessarily lead to heterogeneity of inflation expectations. But they argue that since most households would not have a method of finding where they lie on the distribution of inflation rate, they would use the aggregate inflation rate as a proxy for their individual inflation rate. However, Coibion et al (2015)'s work contradicts this theory, as they find that consumers have a broad distribution of inflation expectations that are consistently higher than the target set by the Federal Reserve. This is also in line with Sims' (2003) original work, which stated agents would rely less on aggregate data when presented with highly variable inflation.

**Section 2D: Original Contributions**

As stated before, central banks generally rely on adaptive expectations and rational expectations models to quantify inflation expectations. This reliance is perfectly valid, as Friedman and Farmer's works show that these models provide a significant level of forecasting accuracy. That being said, Coibion and Gorodnichenko's (2013) work, as well as Łyziak's (2016) work, shows us that economists can use survey measures of inflation expectations to improve economic model's forecasting accuracy. The question that arises is, what survey should be used to quantify inflation expectations? As Coibion and Gorodnichenko (2013) acknowledge,

a survey of firms' inflation expectations would be best. Unfortunately, this data does not exist for the United States. Until the time when such a survey exists, economists must select an adequate proxy. This leads to economists to choose between the MSC and the SPF as a proxy.

The one obvious difference between the MSC and the SPF is the population surveyed. The MSC is distributed to 500 random households from the continuous United States, while the SPF is distributed to 42 professional forecasters from the same geographic area. Another difference between the surveys is the time frame over which they are collected. The MSC surveys households at a monthly rate, while the SPF surveys professional forecasters at a quarterly rate. Despite these key differences, the surveys have a near identical measure of inflation expectations; both surveys take the median expected 1-year inflation rate from the surveyed group. These methods are more or less identical to the measures used in the European surveys outlined in section's 2B and 2C. The one exception is the SPF conducted by the European Central Bank, which publishes the mean expected inflation rate.

I opt to use MSC as my measure of inflation expectations. I base this on Coibion and Gorodnichenko's (2013) empirical model which finds that the MSC has a statistically significant effect on inflation when included in the Phillips Curve alongside the SPF. While Łyziak's (2016) use of Polish survey data finds that professional forecasters' inflation expectations are closer to firms' inflation expectations, I am not convinced by his argument that these results are applicable to the United States. While he cites a working paper that produces preliminary results from a survey of American producers' inflation expectations, I feel that the small sample size of years and states makes it impossible to argue that the MSC is not currently a better proxy.

With this in mind, I build upon Coibion and Gorodnichenko's (2013) work on the determinants of consumers' inflation expectations. I make a number of significant changes to

their model based on what I view to be flaws in their methodology. Firstly, I test to see if previously observed inflation has a significant effect on consumers' inflation expectations. While Coibion and Gorodnichenko (2013) rightfully argue that Phillips Curves which employ Friedman's original adaptive expectations model do not have same the forecasting accuracy as Phillips Curves that rely on survey data, they do not consider that adaptive expectations assumptions should be tested using said survey data. For this purpose, I test to see if the average inflation rate from the past four quarters, the measure Friedman uses to quantify inflation expectations, has a significant effect on consumers' inflation expectations. This idea is partially drawn from Tsenova (2012) and Łyziak (2016), who use observed current inflation as a determinant of survey-measured inflation expectations.

Secondly, while Coibion et al (2015) make a compelling argument that forward guidance fails to anchor consumers' inflation expectations, it does not rest on any sort of empirical model. With this in mind, I include two controls for monetary policy in my model. The first measure is the effective federal funds rate, which I use to capture the effects of conventional monetary policy on consumers' inflation expectations. The second measure is forward guidance, which I quantitatively define as the difference between observed PCE inflation and the Federal Reserve's target of 2%. I employ these controls in order to observe if there is an empirical basis for Coibion et al's (2015) assertions about the Federal Reserve's inability to anchor consumers' inflation expectations. It will also allow me to broadly determine if consumers are rational economic actors as defined by rational expectations theory.

Thirdly, I believe Coibion and Gorodnichenko (2013) omit wage from their model. This belief is partially based on Friedman's argument that workers are primarily concerned with their purchasing power. This leads me to include real wages, which can stagnate, as an important

control in my model. I also include nominal wages as a control, in case consumers prove to be more affected by the dollar value of their wages. While this inclusion is not supported by Friedman's theory, it is still possible that the dollar value of wages will have an effect on consumers' inflation expectations.

I make the above adjustments in order to correct the omissions in Coibion and Gorodnichenko's (2013) model. My final original contribution is to establish which prices consumers are most sensitive to. Drawing on Kaplan and Schulhofer-Wohl's (2016) study, I use different index values of various CPI stratums as my dependent variable. This includes the index for food, energy, and rent. In a similar vein, I also use values from the housing index and the PCE for healthcare. I use these variables because I believe that the values of these goods represent prominent expenditures made by all consumers.

**Section 3: Data and Methodology**

This section is broken into three parts. Section 3A outlines data sources, specifications, and aggregation methods. Section 3B provides summary statistics. Section 3C outlines my base model and its various re-specifications.

**Section 3A: Data**

I use data from the Michigan Survey of Consumers (MSC) to track consumer inflation expectations. The Survey Research Center at the University of Michigan distributes the MSC to 500 random households from the contiguous United States, and follows up with respondents six month later, which allows analysts to track individual fixed effects. They report inflation expectations as the median expected price change in the next 12 months. I take MSC data from Federal Reserve Economic Data (FRED).

In order to test Friedman's theory of adaptive expectations, it is necessary to choose how I want to quantify inflation. While the Federal Reserve uses the percent change in Personal Consumption Expenditures (PCE) as their measure of inflation, I use the percent change in CPI. I base this choice on Coibion and Gorodnichenko's (2013) assumption that this would be the measure of inflation that consumers would be most sensitive to. This data is collected by the Bureau of Labor Statistics, and can be taken directly from their website.

As stated before, my work is heavily based upon Coibion and Gorodnichenko's (2013). They find that changes in oil prices, as transmitted through gasoline prices, have a statistically significant effect on consumers' inflation expectations. My research's goal is to see if whether the price of major expenditures such as food, energy, healthcare, and housing also have a significant effect on consumers' inflation expectations. This presents a problem when selecting variables for my model. Coibion and Gorodnichenko track oil prices because of their effect on the price of gasoline, a good that is more or less homogenous. But when tracking changes in the price of food, energy, and healthcare, categories that include a broad range of goods and services, it is difficult to decide upon a single price to track. I attempt to solve this problem by instead using the index values of various stratums of CPI and PCE, with the theory that I would be able to track aggregate trends in these sectors. With this in mind, I use the following variables from FRED: The CPI for all Urban Consumers: Food and Beverages, the CPI for all Urban Consumers: Energy, and the CPI for all Urban Consumers: Rent of Primary Residence. All of these CPI stratums use an index of 1982-1984=100. Changes in the price of health care are tracked through Personal Consumption Expenditures: Services: Health Care, which uses an index of 2009=100. As an alternative measure of the price of housing I also included the House Price Index for the United States, which uses an index of 1980Q1=100.

My model employs a number of controls, starting with controls for monetary policy. I use two different measures of monetary policy. The first measure is the effective federal funds rate, which can be found on FRED. The second measure is inflation targeting. I measure inflation targeting by recording the difference between observed PCE inflation, based on FRED's dataset Real Personal Consumption Expenditures, and the Federal Reserve's 2% inflation target. The second type of control is wage. I employ two separate measures of wage, both of which are taken from FRED. The first is Average Hourly Earnings of Production and Nonsupervisory Employees: Total Private. The second is the Median Usual Weekly Real Earnings: Wage and salary workers: 16 years and over, which uses 1982-84 CPI adjusted dollars. These two variables are meant to control for nominal and real wages respectively.

The majority of data listed above is collected on a monthly basis. However, the House Price Index and PCE data are collected on a quarterly basis. For the purpose of standardizing time periods, I convert all data into quarterly data; this is done by calculating the variables' average value throughout the quarter. Furthermore, my dataset begins in the first quarter of 1980 and ends in the last quarter of 2015. I use these years due to restrictions on the years in which data is available for certain variables; 1980 is the earliest year for which data from the MSC is available on FRED, and 2015 is the latest year for which data from the House Price Index is available on FRED. By setting these years as the first and last years for my sample, I assure that all variables have 144 observations.

Finally, I generate a series of variables capturing changes the values of my various dependent variables, which I refer to as difference variables. These difference variables are meant to capture the effect of changes in prices, wages, or monetary policy on consumers' inflation expectations. These difference variables are specified as the value of variable $x$ in

period t minus the variable *x*'s value in period t-2. This is based on the fact that the MSC follows up with the same sample of consumers every 6 months; as my data is in quarters, this would be every two periods. Furthermore, the difference variables are defined as $x_t - x_{t-2}$, as opposed to using a percentage change like Coibion and Gorodnichenko (2013) did, due to my use of index values as opposed to a specific price such as oil. The way indexes such as the CPI work is as follows: one year, or group of years serves, as the base year and is given a value of 100. The majority of the indexes employed in this paper use 1982-84 as their index. If, to provide a hypothetical example, the index value for one of these indexes is 101 in 1985, it does not mean the average cost of food has risen by one CPI adjusted dollar. It means that prices have risen by 1% of prices in those base years. Ergo, due to what index values represent, it does not make sense to track the percentage change in their value.

**Section 3B: Summary Statistics**

This section outlines my summary statistics. The summary statistics for my base variables are in Table 1. The summary statistics for my difference variables are in Table 2. All variables have 144 observations.

Table 1: Summary Statistics for Base Variables

| | Mean | Std. Dev. | 25th Q | 50th Q | 75th Q | Min | Max |
|---|---|---|---|---|---|---|---|
| *mich* | 3.41 | 1.34 | 2.8 | 3.1 | 3.4 | 1.1 | 10.2 |
| *dif* | 2.7 | 1.24 | 2.8 | 3.1 | 3.4 | .76 | 7.85 |
| *ai* | .77 | .49 | .47 | .72 | .95 | -.39 | 3.02 |
| *rate* | 5.03 | 4.07 | 1.43 | 5.20 | 7.04 | .07 | 17.78 |
| *food* | 162 | 47 | 121 | 159 | 198 | 83.6 | 247 |
| *energy* | 140.68 | 55.2 | 100.78 | 109.9 | 247.2 | 81.83 | 264.61 |
| *health* | 69.66 | 26.69 | 45.42 | 70.92 | 93.11 | 22.1 | 110.07 |
| *house* | 229.3 | 88.86 | 155.47 | 205.15 | 318.88 | 100 | 378.21 |
| *rent* | 177.95 | 58.69 | 130.3 | 169.28 | 230.32 | 78.33 | 290.31 |
| *nom* | 13.41 | 4.26 | 9.63 | 12.77 | 17.07 | 6.63 | 21.22 |
| *real* | 326.25 | 10.67 | 315 | 328 | 335 | 309 | 345 |

Table 1 reveals a great deal about consumers' inflation expectations. Based on the average value of *mich*, consumers do not appear to have unreasonably high inflation expectations. However, the fact that *mich*'s max value comes from 1990, a year with low observed inflation, shows the potential that consumers expect inflation to be considerably higher than it is the following year. This hypothesis suggests a simple test. The variable *dif* captures the difference between the level of inflation consumers expected in the coming year and the average observed percent change in CPI over that following year. The average value of *dif* is 2.7, meaning that on average consumers expected inflation to be 2.7% higher than actual observed inflation the following year. The fact that *dif* has a maximum value of 7.85 shows that consumers' inflation expectations can be markedly higher than actual inflation.

Writing this paper in 2017, it is hard to remember a time when the federal funds target was not close to zero. The summary statistics for *rate* remind us that this has not always been the case. The average value of *rate* is 5.03, which shows that in the 35 years this sample is drawn from, the Federal Reserve has relied on more contractionary monetary policy relative to the norms of today. By calculating *rate*'s interquartile range, which is 5.61, we can see that the middle 50% of rates fall within a broad range. This demonstrates the level of specificity that the Federal Reserve uses while conducting monetary policy.

When analyzing these summary statistics, it is important to remember that these variables use index values as opposed to dollar amounts. This means that the average value of *food*, 162, indicates that on average food prices are 62% higher than they were in the base period. With this in mind, *house* and *rent* have had the highest average price increase since their base year, followed by *food* then *energy*. The low average value of *health*, 69.66, is due to the fact that it uses 2009 as its index. As the majority of data is collected from before 2009, it would make

sense that the average index value is below 100. Unsurprisingly, the maximum values of all of these variables are grouped amongst recent years.

The average value of *nom* is 13.41, meaning that the average hourly wage from 1980 through 2015 is $13.41. That being said, this average does not really tell us anything, as nominal wages generally trend upwards. This is demonstrated by the max value of 21.22 coming from the sample's last quarter. The results in Table 2 support this. They show that all values of *nomdif* are positive, which confirms that nominal wages always trend upwards. The average value is 0.2, which only amounts to an increase of about 20 cents, but that is unsurprising as hourly wages generally do not increase per quarter. In comparison, real wages can fluctuate, so the average value of *realdif* tells us more than the average value of *nomdif*. The average value of *realdif* is positive, which shows that real wages generally increase from quarter to quarter. That being said, the fact that the value of the 25$^{th}$ quartile is -2 shows that real wages can and do depreciate. While on average these changes in purchasing power are small, the min and max show that under certain circumstances they can be quite drastic.

Table 2: Summary Statistics for Difference Variables

| | Mean | Std. Dev. | 25$^{th}$ Q | 50$^{th}$ Q | 75$^{th}$ Q | Min | Max |
|---|---|---|---|---|---|---|---|
| *michdif* | .09 | 0.67 | -.2 | .004 | .2 | -.17 | 2.7 |
| *ratedif* | -0.19 | 1.34 | -0.57 | -.01 | 0.26 | -5.22 | 6.73 |
| *fooddif* | 2.29 | 1.32 | 1.43 | 2.06 | 2.8 | -1.31 | 7.5 |
| *energydif* | 1.63 | 12.92 | -1.98 | 1.76 | 6.9 | -84.34 | 34.61 |
| *heatlhdif* | 1.23 | 0.43 | 0.89 | 1.23 | 1.47 | -0.57 | 2.21 |
| *housedif* | 3.7 | 6.31 | 1.7 | 3.71 | 6.67 | -20.51 | 20.9 |
| *rentdif* | 2.95 | 1.1 | 2.23 | 2.9 | 3.63 | -.09 | 6.02 |
| *nomdif* | 0.2 | 0.06 | .14 | .2 | .24 | .06 | .36 |
| *realdif* | .34 | 3.39 | -2 | 0 | 2 | -7 | 14 |

The summary statistics for *michdif* show that on average inflation expectations generally rise between periods, but only by a small amount, with infrequent expected deflation. The

summary statistics for *fooddif*, *energydif,* and *healthdif*, show that on average the costs of food, energy, and healthcare grow at a moderate rate. The average changes in the price of housing, as measured by *housedif* and *rentdif*, are higher. The average values of all of these variables show that these prices tend to trend upward, with generally only small dips as demonstrated by their minimums. The two exceptions to this are *energydif* and *housedif*, which have minimums with extremely negative values. These values both come from periods during the Great Recession, which is the most severe economic downturn to occur within the sample; taking this into account, these minimums are not surprising. This is particularly true for *housedif*'s minimum, as it was the precipitous fall in housing values that led to the economic crash. Furthermore, *energydif*'s high standard deviation shows the price of energy are generally volatile and is subject do large jumps and dips.

One of my paper's goals is to see how inflation targeting effects consumers' inflation expectations. However, the Federal Reserve only formally implemented inflation targeting in January of 2012. Because of this, the variables *target* and *targetdif* only have 16 observations, as opposed to 144. The summary statistics for *target* and *targetdif* are outlined in Table 3.

Table 3: Summary Statistics, Inflation Targeting

| | Mean | Std. Dev. | $25^{th}$ | $50^{th}$ | $75^{th}$ | Min | Max |
|---|---|---|---|---|---|---|---|
| *target* | .35 | 1.13 | -0.5 | .35 | 1.15 | -1.3 | 2.6 |
| *targetdif* | .13 | 1.18 | -0.6 | .15 | 0.8 | -1.7 | 2.6 |

When viewing these summary statistics, remember that the variable *target* is defined as the difference between the percentage change in the PCE in the past quarter and the Federal Reserve's inflation target of 2%. This means that on average, PCE inflation is 0.35% higher than the Federal Reserve's target of 2%. This does not mean that inflation is consistently above target, as demonstrated that 25% of quarters saw inflation below target. This makes sense, as lackluster

inflation is what led the Federal Reserve to keep the federal funds rate down in recent years. The mean value of *targetdif* indicates that on average the difference between observed PCE inflation and the 2% target rises by 0.13% during a quarter. This would mean that if PCE inflation is below target, it would move closer to target, and if it is above target it would be even higher.

**Section 3C: Methodology**

This paper's first goal is to establish whether the adaptive expectations hypothesis holds true when consumer inflation expectations, as measured via the MSC, are used to quantify inflation expectations. For this purpose, I use the following regression:

$$mich_t = \beta_0 + \beta_1 a\pi_t + \varepsilon_t \ (12)$$

Where *mich* represents the average expected yearly inflation for that quarter, and *aπ* represents the average inflation rate from the previous four quarters. I created *aπ* based upon the measure of inflation expectations Friedman used in his expectations-adapted Phillips Curve. If the adaptive expectations hypothesis applies when measuring consumers' inflation expectations, the coefficient for *aπ* should be positive and statistically significant.

This paper's second goal is to see which prices have the most significant effect on consumers' inflation expectations. I use the following regression to capture these effects measuring concurrent responses to price levels:

$$mich_t = \beta_0 + \beta_1 good_t + \beta_2 rate_t + \varepsilon_t \ (12)$$

Where *mich* again represents the average expected yearly inflation for that quarter, *good* represents the average value of the respective index from the past quarter, and *rate* represents the average effective federal funds rate for that quarter. I use the variable *good* in this section as a

stand in for the various index values used in my study. If consumers' expectations are sensitive to the value of any of these goods and services, I should find that the various *good* variables should be statistically significant and positive; this prediction is based upon Coibion and Gorodnichenko's (2013) finding that price levels have a positive effect on consumers' inflation expectations. The variable *rate* is included as a control for monetary policy. Theory tells us that increases in the federal funds rate are meant to curb inflation. An informed rational actor would expect lower inflation as interest rates go up. If this dynamic holds true for consumers, then *rate*'s coefficient would be statistically significant and negative.

While Coibion and Gorodnichenko (2013) find that consumers' inflation expectations are affected by the price of oil, they find that these expectations are more sensitive to the changes in these prices. I use first difference model outlined below to capture these effects:

$$michdif_t = \beta_0 + \beta_1 gooddif_t + \beta_2 ratedif_t + \varepsilon_t \quad (13)$$

The variable *michdif* represents the difference between the *mich*'s value in period t and its value in period t-2. The variable *gooddif* represents difference between the value of variable *good* in period t and its value in period t-2. The variable *ratedif* represents the difference between the value of variable *rate* in period t and its value in period t-2. If consumers' inflation expectations are sensitive to changes in the prices of various goods like they are to oil prices, we would expect *gooddif*'s coefficient to be statistically significant and positive. If consumers' inflation expectations are sensitive to changes in monetary policy, and consumers are rational actors, we would expect *ratedif's* coefficient to be statistically significant and negative.

My paper's third goal is to see the effect of the value of wages on consumers' inflation expectations. With this in mind, I introduce nominal wages into equations 2 and 3 to produce the following two regressions:

$$mich_t = \beta_0 + \beta_1 good_t + \beta_2 rate_t + \beta_3 nom_t + \varepsilon_t \text{ (14)}$$

$$michdif_t = \beta_0 + \beta_1 gooddif_t + \beta_2 ratedif_t + \beta_3 nomdif_t + \varepsilon_t \text{ (15)}$$

Where all variables included in previous regressions have the same value, *nom* represents the average hourly earnings of production and non-supervisory employees that quarter, and *nomdif* represents the difference between the value of variable *nom* in period t and its values in period t-2. These variables are included to see if the effects of various prices and their changes are still statistically significant when controlling for nominal wage. I also theorize that *nom* and *nomdif* will have statistically significant positive values, as I believe consumers' inflation expectations will rise if they see the dollar value of their wages rise. However, Friedman argues that workers only care about their real wage. I use the following two regressions to test this:

$$mich_t = \beta_0 + \beta_1 good_t + \beta_2 rate_t + \beta_3 real_t + \varepsilon_t \text{ (16)}$$

$$michdif_t = \beta_0 + \beta_1 gooddif_t + \beta_2 ratedif_t + \beta_3 realdif_t + \varepsilon_t \text{ (17)}$$

Where all variables included in previous regressions have the same value, *real* represents the average median weekly earnings for full-time workers, and *realdif* represents the difference between the value of variable *real* in period t and its value in period t-2. These variables are included to see the effects of various prices and their changes are still significant when controlling for purchasing power. I theorize that *real* and *realdif* will have statistically significant negative values, as an increase in purchasing power should lessen consumers' perception of inflation.

This paper's fourth goal is to see if monetary policy has any effect on consumers' inflation expectations. The base model uses the federal funds rate as its measure of monetary policy, but I desire to see if inflation targeting, which is explicitly intended to shape expectations, affects consumers' inflation expectations. I use my final two regressions to capture these effects:

$$mich_t = \beta_0 + \beta_1 good_t + \beta_2 target_t + \varepsilon_t \quad (18)$$

$$michdif_t = \beta_0 + \beta_1 gooddif_t + \beta_2 targetdif_t + \varepsilon_t \quad (19)$$

Where all variables included in previous regressions have the same value, *target* represents the difference between the average inflation of PCE in the past quarter the Federal Reserve's inflation target of 2%, and *targetdif* represents the difference between the value of variable *target* in period t and its value in period t-2. The theory of rational expectations tells us that, if consumers are rational informed actors and know that as inflation approaches two percent the Federal Reserve is more likely to attempt to curb inflation, *target* and *targetdif* should both have a statistically significant negative value. The variables *target* and *targetdif* replace the variables *rate* and *ratedif* respectively, as they are alternative measures of monetary policy. Unfortunately, due to the fact that the Federal Reserve only announced its 2% inflation target in January of 2012, these regressions will only rely on a sample of 3 years, reducing the number of observations to 16.

**Section 4: Empirical Results**

This section is broken down into 4 subsections. Section 4A discusses my application of adaptive expectations to consumers' inflation expectations. Section 4B outlines the results of my base model and its various re-specifications. Section 4C outlines the results of my various first difference models. Section 4D discusses my implementation of robustness checks.

**Section 4A: Adaptive Expectations**

I begin my regressions by testing the adaptive expectations hypothesis. The results are outlined in Table 4. Variable $a\pi$'s coefficient turned out to be statistically significant. Its value indicates that for every 1% increase in the average inflation rate over the past year, consumers' inflation expectations increase by 1.41%. This indicates that there is some validity to applying the adaptive expectations hypothesis to consumers' inflation expectations, as increases in observed inflation lead to increases in inflation expectations. While Friedman theorizes that economic agents expect inflation to be the same as previously observed inflation, these results show that consumers expect inflation to be higher. This suggests that better explanations can still be found.

Table 4: Adaptive Expectations Model

| Mich | Adaptive |
|---|---|
| $A\pi$ | 1.414*** |
| | (0.187) |
| Constant | 2.144*** |
| | (0.139) |
| Observations | 140 |
| R-squared | 0.622 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Section 4B: Base Model**

The regression results in Table 5 show that all the variables have a statistically significant effect on consumers' inflation expectations at the 1% level. The coefficients' values are small, but when considering the scale of these variables' values, this is understandable. To demonstrate this, one can simply multiply a variable's coefficient by its average value. This produces values of 2.43 for *food*, 2.12 for *rent*, 1.68 for *energy*, 1.65 for *health*, and 1.14 for *house*. These results

show that the average value of these variables increase consumers' inflation expectations by around 1½ to 2 ½%, with the price of food having the greatest effect on average. It is important to note that the average value of *health* is low due to the index year being 2009. This could suggest that the cost of healthcare has had a greater effect on consumers' inflation expectation in recent years, possibility due to its prominence in the political landscape.

Table 5: Base Model

| Mich | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Food | 0.0159*** | | | | |
| | (0.00332) | | | | |
| Rate | 0.371*** | 0.331*** | 0.355*** | 0.306*** | 0.364*** |
| | (0.0534) | (0.0425) | (0.0566) | (0.0479) | (0.0543) |
| Energy | | 0.0127*** | | | |
| | | (0.00167) | | | |
| Health | | | 0.0247*** | | |
| | | | (0.00686) | | |
| House | | | | 0.00547*** | |
| | | | | (0.00147) | |
| Rent | | | | | 0.0121*** |
| | | | | | (0.00282) |
| Constant | -1.040 | -0.0389 | -0.0930 | 0.616 | -0.583 |
| | (0.753) | (0.385) | (0.710) | (0.509) | (0.721) |
| Observations | 144 | 144 | 144 | 144 | 144 |
| R-squared | 0.497 | 0.561 | 0.470 | 0.467 | 0.487 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Interestingly, *rate* generally has a statistically significant positive effect. The theory rational expectations tells us that if the federal funds rate is higher, a rational actor will expect inflation to drop, but my base regression's results instead suggest that consumers' expectations are not tempered by monetary policy in this way. These results raise the question of whether *rate* would have the expected negative effect when not controlling for any of the *good* variables. With this in mind, I run a regression with *mich* as the dependent variable and *rate* as the sole

independent variables. Table 6's results show that even without controlling for *good* variables, *rate* still has a statistically significant positive effect. There are a number of possible reasons as to why this could be. One is that *rate* is capturing an effect from some omitted variable, which is causing the unexpected sign. This would mean that *rate's* value is the result of misspecifications in the model. Another possible explanation is that if consumers are aware of the federal funds rate, they do not understand its effect on the economy. This could lead them to believe that an increase in interest rates means higher inflation, not lower. This explanation would mean *rate*'s value is a result of policy illiteracy. That being said, my base model measures concurrent responses, so there is also the possibility that the federal funds rate might have a lagged effect on consumers' inflation expectations.

Table 6: Only Federal Funds Rate

| Mich | (1) |
|---|---|
| Rate | 0.212*** |
| | (0.0364) |
| Constant | 2.342*** |
| | (0.146) |
| Observations | 144 |
| R-squared | 0.417 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Another of my paper's goals is to see whether the effects these prices have on consumers' inflation expectations remain when controls for wage are implemented. The results of my base regression with variable *nom* added as a control are displayed in Table 7. With the inclusion of nominal wages, only *energy* continues to have a statistically significant positive effect on consumers' inflation expectations. The coefficients for *health* and *rent*, while statistically significant, are negative. The coefficients for *house* and *food* are not statistically significant when

controlling for nominal wages. As predicted, *nom* generally has a statistically significant positive effect. Next, I wanted to see if these dynamics remain when controlling for real wage as opposed to nominal wage. The results of these controls are outlined in Table 8.

Table 7: Base Model, Nominal Wage Control

| Mich | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Food | 0.00609 | | | | |
| | (0.0179) | | | | |
| Nom | 0.105 | -0.115 | 0.388*** | 0.226*** | 0.885** |
| | (0.184) | (0.0700) | (0.101) | (0.0578) | (0.349) |
| Rate | 0.367*** | 0.280*** | 0.319*** | 0.368*** | 0.309*** |
| | (0.0529) | (0.0538) | (0.0548) | (0.0532) | (0.0521) |
| Energy | | 0.0183*** | | | |
| | | (0.00330) | | | |
| Health | | | -0.0413** | | |
| | | | (0.0199) | | |
| House | | | | -0.00262 | |
| | | | | (0.00210) | |
| Rent | | | | | -0.0554** |
| | | | | | (0.0274) |
| Constant | -0.842 | 0.968 | -0.533 | -0.870 | -0.164 |
| | (0.862) | (0.800) | (0.714) | (0.700) | (0.744) |
| Observations | 144 | 144 | 144 | 144 | 144 |
| R-squared | 0.498 | 0.570 | 0.513 | 0.500 | 0.519 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8's results show that even with *real* implemented as a control, all of the *good* variables have a statistically significant positive effect at the 1% level. This shows that consumers' inflation expectations are still affected by price levels when controlling for their purchasing power, as opposed to the dollar value of their wages. Despite these results, the coefficient for *real* is not statistically significant.

Table 8: Base Model, Real Wage Control

| Mich | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Food | 0.0149*** | | | | |
| | (0.00347) | | | | |
| Real | 0.00684 | 0.00336 | 0.0141 | 0.00758 | 0.00498 |
| | (0.0105) | (0.00911) | (0.0106) | (0.0122) | (0.0115) |
| rate | 0.374*** | 0.334*** | 0.360*** | 0.309*** | 0.364*** |
| | (0.0553) | (0.0493) | (0.0583) | (0.0502) | (0.0548) |
| energy | | 0.0124*** | | | |
| | | (0.00153) | | | |
| health | | | 0.0212*** | | |
| | | | (0.00729) | | |
| house | | | | 0.00484*** | |
| | | | | (0.00175) | |
| rent | | | | | 0.0115*** |
| | | | | | (0.00321) |
| Constant | -3.122 | -1.119 | -4.495 | -1.731 | -2.089 |
| | (3.435) | (3.139) | (3.488) | (3.891) | (3.623) |
| Observations | 144 | 144 | 144 | 144 | 144 |
| R-squared | 0.498 | 0.561 | 0.476 | 0.468 | 0.488 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Another of my paper's goals is to see if these effects remain when inflation targeting is used to measure monetary policy. Table 9's results suggest that inflation targeting does not have a statistically significant effect on consumers' inflation expectations. Furthermore, *target*'s inclusion leads to a statistically significant negative effect for my other variables. That being said, it is difficult to draw any definitive conclusions from these results due to the drastic decrease in sample size required for *target*'s inclusion.

Table 9: Base Model, Inflation Targeting Control

| mich | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| food | -0.0440*** | | | |
| | (0.00644) | | | |
| energy | 0.0101*** | | | |
| | (0.00124) | | | |
| target | -0.0282 | 0.0597 | 0.0554 | 0.0514 |
| | (0.0280) | (0.0485) | (0.0481) | (0.0435) |
| health | | -0.158*** | | |
| | | (0.0238) | | |
| house | | | -0.0118*** | |
| | | | (0.00186) | |
| rent | | | | -0.0224*** |
| | | | | (0.00311) |
| Constant | 0.711** | 20.19*** | 6.964*** | 9.148*** |
| | (0.270) | (2.567) | (0.626) | (0.854) |
| Observations | 16 | 16 | 16 | 16 |
| R-squared | 0.751 | 0.617 | 0.705 | 0.730 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Section 4C: First Difference Model**

The next question is whether, as Coibion and Gorodnichenko (2013) suggest, consumers' inflation expectations are affected more by changes in prices rather than price levels themselves. In order to test this, I convert my base model into a first difference model. The results are displayed in Table 10. Only the coefficients for *fooddif* and *energydif* are statistically significant. Furthermore, the coefficients are not particularly high. On average, the change in the price of food only leads to a .31% increase in consumers' inflation expectations, while the average change in the price of energy .01% increase in consumers' inflation expectations. These results suggest that bi-annual price changes do not have a profound effect on consumers' inflation expectations. Changes in the federal funds rate do not appear to have a statistically significant effect on consumers' inflation expectations.

Table 10: First Difference Model

| michdif | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| fooddif | 0.137** | | | | |
| | (0.0629) | | | | |
| ratedif | -0.00918 | -0.0223 | -0.00374 | 0.0117 | 0.00487 |
| | (0.0740) | (0.0806) | (0.0797) | (0.0777) | (0.0773) |
| energydif | | 0.0127** | | | |
| | | (0.00516) | | | |
| healthdif | | | 0.0623 | | |
| | | | (0.105) | | |
| housedif | | | | -0.0205 | |
| | | | | (0.0133) | |
| rentdif | | | | | 0.0909 |
| | | | | | (0.0557) |
| Constant | -0.229* | 0.0636 | 0.0119 | 0.166* | -0.174 |
| | (0.126) | (0.0531) | (0.121) | (0.0879) | (0.144) |
| Observations | 140 | 140 | 140 | 140 | 140 |
| R-squared | 0.074 | 0.059 | 0.002 | 0.036 | 0.021 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Similar to my base model, I include changes in nominal and real wages as controls in my First Difference Model. Table 11's results show that when controlling for changes in nominal wage, changes in price levels largely do not have a statistically significant effect on changes in consumers' inflation expectations; the one exception is *energydif*, which again has a small coefficient. The coefficient for *nomdif* is generally statistically significant and positive. However, even when using the largest coefficient for *nomdif*, the average change in nominal wages will only lead to a .46% increase in consumers' inflation expectations. So while consumers are sensitive to the dollar value of their wages, the effect on their expectations is generally small.

Table 11: First Difference Model, Nominal Wage Control

| michdif | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| fooddif | 0.0195 | | | | |
| | (0.0252) | | | | |
| nomdif | 0.176 | 1.956** | 2.306** | 2.108** | 2.014* |
| | (0.501) | (0.946) | (1.098) | (0.969) | (1.088) |
| ratedif | 0.00705 | -0.0292 | -0.0135 | 0.000635 | -0.0103 |
| | (0.0232) | (0.0754) | (0.0736) | (0.0726) | (0.0747) |
| energydif | | 0.0113** | | | |
| | | (0.00433) | | | |
| healthdif | | | 0.0925 | | |
| | | | (0.111) | | |
| housedif | | | | -0.0185 | |
| | | | | (0.0119) | |
| rentdif | | | | | 0.0342 |
| | | | | | (0.0544) |
| Constant | -0.0741 | -0.332* | -0.496* | -0.271* | -0.421* |
| | (0.103) | (0.172) | (0.260) | (0.158) | (0.220) |
| Observations | 140 | 140 | 140 | 140 | 140 |
| R-squared | 0.009 | 0.096 | 0.054 | 0.080 | 0.053 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12's results show that when controlling for changes in real wages, only *fooddif* and *energydif* are statistically signficant, with both of their coefficients being positive; again, these coefficients are small and on average do not lead to a large increase in consumers' inflation expectations. The coefficient for *realdif* is negative and statistically significant. These results are in line with the hypothesis that as consumers' purchasing power rises, they will expect less inflation. Despite this, the coefficient for *realdif* is extremely low, meaning the overall change in expectations would be negligible.

Table 12: First Difference Model, Real Wage Control

| michdif | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| fooddif | 0.121* | | | | |
| | (0.0626) | | | | |
| realdif | -0.0347** | -0.0240 | -0.0460*** | -0.0409*** | -0.0499*** |
| | (0.0152) | (0.0191) | (0.0164) | (0.0147) | (0.0168) |
| ratedif | -0.0324 | -0.0341 | -0.0374 | -0.0180 | -0.0267 |
| | (0.0756) | (0.0801) | (0.0819) | (0.0781) | (0.0760) |
| energydif | | 0.00929 | | | |
| | | (0.00618) | | | |
| healthdif | | | -0.0428 | | |
| | | | (0.102) | | |
| housedif | | | | -0.0183 | |
| | | | | (0.0125) | |
| rentdif | | | | | 0.114* |
| | | | | | (0.0589) |
| Constant | -0.184 | 0.0746 | 0.150 | 0.165* | -0.233 |
| | (0.129) | (0.0561) | (0.126) | (0.0860) | (0.151) |
| Observations | 140 | 140 | 140 | 140 | 140 |
| R-squared | 0.101 | 0.068 | 0.047 | 0.075 | 0.078 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Lastly, I include inflation targeting as an alternative measure of monetary policy. The variable *targetdif* represents the change from the previous period's PCE inflation's difference from the Federal Reserve's 2% target and current PCE inflation's difference from this target. Table 13 shows that changes in this difference do not have a statistically significant effect on changes in consumers' inflation expectations. Though as with the inclusion of *target* in my base model, it is difficult to reach any definitive conclusions based on the drastic reduction in sample size necessary to include *targetdif*.

Table 13: First Difference Model, Inflation Targeting Control

| michdif | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| fooddif | 0.0467 | | | | |
| | (0.0454) | | | | |
| targetdif | -0.0463 | -0.0271 | -0.0395 | -0.0658 | -0.0330 |
| | (0.0641) | (0.0650) | (0.0550) | (0.0795) | (0.104) |
| energydif | | -0.0108 | | | |
| | | (0.00664) | | | |
| healthdif | | | -0.305 | | |
| | | | (0.197) | | |
| housedif | | | | 0.0232 | |
| | | | | (0.0295) | |
| rentdif | | | | | -0.00399 |
| | | | | | (0.120) |
| Constant | -0.174 | -0.0934 | 0.141 | -0.226 | -0.0570 |
| | (0.156) | (0.0751) | (0.126) | (0.240) | (0.443) |
| Observations | 10 | 10 | 10 | 10 | 10 |
| R-squared | 0.103 | 0.253 | 0.205 | 0.109 | 0.037 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Section 4D: Robustness Checks**

My regressions suggest that consumers' concurrent responses to price levels are stronger than their responses to price changes. However, these regressions do not capture whether previously observed prices or implemented monetary policy help to anchor consumers' inflation expectations. For this purpose, I take the step of creating *goodlag* variables, defined as the value of *good* with a single lag, to my base model. Table 14's results show that when controlling for previously observed price levels, only food, energy, and house prices are statistically significant; that being said, the fact that the coefficients for the lagged values of food and energy are negative, means that while price levels in the current period raise expectations, these expectations lower based on previously observed prices. This means that the net effect of current prices is lower than what my base regression found. Let's assume, for the sake of simplifying this example, that *food* has the same value in period t and period t-1; this is not too great an

assumption, as my summary statistics show that *food*'s value does not change a great deal from period to period. This would mean that the average value of *food* leads to a 71% increase consumers' inflation expectations, and the average value of *foodlag* would lead to a 69% decrease in consumers' inflation expectations; this leads to a net increase in consumers' inflation expectations, which is around .4% lower than the average effect observed when not controlling for previously observed prices. Using this same methodology, the net change in consumers' inflation expectations based on the value of *energy* would be a 1.68% increase, which is the same as the effect observed by my base model. When controlling for previously observed prices, *house*'s coefficient is negative, but the value of *houselag* is positive, which leads to an average net effect of a 1.18% increase in consumers' inflation expectations, which is slightly higher than the average effect observed in the base model. Finally, while one might expect that the lagged value of *rate* would have a negative effect on consumers' inflation expectations, it has the previously observed positive effect. This supports the conclusion that consumers' expectations cannot be shaped by monetary policy the way rational expectations theory suggests.

Table 14: Base Model, Lagged Variables Included

| mich | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| food | 0.441*** | | | | |
| | (0.132) | | | | |
| foodlag | -0.430*** | | | | |
| | (0.133) | | | | |
| rate | 0.241 | 0.253 | 0.265 | 0.265 | 0.273 |
| | (0.228) | (0.250) | (0.267) | (0.255) | (0.266) |
| ratelag1 | 0.0619 | 0.0469 | 0.0649 | 0.0159 | 0.0771 |
| | (0.219) | (0.240) | (0.257) | (0.250) | (0.266) |
| energy | | 0.0274*** | | | |
| | | (0.00832) | | | |
| energylag | | -0.0158* | | | |
| | | (0.00838) | | | |
| health | | | 0.304 | | |
| | | | (0.272) | | |
| healthlag | | | -0.280 | | |
| | | | (0.270) | | |
| house | | | | -0.0566*** | |
| | | | | (0.0209) | |
| houselag | | | | 0.0618*** | |
| | | | | (0.0212) | |
| rent | | | | | -0.0760 |
| | | | | | (0.158) |
| rentlag | | | | | 0.0886 |
| | | | | | (0.161) |
| Constant | -0.467 | 0.217 | -0.169 | 0.883** | -0.503 |
| | (0.632) | (0.336) | (0.628) | (0.423) | (0.632) |
| Observations | 143 | 143 | 143 | 143 | 143 |
| R-squared | 0.546 | 0.566 | 0.456 | 0.478 | 0.473 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

I want to see whether these dynamics remain when controlling for nominal wages and lagged nominal wages. Table 15's results show that when controlling for nominal wage, only *energy* has a significant positive effect on consumers' inflation expectation. While *food* still has a positive coefficient, *foodlag*'s coefficient is equivalently negative, the effects largely cancel each other out. Furthermore, with *nomlag* included as a control, nominal wages no longer have a significant effect on consumers' inflation expectations.

Table 15: Base Model, Lagged Variables Included, Nominal Wage Control

| mich | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| food | 0.422*** | | | | |
| | (0.115) | | | | |
| foodlag | -0.423*** | | | | |
| | (0.123) | | | | |
| nom | 2.248 | 6.319 | 7.216 | 5.433 | 5.981 |
| | (3.426) | (3.817) | (5.007) | (4.582) | (4.485) |
| nomlag | -2.138 | -6.533* | -6.802 | -5.252 | -5.151 |
| | (3.367) | (3.900) | (4.944) | (4.585) | (4.232) |
| rate | 0.223 | 0.184 | 0.210 | 0.257 | 0.212 |
| | (0.228) | (0.229) | (0.231) | (0.246) | (0.234) |
| ratelag | 0.0547 | -0.00239 | -0.00168 | 0.0325 | 0.0227 |
| | (0.214) | (0.218) | (0.216) | (0.232) | (0.230) |
| energy | | 0.0292*** | | | |
| | | (0.00632) | | | |
| energylag | | -0.00985 | | | |
| | | (0.00669) | | | |
| health | | | 0.425 | | |
| | | | (0.269) | | |
| healthlag | | | -0.485* | | |
| | | | (0.263) | | |
| house | | | | -0.0501** | |
| | | | | (0.0217) | |
| houselag | | | | 0.0463** | |
| | | | | (0.0222) | |
| rent | | | | | -0.0810 |
| | | | | | (0.141) |
| rentlag | | | | | 0.0252 |
| | | | | | (0.159) |
| Constant | -0.0268 | 1.946** | -0.0553 | -0.0956 | 0.511 |
| | (0.842) | (0.815) | (0.850) | (0.562) | (0.911) |
| Observations | 143 | 143 | 143 | 143 | 143 |
| R-squared | 0.550 | 0.594 | 0.525 | 0.515 | 0.514 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Finally, I want to see whether these effects remain when controlling for real wage and lagged real wage. Table 16's results show that when controlling for real wage the net effects of food and energy prices have the same net effect on consumers' inflation expectations as before (when controlling for the lagged values of *good* variables). With these controls, real wage still

generally has a statistically significant negative effect. However, this effect is largely offset by the positive coefficients for the lagged value of *real*.

Table 16: Base Model, Lagged Variables Included, Real Wage Control

| mich | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| food | 0.408*** | | | | |
| | (0.137) | | | | |
| foodlag1 | -0.397*** | | | | |
| | (0.139) | | | | |
| real | -0.0547* | -0.0432 | -0.0639* | -0.0629* | -0.0690** |
| | (0.0313) | (0.0337) | (0.0340) | (0.0322) | (0.0308) |
| reallag1 | 0.0580* | 0.0445 | 0.0766** | 0.0703** | 0.0730** |
| | (0.0333) | (0.0365) | (0.0366) | (0.0343) | (0.0329) |
| rate | 0.200 | 0.226 | 0.209 | 0.213 | 0.218 |
| | (0.236) | (0.254) | (0.273) | (0.263) | (0.270) |
| ratelag1 | 0.102 | 0.0719 | 0.118 | 0.0654 | 0.119 |
| | (0.228) | (0.245) | (0.262) | (0.257) | (0.268) |
| energy | | 0.0209** | | | |
| | | (0.00918) | | | |
| energylag1 | | -0.00950 | | | |
| | | (0.00923) | | | |
| health | | | 0.0585 | | |
| | | | (0.312) | | |
| healthlag1 | | | -0.0385 | | |
| | | | (0.309) | | |
| house | | | | -0.0534*** | |
| | | | | (0.0198) | |
| houselag1 | | | | 0.0579*** | |
| | | | | (0.0201) | |
| rent | | | | | -0.0266 |
| | | | | | (0.151) |
| rentlag1 | | | | | 0.0379 |
| | | | | | (0.154) |
| Constant | -1.415 | -0.143 | -3.839 | -1.363 | -1.554 |
| | (2.823) | (2.550) | (2.995) | (3.118) | (2.913) |
| Observations | 143 | 143 | 143 | 143 | 143 |
| R-squared | 0.562 | 0.573 | 0.484 | 0.502 | 0.498 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

My final test is to see whether these dynamics remain when controlling for broader trends in consumers' inflation expectations over the years. For this purpose, I control for time

fixed effects in my base model. I begin by adding time fixed effects to my adaptive expectations model. The results are in Table 17:

Table 17: Adaptive Expectations Model

| mich | Adaptive |
|---|---|
| aπ | 0.0745 |
| | (0.286) |
| Constant | 7.001*** |
| | (0.786) |
| Observations | 140 |
| R-squared | 0.869 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

While I found that consumers' inflation expectations are effected by previously observed inflation had a statistically significant positive effect on consumers' inflation expectations, this relationship vanishes when controlling for time fixed effects. Similarly, as Table 18 displays, price levels largely lose their significance when controlling for time fixed effects, with only *energy* maintains its significance. That being said, *energy*'s coefficient is higher than in my base model, which leads to an average effect of a 3.14% increase in consumers' inflation expectations. As Tables 18 and 19 show, this effect remains even when controlling for nominal and real wages.

Table 18: Base Model, Time Fixed Effects

| mich | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| food | -0.0267 | | | | |
| | (0.0264) | | | | |
| rate | 0.162*** | 0.143*** | 0.170*** | 0.174*** | 0.158*** |
| | (0.0519) | (0.0498) | (0.0560) | (0.0563) | (0.0521) |
| energy | | 0.0223*** | | | |
| | | (0.00437) | | | |
| health | | | -0.00234 | | |
| | | | (0.0431) | | |
| house | | | | -0.00632 | |
| | | | | (0.00820) | |
| rent | | | | | -0.0242 |
| | | | | | (0.0181) |
| Constant | 9.502*** | 5.523*** | 7.137*** | 7.677*** | 9.205*** |
| | (2.280) | (0.702) | (1.201) | (1.108) | (1.511) |
| Observations | 144 | 144 | 144 | 144 | 144 |
| R-squared | 0.949 | 0.959 | 0.948 | 0.948 | 0.949 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 19: Base Model, Time Fixed Effects, Nominal Wage Control

| mich | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| food | -0.0227 | | | | |
| | (0.0500) | | | | |
| nom | -0.0582 | -0.643*** | -1.317** | -0.251 | 0.253 |
| | (0.526) | (0.239) | (0.578) | (0.422) | (0.714) |
| rate | 0.162*** | 0.123*** | 0.174*** | 0.166*** | 0.156*** |
| | (0.0522) | (0.0444) | (0.0529) | (0.0532) | (0.0529) |
| energy | | 0.0255*** | | | |
| | | (0.00384) | | | |
| health | | | 0.193** | | |
| | | | (0.0831) | | |
| house | | | | -0.00307 | |
| | | | | (0.0121) | |
| rent | | | | | -0.0403 |
| | | | | | (0.0451) |
| Constant | 9.555*** | 9.918*** | 11.61*** | 9.170*** | 8.795*** |
| | (2.218) | (1.684) | (2.346) | (2.130) | (2.092) |
| Observations | 144 | 144 | 144 | 144 | 144 |
| R-squared | 0.949 | 0.962 | 0.951 | 0.949 | 0.949 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 20: Base Model, Time Fixed Effects, Real Wage Control

| mich | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| food | -0.0270 | | | | |
| | (0.0257) | | | | |
| real | -0.0201 | 0.0120 | -0.0201 | -0.0186 | -0.0177 |
| | (0.0175) | (0.0145) | (0.0174) | (0.0183) | (0.0180) |
| rate | 0.151*** | 0.147*** | 0.158*** | 0.163*** | 0.149*** |
| | (0.0506) | (0.0501) | (0.0540) | (0.0550) | (0.0512) |
| energy | | 0.0241*** | | | |
| | | (0.00433) | | | |
| health | | | -0.00790 | | |
| | | | (0.0419) | | |
| house | | | | -0.00536 | |
| | | | | (0.00821) | |
| rent | | | | | -0.0219 |
| | | | | | (0.0186) |
| Constant | 16.06*** | 1.498 | 13.81** | 13.64** | 14.76*** |
| | (5.870) | (4.754) | (5.493) | (5.536) | (5.481) |
| Observations | 144 | 144 | 144 | 144 | 144 |
| R-squared | 0.950 | 0.959 | 0.949 | 0.949 | 0.950 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

**Section 5: Discussion**

As stated earlier, this paper has four goals. The first is to see if the adaptive expectations hypothesis applies to consumers' inflation expectations. Friedman argues that people assume that inflation will be the same as previously observed inflation, and uses the metric of average inflation from the past four quarters to measure expected inflation. When testing this hypothesis with consumers' inflation expectation, I initially find that average observed inflation does have a statistically significant positive effect. While Friedman's theory would suggest a 1% increase in consumers' inflation expectations for every 1% increase in observed inflation, my regressions shows a 1.4% increase in consumers' inflation expectations for every 1% increase in average observed inflation. This is not a surprise, as summary statistics show that consumers generally expect inflation to be higher than it actually is. That being said, this relationship vanishes when

controlling for time fixed effects. This suggests that Coibion and Gorodnichenko (2013) are correct in their assumption that consumers are rationally inattentive and do not rely upon aggregate economic data when forming their expectations.

This paper's second goal is to identify which prices have the largest effect on consumers' inflation expectations. While Coibion and Gorodnichenko (2013) find that changes in prices from quarter to quarter have a large, significant effect on consumers' inflation expectations, my results find the changes' effects to be statistically significant but negligible; there is also the surprising finding that *housedif* 's effect is statistically significant but negative. My results suggest that price levels, not changes in price, have the largest effect on consumers' inflation expectations, as my base model finds that all *good* variables have a statistically significant positive effect on consumers' inflation expectations. By comparing these coefficients to good variables' mean values, I find that on average the values of *food* and *rent* have the largest effect on consumers' inflation expectations. However, when controlling for time fixed effects, only *energy*'s coefficient is statistically significant. This is likely due to the fact that the price of energy, particularly oil, can be extremely volatile; this is demonstrated by the extreme maximum and minimum values of *energydif*, as well as its high standard deviation, listed in my summary statistics. As energy prices can fluctuate, it makes sense that consumers' inflation expectations would be sensitive to these changes; this finding supports Coibion and Gorodnichenko's (2013) finding that consumers' inflation expectations are extraordinarily sensitive to the price of oil, as I find an average increase of 3.14% in consumers' inflation expectations based on *energy*'s level

This paper's third goal is to see if price levels still have a significant effect on consumers' inflation expectations when controlling for wages. My fixed effects model finds that *energy*'s coefficient is still significant when controlling for both nominal and real wages. This paper's

final goal is to see if the Federal Reserve can use monetary policy to affect consumers' inflation expectations. My base and fixed effects models find that the federal funds rate, while statistically significant, has a positive effect. This suggests that consumers are either not rational actors, largely ignorant of the effects of monetary policy, or both. This is backed up by the fact that consumers' inflation expectations are unaffected by changes in the federal funds rate, as well as all measures of inflation targeting. These findings suggest that the Federal Reserve is unable to curb consumers' inflation expectations using monetary policy as they would hope.

**Section 6: Conclusion**

My paper makes two important contributions to the literature. Firstly, it confirms that consumers are rationally inattentive, as their expectations are insensitive to observed inflation and monetary policy when controlling for time fixed effects. Secondly, it supports Coibion and Gorodnichenko's (2013) findings, as I find that the price of energy has a large significant effect on consumers' inflation expectations, with an average 3.14% increase in consumers' inflation expectations. I hypothesize that this increased sensitivity to energy prices is due to these goods' volatility. As much of this volatility is a consequence of the United States' reliance on importing oil from the Organization of Petroleum Exporting Countries (OPEC), this finding suggests that increased energy independence would help to anchor consumers' inflation expectations. The federal government has a large number of options for approaching this goal. One immediate pathway could be the loosening of regulations on tapping America's own oil and natural gas reserves; such actions are likely under the Trump Administration. But if the United States is to avoid the negative environmental externalities of these expansions, policymakers should also consider investing in the expansion of renewable energy sources such as solar power and wind.

That being said, such expansions would be less likely to have the immediate effect on consumers' inflation expectations.

There are a number of ways in which future researchers can expand on my work. The first step would be to employ a VAR model to capture potentially unobserved dynamic relationships. However, this is a first step. A researcher with enough resources should expand upon my findings with their own original work at the individual level. I would recommend an experiment where participants are surveyed on their inflation expectations every month, but are gradually educated on basic monetary policy; they would also be required to take in a specific regiment of economic news. The purpose of this experiment would be to see if the addition of low levels of education on monetary policy can help anchor consumers' expectations the way the Federal Reserve desires to. Finally, I believe it would be worthwhile to study the effects of changes in the rhetoric of politicians and popular news personalities on consumers' inflation expectations. As my paper suggests that consumers are largely irrational, such a study could help explain long term trends in consumers' inflation expectations.

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