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Are Consumer Expectations Theory-Consistent? The Role of Macroeconomic Determinants and Central Bank Communication*

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Abstract

Using the microdata of the Michigan Survey of Consumers, we evaluate whether U.S. consumers form macroeconomic expectations consistent with different economic concepts. We check whether their expectations are in line with the Phillips Curve, the Taylor Rule and the Income Fisher Equation. We observe that 50% of the surveyed population have expectations consistent with the Income Fisher equation and the Taylor Rule, while 25% are in line with the Phillips Curve. However, only 6% of consumers form theory-consistent expectations with respect to all three concepts. For the Taylor Rule and the Phillips curve we observe a strong cyclical pattern. For all three concepts we find significant differences across demographic groups. Evaluating determinants of consistency, we provide evidence that the likelihood of having theory-consistent expectations with respect to the Phillips curve and the Taylor rule falls during recessions and with inflation higher than 2%. Moreover, consistency with respect to all three concepts is affected by changes in the communication policy of the Fed, where the strongest positive effect on consistency comes from the introduction of the official inflation target. Finally, we show that consumers with theory-consistent expectations have lower absolute inflation forecast errors and are closer to professionals' inflation forecasts.

Keywords: Macroeconomic expectations, microdata, macroeconomic literacy, central bank communication, consumer forecast accuracy.

JEL classification: C25, D84, E31.

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1 Introduction

Consumers' expectations regarding macroeconomic variables are important for economic decisions, such as the decision to purchase a house, the decision for a savings portfolio or wage negotiations, but also for policy makers attempting to guide consumers' expectations. Therefore, it is crucial to understand how consumers form expectations about key macroeconomic variables such as inflation, unemployment and interest rates. Specifically, we focus on checking whether those expectations comove in a sensible way and hence are in line with established economic concepts. This allows us to identify any patterns in consumers' behaviour that can potentially extend the scope for improvement of communication strategies by central banks. Furthermore, we can also evaluate whether changes in the communication strategies of the Federal Open Market Committee over the last decades contributed to enhanced understanding of the monetary policy and the comovements between key macroeconomic variables.

In this paper, we ask whether consumers form expectations consistent with core concepts in macroeconomic theory. More specifically, we analyse consistency with an Income "Fisher" equation, the Phillips curve and the Taylor rule. We test if consumers' expectations correctly distinguish between real and nominal expected income, implying consistency with the Income Fisher equation. Testing the Phillips curve, we analyse if consumers comprehend the short-run trade-off between inflation and unemployment, or, alternatively, the positive relation between inflation and the output gap. Finally, we evaluate whether consumers are aware of the dual mandate of monetary policy regarding stable prices and high employment and, hence, whether they form expectations regarding interest rates, inflation and unemployment (or the output gap) in line with the Taylor rule. Note that throughout the paper, the term "consistent expectations" denotes consistent with an economic concept.

Our analysis is conducted utilising the microdata from the University of Michigan Survey of Consumers (henceforth Michigan Survey), which since January 1978 comprises monthly data of consumers' expectations regarding core macroeconomic variables, but also includes a wide range of socio-demographic characteristics.

We find that on average about 50% of consumers correctly distinguish between real and nominal income expectations and form expectations in line with the Taylor rule. The average share of consumers with expectations consistent with the Phillips curve is significantly lower at about 25%. However, on average only 6% of consumers form theory-consistent expectations with respect to all three concepts in a given period, implying that economic literacy does not necessarily cover all economic concepts simultaneously. Moreover, we find that the degree of consistency of consumers varies both across demographic groups and across time. Specifically, we show that women, as well as lower income and education groups are significantly worse at forming consistent macroeconomic expectations, particularly with respect to the Income Fisher equation. Moreover, the shares of

consumers consistent with the Phillips curve and the Taylor rule show a cyclical pattern over time with pronounced drops in consistency during recession periods.

Evaluating the impact of macroeconomic determinants on the likelihood of eliciting theory-consistent expectations, we provide evidence that consistency with respect to the Phillips curve and the Taylor rule drops with rising inflation above the official inflation target of 2%, while the effect is positive for consistency with the Income Fisher equation. Moreover, consumers are significantly less likely to form expectations consistent with the Phillips curve and the Taylor rule during recession periods. We further investigate the effect of recession periods by studying the interaction effects with other macro variables. We find that several macroeconomic variables exhibit asymmetric effects on consistency over the business cycle.

Since the understanding of the macroeconomic relations evaluated may be affected by the communication strategy of monetary policy, we additionally analyse the effect of changes in the communication strategy of the Fed on the likelihood of consumers forming consistent expectations. We find that communication measures had mostly positive effects on consistency, with the highest number of effects on consistency with the Taylor rule. This suggests that recent communication strategies contributed to increased understanding of the monetary policy. The most important communication measures in terms of the size of its effect and its significance for consistency with all three concepts under investigation turns out to be the announcement of changes in its target for the federal funds rate in February 1994 and the introduction of the official inflation target in January 2012.

Finally, we evaluate the forecast accuracy regarding future inflation of those consumers who form expectations consistent with those three macroeconomic relations, and compare their absolute forecast errors to those of the inconsistent sample of consumers in the Michigan Survey, as well as to those from the Survey of Professional Forecasters (SPF). This part of our analysis relates to Ang et al. (2007) who compare the forecasting accuracy for inflation of forecasts from ARIMA models, models of the Phillips curve, term structure models and survey measures. We find that consumers with theory-consistent expectations on average have lower absolute forecast errors regarding inflation compared to consumers with non-consistent expectations. Moreover, they are on average closer to the absolute forecast error of inflation forecasts from the SPF, except for the Fisher equation where there are no significant differences, and more often beat the SPF forecast. Again, we find some time-variation of these effects, suggesting that theory-consistency is particularly related to an improvement in inflation forecasting abilities in the later part of our sample.

There are several studies our paper is related to. The paper by Carvalho and Nechio (2012) is closely related to our analysis with respect to the Taylor rule. The authors study consistency of expectations across demographic groups and in comparison to the Survey of Professional Forecasters. We design a complementary exercise to study the Taylor rule relationship, but extent their approach in various ways. Besides considering further macroeconomic relations individually as well as jointly, we account for time variation, test

for possible determinants of having consistent expectations and link consistency of expectations to monetary policy communication and forecast accuracy. Another related paper is Fendel et al. (2011) where the authors rely on the Consensus Economic Forecast poll for the G-7 countries to estimate a Taylor rule relationship for professional forecasters. Interpreting the size of the estimated coefficients they conclude that professional forecasters apply Taylor type rules for their forecasts.

Overall, the existing literature has focused mainly on the formation of consumers' expectations on individual macroeconomic aggregates, measured from survey data, where most approaches focus on consumers' inflation expectations. Earlier studies such as Souleles (2004) and Mankiw et al. (2004) reject the rationality of U.S. consumers' inflation expectations and show that expectations are heterogeneous across demographic groups. Subsequently, Branch (2004, 2007) as well as Coibion and Gorodnichenko (2010, 2012) test for expectation formation processes with limited information. In addition, Carroll and Dunn (1997) as well as Curtin (2003) analyse the formation of U.S. consumers' unemployment expectations. They find a robust link between unemployment expectations and consumption and show that unemployment expectations contain private information measured by reported news heard on unemployment and by individual income expectations. More recently, Tortorice (2012) shows that consumers' unemployment expectations, like inflation expectations, are not formed rationally, but rather may be best explained by an extrapolative forecasting rule. Finally, Baghestani and Kherfi (2008) evaluate U.S. consumers' interest rate expectations and show that consumers are more likely to predict upwards than downwards movements if interest rates are relatively stable, interpreting this result as evidence in favour of asymmetric loss functions.

Analysing theory-consistency, our paper also relates to the literature on macroeconomic literacy, put forward by Blanchflower and Kelly (2008). The authors evaluate macroeconomic literacy regarding inflation and unemployment by estimating the likelihood for "don't know" answers in UK survey microdata asking for inflation expectations and satisfaction with the Bank of England. They find that illiteracy, i.e. the probability of non-response, is significantly higher for women, the young or the old as well as low education or low income groups. Moreover, respondents in the Eurobarometer Survey for the UK from these groups more often reported that they did not know the official rate of inflation. Generally, respondents who did report an estimate of the official inflation rate frequently overestimated actual inflation. In an experimental study, Burke and Manz (2011) moreover show that subjects with a higher economic literacy make a better choice of the information to use for forecasting and better use the given information in an inflation forecasting experiment.

Our paper also relates to the literature studying central bank communication practices. Over the last decades central banks have attached a lot of attention to various communication strategies aimed at explaining monetary policy decisions and guiding expectations of professional forecasters as well as expectations of consumers. While, as pointed out

by Blinder et al. (2008), communication and transparency improves the effectiveness of monetary policy, there is no consensus on what constitutes an optimal communication strategy.[1] Communication strategies of the Fed or more precisely of the Federal Open Market Committee are studied in, e.g., Middeldorp (2011) and Carlson et al. (2006).[2]

The rest of the paper is structured as follows. We describe our identification method for expectations that are consistent with the Fisher Income equation, the Phillips curve and the Taylor rule in detail in section 2. Section 3 offers a description of the dataset. Our results are presented in section 4 and section 5 concludes.

2 Measuring the Consistency of Macroeconomic Expectations

We test the consistency of consumers' macroeconomic expectations in the University of Michigan Survey of Consumers by evaluating three core relations in macroeconomic theory: The distinction between real and nominal values captured by an Income Fisher equation, the Phillips curve and the Taylor rule. Specifically, we check whether the formation of macroeconomic expectations at the time of the interview is consistent with the prediction of the macroeconomic concept being tested. Note that while the Fisher equation is a theoretical concept which should always be satisfied by definition, both the Phillips curve and the Taylor rule were initially derived as empirical regularities. Therefore, they are in reality likely not to be satisfied every period and we expect *a priori* the shares of consistency regarding the Phillips curve and the Taylor rule to be more responsive to current macroeconomic conditions.

First, we test if individual consumers correctly perceive the distinction between real and nominal values. This concept may be derived in the form of the Fisher equation, which describes the relation between nominal and real interest rates. Assuming that a bond earns a nominal return of i_t in the next period, its real return r_t must be depreciated with next period's expected inflation π_t^e:

$$r_t \approx i_t - \pi_t^e. \tag{1}$$

The Fisher equation thus gives the relation between real and nominal values and, hence, provides a concept to test also for money illusion. Since the Michigan Survey does not include any question about real interest rates, we apply the concept of the Fisher equation to consumers' real and nominal income expectations instead. We thus assume that since income expectations concern households' monetary income in the future, their real value

[1] See also Ehrmann and Fratzscher (2007).

[2] Furthermore, it has been shown by for instance Hayo and Neuenkirch (2010) for the Fed or Sturm and Haan (2011) for the ECB that communication can help predicting the future interest decision.

should be depreciated with expected inflation similar to bonds' returns in the Fisher equation. We label this relation the "Income Fisher equation":

$$rinc_t^e \approx inc_t^e - \pi_t^e, \tag{2}$$

where $rinc_t^e$ and inc_t^e denote consumers' real and nominal income expectations, respectively. The Michigan Survey asks consumers to provide quantitative estimates for both expected inflation and expected nominal income in the next 12 months:

A15a "By about what percent do you expect your (family) income to (increase/decrease) during the next 12 months?"

A12b "By about what percent do you expect prices to go (up/down) on the average, during the next 12 months?"

From these two measures, we construct the implied quantitative real income expectations by subtracting individual inflation expectations from individual nominal income expectations. To evaluate the consistency of implied real income expectations, we compare the quantitative estimate that would be consistent with the Income Fisher equation with the qualitative answer to the survey question for real income expectations:

A14 "During the next year or two, do you expect that your (family) income will go up more than prices will go up, about the same, or less than prices will go up?"

We define expectations as being consistent with the Income Fisher equation if the direction of consumers' qualitative real income expectations coincides with the sign of their implied quantitative real income expectations. Hence, if consumers report *"income goes up more than prices"*, they should report nominal price and income expectations which result in positive real income expectations and *vice versa*. Note that a small caveat applies: The horizon of the qualitative real income question includes the next 12 months as in the quantitative questions, but also the year after that. Nevertheless, we argue that it is unlikely that consumers expect such large variations in real income over two years, that they might for instance have positive real income expectations over the next 12 months, but expect a drop in their real income over the next 1-2 years.[3]

Next, we evaluate if consumers form their inflation and their output or unemployment expectations in line with the Phillips curve relation. The original Phillips curve proposed as an empirical relation by Phillips (1958) and Samuelson and Solow (1960) asserts a negative correlation between wage growth, or the general inflation rate π_t (assuming that prices grow in line with wages, adjusted for productivity growth), and the rate of unemployment u_t:

[3]Note that this argument is consistent with the law of iterated expectations.

$$\pi_t = f(u_t), \quad \text{with } \frac{\partial f}{\partial u_t} < 0. \tag{3}$$

Although the Phillips curve may be non-linear, with a smaller slope at low inflation rates, the trade-off between inflation and unemployment is generally assumed to hold at least in the short run. Note that we define the trade-off to be satisfied also if both inflation and unemployment stay constant. Via Okun's law, this may be translated into a positive correlation between inflation and output y_t:

$$\pi_t = f(y_t), \quad \text{with } \frac{\partial f}{\partial y_t} > 0. \tag{4}$$

Modern macroeconomic models generally derive the Phillips curve as an aggregate supply relation with forward-looking firms setting prices under monopolistic competition and subject to sticky prices. This results in the so-called New Keynesian Phillips Curve (Clarida et al., 1999):

$$\pi_t = \kappa E_t \pi_{t+1} + \lambda \hat{y}_t + \varepsilon_t, \tag{5}$$

where inflation is a function of expected inflation $E_t\pi_{t+1}$ and the output gap $\hat{y}_t$, and ε_t may be interpreted as a cost-push shock. Under the New Keynesian Phillips curve, we should thus also observe a positive correlation between inflation and the output gap, with its strength given by the coefficient λ.[4]

For our analysis of consumers' expectations, we concentrate on the short-run relation between inflation and the unemployment rate, or between inflation and business conditions, which we take as a proxy for the output gap. For all three variables, the Michigan survey includes qualitative questions asking for consumers' expectations over the next 12 months:

A7 "How about a year from now, do you expect that in the country as a whole business conditions will be better, or worse than they are present, or just about the same?"

A10 "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?"

A12 "During the next 12 months, do you think that prices in general will go up, (go up at the same rate), go down, or stay where they are now?"

We thus define consumers' expectations as being consistent with the Phillips curve if consumers expect prices to increase and unemployment to decrease or business conditions

[4]There is a possibility that the Phillips curve relationship is muted in real data due to the presence of various shocks. As Carlstrom and Fuerst (2008) point out, especially mark-up shocks might be problematic as they could lead to effects on output and inflation that are not consistent with the short-run Phillips curve correlations. However, under the assumption that shock are not observed, the expectations of the public should still be aligned with the Phillips curve relationship.

to improve and *vice versa*. Similarly, expectations are consistent when consumers expect unemployment or business conditions to stay the same and also expect prices or inflation to stay constant. Note that the wording of the qualitative question regarding inflation expectations asks for expectations regarding *price changes*, rather than the inflation rate. We thus interpret the answer "go up at the same rate", which is offered in a clarifying question only if consumers answer *"stay the same"*, as constant inflation expectations by the consumer and code it together with *"stay the same"*, i.e. zero inflation. We proceed in the same way for our definition of expectations consistent with the Taylor rule explained below.[5]

Finally, we analyse whether consumers form interest rate expectations in line with the Taylor rule, that is whether they are aware of the dual mandate of the Fed regarding price stability and high employment. The Taylor rule was formalized from empirical observations of the Fed's monetary policy by Taylor (1993) and states that the central bank adjusts nominal short-run interest rates i_t in response to both deviations of inflation from the target level $(\pi_t - \pi^*)$ and the output gap $\hat{y}_t$. The general Taylor rule, widely used in modern macroeconomics to describe monetary policy actions, thus takes on the following form:

$$i_t = \gamma + \alpha(\pi_t - \pi^*) + \beta\hat{y}_t \qquad \text{with} \quad \alpha > 1, \beta > 0 \tag{6}$$

We again measure consumers' inflation expectations with the qualitative question [A12] and use either the expectations regarding unemployment (where we expect a reversed sign) in [A10] or regarding business conditions in [A7] as our proxy for the output gap. Finally, the Michigan Survey includes a qualitative question on nominal interest rates, which reads as follows:

[5] We checked for robustness of our results if the "prices go up at the same rate" category is counted as positive inflation expectations together with "go up" and found that results did not change qualitatively. Note that the qualitative inflation question in [A12] is potentially problematic since the question is phrased in terms of prices, rather than in terms of the inflation rate. Therefore, we checked for the robustness of our definitions of consistency if qualitative inflation questions are coded together with the consumers' quantitative inflation expectations in question [A12b], which asks for a point estimate of the expected inflation rate in percent. Figure A.1 in the appendix shows the shares of consumers consistent with the Phillips curve and the Taylor rule for alternative definitions of qualitative inflation expectations. Shares denoted with *_combined* condition on the difference of individuals' quantitative inflation expectations to last month's actual inflation (rounded to the nearest integer), and only code expectations as "increase" if an individual answered "go up" in question [A12] **and** expected higher quantitative inflation than last period's inflation rate (and *vice versa* for "stay the same" and "decrease"). Shares denoted with $\_consdiff$ condition on individuals within the rotating panel dimension and additionally uses the difference in quantitative inflation expectations between interviews. Hence, qualitative expectations will only be coded as "increase" if the consumers answers "go up" in the second interview **and** has higher quantitative inflation expectations than in the first interview. Obviously, both robustness checks imply a loss of observations. Nevertheless, the consistency shares shown in Figure A.1 suggest that our initial definition is relatively robust to these more conservative definitions, as the shares have very similar patterns.

A11 "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?"

We thus code consumers' expectations as being in line with the Taylor rule if respondents report that they expect rising interest rates, as well as increasing prices and falling unemployment (better business conditions). Furthermore, interest rate expectations are also consistent with the Taylor rule if consumers expect rising interest rates with either rising price expectations or falling unemployment (better business conditions) expectations, while the other variable is expected to remain constant. The same rules apply to expectations regarding falling interest rate expectations. Finally, if interest rates are expected to remain constant, both prices and unemployment (business conditions) must also be expected to stay the same.[6]

To simplify the discussion, in the paper we present only results regarding consistency with the Phillips curve and the Taylor rule defined with unemployment expectations, and as a robustness check show some results of probit models that take into account potential sample selection issues with expectations on business conditions in Table A.5 (second columns) in the appendix. Generally, results differ little between specifications with unemployment or business expectations. Additionally, since the Michigan Survey includes a rotating panel dimension where a fraction of consumers is re-interviewed after six months, consistency with both the Phillips curve and the Taylor rule can also be analysed with respect to individual changes in expectations. Under this definition, we define expectations as being consistent if the direction of changes match the macroeconomic relation. For instance, if a consumer has lower unemployment expectations in the second interview compared to the first, she should also have increased her inflation expectations and *vice versa*. Again, we show some results for consistency of differences in expectations in the robustness analysis in Table A.5 (third columns) in the appendix. Here, the sign of the marginal effects is often reversed in both the models for consistency with the Phillips curve and with the Taylor rule.

3 Data

For our analysis, we use the microdata of the University of Michigan Survey of Consumers. The survey collects monthly data since January 1978 on consumers' macroeconomic expectations, personal income expectations, purchasing attitudes, perceived economic news, wealth position as well as demographic characteristics. Each monthly cross-section is

[6] As Carvalho and Nechio (2012) point out, there is a potential endogeneity and causality problem when discussing the relationship among these forecasts. Households' expectations might not reveal the causal effect of inflation and unemployment on interest rates as there exists a potential endogeneity due to monetary policy shocks (i.e. departures from systematic interest rate policy). However, Carvalho and Nechio (2012) show that monetary policy shocks account only for a very small fraction of the variability in inflation and the output gap in the US.

chosen as a representative sample of the U.S. population. Additionally, about 40% of each monthly sample are chosen to be re-interviewed after six months, so that the survey contains a rotating panel dimension. We employ the full available sample period from January 1978 to September 2012 and include the whole cross-section in our analysis.[7]

In addition to the survey questions on consumers' expectations reviewed in the previous section, we use a number of variables from the Michigan Survey as explanatory and control variables. These contain personal demographic characteristics and their interaction terms, where we include the consumer's sex, age, race, marital status, number of children, region as well as education and income groups. While household income is grouped into quintiles, the education groups are defined as follows: *educ1* – "*Grade 0-8, no high school diploma*", *educ2* – "*Grade 9-12, no high school diploma*", *educ3* – "*Grade 0-12, with high school diploma*", *educ4* – "*4 yrs. of college, no degree*", *educ5* – "*3 yrs. of college, with degree*" and *educ6* – "*4 yrs. of college, with degree*". For the analysis of consistency across demographic groups, we further define the following age groups: *age young – 18-34*, *age medium – 35-54* and *age old – 55-97*.

In addition to the microdata from the Michigan survey, a number of macroeconomic variables are included as explanatory variables in the analysis. These include the CPI inflation rate (π) and its volatility (σ_π^2) measured as the sum of squared inflation changes over the previous six months. Moreover, we include data on the civilian unemployment rate (u), the growth rate of the money stock M2 ($m2growth$), the Federal Funds rate ($funds\_rate$), year-on-year oil price growth (oil) as well as a dummy variable $nber\_recession$ which indicates whether the current month is classified as a recession by the NBER. All macroeconomic data is obtained from the FRED database of the St. Louis Federal Reserve.

Additionally, we aim at evaluating the effects of changes in the monetary policy communication strategy on consumers' ability to form consistent macroeconomic expectations. Therefore, we construct dummy variables representing important milestones on the path to more communication and greater transparency. In particular, we control for the introduction of the Beige Book first published in June 1983 ($BeigeBook83_t$), the announcement of changes in its target for the federal funds rate in February 1994 ($FFTargetAnnouncement94_t$), the practice of issuing a "balance of risks" statement along with the policy decision in January 2000 ($BalanceofRisk00_t$), the inclusion of votes with name(s) of dissenters in the statement in March 2002 ($Votes02_t$), providing forward guidance by explicitly indicating the likely direction of rates over an extended period in August 2003 ($ForwardGuidance03_t$), adding the Chairman's press conference to the release of projections in April 2011 ($PressConference11_t$) and finally including an explicit inflation target of 2% in January 2012 ($ExplicitTarget12_t$).

Finally, we use data on professionals' inflation expectations from the SPF in order to compare the forecasting accuracy of consistent consumers with that of professional

[7]For further details on the University of Michigan Survey of Consumers, see http://www.sca.isr.umich.edu.

forecasters. The SPF contains, *inter alia*, quarterly forecasts on inflation over the next 12 months ($\pi_{prof}^{e,1yr}$), where one-year-ahead forecasts are available since 1981q3.

4 Results

4.1 Consistency of Expectations over Time and Across Demographic Groups

In this section, we present and discuss how many consumers form expectations in line with the three mentioned economic concepts (i.e., Income Fisher equation, Phillips curve and Taylor rule). First, we show how the share of consumers with consistent expectations varies across the three economic concepts as well as across sociodemographic groups, where we compare shares between males and females, across age and education groups as well as income quintiles. Note that the unconditional probability of forming theory-consistent expectations in the Michigan Survey is one third for the Income Fisher equation and the Phillips Curve, while it is 25.9% for the Taylor rule. Additionally, the unconditional probability of being consistent with all three principles is 2.88%. For all three relations individually as well as taken together, we find that the overall share of consistent consumers is significantly different from the unconditional probability, see Tables 1-4. Second, we check if the share of consumers with consistent expectations changes over time. If we find support for the latter, it will make sense to check for possible determinants that may affect the degree of consistency.

The following tables show how many individuals, relative to the overall sample, behave in line with accredited economic concepts. Regarding the Income Fisher equation, see Table 1, we conclude that roughly 51% of the surveyed population have theory-consistent expectations. When looking at the sociodemographic characteristics, it seems that men are more consistent than women. Moreover, the propensity to behave in line with the Income Fisher equation rises with education, income, and age. According to t-tests for equality of means and Kruskal-Wallis rank tests for equality of population, in all sociodemographic groups both the mean and the median are significantly different from the remaining sample.[8]

With regard to the Phillips curve (Table 2), on average a lower share of households (26%) forms their expectations in line with this economic relationship than with the Income Fisher equation. While for the Income Fisher equation we could report substantial variation across educational groups, the shares forming expectations in line with the Phillips Curve seem to be relatively homogeneously distributed across all educational

[8]We also apply Kruskal-Wallis equality-of-populations rank tests to test for significant differences in medians within the demographic groups, i.e. within age, education and income groups, for the shares shown in Tables 1-4. In all cases, except for the age groups of consistency with the Taylor rule, we find that the medians differ significantly also within groups. Test results are available from the authors upon request.

Table 1: Shares of Consumers with Consistent Expectations Regarding the Income Fisher Equation

	Mean	Median	SD	Min	Max	N	T-test Mean	K-W Test Median
All	0.51	0.51	0.04	0.41	0.64	223,143	97.23***	–
Male	0.54	0.54	0.04	0.40	0.67	99,539	-20.23***	306.08***
Female	0.49	0.49	0.04	0.37	0.64	123,237	20.22***	305.70***
Age young	0.48	0.49	0.05	0.26	0.61	65,133	15.71***	184.81***
Age medium	0.52	0.52	0.04	0.41	0.66	83,472	-3.61***	9.73***
Age old	0.53	0.53	0.06	0.37	0.69	73,283	-11.84***	104.94***
Educ1	0.47	0.47	0.13	0.00	1.00	9,896	7.11***	37.88***
Educ2	0.47	0.47	0.10	0.13	0.85	15,703	10.06***	75.83***
Educ3	0.47	0.47	0.05	0.34	0.73	68,603	22.16***	367.03***
Educ4	0.51	0.51	0.06	0.33	0.68	53,007	1.43	1.52
Educ5	0.54	0.54	0.06	0.36	0.72	44,962	-13.62***	138.98***
Educ6	0.59	0.58	0.06	0.41	0.81	28,672	-25.43***	483.07***
Inc quint1	0.50	0.50	0.07	0.24	0.75	32,181	5.34***	21.37***
Inc quint2	0.50	0.50	0.07	0.28	0.72	37,637	4.09***	12.51***
Inc quint3	0.50	0.50	0.06	0.31	0.72	39,113	3.71***	10.31***
Inc quint4	0.50	0.50	0.06	0.36	0.73	47,219	4.35***	14.18**
Inc quint5	0.54	0.54	0.05	0.37	0.71	49,124	-15.34***	176.07***

Notes: The last two columns represent (except the first row- All) tests for equality of means (medians) between a particular subsample indicated in the first column and the rest of the sample. For the mean we employ a two-sample mean-comparison t-test with equal variances and for the median a Kruskal-Wallis equality-of-populations rank test. In the first row we test whether the mean is different from the unconditional probability of having theory-consistent expectations in the Michigan Survey (0.33) with a one-sample t-test. ***/**/* indicates significance at the 1/5/10% level.

groups. Otherwise the patterns are very similar. In most cases the sub-groups are significantly different from the rest of the sample. The rather low variation across sociodemographic groups together with the substantial gap between minimum and maximum values already suggest a remarkable time variation. We will dwell on this issue by visual inspection and by an econometric analysis at a later point. Both will support this conjecture.

With respect to the Taylor rule (Table 3) we find the share of consumers that adjust their expectations in line with the Taylor rule concept to be similar to the share of consumers consistent with the Income Fisher equation. Roughly one-half of the population form consistent expectations. Similar to the results for the Phillips curve, we find only little, but nevertheless often significant, variation across socioeconomic characteristics and substantial variation over time. Hence, time-variant factors also seem to play an important role here.

Table 2: Shares of Consumers with Consistent Expectations Regarding the Phillips Curve

	Mean	Median	SD	Min	Max	N	T-test Mean	K-W Test Median
All	0.26	0.27	0.07	0.07	0.41	238,396	-85.38***	–
Male	0.27	0.28	0.08	0.07	0.47	106,349	-13.46***	103.40***
Female	0.25	0.25	0.06	0.07	0.39	131,542	13.19***	99.37***
Age young	0.26	0.27	0.08	0.03	0.48	71,453	-4.75***	12.85***
Age medium	0.25	0.26	0.07	0.07	0.48	88,146	6.80***	26.43***
Age old	0.26	0.27	0.07	0.08	0.44	77,329	-2.62***	3.90**
Educ1	0.27	0.26	0.10	0.00	0.60	11,042	-3.52***	7.13***
Educ2	0.24	0.23	0.08	0.00	0.55	17,527	4.83***	13.37***
Educ3	0.25	0.25	0.07	0.05	0.43	73,949	7.11***	29.00***
Educ4	0.25	0.26	0.08	0.06	0.46	56,170	0.97	0.53
Educ5	0.27	0.28	0.08	0.02	0.48	46,924	-7.62***	33.24***
Educ6	0.26	0.27	0.10	0.03	0.55	30,038	-3.58***	7.37***
Inc quint1	0.25	0.25	0.06	0.00	0.48	32,552	4.88***	13.88***
Inc quint2	0.25	0.25	0.07	0.00	0.45	38,675	7.58***	33.47***
Inc quint3	0.26	0.26	0.07	0.03	0.50	39,847	3.48***	7.04***
Inc quint4	0.27	0.27	0.08	0.03	0.47	48,349	-2.23**	2.90*
Inc quint5	0.28	0.29	0.09	0.00	0.51	50,470	-11.91***	82.65***

Notes: The last two columns represent (except the first row- All) tests for equality of means (medians) between a particular subsample indicated in the first column and the rest of the sample. For the mean we employ a two-sample mean-comparison t-test with equal variances and for the median a Kruskal-Wallis equality-of-populations rank test. In the first row we test whether the mean is different from the unconditional probability of having theory-consistent expectations in the Michigan Survey (0.33) with a one-sample t-test. ***/**/* indicates significance at the 1/5/10% level.

Finally, we present the summary statistics for the share of people that form consistent estimates for all three economic concepts simultaneously at a time. Results are presented in Table 4. Only 6% of the surveyed population have expectations that are in line with all three concepts. This is significantly below the average of the individual tables and indicates that if people have reacted for instance appropriately with regard to the Taylor rule, this does not necessarily imply that they will form expectations in line with the other economic concepts. Nevertheless, this still seems to increase the likelihood of being consistent with all three relations as we find that 6% is significantly higher than the unconditional probability of 2.9%. Again, we find rather little variation across sociodemographic characteristics, but increased variation over time. This result thus also supports the presumption that the degree of consistency is time-varying and may be linked and tested with regard to a set of possible macroeconomic determinants.

The substantial time variation indicated by the previous tables calls for a deeper investigation of this issue. Consequently, we plot the calculated shares over time. Figure 1 shows the shares of consistent expectations for all three economic concepts individually

Table 3: Shares of Consumers with Consistent Expectations Regarding the Taylor Rule

	Mean	Median	SD	Min	Max	N	T-test Mean	K-W Test Median
All	0.51	0.52	0.09	0.25	0.67	238,396	43.44***	–
Male	0.50	0.51	0.10	0.20	0.72	106,349	5.22***	20.47***
Female	0.51	0.52	0.08	0.25	0.68	131,542	-5.29***	20.96***
Age young	0.51	0.52	0.09	0.23	0.72	71,453	-0.03	-0.02
Age middle	0.50	0.52	0.10	0.19	0.71	88,146	0.96	0.72
Age old	0.51	0.52	0.10	0.27	0.69	77,329	-1.07	0.90
Educ1	0.47	0.47	0.12	0.14	1.00	11,042	7.18***	38.61***
Educ2	0.47	0.46	0.11	0.15	0.86	17,527	10.55***	83.53***
Educ3	0.50	0.52	0.09	0.27	0.69	73,949	1.72*	2.26
Educ4	0.51	0.52	0.09	0.20	0.74	56,170	-1.21	1.13
Educ5	0.52	0.54	0.11	0.17	0.78	46,924	-7.63***	43.65***
Educ6	0.52	0.54	0.13	0.14	0.81	30,038	-4.16***	12.97***
Inc quint1	0.47	0.48	0.09	0.17	0.71	32,552	11.98***	107.52***
Inc quint2	0.50	0.51	0.09	0.23	0.71	38,675	3.57***	9.54***
Inc quint3	0.51	0.52	0.10	0.25	0.75	39,847	-4.29***	13.83***
Inc quint4	0.51	0.52	0.10	0.21	0.83	48,349	-1.92**	2.75*
Inc quint5	0.52	0.53	0.12	0.20	0.79	50,470	-7.27***	39.57***

Notes: The last two columns represent (except the first row- All) tests for equality of means (medians) between a particular subsample indicated in the first column and the rest of the sample. For the mean we employ a two-sample mean-comparison t-test with equal variances and for the median a Kruskal-Wallis equality-of-populations rank test. In the first row we test whether the mean is different from the unconditional probability of having theory-consistent expectations in the Michigan Survey (0.26) with a one-sample t-test. ***/**/* indicates significance at the 1/5/10% level.

as well as the share of consistent expectations satisfying all three economic concepts simultaneously.

Regarding the Income Fisher equation, we observe, as indicated by the tables, rather little time variation. This is in line with our presumption that the distinction between real and nominal income should be less dependent on changes in macroeconomic conditions than the Phillips curve and the Taylor rule which may not always be satisfied in reality.[9] Nevertheless, over the last ten years the consistency of the public with respect to the Income Fisher equation seems to follow an upwards trend, thus consumers become more able to form nominal income and inflation expectations in line with their real income expectations. This might be due to very low and stable inflation rates in the recent years.

[9]Figure A.2 in the appendix depicts the shares of consumers consistent with the Phillips curve and the Taylor rule together with the periods when the Phillips curve trade-off and the Taylor rule concept where realised in actual data 12 months ahead, rounded to the nearest integer. It seems that both were realised in the majority of periods in our sample. However, there are pronounced gaps at the beginning of the sample period, when the U.S. economy was hit by stagflation and monetary policy was less active. This could provide an explanation of the low consistency shares observed during this period.

Table 4: Shares of Consumers with Consistent Expectations for All Three Economic Concepts

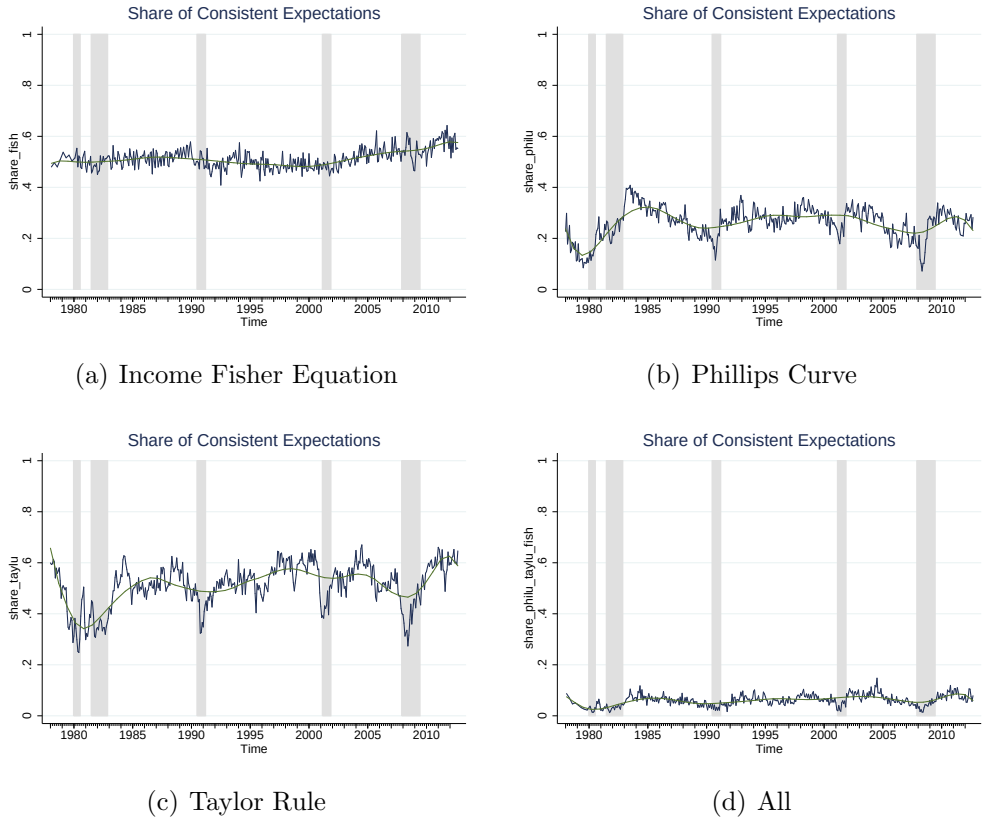
	Mean	Median	SD	Min	Max	N	T-test Mean	K-W Test Median
All	0.06	0.06	0.02	0.01	0.15	223,143	29.13***	–
Male	0.07	0.06	0.03	0.00	0.19	99,539	-11.16***	21.24***
Female	0.05	0.05	0.02	0.01	0.13	123,237	11.10***	21.04***
Age young	0.06	0.06	0.03	0.00	0.23	65,133	2.83***	1.36
Age middle	0.06	0.06	0.03	0.01	0.15	83,472	2.46**	1.02
Age old	0.06	0.06	0.03	0.00	0.18	73,283	-5.40***	4.99**
Educ1	0.06	0.05	0.08	0.00	0.67	9,896	-0.90	0.13
Educ2	0.05	0.04	0.05	0.00	0.21	15,703	4.12***	2.86*
Educ3	0.05	0.05	0.02	0.00	0.16	68,603	10.64***	19.30***
Educ4	0.06	0.06	0.03	0.00	0.22	53,007	1.71*	0.48
Educ5	0.07	0.07	0.04	0.00	0.20	44,962	-7.60***	9.82***
Educ6	0.07	0.07	0.05	0.00	0.20	28,672	-9.57***	15.63***
Inc quint1	0.06	0.06	0.03	0.00	0.19	32,181	2.22**	0.82
Inc quint2	0.05	0.05	0.03	0.00	0.16	37,637	5.91***	5.93**
Inc quint3	0.06	0.05	0.03	0.00	0.15	39,113	2.79***	1.26
Inc quint4	0.06	0.05	0.03	0.00	0.17	47,219	2.30**	0.88
Inc quint5	0.07	0.07	0.04	0.00	0.24	49,124	-11.63***	23.08***

Notes: The last two columns represent (except the first row- All) tests for equality of means (medians) between a particular subsample indicated in the first column and the rest of the sample. For the mean we employ a two-sample mean-comparison t-test with equal variances and for the median a Kruskal-Wallis equality-of-populations rank test. In the first row we test whether the mean is different from the unconditional probability of having theory-consistent expectations in the Michigan Survey (0.029) with a one-sample t-test. ***/**/* indicates significance at the 1/5/10% level.

With respect to the Phillips curve and the Taylor rule, the consistency shares show much more time variation with a pronounced cyclical pattern. Recession periods denoted by the NBER, indicated by the shaded areas, seem to impair the ability to form consistent expectations as they correspond with downward dips in the consistency shares. Looking at the Taylor rule share specifically, we can report that people can forecast rising and constant interest rates more accurately than falling interest rates. Within a tightening cycle the expectations become more in line with the Taylor rule concept. The same holds true for unchanged interest rates. This asymmetric response is not surprising as it may stem from people being unable to forecast recessions are having problems absorbing negative news or policy reversals.

Finally, we further find some variation over time of the share of consumers consistent with all three macroeconomic relations, albeit at a very low level. Again, we observe small dips during recession periods.

Figure 1: Shares of Consistent Expectations



(a) Income Fisher Equation

(b) Phillips Curve

(c) Taylor Rule

(d) All

Note: Graphs present the shares of consumers with consistent expectations, together with a polynomial trend. Shaded areas denote recession periods as defined by the NBER.

While we have shown that the shares of consistent consumers vary over time and across demographic groups, it is also interesting to check if consumers stay consistent between the first and the second interview of the rotating panel. Overall, between 50-60% of consumers are either consistent or inconsistent in both interviews, where this result holds for all three concepts evaluated. Moreover, being consistent in the first interview increases the likelihood of consistency in the second interview by about 15-16% for a representative consumer as defined below, with a highly significant effect.[10] Indeed, the shares of consistent consumers increase in the second interview, implying some learning effect between the first and the second interview.

Furthermore, we are interested in elaborating the reasons why expectations are not consistent with the economic concepts. Hence, before we turn to a more rigorous econometric approach, we introduce cross tabulations of the underlying expectations in Tables A.1-A.4 in the Appendix. Looking at the Income Fisher relationship in Table A.1, we observe that there are more inconsistent households that have negative real income expectations, but at the same time expect higher growth in nominal income than in prices,

[10]Estimation results from heckprobit models controlling for demographic factors are available from the authors upon request.

than *vice versa*. Table A.2 indicates that the reason why households produce forecasts that are not consistent with the Phillips curve is that those households that report prices to go up, do not expect unemployment to go down. In fact, more than 85% of households who expect inflation to go up, predict the unemployment rate to stay about the same or to be higher in the next year. Dissecting the Taylor rule relationship in Tables A.3 and A.4 implies that households get the relationship between inflation and interest rates quite right, but have more problems with the relation between unemployment and interest rates. There exist only weak links between expecting higher rates of unemployment and falling interest rates.[11] This is quite an interesting result. The Fed is known to put significant weight on unemployment rates and economic growth relative to inflation as compared for instance to the ECB. Therefore, it is remarkable that consumers in the U.S. have still difficulties in understanding this relationship for a central bank that is as active in regarding stabilizing unemployment as the Fed is.

Overall, this section provides some very interesting insights. Looking at consistency, we find that half of the surveyed U.S. population holds beliefs in line with the Taylor rule and the Income Fisher equation. Expectations consistent with the Phillips curve are observed only in 25% of cases. For concsistency with respect to the Phillips curve and the Taylor rule, we find more time-variation than cross-sectional variation, while the reverse is true for consistency with the Income Fisher equation. The observed time-variation seems to be linked to macroeconomic fundamentals as we observe strong patterns with respect to recessions, where the share of consistent answers drops dramatically.

4.2 Determinants of Consistency

In this section, we analyse possible macroeconomic determinants for the formation of consistent expectations and check for effects of monetary policy communication. Specifically, we evaluate effects of macroeconomic conditions like inflation, unemployment, money growth, short-run interest rates or the effect of being in a recession. After the benchmark estimation, we evaluate the inflation effect on consistency in more detail by distinguishing between inflation above and below the official target of 2%. Next, we check whether macroeconomic effects differ between boom and recession periods. Finally, we analyse how changes in the communication strategy of the Federal Reserve have affected consumers' consistency with macroeconomic concepts. All macroeconomic variables are included with one lag in order to account for a possible publication lag.

We estimate probit models on the probability of forming theory-consistent expectations regarding the Income Fisher equation, the Phillips curve, the Taylor rule as well as all three macroeconomic relations simultaneously. Tables 5-8 report marginal effects for our set of determinants. In order to enable comparability across models, all marginal effects are evaluated at a hypothetical "representative" consumer which we take to be male,

[11] This result is in line with Carvalho and Nechio (2012).

white, 40 years old, married, with a medium level of education and income and living in the Northcentral region of the U.S. All models additionally include a wide range of demographic controls including interaction terms.

We thus specify a binary response model. The following variable is defined:

$$z_{i,t} = \begin{cases} 1 \text{ if } z^*_{i,t} > 0 \\ 0 \text{ if } z^*_{i,t} \leq 0 \end{cases}, \; i = 1, 2, ..., N, \tag{7}$$

where $z^*_{i,t}$ is the latent variable that accounts for consumers' theory-consistent expectations. Its discrete counterpart, $z_{i,t}$, takes value one if the ith respondent formed theory-consistent expectations in period t, and zero otherwise. The following latent process is assumed:

$$z^*_{i,t} = \alpha_1 + \mathbf{y}_t\alpha_2 + \mathbf{x}_{i,t}\alpha_3 + u_{i,t}, \tag{8}$$

where α_1 is a constant, $\mathbf{y}_t$ is the vector of macroeconomic variables, $\mathbf{x}_{i,t}$ is a vector of socio-demographic characteristics (namely gender, age, income, education, race, marital status, location in the US and interaction terms between gender and education, race and region, as well as income and marital status) and $u_{i,t}$ is normally distributed. We derive the marginal partial effects from the estimation of $\Pr(z_{i,t}= 1|\, \mathbf{h}_{i,t}) = \Phi(\mathbf{h}_{i,t}\xi)$, where $\Phi(\cdot)$ is the CDF of the standard normal distribution, $\mathbf{h}_{i,t}$ is the vector of covariates and ξ is a vector of coefficients.

Since our dataset contains single survey interviews as well as interviews within the rotating panel, estimations on the full dataset may lead to biased estimates due to a sample selection problem. Moreover, additional sample selection might arise from non-response bias, which might be higher for specific demographic groups.[12] We therefore account for possible attrition both with respect to non-response and with respect to being selected into the rotating panel and estimate all models with a Heckman correction. Our selection variable thus takes on the value of one for second interviews within the rotating panel, conditional on response to the question on quantitative inflation expectations.[13] Sample selection will only bias the estimates if the error terms of the outcome and of the selection equation are significantly correlated as measured by the parameter ρ. Overall, sample selection seems to have relatively small effects in our models since a Wald test frequently cannot reject $\rho = 0$.

The marginal effects from the Heckman probit models in Table 5 imply that U.S. consumers are less likely to form theory-consistent macroeconomic expectations with respect

[12]Specifically, we evaluate non-response to the question on quantitative inflation expectations. We argue that this question might be perceived as being more demanding than the qualitative questions and, thus, more prone to non-response.

[13]Note that our Heckman probit estimates thus effectively account for only second interviews within the rotating panel.

to the Taylor rule in periods with high inflation.[14] Additionally, we find a positive effect of inflation volatility on consistency with the Phillips curve and with all concepts simultaneously, which could be linked to an increase in attention towards macroeconomic variables in these periods. Interestingly, inflation volatility has a negative impact on consistency with the Income Fisher equation. Higher unemployment or a higher Federal Fund rate also significantly reduce the likelihood of consistent expectations regarding the Income Fisher equation and the Taylor rule. Moreover, consumers show significantly lower degrees of consistency with the Phillips curve and the Taylor rule in recession periods, while we find no significant business-cycle-effect on consistency with the Income Fisher equation. This result is as expected, considering the low time-variation in the share of consistent consumers regarding the Income Fisher equation compared to consistency shares regarding the Phillips curve and the Taylor rule.

Table 5: Macro Determinants of Consistency

	Income Fisher eq.	Phillips curve	Taylor rule	All Three
π_{t-1}	0.0052	-0.0039	-0.0140***	0.0023
	(0.0040)	(0.0043)	(0.0042)	(0.0030)
$\sigma^2_{\pi,t-1}$	-0.0050***	0.0064***	0.0027	0.0026*
	(0.0018)	(0.0019)	(0.0019)	(0.0013)
oil_{t-1}	0.0002*	-0.0003**	-0.0001	-0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
u_{t-1}	-0.0215***	0.0165*	-0.0242***	-0.0010
	(0.0078)	(0.0098)	(0.0085)	(0.0070)
$m2growth_{t-1}$	0.0002	-0.0048**	-0.0013	-0.0038**
	(0.0021)	(0.0022)	(0.0022)	(0.0018)
$funds\_rate_{t-1}$	-0.0107**	-0.0060	-0.0155***	-0.0072
	(0.0049)	(0.0058)	(0.0052)	(0.0050)
$nber\_recession_t$	0.0046	-0.0338***	-0.0472***	0.0108
	(0.0111)	(0.0130)	(0.0131)	(0.0104)
N	93763	95893	95389	93109
χ^2	848.684	1127.469	1108.565	467.516
Demographic Controls	Yes	Yes	Yes	Yes
ρ	-0.736	-0.290	-0.321	-0.376
Wald test (ρ=0, χ^2)	11.12***	1.32	2.57	1.44

Notes: Table 5 reports the marginal partial effects from the heckprobit models evaluated at the representative consumer. The Wald test for $\rho = 0$ gives the χ^2 statistics of the Wald test for independence from the sample selection equation. Standard errors are calculated with the δ method (Oehlert 1992) and are reported in parentheses. ***/**/* indicates significance at the 1/5/10% level.

[14] We show some results for consistency when the Phillips curve and the Taylor rule are specified with business cycle expectations instead of unemployment expectations and when we evaluate the consistency of individual differences in expectations in the robustness analysis in Table A.5 in the appendix. The results remain broadly consistent when using business cycle expectations. However, the sign of the marginal effects is often reversed in the models for consistency of differences in expectations.

Table 6: Inflation Effects Above and Below 2% on Consistency

	Income Fisher eq.	Phillips curve	Taylor rule	All Three
$dummy\_\pi\_below2_{t-1}$	0.0247**	-0.0838***	-0.0444***	-0.0159
	(0.0116)	(0.0135)	(0.0137)	(0.0103)
π_{t-1}	0.0127***	-0.0298***	-0.0170***	-0.0039
	(0.0029)	(0.0033)	(0.0033)	(0.0026)
$\pi_{t-1} * dummy\_\pi\_below2_{t-1}$	-0.0080	0.0440***	0.0182***	0.0146***
	(0.0056)	(0.0064)	(0.0065)	(0.0053)
$\sigma^2_{\pi,t-1}$	-0.0009	-0.0004	-0.0043*	0.0015
	(0.0020)	(0.0024)	(0.0023)	(0.0017)
$\sigma^2_{\pi,t-1} * dummy\_\pi\_below2_{t-1}$	-0.0009	-0.0022	0.0065**	-0.0016
	(0.0025)	(0.0031)	(0.0030)	(0.0023)
oil_{t-1}	0.0002***	0.0000	0.0004***	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
u_{t-1}	0.0072***	0.0179***	-0.0012	0.0048**
	(0.0012)	(0.0017)	(0.0014)	(0.0019)
$m2growth_{t-1}$	0.0026***	0.0033***	0.0023***	0.0015
	(0.0007)	(0.0011)	(0.0009)	(0.0011)
$funds\_rate_{t-1}$	-0.0086***	0.0046**	-0.0058***	-0.0042
	(0.0010)	(0.0023)	(0.0014)	(0.0027)
$nber\_recession_t$	0.0032	-0.0565***	-0.1159***	-0.0324***
	(0.0085)	(0.0114)	(0.0166)	(0.0070)
N	93763	95893	95389	93109
χ^2	649.422	913.08	680.389	355.887
Demographic Controls	Yes	Yes	Yes	Yes
ρ	-0.814	-0.302	-0.407	-0.508
Wald test (ρ=0, χ^2)	12.95***	1.10	3.46*	2.01

Notes: Table 6 reports the marginal partial effects from the heckprobit models evaluated at the representative consumer. The Wald test for $\rho = 0$ gives the χ^2 statistics of the Wald test for independence from the sample selection equation. Standard errors are calculated with the δ method (Oehlert 1992) and are reported in parentheses. ***/**/* indicates significance at the 1/5/10% level.

Next, we evaluate the nature of the inflation effect on consistency in more detail. In Table 6 we check whether inflation effects on consistency differ between periods with inflation above or below the official target of 2%. Interestingly, this gives a positive marginal effect of inflation rates on consistency with the Income Fisher equation, while the inflation volatility effect becomes insignificant. By contrast, consistency with the Phillips curve and the Taylor rule, and to some extent also consistency with all relations, is negatively affected by inflation at rates above 2%: At high inflation rates, consumers are increasingly unsure about the inflation-unemployment trade-off and the appropriate monetary policy reaction. Additionally, we find a positive inflation effect at rates below 2%, suggesting that consumers also have problems with correctly identifying the macroeconomic relations under consideration when inflation is below the target. Interestingly, the marginal

Table 7: Recession Interaction Effects on Consistency

	Income Fisher eq.	Phillips curve	Taylor rule	All Three
π_{t-1}	0.0127***	-0.0171***	-0.0096***	-0.0014
	(0.0029)	(0.0027)	(0.0029)	(0.0016)
$\pi_{t-1} * nber\_recession_t$	-0.0065	0.0411***	0.0159	0.0139*
	(0.0116)	(0.0118)	(0.0114)	(0.0079)
$\sigma^2_{\pi,t-1}$	0.0022	-0.0011	-0.0072***	-0.0003
	(0.0023)	(0.0022)	(0.0022)	(0.0014)
$\sigma^2_{\pi,t-1} * nber\_recession_t$	-0.0047	-0.0049	0.0054	0.0024
	(0.0040)	(0.0038)	(0.0039)	(0.0025)
oil_{t-1}	-0.0001	0.0001	0.0006***	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
$oil_{t-1} * nber\_recession_t$	0.0009***	-0.0022***	-0.0015***	-0.0004**
	(0.0003)	(0.0003)	(0.0003)	(0.0002)
u_{t-1}	0.0069***	0.0156***	-0.0028**	0.0029***
	(0.0015)	(0.0014)	(0.0014)	(0.0009)
$u_{t-1} * nber\_recession_t$	0.0095	-0.0039	0.0139*	0.0070
	(0.0080)	(0.0085)	(0.0079)	(0.0053)
$m2growth_{t-1}$	0.0007	0.0038***	0.0015*	0.0013**
	(0.0009)	(0.0009)	(0.0009)	(0.0006)
$m2growth_{t-1} * nber\_recession_t$	0.0113	-0.0068	0.0233**	0.0080
	(0.0097)	(0.0102)	(0.0095)	(0.0064)
$funds\_rate_{t-1}$	-0.0041***	0.0032**	-0.0040***	-0.0031***
	(0.0014)	(0.0013)	(0.0014)	(0.0010)
$funds\_rate_{t-1} * nber\_recession_t$	0.0036	-0.0152***	0.0132***	0.0031
	(0.0051)	(0.0053)	(0.0051)	(0.0035)
$nber\_recession_t$	-0.1517	-0.0620	-0.4810***	-0.1971
	(0.1317)	(0.1427)	(0.1300)	(0.0889)
N	93763	95893	95389	93109
χ^2	609.24	861.226	778.205	289.099
Demographic Controls	Yes	Yes	Yes	Yes
ρ	-0.019	-0.336	0.026	-0.265
Wald test (ρ=0, χ^2)	0.06	14.35***	0.06	6.49**

Notes: Table 7 reports the marginal partial effects from the heckprobit models evaluated at the representative consumer. The Wald test for $\rho = 0$ gives the χ^2 statistics of the Wald test for independence from the sample selection equation. Standard errors are calculated with the δ method (Oehlert 1992) and are reported in parentheses. ***/**/* indicates significance at the 1/5/10% level.

effects of inflation volatility mostly become insignificant when we account for asymmetric inflation effects below and above 2%.

In a next step, we interact the recession dummy with the other macroeconomic determinants in Table 7 in order to evaluate whether these macro effects differ over the business cycle. Throughout all three macroeconomic concepts analysed, macroeconomic determinants have significantly different effects between boom and recession periods. In line with our results in Table 6, we find that inflation increases the likelihood for con-

sumers to form expectations consistent with the Phillips curve during recessions (when inflation rates typically fall). Interestingly, our results suggest that the effect of oil price increases moves in the opposite direction to the inflation effect: Higher oil prices significantly increase the likelihood of consistency with the Income Fisher equation during recessions, while they have a detrimental effect on consistency with the Phillips curve or the Taylor rule. This can be explained with rather strong oil price hikes during some of the recessions in our sample period, especially during the oil price shocks of 1980 and 1990-91 and at the beginning of the financial crisis in 2008. The Federal Funds rate also affects consistency with respect to the Phillips curve and the Taylor rule differently during recessions, albeit in opposite directions: Restrictive monetary policy makes it harder for consumers to form expectations consistent with the Phillips curve trade-off, but increases the likelihood of expectations consistent with the Taylor rule. Finally, both the marginal effects of the unemployment rate and money supply growth seem relatively constant over the business cycle.

Finally, we test for an impact of changes in the communication strategy of the Fed on consumers' likelihood of forming consistent expectations. This is highly relevant, since having a sound understanding of monetary policy increases the effectiveness of monetary policy making. In an effort to improve the understanding of monetary policy and to guide expectations of the public, central banks have, over the last two decades, established new means of communication and transparency. To evaluate the success of these efforts, we test to which extend the introduction of specific elements improved the understanding of the public regarding monetary policy and helped them to form consistent expectations. In order to analyse potential effects, we use the same set of macroeconomic determinants used beforehand and amend this regression by the set of dummy variables representing important milestones in the communication strategy of the Fed.[15] Estimation results are presented in Table 8.

As those milestones should influence the likelihood of being consistent with the Taylor rule the most, we interpret these results first. We can report that the introduction of the Beige book, the Announcement of the Federal Funds Target rate, the assessment of Risk, the establishment of the press conference as well as the announcement of an explicit inflation target helped to increase the propensity of consumers to form consistent expectations. Regarding the relative size of the effects, the announcement of the explicit inflation target stands out followed by the introduction of the Beige book. Both events may certainly be characterized as major steps in the communication policy of the Federal Reserve. Moreover, given that the introduction of the explicit target has to be seen relative to the introduction of the means beforehand, this result is remarkable in terms of size and significance. Furthermore, we can also observe that the publication of the voting record did not help to improve the ability to form consistent expectations with respect

[15] Middeldorp (2011) also incorporates dummy variables to control for important milestones of communication.

Table 8: Consistency and Central Bank Communication

	Income Fisher eq.	Phillips curve	Taylor rule	All Three
π_{t-1}	-0.0008	0.0014	-0.0117***	0.0037
	(0.0031)	(0.0037)	(0.0035)	(0.0026)
$\sigma^2_{\pi,t-1}$	-0.0031**	0.0032*	0.0008	0.0012
	(0.0015)	(0.0017)	(0.0017)	(0.0013)
oil_{t-1}	0.0001**	-0.0002**	0.0003***	-0.0002**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
u_{t-1}	0.0044***	0.0216***	0.0031*	0.0066***
	(0.0017)	(0.0021)	(0.0019)	(0.0023)
$m2growth_{t-1}$	-0.0031***	0.0066***	-0.0006	0.0017*
	(0.0010)	(0.0013)	(0.0012)	(0.0009)
$funds\_rate_{t-1}$	0.0022	-0.0035**	0.0011	-0.0038***
	(0.0015)	(0.0017)	(0.0017)	(0.0014)
$nber\_recession_t$	0.0286***	-0.0964***	-0.1247***	-0.0384***
	(0.0081)	(0.0090)	(0.0183)	(0.0062)
$BeigeBook83_t$	-0.0392***	0.0214	0.0699***	0.0201*
	(0.0131)	(0.0178)	(0.0211)	(0.0114)
$FFTargetAnnouncement94_t$	-0.0061	0.0445***	0.0239***	0.0164**
	(0.0072)	(0.0081)	(0.0081)	(0.0070)
$BalanceofRisk00_t$	0.0125	-0.0134	0.0288**	-0.0026
	(0.0098)	(0.0139)	(0.0114)	(0.0118)
$Votes02_t$	0.0214*	-0.0051	-0.0327**	0.0117
	(0.0116)	(0.0135)	(0.0139)	(0.0112)
$ForwardGuidance03_t$	0.0234**	-0.0492***	0.0115	-0.0137
	(0.0103)	(0.0119)	(0.0115)	(0.0103)
$PressConference11_t$	0.0391***	-0.0851***	0.0299*	-0.0304***
	(0.0145)	(0.0152)	(0.0163)	(0.0114)
$ExplicitTarget12_t$	0.1000***	0.0916**	0.0957***	0.0678
	(0.0171)	(0.0443)	(0.0240)	(0.0588)
N	93,763	95,893	95,389	93,109
χ^2	826.6	946.8	794.3	356.4
Demographic Controls	Yes	Yes	Yes	Yes
ρ	-0.832	-0.234	-0.380	-0.472
Wald test (ρ=0, χ^2)	17.91	0.852	3.269	1.684

Notes: Table 8 reports the marginal partial effects from the heckprobit models evaluated at the representative consumer. The Wald test for $\rho = 0$ gives the χ^2 statistics of the Wald test for independence from the sample selection equation. Standard errors are calculated with the δ method (Oehlert 1992) and are reported in parentheses. ***/**/* indicates significance at the 1/5/10% level.

to the Taylor rule. This might not be surprising as this basically reflects a dimension of disagreement that may not help to steer expectations in a specific direction. Interestingly, the introduction of forward guidance in 2003 does not lead to significantly more people having consistent Taylor rule expectations relative to the other means introduced beforehand. Given that this effect has to be seen relative to all other established measures up to

this date, which especially regarding the balance of risk assessment have forward looking elements in it, this should not be interpreted as having no effect.

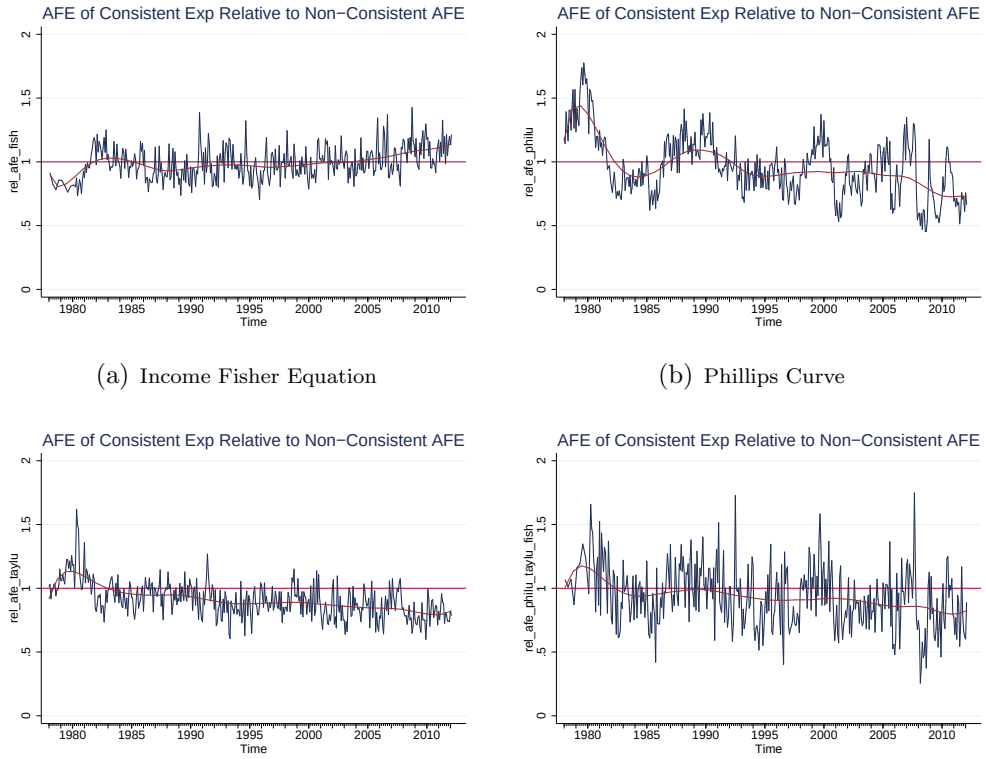
Moreover, we also find effects of monetary policy communication on consistency with the Income Fisher equation and the Phillips curve. Notably, they are much less clear cut. However, there is one event that is important for consistency with all three economic concepts: The announcement of an explicit inflation target in January 2012 helped to improve the understanding of all three economic concepts. Additionally, the announcement of changes in the Federal Funds target rate in February 1994 stands out as it had a positive effect on consistency with the Phillips curve, the Taylor rule as well as consistency with all three concepts simultaneously. Interestingly, both the introduction of forward guidance and of the press conference improved consumers' likelihood of correctly distinguishing between real and nominal expected income. Analysing consistency with all three relations simultaneously, we additionally find a relevant role for the introduction of the Beige book and the establishment of the press conference.

4.3 Consistency and Forecast Accuracy

Do respondents that form theory-consistent expectations also form more accurate forecasts? Ang et al. (2007) show that professional forecasters in the SPF predict inflation better than any other forecasting model or than expectations extracted from the bond market. Several studies have further pointed out that household expectations are important from the perspective of monetary policy. We study the accuracy of quantitative inflation expectations of consistent and non-consistent consumers and compare them to the median forecast of the SPF. Thus, we evaluate if we can systematically extract individuals – not only based on demographic characteristics – that produce more accurate inflation forecasts.

We start the analysis by plotting the average absolute forecast errors (AFEs) of theory-consistent consumers relative to the AFEs of consumers with non-consistent expectations in Figure 2, where summary statistics of the relative shares are given in Table 9. A relative share below one means that theory-consistent consumers in a given period have lower absolute forecast errors than non-consistent consumers, and *vice versa*. In most periods, consistent consumers produce lower AFEs with respect to inflation. An exception is the period at the beginning of our sample where consumers that have theory-consistent expectations perform worse than non-consistent consumers, especially in the case of consistency with the Phillips curve and the Taylor rule. We have to bear in mind that those respondents surveyed in the late 1970's and early 1980's experienced stagflation and non-active monetary policy and that in most of these early periods neither the Phillips curve relationship nor the Taylor rule held in reality as shown in Figure A.2 in the appendix. As shown in Figure 1 in section 4.1, we also find a relatively lower share of consumers forming consistent expectations during this period, which one would expect when consumers

Figure 2: Relative AFEs with Consistent and Non-Consistent Exp



(a) Income Fisher Equation

(b) Phillips Curve

(c) Taylor Rule

(d) All

Note: Graphs show average absolute forecast errors of consistent consumers, relative to the forecast errors of non-consistent consumers.

expect stagflation. With the appointment of Volcker as the FED chairman at the end of 1979, more consumers started to forecast in a theory-consistent way and their forecasts became more accurate compared to consumers giving non-consistent forecasts.

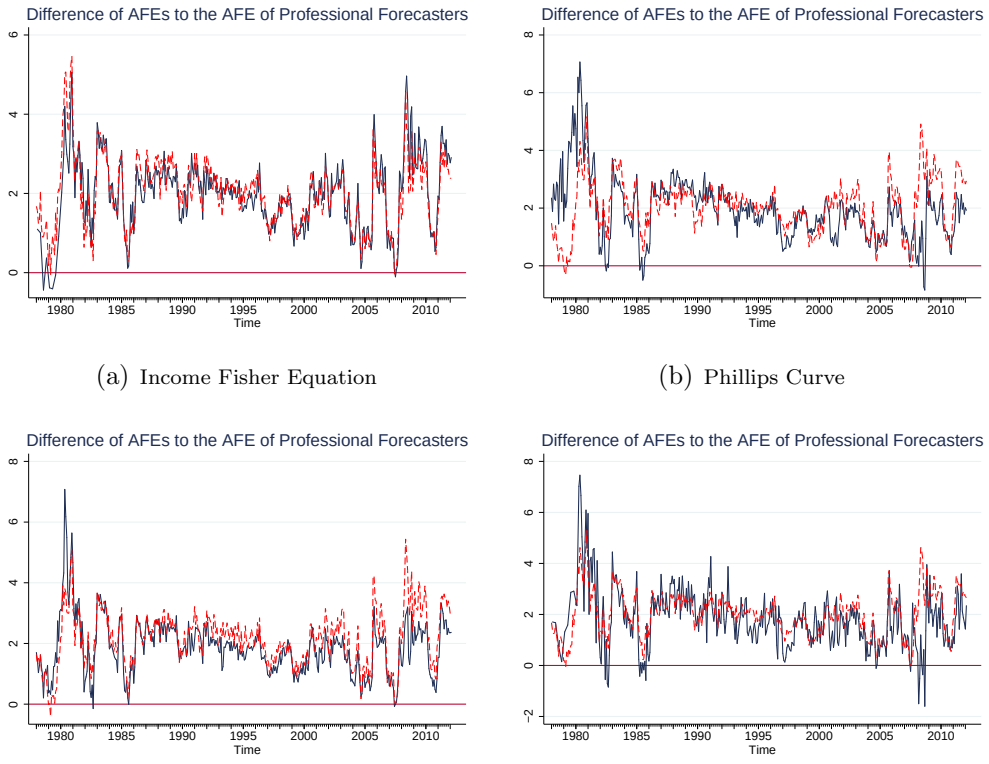
Overall, respondents who correctly distinguish between nominal and real variables produce forecasts that have on average 1% lower AFEs than non-consistent consumers. While this difference is relatively small, respondents who form consistent expectations with respect to the Taylor rule and the Phillips curve differ more in their forecast accuracy compared to the respective non-consistent samples. Regarding consistency with the Phillips curve, consistent consumers have about 4% lower AFEs and in the case of consistency with the Taylor rule about 9% lower AFEs. Consumers whose expectations are consistent with all three principles have on average 7% lower AFEs than the non-consistent consumers. Note that the improvement in forecast accuracy of consistent consumers is even larger when we compare the median values. In Figure 2 we can also observe that the variance is relatively high with the highest variance for consistency with all three principles. Summary statistics are provided in Table 9.

Next, we evaluate the distance of the AFEs of consistent and non-consistent forecasts to the AFEs of the SPF, shown in Figure 3 with summary statistics in Table 10. As the

Table 9: AFEs of Consumers with Consistent Expectations Relative to AFEs with Non-Consistent Expectations

	Mean	Median	SD	Min	Max	N
Income Fisher equation	0.99	0.98	0.12	0.71	1.43	392
Phillips curve	0.96	0.94	0.24	0.45	1.78	410
Taylor rule	0.91	0.90	0.14	0.60	1.62	410
All three	0.93	0.91	0.24	0.26	1.75	392

Figure 3: Consistent and Non-Consistent AFEs of Consumers vs. AFEs in the SPF



(a) Income Fisher Equation

(b) Phillips Curve

(c) Taylor Rule

(d) All

Note: Black lines denote differences in AFEs of consistent consumers, red dotted lines denote differences in AFEs of non-consistent consumers.

Table 10: Distance of Consumers' AFEs to the AFE of Professional Forecasters

	Mean	Median	SD	Min	Max	N	T-test Mean	K-W Test Median
Consistent Fisher	2.01	2.06	0.88	-0.44	5.06	392	0.28	31.74***
Non-Consistent Fisher	2.01	2.06	0.87	-0.05	5.46	410	–	–
Consistent Phillips	1.94	1.89	1.09	-0.84	7.06	410	4.31***	199.83***
Non-Consistent Phillips	2.05	2.11	0.92	-0.31	5.17	410	–	–
Consistent Taylor rule	1.87	1.87	0.92	-0.15	7.08	410	21.01***	207.78***
Non-Consistent Taylor rule	2.16	2.20	0.91	-0.41	5.45	410	–	–
Consistent all three	1.81	1.74	1.17	-1.60	7.46	392	8.17***	5.60**
Non-Consistent all three	2.02	2.06	0.86	-0.05	5.30	410	–	–

Notes: The last two columns represent tests for equality of means (medians) between the subsamples of consistent vs. non-consistent consumers for a particular relation. For the mean we employ a two-sample mean-comparison t-test with equal variances and for the median a Kruskal-Wallis equality-of-populations rank test. ***/**/* indicates significance at the 1/5/10% level.

difference approaches zero, consumers' forecast accuracy regarding inflation approaches that of the SPF. A positive difference means that consumers have higher AFEs than professional forecasters, while a negative difference means that consumers beat the SPF forecast on average. As one would expect, in most periods consumers' AFEs are higher than the SPF errors for both consistent and non-consistent consumers, where the overall median AFE from the Michigan survey is 135% higher than the median AFE of the SPF. As shown in Table 10, consumers with expectations consistent with the Income Fisher equation produce AFEs that are 2.01 inflation points higher than those in the SPF, while AFEs from forecasts consistent with the Phillips curve and the Taylor rule are 1.94 and 1.87 points higher, respectively. For comparison the average absolute forecasts error in the SPF is 1.27 inflation points.

Nevertheless, there exist periods where consumers that form consistent forecasts outperform the SPF. These are most evident in the first half of the 1980s and in 2008; the latter especially for consistency with all three principles. Moreover, consumers with consistent expectations are consistently better able to match the SPF forecast accuracy than their non-consistent counterparts. This is especially true in the later part of the sample period, after the Volcker disinflation and the beginning of an active monetary policy regime in the U.S. As shown in Table 10, these differences are statistically significant in almost all cases, meaning that consistency with economic concepts on average moves consumers' inflation forecasts closer to professionals' estimates.

5 Conclusion

Expectations are of key relevance for macroeconomic outcomes. While many papers have investigated the properties of expectations of individual series in depth, there is almost

no evidence on whether expectations on several macroeconomic aggregates are formed consistent with important economic concepts.

This paper addresses this research gap by calculating the share of people that form consistent expectations regarding the Taylor rule, the Phillips curve and the Income Fisher equation. In addition, we explore how this share of consistent consumers changes over time and how it is affected both by macroeconomic variables and by the communication policy of the Federal Reserve, and finally check if people benefit from having consistent expectations in terms of reduced inflation forecast errors.

We find that 50% of the surveyed U.S. population form expectations in line with the Taylor rule and the Income Fisher equation. Furthermore, 25% correctly infer the structural relationship of the Phillips curve. While this share is relatively time-invariant for the Income Fisher equation, it seems to be more business-cycle-dependent for the Phillips curve and the Taylor rule. When looking at the heterogeneity across socioeconomic characteristics, we find some variation for all concepts considered.

In addition, we show that having consistent expectations is affected by a certain set of macro determinants. In particular, higher inflation above 2% decreases the probability of forming consistent expectations with respect to the Phillips curve and the Taylor rule, while the effect is positive for consistency with the Income Fisher equation. Also, during recessions people have problems forming consistent expectations with respect to the Phillips curve and the Taylor rule. Moreover, consistency with respect to all macroeconomic concepts analysed was affected significantly by changes in the communication strategy of the Federal Reserve. While we find that consistency with the Taylor rule is most strongly positively affected by improvements in communication and transparency, the likelihood of consistency with respect to all concepts was significantly improved by the announcement of changes in its target for the federal funds rate in February 1994 and the introduction of the official inflation target in January 2012. Finally, we can show that having consistent expectations benefits consumers. Investigating their inflation forecast accuracy, we report that consumers make better inflation forecasts and are closer to the SPF forecast accuracy if they have consistent expectations.

This paper offers interesting insights regarding the formation process of expectations by consumers. By testing for the consistency of economic concepts instead of only analysing the rationality of individual time series, we contribute to the literature. Furthermore, the result that people benefit from having consistent expectations and at the same time have problems with recession periods may call for policy actions. At the same time, we can show that the already introduced measures of monetary policy communication have significantly positive effects on the likelihood of forming consistent expectations, especially regarding the Taylor rule. Nevertheless, our results could give further reasons for a clear communication by monetary and fiscal authorities especially during recession periods and, thus, could give further motivation for the recently popular measures of forward guidance. Additional benefit might be gained by targeting specific demographic

groups such as older, less educated and lower income groups as this could increase overall economic literacy in the population.

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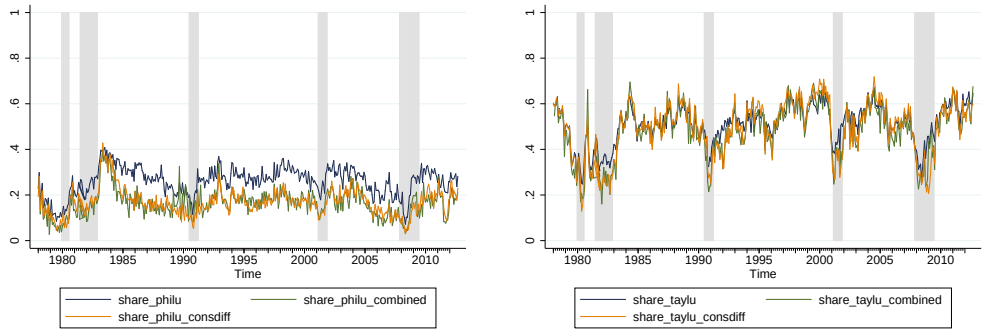
6 Appendix

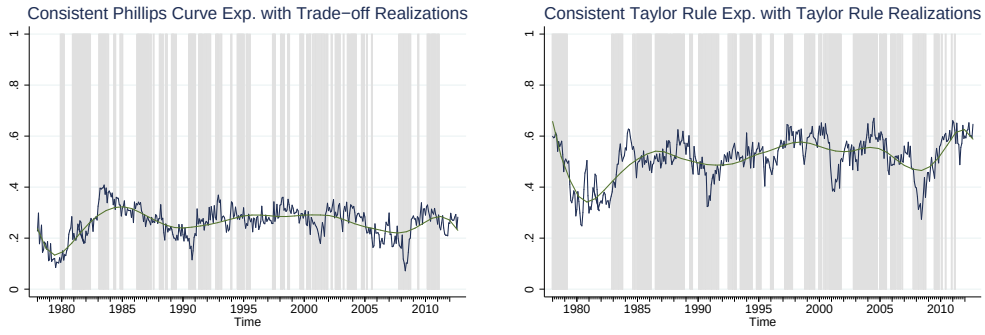
Figure A.1: Altenative Definitions of Consistency



(a) Phillips Curve (b) Taylor Rule

Note: *Share_philu* (*share_taylu*) gives the share of consumers consistent with the Phillips curve (Taylor rule), where inflation expectations are defined from the qualitative question [A12] as discussed in the paper. *Share_philu_combined* (*share_taylu_combined*) additionally use the answers to the quantitative question on expected inflation [A12b] and code inflation expectations as "increase"/"stay the same"/"decrease" if the difference of quantitative expectations compared to last month's actual inflation rate, rounded to the nearest integer, points in the same direction as the answer to the qualitative inflation question [A12]. *Share_philu_consdiff* (*share_taylu_consdiff*) conditions the answers to the qualitative inflation question [A12] on the sign of the change in individual quantitative inflation expectations between the first and the second interview in the rotating panel. Shaded areas denote recession periods as defined by the NBER.

Figure A.2: Consistency and Realised Data



(a) Phillips Curve (b) Taylor Rule

Note: Shaded areas denote periods where the Phillips curve trade-off, using actual data rounded to the nearest integer, was realised 12 months ahead, i.e. where future changes 12 months ahead of the Federal Funds rate, the inflation rate, and the unemployment rate, rounded to the nearest integer, were in line with a Taylor rule.

Table A.1: Income Fisher equation: Explicit and Implicit Real Income Expectations

REAL INCOME UP/DOWN NEXT YEAR	(NOMINAL INCOME-PRICES) NEXT YEAR			
	Up	Same	Down	Total
Go up more than prices	**41%**	8%	5%	20%
	31,392	1,963	4,340	37,695
Go up same as prices	43%	**62%**	37%	43%
	33,191	**14,909**	31,364	79,464
Go up less than prices	16%	30%	**58%**	37%
	11,836	7,325	**48,396**	67,557
Total	41%	13%	46%	100%
	76,419	24,197	84,100	184,716

Notes: Number of respondents and column frequencies are reported. Consistent fractions are marked in bold.

Table A.2: Phillips curve: Inflation and Unemployment Expectations

PRICES UP/DOWN NEXT YEAR	UNEMPLOYMENT MORE/LESS NEXT YEAR			
	More	About the same	Less	Total
Go up	76%	68%	**62%**	70%
	63,554	76,427	**23,125**	163,106
Go up (at the same rate)	7%	**12%**	11%	10%
	6,139	**13,889**	4,237	24,265
Stay the same	12%	**17%**	22%	16%
	9,966	**19,164**	8,042	37,172
Go down	**4%**	3%	5%	4%
	3,523	3,065	1,948	8,536
Total	36%	48%	16%	100%
	83,182	112,545	37,352	233,079

Notes: Number of respondents and column frequencies are reported. Consistent fractions are marked in bold.

Table A.3: Taylor rule: Interest rate and Inflation Expectations

INTEREST RATES UP/ DOWN NEXT YEAR	PRICES UP/DOWN NEXT YEAR				
	Go up	Go up (same rate)	Same	Go down	Total
Go up	**59%**	43%	32%	24%	52%
	94,885	10,342	11,822	1,979	119,028
Stay the same	27%	**39%**	**42%**	29%	31%
	44,063	**9,296**	**15,533**	2,431	71,323
Go down	14%	18%	26%	**48%**	17%
	22,349	4,427	9,370	**4,007**	40,153
Total	70%	10%	16%	4%	100%
	161,297	24,065	36,725	8,417	230,504

Notes: Number of respondents and column frequencies are reported. Consistent fractions are marked in bold and are conditional on consistent answers to the unemployment question.

Table A.4: Taylor rule: Interest rate and Unemployment Expectations

INTEREST RATES UP/ DOWN NEXT YEAR	UNEMPLOYMENT MORE/LESS NEXT YEAR			
	More	Same	Less	Total
Go up	55%	51%	**46%**	52%
	45,025	56,579	**16,952**	118,556
Stay the same	26%	**34%**	33%	31%
	21,176	**37,937**	12,133	71,246
Go down	**19%**	15%	21%	17%
	15,627	16,769	7,795	40,191
Total	36%	48%	16%	100%
	81,828	111,285	36,880	229,993

Notes: Number of respondents and column frequencies are reported. Consistent fractions are marked in bold and are conditional on consistent answers to the inflation question.

Table A.5: Robustness Checks Heckprobit Models

	Phillips curve			Taylor rule		
	Baseline Unemp. Exp.	Business Condition Exp	Differences Unemp. Exp.	Baseline Unemp. Exp.	Business Condition Exp	Differences Unemp. Exp.
π_{t-1}	-0.0039	-0.0165***	-0.0077*	-0.0140***	-0.0160***	-0.0008
	(0.0043)	(0.0046)	(0.0044)	(0.0042)	(0.0043)	(0.0045)
$\sigma^2_{\pi,t-1}$	0.0064***	0.0069***	-0.0055***	0.0027	0.0016	-0.0046**
	(0.0019)	(0.0019)	(0.0020)	(0.0019)	(0.0020)	(0.0020)
oil_{t-1}	-0.0003**	-0.0002	0.0003***	-0.0001	0.0002*	0.0002*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
u_{t-1}	0.0165*	0.0105	-0.0173*	-0.0242***	-0.0125	-0.0135
	(0.0098)	(0.0108)	(0.0101)	(0.0085)	(0.0091)	(0.0101)
$m2growth_{t-1}$	-0.0048**	-0.0002	0.0039	-0.0013	0.0001	-0.0053**
	(0.0022)	(0.0023)	(0.0024)	(0.0022)	(0.0023)	(0.0023)
$funds\_rate_{t-1}$	-0.0060	0.0009	0.0048	-0.0155***	-0.0125**	0.0000
	(0.0058)	(0.0062)	(0.0063)	(0.0052)	(0.0055)	(0.0060)
$nber\_recession_t$	-0.0338***	-0.0234*	0.0077	-0.0472***	-0.0665***	-0.0048
	(0.0130)	(0.0130)	(0.0128)	(0.0131)	(0.0128)	(0.0132)
N	95893	95532	95504	95389	95027	94403
χ^2	1127.469	866.235	339.791	1108.565	1416.229	747.433
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
ρ	-0.290	-0.090	-0.407	-0.321	0.033	0.011
Wald test (ρ=0, χ^2)	1.32	0.07	2.29	2.57	0.03	0.00