

Are People Aware of the Taylor Rule?*

[Preliminary and incomplete; please do not quote without permission]

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Abstract

We combine questions from the Michigan Survey about the future path of prices, interest rates, and unemployment to investigate whether U.S. households are aware of the so-called Taylor (1993) rule. For comparison, we perform the same analysis using questions from the Survey of Professional Forecasters. Our findings support the view that some households form their expectations about the joint future path of interest rates, inflation, and unemployment in a way that is consistent with Taylor-type rules. The extent to which this happens, however, does not appear to be uniform across income and education levels. In particular, we find evidence that the relationship between unemployment and interest rates is not properly understood by households in the lowest income quartile, and by no-high-school-diploma households.

JEL classification codes: E52, E58

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1 Introduction

Most questions of interest to macroeconomists have a dynamic dimension. This is the main reason why the issue of how economic agents form expectations is so central to macroeconomics. In particular, agents' understanding of how policies that affect their decisions are conducted is a key ingredient in the transmission mechanism of such policies. For example, underlying the so-called "Taylor principle" that the monetary authority should respond to deviations of inflation from target by moving the policy interest rate "aggressively" is the fact that agents understand that policy will be conducted accordingly in the future. It is the interaction between the actual conduct of policy and agents' understanding of it which jointly determines the behavior of the economy in monetary, dynamic, stochastic, general-equilibrium models that are often used for policy analysis (see, e.g., Woodford 2003).

Since the work of Taylor (1993), it became standard practice to posit that the Fed conducts monetary policy according to an interest-rate ("Taylor") rule that specifies a target for the federal funds rate as a function of deviations of inflation from a target and some measure of slack in economic activity, such as the output gap. Estimating such policy reaction functions is the focus of a large empirical literature in monetary economics.¹ Overall, Taylor-type interest-rate rules are seen as a reasonable description of how policy has been conducted in the U.S. during most of the time since the late 80s.² However, there is much less empirical work on the question of how agents perceive the conduct of monetary policy. Perhaps this is the case because these perceptions are not directly observed, nor surveyed directly.

In this paper we investigate whether economic agents - households in particular - are aware of how monetary policy is conducted in the U.S. Specifically, if they are aware of what we refer to as the *stabilization principles underlying the Taylor rule*: that the policy rate tends to increase with inflation and decrease with slack in economic activity.³ Most of the time, these principles provide a qualitative description of how the Fed pursues its so-called "dual mandate" of price stability and full employment. To address the question, we make use of the Survey of Consumers, conducted by the Michigan University and known as the "Michigan Survey", combining questions about the future path of prices, interest rates, and unemployment.

One difficulty we face is that, while one of the questions in the survey about the path of prices is quantitative, questions about the paths of interest rates and unemployment are categorical in

¹For a survey, see Hamalainen (2004).

²See, e.g., Judd and Rudebusch (1998). At times, however, monetary policy seems to deviate more substantially from what Taylor rules would imply (e.g., Pesenti 2008).

³These principles are not to be confused with the aforementioned "Taylor principle", which refers to the strength of the interest-rate response to changes in inflation.

nature – about whether these variables will move up or down. We address this data limitation by adopting a simple empirical approach that, at an intuitive level, is based on the idea of separating answers about the joint paths of inflation, interest rates, and unemployment that are consistent with the stabilization principles underlying the Taylor rule from those that are not. To fix ideas, imagine that the Fed’s target for the Federal Funds Rate depends positively on contemporaneous inflation and negatively on contemporaneous unemployment, and only changes with these two variables. Then, in order to be consistent with how the Fed conducts monetary policy, answers that unemployment will go down and inflation will go up in one year would necessarily have to be accompanied by an answer that the Fed will tighten monetary policy in the same period. Likewise, answers that inflation will drop and unemployment will go up must be associated with a call that the Fed will ease policy.

More generally, however, an answer that is inconsistent with a particular version of the Taylor rule need not imply a misunderstanding of how monetary policy is conducted. The reason is that no specific interest-rate rule is a perfect description of policy.⁴ To address this issue and provide answers to our research question that can be relied on more generally, we look for consistency in households’ answers in a way that is less restrictive than the test illustrated in the previous paragraph. Specifically, we test whether various empirical frequencies of households’ responses about the future paths of interest rates, inflation, and unemployment differ from each other in a way that is consistent with the principles underlying the Taylor rule. To give a concrete example of our empirical approach, given a response about future inflation, we test if forecasts that interest rates will go up are more prevalent among households who forecast unemployment to decline than among those who predict the opposite.

To help in the interpretation of our results for the Michigan Survey, we apply the same consistency tests using forecasts from the Survey of Professional Forecasters (SPF), conducted by the Federal Reserve Bank of Philadelphia. We take the view that professional forecasters are likely aware of how monetary policy is conducted in the U.S., and use results based on this survey as a reference against which to judge the findings based on the Michigan Survey. Finally, as an additional set of results that can help us interpret our findings, we analyze an artificial survey in which the questions on the direction of interest rates, inflation, and unemployment are answered by an unrestricted three-variable vector-autoregression (VAR). The VAR is estimated using rolling windows, and then used to construct the forecasts of interest rates, inflation, and unemployment at each month. The results are then used to generate model-based answers to questions analogous

⁴For example, if the Taylor rule involves interest-rate smoothing (i.e., if it includes lags of the policy rate), a given forecast for inflation and unemployment can be consistent with different forecasts for the policy rate, depending on its past trajectory.

to those that the Michigan Survey asks its participants.

Our sample runs from August 1987 to December 2007. Our choice for the start of the sample is driven by the fact that August 1987 marks the beginning of Alan Greenspan's tenure as Chairman of the Federal Reserve Board, during which the Taylor rule came to be seen as a good description of U.S. monetary policy. We end the sample in December 2007 mainly because the questions we use from the Michigan Survey pertain to 12-month forecasts, and during 2008 short-term interest rates in the U.S. started to diverge significantly from predictions by Taylor-type rules, until essentially hitting the zero bound at the end of that year.

The results we obtain are broadly consistent with the view that some U.S. households are aware of the principles underlying the Taylor rule when forming their expectations about the joint future path of interest rates, inflation, and unemployment. The degree of awareness, however, does not appear to be uniform across income and education levels, nor symmetric across predicted movements for interest rates. Our findings support the view that households are generally aware of how monetary policy tends to respond to changes in inflation. When it comes to unemployment, however, we find that answers by households in the lowest income quartile and by no-high-school-diploma households do not reveal the expected relationship between changes in that variable and changes in interest rates. In fact, their answers are consistent with the opposite relationship. Finally, answers by households in the upper quartile of the income distribution, and households with a college degree only reveal a statistically significant relationship between *increases* in unemployment and *decreases* in interest rates.

Applying the same analysis to the SPF, we find the expected relationship between predicted changes in unemployment and predicted changes in interest rates. Surprisingly, however, we do not find statistically significant evidence of the expected relationship between predicted changes in interest rates and predicted changes in inflation. This result is troubling because in the Michigan Survey the expected relationship between interest rates and inflation shows up even in the responses of low-income and no-high-school-diploma households. We then entertain the possibility that professional forecasters consider core inflation to be a more important factor than headline inflation in recent monetary policy decisions. Fortunately, since 2007 the SPF includes forecasts of core inflation – in addition to headline inflation. Despite the small number of observations that include forecasts of core inflation (only one year of data in our sample), our analysis based on the latter provides statistical support for the view that professional forecasters' answers are consistent with the stabilization principles underlying the Taylor rule in both of its unemployment and (core) inflation dimensions.

A few recent papers investigate whether professional economists' and financial market partici-

pants' forecasts of interest rates, inflation, and output growth or some other measure of economic activity conform with Taylor-type interest-rate rules. Mitchell and Pearce (2009) analyze the Wall Street Journal's semi-annual survey of professional economists, and Fendel et al. (2011) rely on the Consensus Economic Forecast poll for the G7 countries. Both papers estimate Taylor rules by panel regressions using numerical forecasts, and address quantitative questions such as whether the estimated coefficient on inflation is greater than unity. Schmidt and Nautz (2010) also use forecasts from financial market experts, but their panel data from the ZEW Financial Market Survey are categorical in nature – the expected direction of changes in interest rates, inflation, and in the economic situation in the Euro zone. They focus on the accuracy of interest-rate forecasts, and on decomposing forecast errors into forecast errors of inflation and economic activity, and errors due to misunderstanding of how the European Central Bank conducts monetary policy. These three papers are thus related to our analysis of the SPF, although our approach is somewhat different because we tailor it to serve as a benchmark for our analysis of the Michigan Survey, which is the focus of the paper.

In Section 2 we start by describing the data we use in our analysis. Section 3 reports our results, contrasting the findings for the Michigan Survey with those for the SPF, and the ones based on the estimated VARs. This section also presents our analysis by demographic groups in the Michigan Survey, and robustness analyses in some important dimensions. Section 4 presents a simple framework to motivate our empirical approach. We also provide a discussion of issues such as how to think about endogeneity and causality within this framework. The last section concludes.

2 Data, framework, and empirical approach

2.1 Survey data

We use two independent survey data sources. Given our primary focus on households, the main data set used in our analysis is the Michigan Survey. Our second data source is the Survey of Professional Forecasters (SPF). For comparison, we also construct an artificial survey data in which the questions on the direction of interest rates, inflation, and unemployment are answered by a statistical model based on an unrestricted three-variable vector autoregressive process (VAR).

2.1.1 Michigan Survey

Each month the Michigan Survey conducts telephone interviews with a minimum of 500 households, and asks around 50 questions. The questionnaire covers personal finances, demographics, business

conditions, and key, to this paper, it also inquires about households' expectations about main economic variables, such as interest rates, inflation, and unemployment. The sample choice is statistically designed to represent all American households, and survey weights are provided to allow for inference on the population.⁵ At each month, a cross-section independent sample of households is selected and the respondents are re-interviewed six months later. Under this rotating sample method, at each survey around 40% of households are being interviewed for the second time and 60% are new respondents.⁶ The monthly survey data begins in January 1978. Besides the inclusion of new questions, no substantial changes have been made to the pre-existent questionnaire since that time.

Our interest-rate variable corresponds to the answer to the following survey question:

“No one can say for sure, but what do you think will happen to interest rates for borrowing money during the next 12 months – will they go up, stay the same, or go down?”

For unemployment, we consider the answer to the question:

“How about people out of work during the coming 12 months – do you think that there will be more unemployment than now, about the same, or less?”

Households are not directly inquired about inflation, but instead about the direction of price movements and its expected size. In particular, they answer the following two questions:

“During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?” and *“By about what percent do you expect prices to go (up/down) on the average, during the next 12 months?”*

We are interested in whether U.S. households's perceptions of how monetary policy operates are in accordance with the principles underlying the Taylor rule. Unfortunately, the Michigan Survey does not include explicit questions about slack in economic activity – only about unemployment, which, because of fluctuations in the unobservable unemployment rate that would correspond to full employment, need not vary one-to-one with measures of economic slack. Moreover, the questions about interest rates and unemployment refer to 12-month changes, whereas the quantitative question about the future path of prices amounts to a question about the *level* of 12-month inflation. Finally, the survey is not explicit about the measures that the questions pertain to.

In order to use the available questions to study the question we are interested in, we make the following assumptions. To deal with the fact that the question about interest rates pertains to “interest rates for borrowing money”, and does not specify the measure it refers to, we simply

⁵Throughout this paper, all statistics from the Michigan Survey are weighted, unless stated otherwise. Hence they refer to the U.S. population of households.

⁶We chose to keep the repeated interviews and assume them as independent. For robustness, we repeat all steps of the empirical analysis below described after dropping the repeated interviews and results are unchanged (unreported for brevity).

assume that the answers to an analogous question about the policy rate would be the same. This is a good assumption as long as the spread between the borrowing rates that the household has in mind when answering the survey question and the policy rate does not vary “too much”. In Subsection 3.2.2 we verify that our findings are little changed if we restrict attention to periods in which borrowing rates and the policy rate move in the same direction. Regarding unemployment, under the assumption that it varies significantly more than the unobserved level of unemployment that corresponds to full employment, the direction of change of unemployment should map one-to-one into the direction of change in measures of slack in economic activity.

The question related to the path of prices is slightly trickier. First, it does not specify a specific price measure. We assume it refers to the level of the headline Consumer Price Index. Second, it refers to the path for the general *level* of prices in the next 12 months, and not to expected changes in 12-month inflation. We thus construct artificial responses to a question about the direction of 12-month inflation by subtracting the CPI inflation in the 12 months leading up to the month of the survey from each individual response. We then convert the resulting numbers into an answer about the direction of CPI inflation by assigning a value of one when households’ 12-month inflation forecast exceeds inflation in the 12 months up to and including the month of the survey, zero if these two numbers coincide, and -1 otherwise. We convert the categorical answers about interest rates and unemployment in the same way.

Thus, conditional on our assumptions, we have answers to questions about the sign of expected 12-month changes in interest rates, inflation, and unemployment. The Michigan Survey also provides demographic characteristics about respondents. This allows us to redo our analysis conditional on specific characteristics. In particular, we will focus on levels of education and income.

The sample period for our analysis starts in August 1987 and ends in December 2007. The starting point coincides with the beginning of Alan Greenspan’s tenure as Chairman of the Federal Reserve Board, during which the Taylor rule came to be seen as a good description of U.S. monetary policy. The sample ends in December 2007 because the questions we use from the Michigan Survey pertain to 12-month forecasts, and at the end of 2008 short-term interest rates in the U.S. had essentially hit the zero bound. Moreover, as discussed above the question about interest rates in the Michigan Survey refers to borrowing rates, which diverged markedly from short-term low-risk rates during most of 2008.

2.1.2 Survey of Professional Forecasters

The SPF is conducted at a quarterly frequency and dates from the last quarter of 1968, when it was implemented by the American Statistical Association and the National Bureau of Economic Research. Since the second quarter of 1992, the SPF has been conducted by the Federal Reserve Bank of Philadelphia. The sample size varies from year to year, with the Survey interviewing an average of 138 forecasters per year. In addition, the questionnaire has changed somewhat since the start date of the survey, with several questions being added. At each quarter, respondents receive the questionnaire, which has to be filled and returned within a pre-established deadline. The Survey covers expectations about several inflation, economic activity, unemployment, and interest-rate measures. Respondents are also required to provide their quarterly and yearly forecasts for time frames that vary from 1 year to 3 years ahead.

Differently from the Michigan Survey, the SPF inquires agents about their expectations for future *levels* of interest rates, inflation, and unemployment. In particular, respondents are asked to provide their forecast for the next four quarters for well-specified measures of each of the three variables of interest. We focus on forecasts for the 3-month Treasury Bill rate, CPI inflation, and the urban civilian unemployment rate. In order to make our results based on the SPF comparable to the Michigan Survey, we build categorical variables indicating whether the respondents expect the variable to move up, down, or stay the same. For CPI inflation, we average across agents' forecasts for the next four quarters, and subtract realized inflation in the four quarters up to and including the quarter of the survey.

2.1.3 Artificial survey based on statistical model

To help in the interpretation of our results, we also construct an artificial survey in which the questions about the direction of interest rates, inflation, and unemployment are answered by a statistical model. Specifically, we use an unrestricted three-variable VAR with the 3-month Bill rate, 12-month CPI inflation, and the unemployment rate, including 4 lags of each variable. The VAR is estimated using 5-year rolling windows, and then used to construct forecasts of the changes in those three variables in the subsequent 12 months. The differences between the forecasts and the “current” monthly values are then converted into categorical variables indicating the direction of change for the variables, thus providing the answers to the hypothetical survey questions about whether they will move up, down, or stay the same over this time period.

The probability that a VAR forecast for one of these variables will coincide with any of the observed monthly values is essentially zero, so we define thresholds for each of the three variables to create an interval over which the forecasted change will produce a response that the variable will

remain unchanged. We calibrate these up- and down-thresholds for each variable (six parameters in total) in order to match the unconditional frequencies of up/down/same responses in the Michigan Survey as closely as possible. We then run our analysis of the partial effects of inflation and unemployment using the categorical answers thus constructed.

2.2 Empirical approach

As a first step in our analysis we perform a simple test for the presence of a statistical relationship between interest rates, inflation, and unemployment. Specifically, we use the Kolmogorov-Smirnov test for equality of two distributions to test whether the empirical frequencies of responses about the direction of interest rates conditional on the responses about the direction of inflation and unemployment differ statistically from the unconditional frequencies. We then test if whatever relationship between expected movements of interest rates and expected movements of inflation and unemployment exists in the data is consistent with the stabilization principles underlying the Taylor rule.

To ease the exposition of what we actually test for, we introduce some notation. For a given pool of answers about the direction of change of interest rates, inflation, and unemployment in the subsequent 12 months, let $\mathcal{P}(x \uparrow)$ denote the fraction of answers that indicate that variable x will increase. We refer to $\mathcal{P}(x)$ as the (unconditional) empirical frequency of 12-month changes in x . Likewise, when it comes to conditional frequencies, we use $\mathcal{P}(x \downarrow | y \uparrow, z \leftrightarrow)$ to denote the conditional empirical frequency that x will decrease in the next 12 months, given that y increases and z remains unchanged over the same period.

With this notation, we define the *partial effects of inflation and unemployment* that follow from what we refer to as the stabilization principles underlying the Taylor rule:

$$\mathcal{P}(i \uparrow | \pi \uparrow, u) - \mathcal{P}(i \uparrow | \pi \leftrightarrow, u) \geq 0; \quad \mathcal{P}(i \uparrow | \pi \leftrightarrow, u) - \mathcal{P}(i \uparrow | \pi \downarrow, u) \geq 0, \quad (1)$$

$$\mathcal{P}(i \downarrow | \pi \downarrow, u) - \mathcal{P}(i \downarrow | \pi \leftrightarrow, u) \geq 0; \quad \mathcal{P}(i \downarrow | \pi \leftrightarrow, u) - \mathcal{P}(i \downarrow | \pi \uparrow, u) \geq 0, \quad (2)$$

$$\mathcal{P}(i \uparrow | \pi, u \downarrow) - \mathcal{P}(i \uparrow | \pi, u \leftrightarrow) \geq 0; \quad \mathcal{P}(i \uparrow | \pi, u \leftrightarrow) - \mathcal{P}(i \uparrow | \pi, u \uparrow) \geq 0, \quad (3)$$

$$\mathcal{P}(i \downarrow | \pi, u \uparrow) - \mathcal{P}(i \downarrow | \pi, u \leftrightarrow) \geq 0; \quad \mathcal{P}(i \downarrow | \pi, u \leftrightarrow) - \mathcal{P}(i \downarrow | \pi, u \downarrow) \geq 0. \quad (4)$$

The differences in (1) and (2) are the partial effects of inflation that we test for. For example, for any given forecasted change in unemployment u (\uparrow , \downarrow , or \leftrightarrow), going from a pool of households that predict stable inflation to a pool that predicts increasing inflation should increase the incidence of answers saying that interest rates will go up, and decrease the incidence of forecasts that interest rates will trend down. Likewise, inequalities in (3) and (4) define the partial effects of

unemployment that we test for.⁷ For each of the partial effects defined in (1)-(4), we set up a one-sided test where the null hypothesis is the inequality that violates the stabilization principles underlying the Taylor rule (i.e., that contradicts those partial effects). Rejection of a null hypothesis thus amounts to evidence that the particular partial effect being tested conforms with those stabilization principles.

3 Results

3.1 Realized data

We start by illustrating our empirical approach using the actual monthly data on the 3-month Treasury Bill rate, 12-month CPI inflation, and the unemployment rate for the sample period defined in Subsection 2.1.1. We caveat at the outset that some of the conditional frequencies that we need to estimate are based on a small number of observations, and some are even degenerate. Still, we choose to illustrate our empirical approach subject to these limitations, as this also serves the additional purpose of providing evidence that the stabilization principles underlying the Taylor rule are discernible in the data when we apply our empirical approach.

The top half of Table 1 documents the (unconditional) frequency of upward and downward movements in each of the three variables, whereas the bottom half of the table reports the frequency of the direction of interest-rate changes conditional on combinations of movements in inflation and unemployment.⁸ In line with the notation defined in Subsection 2.2, we use $\mathcal{P}(x)$ and $\mathcal{P}(x | y \uparrow, z \downarrow, w \leftrightarrow)$ to denote, respectively, the unconditional empirical frequencies of the direction of 12-month changes in variable x , and the conditional empirical frequencies of the direction of 12-month changes in variable x , given that y increases, z decreases, and w remains unchanged over the same period. Note that the number of observations in the conditional frequencies $\mathcal{P}(i | \pi \uparrow, u \leftrightarrow)$ and $\mathcal{P}(i | \pi \downarrow, u \leftrightarrow)$ is extremely small. In what follows we drop these two distributions and perform our tests based on partial effects that only involve frequencies that condition on answers that unemployment will move up ($u \uparrow$) or down ($u \downarrow$). Equations (5) and (6) measure the partial effects of inflation defined by equations (1) and (2), after dropping the few occurrences of unchanged unemployment. Equivalently, equations (7) and (8) measure the partial effects of unemployment and

⁷We can also use combinations of the directions of change in inflation and unemployment to perform additional inequality tests. We present these in the Appendix.

⁸Episodes that are conditional on 12-month inflation remaining constant do not appear because this is never observed in our sample.

correspond to equations (3) and (4) after dropping the occurrences of unchanged unemployment.

$$\mathcal{P}(i \uparrow | \pi \uparrow, u) - \mathcal{P}(i \uparrow | \pi \downarrow, u) \geq 0, \quad (5)$$

$$\mathcal{P}(i \downarrow | \pi \downarrow, u) - \mathcal{P}(i \downarrow | \pi \uparrow, u) \geq 0, \quad (6)$$

$$\mathcal{P}(i \uparrow | \pi, u \downarrow) - \mathcal{P}(i \uparrow | \pi, u \uparrow) \geq 0, \quad (7)$$

$$\mathcal{P}(i \downarrow | \pi, u \uparrow) - \mathcal{P}(i \downarrow | \pi, u \downarrow) \geq 0. \quad (8)$$

Table 1: Empirical frequencies – data (%)

	Unconditional frequencies			
	↓	↔	↑	
$\mathcal{P}(i)$	58.78	-	41.22	
$\mathcal{P}(\pi)$	47.76	-	52.24	
$\mathcal{P}(u)$	60.41	3.27	36.33	
	Conditional frequencies			#Obs
	↓	↔	↑	
$\mathcal{P}(i \pi \uparrow, u \downarrow)$	22.78	-	77.22	79
$\mathcal{P}(i \pi \uparrow, u \leftrightarrow)$	100.00	-	0.00	3
$\mathcal{P}(i \pi \uparrow, u \uparrow)$	100.00	-	0.00	46
$\mathcal{P}(i \pi \downarrow, u \downarrow)$	43.48	-	56.52	69
$\mathcal{P}(i \pi \downarrow, u \leftrightarrow)$	80.00	-	20.00	5
$\mathcal{P}(i \pi \downarrow, u \uparrow)$	100.00	-	0.00	43

Table 1 presents conditional and unconditional frequencies in the data. Kolmogorov-Smirnoff tests based on these frequencies suggest that, unsurprisingly, changes in interest rates, inflation, and unemployment are statistically related. For brevity we defer all results based on Kolmogorov-Smirnoff tests to the Appendix.

Table 2 report one-sided tests of the partial effects of inflation and unemployment.⁹ Note that we use overlapping 12-month periods, and thus we compute the standard errors based on a block-bootstrap procedure. In the absence of a guide to pick the block length, we choose the window length between one and 12 months that roughly maximizes the standard errors, which yields 6 months. For consistency, throughout the paper we report standard errors obtained by block-bootstrap with a 6-month window.¹⁰ All of the partial effects are statistically significant, and in line with the principles underlying the Taylor rule.

⁹The entries with dashes correspond to cases that involve degenerate distributions. The symmetry in the table comes from the fact that in the data interest rates always move (either up or down) in 12-month periods, and so the events $i \uparrow | \cdot$ and $i \downarrow | \cdot$ constitute a partition of the universe of possible outcomes in all of the conditional distributions.

¹⁰Statistical tests with block-bootstrapped standard errors using windows that vary from 1 to 12 months yield essentially the same results, and are available upon request.

Table 2: Partial effects – data

Partial effects of inflation			
Null Hypothesis	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.21	1.69	0.05
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	-	-	-
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.21	1.69	0.05
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	-	-	-
Partial effects of unemployment			
Null Hypothesis	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	0.57	6.09	0.00
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.77	8.68	0.00
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.57	6.09	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.77	8.68	0.00

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 6-month window.

3.2 Michigan Survey

Table 3 reports the unconditional and conditional frequencies of households' responses regarding the expected changes in interest rates, inflation, and unemployment, in analogy with Table 1. A striking difference relative to the empirical distributions based on the realized data is the unconditional frequency of responses about the direction of changes in unemployment. While households got it roughly right that unemployment would increase slightly more than one third of the time during our sample, more than half of their responses indicated that unemployment would be unchanged after 12 months – whereas in reality this only happened around 3% of the time. The discrepancy in the distribution of answers about changes in interest rates is smaller, but also noteworthy. Answers about inflation fare better in this comparison. These discrepancies notwithstanding, the Michigan Survey provides evidence that answers to those two questions provide useful information about economic developments over time. In particular, the difference between the fraction of responses predicting increases and the fraction of responses predicting decreases in interest rates and unemployment commove quite strongly with, respectively, the annual percentage point change in the prime borrowing rate and the annual percentage point change in the unemployment rate.¹¹

The bottom half of Table 3 reports the conditional frequencies of movements in interest rates based on households' responses. They also appear to be quite different from the corresponding empirical distributions based on realized data. These differences may reflect poor forecasting performance and/or poor understanding of the relationship between inflation and unemployment on one side, and interest rates on the other side. In what follows we focus on whether we can use

¹¹See the material about the Survey available in <http://www.sca.isr.umich.edu/documents.php?c=i> (file Survey Description). For a critical view of the informational content of the answers regarding unemployment, see Tortorice (2011).

these answers to tease out information about how households perceive that relationship using the partial effects defined in the previous section. This question is of interest irrespective of whether households are good forecasters.

Table 3: Frequencies of responses – Michigan Survey (%)

	Unconditional frequencies			
	↓	↔	↑	
$\mathcal{P}(i)$	14.54	28.46	57.00	
$\mathcal{P}(\pi)$	46.47	-	53.53	
$\mathcal{P}(u)$	14.21	51.34	34.44	
	Conditional frequencies			#Obs*
	↓	↔	↑	
$\mathcal{P}(i \pi \uparrow, u \downarrow)$	12.73	26.36	60.90	7,411
$\mathcal{P}(i \pi \uparrow, u \leftrightarrow)$	10.72	28.73	60.55	27,611
$\mathcal{P}(i \pi \uparrow, u \uparrow)$	15.19	22.36	62.45	21,651
$\mathcal{P}(i \pi \downarrow, u \downarrow)$	15.32	33.05	51.63	7,736
$\mathcal{P}(i \pi \downarrow, u \leftrightarrow)$	14.48	33.61	51.90	27,084
$\mathcal{P}(i \pi \downarrow, u \uparrow)$	21.34	26.28	52.39	14,884

*Unweighted number of observations.

Table 4 report one-sided tests of the partial effects of inflation and unemployment perceived by households, given in equations (1) - (4). All of the partial effects of inflation are statistically significant, and in line with the principles underlying the Taylor rule. The same is not true of the partial effects of unemployment. In fact, only two out of the eight partial effects that we test for are consistent with the principles underlying the Taylor rule, and some of the tests actually provide statistically significant evidence in favor of partial effects with the opposite sign.

However, results for the partial effects of unemployment might be driven by distributions of responses that condition on answers that predict stable unemployment ($u \leftrightarrow$). Indeed, all of the partial effects involve one of those conditional distributions. To check whether they drive the results for the partial effects of unemployment, we redo the tests based on partial effects that only involve distributions that condition on answers that unemployment will move up or down, as described by equations (5)-(8).

The results of the one-sided tests are presented in Table 5 (for completeness we also redo the tests for the partial effects of inflation). They show that the statistically significant evidence against the perceived partial effects of unemployment being consistent with the Taylor rule does not hinge on the distributions that condition on forecasts of stable unemployment.

We conclude that households' perceived partial effects of inflation are consistent with the principles underlying the Taylor rule in all cases. For unemployment, however, this is not the case. There is statistical evidence that some of the partial effects of unemployment are consistent with those principles – those that pertain to interest-rate decreases. But there is also evidence that some of the perceived partial effects of unemployment are opposite to what the principles underlying the Taylor rule imply. These results might suggest that households do not perceive

Table 4: Partial effects – Michigan Survey

Partial effects of inflation			
Null Hypothesis:	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.09	6.65	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \leftrightarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \leftrightarrow)$	0.09	8.69	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.10	9.30	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.03	2.95	0.00
$\mathcal{P}(i \downarrow \pi \downarrow, u \leftrightarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \leftrightarrow)$	0.04	5.39	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.06	5.90	0.00
Partial effects of unemployment			
Null Hypothesis:	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \leftrightarrow)$	0.00	-0.30	0.62
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \leftrightarrow)$	-0.02	-1.34	0.91
$\mathcal{P}(i \uparrow \pi \downarrow, u \leftrightarrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	0.00	-0.24	0.59
$\mathcal{P}(i \uparrow \pi \uparrow, u \leftrightarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.00	0.33	0.37
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \leftrightarrow)$	-0.01	-1.02	0.85
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \leftrightarrow)$	-0.02	-2.92	1.00
$\mathcal{P}(i \downarrow \pi \downarrow, u \leftrightarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.07	5.71	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \leftrightarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.04	4.52	0.00

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 6-month window.

Table 5: Partial effects after “dropping $i | \pi, u \leftrightarrow$ ” – Michigan Survey

Partial effects of inflation			
Null Hypothesis	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.09	7.09	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.10	7.76	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.03	3.31	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.06	5.56	0.00
Partial effects of unemployment			
Null Hypothesis	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	-0.01	-0.33	0.63
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	-0.02	-0.78	0.78
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.06	3.77	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.02	1.86	0.03

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 6-month window.

the relationship between unemployment and interest rates symmetrically, failing to realize the effects that tightening labor market conditions appear to have on the probability of interest-rate increases. We explore this possibility further in the next subsection, where we redo our analysis pooling answer by households' demographic characteristics.

3.2.1 Demographics

We first focus on income and education levels, and then on age. We start by comparing results for the lowest and highest income quartiles, and for the groups of respondents with no high-school diploma, and those that have at least a college degree. For brevity we present the conditional and unconditional frequencies of responses in the Appendix, and exclude results that condition on forecasts of stable unemployment (results are robust to using those answers as well).

The first part of Table 6 shows the partial effects of inflation by, respectively, income and education levels. With few exceptions, they are statistically significant at the usual levels, and in accordance with the principles underlying the Taylor rule. The same is not true of the partial effects of unemployment. The second part of Table 6 shows that for low-income households there is only one statistically significant partial effect with the expected sign. In fact, two of the partial effects of unemployment for this demographic group show up as statistically significant with a sign that contradicts the stabilization principles underlying the Taylor rule. In contrast, all but one of the partial effects of unemployment come out as expected for households in the highest income quartile. Turning to education, for households without a high-school diploma only one partial effect of unemployment is statistically significant with the expected sign. In contrast, both partial effects of unemployment for interest-rate decreases come out as expected for households with at least a college degree.

Among the several demographic characteristics that the Michigan Survey provides, we report in Table 7 the partial effects of inflation and unemployment across age intervals of the head of the household. Heads with a higher age profile have experienced different economic environments, and are more likely to have learned about monetary policy over time. Indeed, the table shows that the highest age bracket is the only one for which all of the partial effects of unemployment come out consistent with the stabilization principles underlying the Taylor rule.

Table 6: Partial effects by income and education

Partial effects of inflation						
Null Hypothesis	Lowest income quartile			No high-school diploma		
	Mean diff	t-stat	p-value	Mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.12	5.65	0.00	0.11	3.68	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.10	6.82	0.00	0.11	6.56	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.03	1.55	0.06	0.02	1.33	0.09
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.06	5.26	0.00	0.05	3.83	0.00
Null Hypothesis	Highest income quartile			At least college degree		
	Mean diff	t-stat	p-value	Mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.09	3.89	0.00	0.08	4.02	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.11	6.49	0.00	0.10	5.21	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.02	2.01	0.02	0.03	2.17	0.01
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.07	4.12	0.00	0.08	4.83	0.00
Partial effects of unemployment						
Null Hypothesis	Lowest income quartile			No high-school diploma		
	Mean diff	t-stat	p-value	Mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	-0.06	-2.63	1.00	-0.02	-0.90	0.82
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	-0.04	-1.93	0.97	-0.03	-1.11	0.87
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.04	2.11	0.02	0.04	1.99	0.02
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.00	0.32	0.38	0.01	0.50	0.31
Null Hypothesis	Highest income quartile			At least college degree		
	Mean diff	t-stat	p-value	Mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	0.05	1.76	0.04	0.03	1.18	0.12
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.02	0.95	0.17	0.01	0.42	0.34
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.10	5.37	0.00	0.10	5.11	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.05	2.54	0.01	0.05	2.63	0.00

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 6-month window.

Table 7: Partial effects by age intervals

Partial effects of inflation						
Null Hypothesis	18 – 29 years			30 – 45 years		
	mean diff	t-stat	p-value	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.07	3.89	0.00	0.09	5.82	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.08	4.35	0.00	0.11	8.39	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.02	1.69	0.05	0.02	1.82	0.03
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.06	3.99	0.00	0.05	5.17	0.00
Null Hypothesis	46 – 60 years			60 – 80 years		
	mean diff	t-stat	p-value	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.11	4.02	0.00	0.11	5.76	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.10	5.45	0.00	0.10	6.05	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.03	2.29	0.01	0.03	2.47	0.01
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.07	4.34	0.00	0.06	4.06	0.00
Partial effects of unemployment						
Null Hypothesis	18 – 29 years			30 – 45 years		
	mean diff	t-stat	p-value	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	-0.04	-1.75	0.96	-0.03	-0.90	0.81
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	-0.05	-2.11	0.98	-0.05	-2.07	0.98
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.06	3.15	0.00	0.04	1.99	0.02
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.02	1.13	0.13	0.01	0.57	0.29
Null Hypothesis	46 – 60 years			60 – 80 years		
	mean diff	t-stat	p-value	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	-0.02	-0.66	0.75	0.03	1.53	0.06
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	-0.01	-0.37	0.64	0.04	1.90	0.03
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.06	2.91	0.00	0.08	5.32	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.02	0.84	0.20	0.06	4.29	0.00

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 6-month window.

3.2.2 Robustness

Information about borrowing rates As mentioned previously, the question about interest rates in the Michigan Survey pertains to households’ expectations about future borrowing rates. In our benchmark results we assume that the same answers would apply to expectations about the direction of policy rates. Here we redo our analysis of the partial effects of inflation and unemployment restricting the sample to 12-month periods in which borrowing rates and the policy rate moved in the same direction. We consider the 3-month Treasury bill rate as the policy rate, which is the measure that features in the question of the SPF that we use in our analysis.¹² As a proxy for borrowing rates, we consider the Freddie Mac national mortgage rate.¹³ Results based on this restricted sample are essentially unchanged. This is the case for both the analysis that pools all household answers, and for the findings based on answers by demographic groups. For brevity we only present here the results for overall partial effects of inflation and unemployment in Table 8, and show the analogous table by income and education groups in the Appendix.

Table 8: Partial effects of inflation accounting for movements in borrowing rates – Michigan Survey

Partial effects of inflation			
Null Hypothesis	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.10	7.42	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.10	6.99	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.03	2.81	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.06	4.79	0.00
Partial effects of unemployment			
Null Hypothesis	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	-0.01	-0.26	0.60
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	-0.01	-0.36	0.64
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.07	3.18	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.03	1.75	0.04

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 6-month window.

Inflation deciles For questions referring to unemployment and interest rates, the Michigan Survey only inquires about the direction of change. However, it inquires about households’ inflation expectations. We can thus re-estimate the partial effects of unemployment while holding fixed the expected change in inflation. To that end, we divide the expected change in inflation in 10 deciles, and estimate the partial effects of unemployment for each decile. While the results vary across deciles, as a general statement they confirm our baseline results (see Table 9). When

¹²Results are robust to using the effective Federal Funds Rate.

¹³Freddie Mac’s National Mortgage rates are the average of 125 lender’s rates who contributed rates to Freddie Mac. These rates are based on a 30 yr. fixed-rate mortgage, with 20% downpayment and 80% financed over the life of the loan.

Table 9: Partial effects of unemployment by inflation deciles

	decile 1			decile 2		
	mean diff	t-stat	p-value	mean diff	t-stat	p-value
Null Hypothesis						
$\mathcal{P}(i \uparrow \pi, u \uparrow) \geq \mathcal{P}(i \uparrow \pi, u \downarrow)$	0.02	0.39	0.35	0.03	0.82	0.21
$\mathcal{P}(i \downarrow \pi, u \downarrow) \geq \mathcal{P}(i \downarrow \pi, u \uparrow)$	0.09	2.40	0.01	0.06	2.56	0.01
	decile 3			decile 4		
	mean diff	t-stat	p-value	mean diff	t-stat	p-value
Null Hypothesis						
$\mathcal{P}(i \uparrow \pi, u \uparrow) \geq \mathcal{P}(i \uparrow \pi, u \downarrow)$	0.02	0.62	0.27	0.01	0.38	0.35
$\mathcal{P}(i \downarrow \pi, u \downarrow) \geq \mathcal{P}(i \downarrow \pi, u \uparrow)$	0.05	1.76	0.04	0.05	3.77	0.00
	decile 5			decile 6		
	mean diff	t-stat	p-value	mean diff	t-stat	p-value
Null Hypothesis						
$\mathcal{P}(i \uparrow \pi, u \uparrow) \geq \mathcal{P}(i \uparrow \pi, u \downarrow)$	-0.03	-1.12	0.87	0.01	0.49	0.31
$\mathcal{P}(i \downarrow \pi, u \downarrow) \geq \mathcal{P}(i \downarrow \pi, u \uparrow)$	0.07	3.48	0.00	0.02	1.49	0.07
	decile 7			decile 8		
	mean diff	t-stat	p-value	mean diff	t-stat	p-value
Null Hypothesis						
$\mathcal{P}(i \uparrow \pi, u \uparrow) \geq \mathcal{P}(i \uparrow \pi, u \downarrow)$	0.02	0.53	0.30	0.00	-0.07	0.53
$\mathcal{P}(i \downarrow \pi, u \downarrow) \geq \mathcal{P}(i \downarrow \pi, u \uparrow)$	0.02	1.35	0.09	0.01	0.63	0.26
	decile 9			decile 10		
	mean diff	t-stat	p-value	mean diff	t-stat	p-value
Null Hypothesis						
$\mathcal{P}(i \uparrow \pi, u \uparrow) \geq \mathcal{P}(i \uparrow \pi, u \downarrow)$	0.05	1.86	0.03	0.01	0.65	0.26
$\mathcal{P}(i \downarrow \pi, u \downarrow) \geq \mathcal{P}(i \downarrow \pi, u \uparrow)$	0.03	1.66	0.05	0.02	1.45	0.07

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 6-month window.

conditioning on demographics, we find that answers by households that have at least a college degree and households at the highest income quartile are more in line with the relationship between unemployment and interest rates implied by the stabilization principles underlying the Taylor rule, than answers by households with no high-school diploma, and by households at the lowest income quartile. For brevity we do not include the corresponding tables, which are available upon request.

3.3 SPF

We now turn to the SPF. The top half of Table 10 reports the unconditional frequencies of professional forecasters' responses regarding the direction of 12-month changes in interest rates, inflation, and unemployment, while the bottom half of the table reports the conditional frequencies of answers regarding interest-rate changes. In line with the realized data, note the small number of observations for distributions that condition on stable unemployment. In what follows we exclude results based on comparisons that involve these conditional frequencies.

Table 11 reports one-sided tests of the partial effects of inflation and unemployment perceived by professional forecasters. Perhaps surprisingly, none of the partial effects of inflation implied by the Taylor rule are statistically significant at the usual significance levels. In contrast, the partial effects of unemployment are statistically significant, in line with the Taylor rule, and relatively strong when compared to previous results on the partial effects of unemployment.

The results on the partial effects of inflation and unemployment may suggest that professional forecasters perceive the relationship between interest-rate decisions, inflation, and unemployment

Table 10: Frequencies of responses – SPF (%)

	Unconditional frequencies			
	↓	↔	↑	
$\mathcal{P}(i)$	35.05	-	64.96	
$\mathcal{P}(\pi)$	47.90	-	52.10	
$\mathcal{P}(u)$	45.17	0.16	54.67	

	Conditional frequencies			#Obs
	↓	↔	↑	
$\mathcal{P}(i \pi \uparrow, u \downarrow)$	16.10	-	83.90	652
$\mathcal{P}(i \pi \uparrow, u \leftrightarrow)$	-	-	-	0
$\mathcal{P}(i \pi \uparrow, u \uparrow)$	45.30	-	54.70	649
$\mathcal{P}(i \pi \downarrow, u \downarrow)$	18.91	-	81.09	476
$\mathcal{P}(i \pi \downarrow, u \leftrightarrow)$	25.00	-	75.00	4
$\mathcal{P}(i \pi \downarrow, u \uparrow)$	53.77	-	46.23	716

Table 11: Partial effects – SPF

Partial effects of inflation				
Null Hypothesis	mean diff	t-stat	p-value	
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.03	0.66	0.25	
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.08	1.18	0.12	
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.03	0.66	0.25	
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.08	1.18	0.12	

Partial effects of unemployment				
Null Hypothesis	mean diff	t-stat	p-value	
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	0.35	7.63	0.00	
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.29	7.96	0.00	
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.35	7.63	0.00	
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.29	7.96	0.00	

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 2-quarter window.

to be tilted towards the employment dimension. Alternatively, they may imply a perception that headline inflation is not the most important metric for the FOMC’s gauge of price stability. As an attempt to test the latter conjecture, we redo our analysis of the partial effects of inflation perceived by professional forecasters using their forecasts for core CPI (excluding food and energy) instead of headline CPI inflation. We caveat that the SPF only started inquiring participants about their forecasts for core CPI in 2007, so that our sample is limited to a single year. Despite this data limitation, Table 12 shows that once the partial effects of inflation are cast in terms of core rather than headline CPI, they become larger, and some of them become statistically significant. This suggests that professional forecasters indeed have a more nuanced view of how inflation affects monetary policy.

Table 12: Partial effects of core inflation – SPF

Null Hypothesis	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.31	1.83	0.03
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.24	1.15	0.13
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.31	1.83	0.03
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.24	1.15	0.13

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 2-quarter window.

3.4 VAR

Finally, we perform our analysis using artificial survey answers based on a VAR, as described in Subsection 2.1.3. The results of our exercise are reported in Tables 13 and 14. They show that using VAR-based forecasts to answer the questions about the direction of changes in interest rates, inflation, and unemployment posed by the Michigan Survey would produce results that conform with the stabilization principles underlying the Taylor rule.

4 A framework to interpret our empirical approach

In this section we present a simple framework to interpret our empirical approach. The goal is to have a setting in which we can think formally about how to interpret the partial effects and the statistical tests performed in Section 3. We make no attempt to be general, and at times rely on assumptions that are made in order to allow a formal interpretation of the comparative statics exercises on which we base our empirical approach.

Our starting point is a population of households, some of which reason according with a simple form of the Taylor rule. We assume that a such household has in mind a simple Taylor rule with two additive components. The first is a “systematic” component that embeds the stabilization principles underlying the Taylor rule, and which dictates how, *on average*, the household’s numerical interest-rate forecast for a given date T should be related to the same household’s nu-

Table 13: Frequencies of responses – VAR (%)

	Unconditional frequencies			
	↓	↔	↑	
$\mathcal{P}(i)$	11.60	30.94	57.46	
$\mathcal{P}(\pi)$	51.93	-	48.07	
$\mathcal{P}(u)$	14.36	51.93	33.70	

	Conditional frequencies			#Obs
	↓	↔	↑	
$\mathcal{P}(i \pi \uparrow, u \downarrow)$	0.00	0.00	100.00	22
$\mathcal{P}(i \pi \uparrow, u \leftrightarrow)$	0.00	13.16	86.84	38
$\mathcal{P}(i \pi \uparrow, u \uparrow)$	14.81	18.52	66.67	27
$\mathcal{P}(i \pi \downarrow, u \downarrow)$	0.00	0.00	100.00	4
$\mathcal{P}(i \pi \downarrow, u \leftrightarrow)$	3.57	57.14	39.29	56
$\mathcal{P}(i \pi \downarrow, u \uparrow)$	44.12	41.18	14.71	34

Table 14: Partial effects – VAR

Partial effects of inflation			
Null Hypothesis	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	-	-	-
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.52	4.18	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	-	-	-
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.29	2.35	0.01

Partial effects of unemployment			
Null Hypothesis	mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	0.85	11.08	0.00
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.33	2.32	0.01
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.44	2.92	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.15	1.37	0.08

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 6-month window.

merical forecasts of inflation and unemployment for the same date. We denote this “systematic interest-rate forecast” by $i_{t,T}^*$, and assume that it only depends on the household’s forecasts of unemployment for date T (denoted $u_{t,T}$) and of inflation in the 12-month period ending at date T (denoted $\pi_{t,T}$), according to a simple Taylor-type rule:

$$i_{t,T}^* = \phi_\pi \pi_{t,T} + \phi_u u_{t,T}. \quad (9)$$

We do not specify how the household forms her inflation and unemployment forecasts, and only assume that they are based on some model which produces a joint distribution of these two forecasts for any given horizon.

The second component of the household’s interest-rate forecast for date T is the amount by which she believes the interest rate will deviate from her systematic forecast $i_{t,T}^*$. We introduce this “forecast shock” component (denoted $-\varepsilon_{t,T}$) because (9) is an imperfect description of how the Fed sets its policy rate, and so we want to allow a household who understands the conduct of monetary policy to make interest-rate forecasts that deviate from her systematic forecast. We think of $\varepsilon_{t,T}$ as being drawn by the household when forming her interest-rate forecast, from a distribution with cdf $F_\varepsilon(\varepsilon)$,¹⁴ and assume that $\varepsilon_{t,T}$ is independent of $\pi_{t,T}$, $u_{t,T}$ and of $i_{t,t}$, $\pi_{t,t}$, $u_{t,t}$. We discuss the implications of the lack of independence between $\varepsilon_{t,T}$ and $\pi_{t,T}$, $u_{t,T}$ in Subsection 4.1. Our previous assumption that $i_{t,T}^*$ is the forecast that the household makes on average implies that $\varepsilon_{t,T}$ has mean zero.

The variables $i_{t,t}$, $\pi_{t,t}$, and $u_{t,t}$ denote, respectively, the household’s perception of the policy rate at time t , of inflation in the 12 months up to and including time t , and of the unemployment rate at time t , which we assume to coincide with the actual values of these three variables (i.e., we assume that they are known to the household when she answers the survey questions at time t). Because we assume $i_{t,t}$, $\pi_{t,t}$, and $u_{t,t}$ to be known at time t , and because ϕ_π , and ϕ_u are assumed to be time invariant, the realization of $\varepsilon_{t,t}$ also becomes known at time t .

The actual numerical interest-rate forecast of the household is denoted by $i_{t,T} = i_{t,T}^* - \varepsilon_{t,T}$:

$$i_{t,T} = \phi_\pi \pi_{t,T} + \phi_u u_{t,T} - \varepsilon_{t,T}. \quad (10)$$

Recall that with the exception of inflation, the questions in the Michigan Survey that we use in our analysis pertain to the direction of interest rates and unemployment in the subsequent 12 months. So, to move closer to the analysis that we perform with available data, we need to go from (10) to a specification in changes instead of levels. To that end, we subtract (10) with $T = t$ from (10) itself to arrive at:

$$\Delta i_{t,T} = \phi_\pi \Delta \pi_{t,T} + \phi_u \Delta u_{t,T} - \varepsilon_{t,T} + \varepsilon_{t,t}, \quad (11)$$

where $\Delta x_{t,T} = x_{t,T} - x_{t,t}$ for $x = i, \pi, u$.

¹⁴More generally it would seem reasonable to assume that this distribution depends on others things, such as the forecast horizon $T - t$. Since we are tailoring the framework to what we can achieve with the available data we do not worry about making assumptions that would otherwise be unnecessarily restrictive.

With what we have developed so far, we can ask hypothetical questions such as the following: given numerical forecasts of inflation and unemployment that imply a change in 12-month inflation of $\Delta\pi$ and a change in unemployment of Δu in 12 months from now, what is the probability that the household will answer that interest rates will go up in the next 12 months? Equation (11) implies that:

$$\Delta i_{t,T} \geq 0 \iff \varepsilon_{t,T} \leq \phi_\pi \Delta\pi_{t,T} + \phi_u \Delta u_{t,T} + \varepsilon_{t,t}.$$

Thus the answer to the hypothetical question would be:

$$\begin{aligned} \Pr(\Delta i_{t,T} \geq 0 \mid \Omega_t) &= \Pr(\varepsilon_{t,T} \leq \phi_\pi \Delta\pi_{t,T} + \phi_u \Delta u_{t,T} + \varepsilon_{t,t}) \\ &= F_\varepsilon(\phi_\pi \Delta\pi_{t,T} + \phi_u \Delta u_{t,T} + \varepsilon_{t,t}), \end{aligned}$$

where $\Omega_t = \{\Delta\pi_{t,T}, \Delta u_{t,T}, i_{t,t}, \pi_{t,t}, u_{t,t}, \phi_\pi, \phi_u\}$, and to avoid cluttering the notation we omit the conditioning variables in the expressions in the right-hand-side of the expressions above.

We can also ask simple questions of comparative statics, such as how that probability changes with the household's inflation and unemployment forecasts:

$$\frac{\partial F_\varepsilon(\phi_\pi \Delta\pi_{t,T} + \phi_u \Delta u_{t,T} + \varepsilon_{t,t})}{\partial \Delta\pi_{t,T}} = F'_\varepsilon(\phi_\pi \Delta\pi_{t,T} + \phi_u \Delta u_{t,T} + \varepsilon_{t,t}) \phi_\pi \leq 0, \quad (12)$$

$$\frac{\partial F_\varepsilon(\phi_\pi \Delta\pi_{t,T} + \phi_u \Delta u_{t,T} + \varepsilon_{t,t})}{\partial \Delta u_{t,T}} = F'_\varepsilon(\phi_\pi \Delta\pi_{t,T} + \phi_u \Delta u_{t,T} + \varepsilon_{t,t}) \phi_u \leq 0, \quad (13)$$

where the signs of the expressions (12) and (13) depend on the signs of ϕ_π and ϕ_u , and thus reflect the stabilization principles underlying the Taylor rule ($\phi_\pi > 0$, and $\phi_u < 0$).

The results obtained so far would be very useful if we could observe numerical forecasts of households over time. However, in the data we analyze we do not observe the same household more than once,¹⁵ and we only have numerical forecasts for inflation. Our next step is to spell out assumptions under which we can make comparative statics statements analogous to (12) and (13) based on one-time answers by a pool households.

Assume that we observe answers from a large pool of households such as the one we have been modeling so far in this subsection, and that there is heterogeneity in their forecasts of interest rates, inflation, and unemployment and in their assumptions about ϕ_π and ϕ_u .¹⁶ As a first step, assume that inflation and unemployment forecasts are numerical, but interest-rate forecasts are categorical as in our data (up/down/same).

One way to think about an individual household j 's categorical response regarding the direction of interest rates in the context of our simple framework is to also condition on the realization of

¹⁵As mentioned when we described the data, the Michigan Survey does have a small panel dimension, since a fraction of households are interviewed a second time. Nevertheless, having at most two observations for some household would not be enough for us to do the empirical counterpart of the comparative statics analysis that we just did, household by household.

¹⁶We assume a large enough sample that for any combination of inflation and unemployment forecasts we have a large number of observations.

$\varepsilon_{t,T}^j$ that she draws:

$$\mathbb{1}(\Delta i_{t,T}^j \geq 0) = \begin{cases} 1 & \text{if } \varepsilon_{t,T}^j \leq \phi_\pi^j \Delta \pi_{t,T}^j + \phi_u^j \Delta u_{t,T}^j + \varepsilon_{t,t}^j \\ 0 & \text{if } \varepsilon_{t,T}^j > \phi_\pi^j \Delta \pi_{t,T}^j + \phi_u^j \Delta u_{t,T}^j + \varepsilon_{t,t}^j \end{cases},$$

Under the additional assumption that the forecast shocks $\varepsilon_{t,T}^j$ are independent across households,¹⁷ we can do comparative statics exercises analogous to (12) and (13) by pooling households according to their forecasts of inflation and unemployment.

As a preliminary step, if we select a large pool of households with the same Taylor rule coefficients ϕ_π, ϕ_u and the same given forecasts for changes in inflation and unemployment $\Delta\pi$ and Δu , by the law of large numbers the fraction of households answering that interest rates will move up will be given by:¹⁸

$$\begin{aligned} Fr(\Delta i \geq 0 | \phi_\pi, \phi_u, \Delta\pi, \Delta u) &= \\ &= \frac{\int_{j \in J} \mathbb{1}(\varepsilon^j \leq \phi_\pi \Delta\pi + \phi_u \Delta u + \varepsilon_{\phi_\pi, \phi_u}) dj}{\int_{j \in J} \mathbb{1}(\varepsilon^j \leq \phi_\pi \Delta\pi + \phi_u \Delta u + \varepsilon_{\phi_\pi, \phi_u}) dj + \int_{j \in J} \mathbb{1}(\varepsilon^j > \phi_\pi \Delta\pi + \phi_u \Delta u + \varepsilon_{\phi_\pi, \phi_u}) dj} \quad (14) \\ &= F_\varepsilon(\phi_\pi \Delta\pi + \phi_u \Delta u + \varepsilon_{\phi_\pi, \phi_u}), \end{aligned}$$

where J collects the indices of households in the pool with the forecasts $\Delta\pi$ and Δu and the Taylor rule coefficients ϕ_π, ϕ_u , the numerator in equation (14) counts households in that pool who responded that interest rates will increase, and the denominator accounts for all possible responses about future interest rates (i.e., the size of the pool of households in J). $\varepsilon_{\phi_\pi, \phi_u}$ represents the perceived $\varepsilon_{t,t}$ realized at time t as a function of ϕ_π, ϕ_u .¹⁹

To obtain the fraction of households that respond that interest rates will increase for given forecasts $\Delta\pi$ and Δu , we need to integrate over the distribution of $\phi = (\phi_\pi, \phi_u)$, which we denote by $F_\phi(\phi_\pi, \phi_u)$:²⁰

$$Fr(\Delta i \geq 0 | \Delta\pi, \Delta u) = \int_\phi F_\varepsilon(\phi_\pi \Delta\pi + \phi_u \Delta u + \varepsilon_{\phi_\pi, \phi_u}) dF_\phi(\phi_\pi, \phi_u).$$

If we select another large pool of households with the same forecasted change in unemployment Δu , but with an infinitesimally higher forecast for the change in inflation (“ $\Delta\pi + \delta_\pi$ ”), the difference between the two pools in the fraction of households answering that interest rates will go up will be given by:

$$\int_\phi [F_\varepsilon(\phi_\pi (\Delta\pi + \delta_\pi) + \phi_u \Delta u + \varepsilon_{\phi_\pi, \phi_u}) - F_\varepsilon(\phi_\pi \Delta\pi + \phi_u \Delta u + \varepsilon_{\phi_\pi, \phi_u})] dF_\phi(\phi_\pi, \phi_u). \quad (15)$$

¹⁷Naturally, we also extend the assumption of independence between forecast shocks $\varepsilon_{t,T}^j$ and $\pi_{t,T}^j, u_{t,T}^j$ and $i_{t,t}^j, \pi_{t,t}^j, u_{t,t}^j$ for all j .

¹⁸To avoid cluttering the notation, from now on we drop the time subscripts.

¹⁹This depends on the Taylor rule coefficients because it is assumed to be inferred from the observation of the realized values for the interest rate, inflation, and unemployment.

²⁰We assume that ϕ is distributed independently of all other variables in the population of households.

We refer to quantities such as (15) as the δ_π -*partial effects of inflation*. Dividing (15) by δ_π and taking the limit as $\delta_\pi \rightarrow 0$ yields the comparative statics result analogous to (12), i.e.:

$$\begin{aligned} & \lim_{\delta_\pi \rightarrow 0} \frac{\int_\phi [F'_\varepsilon(\phi_\pi(\Delta\pi + \delta_\pi) + \phi_u\Delta u + \varepsilon_{\phi_\pi, \phi_u}) - F'_\varepsilon(\phi_\pi\Delta\pi + \phi_u\Delta u + \varepsilon_{\phi_\pi, \phi_u})] dF_\phi(\phi_\pi, \phi_u)}{\delta_\pi} \\ &= \int_\phi F'_\varepsilon(\phi_\pi\Delta\pi + \phi_u\Delta u + \varepsilon_{\phi_\pi, \phi_u}) \phi_\pi dF_\phi(\phi_\pi, \phi_u) \end{aligned} \quad (16)$$

Likewise, we can compute the δ_u -*partial effects of unemployment* by appropriate choice of two pools of households that share the same forecast for the change in inflation, but differ in the forecast for the change in unemployment (by δ_u). The difference between the fractions of households answering that interest rates will go up in the two pools will be given by:

$$\int_\phi [F'_\varepsilon(\phi_\pi\Delta\pi + \phi_u(\Delta u + \delta_u) + \varepsilon_{\phi_\pi, \phi_u}) - F'_\varepsilon(\phi_\pi\Delta\pi + \phi_u\Delta u + \varepsilon_{\phi_\pi, \phi_u})] dF_\phi(\phi_\pi, \phi_u). \quad (17)$$

The comparative statics result in (13) can be obtained as before, dividing (17) by δ_u and taking the limit as $\delta_u \rightarrow 0$.

Hence, we can write the partial effects as:

$$\begin{aligned} \frac{\partial Fr(\Delta i \geq 0 | \Delta\pi, \Delta u)}{\partial \Delta\pi} &= \int_\phi F'_\varepsilon(\phi_\pi\Delta\pi + \phi_u\Delta u + \varepsilon_{\phi_\pi, \phi_u}) \phi_\pi dF_\phi(\phi_\pi, \phi_u) \\ \frac{\partial Fr(\Delta i \geq 0 | \Delta\pi, \Delta u)}{\partial \Delta u} &= \int_\phi F'_\varepsilon(\phi_\pi\Delta\pi + \phi_u\Delta u + \varepsilon_{\phi_\pi, \phi_u}) \phi_u dF_\phi(\phi_\pi, \phi_u). \end{aligned}$$

Under the special case where ε has a uniform distribution, F'_ε is a constant and the partial effects above are proportional to the average values of ϕ_π and ϕ_u in the population. More generally, the partial effects uncover weighted averages of the Taylor rule coefficients in the population of respondents. This result underlies the way in which we interpret our estimated partial effects, as being informative of the perceptions that some households (the ones that dominate the aforementioned weighted averages) have about monetary policy.

Finally, note that we have assumed that the forecasts for inflation and unemployment are numerical, whereas in our baseline results we use categorical answers for the questions about the future path of these two variables. Conditioning on the direction of the forecasted change instead of on the numerical forecasts can make a difference for some the results derived in the model. For instance, it may cause answers that were otherwise well defined to depend on the distribution of Taylor rule coefficients perceived by households in the pool of respondents.

Since we only have categorical responses regarding the future path of unemployment, our empirical approach for estimating the partial effects of inflation can only be imperfectly justified on the basis of the framework developed in this section. We could try to condition on households' questions to other questions in the Michigan Survey, in the hope that doing so would make it more likely that the selected pool of respondents had in mind the same (unobserved) forecasted change in unemployment when answering the survey question. However, we would still have to

live with the possibility that unobserved heterogeneity in those numerical forecasts would cause problems. Fortunately, as seen in previous sections, the Michigan Survey inquires households about the numerical forecasts for inflation. Our results for the partial effects of unemployment using those numerical inflation forecasts – instead of only the direction for the change in inflation – show that problems of the kind discussed in the previous paragraph do not arise in this case, as the substantive conclusions drawn from both exercises are the same. So perhaps we can be less concerned with the fact that the partial effects of inflation that we estimate condition on the categorical responses about the future path of unemployment.

4.1 A few digressions

Our simple framework helps us think about how a household that reasons in accordance with the stabilization principles underlying the Taylor rule might answer categorical questions about interest rates, such as the one in the Michigan Survey. It also shows how, within the framework, those principles can be recovered from answers by a pool of such households that differ in their forecasts of inflation and unemployment, and also possibly in their perceived Taylor rule coefficients.

It is natural to ask whether the lessons we can draw are robust to alternative assumptions, even strictly within our simple framework. An important implicit assumption that we make is that households’ answers about the direction of interest rates is indeed conditional on their responses about inflation and unemployment, which we assume come from a unspecified model that produces a joint forecast for the path of these two variables. **[To be completed: discuss Manski’s problem]**.

An issue that we haven’t discussed to this point is how we think about endogeneity and causality within our framework. We spelled out an assumption that allowed us to sidestep this discussion altogether: that of independence between “forecast shocks” ($\varepsilon_{t,T}$) and $\pi_{t,T}$, $u_{t,T}$, $\dot{i}_{t,t}$, $\pi_{t,t}$, $u_{t,t}$. The economic interpretation of this assumption is that the households that we are modelling do not perceive departures from their view of systematic monetary policy to have effects on inflation and unemployment in the forecast horizon. Put differently, that none of the variation in inflation and unemployment at that horizon comes from non-systematic monetary policy. If this is not the case, and such (monetary) shocks affect the (endogenous) determination of inflation and output (through whatever mechanism that we do not need to make explicit in our simple framework), then there is a clear problem of endogeneity, and the comparative statics results presented in the previous subsection need not recover the true causal relationship between inflation and unemployment on one side, and interest rates on the other side. So, how to think about this question given that, in reality, there is evidence that interest-rate shocks do affect inflation and economic activity?

Our view is that, given our empirical approach, this is not likely to be a quantitatively important issue. The reasons are twofold. First, while any extent of endogeneity bias immediately creates a problem for inference about the magnitude of the parameters of the monetary policy rule that control the causal effects of interest, this may not matter for our conclusions. The reason is that our analysis is based on the *signs* of the effects of inflation and unemployment on interest rates – not

on the magnitude of these effects. So, to the extent that the endogeneity bias affects the magnitude of the estimated coefficients in the “reduced-form relationship” of interest between interest rates, inflation, and unemployment, but does not affect their sign, it does not matter for our conclusions. Second, most evidence about the effects of monetary (interest-rate) shocks suggests that they only explain a small to moderate fraction of the variance of inflation and unemployment. For example, in the Gali, Smets, and Wouters (2011) estimated DSGE model of the U.S. economy, which includes unemployment, shocks to the monetary policy rule explain only 3% of the variance of inflation and 5% of the variance of unemployment on impact, and roughly 7.5% of the variance of inflation and 15.5% of the variance of unemployment at a one year horizon. Because of these magnitudes, and of the fact that our conclusions depend on the sign of the causal effects of inflation and unemployment on interest rates, we conjecture that the endogeneity of inflation and unemployment to interest-rate shocks is unlikely to be a problem for our analysis.

Table 15: Partial effects in the Gali, Smets, and Wouters (2011) model

Partial Effects of Inflation						
Null Hypothesis	GSW			TR		
	Mean diff	t-stat	p-value	Mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.22	22.94	0.00	0.41	7.73	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.26	17.73	0.00	0.34	39.97	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.22	22.94	0.00	0.41	7.73	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.26	17.73	0.00	0.34	39.97	0.00

Partial Effects of Unemployment						
Null Hypothesis	GSW			TR		
	Mean diff	t-stat	p-value	Mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	0.37	18.00	0.00	0.12	3.34	0.00
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.33	88.74	0.00	0.18	23.21	0.00
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.37	18.00	0.00	0.12	3.34	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.33	88.74	0.00	0.18	23.21	0.00

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 2-quarter window.

To test if our conjecture is correct, we simulate a New Keynesian DSGE economy and test our empirical framework in the model-simulated data. In particular, we simulate the Gali-Smets-Wouters model to obtain artificial time series for the policy rate, inflation, and unemployment.²¹ For each simulated series, we build categorical variables corresponding to the direction of 12-month changes in interest rates, inflation, and unemployment, just as we do with realized data. We then apply our empirical approach to make inference about the partial effects of inflation and unemployment.

In their model, the monetary policy rule is slightly different than the one assumed in our framework (equation (10)). Their rule includes an interest rate smoothing component, in addition to including current inflation and output growth. Hence, in addition to their model we consider

²¹We thank the authors for kindly providing their codes.

an alternative specification of the Taylor rule, which is in line with equation (10). Under these two alternative specifications for the Taylor rule, we use the simulated data for these three economies to calculate the partial effects of inflation and unemployment.

Table 15 provides the results. Columns labeled with “GSW” provide the results for the simulated model using their specification for the Taylor rule, while columns labeled with “TR” provide the results from the simulated model using the alternative specification for the Taylor rule. Confirming our intuition, irrespective of the assumption for the interest rate rule, we find that in estimated model economies, partial effects of inflation and unemployment come out with the expected signs and statistical significance. Hence, we hope we need to worry less about endogeneity problems.

Finally, a natural alternative to our empirical approach would be to use ordered probit models. In fact, the simple framework developed in the previous subsection suggests precisely an ordered-probit-type specification. In that case, the signs of the partial effects, as well as statistical significance of the possible relationships between inflation and unemployment on one side, and interest rates on the other side, would be dictated by the Taylor rule coefficients on inflation and unemployment. Thus, either all partial effects of inflation would come out in accordance with the principles underlying the Taylor rule, or they would all come out contradicting those principles. The same would be true of the partial effects of unemployment. One advantage of an approach based on ordered probits is that it imposes a parametric structure that uses information from all the conditional distributions of interest-rate responses given responses about inflation and unemployment to estimate the two coefficients that control those partial effects. In contrast, our non-parametric approach estimates each possible partial effect using only data from the two conditional distributions that define it, and this reduces the number of observations underlying the estimates. On the positive side, because our approach does not impose any structure on the data, it allows for partial effects that contradict each other. For example, we may estimate partial effects of inflation that are consistent with the stabilization principles underlying the Taylor rule when it comes to interest-rate increases, but which otherwise do not conform with those principles. In other words, the approach allows for asymmetries in perceptions about monetary policy that a standard ordered probit would rule out by construction. Of course we could have modeled households’ perceptions about the conduct of monetary policy by allowing explicitly for these asymmetries in the systematic component of households’ interest-rate forecasts. However, that flexibility would have increased the number of parameters to be estimated one-to-one with the degrees of freedom that we wished to allow for in the estimation of partial effects. In the limit, if we wished to allow each partial effect to take any possible value, we would essentially be back to our non-parametric approach.²²

²²In unreported results, available upon request, we confirm our findings using ordered probit specifications.

5 Conclusion

We combine questions from the Michigan Survey about the future path of prices, interest rates, and unemployment to investigate whether U.S. households are aware of what we refer to as the stabilization principles underlying the Taylor rule. For comparison, we perform the same analysis using questions from the Survey of Professional Forecasters, and hypothetical answers to the same survey questions based on the forecasts of a VAR. Our findings are broadly consistent with the view that some U.S. households are aware of how the Fed conducts monetary policy when forming their expectations about the joint future path of interest rates, inflation, and unemployment. The degree of awareness, however, does not appear to be uniform across income and education levels, and age groups. Higher income, more educated, and older households appear to be more aware of the Taylor rule than younger, less educated, and lower income households. In addition, even among the former group of households, people seem to better understand the relation between unemployment and interest rates when predicting downward movements of interest rates. These results are robust to several changes in the baseline framework and also robust to different estimation methods.

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6 Appendix

6.1 Kolmogorov-Smirnov tests

Table 16 presents results for Kolmogorov-Smirnov tests of equality between the unconditional frequencies of the direction of interest-rate changes in Table 1 and each of the conditional empirical frequencies of the same Table 1. Quite unsurprisingly, movements in interest rates do not appear to be independent of movements in inflation and unemployment. With the exception of the test for equality between $\mathcal{P}(i)$ and $\mathcal{P}(i | \pi \downarrow, u \downarrow)$, the Kolmogorov-Smirnov test always rejects equality of the conditional and unconditional frequency of responses of the direction of changes in interest rates.

Table 16: Kolmogorov-Smirnov tests – data

	Test statistic	p-value
$\mathcal{P}(i) = \mathcal{P}(i \pi \uparrow, u \downarrow)$	0.360	0.000
$\mathcal{P}(i) = \mathcal{P}(i \pi \uparrow, u \uparrow)$	0.412	0.000
$\mathcal{P}(i) = \mathcal{P}(i \pi \downarrow, u \downarrow)$	0.153	0.125
$\mathcal{P}(i) = \mathcal{P}(i \pi \downarrow, u \uparrow)$	0.412	0.000

Table 17 presents results for Kolmogorov-Smirnov tests of equality between the empirical frequencies or responses about the direction of interest-rate changes in Table 3 and each of the conditional frequencies reported in Table 3. According to households' perceptions, movements in interest rates are not independent of movements in inflation and unemployment, as the Kolmogorov-Smirnov test always rejects equality of those empirical frequencies.

Table 17: Kolmogorov-Smirnov tests – Michigan Survey

	Test statistic	p-value
$\mathcal{P}(i) = \mathcal{P}(i \pi \uparrow, u \downarrow)$	0.039	0.000
$\mathcal{P}(i) = \mathcal{P}(i \pi \uparrow, u \leftrightarrow)$	0.039	0.000
$\mathcal{P}(i) = \mathcal{P}(i \pi \uparrow, u \uparrow)$	0.054	0.000
$\mathcal{P}(i) = \mathcal{P}(i \pi \downarrow, u \downarrow)$	0.059	0.000
$\mathcal{P}(i) = \mathcal{P}(i \pi \downarrow, u \leftrightarrow)$	0.051	0.000
$\mathcal{P}(i) = \mathcal{P}(i \pi \downarrow, u \uparrow)$	0.066	0.000

6.2 Additional descriptive analysis

Table 18 presents empirical frequencies of households' responses by demographic groups.

Table 18: Frequencies of Responses – by demographics (%)

Unconditional frequencies						
	Lowest income quartile			No high-school diploma		
	↓	↔	↑	↓	↔	↑
$P(i)$	14.25	26.92	58.83	14.54	26.18	59.28
$P(\pi)$	42.22	-	57.78	46.02	-	53.98
$P(u)$	14.27	47.54	38.19	15.10	45.7	39.21
Highest income quartile						
	Highest income quartile			At least college degree		
	↓	↔	↑	↓	↔	↑
$P(i)$	15.12	29.71	55.17	15.43	29.09	55.48
$P(\pi)$	50.12	-	49.88	47.52	-	52.48
$P(u)$	15.17	52.77	32.06	14.76	52.18	33.06
Conditional frequencies						
	Lowest income quartile			No high-school diploma		
	↓	↔	↑	↓	↔	↑
$\mathcal{P}(i \pi \uparrow, u \downarrow)$	13.85	24.89	61.26	14.19	21.91	63.90
$\mathcal{P}(i \pi \uparrow, u \leftrightarrow)$	10.42	27.75	61.82	10.00	28.09	61.91
$\mathcal{P}(i \pi \uparrow, u \uparrow)$	14.35	19.91	65.74	14.91	18.64	66.44
$\mathcal{P}(i \pi \downarrow, u \downarrow)$	16.93	33.67	49.40	16.65	30.03	53.32
$\mathcal{P}(i \pi \downarrow, u \leftrightarrow)$	13.84	34.57	51.59	14.07	33.87	52.06
$\mathcal{P}(i \pi \downarrow, u \uparrow)$	20.73	23.59	55.68	20.38	23.83	55.80
Highest income quartile						
	Highest income quartile			At least college degree		
	↓	↔	↑	↓	↔	↑
$\mathcal{P}(i \pi \uparrow, u \downarrow)$	11.22	26.34	62.45	11.54	27.40	61.06
$\mathcal{P}(i \pi \uparrow, u \leftrightarrow)$	11.14	30.38	58.48	11.45	29.82	58.73
$\mathcal{P}(i \pi \uparrow, u \uparrow)$	16.34	23.69	59.97	16.41	23.68	59.90
$\mathcal{P}(i \pi \downarrow, u \downarrow)$	13.32	32.84	53.84	14.09	32.98	52.93
$\mathcal{P}(i \pi \downarrow, u \leftrightarrow)$	15.24	33.71	51.05	15.61	33.14	51.25
$\mathcal{P}(i \pi \downarrow, u \uparrow)$	23.27	28.11	48.62	23.99	26.33	49.68

6.3 Additional inequality tests

We define the following *Taylor rule orderings*:

$$\mathcal{P}(i \uparrow | \pi \downarrow, u \uparrow) < \left\{ \begin{array}{l} \mathcal{P}(i \uparrow | \pi \downarrow, u \leftrightarrow) \\ \mathcal{P}(i \uparrow | \pi \leftrightarrow, u \uparrow) \end{array} \right\} < \mathcal{P}(i \uparrow) < \left\{ \begin{array}{l} \mathcal{P}(i \uparrow | \pi \uparrow, u \leftrightarrow) \\ \mathcal{P}(i \uparrow | \pi \leftrightarrow, u \downarrow) \end{array} \right\} < \mathcal{P}(i \uparrow | \pi \uparrow, u \downarrow), \quad (18)$$

and

$$\mathcal{P}(i \downarrow | \pi \uparrow, u \downarrow) < \left\{ \begin{array}{l} \mathcal{P}(i \downarrow | \pi \uparrow, u \leftrightarrow) \\ \mathcal{P}(i \downarrow | \pi \leftrightarrow, u \downarrow) \end{array} \right\} < \mathcal{P}(i \downarrow) < \left\{ \begin{array}{l} \mathcal{P}(i \downarrow | \pi \downarrow, u \leftrightarrow) \\ \mathcal{P}(i \downarrow | \pi \leftrightarrow, u \uparrow) \end{array} \right\} < \mathcal{P}(i \downarrow | \pi \downarrow, u \uparrow), \quad (19)$$

and present the results in the tables below.

6.3.1 Realized data

Table 19 reports the results based on realized data, dropping the distributions that condition on $u \leftrightarrow$. To make it easier to read the table, we index the inequalities that constitute the null hypotheses and reproduce the Taylor rule orderings below, mapping the inequalities to the index of null hypothesis in the first column of the table. All of the results provide strong statistical support for the orderings.

$$\mathcal{P}(i \uparrow | \pi \downarrow, u \uparrow) \stackrel{(1)}{<} \mathcal{P}(i \uparrow) \stackrel{(2)}{<} \mathcal{P}(i \uparrow | \pi \uparrow, u \downarrow) \quad (20)$$

$$\mathcal{P}(i \downarrow | \pi \uparrow, u \downarrow) \stackrel{(3)}{<} \mathcal{P}(i \downarrow) \stackrel{(4)}{<} \mathcal{P}(i \downarrow | \pi \downarrow, u \uparrow) \quad (21)$$

Table 19: Taylor rule orderings - data

	Null Hypothesis	mean diff	t-stat	p-value
(1)	$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow)$	0.41	13.08	0.00
(2)	$\mathcal{P}(i \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.36	6.31	0.00
(3)	$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow)$	0.59	6.31	0.00
(4)	$\mathcal{P}(i \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.18	13.08	0.00

6.3.2 Michigan Survey

Table 20 presents the results of one-sided tests for the inequalities that appear in the Taylor rule orderings after we bypass the ones involving distributions that condition on $u \leftrightarrow$ (orderings (20) and (21)).

Table 20: Taylor rule orderings - Michigan Survey

	Null Hypothesis	mean diff	t-stat	p-value
(1)	$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow)$	0.05	9.61	0.00
(2)	$\mathcal{P}(i \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.04	6.02	0.00
(3)	$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow)$	0.02	4.07	0.00
(4)	$\mathcal{P}(i \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.07	17.55	0.00

6.3.3 SPF

Table 21 presents the results of one-sided tests for the inequalities that appear in the Taylor rule orderings (20) and (21). They are all consistent with those orderings.

Table 21: Taylor rule orderings - SPF

	Null Hypothesis	mean diff	t-stat	p-value
(1)	$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow)$	0.19	8.94	0.00
(2)	$\mathcal{P}(i \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.19	10.96	0.00
(3)	$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow)$	0.19	10.96	0.00
(4)	$\mathcal{P}(i \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.19	8.94	0.00

6.4 Robustness

Table 22 shows results based on the sample restricted to periods in which the 3-month Treasury bill and the Freddie Mac mortgage rate move in the same direction.

Table 22: Partial effects accounting for movements in borrowing rates by income and education

Partial effects of inflation						
Null Hypothesis	Lowest income quartile			No high-school diploma		
	Mean diff	t-stat	p-value	Mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.14	6.35	0.00	0.13	4.28	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.10	6.30	0.00	0.09	5.23	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.05	2.15	0.02	0.06	3.32	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.06	4.83	0.00	0.05	3.55	0.00
Null Hypothesis	Highest income quartile			At least college degree		
	Mean diff	t-stat	p-value	Mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.07	2.90	0.00	0.09	4.04	0.00
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \uparrow)$	0.11	5.47	0.00	0.11	5.56	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \downarrow)$	0.01	1.00	0.16	0.02	1.34	0.09
$\mathcal{P}(i \downarrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.07	4.37	0.00	0.08	4.35	0.00
Partial effects of unemployment						
Null Hypothesis	Lowest income quartile			No high-school diploma		
	Mean diff	t-stat	p-value	Mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	-0.08	-3.73	1.00	-0.01	-0.28	0.61
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	-0.04	-1.42	0.92	0.01	0.66	0.25
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.03	1.50	0.07	0.02	1.17	0.12
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.02	0.89	0.19			
Partial effects of unemployment	Highest income quartile			At least college degree		
	Mean diff	t-stat	p-value	Mean diff	t-stat	p-value
$\mathcal{P}(i \uparrow \pi \downarrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \downarrow, u \downarrow)$	0.06	1.66	0.05	0.03	0.83	0.20
$\mathcal{P}(i \uparrow \pi \uparrow, u \uparrow) \geq \mathcal{P}(i \uparrow \pi \uparrow, u \downarrow)$	0.02	0.71	0.24	0.01	0.34	0.37
$\mathcal{P}(i \downarrow \pi \downarrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \downarrow, u \uparrow)$	0.11	4.32	0.00	0.11	4.05	0.00
$\mathcal{P}(i \downarrow \pi \uparrow, u \downarrow) \geq \mathcal{P}(i \downarrow \pi \uparrow, u \uparrow)$	0.05	2.09	0.02	0.05	2.12	0.02

Test statistics and p-values are based on standard errors obtained by block-bootstrap with a 6-month window.