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Are Survey Expectations Theory-Consistent? The Role of Central Bank Communication and News*

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Abstract

In this paper we analyze whether central bank communication can facilitate the understanding of key economic concepts. Using survey data for consumers and professionals, we calculate how many of them have expectations consistent with the Fisher Equation, the Taylor rule and the Phillips curve and test, by accounting for three different communication channels, whether central banks can influence those. A substantial share of participants has expectations consistent with the Fisher equation, followed by the Taylor rule and the Phillips curve. We show that having theory-consistent expectations is beneficial, as it improves the forecast accuracy. Furthermore, consistency is time varying. Exploring this time variation, we provide evidence that central bank communication as well as news on monetary policy can facilitate the understanding of those concepts and thereby improve the efficacy of monetary policy.

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

JEL classification: E31, E52, E58, D84, C25.

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1 Introduction

If people have better knowledge of the economy, they can make better informed decisions. Especially central banks argue that the effectiveness of the transmission channel increases if people have a sound understanding of monetary policy goals and strategies (see e.g. Bernanke, 2007). In this paper, we try to infer the extent to which people have an understanding of key economic concepts and whether policymakers can facilitate this understanding. We apply the concept of theoretical consistency to evaluate how monetary policy announcements are perceived and how they are factored into economic decision making.

For this purpose, we look at macroeconomic expectations and assess whether they are consistent with key economic concepts. We then evaluate whether having theory-consistent expectations is beneficial for consumers' inflation forecasting accuracy and if we can explain part of its variation by changes in central bank communication and monetary news. This evaluation has considerable policy implications as it tests to what extent central banks can improve the understanding of monetary policy via their communication and whether they have been successful in doing so. Over the last 20 years, central banks around the world have increased their effort in communicating to the general public, reiterating its importance for guiding expectations of the public. Nevertheless, it is not yet clear what should be the best way to conduct central bank communication. Morris and Shin (2002, 2007) conjecture that too much information might even deteriorate the understanding of monetary policy. While there is some evidence that communication can help in predicting future interest rate changes with respect to professional forecasters (see, e.g., Sturm and de Haan, 2011), there is as yet no evidence as to whether this improvement is linked to a sound understanding of monetary policy. Sims (2010) argues that while financial market participants and professional forecasters are likely to be very attentive to even the smallest change in the policy statement, the effects may be very different regarding individuals. Consistent with this view, Blinder et al. (2008, p. 941) argue: "Virtually all the research to date has focused on central bank communication with the financial markets. It may be time to pay some attention to communication with the general public."

Using the microdata from the Surveys of Consumers conducted by the University of Michigan (henceforth MS) and the Survey of Professional Forecasters conducted by the Federal Reserve Bank of Philadelphia (henceforth SPF), we evaluate how the changes in the Federal Open Market Committee's (FOMC) communication influence individual consistency with a version of the "Fisher" equation applied to income expectations, the Phillips curve, and the Taylor rule. Specifically, we test whether consumers' expectations correctly distinguish between real and nominal expected income, implying consistency with the Income Fisher equation. Regarding the Phillips curve, we analyze if consumers use the short-run trade-off between inflation and unemployment for forecasting. Although

this is an empirical relationship which might not be realized in every period, the Phillips curve trade-off is embedded in many forecasting models for inflation (see, e.g., Stock and Watson, 2008 and Faust and Wright, 2013).[1] Finally, we evaluate whether consumers form expectations regarding interest rates, inflation, and unemployment (or the output gap) in line with the Taylor rule. Similarly to our definition of consistency with the Phillips curve, we have to be careful in identifying consistency with the Taylor rule. Following Carvalho and Nechio (2014), we avoid endogeneity issues by excluding periods with large monetary policy shocks, i.e., the period before 1987 and further exclude the period where the correlation between borrowing rates and the federal funds rate dropped, i.e., the zero lower bound (ZLB) period from 2008 onwards.[2] Note that throughout the paper, the term "consistent expectations" denotes consistent with an economic concept.

We consider three channels of central bank communication: the sender channel (central bank announcements), the transmission channel (the volume of news in the media), and the receiver channel (consumers' reported perception of news). For the first channel, we look at milestones of changes in the FOMC's communication strategy as identified by Middeldorp (2011) and Bernanke (2007). For the latter two channels, we generate a new dataset capturing media news in leading US newspapers, and use data provided in the MS on perceived news. The use of perceived news can be motivated by theories of rational inattention, where agents have limited information-processing capacity and therefore cannot absorb all available information. There is empirical evidence that under these circumstances, the media have a strong impact on the expectation formation of the general public. For instance, Hamilton (2004) and Soroka (2006) report that the media report more "bad" news than "good" news and that especially bad news might influence the information set. Therefore, the media might potentially introduce a bias in this part of the transmission channel, as especially consumers may be relatively more exposed to bad news compared to good news.

While our focus is on consumers' consistency, we also study professional forecasters, which allows us to draw comparisons between the two groups and evaluate the importance of different transmission channels for central bank communication. Using the SPF brings some additional advantages, as we benefit from a longer panel dimension and the fact that the interest rate question directly asks for quantitative forecasts of the policy rate. Furthermore, we can account for the issue of nowcasting when defining consistency, as the

[1] We furthermore check the extent to which demand and supply shocks affect the propensity to form consistent expectations and control for different phases of the business cycle and movements in oil prices.

[2] Endogeneity issues may arise as monetary shocks where known to be larger before 1987 (Leeper et al., 1996). Also, Judd and Rudebusch (1998) have argued that the Taylor rule became a better approximation for monetary policy in the Greenspan era. Furthermore, as the MS asks for expectations on borrowing rates and not for the federal funds rate, the link might be much weaker in the aftermath of the financial crisis when some interest rates hit the ZLB (Carvalho and Nechio, 2014). Note that for professional forecasters, the ZLB period is included as the survey asks for the 3-month Treasury bill rate, which is highly correlated with the federal funds rate also in the ZLB period.

most recent GDP and inflation rate is unknown to the survey participants when making one-year-ahead predictions.

Before proceeding with the analysis of communication effects on the shares of consistent expectations, we briefly discuss the results for average levels of consistency. It is not surprising that the highest share of consistent expectations for both consumers as well as professionals is observed for the Fisher equation, as this is a fundamental relationship. There is, however, a big gap between consumers and professionals. While the share of forecasts consistent with the Fisher equation is around 84% for professionals, only half of the consumers have consistent expectations. Regarding the Taylor rule, the average shares are very similar, as about half of the population of consumers as well as professionals have consistent expectations. Regarding the Phillips curve, there are again fewer consumers consistent than professionals, 34% to 50%. However, on average only 6% of consumers form theory-consistent expectations with respect to all three concepts in a given period. At about 31%, this share is considerably higher for professionals. Furthermore, we observe strong time-variation in consistency shares for both groups. Additionally, we can show that consistency on average improves the forecast accuracy of consumers relative to professional forecasters, as it moves consumers' quantitative inflation forecasts closer to those by professionals.

Given the time-variation in consistency shares, we next ask whether central bank communication can account for it. We find that the continued steps towards a more transparent monetary policy significantly affect the consistency of both consumers and professionals. The most important events in the case of consumers, in terms of improvements in consistency and the magnitude of the effect, turn out to be the announcement of changes in the target for the Federal Funds rate starting in February 1994, the introduction of the balance-of-risks statement in January 2000, and the introduction of the official inflation target in January 2012. Furthermore, for professional forecasters the introduction of the press conference after the FOMC meetings in April 2011 plays a particularly important role.

News on monetary policy have a positive effect on the probability of having consistent expectations with the Taylor rule and the Fisher equation in the case of consumers. For professionals, we find an additional positive effect of monetary-policy news on consistency with the Phillips curve and a positive link also from news on the Federal Funds rate on consistency with the Fisher equation. This indicates that the "transmission channel" influences both consumers and professionals. Although our prior was that professionals' consistency would be less affected by media news than consumers', it nevertheless seems that there exists at least some correlation of professionals' consistency with different types of news. These can be both positive and negative, suggesting that the media may both clarify or bias the information set.

For consumers, we can additionally check for effects of the "receiver channel". The results suggest that consumers' consistency is generally negatively affected by negative

news observed about inflation, unemployment, and credit conditions, while positive news yield increases in consistency. There is evidence that consumers overreact to negative news, which might explain why suddenly fewer people have consistent expectations. Furthermore, this hypothesis might also explain why the overall media effect is smaller for consumers than for professionals.

Our paper relates to the literature studying central bank communication practices. Over recent 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 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 (see also Ehrmann and Fratzscher, 2007). Communication strategies of the FOMC are studied in, e.g., Middeldorp (2011) and Carlson et al. (2006). It has been shown, for instance, by Hayo and Neuenkirch (2010) for the FOMC or Sturm and de Haan (2011) for the ECB that communication can help predict the future interest rate decision.

The paper by Carvalho and Nechio (2014) is closely related to our analysis with respect to the Taylor rule. The authors study consistency of expectations with the Taylor rule by evaluating the fractions of answers within the cross-section of the MS that give consistent interest rate expectations, given their answers to the questions on unemployment and inflation. The results are then compared across demographic groups and to the SPF. We design a complementary exercise to study the individual consistency with the Taylor rule relationship, but extend their approach in various ways. Besides considering further macroeconomic relations individually as well as jointly, we evaluate the effects on forecast accuracy and link consistency of expectations to monetary policy communication and monetary news.[3]

There also exist a few recent papers that investigate whether professional forecasters behave in line with macroeconomic concepts. Mitchell and Pearce (2010) test whether Wall Street economists believe in Okun's law and the Taylor rule. Pierdzioch et al. (2011), Fendel et al. (2011a), and Fendel et al. (2011b) use the Consensus Economic Forecast poll for the G-7 countries to estimate whether professional forecasters report point estimates in line with a Phillips curve, the Taylor rule or Okun's law. Lastly, Rülke (2012) investigates the behavior of professional forecasters for six Asian-Pacific countries. Analyzing theory-consistency, our paper also relates to the literature on the relationship between macroeconomic literacy and economic forecasting, as studied by Blanchflower and Kelly (2008), Armantier et al. (2011), and Burke and Manz (2011).

The remainder of the paper is structured as follows. We describe our dataset and the identification method for expectations that are consistent with the Fisher Income equation, the Phillips curve, and the Taylor rule in detail in section 2. Our results on

[3]We also differ somewhat in the identification strategy of the Taylor rule as discussed in section 2.2.

central bank communication, news, and consistency are presented in section 3. Section 4 concludes.

2 Data and the Measurement of Consistent Expectations

This section describes the datasets used in our analysis and the definitions for measuring consistent expectations with an Income Fisher equation, the Phillips curve, and the Taylor rule. Moreover, we discuss shares of consistency, implications of consistency for forecast accuracy and issues regarding the identification of consistency.

2.1 Data

For the analysis of consumers, we use the microdata of the University of Michigan Survey of Consumers (MS), where each monthly cross-section gives 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. Note that we truncate quantitative inflation estimates to lie in the range from -5 to 30 to exclude any extreme forecasts.[4] We include the whole cross-section in our analysis, but generally restrict our time sample to start in August 1987 and for the analysis of the Taylor rule to end in January 2007 (otherwise ending in September 2012). We start the sample in August 1987 with the appointment of Greenspan as Fed chairman to exclude the period with large monetary policy shocks beforehand. For the analysis of consistency with respect to the Taylor rule and regarding all three relations jointly, we additionally exclude the ZLB period from January 2008 onwards, since the MS asks for expectations on borrowing rates, which were less correlated with the policy rate during this period. Robustness of our results with respect to the ZLB period is checked in section 3.3.[5]

In addition to the survey questions on consumers' expectations reviewed in the next section, we use a number of sociodemographic characteristics from the MS as control variables. Moreover, we use the answers to an open question [A6] asking consumers whether they heard of any favorable or unfavorable changes in business conditions recently: Consumers reporting news on high or low prices or inflation (*news_prices_high* and *news_prices_low*) are assigned a value of 1 and 0 otherwise, and similarly on high or

[4]For further details on the MS, see http://www.sca.isr.umich.edu.

[5]As Carvalho and Nechio (2014) 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), which was particularly prevalent in the pre-Greenspan period before 1987m8. Additionally, the correlation between interest rates at long maturities likely triggered with question [A11] and the 3-months Treasury Bill rate dropped from 0.8 to 0.35 during the ZLB period starting in 2008.

low unemployment (*news_u_high* and *news_u_low*) and on tight or easy credit conditions (*news_credit_tight* and *news_credit_easy*).

For the analysis of professionals' consistency, we use data on professionals' quantitative macroeconomic expectations from the Survey of Professional Forecasters (SPF). The SPF contains, inter alia, quarterly nowcasts as well as forecasts over the next 12 months on inflation, unemployment, 3-months treasury bill rates, real and nominal GDP, and the GDP deflator. We use data from 1987q4 to 2015q1.

In addition, we include a number of macroeconomic variables 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. We also include data on year-on-year oil price growth (*oil*) as well as a the short-run unemployment gap (u^{gap}) as provided by the Congressional Budget Office (CBO) as a measure of the business cycle phase. All macroeconomic data are obtained from the FRED database of the St. Louis Federal Reserve.

To evaluate the effects of changes in the monetary policy communication strategy on consumers' ability to form consistent macroeconomic expectations, we construct, following Middeldorp (2011) and Bernanke (2007), dummy variables representing important milestones on the path to more communication and greater transparency. In particular, we control for the announcing changes in the federal funds rate target beginning in February 1994 ($FFTarget94_t$), 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 ($ExplicitTarget12_t$). Note that all communication dummies take on the value of 1 at the month of the introduction of the measure and all subsequent months, so that the coefficients measure the additional effect of this particular communication measures relative to the ones introduced previously.

To further study the effects of changes in the monetary policy communication strategy, we compute indices of media reporting in the spirit of Carroll (2003). More media reporting should imply that people are better informed and produce more consistent forecasts. While Carroll (2003) computes a yearly index of the intensity of news coverage regarding inflation in the *New York Times* and the *Washington Post*, we extend his approach to compute monthly indices for news on inflation (*media_*π), unemployment (*media_u*), federal funds rates (*media_FFR*), and monetary policy more generally (*media_monetarypolicy*). These indices are based on a search of each of the two newspapers for related articles, converted into indices by dividing the number of articles on a particular topic by the total

number of articles. For the regression analysis, we use moving averages of the last three months.[6]

2.2 Measuring the Consistency of Macroeconomic Expectations

We start our analysis by checking whether individual consumers correctly distinguish 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 gives the relation between real and nominal values and thus allows us to test also for money illusion.[7] Since the MS 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 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 MS 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 to the qualitative answer to the survey question for real income expectations:

[6] Using the moving average helps to aggregate the overall tone of the news reported and furthermore allows a better comparison to the perceived news question used in the survey, which asks about the news heard recently.

[7] Money illusion is a term coined by Irving Fisher which refers to a tendency to think in terms of nominal rather than real monetary values. As a consequence, people behave differently when the same objective situation is represented in nominal or in real terms (Fehr and Tyran, 2001).

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*.[8] Table 1 shows the shares of consumers' answers that are consistent with our definition of the Income Fisher equation marked in bold. Out of nine possible answer combinations, three are defined as being consistent, which gives us an unconditional probability of being consistent of 33%. Note that in Table 1 we observe more mass of answers below than above the diagonal, suggesting that more consumers expect negative developments in their real income, while giving estimates for nominal income and inflation resulting in positive real income. This suggests that more consumers are overly pessimistic about their real income prospects, which could imply problems with money illusion. The overall share of consistent expectations together with a test against the unconditional probability is shown for all three relations in Table 5 below.

Table 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%
	20,848	1,331	3,116	25,295
Go up same as prices	43%	**62%**	37%	43%
	22,022	**10,046**	22,621	54,689
Go up less than prices	15%	30%	**58%**	37%
	7,818	4,903	**34,901**	47,622
Total	100%	100%	100%	100%
	50,688	16,280	60,638	127,606

Notes: The time sample is 1987m8-2012m9. Number of respondents and column frequencies are reported. Consistent fractions are marked in bold.

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.[9]

[8] Our test for consistency with the Income Fisher equation implicitly assumes that consumers' inflation and nominal income distributions are distributed in such a way that their joint distribution is in line with the implication of the individual distributions. Consequently, this assumption does not account for asymmetric loss functions regarding expected real income.

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

Next, we evaluate if consumers have a Phillips curve trade-off in mind when forming expectations on inflation and unemployment. This trade-off is embedded in most inflation forecasting models, see, for instance, Stock and Watson (2008), Dotsey et al. (2011), as well as Faust and Wright (2013). 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. Taking expectations with respect to inflation and unemployment one year ahead, we then get:

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

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.[10]

For unemployment expectations, the MS includes a qualitative question, while for inflation expectations we use both a quantitative and a qualitative question:

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?"

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

As the above two questions on expected inflation are posed regarding changes in prices, we need to redefine them in terms of changes in inflation. Thus, following Carvalho and Nechio (2014), positive changes in expected inflation are defined as an expected increase of inflation stated in [A12b] above the average inflation in the last 12 months rounded to the nearest integer and *vice versa* for negative changes. Consumers giving point estimates equal to average rounded past inflation are coded as expecting no change in inflation. Additionally, we extend the approach of Carvalho and Nechio (2014) and use information about perceived inflation, which we obtain for those respondents that answered in the qualitative question [A12] that prices will increase at the same rate or stay where they are now. We characterize them as expecting no change in inflation.

Consumers' expectations are then defined as being consistent with the Phillips curve if consumers expect inflation to increase and unemployment to decrease and *vice versa*. They are also consistent if they expect no changes in both inflation or unemployment.[11]

[10] The empirical papers testing the Phillips curve trade-off for professional forecasters employ a similar definition (Pierdzioch et al. 2011, Fendel et al., 2011a; and Fendel et al., 2011b).

[11] We check for robustness of our results with respect to alternative definitions of consumers' inflation expectations; see Figure A.1 in the Appendix.

Table 2 presents the fractions of answers consistent with the Phillips curve trade-off, where the unconditional probability of being consistent is again 33%. Note that consumers seem to have a prior for expecting positive changes in inflation regardless of their unemployment expectations, so that the trade-off is less often incorporated into their expectation formation when they expect unemployment to increase. Among those classified as consistent with the Phillips curve, on average about 68% expect no change in either inflation or unemployment, while about 32% incorporate the trade-off in either direction.

Table 2: Phillips curve: Inflation and Unemployment Expectations

INFLATION UP/DOWN NEXT YEAR	UNEMPLOYMENT MORE/LESS NEXT YEAR			
	Less	About the same	More	Total
Go down	19%	19%	**17%**	19%
	3,731	13,072	**7,938**	24,741
Stay the same	49%	**45%**	36%	43%
	9,846	**30,691**	16,406	56,943
Go up	**32%**	35%	47%	39%
	6,421	23,880	21,177	51,478
Total	100%	100%	100%	100%
	19,998	67,643	45,521	133,162

Notes: The time sample is 1987m8-2012m9. Number of respondents and column frequencies are reported. Consistent fractions are marked in bold.

Finally, we analyze 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 past empirical observations of the Fed's monetary policy by Taylor (1993).

If a central bank follows a forward-looking Taylor rule, it sets interest rates with respect to deviations of expected inflation from the target level ($\pi_t^e - \pi^*$) and the expected unemployment rate u_t^e. Hence, a central bank will increase interest rates if it expects either inflation to increase and/or unemployment to decrease in the future. This gives us the following relation:

$$i_t = f(\pi_t^e, u_t^e) = \gamma + \alpha(\pi_t^e - \pi^*) + \beta u_t^e \quad \text{with} \quad \alpha > 1, \beta < 0 \tag{4}$$

If, furthermore, central banks apply interest rate smoothing, consumers should not only expect a one time change in interest rates, but several consecutive interest rate movements. Hence, for instance, an increase in expected inflation should lead to expected higher interest rates.

We measure consumers' inflation and unemployment expectations as explained above for the definition of consistency with the Phillips curve.[12] For interest rates, we use the MS's qualitative question on nominal interest rates, which reads as follows:

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. Furthermore, interest rate expectations are also consistent with the Taylor rule if consumers expect rising (or constant) interest rates with either rising price expectations or falling unemployment 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 must also be expected to stay the same.

Table 3: Taylor rule I: Interest Rate and Inflation Expectations

INTEREST RATES UP/ DOWN NEXT YEAR	INFLATION UP/DOWN NEXT YEAR			
	Go down	Stay the same	Go up	Total
Go down	**14%**	17%	10%	14%
	3,173	8,047	3,813	15,033
Stay the same	27%	**35%**	23%	29%
	5,921	**16,496**	8,793	31,210
Go up	59%	48%	**67%**	57%
	12,860	22,827	**25,857**	61,544
Total	100%	100%	100%	100%
	21,954	47,370	38,463	107,787

Notes: The time sample is 1987m8-2007m12. Number of respondents and column frequencies are reported. Consistent fractions are marked in bold and are conditional on consistent answers to the unemployment question.

Tables 3 and 4 show the fractions of answers to interest rate expectations, inflation, and unemployment expectations that would be consistent with a Taylor rule relationship, where each Table is conditional on the answer to either unemployment or inflation expectations, respectively. The unconditional probability of being consistent given all possible answer combinations is 41.23%. Note from Tables 3 and 4 that consumers have more difficulties in giving consistent expectations when interest rates would be expected to decrease.[13]

[12] Additionally, we check for robustness of our results with respect to an alternative definition of consistency with the Taylor rule which attempts to account for the role of the (possibly implicit) inflation target in equation (4), shown in Figure A.2 in the Appendix.

[13] This is in line with the findings in Baghestani and Kherfi (2008).

Table 4: Taylor rule II: Interest Rate and Unemployment Expectations

INTEREST RATES UP/ DOWN NEXT YEAR	UNEMPLOYMENT MORE/LESS NEXT YEAR			
	Less	About the same	More	Total
Go down	14%	12%	**18%**	15%
	2,472	7,578	**7,261**	17,311
Stay the same	30%	**31%**	24%	29%
	5,214	**19,150**	9,870	34,234
Go up	**56%**	56%	58%	57%
	9,657	34,100	24,022	67,779
Total	100%	100%	100%	100%
	17,343	60,828	41,153	119,324

Notes: The time sample is 1987m8-2007m12. 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 5: Shares of Consumers with Consistent Expectations

	Mean	Median	SD	Min	Max	N	Uncond. Prob.	T-test
Fisher equation	0.52	0.51	0.04	0.41	0.64	152,041	0.33	78.196***
Phillips curve	0.34	0.34	0.05	0.16	0.44	152,041	0.33	1.736*
Taylor Rule	0.46	0.46	0.06	0.29	0.61	123,324	0.41	11.606***
All Relations	0.06	0.06	0.02	0.02	0.12	123,324	0.046	13.612***

Notes: The time sample is 1987m8-2012m9 for the Fisher equation and the Phillips curve and 1987m8-2007m12 for the Taylor rule and all three relations jointly. The last column tests whether the mean is different from the unconditional probability of having theory-consistent expectations in the MS with a one-sample t-test. ***/**/* indicates significance at the 1/5/10% level.

Table 5 gives the summary statistics of the shares of consumers with expectations consistent with the Income Fisher equation, the Phillips curve, the Taylor rule, and all three relations jointly and tests the average consistency shares against the unconditional probabilities derived from Tables 1-4. On average, about 52% of consumers form expectations consistent with an Income Fisher equation, which is significantly higher than the unconditional probability of one third. About 34% of consumers in our sample are consistent with the Phillips curve trade-off on average, while 46% incorporate the Taylor rule relation in their expectations. While both of these mean shares are statistically higher than the respective unconditional probability, it should be noted that the difference regarding the Phillips curve is probably not economically significant. Nevertheless, we observe systematic movements in consistency with the Phillips curve across the business cycle, as discussed in the next section, which suggests that answers are not random. Finally, on average about 6% of consumers are consistent with all three macroeconomic relations, which is again statistically higher than the unconditional probability of 4.6%.

2.3 Characteristics of Consistent Expectations

In this section, we evaluate over time the shares of consumers with expectations consistent with the Income Fisher equation, the Phillips curve, the Taylor rule, and all three relations jointly. Figure 1 shows the shares of consistent expectations, starting in the Greenspan-period in August 1987, where we do not interpret consistency with respect to the Taylor rule and all relations during the ZLB period from January 2008 onwards.

We observe that the share of consumers with expectations consistent with an Income Fisher equation stays relatively constant around its mean value of 52%. Consistency shares for the Phillips curve and the Taylor rule show more pronounced time-variation, especially regarding consistency with the Taylor rule and, hence, also regarding all relations jointly. For both the Phillips curve and the Taylor rule, Figure 1 suggests a drop in consistency during the beginning of NBER recessions, where the subsequent rise in consistency starts already during the recession. Note that this drop is particularly pronounced during the recent Great Recession, which we exclude from our analysis of the Taylor rule. Additionally, it can be shown that the relative share of consumers actually incorporating the Phillips curve trade-off, rather than expecting no change in either inflation or unemployment, becomes larger during periods of high macroeconomic volatility such as recessions.[14]

In the Appendix, we also evaluate the shares of consistent expectations across demographic groups (Tables A.1-A.4). Generally, we observe similar patterns as those observed in the literature regarding inflation forecast accuracy across demographic groups, where consistency is higher for men and increases with both education and income.[15] Note that these patterns are most pronounced in the case of consistency with the Income Fisher equation. Variations across age groups are less clear-cut and we observe almost no systematic variation in consistency across different regions of the US.[16]

Next, we check whether consistency is related to consumers' forecast accuracy regarding inflation one year ahead, building on the analysis in Ang et al. (2007). In addition to our finding of consistency shares above the unconditional probabilities, a relation between consistency and forecast accuracy provides further structure and meaningfulness to our concept of consistency. We thus evaluate the distance of the absolute inflation forecast errors (AFEs) of consistent and non-consistent forecasts to the AFEs of professional fore-

[14] Note that the shares of consumers consistent with the Phillips curve under random walk expectations $(\overline{\pi}, \overline{u})$ and those incorporating the Phillips curve trade-off move in opposite directions over the business cycle. Hence, we observe a relatively high share of random-walk expectations during stable periods, whereas non-random-walk expectations become relatively more prominent during recessions and when macroeconomic volatility is high. The correlation coefficient of the two fractions of consistency regarding the Phillips curve is -0.5. Results are shown in Figure A.3 in the Appendix.

[15] See, for example, Jonung (1981), Bryan and Venkatu (2001), Pfajfar and Santoro (2009), and Anderson et al. (2010).

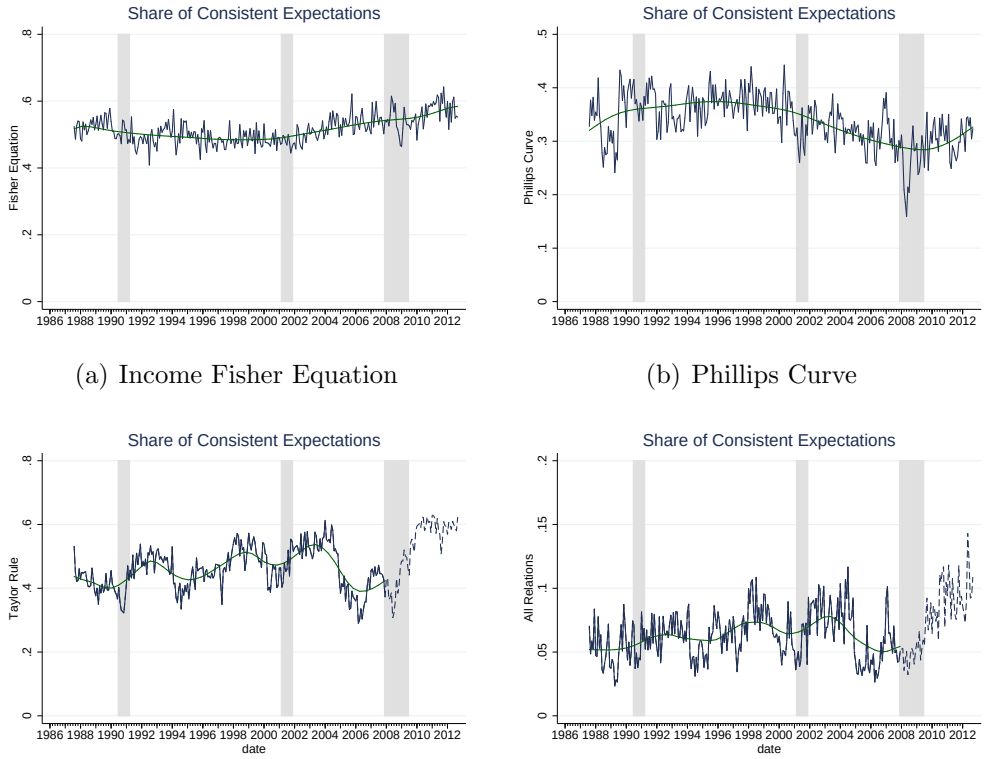
[16] While we have shown that the shares of consistent consumers vary over time and across demographic groups, it is also possible to show that consumers forming consistent expectations in the first interview have a higher likelihood of being consistent in the second interview, compared to their counterparts forming non-consistent expectations in the first interview. Results are available upon request.

Table 6: Distance of Consumers' Inflation AFEs to the AFE of Professional Forecasters

	Mean	Median	SD	Min	Max	N	T-test Mean	K-W Test Median
Consistent Fisher equation	1.98	2.03	0.81	-0.11	4.96	148,504	-3.945***	1.495
Non-consistent Fisher equation	1.97	2.04	0.71	-0.04	4.61	148,504	–	–
Consistent Phillips curve	1.38	1.41	0.62	-0.43	3.01	148,504	49.712***	1777.005***
Non-consistent Phillips curve	2.26	2.39	0.89	-0.10	5.37	148,504	–	–
Consistent Taylor rule	1.89	1.98	0.69	-0.16	3.84	123,324	0.4845	41.911***
Non-consistent Taylor rule	1.87	1.93	0.70	0.01	3.66	123,324	–	–
Consistent all relations	1.61	1.60	0.81	-0.40	4.36	123,324	7.662***	21.866***
Non-consistent all relations	1.88	2.01	0.65	0.02	3.69	123,324	–	–

Notes: The time sample is 1987m8-2012m9 for the Fisher equation and the Phillips curve and 1987m8-2007m12 for the Taylor rule and all three relations jointly. 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.

Figure 1: Shares of Consistent Expectations



(a) Income Fisher Equation

(b) Phillips Curve

(c) Taylor Rule

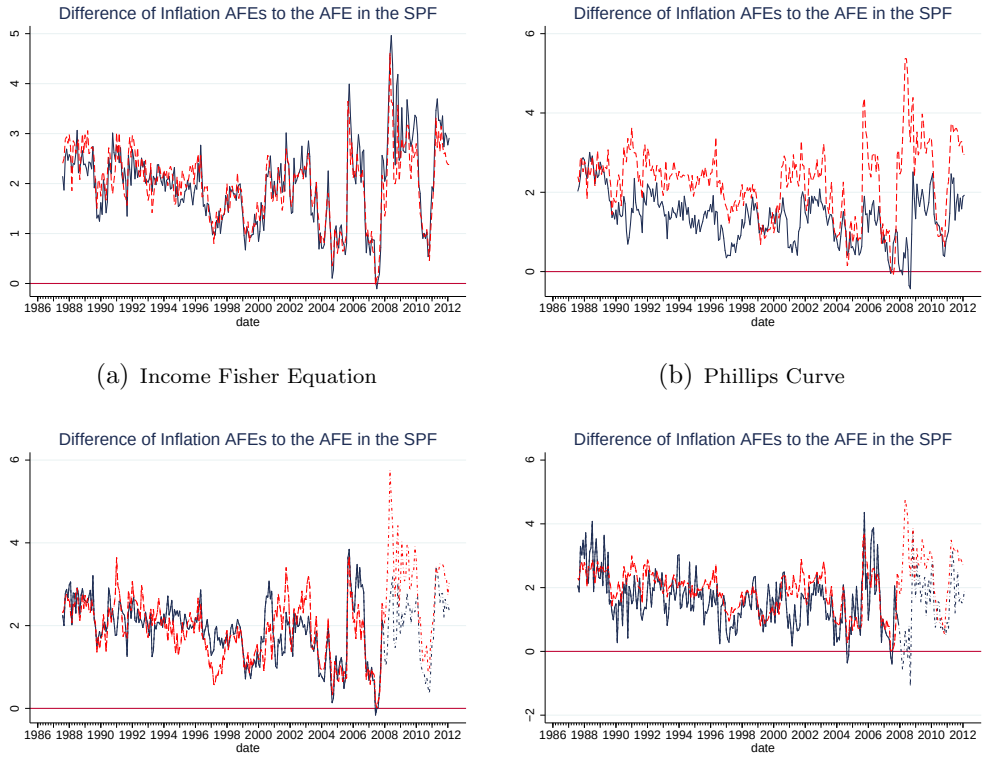
(d) All Relations

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.

casters in the SPF, shown in Figure 2 with summary statistics in Table 6. As the 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. However, we observe especially for the Phillips curve and consistency regarding all three relations that consistent consumers are frequently closer to the SPF forecast than the non-consistent group. This suggests that our results regarding consistency with the Phillips curve are economically significant, even if the difference in the average share from the unconditional probability is not.

As shown in Table 6, consumers with expectations consistent with the Income Fisher equation produce AFEs that are 1.98 inflation points higher than those in the SPF, while AFEs from forecasts consistent with the Phillips curve and the Taylor rule are 1.38 and 1.89 points higher, respectively. Moreover, consumers with consistent expectations are consistently better able to match the SPF forecast accuracy than their non-consistent counterparts, except in the case of consistency with the Income Fisher equation. These

Figure 2: Consistent and Non-Consistent Inflation AFEs of Consumers vs. the Inflation AFE in the SPF



(a) Income Fisher Equation

(b) Phillips Curve

(c) Taylor Rule

(d) All Relations

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

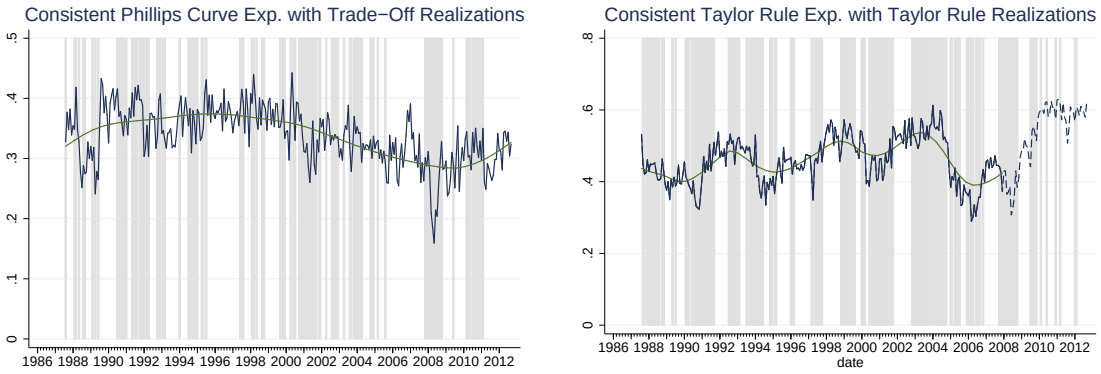
differences are statistically significant in almost all cases, meaning that consistency with economic concepts on average moves consumers' inflation forecasts closer to professionals' estimates.

2.4 Endogeneity, Causality, and Identification

This section focuses on potential issues with the identification of the Phillips curve and the Taylor rule. We start by assessing whether the Taylor rule or the Phillips curve was realized in the actual data in any given period of time and how this compares to the share of people with beliefs consistent with those theories. Even though, for instance, the Phillips curve trade-off may not always be realized in empirical data, several authors argue that, irrespective of its existence, incorporating a Phillips curve relationship improves the

accuracy of forecasting models.[17] With respect to consistency regarding the Taylor rule, we have to keep in mind that inconsistency could still imply consistent beliefs about the actual conduct of monetary policy, since the central bank may deviate from an implicit Taylor rule. In Figure 3, we thus show the share of consumers consistent with the Phillips curve and the Taylor rule together with those periods where either the Phillips curve trade-off or the Taylor rule relationship were realized 12 months ahead in actual macroeconomic data rounded to the nearest integer. We observe that both relations were satisfied also by actual macroeconomic data in most periods of our sample. The Phillips curve trade-off was not realized during the mid-90s and in the years prior to the recent financial crisis, but this does not seem to have affected the general trend in consistency.

Figure 3: Consistency and Realised Data



(a) Phillips Curve

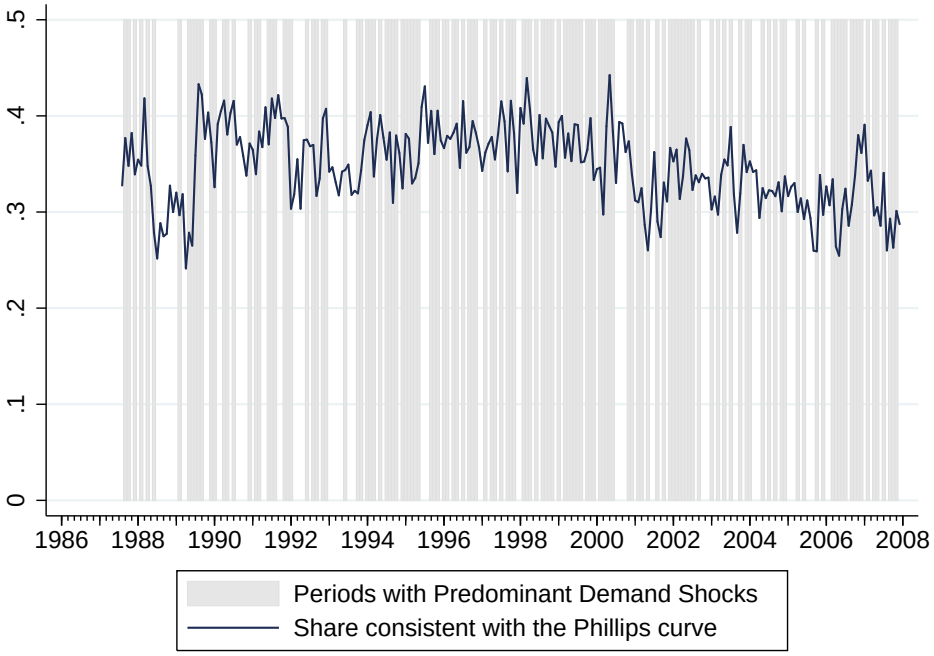
(b) Taylor Rule

Note: Shaded areas denote periods where the Phillips curve trade-off, using actual data rounded to the nearest integer, was realized 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.

Additionally, consistency especially with the Phillips curve might depend on the existence of specific 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. Consequently, we check for the role of supply and demand shocks, as predominant supply shocks would shift the Phillips curve so that inflation and unemployment would in fact be expected to move in the same direction. The potential importance of supply shocks for the identification of consistency with the Phillips curve is evaluated in Figure 4. We obtain data on both demand and supply shocks from Kilian (2009), who extracts the shocks from a VAR model

[17] Comparing different methods of forecasting, Stock and Watson (2008), Dotsey et al. (2011), as well as Faust and Wright (2013) show that forecasting methods based on the Phillips curve were frequently outperformed by survey forecasts and univariate methods, especially during the Great Moderation years. Nevertheless, Phillips curve forecasts can perform relatively better especially during recessions and when inflation is relatively volatile, pointing towards potential non-linearities and a role of the trade-off especially for forecasting turning points in inflation.

Figure 4: Identification of the Phillips Curve



Note: Shaded areas denote periods with predominant demand shocks, which are identified as those periods where demand shocks are larger than supply shocks in absolute terms. Data for demand and supply shocks is obtained from Kilian (2009), where the sample ends in 2007m12.

of the crude oil market.[18] In Figure 4, we then plot the share of consumers consistent with the Phillips curve trade-off against periods with predominant demand shocks, i.e., periods where demand shocks are larger than supply shocks in absolute terms. In these periods, the Phillips curve should not shift and the trade-off would be assumed to hold. This seems to be the case in the majority of periods of our sample, suggesting that the existence of supply shocks does not pose a major problem for our identification of consistency. Nevertheless, as expected, we observe that consistency regarding the Phillips curve drops around 1988-89 and around 1993 when supply shocks dominated demand shocks. To control for some of these effects, we include lagged oil prices as a control variable in the regressions of the next sections and conduct further robustness checks in section 3.3.

Carvalho and Nechio (2014) study in detail potential endogeneity and causality for the case of the Taylor rule. First, they point out that as long as the signs of the relationships between inflation and interest rates, and unemployment and interest rates remain unaffected by the endogeneity bias, the results will be unchanged. This holds because both Carvalho and Nechio (2014) and our study rely on the signs of the relationships and not the magnitude of the effects. Second, they show that monetary policy shocks that could potentially cause endogeneity problems are relatively small after 1987 by estimating a variant of the new Keynesian model of Galí et al. (2011) with two different Taylor rules.

[18] Note that the time series in Kilian (2009) run only until 2007m12.

In fact, monetary policy shocks explain about 7.6% of the variance of inflation and 6.5% of the variance of unemployment for the specification with an inertial Taylor rule. They proceed with an exercise where they apply their procedure to define consistency to the simulated data. Comparing results with estimated monetary policy shocks and a version that uses an increased variance of monetary policy shocks, they show that their inference might become invalid only if monetary policy shocks were excessively volatile. Only with a variance of the shock at least four times larger than their estimate the unemployment effect results in a wrong sign.

Finally, Carvalho and Nechio (2014) also quantitatively address the concern about a potential comovement of expected inflation and interest rate changes which does not necessarily reflect expectations formed consistent with the Taylor rule. In particular, they identify periods where the Fed deviated from the Taylor rule (August 2003–December 2005) and monitor the response of consumers. Consistent with the idea that households' responses reflect their perceptions of monetary policy, the share of consistent expectations should be lower during periods of Taylor rule deviations. Indeed, the results of Carvalho and Nechio (2014) support this conjecture. Furthermore, as can be observed in Figure 1, the share of consumers consistent with the Taylor rule starts to drop also in our analysis in August 2003–December 2005. We further analyze this issue in our regression analysis.

3 Central Bank Communication, News and Consistency of Expectations

In this section, we analyze the impact of central bank communication and news on the consistency of consumers' expectations. The focus of the analysis lies hence on the question if and how communication and news affect consumers' consistency. This is highly relevant, since having a sound understanding of monetary policy increases the effectiveness of monetary policy making.

We test three different parts of the central bank communication channel: We distinguish between the sender channel (central bank announcement), the transmission channel (the volume of news in the media), and the receiver channel of news (consumers' reported perception of news). The main motivation for this is that both the transmission and the receiver channel can be muted: The media tend to report "specific" news, and people have limited information-processing capacities and therefore devote only a limited amount of time to economic news. All these can substantially compromise the effectiveness of the communication strategies by the central bank. In particular, Hamilton (2004) and Soroka (2006) report that the media report more "bad" news than "good" news and Sims (2003) points out that people have a finite Shannon capacity to process information. Furthermore, Sims (2010) discusses the role of central bank communication and transparency from the perspective of rational inattention and argues that financial market participants

(and professional forecasters) are likely to be very attentive to central bank policy statements. If the central bank is relatively vague, professional forecasters will make their own assumptions and estimate the most likely path of actions. However, consumers may react very differently than professional forecasters, paying less attention to policy announcements and possibly reacting with a delay.

This leads us to expect different effects of central bank communication on consumers and professional forecasters. The sender channel may be more important for professionals than for consumers: While for professionals it is plausible to expect that every communication milestone discussed in this paper should improve the understanding of the FOMC actions and thus the understanding of how the economy works, or at least have a non-negative effect, it is not obvious that the same is true for consumers. Additional information can be confusing or understood with error. Thus, especially for consumers, we would have a prior that the transmission channel (the role of media) plays a relatively more important role and that the sender channel may play a smaller role. However, certain communication milestones, such as the announcement of an inflation target, should be relevant also for consumers. The transmission channel from media news should be of lower relevance for professionals. However, we could observe significant effects if the response of professionals' consistency is correlated with the media echo. In this respect, an important milestone for professionals was the introduction of the press conferences after every other FOMC meeting (the ones that are paired with the survey of economic projections), where they can hear additional explanations and clarifications of policy actions and forward guidance.

For consumers, we also have the data to test the receiver channel. Furthermore, we can distinguish between perceived positive and negative news. Similarly to the case of media reporting, and in line with the prospect theory of Kahneman and Tversky (1979), agents tend to display higher receptiveness towards "bad" news than "good" news. This leads us to expect that there may be asymmetries in the effect of positive and negative news.[19]

3.1 Results for Consumers

To evaluate the effects of communication on consistency of consumers, we estimate probit models on the individual probability of forming theory-consistent expectations regarding the Income Fisher equation, the Phillips curve, the Taylor rule, as well as for all three macroeconomic relations simultaneously. Tables 7-9 report marginal effects for our set of determinants. To enhance comparability across models, all marginal effects are evaluated

[19]Figures A.4 and A.5 in the Appendix display the evolution of the relative volume of media news and of the share of consumers reporting that they have heard news on a specific topic. Table A.5 presents a correlation table between all the communication measures. Additionally, we test for Granger causality between the different news measures, shown in Table A.6 in the Appendix. We find that media news typically Granger-causes the perceptions of news by consumers.

at a hypothetical "representative" consumer which we take to be male, 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 thereof. Robust standard errors are calculated with the δ method (Oehlert, 1992). Additionally, we control for macroeconomic variables such as inflation, oil prices, and the unemployment gap as a measure of the business cycle, where all price variables are included with one lag to account for a publication lag.

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

$$z_{i,t} = \begin{cases} 1 \text{ if } z^*_{i,t} > 0 \\ 0 \text{ if } z^*_{i,t} \leq 0 \end{cases}, \; i = 1, 2, ..., N, \tag{5}$$

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:

$$z^*_{i,t} = \alpha_1 + \mathbf{y}_t\alpha_2 + \mathbf{c}_{t/i,t}\alpha_3 + \mathbf{x}_{i,t}\alpha_4 + u_{i,t}, \tag{6}$$

where α_1 is a constant, $\mathbf{y}_t$ is the vector of macroeconomic variables, $\mathbf{c}_{t/i,t}$ is a vector of communication 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.

The MS contains single survey interviews as well as interviews within the rotating panel. As some consumers are not selected to be interviewed a second time, this might lead to a sample bias. Moreover, additional sample selection might arise from non-response bias, which might be higher for specific demographic groups.[20] 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.[21] 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 $\rho = 0$.

[20]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.

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

Table 7: Consistency and Central Bank Communication

	Income Fisher eq.	Phillips curve	Taylor rule	All Relations
π_{t-1}	0.0031	0.0002	-0.0500***	-0.0087**
	(0.0027)	(0.0031)	(0.0043)	(0.0035)
$\sigma^2_{\pi,t-1}$	-0.0011	0.0024	-0.0104**	0.0024
	(0.0014)	(0.0021)	(0.0041)	(0.0031)
oil_{t-1}	0.0001	-0.0001	0.0003***	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
u_t^{gap}	-0.0073***	0.001	-0.0096*	-0.0072
	(0.0020)	(0.0030)	(0.0052)	(0.0067)
$FFTarget94_t$	-0.0111	0.0270***	-0.0730***	-0.0038
	(0.0072)	(0.0085)	(0.0102)	(0.0070)
$BalanceofRisk00_t$	0.0148*	-0.0416***	0.0434***	0.0081
	(0.0076)	(0.0133)	(0.0155)	(0.0174)
$Votes02_t$	0.0046	0.0019	-0.0044	0.013
	(0.0104)	(0.0126)	(0.0147)	(0.0095)
$ForwardGuidance03_t$	0.0296***	-0.0378***	-0.0379***	-0.0241*
	(0.0089)	(0.0123)	(0.0124)	(0.0130)
$PressConference11_t$	0.0164	-0.0148	–	–
	(0.0127)	(0.0159)		
$ExplicitTarget12_t$	0.1194***	0.0194	–	–
	(0.0159)	(0.0585)		
N	75,154	76,659	61,096	59,661
χ^2	735.731	310.694	391.002	1332.859
Demographic Controls	Yes	Yes	Yes	Yes
ρ	-0.914	0.19	-0.122	-0.439
p-value Wald (ρ=0, χ^2)	0.000	0.629	0.680	0.394

Notes: Table 7 reports the marginal partial effects from the heckprobit models evaluated at the representative consumer. The time sample is 1987m8-2012m9 for the Fisher equation and the Phillips curve and 1987m8-2007m12 for the Taylor rule and all three relations jointly. The Wald test for $\rho = 0$ gives the χ^2 statistics of the Wald test for independence from the sample selection equation. Robust standard errors are calculated with the δ method (Oehlert 1992) and are reported in parentheses. ***/**/* indicates significance at the 1/5/10% level.

First, we test for an impact of changes in the communication strategy of the Fed on consumers' likelihood of forming consistent expectations.[22] We thus incorporate a set of monthly time dummy variables representing important milestones in the communication strategy of the Fed, as defined in section 2.1.[23] Results are presented in Table 7.

Overall, changes in central bank communication affect consumers' consistency regarding all macroeconomic relations analyzed here. We find a positive link between the publica-

[22]We also tested for an effect of the Chairmen of the Federal Reserve Board by including a dummy variable for the term of Greenspan, with Bernanke's term as reference period. While most results regarding central bank communication remain robust, the results suggest an additional positive effect of the Greenspan period on consistency with the Phillips curve and the Taylor rule. The results are available upon request.

[23]Middeldorp (2011) incorporates dummy variables in the same fashion to control for important milestones of communication.

tion of the Federal Funds target rate in February 1994 on consumers' individual likelihood of being consistent with the Phillips curve, while the publication of the balance-of-risks statement in January 2000 coincides with improvements in consistency regarding both the Income Fisher equation and the Taylor rule. The latter effect is quantitatively particularly important for consistency with the Taylor rule, which is plausible considering that the statement specifically discusses the FOMC's views on risks regarding its dual mandate of inflation and business cycle stabilization. Additionally, the introduction of forward guidance in August 2003 and of the explicit inflation target in January 2012 are found to impact positively on consistency with the Income Fisher equation. Given that the effect of the explicit inflation target has to be seen relative to the introduction of the communication measures beforehand, this result is remarkable in terms of size and significance. Note that due to the restrictions regarding the appropriate time sample, we do not analyze this effect for the Taylor rule.

Our results suggest also some negative links between central bank communication and consumers' consistency, stemming for instance from the balance of risks on consistency with the Phillips curve and from the introduction of forward guidance on consistency with both the Phillips curve and the Taylor rule. As there is no consensus on the optimal way of central bank communication, it is not surprising that we observe also negative effects. The former effect could point towards difficulties consumers have in inferring the Phillips curve trade-off from the Fed's risk assessment, while the latter could imply that consumers perceived that the Fed was deviating from the rule. Indeed, the period between August 2003 – December 2005, according to Taylor (2007) and Carvalho and Nechio (2014), can be considered as a period where the Fed deviated from a Taylor rule.

In addition to the communication effects on consistency, the results in Table 7 imply that especially consistency regarding the Taylor rule is affected significantly by macroeconomic price developments. It seems that in periods with both a higher level and higher volatility of inflation, consumers are less likely to anticipate monetary policy reactions in terms of a simple Taylor rule, while an increase in oil price growth has the opposite effect.[24] Moreover, the unemployment gap is negatively linked to consistency with the Income Fisher equation and the Taylor rule.

Next, we evaluate the effect of media news on macroeconomic and monetary policy issues on consumers' consistency, while controlling for both central bank communication and macroeconomic variables. Thus, we are assessing the importance of the transmission channel. The results in Table 8 show that most of the communication effects remain robust, while a number of additional news effects emerge, especially on consistency with the Taylor rule, but also on other definitions of consistency. Most importantly, the results

[24] Additionally, we check whether consumers might have their "personal" CPI in mind when they answer questions about prices, which we calculate from demographic-specific CPIs calculated by the Chicago Fed (McGranahan and Paulson, 2005). Notably, the differences between general CPI and personal CPI inflation are generally quite small. Incorporating personal CPI inflation as a control variable in the regression gives virtually unchanged results.

Table 8: Consistency and Media News

	Income Fisher eq.	Phillips curve	Taylor rule	All Relations
$media\_\pi_t$	0.0158	-0.0490***	-0.1475***	-0.0511**
	(0.0108)	(0.0146)	(0.0154)	(0.0244)
$media\_u_t$	-0.0258**	0.0212	0.0671**	0.0391*
	(0.0129)	(0.0174)	(0.0275)	(0.0220)
$media\_FFR_t$	0.0191	-0.0756	-0.0541	-0.0982
	(0.0544)	(0.0656)	(0.0833)	(0.0656)
$media\_monetarypolicy_t$	0.1464***	-0.0174	0.1821*	0.0944
	(0.0530)	(0.0747)	(0.1088)	(0.1142)
$FFTarget94_t$	-0.0144*	0.0282***	-0.0703***	-0.0019
	(0.0074)	(0.0087)	(0.0109)	(0.0079)
$BalanceofRisk00_t$	0.0225**	-0.0639***	-0.0206	-0.0165
	(0.0089)	(0.0130)	(0.0151)	(0.0106)
$Votes02_t$	0.0048	0.0077	0.0192	0.0243**
	(0.0109)	(0.0134)	(0.0149)	(0.0115)
$ForwardGuidance03_t$	0.0224**	-0.0231*	0.0009	-0.0109
	(0.0096)	(0.0121)	(0.0130)	(0.0098)
$PressConference11_t$	0.0211	-0.0232	–	–
	(0.0149)	(0.0181)		
$ExplicitTarget12_t$	0.1263***	0.0034	–	–
	(0.0176)	(0.0595)		
N	75,154	76,659	61,096	59,661
χ^2	754.319	323.862	490.703	1156.684
Demographic Controls	Yes	Yes	Yes	Yes
Macroeconomic Controls	Yes	Yes	Yes	Yes
ρ	-0.919	0.148	-0.168	-0.478
p-value Wald (ρ=0, χ^2)	0.000	0.705	0.514	0.329

Notes: Table 8 reports the marginal partial effects from the heckprobit models evaluated at the representative consumer. The time sample is 1987m8-2012m9 for the Fisher equation and the Phillips curve and 1987m8-2007m12 for the Taylor rule and all three relations jointly. The Wald test for $\rho = 0$ gives the χ^2 statistics of the Wald test for independence from the sample selection equation. Robust standard errors are calculated with the δ method (Oehlert 1992) and are reported in parentheses. ***/**/* indicates significance at the 1/5/10% level.

show a positive link between media news on monetary policy issues and consumers' consistency with both the Income Fisher equation and the Taylor rule. This result suggests that the central bank may affect the formation of consumers' expectations also indirectly via a media communication channel. Interestingly, media reports on changes in the Federal Funds rate per se have no impact on consistency with either of the relations. Regarding the effects of media news on macroeconomic variables, the results are in line with the effects of macroeconomic control variables in the case of the Taylor rule, as media news on inflation also coincide with a lower likelihood of consistency. We find a similar effect on consistency with the Phillips curve. Media news on inflation and unemployment affect the Taylor rule consistency with opposite signs. While more news on unemployment

Table 9: Consistency and News Heard by Consumers

	Income Fisher eq.	Phillips curve	Taylor rule	All Relations
$news\_prices\_high_{i,t}$	0.0122	-0.0634***	-0.0520***	-0.0184
	(0.0088)	(0.0150)	(0.0128)	(0.0148)
$news\_prices\_low_{i,t}$	0.026	0.0305	0.0485*	0.0323*
	(0.0188)	(0.0214)	(0.0251)	(0.0177)
$news\_u\_high_{i,t}$	0.0213***	-0.0528***	-0.0481***	-0.0241**
	(0.0055)	(0.0101)	(0.0079)	(0.0108)
$news\_u\_low_{i,t}$	-0.0439***	0.0319	0.0458**	0.0015
	(0.0082)	(0.0195)	(0.0194)	(0.0225)
$news\_credit\_tight_{i,t}$	0.0067	-0.0235	-0.1232***	-0.0582*
	(0.0105)	(0.0189)	(0.0145)	(0.0312)
$news\_credit\_easy_{i,t}$	-0.0257**	0.0249	-0.0088	-0.0294
	(0.0109)	(0.0238)	(0.0201)	(0.0323)
$FFTarget94_t$	-0.0108	0.0286***	-0.0684***	-0.0022
	(0.0072)	(0.0088)	(0.0108)	(0.0079)
$BalanceofRisk00_t$	0.0104	-0.0299*	0.0556***	0.0181
	(0.0078)	(0.0178)	(0.0142)	(0.0231)
$Votes02_t$	0.0049	-0.0015	-0.013	0.0081
	(0.0104)	(0.0135)	(0.0148)	(0.0119)
$ForwardGuidance03_t$	0.0322***	-0.0401***	-0.0367***	-0.0266**
	(0.0090)	(0.0123)	(0.0124)	(0.0117)
$PressConference11_t$	0.0192	-0.0226	–	–
	(0.0127)	(0.0170)		
$ExplicitTarget12_t$	0.1219***	0.0334	–	–
	(0.0161)	(0.0766)		
N	75,154	76,659	61,096	59,661
χ^2	787.065	419.705	549.685	1030.051
Demographic Controls	Yes	Yes	Yes	Yes
Macroeconomic Controls	Yes	Yes	Yes	Yes
ρ	-0.908	0.083	-0.239	-0.591
p-value Wald (ρ=0, χ^2)	0.000	0.865	0.432	0.264

Notes: Table 9 reports the marginal partial effects from the heckprobit models evaluated at the representative consumer. The time sample is 1987m8-2012m9 for the Fisher equation and the Phillips curve and 1987m8-2007m12 for the Taylor rule and all three relations jointly. The Wald test for $\rho = 0$ gives the χ^2 statistics of the Wald test for independence from the sample selection equation. Robust standard errors are calculated with the δ method (Oehlert 1992) and are reported in parentheses. ***/**/* indicates significance at the 1/5/10% level.

increases consistency, the negative effect of media news on inflation can be interpreted as follows: When media reporting on inflation is high, there are two reasons why the Taylor rule consistency declines. First, consistency with the Phillips curve trade-off is lower in these circumstances (as can be seen in Table 8) and second, consumers do not seem to update their interest rate expectations consistently when the volatility of inflation is high (as can be seen in Table 7), which typically coincides with a higher media coverage

on inflation. Overall, we can say that consumer opinions and consistency with various economic concepts is importantly shaped also by the transmission channel.

Finally, we also account for the effect of central bank communication via the news channel from consumers' receiver perspective. To do so, we construct individual dummy variables measuring if the consumer recently observed news on high or low prices/ inflation, on high or low unemployment and on easy or tight credit conditions. Table 9 presents the results, where again the central bank communication effects remain mainly robust. As we can disentangle the news perceived by consumers into more negative and more positive news, we observe an interesting asymmetric news effect: Negative news on high inflation, high unemployment and tight credit conditions are frequently linked with negative effects on consumers' consistency regarding the Phillips curve and the Taylor rule, while the reverse is true for positive news. This implies that not only the "transportation" of both monetary and macroeconomic news to consumers affects consistency, but also their content. Again in line with the macroeconomic effects observed in Table 7, consumers are less likely to be consistent with the Taylor rule if they observed news on high prices. Ehrmann et al. (2015) show that the correlation between perceived news on price increases and inflation of retail gasoline prices is very high (0.63), thus one can expect that this type of news is perceived as a supply shock and therefore is not consistent with the Phillips curve relationship and the Taylor rule. For the Income Fisher equation, the likelihood of consistency is higher with news on high unemployment and lower if the consumers observed news on low unemployment or easy credit conditions. These results further emphasize that it is important to communicate clearly with individuals, especially when adverse shocks hit the economy. One of the implications of our results is that the various transmission channels studied in this paper are to some degree complementary to one other, and thus policies that reinforce different channels—such as press conferences—may be particularly effective in guiding expectations of economic agents.

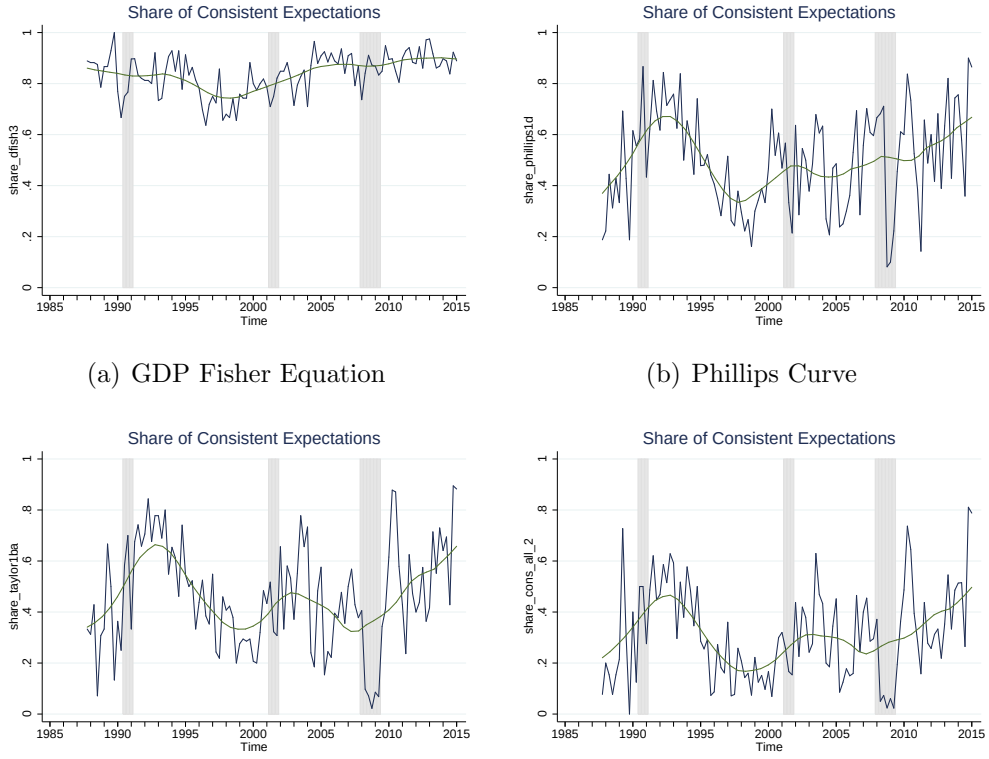
3.2 Results for Professional Forecasters

To compare our results on consumers to those of professional forecasters, we check the consistency of expectations also with respect to the SPF. Again, we restrict the sample to start in 1987q4 to avoid distorting effects from large monetary policy shocks, but include the ZLB period after 2007 in our analysis of consistency with the Taylor rule, since the SPF asks for quantitative expectations regarding 3-month Treasury bill rates, which are highly correlated with the policy rate throughout.

As the SPF consists of quantitative forecasts, we have to slightly adapt the definitions of consistency in Section 2. To test for consistency with respect to the Fisher equation, we employ forecasts related to GDP. Specifically, using forecasts of the level of nominal GDP and of the GDP deflator, we define the implied expected real GDP in both the current period and one year ahead. These two measures are then used to define the "perceived"

one-year-ahead real GDP growth that is then compared with professionals' answers for expected one-year-ahead real GDP growth. We treat expectations to be consistent with the GDP Fisher equation if "perceived" GDP growth is not more than 0.1 percentage point different to their answer for the one-year-ahead real GDP growth. A threshold has to be chosen for the SPF forecasts to account for rounding effects. We find that 84% of forecast in the SPF are consistent with this definition.[25] As expected, this share is substantially higher among professional forecasters than for consumers.

Figure 5: Shares of Consistent Expectations, SPF



(a) GDP Fisher Equation

(b) Phillips Curve

(c) Taylor Rule

(d) All Relations

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

We define consistency with the Phillips curve and the Taylor rules in the same way as for consumers, except that we take into account rounding for the relationships that include equality, as in the case of the Fisher equation.[26] We find that on average 50% of forecasts are consistent with the Phillips curve and 46% of all forecasts are consistent with the Taylor rule. While there are more forecasts consistent with the Phillips curve for

[25] This is a relatively "generous" threshold for professional forecasters: if we reduced it to 0.05 percentage point, then the share of consistent expectations would drop from 0.84 to 0.73.

[26] As our Taylor rule definition includes a period when interest rates are at their effective zero lower bound, we do a robustness check where we explicitly take into account this constraint in our definition of consistency. The zero lower bound constraint affects only about 1% of all forecasts in the post 2009q1 period. All affected forecasts are between 2009–2010.

Table 10: Shares of Professional Forecasters with Consistent Expectations, SPF

	Mean	Median	SD	Min	Max	N
Fisher Equation	0.84	0.86	0.08	0.64	1.00	4,075
Phillips Curve	0.50	0.50	0.20	0.08	0.90	4,075
Taylor Rule	0.46	0.44	0.21	0.02	0.89	4,075
All Relations	0.31	0.29	0.18	0.00	0.81	4,075

Notes: The time sample is 1987q4-2015q1.

Table 11: Consistency and Media News, SPF

	GDP Fisher eq.	Phillips curve	Taylor rule	All Relations
π_{t-1}	-0.0038	-0.0526***	-0.0513***	-0.0324**
	(0.0094)	(0.0159)	(0.0132)	(0.0129)
$\sigma^2_{\pi,t-1}$	-0.0016	0.0082	-0.0137***	-0.0046
	(0.0025)	(0.0053)	(0.0049)	(0.0038)
oil_{t-1}	0.0002	0.0015***	0.0002	-0.0000
	(0.0002)	(0.0005)	(0.0004)	(0.0003)
u_t^{gap}	-0.0253*	-0.0539***	-0.0838***	-0.0567***
	(0.0149)	(0.0200)	(0.0192)	(0.0180)
$media\_\pi_t$	0.0709**	0.2382***	-0.0941*	0.0079
	(0.0295)	(0.0482)	(0.0483)	(0.0397)
$media\_u_t$	-0.0332	-0.2984***	-0.2437***	-0.2119***
	(0.0326)	(0.0450)	(0.0519)	(0.0494)
$media\_FFR_t$	0.3723*	-1.0349***	-0.7940***	-0.6043**
	(0.1966)	(0.2171)	(0.2259)	(0.2568)
$media\_monetarypolicy_t$	-0.2267	0.4265**	0.9307***	0.8468***
	(0.1788)	(0.1862)	(0.2232)	(0.2009)
$FFTarget94_t$	-0.0507	-0.2735***	-0.2167***	-0.2255***
	(0.0353)	(0.0489)	(0.0466)	(0.0429)
$BalanceofRisk00_t$	0.0448*	0.1762***	0.0029	0.0578
	(0.0249)	(0.0452)	(0.0437)	(0.0406)
$Votes02_t$	-0.0119	-0.1264**	-0.0247	0.0287
	(0.0245)	(0.0582)	(0.0525)	(0.0490)
$ForwardGuidance03_t$	0.0404	-0.0672	-0.0292	-0.0536
	(0.0397)	(0.0501)	(0.0520)	(0.0448)
$PressConference11_t$	0.0615	0.3511***	0.2031***	0.1400**
	(0.0481)	(0.0633)	(0.0663)	(0.0593)
$ExplicitTarget12_t$	0.0601	-0.0985	-0.0829	-0.0541
	(0.0579)	(0.0657)	(0.0714)	(0.0665)
N	3630	3714	3502	3322
χ^2	22.134	144.231	148.447	93.469

Notes: Table 11 reports the average marginal effects from the population average panel probit models. The time sample is 1987q4-2015q1. Robust standard errors are calculated with the δ method (Oehlert 1992) and are reported in parentheses. ***/**/* indicates significance at the 1/5/10% level.

professional forecasters, the share of consistent forecasts with the Taylor rule is remarkably close to the one by consumers. However, 31% of all forecasts are consistent with all three principles, which is substantially higher than 6% in the case of consumers.

Regarding the time variation of these shares, there are several regularities that can be seen in Figure 5. The share of forecasts consistent with the GDP Fisher equation is relatively stable and does not exhibit as much volatility as the other shares. There is a small decrease of the share of consistent expectations in the second half of the 1990's. It is also evident that the share always decreases just before or at the beginning of recessions (around the turning points). The other three shares display very similar cyclical properties. They all feature a drop in the share of consistent expectations during the last recession. The share of consistent forecasts peaks one or two years after the first two recessions in our sample, however after the last recession we again observe increasing levels of consistency. In the last 2 quarters of our sample, the share of consistent expectations with all three principles reached around 80% of all forecasts.

The microdata of the SPF contains a larger panel dimension than the MS, but does not report any demographic characteristics. Therefore, we cannot account for attrition, but instead estimate panel probit models for the individual likelihood of consistency and report average marginal effects. The effects of the macroeconomic control variables on professionals' consistency are mostly in line with our results for consumers. Here, we additionally find that consistency with the Phillips curve is less likely with higher inflation or a higher unemployment gap, in line with the effect on the Taylor rule.

Regarding the sender channel of central bank communication, two communication milestones stand out: The consistency of professional forecasters in the SPF significantly improved with the introduction of the balance of risk in January 2000 and with the press conference in April 2011. The latter effect is especially plausible, as it adds additional clarification and interpretation to the FOMC's decision. By contrast, we find no significant effect of the publication of the inflation target in January 2012 on professionals' consistency, which may mean that the target was already incorporated into their forecasts. We also find that some communication milestones have negative effects on consistency with various macroeconomic concepts, where especially the announcement of the Federal Funds target in February 1994 stands out. Again, as noted earlier, it is not clear that all means of communication necessarily improve the understanding of monetary policy.

Somewhat surprisingly, the results show more significant effects of media reports on professionals' consistency compared to consumers. It thus seems that changes in professionals' consistency are at least correlated with the intensity of media news. In line with our result for consumers, we find a positive link between media reports on monetary policy and professionals' consistency with the Taylor rule. With the exception of some positive effects of news on inflation and news on the Federal Funds rate on consistency with the GDP Fisher equation and the Phillips curve, the remaining media effects are mostly negative.

3.3 Robustness Checks

Finally, we conduct some robustness checks. First, we control for a potential effect of the ZLB period for consumers' consistency with the Taylor rule, and second we check for effects of demand and supply shocks as identified by Kilian (2009).

Table 12 comprises the results for consistency with the Taylor rule when the estimation sample is extended to include the ZLB period after 2007. We control for additional effects from this period with a dummy, which takes on the value of one from 2008m1 onwards. In the first column, the ZLB dummy accounts only for level shifts in consistency, while the second column estimates also interaction terms with our macroeconomic determinants. Notably, in both models the effects of both the macroeconomic determinants and of the central bank communication variables remain robust with respect to our results for the reduced time sample. Hence, it seems that the lower correlation between interest rates at short and long maturities during the ZLB period does not overthrow any of our main results. Additionally, the level ZLB dummy is not significant in the first column. Nevertheless, accounting for interaction terms with the macroeconomic variables, we find a number of significant effects. As expected, the results suggest that overall consistency was lower during the ZLB period, where the negative effect of inflation is reduced, but the negative effect of a higher unemployment gap is reinforced. Considering that this was the most severe recession during our time sample, these results are quite plausible. While all central bank communication effects on consistency with the Taylor rule stay robust, extending the sample yields additional positive links between communication efforts and consistency: The introduction of the press conference has a significant positive effect in both models, while the model with interaction terms also yields a significantly positive effect from the introduction of the official inflation target. The former effect is in line with our results for professional forecasters, while the latter effect suggests that contrary to professionals, consumers did not previously completely incorporate the inflation target in their expectation formation.

Lastly, we check whether demand and supply shocks hitting the economy have an effect on consistency, as shown in Table 13. As discussed in section 2.3, especially large supply shocks could affect consumers' consistency with the Phillips curve. To check for the robustness of our main estimation results, we re-estimate the models with macroeconomic determinants and central bank communication in Table 7 with the dummy for predominant demand shocks (*demdominant*) used in Figure 4.[27] We find no significant effects of the shocks on consistency with either the Income Fisher equation, the Phillips curve, or the Taylor rule. All effects from the macroeconomic determinants and central bank communication remain robust.

[27]Since the time series in Kilian (2009) run only until 2007m12, we cannot check for robustness of the effects from introducing a press conference in April 2011 and the explicit inflation target in January 2012.

Table 12: Robustness Check: Accounting for the Effect of the Zero Lower Bound Period on Consistency with the Taylor Rule

	Taylor rule level dummy	Taylor rule interaction terms
d_zlb_t	-0.0037	-0.2221***
	(0.0117)	(0.0398)
π_{t-1}	-0.0355***	-0.0501***
	(0.0035)	(0.0042)
$\pi_{t-1} * d\_zlb_t$	–	0.0473***
		(0.0096)
$\sigma^2_{\pi,t-1}$	-0.0021	-0.0110***
	(0.0019)	(0.0040)
$\sigma^2_{\pi,t-1} * d\_zlb_t$	–	0.0121***
		(0.0045)
oil_{t-1}	0.0004***	0.0003***
	(0.0001)	(0.0001)
$oil_{t-1} * d\_zlb_t$	–	0.0001
		(0.0003)
u_t^{gap}	-0.0188***	-0.0077**
	(0.0033)	(0.0039)
$u_t^{gap} * d\_zlb_t$	–	-0.0441***
		(0.0090)
$FFTarget94_t$	-0.0431***	-0.0749***
	(0.0091)	(0.0099)
$BalanceofRisk00_t$	0.0384***	0.0462***
	(0.0128)	(0.0125)
$Votes02_t$	-0.0048	-0.0028
	(0.0135)	(0.0140)
$ForwardGuidance03_t$	-0.0475***	-0.0384***
	(0.0118)	(0.0123)
$PressConference11_t$	0.0982***	0.0525***
	(0.0171)	(0.0202)
$ExplicitTarget12_t$	0.0528	0.1133***
	(0.0382)	(0.0317)
N	76287	76287
χ^2	728.471	810.301
Demographic Controls	Yes	Yes
ρ	-0.216	-0.185
p-value Wald (ρ=0, χ^2)	0.346	0.385

Notes: The dummy *d_zlb* takes on the value of 1 from 2008m1 onwards, when the financial crisis hit and interest rates converged to the ZLB. Table 12 reports the marginal partial effects from the heckprobit models evaluated at the representative consumer. The time sample for the estimations is 1987m8-2012m9. The Wald test for $\rho = 0$ gives the χ^2 statistics of the Wald test for independence from the sample selection equation. Robust standard errors are calculated with the δ method (Oehlert 1992) and are reported in parentheses. ***/**/* indicates significance at the 1/5/10% level.

Table 13: Robustness Check: Accounting for the Effect of Demand and Supply Shocks

	Income Fisher eq.	Phillips curve	Taylor rule	All Three
π_{t-1}	0.0078**	-0.0005	-0.0501***	-0.0089**
	(0.0033)	(0.0041)	(0.0044)	(0.0035)
$\sigma^2_{\pi,t-1}$	-0.0008	0.0174***	-0.0103**	0.0025
	(0.0033)	(0.0044)	(0.0041)	(0.0032)
oil_{t-1}	0.0001	-0.0001	0.0003***	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
u_t^{gap}	-0.0074**	-0.0024	-0.0096*	-0.0073
	(0.0032)	(0.0062)	(0.0052)	(0.0069)
$demdominant_t$	0.0028	0.0042	-0.0021	-0.0032
	(0.0041)	(0.0051)	(0.0051)	(0.0037)
$FFTarget94_t$	-0.0046	0.0305***	-0.0727***	-0.0034
	(0.0081)	(0.0104)	(0.0102)	(0.0071)
$BalanceofRisk00_t$	0.0131*	-0.0410**	0.0433***	0.0085
	(0.0078)	(0.0170)	(0.0155)	(0.0181)
$Votes02_t$	0.0092	-0.0037	-0.0046	0.0127
	(0.0112)	(0.0149)	(0.0147)	(0.0097)
$ForwardGuidance03_t$	0.0221**	-0.0378***	-0.0379***	-0.0245*
	(0.0099)	(0.0129)	(0.0124)	(0.0131)
N	60074	61404	61096	59661
χ^2	422.452	189.614	391.128	1035.097
Demographic Controls	Yes	Yes	Yes	Yes
ρ	-0.929	0.002	-0.123	-0.457
p-value Wald (ρ=0, χ^2)	0	0.996	0.677	0.379

Notes: The time series for demand and supply shocks are taken from Kilian (2009) and cover the time period 1978m1-2007m12. The dummy variable *demdominant* takes on the value of one in time periods where demand shocks are larger than supply shocks in absolute terms. Table 13 reports the marginal partial effects from the heckprobit models evaluated at the representative consumer. The time sample for the estimations is 1987m8-2007m12. The Wald test for $\rho = 0$ gives the χ^2 statistics of the Wald test for independence from the sample selection equation. Robust standard errors are calculated with the δ method (Oehlert 1992) and are reported in parentheses. ***/**/* indicates significance at the 1/5/10% level.

4 Conclusion

Consumers' and professional forecasters' macroeconomic expectations are of key relevance for central banks' policy decisions and, hence, 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 is, however, an important issue as the efficiency of monetary policy strongly depends on the understanding of the implication of central bank actions.

This paper first calculates the share of both consumers and professional forecasters that have expectations in line with the Fisher equation, the Phillips curve and the Taylor rule. Second, we evaluate the implication of having consistent expectations by looking at forecast accuracy and investigate whether communication can help facilitate the under-

standing of monetary policy and thereby increase the share of people having consistent expectations. We link consistency to three different channels of central bank communication: the sender channel (central bank announcements), the transmission channel (the volume of news in the media), and the receiver channel of news (consumers' reported perception of news). Specifically, we propose consistency as a measure for assessing the effectiveness of central bank communication.

While the share of professional forecasters with consistent expectations is generally found to be higher than the corresponding share for consumers, both groups show a similar time-variation in their degree of consistency. Part of this time-variation can be related to the communication channels. Specifically, we find that both consumers' and professional forecasters' consistency improves with certain changes in the communication strategy of the FOMC. While consumers were mostly affected by the announcement of the Federal Funds Target rate in February 1994, the introduction of the balance-of-risks statement in January 2000 and the introduction of the official inflation target in January 2012, professionals' consistency gained particularly from the introduction of the press conference after the FOMC meetings in April 2011. Moreover, both the transmission and the receiver channel play an important role. Our results suggest that consistency of both groups benefits from media news on monetary policy, reiterating the importance of the media in focusing attention on these topics and in clarifying the FOMC's decisions. Looking at the receiver channel for consumer, we find evidence that especially negative news impair the probability of having consistent expectations.

Overall, our results suggest that central bank communication can increase the extent to which people form expectations consistent with key economic concepts. Furthermore, having consistent expectations helps predict economic outcomes with a higher accuracy.

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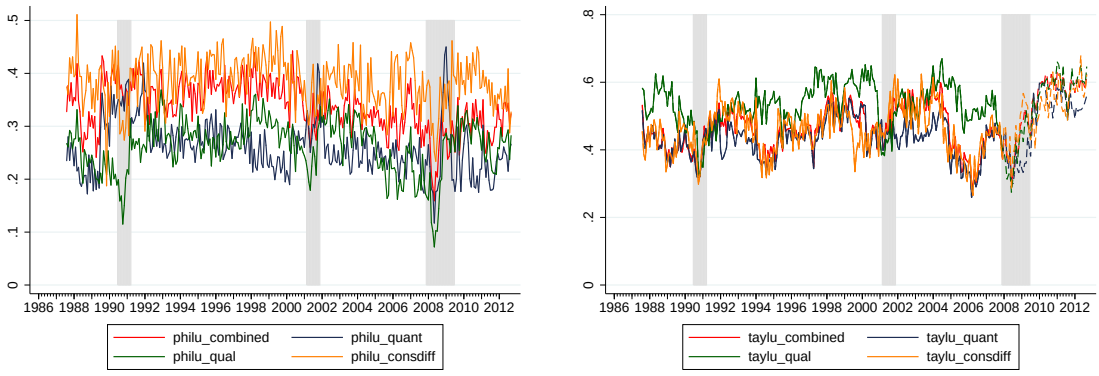
6 Appendix

6.1 Additional Graphs and Tables

Figure A.1: Consistency Shares with Alternative Definitions of Inflation Expectations

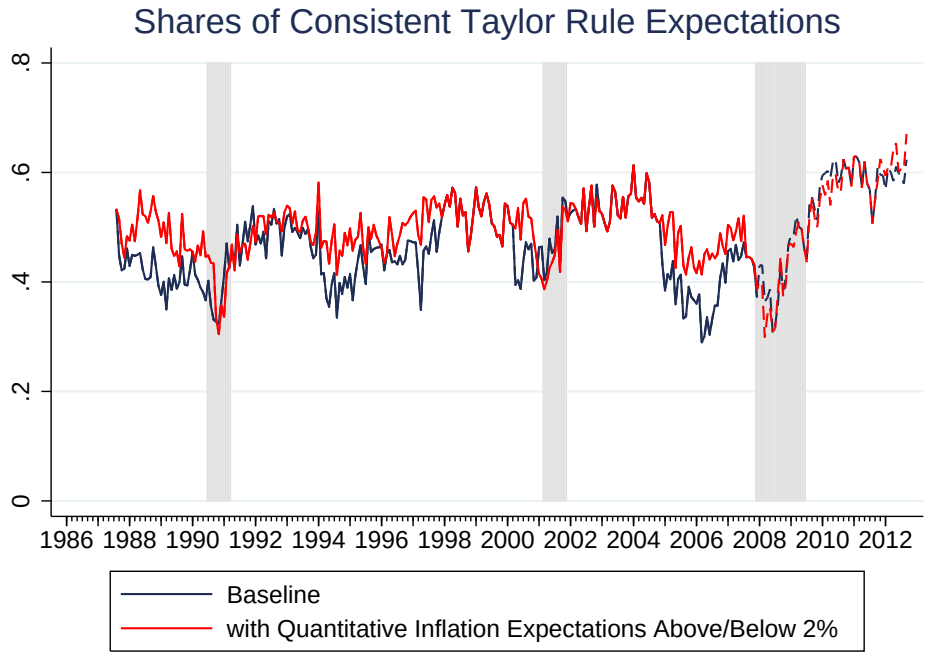


(a) Phillips Curve

(b) Taylor Rule

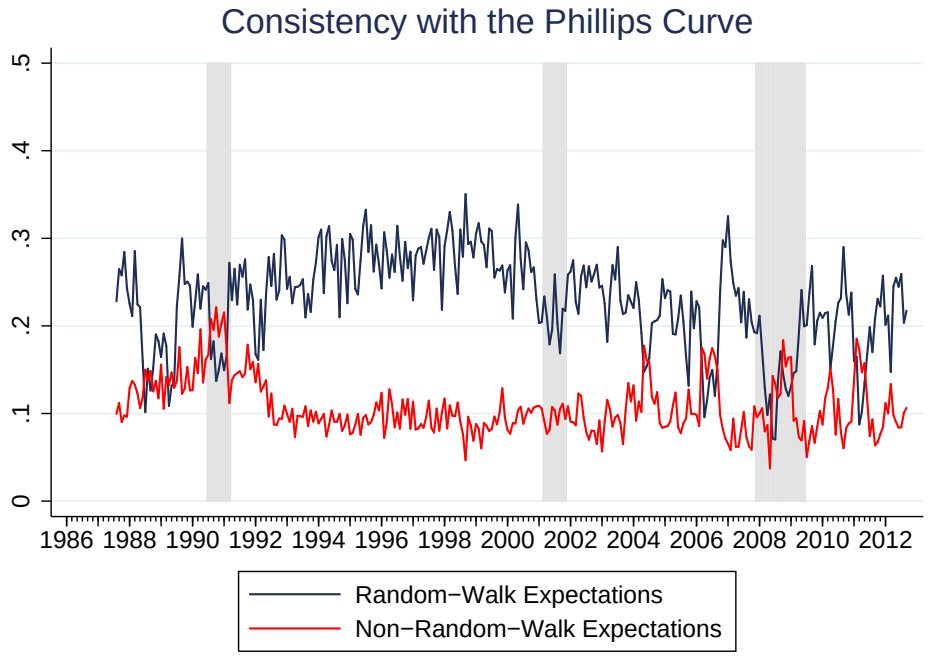
Note: *philu_combined* (*taylu_combined*) gives the baseline share of consumers consistent with the Phillips curve (Taylor rule), where inflation expectations are defined from both the quantitative question [A12b], compared to a rounded average of actual inflation over the previous 12 months, and the qualitative question [A12] as discussed in the paper. *Philu_quant* (*taylu_quant*) uses the identification of inflation expectations from only the quantitative question [A12b] as in Carvalho and Nechio (2014), where quantitative point estimates are compared to a rounded average of actual inflation over the previous 12 months. *Philu_qual* (*taylu_qual*) is derived using only qualitative inflation expectations from question [A12]. $Philu\_consdiff$ ($taylu\_consdiff$) identifies expected inflation changes by comparing the quantitative inflation forecasts between the second and the first interview in the rotating panel. Shaded areas denote recession periods as defined by the NBER.

Figure A.2: Consistency with the Taylor Rule when Inflation Expectations are Evaluated Relative to the Inflation Target



Note: Shaded areas denote recession periods as defined by the NBER.

Figure A.3: Random Walk vs. Non-Random-Walk Expectations Regarding the Phillips Curve



Note: Shaded areas denote recession periods as defined by the NBER.

Table A.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	0.52	0.51	0.04	0.41	0.64	152,041	–	–
Male	0.54	0.54	0.05	0.40	0.67	67,838	-14.746***	162.654***
Female	0.50	0.49	0.05	0.37	0.64	84,199	14.746***	162.630***
Age young	0.47	0.48	0.06	0.26	0.61	37,280	16.738***	209.464***
Age middle	0.52	0.52	0.04	0.41	0.66	60,580	-2.519**	4.767**
Age old	0.54	0.54	0.06	0.39	0.69	53,614	-12.760***	121.829***
Educ1	0.47	0.46	0.17	0.00	1.00	5,016	5.415***	21.985***
Educ2	0.46	0.47	0.12	0.13	0.85	8,356	8.559***	54.833***
Educ3	0.48	0.48	0.06	0.34	0.73	44,619	15.647***	183.110***
Educ4	0.51	0.51	0.06	0.33	0.68	37,655	2.556**	4.875**
Educ5	0.54	0.54	0.06	0.36	0.72	34,089	-9.085***	61.792***
Educ6	0.58	0.58	0.06	0.43	0.74	21,468	-19.372***	280.359***
Inc quint1	0.50	0.50	0.08	0.24	0.69	22,492	4.382***	14.376***
Inc quint2	0.51	0.51	0.07	0.29	0.72	25,699	0.934	0.653
Inc quint3	0.51	0.50	0.07	0.31	0.72	29,171	3.168***	7.541***
Inc quint4	0.51	0.51	0.06	0.36	0.73	32,941	3.516***	9.257***
Inc quint5	0.54	0.54	0.05	0.37	0.71	33,749	-10.639***	84.709***
West	0.52	0.52	0.06	0.32	0.67	30,692	-2.066**	3.209*
North central	0.52	0.52	0.06	0.34	0.68	40,423	-2.030**	3.086*
Northeast	0.52	0.52	0.06	0.35	0.70	29,180	0.014	-0.005
South	0.51	0.51	0.06	0.39	0.69	51,746	3.649***	9.960***

Notes: The time sample is 1987m8-2012m9. The last two columns present 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. ***/**/* indicates significance at the 1/5/10% level.

Table A.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	0.34	0.34	0.05	0.16	0.44	152,041	–	–
Male	0.34	0.35	0.05	0.17	0.45	67,838	-4.036***	10.913***
Female	0.33	0.33	0.05	0.15	0.47	84,199	4.032***	10.913***
Age young	0.36	0.36	0.06	0.16	0.53	37,280	-10.580***	75.129***
Age middle	0.33	0.34	0.05	0.16	0.46	60,580	2.188**	3.238*
Age old	0.32	0.32	0.06	0.14	0.48	53,614	7.344***	36.209***
Educ1	0.33	0.33	0.15	0.00	1.00	5,016	0.834	0.469
Educ2	0.33	0.32	0.11	0.00	0.60	8,356	1.879*	2.348
Educ3	0.33	0.33	0.06	0.16	0.51	44,619	1.456	1.432
Educ4	0.33	0.33	0.06	0.13	0.50	37,655	3.482***	8.124***
Educ5	0.35	0.35	0.06	0.16	0.52	34,089	-4.834***	15.688***
Educ6	0.34	0.35	0.07	0.13	0.54	21,468	-1.866*	2.348
Inc quint1	0.32	0.32	0.07	0.15	0.57	22,492	6.731***	30.447***
Inc quint2	0.32	0.32	0.07	0.14	0.59	25,699	5.939***	23.671***
Inc quint3	0.33	0.33	0.07	0.09	0.52	29,171	3.293***	7.290***
Inc quint4	0.35	0.35	0.07	0.11	0.50	32,941	-4.978***	16.672***
Inc quint5	0.36	0.36	0.06	0.16	0.55	33,749	-8.741***	51.321***
West	0.34	0.34	0.07	0.16	0.53	30,692	0.654	0.331
North central	0.34	0.34	0.06	0.13	0.54	40,423	-0.700	0.331
Northeast	0.34	0.34	0.07	0.14	0.49	29,180	-0.820	0.467
South	0.34	0.34	0.05	0.15	0.49	51,746	0.782	0.422

Notes: The time sample is 1987m8-2012m9. The last two columns present 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. ***/**/* indicates significance at the 1/5/10% level.

Table A.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	0.46	0.46	0.06	0.29	0.61	123,324	–	–
Male	0.46	0.45	0.07	0.27	0.65	55,377	-0.386	0.112
Female	0.46	0.46	0.07	0.28	0.61	67,943	0.376	0.112
Age young	0.45	0.45	0.07	0.22	0.65	33,932	3.228***	7.770***
Age middle	0.46	0.46	0.07	0.30	0.63	50,537	-0.009	0.007
Age old	0.47	0.47	0.08	0.27	0.64	38,380	-2.998***	6.681***
Educ1	0.44	0.44	0.16	0.00	1.00	4,444	2.158**	3.458*
Educ2	0.43	0.43	0.12	0.16	0.80	7,205	4.248***	13.428***
Educ3	0.45	0.45	0.07	0.28	0.62	37,378	2.049**	3.139*
Educ4	0.45	0.45	0.07	0.29	0.63	29,325	1.420	1.507
Educ5	0.47	0.47	0.08	0.23	0.68	27,516	-3.207***	7.645***
Educ6	0.47	0.47	0.10	0.20	0.70	16,690	-4.237***	13.357***
Inc quint1	0.44	0.44	0.08	0.19	0.74	17,836	3.941***	11.567***
Inc quint2	0.45	0.46	0.07	0.23	0.63	20,519	1.629	1.971
Inc quint3	0.45	0.46	0.08	0.23	0.64	23,333	1.106	0.900
Inc quint4	0.45	0.45	0.09	0.23	0.66	27,225	2.084**	3.251*
Inc quint5	0.48	0.48	0.09	0.22	0.71	28,016	-7.545***	42.325***
West	0.46	0.46	0.08	0.25	0.70	24,803	0.154	0.007
North central	0.46	0.46	0.07	0.25	0.64	32,697	-1.233	1.131
Northeast	0.46	0.46	0.08	0.23	0.67	23,684	-1.263	1.166
South	0.45	0.46	0.07	0.27	0.66	42,140	2.069**	3.168*

Notes: The time sample is 1987m8-2007m12. The last two columns present 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. ***/**/* indicates significance at the 1/5/10% level.

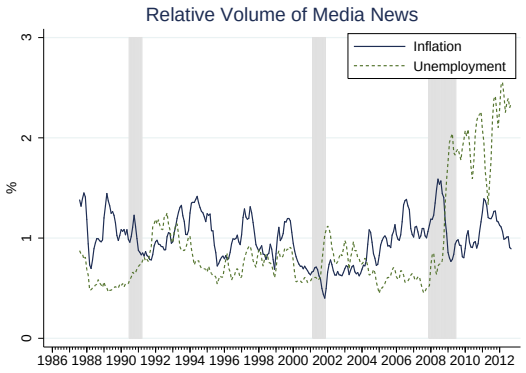
Table A.4: Shares of Consumers with Consistent Expectations for All Three Economic Concepts

	Mean	Median	SD	Min	Max	N	T-test Mean	K-W Test Median
All	0.06	0.06	0.02	0.02	0.12	123,324	–	–
Male	0.07	0.07	0.03	0.02	0.16	55,377	-7.366***	9.520***
Female	0.06	0.05	0.02	0.01	0.13	67,943	7.359***	9.500***
Age young	0.06	0.06	0.03	0.00	0.18	33,932	2.855***	1.437
Age middle	0.06	0.06	0.02	0.01	0.15	50,537	-0.273	0.002
Age old	0.07	0.06	0.03	0.01	0.18	38,380	-2.568**	1.165
Educ1	0.06	0.06	0.09	0.00	0.67	4,444	0.481	0.072
Educ2	0.05	0.05	0.05	0.00	0.24	7,205	2.578***	1.167
Educ3	0.05	0.06	0.02	0.01	0.17	37,378	7.153***	8.953
Educ4	0.06	0.06	0.03	0.00	0.22	29,325	3.624***	2.302
Educ5	0.07	0.07	0.03	0.01	0.18	27,516	-5.815***	5.921***
Educ6	0.08	0.08	0.04	0.00	0.20	16,690	-8.484***	12.592***
Inc quint1	0.06	0.05	0.04	0.00	0.19	17,836	1.656*	0.455
Inc quint2	0.05	0.05	0.03	0.00	0.14	20,519	5.108***	4.532**
Inc quint3	0.06	0.06	0.03	0.00	0.15	23,333	1.736*	0.518
Inc quint4	0.06	0.06	0.03	0.00	0.16	27,225	1.877*	0.601
Inc quint5	0.07	0.07	0.03	0.01	0.17	28,016	-9.060***	14.297***
West	0.06	0.06	0.03	0.00	0.15	24,803	0.470	0.041
North central	0.06	0.06	0.03	0.00	0.14	32,697	-1.273	0.293
Northeast	0.06	0.06	0.03	0.00	0.16	23,684	-0.615	0.080
South	0.06	0.06	0.02	0.01	0.16	42,140	1.302	0.274

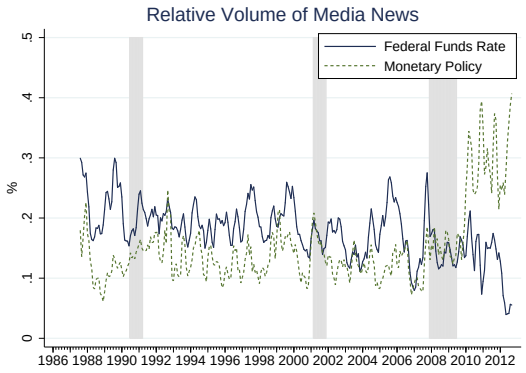
Notes: The time sample is 1987m8-2007m12. The last two columns present tests for equality of means (medians) between a particular subsample indicated in the first column and the rest of the sample. For the mean we employ a two-sample mean-comparison t-test with equal variances and for the median a Kruskal-Wallis equality-of-populations rank test. ***/**/* indicates significance at the 1/5/10% level.

6.2 Analysis of News Variables

Figure A.4: News in the Media

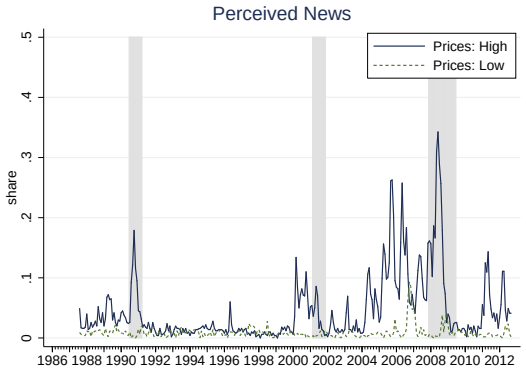


(a) News on Inflation and Unemployment

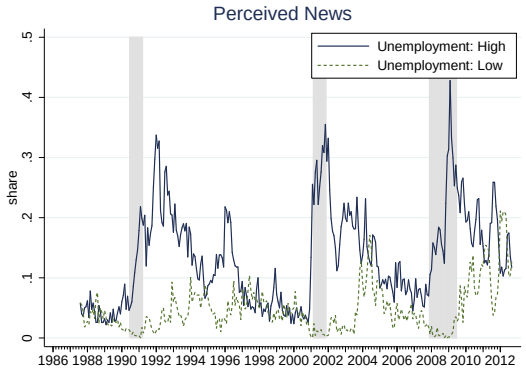


(b) News on the Federal Funds Rate and Monetary Policy

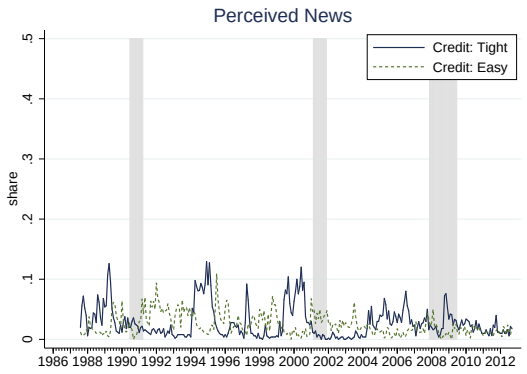
Figure A.5: News Perceived by Consumers



(a) News on Prices/Inflation



(b) News on Unemployment



(c) News on Credit Conditions

In the analysis shown in the Table A.6, we show that we can identify a pattern in the direction of Granger causality between different measures of news. As expected, we find that media news typically Granger-causes the perceptions of news by consumers. The only exception is perceived news on high inflation. However, we have to take into account that perceived news on inflation mainly reflect consumer experiences with frequently purchased items, where gasoline prices play a predominant role (see Ehrmann et al., 2015). Regarding the sender channel, we can only assess whether specific communication milestones have increased the level of news in the economy or the average perception of news. Indeed, we see quite a few significant effects on both the share of consumers reporting hearing news and also on the volume of media news. Especially the introduction of forward guidance and of the press conferences increased the volume of media news significantly, while, as expected, the evidence is less clear-cut for the share of perceived news.[28]

[28]Results for tests on these relations are available upon request.

Table A.5: Correlations between Different Channels of Communication

	news_ph	*news_pl*	*news_uh*	*news_ul*	*news_ct*	*news_ce*	*media_π*	*media_u*	*media_FFR*	*media_mp*	*FFT*94	*BoR*00	*V*02	*FG*03	*PC*11	*ET*12
news_prices_high	1.000															
news_prices_low	-0.119	1.000														
news_u_high	-0.076	-0.130	1.000													
news_u_low	-0.149	0.040	-0.210	1.000												
news_credit_tight	0.231	-0.058	-0.224	-0.099	1.000											
news_credit_easy	-0.266	0.526	0.063	-0.046	-0.218	1.000										
media_π	0.241	0.297	-0.119	-0.047	0.572	0.320	1.000									
media_u	-0.175	0.144	0.425	0.374	-0.096	0.271	0.267	1.000								
media_FFR	-0.182	0.361	-0.262	-0.019	0.219	0.572	0.563	0.124	1.000							
media_monetarypolicy	-0.124	0.196	0.163	0.359	-0.011	0.288	0.328	0.749	0.358	1.000						
*FFTarget*94	0.139	-0.273	0.146	0.182	-0.180	-0.455	-0.521	-0.034	-0.629	-0.158	1.000					
*BalanceofRisk*00	0.370	-0.184	0.324	0.133	-0.196	-0.398	-0.406	0.144	-0.568	0.008	0.693	1.000				
*Votes*02	0.373	-0.125	0.258	0.233	-0.201	-0.378	-0.279	0.230	-0.514	0.067	0.600	0.865	1.000			
*ForwardGuidance*03	0.433	-0.090	0.201	0.313	-0.131	-0.372	-0.194	0.269	-0.470	0.134	0.541	0.780	0.902	1.000		
*PressConference*11	0.045	-0.073	0.100	0.422	-0.110	-0.139	-0.042	0.480	-0.275	0.411	0.186	0.268	0.310	0.343	1.000	
*ExplicitTarget*12	0.045	-0.030	0.009	0.415	-0.081	-0.087	-0.057	0.377	-0.270	0.305	0.126	0.182	0.210	0.233	0.678	1.000

Table A.6: Granger Causality between Different Channels of Communication

	news_prices_high	*news_prices_low*	*news_u_high*	*news_u_low*	*news_credit_tight*	*news_credit_easy*
news_prices_high						
news_prices_low						
news_u_high	-	-				
news_u_low	-	-	-			
news_credit_tight	-	-	-	-		
news_credit_easy	-	-	-	-	-	$\Longleftarrow$
media_π	$\Longleftarrow$	$\Longrightarrow$	-	-	-	-
media_u	-	-	$\Longleftrightarrow$	$\Longrightarrow$	-	-
media_FFR	-	-	-	-	$\Longleftrightarrow$	$\Longleftrightarrow$
media_monetarypolicy	-	-	-	-	$\Longrightarrow$	$\Longrightarrow$

Notes: $\Longleftarrow$ means Granger causality runs from the variable at the top of the column to the row variable; $\Longrightarrow$ means Granger causality runs from the row variable to the variable at the top of the column; $\Longleftrightarrow$ means that Granger causality runs both ways.