Are US Inflation Expectations Re-Anchored?

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Anchored inflation expectations are of key importance for monetary policy. If long-term inflation expectations are well-anchored, they should be unaffected by short-term economic news. This letter introduces news-regressions with multiple endogenous breaks to investigate the de- and re-anchoring of US inflation expectations. We confirm earlier evidence on the de-anchoring of expectations driven by the outbreak of the crisis. Our results indicate that expectations have not been re-anchored ever since.

1 Introduction

Anchoring of inflation expectations is of key importance for monetary policy. Yet, recent evidence suggests that US inflation expectations have been less anchored since the outbreak of the financial crisis, see e.g. Galati et al. (2011) and Autrup and Grothe (2014). Clearly, if inflation expectations are *de-anchored* they should be *re-anchored* as soon as possible. So far, however, it is not clear to what extent the crisis-related de-anchoring of inflation expectations can be viewed as only a temporary phenomenon. In particular, the length of the de-anchoring period is unclear. Therefore, the current letter investigates whether US inflation expectations have been successfully re-anchored over the recent years.

Firmly anchored inflation expectations should be unaffected by the release of economic news. News-regressions, where measures of expected inflation are regressed on news about inflation and other macroeconomic variables, are a widely used approach to test for the anchoring of inflation expectations, compare Levin et al. (2004) and Gürkaynak et al. (2005).[1] Autrup and Grothe (2014) applied news-regressions and (exogenously) allowed for a de-anchoring of US inflation expectations in January 2008. Galati et al. (2011) estimate a single break (October 2008) in the news-regression and establish its significance using the endogenous break point test by

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[1]The non-response to news should be seen as a necessary but not sufficient condition for anchored inflation expectations. Alternative approaches assess the anchoredness of inflation expectations from different perspectives, including the level, volatility and persistence of inflation expectations, compare Beechey et al. (2011) and Strohsal and Winkelmann (2014). News-regressions are estimated for *changes* of expected inflation implying that the level of expected inflation plays no particular role. Therefore, news-regressions are not distorted by a possible change in the central bank's inflation target, see Hördahl and Tristani (2014).

Andrews (1993). Since our focus is on the possible re-anchoring of inflation expectations in the aftermath of the crisis, we have to account for multiple structural breaks. Therefore, we explore the time-varying responsiveness of expected inflation to news by use of various multiple endogenous break tests developed in Bai (1997) and Bai and Perron (1998).

Our empirical findings do not depend on the choice of the breakpoint test. First, all tests confirm earlier findings regarding the de-anchoring of US inflation expectations in the aftermath of the financial crisis. Second, none of the break point tests indicates a significant second break in our sample period. Therefore, the evidence obtained from news-regressions suggests that long-term inflation expectations are still de-anchored in the US.

The rest of our paper is structured as follows. Section 2 introduces the data for expected inflation derived from break-even inflation rates as well as the economic news variables. Section 3 briefly reviews the news-regression approach to anchoring inflation expectation and the multiple breakpoint tests. Section 4 shows our main empirical results and Section 5 concludes.

2 Data

2.1 Market based inflation expectations

The growing market for inflation-linked securities have become an increasingly important source of information about expected inflation. Yields of index-linked and nominal bonds with equal maturity are used to derive the break-even inflation rate (BEI rates), i.e., the rate of inflation for which the payoff of the two types of bonds would be equal. In contrast to e.g. quarterly surveys of expected inflation, BEI rates are available at high frequency and are, therefore, particularly suitable to investigate how inflation expectations respond to economic news. The credibility of the central bank's commitment to maintaining price stability is particularly reflected in long-term inflation expectations implied by derived from implied forward break-even inflation rates. In our empirical analysis, we focus on the one-year forward rate nine years ahead which has become a standard indicator for long-term inflation expectations, see e.g. Gürkaynak et al. (2010a) and Galati et al. (2011).

Liquidity conditions may affect the pricing of nominal and inflation-linked bonds and, thereby, the information content of BEI rates. For example, a higher trading volume in inflation-linked bonds may increase the break-even inflation rate only because it reduces the liquidity premium on inflation-linked bonds and, thereby, lowers the real yield. In line with e.g. Gürkaynak et al. (2010a), we obtain liquidity-adjusted BEI rates by pre-filtering index-linked data based on common measures of liquidity risk.

Figure 1   The Long-Run Forward Break-Even Inflation Rate in the US
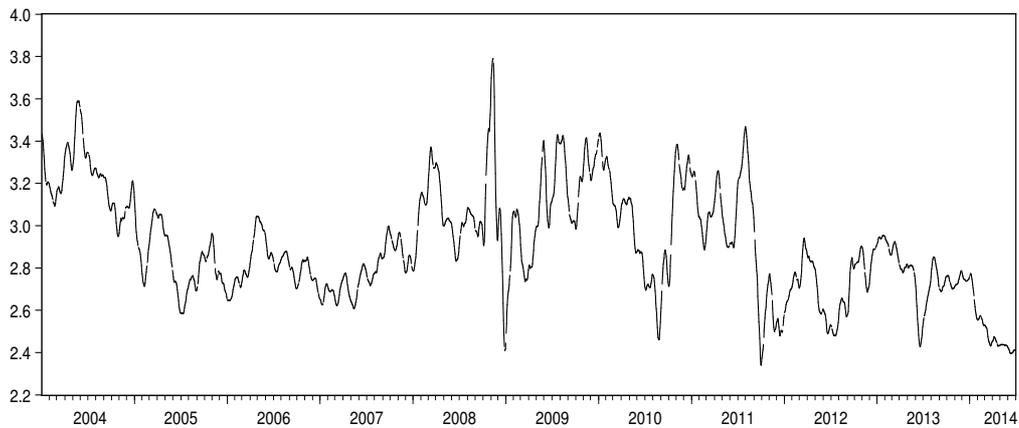
Notes: The figure shows the 1-year forward break-even rate 9 years ahead. Source: Federal Reserve Board staff, compare Gürkaynak et al. (2010b).

Our sample period starts in 2004 in order to ensure the availability of a sufficient number of index-linked bonds, see e.g. Gürkaynak et al. (2010b).[2] The sample period ends in 6/30/2014 which allows to investigate whether inflation expectations have been re-anchored in the aftermath of the crisis. Data on break-even inflation rates are provided by the Federal Reserve Board staff (see also Gürkaynak et al. (2010b)), compare Figure 1. The relative trading volume of inflation-indexed bonds is taken from the Federal Reserve Bank of New York and and the corporate bond spread, a further proxy for liquidity conditions, is obtained from Datastream.

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[2] In 2004, already 12 different inflation-indexed bonds are traded at the US secondary market. This number has almost tripled until today.

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2.2 Economic news

Following Gürkaynak et al. (2010a), the set of economic news variables includes surprises in economic activity (unemployment, advance GDP release, ISM manufacturing index, new home sales), prices (core CPI index,) and wages (nonfarm payrolls). These data are obtained from the Thomson Reuters IFR survey and are based on Wall Street economists' expectations of upcoming US economic reports. The news variable realizes at the day when the economic report is published and is defined as the actual value minus the median expectation. Thus, a higher-than-expected surprise would result in a positive realization of a news variable. To facilitate the interpretation of the estimated news-regression, we normalize the surprise variables by their standard deviation. Finally, monetary policy surprises are measured as percentage point changes in the 30-day T-bill rate at the monetary policy announcement day. Accordingly, a positive realization of the surprise variable would indicate that monetary policy is tighter than expected.

3 News-Regressions with Multiple Breaks

We investigate the time-varying degree of anchoring of inflation expectations using the following news-regression with multiple breaks,

$$\Delta \pi_t^e = \alpha + \beta_i' X_t + \varepsilon_t \ , \ \ i = 1, \ldots, l+1 \ . \tag{1}$$

where $\Delta \pi_t^e$ denotes the daily change of long-term inflation expectations and X_t contains the set of economic news variables. Since the degree of the anchoring of inflation expectations may be subject to regime changes, the vector of coefficients β may break l times which gives us $l + 1$ regimes. Inflation expectations are anchored in regime i if the news-coefficients β_i are jointly zero.

The testing theory for multiple endogenous breaks has been developed by Bai (1997), Bai and Perron (1998), Bai and Perron (2003b), Bai and Perron (2003a).[3] For sake of robustness, we consider several variants of multiple break tests. Each variant builds on the sum of squared residuals

$$\sum_{i=1}^{l+1} \sum_{t=T_{i-1}+1}^{T_i} (\Delta \pi_t^e - \hat{\alpha} - \hat{\beta}_i' X_t)^2 \tag{2}$$

($T_0 = 0$ and $T_{l+1} = T$) and is based on the corresponding F-statistic

$$F(T_1, ..., T_l; q) = \frac{1}{T} \left(\frac{T - (l+1)q - p}{l} \right) \hat{\beta}' R' (R \, \hat{V}(\hat{\beta}) \, R')^{-1} R \hat{\beta} \tag{3}$$

where $V(\hat{\beta})$ is a heteroscedasticity and autocorrelation consistent estimate of the covariance matrix of breaking regression coefficients. R is defined such that $R\hat{\beta} = (\hat{\beta}_1' - \hat{\beta}_2', \ldots, \hat{\beta}_l' - \hat{\beta}_{l+1}')$, and q and p denote the numbers of breaking and non-breaking coefficients, respectively. Apparently, the F-statistic increases and an additional break date becomes more likely, if differences between estimated coefficients of adjacent regimes are large. Bai and Perron (2003b) provide simulated critical values for the following variants of the tests.

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[3]For a comprehensive discussion of multiple break tests, see Perron (2006).

In the first step of the *sequential* test, the F-statistic is used to test for a single break over the full sample. The natural breakpoint candidate is the date that reduces the sum of squared residuals most. Provided that the break is found to be significant, the procedure is repeated for both regimes to identify a possible second break date. The sequential testing procedure stops until the null of no break cannot be rejected. In the *global* test, optimization is performed along both dimensions, the number of breakpoints and the break dates. Bai and Perron (2003a) propose an efficient algorithm to reduce the computational burden of the global test considerably.[4] Finally, we use the *combined* break test proposed by Bai and Perron (1998). In this variant, l is determined globally and sequential tests for additional breaks are conducted in each of the $l + 1$ regimes.

In our empirical application, we allow for up to $l^* = 3$ structural breaks implying up to 4 different anchoring regimes. Note that this choice covers the case of 3 regimes referring to periods of anchored, de-anchored and re-anchored inflation expectations. We trim 10% of the observations at the boundaries of each regime. This implies a minimum regime length of 12 [6] months in case of $l = 1$ [2] breaks.

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[4]For the global test, Bai and Perron (1998) propose two versions of the test statistic, UD_{max} and WD_{max}. UD_{max} assigns equal weights implying that each number of breaks is considered equally likely. WD_{max} uses weights which improve the power of the test when the true number of breaks is higher than the number of breaks under the null.

4 The Time-Varying Degree of Anchoring of Inflation Expectations

Let us first investigate whether the response of long-term inflation expectations to economic news has changed over time. Table 1 summarizes our results obtained from multiple endogenous structural break tests. Irrespective of the underlying test variant, there is clear evidence for a single break in the news-regression. For each test, the suggested break date is 07/01/2009 which is line with the crisis-related de-anchoring of inflation expectations found by Galati et al. (2011) and Autrup and Grothe (2014). However, none of the tests provide any evidence, not even at the 10% level, for the existence of an additional break, i.e., for a possible re-anchoring.

Table 1   Regimes of Anchoring of Inflation Expectations: Results from Endogenous Break Tests

multiple break test variant	breaks (l) under H_1	test statistic	5% crit. value	break date	breaks (l) under H_1	test statistic	10% crit. value	breaks (l) under H_1	test statistic	10% crit. value
global (UD_{max})	1	25.49	21.46	07/01/2009	2	12.82	19.30	3	14.81	19.30
global (WD_{max})	1	25.49	22.76	07/01/2009	2	14.70	20.56	3	19.57	20.56
sequential	1	25.49	21.33	07/01/2009	2	18.41	21.24	$--$	$--$	$--$
combined	1	25.49	21.33	07/01/2009	2	18.41	21.24	3	21.30	22.42

Notes: Results of multiple structural break tests for the news-regression (1). Critical values are taken from Bai and Perron (2003b). *global* (UD_{max}) and *global* (WD_{max}) refer to the global testing procedures described in Bai and Perron (1998). The *sequential* test is introduced by Bai (1997). For the *combined* testing approach, see Bai and Perron (1998). In each panel, the columns provide the number of breaks (l) under H_1, followed by the robust test statistic, the relevant critical value, and — in case of significance ($l = 1$) — the estimated break date. According to 10% critical values (shown for $l = 2, 3$), all tests indicate a single break in July 2009.

Table 2 presents the estimated coefficients of the news-regression that accounts for the structural break found in 07/01/2009. Before the break, the response of inflation expectations to economic news is typically small and insignificant. The only exception refers to the coefficient of New Home Sales. According to the p-value of the test for the joint significance of economic news ($p = 0.59$), inflation expectations

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were well-anchored during the pre-crisis period. However, estimates look rather different for the second period, i.e. after the break. For many of the news variables, both size and significance of the estimated coefficients increased. The increasing role of economic news for inflation expectations is also reflected in the test for joint significance which is now statistically significant at any conventional confidence level. As a consequence, the estimation results confirm earlier concerns regarding a crisis-related de-anchoring of inflation expectations in the US. Unfortunately, our findings do not indicate that inflation expectations have been successfully re-anchored ever since.

Table 2   The Time-Varying Response of Inflation Expectations to Economic News

news-regression before break	CPI	Unemployment	GDP	ISM	New Home Sales	Nonfarm Payrolls	Monetary Policy
$\Delta\pi_t^e$	0.13 (0.81)	0.11 (0.90)	-0.00 (0.99)	0.18 (0.61)	**0.42** (0.05)	-0.93 (0.35)	-0.19 (0.68)
diagnostics	joint test	R^2	DW	# of obs.			
	0.80 (0.59)	0.01	2.50	1376			
news-regression after break	CPI	Unemployment	GDP	ISM	New Home Sales	Nonfarm Payrolls	Monetary Policy
$\Delta\pi_t^e$	-0.51 (0.33)	-0.17 (0.64)	**2.39** (0.00)	**1.10** (0.07)	-1.53 (0.06)	**0.55** (0.04)	**5.51** (0.10)
diagnostics	joint test	R^2	DW	# of obs.			
	4.55 (0.00)	0.04	2.57	1249			

Notes: Estimation results for news-regressions accounting for a structural break at 07/01/2009. Significance tests in the news-regression model are based on Newey-West heteroskedasticity and autocorrelation consistent standard errors with automatic bandwidth selection. Values in parentheses below coefficients and test statistics refer to p-values.

Endogenous break point tests have difficulties to identify regime changes at the boundaries of the sample period. In our case, the required trimming of the data implies that a second break point probably indicating the re-anchoring of inflation expectations has to be found until the end of 2013. What if re-anchoring has actually taken place but tests are simply not powerful enough to detect a second break

in the news-regression? To shed more light on this issue, we re-estimated the news-regression accounting for the most likely (but still insignificant) second break date. All test variants suggest the 03/17/2011 as the start of the third regime. Table 3 shows the results of the news-regression for that period. While inflation expectations are not fully re-anchored, the importance of economic news has decreased. This might indicate that monetary policy is back on track to regain its credibility.

Table 3   What if there was a Second Break? Some Evidence towards a Re-Anchoring

news-regression during period of re-anchoring	CPI	Unemployment	GDP	ISM	New Home Sales	Nonfarm Payrolls	Monetary Policy
$\Delta\pi_t^e$	-0.20 (0.67)	0.25 (0.52)	**1.46** **(0.02)**	0.10 (0.84)	-0.84 (0.36)	**0.83** **(0.00)**	2.38 (0.47)
diagnostics	joint test	R^2	DW	# of obs.			
	1.74 (0.11)	0.01	2.49	822			

Notes: Estimation results for the news-regression over the last subsample from 03/17/2011 to 06/30/2014 given a hypothetical second break. Significance tests in the news-regression model are based on Newey-West heteroskedasticity and autocorrelation consistent standard errors with automatic bandwidth selection. Values in parentheses below coefficients and test statistics refer to p-values.

5 Conclusion

We provided new evidence on the anchoring of US long-term inflation expectations. A necessary condition for firmly anchored long-term inflation expectations is that they are unaffected by short-term economic news. In order to control for a changing degree of anchoring, we employed news-regressions with multiple endogenous break points. Our results clearly indicate that US long-term inflation expectations were less-anchored in the aftermath of the financial crisis. The de-anchoring of inflation expectations, however, might be not only a temporary phenomenon. Even

several years after the Lehman breakdown, the evidence in favor of re-anchored inflation expectations remains only weak.

References

Andrews, D. W. K. (1993). Tests for parameter instability and structural change with unknown change point. *Econometrica*, 61(4):pp. 821–856.

Autrup, S. L. and Grothe, M. (2014). Economic surprises and inflation expectations: Has anchoring of expectations survived the crisis? *European Central Bank Working Paper Series*, 1671.

Bai, J. (1997). Estimating multiple breaks one at a time. *Econometric Theory*, 13(3):pp. 315–352.

Bai, J. and Perron, P. (1998). Estimating and testing linear models with multiple structural changes. *Econometrica*, 66(1):pp. 47–78.

Bai, J. and Perron, P. (2003a). Computation and analysis of multiple structural change models. *Journal of Applied Econometrics*, 18(1):1–22.

Bai, J. and Perron, P. (2003b). Critical values for multiple structural change tests. *The Econometrics Journal*, 6(1):pp. 72–78.

Beechey, M. J., Johannsen, B. K., and Levin, A. T. (2011). Are long-run inflation expectations anchored more firmly in the euro area than in the united states? *American Economic Journal: Macroeconomics*, 3(2):pp. 104–129.

Galati, G., Poelhekke, S., and Zhou, C. (2011). Did the crisis affect inflation expectations? *International Journal of Central Banking*, 7(1):167–207.

Gürkaynak, R. S., Levin, A., and Swanson, E. (2010a). Does inflation targeting anchor long-run inflation expectations? evidence from the u.s., uk, and sweden. *Journal of the European Economic Association*, 8(6):1208–1242.

Gürkaynak, R. S., Sack, B., and Swanson, E. (2005). The sensitivity of long-term interest rates to economic news: Evidence and implications for macroeconomic models. *The American Economic Review*, 95(1):pp. 425–436.

Gürkaynak, R. S., Sack, B., and Wright, J. H. (2010b). The tips yield curve and inflation compensation. *American Economic Journal: Macroeconomics*, 2(1):pp. 70–92.

Hördahl, P. and Tristani, O. (2014). Inflation risk premia in the euro area and the united states. *International Journal of Central Banking*, 10(3).

Levin, A. T., Natalucci, F. M., and Piger, J. (2004). Explicit inflation objectives and macroeconomic outcomes. *European Central Bank Working Paper Series*, 383.

Perron, P. (2006). Dealing with structural breaks. In *Palgrave Handbook of Econometrics, Vol. 1: Econometric Theory, T. C. Mills and K. Patterson (eds.)*, pages 278–352.

Strohsal, T. and Winkelmann, L. (2014). Assessing the anchoring of inflation expectations. *Journal of International Money and Finance*, forthcoming.