Anchoring of Consumers' Inflation Expectations: Evidence from Microdata

Lena Dräger*
Michael J. Lamla**

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Abstract

In this paper, we explore the degree of anchoring of consumers' individual long-run inflation expectations. If expectations are firmly anchored, transitory shocks to short-run expectations should not pass through to their long-run inflation beliefs. Utilizing the University of Michigan Survey of Consumer's rotating panel microstructure, we can identify changes in inflation expectations of individual consumers over time. Our results indicate that long-run inflation expectations became more anchored over the last decades, as the degree of comovement between short- and long-run expectations fell significantly around 1996. Nevertheless, the probability of a joint adjustment stayed relatively constant. Regarding the possible determinants of anchoring, we find that perceived news on current easy money and credit conditions as well as high interest rate expectations are correlated with a reduced anchoring of long-run expectations before 1996, while these effects are no longer present in the post-1996 period. However, a detrimental effect of perceived news on government debt emerges after 1996, alluding to a potentially problematic link between fiscal and monetary policy.

Keywords: Anchoring, inflation expectations, microdata, news.

JEL classification: E52, D84.

*University of Hamburg. Email: Lena.Draeger@wiso.uni-hamburg.de

**University of Essex and ETH Zurich, KOF Swiss Economic Institute. Email: mlamla@essex.ac.uk.
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1 Introduction

To anchor inflation expectations around an implicit or explicit inflation target is one of the most important tasks of monetary policy aiming to stabilize inflation (Bernanke, 2007). Well-anchored expectations enable inflation-targeting central banks to achieve greater stability of output and employment in the short-run, while ensuring price stability in the long-run (Orphanides and Williams, 2007). Consequently, central bank communication frequently talks about how well anchored inflation expectations are. Especially since the outbreak of the recent financial crisis and the following ultra-expansionary monetary policy stance, politicians and central bankers closely monitor the degree of anchoring.

There exists a large body of literature on the degree of anchoring of expectations. Implications are derived using financial market data or surveys of professional forecasters. Notably, the literature is silent on the consumer side. However, the degree of anchoring of consumers' inflation expectations should be of equal importance to monetary policy makers, since through their wage-setting and consumption-saving decisions, this group has an important impact on an economy's price developments.

In this paper, we address this research gap and evaluate the degree of anchoring using consumers' expectations. Ideally, if inflation expectations are firmly anchored, a transitory shock may influence short-run inflation expectations, but should not affect long-run inflation expectations. Consequently, a transmission of the shock from short- to long-run expectations would be judged unfavorably.

We use data at the micro level, rather than aggregate survey data. Since the individual-level micro dataset includes information on both short- and long-run inflation expectations of consumers, we can identify the degree of anchoring via the comovement between expectations at different horizons. In addition, the identification is achieved not only through the cross-section of individuals, but also through a time dimension, as the micro survey allows to track changes in indiviual expectations over a period of six months. To the best of our knowledge, this is the first paper evaluating the degree of anchoring of consumers', rather than professionals', inflation expectations on an individual level with a sound identification over the cross section and time, analyzing the comovement between short- and long-run inflation expectations over a period of about 30 years.

Evaluating the degree of comovement between US consumers' short- and long-run inflation expectations, i.e. the degree of anchoring, we find that the strength of comovement has fallen considerably over time, implying a stronger anchoring of expectations. Interestingly, our results suggest that the turning point for the higher anchoring of inflation expectations was not the Volcker disinflation, but the period of preemptive tightening by the Greenspan Fed after 1996. This could imply that consumers might need several years to learn about the new regime of stable inflation and to incorporate it into their long-run inflation expectations. A related explanation for this finding might be that consumers need to observe several policy interventions in order to adjust their long-run expectations to a new regime. Finally, while we find that the strength of comovement has fallen over time, the probability of a simultaneous adjustment of both short- and long-run expectations remains relatively constant. This implies that despite the change in pass-through, consumers are still equally likely to adjust short- and long-run expectations simultaneously. In other words, consumers rationally expect a looser link between current inflation shocks and future inflation, but do not neglect longer run expectations.

We do not only describe changes in the degree of anchoring over time, but additionally elaborate on its determinants. We focus on macroeconomic variables related to the conduct of monetary policy and also consider effects from news on price changes, conditions in the money and credit market and debt observed by the consumer. Given that consumers are likely to be at least partially inattentive to macroeconomic developments, we believe that controlling for perceived news should be of importance. Our results suggest that higher interest rate expectations of consumers increase both the degree and the probability of comovement, and thus have a detrimental effect on the degree of anchoring, while past inflation has only little effects. Notably, inflation persistence is not significantly related to either the strength or the probability of comovement, once we control for other determinants. The interest rate expectations channel becomes insignificant in the post-1996 period, thus reinforcing our previous result that long-run inflation expectations became more anchored during this period.

Furthermore, news observed by the consumer as well as monetary policy shocks matter. Again, most news effects become insignificant in the post-1996 era, with the exception of interest rate shocks in the Fed Funds rate as well as news on high prices, which are positively related with an increase in the probability of comovement throughout. In addition, we find a positive effect of perceived news on government debt on the degree of comovement, which emerges in the post-1996 period. This might indicate that consumers are uncertain whether rising levels of fiscal debt during the financial crisis may translate into higher future inflation. Finally, we control for interest rate cycles in the Fed Funds Target rate, since news on prices and the monetary policy stance might be perceived differently if the Fed currently conducts a tightening or an expansive cycle. We provide evidence for asymmetric news effects between periods of monetary policy easing or tightening by the Fed. Especially news on low prices in periods of a monetary tightening and news on tight money conditions in a monetary easing period help to anchor long-run expectations in the period after 1996, while these effects are not present or even reversed in the pre-1996 sample.

There exists a large body of literature on the anchoring of inflation expectations that our paper is related to. Notably, there is no unified approach to identifying "anchored inflation expectations". Approaches used in the literature range from investigating the movements of individual time series, like for instance deviations of inflation expectations from an explicit inflation target or the dispersion of inflation expectations, to strategies using advanced econometrics techniques that consider the response of high frequency financial market data.

Straightforward strategies to measure the anchoring of inflation expectations include analyzing the level, the volatility and the dispersion of expectations from survey data. Coibion and Gorodnichenko (2010) derive a rationality test for expectations under the alternative hypothesis of information frictions affecting the expectation formation process. The test may be extended to allow for an effect of anchoring due to inflation targeting or central bank independence, where the authors argue that both measures should reduce inflation volatility and, hence, also attention towards inflation. Dovern et al. (2012) analyze disagreement among professional forecasters and state that anchored expectations imply that mean expectations stabilize at some target level and that cross-sectional dispersion is reduced. Both Coibion and Gorodnichenko (2010) as well as Dovern et al. (2012) report evidence that central bank independence improves the anchoring of inflation expectations. Finally, Pierdzioch and Rülke (2013) analyse the herding behavior of professional forecasters to assess whether inflation targeting strengthened the anchoring of inflation expectations across different countries.

Another strand of the literature defines expectations at different horizons as anchored if changes in expectations are insensitive to macroeconomic news. Inflation expectations are derived from high-frequency financial markets data, where forward rates for different maturities correspond to inflation expectations at different horizons. Studies by Beechey et al. (2011), Levin et al. (2004) and Gürkaynak et al. (2007, 2010) generally find that long-run expectations are more anchored, i.e. less sensitive to economic news, than short-run expectations. Similarly, inflation expectations in inflation targeting countries appear better anchored. Applying a nonlinear estimation framework on the level of inflation expectations, Strohsal and Winkelmann (2012) report a contrasting result, where short-run expectations are more anchored than long-run expectations.

Under the definition closest to our approach, inflation expectations are assumed to be anchored if changes in short-run expectations have no or little impact on long-run expectations. This is measured with the inflation pass-through criterion in Jochmann et al. (2010) and Gefang et al. (2012). Both studies extract short- and long-run inflation expectations from high-frequency data on forward inflation compensation in the US and the UK bond markets.[1] The authors test for the hypotheses of anchored, unmoored or contained expectations. Results suggest that inflation expectations are contained, i.e. they are not fully anchored, but move within a bounded interval. In the UK, results suggest that inflation expectations are contained within an interval around the inflation target.

[1] High-frequency financial data does not identify inflation expectations directly. Specifically, it helps to identify the inflation compensation which is the sum of inflation expectations and an inflation term premium. Under certain assumptions, the inflation compensation can shed light on the sensitivity of inflation expectations.

While the literature evaluates the anchoring of inflation expectations from professional forecasters or from financial market data, this paper assesses the anchoring of consumers' inflation expectations. To our knowledge, the only approach that studies the anchoring of consumers' expectations so far is the study by Easaw et al. (2012). The authors extend the epidemiological model by Carroll (2003) to test whether households anchor their expectations to professionals' forecasts or on the official inflation target. For a dataset of Italian consumers, the authors report that households anchor more on professionals' inflation forecasts than on the ECB's inflation target.

The remainder of the paper is structured as follows. Section 2 provided the theoretical foundation for the comovement of inflation expectations. We discuss the dataset from the University of Michigan Survey of Consumers in section 3. In Section 4 we calculate and discuss the degree of anchoring of inflation expectations over time. Section 5 elaborates on the relation between the degree of anchoring and the persistence of inflation, while Section 6 tests for the effects of macroeconomic determinants and news. Finally, section 7 summarizes and concludes.

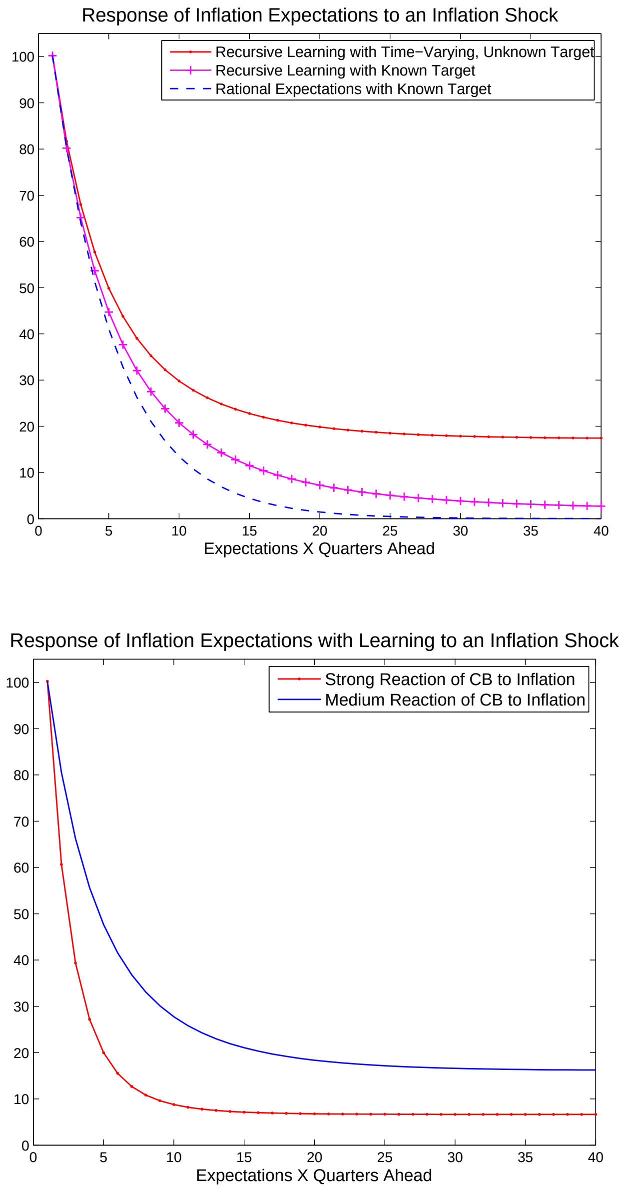
2 Theoretical Motivation for the Anchoring of Inflation Expectations

From a theoretical perspective, the degree of anchoring of inflation expectations depends to a large extent on the expectations formation process. This affects both the strength of an inflation shock on expectations in general as well as the degree of comovement between short- and long-run inflation expectations. A certain pass-through from short-run to long-run inflation expectations could be related to both theories of imperfect information (Sims, 2003; Mankiw and Reis, 2002; Carroll, 2003) or to theories with recursive learning (Orphanides and Williams, 2004, 2007). Under both types of theories, *a priori* we would expect to observe some degree of comovement between short- and long-run expectations as agents receive noisy signals about occuring shocks or only gradually learn the model-implied law of motion for inflation. Similarly, under both theories we would expect agents to anchor their long-run expectations more strongly as they receive additional information about the monetary policy reaction function, for instance in the form of an official inflation target.

Beechey et al. (2011) present a model with imperfect knowledge and recursive learning as in Orphanides and Williams (2004, 2007) and use the models' implications to show that the anchoring of long-run inflation expectations, i.e. their sensitivity to an inflation shock, differs with the monetary policy regime.

This model gives important insights for our analysis. First, it shows that with recursive learning, there is always comovement between short- and long-run expectations. Second, this comovement becomes stronger, the more uncertain people are about monetary policy targets and the smaller the reaction of the central banks to inflation deviations (θ) is. In the upcoming paragraph, we will lay out the model and offer simulations for specific monetary policy regimes.

Figure 1: Comovement in the Recursive Learning Model in Beechey et al. (2011)



Note: Mean coefficients from 600 simulations.

The model economy consists of an aggregate supply curve, an aggregate demand curve and a monetary policy reaction function:

$$\pi_{t+1} = \phi\pi^e_{t+1/t} + (1-\phi)\pi_t + \alpha y_{t+1} + e_{t+1}, \quad e \sim \text{iid}(0, \sigma^2_e) \tag{1}$$

$$y_{t+1} = -\zeta(r_t - r^*) + u_{t+1}, \quad u \sim \text{iid}(0, \sigma^2_u) \tag{2}$$

$$r_t - r^* = \frac{\theta}{\zeta}(\pi_t - \pi^*) + k_t \quad k \sim \text{iid}(0, \sigma^2_k), \tag{3}$$

where π_t is the inflation rate, $\pi^e_{t+1/t}$ denotes inflation expectations for period $t+1$ formed in t, y_t is the output gap, $(r_t - r^*)$ is the deviation of the real interest rate from its long-run value and π^* is the central bank's inflation target. Given that agents form rational expectations, the solution for the dynamics of inflation is given by:

$$\pi^e_{t+1/t} = \frac{\alpha\theta}{1-\phi}\pi^* + \frac{1-\phi-\alpha\theta}{1-\phi}\pi_t \quad (4)$$

Note that if agents form their expectations under imperfect knowledge, they cannot obtain the solution in (4). Instead, Beechey et al. (2011) assume that they infer the dynamics of inflation via recursive learning, as they recursively estimate a reduced form of (4):

$$\pi_t = \hat{c}_{1,t} + \hat{c}_{2,t}\pi_{t-1} + \nu_t \quad (5)$$

While the long-run value r^* is assumed to be common knowledge, agents estimate the central banks' inflation target π^* to be $\hat{c}_{1,t}/(1-\hat{c}_{2,t})$. The learning problem is thus simplified if the central bank announces an explicit inflation target since this removes the constant term from equation (5). By contrast, if the central bank's inflation target is not made official and even varies over time, the learning problem becomes more advanced.

From numerical simulations of the model, we derive the impact of an inflation shock e_t on inflation expectations at different horizons and under different monetary policy regimes. The results of the simulations are shown in Figure 1.[2]

In the first graph, we observe that even under rational expectations (with full information), an inflation shock is associated with a positive change in medium-run inflation expectations. Hence, a certain comovement of short- and long-run expectations in response to economic shocks can be expected, but short-run expectations should be more volatile than long-run expectations. If agents have to recursively learn the models' solution, the importance of a credible monetary policy regime becomes evident: Inflation expectations will generally be more anchored if the central bank has an explicit inflation target, as this reduces agents' learning problem. By contrast, under an unknown and time-varying target, both short- and long-run inflation expectations will be more responsive to inflation shocks. Similarly, the second graph shows that inflation expectations with recursive learning are considerably more anchored if the central bank reacts strongly to deviations of inflation from its target. This is due to the fact that a higher parameter θ in equation (4) reduces the effect of actual inflation on inflation expectations and increases the effect of the inflation target, thus anchoring expectations more closely to the target.

[2] The model code for the simulations in Beechey et al. (2011) was obtained from the supplementary material at http://www.aeaweb.org/articles.php?doi=10.1257/mac.3.2.104.

3 The Data

We employ the microdata from the University of Michigan Survey of Consumers, which is available for the sample period January 1978 to July 2012 at a monthly frequency.

For the analysis of the dynamics of individuals' inflation expectations, we exploit the fact that the Michigan Survey of Consumers includes a rotating panel: Each month, a randomly determined sub-sample of households is chosen to be re-interviewed six months after the first interview. The complete cross-section each month includes about 40% of individuals that are interviewed for the second time.[3] Via the rotating panel structure of the survey, we are able to identify changes in expectations on an individual consumer level.

In order to identify individual changes in inflation expectations at a micro level, we follow Souleles (2004) and Pfajfar and Santoro (2013) and restrict our sample to households where the same person answered both interviews. We thus keep all pairs of observations in the rotating panel, where the interviews were six months apart and where the respondent reported the same sex, race as well as month and year of birth. Additionally, we control for the age of the respondent and only allow increases by one year between interviews. In order to rule out extreme values for inflation expectations, we further truncate our sample by excluding the upper and lower 2.5% of the distribution of both short- and long-run quantitative inflation expectations.[4]

For the evaluation of changes in individuals' inflation expectations, we use the questions from the survey asking for individuals' quantitative estimates of short-run and long-run inflation expectations. The precise questions of the survey read:

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

A13b. "By about what percent per year do you expect prices to go (up/down) on the average, during the next 5 to 10 years?"

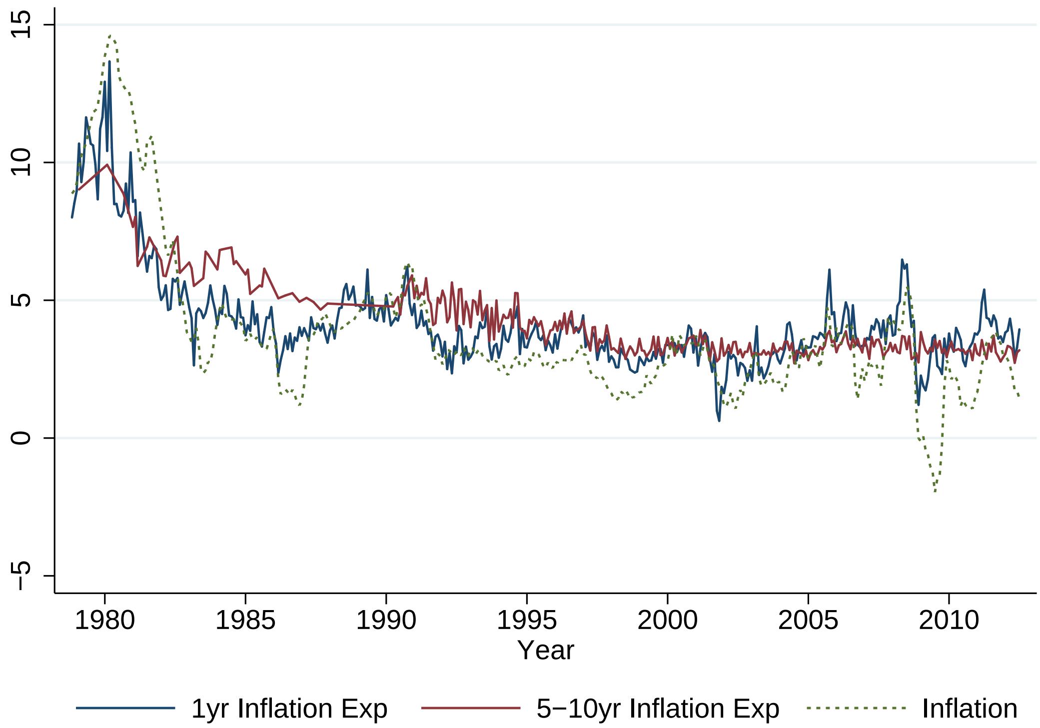
Time series of consumers' mean quantitative short- and long-run inflation expectations from the Michigan Survey are presented in Figure 2. Both short- and long-run inflation expectations declined considerably during the disinflation period in the 1980s. After a period of stabilization, it seems that short-run expectations became more volatile after 2002, while long-run expectations remained stable at around 3%.

As we are also interested in evaluating the role of news effects on the stability of inflation expectations, we employ the question in the Michigan Survey of Consumers asking for news on the economy heard by the respondent as a measure of perceived news

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

[4] For a detailed description of the rotating panel dimension of the Michigan Survey of Consumers and our identification of individuals in the rotating panel, see Dräger and Lamla (2012).

Figure 2: Short- and Long-run Inflation Expectations



regarding inflation and other potentially relevant topics. The wording of the question is as follows:

A6. "During the last few months, have you heard of any favorable or unfavorable changes in business conditions?"
1. YES 2. NO

If the question is answered with "yes", an open question with two possible answers follows:

A6a. "What did you hear? (Have you heard of any other favorable or unfavorable changes in business conditions?)"

The answers are coded into categories by the Michigan Survey of Consumers. For our purposes, we construct dummy variables on perceived news regarding monetary conditions as well as fiscal and private debt. Specifically, we distinguish between news heard about high and low inflation or prices with the dummy variables *newsprices_high* and *newsprices_low*. News on money and credit conditions are measured by the dummy variables *newsmoney_tight* and *newsmoney_easy*, where the former takes on the value of one if the consumer reports news heard on *"tight money, interest rates high"*, while the latter includes news on *"easier money, credit easy to get, low interest rates"*. Finally, news heard in the categories *"fiscal policy, budgets, deficits"* are summarized in the dummy variable *newsgovdebt*, while news on *"low debts, higher savings/assets, investment"* as well as on *"high(er) debts, lower savings/assets"* are reported in the dummy variable *newsprivdebt*.

Furthermore, we control for a number of sociodemographic characteristics captured in the Michigan Survey of Consumers such as age and sex of the respondent as well as income quartiles and a categorical variable measuring education of the respondent in six categories. These are defined as follows: *Educ1* – "*Grade 0-8, no high school diploma*", *Educ2* – "*Grade 9-12, no high school diploma*", *Educ3* – "*Grade 0-12, with high school diploma*", *Educ4* – "*4 yrs. of college, no degree*", *Educ5* – "*3 yrs. of college, with degree*" and *Educ6* – "*4 yrs. of college, with degree*".

In addition to the microdata from the Michigan Survey of Consumers, we aim at capturing monetary policy surprises by evaluating the conference calls held by the Federal Open Market Committee of the Fed. Conference calls are unscheduled meetings that usually take place after surprising events or in times of economic turmoil which may require monetary policy action before the next scheduled meeting. Monetary policy surprises are then identified by the dummies *i_shock* and *alt_mp_shock*, where the former identifies those periods where the Fed decided on an interest rate adjustment during the conference call and the latter measures those periods where alternative monetary policy measures, such as quantitative easing, where decided. An additional measure of monetary policy shocks is taken from the literature: Kuttner (2001) extracts monetary policy surprises, measured in basispoints, from daily data of the Federal Funds futures market (the dataset starts in 1989m6 and is extended until 2008m6 by the author). We convert the daily data into monthly frequency. Finally, we control for effects of actual inflation with CPI inflation for the US obtained from the FRED database at the Federal Reserve Bank of St. Louis.

4 Anchoring of Inflation Expectations Over Time

To analyze the time-varying degree of anchoring of long-run inflation expectations, we run the following regression:

$$\Delta\pi_{it}^{e(5-10y)} = \alpha_t + \beta_t \Delta\pi_{it}^{e(1y)} + \varepsilon_{it}, \tag{6}$$

where $\Delta\pi_{it}^{e(5-10y)}$ is the individual change in 5-10 years ahead inflation expectations over the six months between interviews and $\Delta\pi_{it}^{e(1y)}$ is the corresponding change in short-run inflation expectations. We are interested in the strength of the comovement between an adjustment in short-run and in long-run expectations. If long-run expectations are firmly anchored, the coefficient β_t should be statistically insignificant, implying that an individual adjustment in short-run inflation expectations between the two interviews is not reflected in a corresponding adjustment of long-run expectations. However, theory suggests that if people cannot identify shocks and have to learn the policy response function of the central bank, a positive comovement emerges. For the initial analysis, we decided to aggregate all individuals over a rolling window of 36 months to show longer-term movements. However, when testing the determinants of the degree of anchoring in section 6, we will analyze the effects based on a regression model for each monthly cross-section separately. This is necessary to exactly match the monthly frequency of our explanatory variables.[5]

Table 1 gives the summary statistics of the time-varying coefficient β_t using the 36-months aggregation, where the corresponding time variation is shown in Figure 3. With regard to the summary statistics, we observe that a 1 percentage-point change in short-run inflation expectations leads to an change in long-run expectations of 0.29 percentage-points on average. Notably, this comovement varies over time. It can rise up to 0.44 and be as low as 0.12 percentage-points.[6] The estimations includes 2574 individual consumers on average per window.

Table 1: Summary Statistics of Comovement

Variable	Mean	Std. Dev.	Min.	Max.
β_t	0.289	0.0953	0.124	0.442
standard error	0.039	0.021	0.016	0.137
Observations	2574	899	76	4493

Note: Results based on 405 regressions.

Table 2: Sample Split Comovement

Variable	before 1996	after 1996
β_t	0.371***	0.207***
	(0.0200)	(0.0130)
Observations	15,016	14,152
R^2	0.118	0.082
t-test $\beta_t^{before96} - \beta_t^{after96} = 0$	5.52***	

Note: *** p<0.01, ** p<0.05, * p<0.1

Figure 3 plots a moving average of the comovement coefficient β_t over time together with the corresponding confidence bands. It shows that over the recent 30 years, a decoupling of short- and long-run expectations seems to have taken place. Until 1996, the comovement of inflation expectations was much stronger and fell substantially after-

[5]Note that even the monthly cross-sectional regressions implicitly account for a dynamic time effect, since we evaluate individual changes in expectations over a period of six months.

[6]Alternatively we estimate this equation in levels instead of six-months differences using a random-effects panel estimator. Estimating this equation in levels leads to very similar results. Figure 9 in the appendix shows the corresponding graph. The coefficient estimate for a one-unit increase in short-run inflation expectations increases from 0.11 percentage-points to 0.53 percentage-points on average and is again highly significant.

Figure 3: The Strength of Comovement Between Changes in Short- and Long-Run Inflation Expectations

Note: The regression coefficient β_t from equation (1) is plotted, showing the coefficient estimate of a change in one year ahead inflation expectations on the change of 5-10 years ahead expectations. Shaded areas denote confidence bands at the 5% and the 10% level.

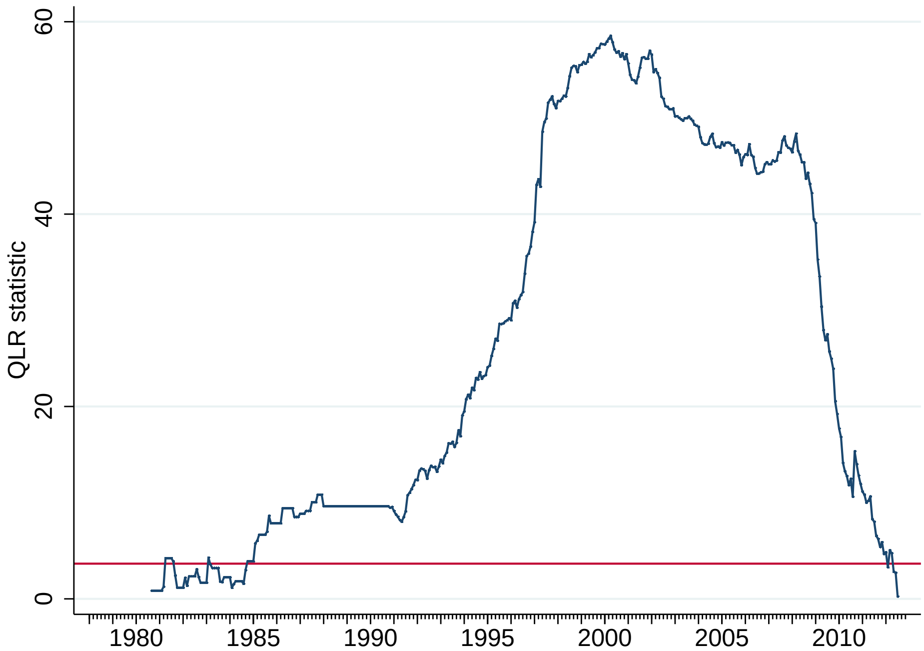
wards.[7] As shown in Table 2, this difference is statistically significant: Up to 1996, a one percentage-point change in short-run inflation expectations induced a change in long-run expectations of 0.37 percentage points. After 1996, this value decreases substantially, with a one percentage-point change in short-run inflation expectations leading to only a 0.21 percentage-point change in long-run expectations. This difference is significant at the 1% level. In order to formally test for a structural break with unknown break date, we calculate the Quandt likelihood ratio (QLR) statistic over our sample period, shown in Figure 4 together with the 5% critical value. We can observe that after 1995, the QLR statistic increases dramatically, indicating a substantial change in the relationship beginning at that point. Obviously, we cannot exactly pinpoint the break date. However, considering the QLR test results together with the anecdotal evidence from Figure 3, it seems that 1996 might be a good reference breakpoint for our analysis.[8]

Hence, even after the Volker Disinflation until 1987, when inflation rates were already quite low, inflation expectations were – according to our definition – still not very well anchored. In line with the model this could imply that consumers required several years of falling inflation rates in order to learn about the new monetary policy regime. Fur-

[7] The constant period from 1988 until 1990 is explained by missing long-run expectations in the Michigan survey.

[8] Notably, our results remain qualitatively the same if we choose 1997 or 1998 as the breakpoint date.

Figure 4: QLR Breakpoint Test – Strength of Comovement



Note: The red line represents the 5% critical value.

thermore, it could be that the Greenspan Fed's first preemptive actions against inflation over the years 1994 to 1996 provided the trigger for a substantial anchoring of inflation expectations. Another explanation could be the emerging believe at that time, that higher growth rates at lower inflation rates were possible due to technological change. In that line of argument, Leigh (2005) evaluates the implicit inflation target in the U.S. and finds that it was lowered after the 1990/91 recession, which roughly coincides with the timing of our structural break.

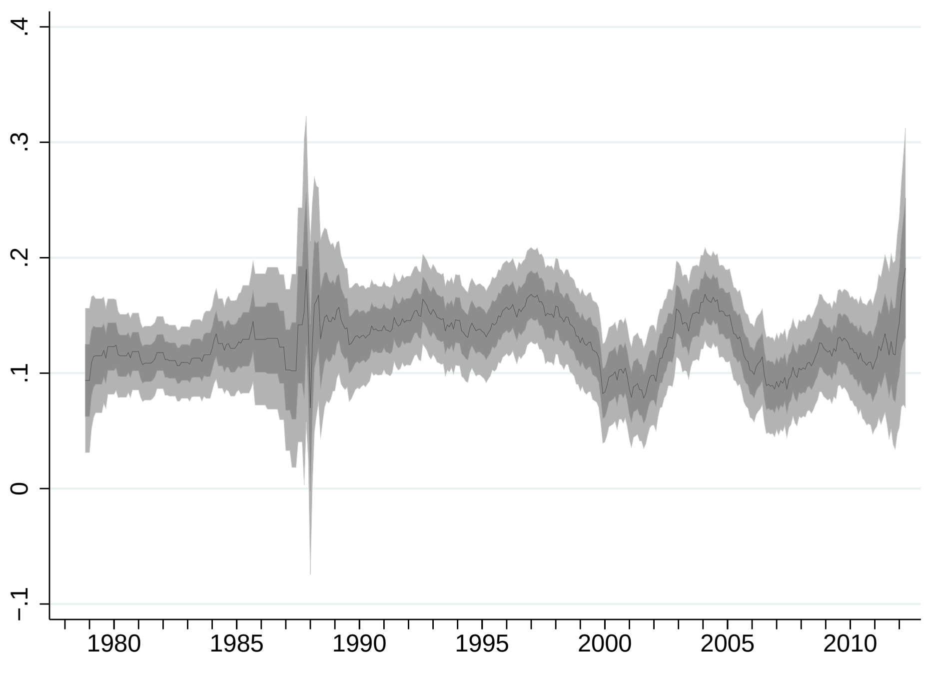
Slightly before the onset of the financial crisis, we observe a sharp drop in the degree of comovement, with a subsequent rise from 2010 onwards. While factors related to the financial crisis will certainly have contributed to this development, in our view it may be best explained by the sharp rise and fall of oil prices in 2008. The decoupling of short- and long-run inflation expectations after the oil price shock seems to suggest that consumers realized the transitory nature of this shock. Hence, after the shock died out, we see an increase in the comovement of short- and long run expectations since 2010 to pre-shock and pre-crisis levels. An important question is whether this trend will continue and overshoot the pre-crisis level of comovement, i.e. lead to lower anchoring in the medium term.

So far, we have looked at the strength of the comovement between short- and long-run inflation expectations. Next, we would like to evaluate the probability that short- and long-run expectations are adjusted simultaneously. While the degree of comovement measures the pass-through of short-run to long-run expectations, the probability of comovement may be interpreted as measuring the extent to which individual long-run inflation expectations are adjusted at all, conditional on a change in individual short-run expectations. Specifically, we are interested in whether we see a similar pattern over time than the one observed in Figure 3. The marginal effects stem from a rolling-window probit regression similar to equation (6), where the change in inflation expectations is replaced by an indicator variable being 1 if expectations are adjusted and 0 otherwise:

$$P(y_{it} = 1|X) = \Phi(X_{it}\beta_t) \tag{7}$$

where P is the probability of y_{it} being 1, i.e. the probability that individual long-run expectations are adjusted within six months, Φ is the cumulative distribution function (CDF) of the standard normal distribution and X_{it} is an indicator variable with value equal to one if individual short-run expectations were adjusted in t with respect to the interview six months before. Again, we estimate a rolling window regression with a window of 36 months, where the time-varying marginal effect β_t is estimated by maximum likelihood.

Figure 5: The Probability of a Simultaneous Adjustment of Short- and Long-Run Inflation Expectations



Note: The marginal effect β_t from equation (2) is plotted, measuring the probability of a change in one year ahead expectations inducing a change in 5-10 years ahead inflation expectations. Shaded areas denote confidence bands at the 5 % and the 10% level.

The time-varying marginal effect β_t of an individual change in short-run inflation expectations on the probability of an adjustment in long-run expectations is plotted in

Table 3: Summary Statistics Probability of Comovement

Variable	Mean	Std. Dev.	Min.	Max.
Marginal Effect β_t	0.128	0.022	0.07	0.197
Standard Error	0.023	0.011	0.015	0.123
Observations	2574	899	76	4493

Note: Results based on 405 regressions.

Table 4: Sample Split Probability of Comovement

	before 1996	after 1996
β_t	0.128***	0.132***
	(0.00913)	(0.00876)
Observations	14,152	15,016
t-test $\beta_t^{before96} - \beta_t^{after96} = 0$	-1.30	

Note: *** p<0.01, ** p<0.05, * p<0.1

Figure 6: QLR Breakpoint Test – Probability of Comovement

Note: The red line represents the 5% critical value.

Figure 5. Interestingly, we cannot observe a corresponding change over time in the probability of comovement as in the degree of comovement. By using the same Wald and QLR tests as before, this conjecture is supported. Neither the sample split, where the marginal effect changes only insignificantly around a value of 13%, nor the structural break test with unknown break date, shown in Figure 6, find evidence for a significant structural change in this series. Both approaches thus confirm that we cannot reject the hypothesis that the coefficients of the subsamples are statistically speaking the same. This indicates that while the strength of the comovement between short- and long-run inflation expectations has decreased over time, implying a stronger anchoring of long-run expectations, individual consumers keep on adjusting short- and long-run expectations simultaneously with the same probability. This is an interesting result. It would imply that anchoring means that people continue thinking about the relation between short- and long-run expectations, but simply and willingly do not adjust long-run expectations as much as before.

While we estimate both the probability of comovement and the degree of comovement separately, the two measures for the anchoring of expectations should be interrelated. A high comovement should also imply that the probability of a joint adjustment has increased. To check this, we calculate the correlation and find that it is reasonably high at a value of 0.32.

5 Linking Inflation and Inflation Persistence to the Degree of Anchoring

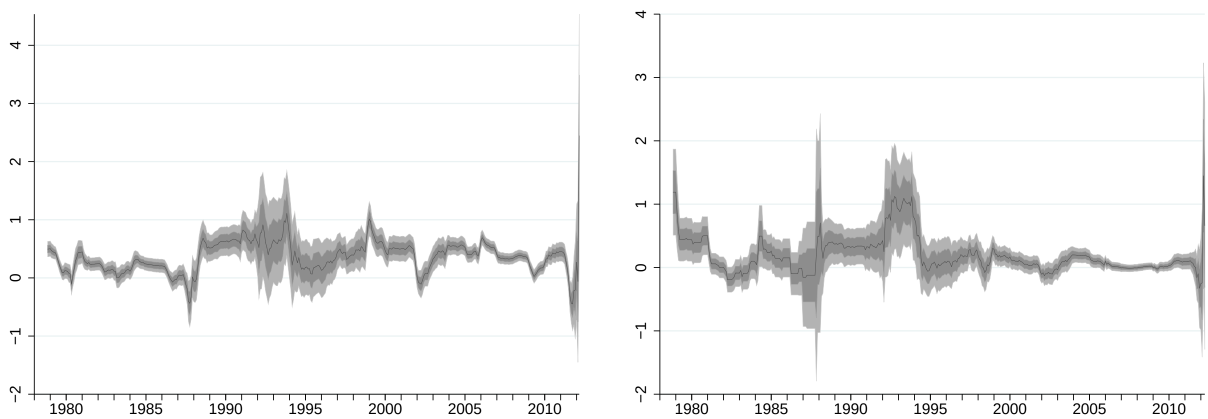
In this section, we take a specific look at the relationship between the level as well as the persistence of inflation and the degree of anchoring. This allows us to check to which extent short- and long-run expectations are affected by shocks to inflation and how the persistence of inflation and the degree of anchoring interact with each other.

From the theoretical model by Orphanides and Williams (2004, 2007) and Beechey et al. (2011) discussed in section 2, we infer that inflation shocks affect both short- and long-run inflation expectations, conditional on the degree of anchoring. If uncertainty prevails about the monetary policy strategy, shocks to inflation affect short- and long-run expectations more strongly and thus lead to a lower degree of anchoring in long-run expectations.

Another implication of the model is that the specific expectation formation mechanism has implications for the relationship between inflation persistence and anchoring. If inflation expectations are formed rationally, agents know the equilibrium law of motion for inflation, implying that long-run inflation expectations are well-anchored and actual inflation is less persistent. By contrast, if agents have to estimate the law of motion recursively due to incomplete information about the monetary policy strategy, the recursive structure of expectation formation causes an effect of inflation shocks also on long-run expectations, implying an effect also on future inflation at longer horizons which leads to a higher persistence of inflation. From the theory, we would thus expect a higher degree of anchoring to coincide with less effects of inflation shocks on long-run expectations and a negative correlation between the persistence of inflation and the degree of anchoring, i.e. a positive correlation with the degree of comovement. Note that the direction of causality between inflation persistence and the degree of anchoring is unclear, at least from a theoretical point of view.

To shed some light on these issues, we first evaluate the effect of inflation shocks on short- and long-run expectations separately. Similar to the analysis done in the previous section, we estimate the comovement between actual and expected inflation over time, regressing six-months changes in individual short- or long-run expectations on actual changes in inflation for rolling windows of 36 months. Figure 7 shows the degree of comovement between actual inflation and inflation expectations over time. We observe that the impact of inflation on short- and long-run expectations varies over time, where sudden increases in the comovement may be interpreted as inflation shocks affecting expectations. For short-run expectations it seems that, on average, the nature of comovement with inflation has not changed over time. By contrast, when considering long-run expectations, we clearly observe a decline in the influence of inflation shocks after 1996. Hence, in line with the theoretical predictions it seems that the observed increase in the degree of anchoring in the second part of our sample period is driven by the reduced comovement between inflation and long-run inflation expectations. Interestingly, we observe some important events where inflation movements have effected long- and short-run expectations simultaneously. Those are identified very roughly in 1980, 1985, a very prominent influence in the two years following 1994 and finally the current financial crisis.

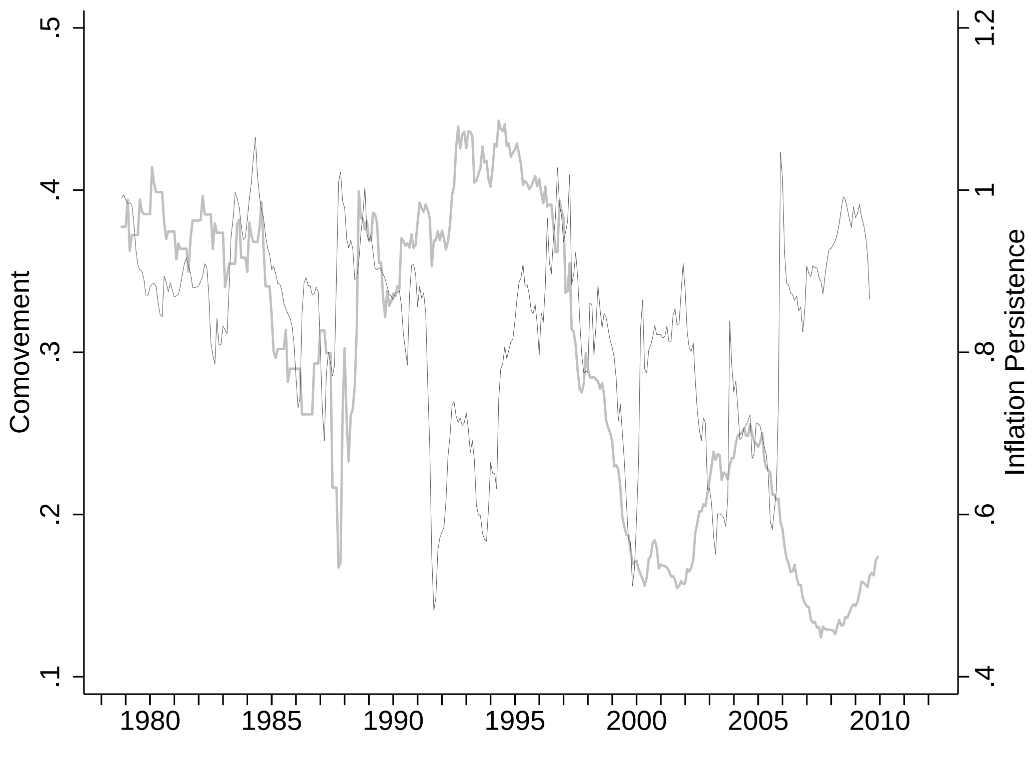
Figure 7: Comovement Inflation and Expectations



(a) Short-run Inflation Expectations (b) Long-run Inflation Expectations

Next, we analyze the relation between the degree of anchoring and the persistence of inflation. We estimate inflation persistence based on a Phillips curve relationship, where the inflation rate in the current month depends on the inflation rate observed in the recent past, the unemployment rate in the previous month, and a constant. The persistence measure is defined as the coefficient on the lag of inflation. Again, inflation persistence is estimated over a rolling window of 36 months and then compared against our anchoring measure derived in the previous section (see Figure 3). A positive correlation between the measures would suggest that a bigger coefficient β_t (higher comovement implying a lower degree of anchoring) coincides with an increase in the persistence of inflation. This would be the rational expectations scenario with anchored expectations (lower uncertainty on the monetary policy) discussed above. Figure 8 plots inflation persistence together with the comovement between short- and long-run expectations. Overall, we find weak evidence for the suggested positive link. Calculating the correlation between both time series reveals a positive value of 0.02. A bivariate least squares estimation confirms a positive, but statistically insignificant relationship between both measures. Hence, the theoretically expected link between anchoring and inflation persistence is only very tentatively confirmed by the data.

Figure 8: Comovement of Expectations and Inflation Persistence



Note: Grey line represents the comovement between short and long-run expectations while the black line shows the degree of inflation persistence based taken from a Phillips curve estimation.

One potential reason for this weak link might be the inability to find strong statistical evidence for a decline in inflation persistence in recent decades. Although many scholars agree that inflation persistence has gone down in the US since the beginning of the

1990s, it remains difficult to find clear statistical evidence for that. Recently, Beechey and Österholm (2012) report evidence for lower persistence of inflation for the US. Unfortunately, their sample ends in 2006. Looking at our persistence measure, we also find persistence going down until 2006 and from that might have had conjectured in a similar fashion. However, after 2006 inflation persistence increases again and, hence, we cannot make such a clear statement. One reason for the unclear results may be the imprecision of the coefficient estimates. This is consistent with the findings of Pivetta and Reis (2007) as well as Williams (2006), who argue that the low degree of inflation persistence observed in recent years may well be due to random variation in the data, rather than to a true shift in the observed behavior of inflation.

6 News Effects and Anchoring

In the previous sections, we conclude that the anchoring of consumers' inflation expectations in the US has changed over time, and is related to less effects of inflation shocks on long-run expectations. This section sheds light on the determinants that may affect the anchoring of expectations and checks whether their influence has changed over the sample period. In line with the previous literature on the anchoring of inflation expectations, we concentrate on the effects of economic news and shocks, while controlling for macroeconomic and demographic factors.[9]

As we believe that the probability and the degree of comovement are interrelated, we estimate the same conditioning set of variables for both dependent variables and analyze the implications of the results jointly in order to be able to draw a more complete picture of the overall underlying dynamics.

From the Michigan survey dataset, we have a very clear identification of perceived news, with the great advantage of capturing only those news that are indeed absorbed and recalled by the consumer (i.e. the receiver perspective). Anchoring of expectations means also a certain insensitivity to short-term news effects. From our previous results, an *a priori* hypothesis would be that news loose explanatory power as long-run inflation become more anchored in the second half of our sample period. Additionally, we test for effects from different monetary policy shocks, as defined in section 3. Again, an *a priori* hypothesis would be that shocks have less effects on long-run inflation expectations, and thus on the degree of anchoring, in the later sample. Finally, we control for consumers' one-year-ahead interest rate expectations, actual CPI inflation in the previous month and lagged inflation persistence. Moreover, we evaluate the effect of the introduction of the

[9]Note that we have tested for effects of a broad set of determinants including a broader set of macroeconomic variables, professionals' inflation expectations and measures of economic uncertainty in order to check the robustness of our results. Our main results remain robust and results for the other determinants are available upon request.

explicit inflation target by the Fed and include a dummy variable *fedtarget* which takes on the value of one after 2012m1.

To test for the influence of our set of news and economic shocks on the strength of the comovement, we first take the coefficient β_t from monthly cross-sectional regressions of equation (6) as a dependent variable. Since the dependent variable is a monthly time series, we calculate the monthly shares of consumers who reported news from the individual news variables and include the balance statistic of qualitative interest rate expectations.[10] Second, we estimate bi-probit models with the individual microdata, where we test which factors affect the joint probability of adjusting both short- and long-run inflation expectations simultaneously. Given that the results of the previous section suggest a shift in the degree of anchoring of inflation expectations around 1996, we report additional results for the pre- and post-1996 periods. All models are estimated with yearly time fixed effects and, in the biprobit regressions at the micro level, a set of demographic characteristics. The bivariate probit model has the following form:

$$\begin{aligned} Pr(Y_{1it}=1, Y_{2it}=1) &= \int_{-\infty}^{u_{1it}} \int_{-\infty}^{u_{2it}} \phi_2(X_{1it}\beta_1, X_{2it}\beta_2, \rho) du_{1it} du_{2it} \\ &= \Phi_2(X_{1it}\beta_1, X_{2it}\beta_2, \rho) \end{aligned} \tag{8}$$

where Φ_2 denotes the bivariate normal cumulative distribution function, where $Y_{1it} = 1$ represents the probability that short-run expectations are adjusted and $Y_{2it} = 1$ is the probability that long-run expectations are adjusted. β_1 and β_2 are the corresponding coefficients of the determinants X_{1it} and X_{2it}, respectively. Finally, ρ is a parameter denoting the extent to which the two residuals u_{1it} and u_{2it} covary. Furthermore, we assume that the errors are $\{u_{1it}, u_{2it}\} \sim \phi_2(0, 0, 1, 1, \rho)$. After the estimations of both probit models, we calculate the bivariate predicted probability $Pr(Y_{1it} = 1; Y_{2it} = 1)$ of a simultaneous adjustment. Overall, we find a strong and significant comovement in all of our biprobit regressions, since the correlation parameter ρ is significant according to the Wald test in every specification. This indicates that similar factors drive the adjustment in both short- and long-run expectations.

The results for the determinants of the strength of comovement are reported in Table 5. Overall, we find no effects of either actual inflation or inflation persistence on the degree of anchoring, once we control for other determinants. A relatively larger share of consumers expecting rising interest rates within the next year is related to an increase in the level of comovement and, thus, a reduction in the anchoring of long-run inflation expectations. This is, in general, not a good sign for monetary policy as it may imply that people do not believe that the central bank is hawkish enough to fight inflation (i.e. raising interest rates enough to fight inflation). Notably, the impact of expected interest rate changes

[10] The balance statistic is defined as the monthly difference between the number of consumers expecting rising versus falling interest rates in relation to the overall number of consumers reporting interest rate expectations.

becomes insignificant or is significantly smaller in the post-1996 sample, which may be interpreted in favor of a recently more credible and hawkish monetary policy.

Regarding our set of news variables related to prices and money, we find no significant effect of news on either high or low prices on the degree of comovement. However, we can report a significantly positive effect of news observed on current easy money conditions, which again becomes insignificant in the post-1996 sample. Taken together with the effect of interest rate expectations, this implies that easy money conditions related to boom periods, when more news are observed that credit is easily obtained, but interest rates might be expected to rise, affected both short- and long-run inflation expectations only in the pre-1996 sample. Overall, this lends support to the conclusion that inflation expectations became more anchored, as the transmission of transitory shocks (news and macroeconomic shocks) to long-run inflation expectations was reduced.

With respect to news on private and public debt, both shares remain insignificant in the pre-1996 period. However, a larger share of consumers observing news on government debt is significantly related with a lower degree of anchoring in the post-1996 period. This could indicate that people fear that high government debt might affect the stance of monetary policy and, thereby, may lead to higher inflation rates also in the long run. Finally, we find little evidence of monetary policy shocks affecting the degree of comovement.

Table 6 comprises the results on the determinants of the individual probability of comovement with the marginal effects from the biprobit models. Again, the estimates show only little effects of actual inflation, while inflation persistence has no significant effect. In line with our previous results, we find that higher individual interest rate expectations are associated with a detrimental effect on the anchoring of long-run inflation expectations, and again this effect is only relevant in the pre-1996 era. In that sense, our earlier result that the Fed may be perceived as being more credible since 1996 seems to be confirmed here. Additionally, the established Fed inflation target reduces the probability of adjusting both short- and long-run inflation expectations and thus has the expected effect.[11]

Regarding the news effects, consumers who observe news on high prices or inflation are more likely to adjust both short- and long-run inflation expectations throughout the whole sample period. Similarly, we find that unexpected changes in the Fed Funds Target rate are related with an increase in the probability of a joint adjustment throughout. It thus seems that news on high prices as well as interest rate shocks might be some of the determinants of the relatively constant probability of comovement throughout our sample period.

Additionally, we find that news on low prices as well as on easy money market conditions observed by the consumer coincide with a lower likelihood of adjusting both short- and long-run expectations, but this effect is only significant in the pre-1996 sample. Taken

[11]Note that the $fedtarget$ dummy does not feature in the last regression column (7) since the Kuttner (2001) time series of monetary policy shocks ends in 2008m6.

Table 5: Determinants of the Strength of the Comovement

				Before 1996		After 1996	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
β_{t-1}	-0.0941	-0.0814	-0.1091	-0.1470	-0.2235	-0.0208	-0.0162
	(0.0580)	(0.0577)	(0.0705)	(0.1077)	(0.1353)	(0.0762)	(0.0886)
π_{t-1}	0.0171*	0.0159	0.0315	0.0295	0.0499	0.0129	0.0114
	(0.0092)	(0.0100)	(0.0299)	(0.0233)	(0.0589)	(0.0111)	(0.0341)
$\pi_{t-1}^{persistence}$	-0.0240	-0.0668	-0.2367	-0.0832	-0.2766	-0.1118	-0.2280
	(0.1629)	(0.1670)	(0.2180)	(0.3044)	(0.4620)	(0.2281)	(0.2926)
balance stat $i_t^{e(1y)}$	0.2069***	0.1795**	0.4726***	0.2528*	0.6724**	0.1110	0.2948*
	(0.0734)	(0.0750)	(0.1460)	(0.1505)	(0.3337)	(0.0951)	(0.1625)
$fedtarget_t$	0.0743	0.0804				0.0864	
	(0.0809)	(0.0804)				(0.0775)	
$share\_newsprices\_high_t$	0.0461	0.1528	0.2602	0.8659	0.6283	0.1128	0.3848
	(0.2104)	(0.2224)	(0.3120)	(0.7913)	(1.1961)	(0.2605)	(0.3774)
$share\_newsprices\_low_t$	0.2363	0.2266	1.0935	-0.3106	-1.5900	0.7334	1.1891
	(0.4734)	(0.4878)	(0.8764)	(0.7501)	(3.5408)	(0.6694)	(0.8741)
$share\_newsmoney\_easy_t$	0.9027*	1.0447**	2.7185***	1.2970*	3.7443**	0.2349	1.0616
	(0.4881)	(0.4881)	(0.9771)	(0.7099)	(1.5961)	(1.0697)	(1.3685)
$share\_newsmoney\_tight_t$	0.2252	0.3542	-0.0677	-0.0629	-0.5550	0.5333	0.0328
	(0.4363)	(0.4436)	(0.6353)	(0.6643)	(1.1098)	(0.7531)	(0.8779)
$share\_newsgovdebt_t$		1.5831*	2.1792	0.2056	-0.1569	2.2359*	5.2190*
		(0.9454)	(2.2999)	(2.2271)	(3.6171)	(1.1916)	(3.1402)
$share\_newsprivdebt_t$		-0.0384	0.5556	-0.3124	1.5009	0.2087	0.5681
		(0.4823)	(0.7848)	(3.2921)	(4.0619)	(0.4659)	(0.7240)
i_shock_t		-0.0590		-0.0998		-0.0536	
		(0.0545)		(0.0834)		(0.0750)	
$alt\_mp\_shock_t$		-0.0830		-0.0362		-0.1504**	
		(0.0592)		(0.1036)		(0.0720)	
$kuttner\_mp\_shock_t$			0.0011		0.0009		0.0007
			(0.0019)		(0.0035)		(0.0024)
Constant	0.0715	0.0927	0.0364	0.0873	-0.1013	0.1483	0.1203
	(0.1512)	(0.1550)	(0.2270)	(0.3863)	(0.5205)	(0.2056)	(0.2839)
Observations	365	365	229	166	79	199	150
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.189	0.193	0.152	0.117	0.110	0.164	0.115

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

Table 6: Determinants of the Probability of Comovement

				Before 1996		After 1996	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
π_{t-1}	0.0070	0.0065	-0.0034	0.0116	0.0193***	0.0027	-0.0137
	(0.0071)	(0.0073)	(0.0111)	(0.0097)	(0.0063)	(0.0110)	(0.0123)
$\pi_{t-1}^{persistence}$	-0.0149	-0.0218	-0.0039	-0.1902	-0.0126	0.0655	-0.0139
	(0.0741)	(0.0749)	(0.0501)	(0.1692)	(0.0407)	(0.0733)	(0.0697)
$i_{it}^{e(1y)}$	0.0117***	0.0117***	0.0055	0.0187***	0.0104**	0.0048	0.0025
	(0.0038)	(0.0038)	(0.0052)	(0.0041)	(0.0050)	(0.0056)	(0.0071)
$fedtarget_t$	-0.0905***	-0.0902***				-0.0884***	
	(0.0049)	(0.0050)				(0.0081)	
$newsprices\_high_{it}$	0.0232*	0.0229*	0.0304***	0.0426	0.0620***	0.0202**	0.0279***
	(0.0130)	(0.0132)	(0.0099)	(0.0441)	(0.0210)	(0.0096)	(0.0101)
$newsprices\_low_{it}$	0.0146	0.0149	-0.0339	0.0344	-0.0394*	-0.0357	-0.0407
	(0.0240)	(0.0240)	(0.0233)	(0.0212)	(0.0202)	(0.0293)	(0.0285)
$share\_newsmoney\_easy_t$	-0.0235**	-0.0233**	-0.0254	-0.0191*	-0.0144	-0.0372	-0.0336
	(0.0110)	(0.0112)	(0.0216)	(0.0104)	(0.0316)	(0.0269)	(0.0306)
$share\_newsmoney\_tight_t$	-0.0176	-0.0179	-0.0077	-0.0234	-0.0242	-0.0151	0.0015
	(0.0116)	(0.0119)	(0.0157)	(0.0167)	(0.0202)	(0.0181)	(0.0198)
$share\_newsgovdebt_t$		0.0480*	0.0652	0.0478	0.0723	0.0444	0.0463
		(0.0261)	(0.0456)	(0.0384)	(0.0595)	(0.0362)	(0.0714)
$share\_newsprivdebt_t$		-0.0094	-0.0005	0.0083	0.0183	-0.0227	-0.0088
		(0.0303)	(0.0372)	(0.0496)	(0.0742)	(0.0345)	(0.0408)
i_shock_t		0.0388***		0.0748***		0.0266***	
		(0.0136)		(0.0135)		(0.0103)	
$alt\_mp\_shock_t$		-0.0111		-0.0212		0.0096	
		(0.0235)		(0.0379)		(0.0222)	
$kuttner\_mp\_shock_t$			-0.0006		-0.0016***		0.0003
			(0.0004)		(0.0003)		(0.0005)
Observations	24,831	24,831	14,958	11,059	4,618	13,772	10,340
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
ρ	0.217	0.217	0.220	0.233	0.247	0.205	0.211
Wald Test	277.6	278.2	147.3	258.4	86.46	105.8	77.61

Note: Marginal effects with standard errors clustered at the year level in parentheses. The columns show marginal effects from bi-probit models for simultaneous updates of both short- and long-run expectations. *** p<0.01, ** p<0.05, * p<0.1.

together with our earlier result on the degree of comovement, this implies that news observed on current easy money and credit conditions are related with a higher degree of pass-through from short- to long-run inflation expectations, on the one hand, but a reduction in the probability of a joint adjustment, on the other hand. Moreover, news on government debt have a marginally significant positive effect on the probability of comovement when evaluating the full sample period, which becomes insignificant in the sub-periods.

Since the effect of news observed on the strength and the probability of comovement may differ between monetary policy regimes, we conduct a robustness check of our results and estimate additional interaction effects with dummy variables identifying periods with positive or negative changes in the Federal Funds Target rate. This allows us to distinguish between news effects in periods of monetary policy tightening, and in periods of monetary policy easing. The results are shown in Tables A.1 and A.2 in the Appendix.

Interestingly, when we account for asymmetric news effects in different monetary policy regimes, the effect of consumers' interest rate expectations for the anchoring of long-run expectations vanishes in the post-1996 sample in both models, while the remaining effects of macroeconomic determinants and monetary policy shocks remain robust.[12] However, several asymmetric news effects emerge between periods of monetary easing or tightening: In the pre-1996 sample, individual consumers who observe news on higher prices are more likely to jointly change short- and long-run expectations only in periods of monetary policy tightening and, similarly, have a higher probability of comovement when they observe news on lower prices in periods of monetary easing. While this suggests that consumers correctly incorporate news in their expectation formation, it also implies that short- and long-run inflation expectations are equally affected. By contrast, for the post-1996 sample we observe a positive effect of observed news on high prices, which is independent from the monetary policy regime, while news on lower prices are related with a lower probability of comovement in periods of monetary policy tightening. Thus, it seems that news on higher inflation are always perceived as potentially affecting both short- and long-run inflation, while news on lower inflation may stabilize long-run inflation expectations if monetary policy is already actively working at reducing inflation rates. In that sense, these news may be perceived as confirming the credibility of the central bank.

Moreover, we find that in the post-1996 sample news on money conditions may be related to either stronger or weaker anchoring of long-run expectations: If consumers observe news on easy money market conditions, our results suggest both a higher strength and a higher probability of comovement in periods of monetary policy tightening. This might be interpreted as people not believing that the central banks raises interest rates enough to fight inflation. By contrast, news on tight money market conditions are related

[12] Note that the implausibly high coefficient of the share of consumers oberving news on low prices and inflation in the model including the Kuttner (2001) monetary policy shock, which is observable only from 1989m6 onwards, is due to the very few observations with increases in the Federal Funds Target in this reduced sample. We thus do not interpret this coefficient.

in periods of a monetary policy easing help to anchor long-run expectations. These news thus have a similar effect than news on low prices post-1996. Note that this effect has the opposite sign than in the pre-1996 period, suggesting that long-run inflation expectations became more anchored after 1996.

Finally, our previous finding of an overall detrimental effect of news on government debt on the strength of the anchoring after 1996 remains robust. Nevertheless, we find additional effects of news on both government and private debt on the probability of comovement in the pre-1996 sample: Individual consumers are found to be more likely to adjust both short- and long-run expectations if they observe news on private debt in periods of a monetary policy tightening. This effect may be similar to the one observed for news on higher inflation. Additionally, we find an increased likelihood of a joint adjustment in expectations if consumers observe news on government debt in periods of a monetary policy easing, while the probability of comovement is lower if they observe the news in periods of monetary tightening.

7 Conclusion

In this paper, we investigate the degree of anchoring of inflation expectations of consumers in the US. We add to the literature by shedding light on consumers' behavior based on a rich micro dataset. Specifically, we analyze the comovement of short- and long-run inflation expectations at the individual level over time. For a sound identification, we employ the rotating panel microstructure of the Michigan Survey of Consumers. This allows us to track the simultaneous adjustment of short- and long-run expectations of individuals over time. In an additional step, we test the relevance of several macroeconomic factors and the importance of perceived news on inflation, credit conditions and debt for the strength as well as the probability of comovement.

Based on this set-up, we can report that since 1978 inflation expectations have become more anchored in the US: Changes in short-run inflation expectations induce smaller changes in long-run expectations. Interestingly, the comovement was substantially reduced not during the Volker Disinflation, but in the aftermath of the 1996 pre-emptive tightening policy by the Greenspan Fed. This could either indicate that consumers require some time to learn about changes in the conduct of monetary policy and incorporate them into their expectation formation, or that they need several changes in monetary policy to trigger an adjustment. Looking at the probability of adjusting short- and long-run expectations simultaneously, we find no significant reduction over time. Hence, while the degree of comovement between short- and long-run expectations has decreased, the probability to think about and revise them jointly has not been affected. Notably, movements in the degree of anchoring seem to be only marginally connected to changes in the persistence of inflation.

Regarding the possible determinants of both the strength of comovement and the probability of a joint adjustment, we find that news, consumers' interest rate expectations and monetary policy shocks affect both the degree and the probability of comovement. Especially observed news on higher prices, higher interest rate expectations as well as unexpected interest rate shocks increase the comovement and, thus, reduce the degree of anchoring. The effect of interest rate expectations, however, dies out in the post-1996 era. Similar results can be reported for perceived news, as most news effects are diminished in the post-1996 sample. Additionally, we report asymmetric news effects on the degree of anchoring between periods of monetary policy tightening or easing. Especially after 1996, news that may convey the central banks' efforts in maintaining price stability throughout the business cycle seem to help in anchoring consumers' long-run expectations.

To sum up, the results tell us an intriguing story about the determinants of the anchoring of consumers' long-run inflation expectations. The most important message here is certainly that the observed anchoring is established more firmly since 1996, as consumers are not irritated anymore by news regarding monetary conditions and trust the Federal Reserve in setting the appropriate interest rate. This is so far good news. Nevertheless, a positive effect of news on higher prices as well as of shocks to the Federal Funds Target rate remains throughout the sample period. But most importantly, we have to highlight one result that needs further consideration. We find that perceived news on the fiscal budget deficit reduces the anchoring of long-run expectations. As most determinants loose explanatory power in the post-1996 sample, this effect gains significance. While this result is likely driven by the financial crisis, the link between monetary and fiscal policy and its effect on the anchoring of inflation calls for more attention and may be a welcome avenue for future research.

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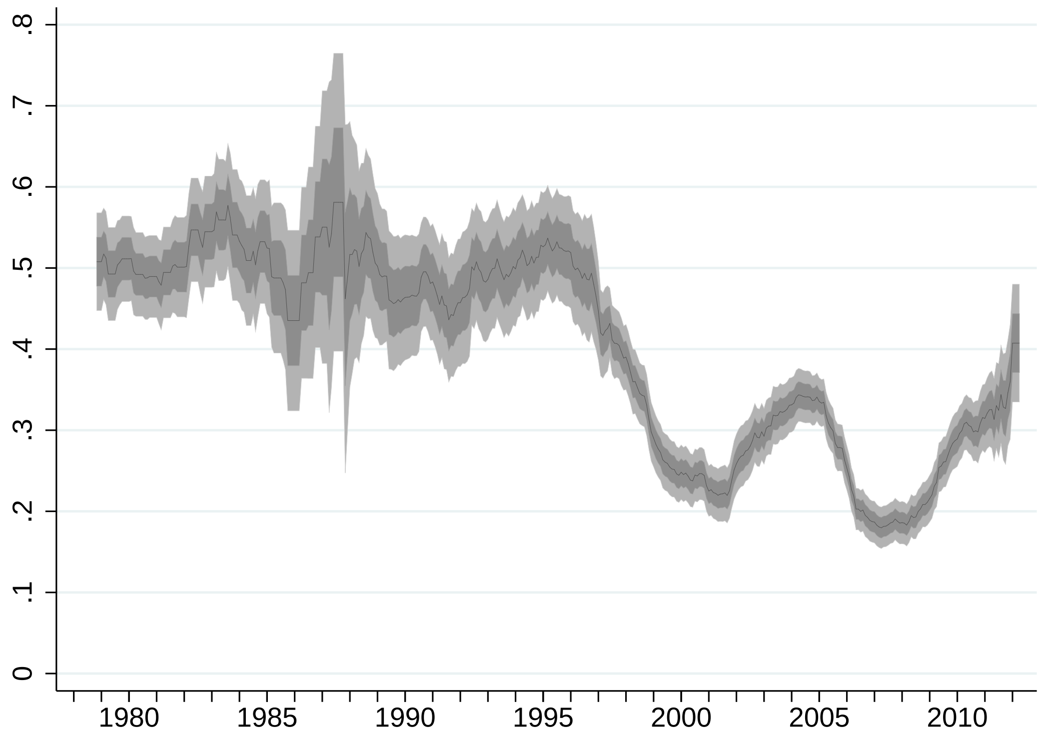
8 Appendix

Figure 9: Panel Estimation Comovement of Short- and Long-run Inflation Expectations



Note: The regression coefficient β_t from a panel random effects estimation is plotted, showing the coefficient estimate of a 1% increase in one year ahead inflation expectations on 5-10 years ahead expectations. Shaded areas denote confidence bands at the 5% and the 10% level.

Table A.1: Asymmetric News Effects on the Strength of the Comovement

	Before 1996			After 1996		
	(1)	(2)	(3)	(4)	(5)	(6)
β_{t-1}	-0.1850	-0.2006*	-0.1952	-0.0276	-0.0109	-0.0030
	(0.1171)	(0.1163)	(0.1591)	(0.0792)	(0.0808)	(0.0940)
π_{t-1}	0.0262	0.0305	0.0439	0.0139	0.0220*	0.0374
	(0.0217)	(0.0228)	(0.0622)	(0.0108)	(0.0115)	(0.0368)
$\pi_{t-1}^{persistence}$	0.0324	0.0671	0.4703	-0.0973	-0.1303	-0.2450
	(0.3448)	(0.3288)	(0.7065)	(0.2351)	(0.2389)	(0.2963)
balance stat $i_t^{e(1y)}$	0.2686	0.2778*	0.7736**	0.0607	0.0844	0.1883
	(0.1644)	(0.1641)	(0.3543)	(0.1063)	(0.1079)	(0.1947)
$dummy_{\Delta i_t>0}$	-0.0483	-0.0379	1.6232	-0.2408*	-0.2511*	-0.2589
	(0.1859)	(0.1817)	(2.2361)	(0.1333)	(0.1342)	(0.1571)
$dummy_{\Delta i_t<0}$	-0.1723	-0.1446	-0.0905	0.1540	0.1693	0.2487
	(0.1668)	(0.1705)	(0.3235)	(0.1528)	(0.1401)	(0.1672)
$share\_newsprices\_high_t$	0.0920	0.0764	-0.8555	-0.2360	-0.3149	-0.3676
	(1.3123)	(1.3149)	(2.2481)	(0.2915)	(0.2857)	(0.4412)
$'' * dummy_{\Delta i_t>0}$	2.0358	1.8916	72.5041	0.8584	0.9064	0.9648
	(2.4730)	(2.4206)	(101.8644)	(0.6437)	(0.6372)	(0.6862)
$'' * dummy_{\Delta i_t<0}$	0.2980	0.4638	0.6794	1.0155	1.2951*	1.0314
	(1.4180)	(1.4170)	(2.2368)	(0.6677)	(0.6591)	(0.8291)
$share\_newsprices\_low_t$	-2.8069	-2.9954	-3.0385	-0.0535	0.1368	0.4745
	(2.1061)	(2.1311)	(4.8852)	(0.8420)	(0.8357)	(1.1335)
$'' * dummy_{\Delta i_t>0}$	3.4456	3.4551	-97.8664***	5.8799	5.4684	4.6827
	(2.2053)	(2.2361)	(15.5540)	(3.5852)	(3.5912)	(3.9771)
$'' * dummy_{\Delta i_t<0}$	2.4051	2.5764	0.7510	7.1856	5.1093	2.4719
	(2.3283)	(2.3388)	(7.8947)	(4.9992)	(5.8537)	(9.1547)
$share\_newsmoney\_easy_t$	1.8248	1.9692	3.6463	-0.5057	-0.6393	-0.4998
	(1.3349)	(1.3735)	(2.7706)	(1.2703)	(1.2387)	(1.6710)
$'' * dummy_{\Delta i_t>0}$	-1.7637	-1.7922	-24.9918	9.5584***	9.8517***	10.4816***
	(1.3285)	(1.3615)	(25.3465)	(3.1767)	(3.1588)	(3.6609)
$'' * dummy_{\Delta i_t<0}$	0.0900	-0.0453	0.0903	-1.2501	-1.0635	-1.7907
	(1.5963)	(1.6087)	(3.2801)	(2.2624)	(2.0482)	(2.5562)
$share\_newsmoney\_tight_t$	0.1205	0.1817	-0.2829	0.6518	0.5801	0.4341
	(0.7857)	(0.7855)	(1.5362)	(0.8773)	(0.8793)	(0.9982)
$'' * dummy_{\Delta i_t>0}$	-1.1559	-1.1942	-0.7742	-0.0162	0.0775	0.1327
	(0.9872)	(1.0056)	(8.7959)	(1.2012)	(1.1999)	(1.3142)
$'' * dummy_{\Delta i_t<0}$	3.4192***	3.4787***	2.2502	-5.4532**	-4.6690**	-1.5653
	(1.2374)	(1.2369)	(5.3421)	(2.1883)	(2.3206)	(2.5532)
$share\_newsgovdebt_t$	-0.9316	-0.7812	0.6274	1.6609*	1.7070	4.8807
	(2.9970)	(2.9869)	(4.5080)	(1.0018)	(1.1142)	(4.5033)
$'' * dummy_{\Delta i_t>0}$	5.3514	5.4815	-90.7981	-6.7453	-6.7236	-9.3501
	(4.7023)	(4.7009)	(77.2843)	(4.9835)	(5.0371)	(6.3597)
$'' * dummy_{\Delta i_t<0}$	1.7251	0.6254	-1.9034	3.8725	3.9607	1.4304
	(4.0902)	(4.2019)	(8.2446)	(2.7597)	(2.7889)	(5.4918)
$share\_newsprivdebt_t$	-1.2177	-1.3676	-2.3412	0.2034	0.5221	1.0032
	(4.5838)	(4.5578)	(5.4185)	(0.6240)	(0.5618)	(0.7691)
$'' * dummy_{\Delta i_t>0}$	1.0769	0.4307	-69.2902	5.3029	4.8499	4.4572
	(6.5974)	(6.3694)	(79.1951)	(5.8227)	(5.8209)	(6.4301)
$'' * dummy_{\Delta i_t<0}$	3.5231	3.3110	8.0174	-1.5645	-1.8222	-3.8188**
	(5.5089)	(5.4642)	(6.1329)	(1.0909)	(1.2665)	(1.5405)
i_shock_t		-0.1029			-0.0690	
		(0.1069)			(0.0640)	
$alt\_mp\_shock_t$		-0.0802			-0.1852**	
		(0.0957)			(0.0803)	
$kuttner\_mp\_shock_t$			0.0040			0.0031
			(0.0054)			(0.0027)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.110	0.106	0.0700	0.179	0.196	0.144

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

Table A.2: Asymmetric News Effects on the Probability of Comovement

	Before 1996			After 1996		
	(1)	(2)	(3)	(4)	(5)	(6)
π_{t-1}	0.0115	0.0097	0.0147**	0.0056	0.0046	-0.0117
	(0.0091)	(0.0086)	(0.0073)	(0.0095)	(0.0103)	(0.0109)
$\pi_{t-1}^{persistence}$	-0.1716	-0.1887	-0.0087	0.0640	0.0649	-0.0170
	(0.1614)	(0.1586)	(0.0544)	(0.0729)	(0.0718)	(0.0691)
$i_{it}^{e(1y)}$	0.0179***	0.0181***	0.0101**	0.0050	0.0050	0.0028
	(0.0041)	(0.0041)	(0.0043)	(0.0054)	(0.0054)	(0.0070)
$dummy_{\Delta i_t>0}$	0.0073	0.0018	0.0189**	-0.0188	-0.0185	-0.0136
	(0.0147)	(0.0112)	(0.0085)	(0.0181)	(0.0180)	(0.0154)
$dummy_{\Delta i_t<0}$	0.0110	0.0101	-0.0437	0.0037	-0.0033	0.0015
	(0.0233)	(0.0244)	(0.0309)	(0.0181)	(0.0192)	(0.0186)
$newsprices\_high_{it}$	-0.0298	-0.0304	0.0074	0.0227*	0.0226*	0.0300*
	(0.0461)	(0.0462)	(0.0358)	(0.0126)	(0.0125)	(0.0156)
$'' * dummy_{\Delta i_t>0}$	0.1613*	0.1613*	0.4252***	0.0014	0.0016	-0.0037
	(0.0866)	(0.0867)	(0.0029)	(0.0204)	(0.0204)	(0.0231)
$'' * dummy_{\Delta i_t<0}$	0.0509	0.0510	0.0888**	-0.0270	-0.0279	-0.0133
	(0.0775)	(0.0758)	(0.0440)	(0.0609)	(0.0634)	(0.0603)
$newsprices\_low_{it}$	-0.0140	-0.0161	-0.0017	-0.0014	-0.0019	0.0018
	(0.0348)	(0.0335)	(0.0764)	(0.0346)	(0.0346)	(0.0355)
$'' * dummy_{\Delta i_t>0}$	0.0422	0.0431	-0.3112	-0.3163***	-0.3156***	-0.3197***
	(0.0536)	(0.0529)	(0.3162)	(0.0789)	(0.0789)	(0.0738)
$'' * dummy_{\Delta i_t<0}$	0.0950*	0.0987**	-0.0063	-0.0485	-0.0414	-0.0552
	(0.0494)	(0.0469)	(0.1675)	(0.0776)	(0.0778)	(0.0924)
$newsmoney\_easy_{it}$	-0.0112	-0.0109	-0.0212	-0.0453	-0.0449	-0.0424
	(0.0279)	(0.0288)	(0.0173)	(0.0319)	(0.0319)	(0.0380)
$'' * dummy_{\Delta i_t>0}$	-0.0092	-0.0108	0.1285***	0.1417***	0.1413***	0.1440***
	(0.0326)	(0.0352)	(0.0185)	(0.0402)	(0.0402)	(0.0436)
$'' * dummy_{\Delta i_t<0}$	-0.0355	-0.0344	-0.0114	-0.0127	-0.0136	-0.0147
	(0.0830)	(0.0835)	(0.0485)	(0.0421)	(0.0427)	(0.0436)
$newsmoney\_tight_{it}$	-0.0365	-0.0350	-0.0467	-0.0123	-0.0122	0.0106
	(0.0506)	(0.0503)	(0.0420)	(0.0167)	(0.0168)	(0.0153)
$'' * dummy_{\Delta i_t>0}$	0.0166	0.0146	0.0838	-0.0249	-0.0250	-0.0476
	(0.0654)	(0.0653)	(0.0856)	(0.0649)	(0.0650)	(0.0682)
$'' * dummy_{\Delta i_t<0}$	-0.0059	-0.0075	-0.0144	-0.0127	-0.0126	0.0040
	(0.0736)	(0.0725)	(0.0729)	(0.0355)	(0.0367)	(0.0364)
$newsgovdebt_{it}$	0.0142	0.0144	0.0541	0.0380	0.0382	0.0298
	(0.0450)	(0.0453)	(0.0732)	(0.0380)	(0.0378)	(0.0926)
$'' * dummy_{\Delta i_t>0}$	0.0080	0.0102	-0.5763***	0.0550	0.0551	0.0776
	(0.1010)	(0.1010)	(0.0029)	(0.1705)	(0.1704)	(0.1991)
$'' * dummy_{\Delta i_t<0}$	0.1915**	0.1923**	0.0890	0.0227	0.0253	0.0121
	(0.0830)	(0.0817)	(0.0931)	(0.1080)	(0.1084)	(0.1394)
$newsprivdebt_{it}$	-0.0817	-0.0820	-0.0550	-0.0333	-0.0340	-0.0299
	(0.0547)	(0.0560)	(0.0564)	(0.0319)	(0.0327)	(0.0432)
$'' * dummy_{\Delta i_t>0}$	0.2115***	0.2100***	0.4262***	0.0950	0.0957	0.0939
	(0.0782)	(0.0780)	(0.0030)	(0.2261)	(0.2259)	(0.2272)
$'' * dummy_{\Delta i_t<0}$	0.1310	0.1316	0.0677	0.0035	0.0072	0.0264
	(0.0813)	(0.0814)	(0.1148)	(0.0277)	(0.0278)	(0.0307)
i_shock_t		0.0704***			0.0294***	
		(0.0118)			(0.0108)	
$alt\_mp\_shock_t$		-0.0248			0.0094	
		(0.0405)			(0.0245)	
$kuttner\_mp\_shock_t$			-0.0029***			0.0003
			(0.0009)			(0.0004)
Demographic Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
ρ	0.235	0.235	0.249	0.206	0.206	0.212
Wald Test	258.2	259.9	80.49	109.3	109.5	81.71

Note: Marginal effects with standard errors clustered at the year level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.