**Addendum: Correction to "Can We Rely on Market-Based Inflation Forecasts?"**

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In our recent *Economic Letter* (Bauer and McCarthy 2015), we investigated how well market-based measures of inflation expectations (calculated from the prices of financial securities) predict consumer price index (CPI) inflation compared with other forecasting methods. This addendum provides a technical discussion of the analysis reported in the *Economic Letter* and additional results. The addendum provides more depth and detail to our original analysis, and we have revised the *Economic Letter* accordingly.

**Indexation lag of inflation swap contracts**

Inflation swap (IS) contracts are structured in a manner that complicates direct forecast comparisons. For example, consider the forecast made in 2013:Q1, on January 31, 2013. The one-year IS rate observed on that day does not refer to the percentage change in the CPI from January 2013 to January 2014, but instead to that from November 2012 to November 2013, due to the "indexation lag." [1] For the same reason, the one-to-two-year forward rate, calculated from the one-year and two-year rates, does not refer to inflation from January 2014 to January 2015 but instead to inflation from November 2013 to November 2014.

In our analysis we initially ignored this indexation lag under the assumption that it would make little difference to the forecast accuracy of inflation swaps. Our reason for simply relying on the calendar-reference dates in the IS contract (rather than the exact horizon implied by the indexation lag) was that in this way we could compare market-based forecasts in a straightforward fashion to survey-based forecasts (which of course do not have a phase shift/indexation lag). In our revised version of the *Economic Letter*, we account for the indexation lag since we have found that this somewhat improves market-based forecasts, and not doing so would give them an unfair disadvantage. This, however, has the effect that market-based and survey-based forecasts refer to different future horizons, which somewhat reduces their comparability.

Accounting for the IS indexation lag requires using inflation data over the period that is covered by the IS contract. For the two-year forecast, the correct horizon is from 10 to 22 months into the future—that is, in our example, we are forecasting the one-year CPI inflation rate in November 2014. The swap-based forecasts remain the same, as do two other forecasts that we considered in our *Economic Letter*: the constant forecast (equal to 2.3%) and the no-change forecast (based on current core CPI inflation).

Further complications arise for the one-year forecast because due to the indexation lag inflation over the contract horizon is partially known at the time the contract is initiated. In the example, the one-year contract covers the period from November 2012 to November 2013, but at the trading date (January 31,

[1] For a trading date of January 31, 2013, the contract start date is two business days later, on February 2, 2013. The market convention implies that the relevant index level for February 1 is the CPI in November of the previous year (a three-month indexation lag). For February 2, the convention of interpolating monthly values implies that the relevant index level can be closely approximated by the index level corresponding to February 1.

2013) the November 2012 and December 2012 CPI releases were already observed. As a result, comparing inflation data to expectations from the IS contract over the contract period would mechanically deliver more accurate "forecasts" since some of the inflation is already known by market participants.

One way around this issue is to adjust both the observed IS rate and the future realizations of inflation using data already observed by market participants (see also Grothe and Meyler 2015). Continuing with the example from above, the payoff of the one-year contract will be based on the following inflation rate

$$Inflation = \frac{CPI(Nov13)}{CPI(Nov12)} - 1 = \frac{CPI(Dec12)}{CPI(Nov12)}\frac{CPI(Nov13)}{CPI(Dec12)} - 1,$$

where the first factor is already observed. Based on this we can adjust the observed 1-year IS rate so that the inflation underlying the adjusted rate, say $\widetilde{IS}$, does not include any known inflation data:

$$\widetilde{IS} = \left[(IS + 1)\frac{CPI(Nov12)}{CPI(Dec12)}\right]^{12/11} - 1.$$

This (annualized) adjusted rate refers to inflation over the horizon from December 2012 to November 2013. It is a true forecast in the sense that only the base index level is known, and it can be compared to the (annualized) realization of CPI inflation over the same horizon.

**Risk and liquidity premia in inflation swaps**

Inflation swap rates are not equal to the actual expectations of market participants for future inflation. Conceptually, inflation swaps are risky due to the uncertainty about future inflation, and market participants would generally require a compensation for bearing this risk. This can drive a wedge between the inflation swap rate and the inflation rate expected by the market. In addition to such a "risk premium" there may also be a "liquidity premium" due to the differences in liquidity in nominal and inflation-indexed government bonds (see Christensen and Gillan 2011 and D'Amico et al. 2014). Since the (breakeven) spreads between these two types of bonds are closely tied to inflation swap rates, the latter would be affected by this as well. More generally, market prices for inflation swaps could be affected by a variety of market forces that are unrelated to fundamentals (see Bauer and Rudebusch 2015).

Using estimates of risk and liquidity premiums, the observed inflation swap rates could be adjusted in order to possibly obtain better estimates of market expectations of future inflation. However, this entails significant model and estimation uncertainty, as it is inherently difficult to estimate these unobserved factors. In addition, such estimates would typically be based on the whole sample of data, and therefore are not available in real time to forecast inflation. For these reasons, we do not attempt any such adjustment and instead use the observed inflation swap rates to construct our forecasts.

**Seasonality in CPI**

There are seasonal effects in every price index, including the CPI. Payoffs of inflation swaps are tied to the CPI series that is not seasonally adjusted. When using inflation swaps to forecast inflation, the seasonality in the CPI could in some cases become relevant. For the case of our two-year forecast, the seasonality by construction does not play a role, as we are forecasting an annual inflation rate. For the case of the one-year forecast, where due to the indexation lag adjustment we are forecasting the change in CPI over an 11-month period, the seasonality could potentially be a factor. However, we have found that trying to account for it does not improve the performance of inflation swaps, and instead somewhat worsens it. Importantly, adjusting for seasonal effects always requires estimates of the seasonal patterns, which are fraught with uncertainty.

**Sample and frequency of observation**

The sample we use in our *Economic Letter* is determined by two limitations. First, data on the Survey of Professional Forecasters are available only quarterly. Second, data on inflation swaps are available starting in mid-2005. As a result, the sample we used contained only 33 quarterly forecast dates, from 2005:Q3 to 2013:Q3. In the analysis here, we will focus on the comparison of market-based forecasts to simple forecast rules (constant and no-change forecasts), hence we can consider a monthly frequency sample which contains 97 forecast dates from July 2005 to July 2013.

**Subsample analysis**

Our sample period is characterized by periods of high volatility, in particular the Great Recession. It is therefore important to check whether the results obtained in the full sample might be driven by observations over a specific time period. We do so by considering two subsamples, the first and the second half of the sample period. Since this would leave us with too few observations in the quarterly sample, we carry out this subsample analysis only for the monthly sample.

**Additional forecasting method**

In our *Economic Letter* we used a constant 2.3% forecast for future CPI inflation. This forecast is based on the Fed's 2% long-run inflation target for personal consumption expenditures (PCE) price inflation, and a simple adjustment for the average historical difference between PCE and CPI inflation. One could argue that this constant forecast is really ex-post, as the Fed did not set an explicit inflation target until 2012.[2] One alternative is to use a moving average (MA) of past CPI inflation over a long period as a forecast for future inflation. For completeness, we will include a moving 15-year average of headline CPI inflation.

**Measuring forecast accuracy**

In our *Economic Letter* we reported root-mean-squared forecast errors (RMSEs), which are a common measure of forecast accuracy. This measure can be affected by a few large forecast errors since each deviation is squared. An alternative measure is the mean absolute error (MAE), which in some ways is a more robust measure of forecast accuracy. Here we will consider both RMSEs and MAEs.

[2] On the other hand, a target of 2% for inflation was discussed among Fed policymakers long before the explicit announcement—see in particular the transcript of the July 1996 FOMC meeting, which was released in 2002 (http://www.federalreserve.gov/monetarypolicy/files/FOMC19960703meeting.pdf).

**Results**

Table 1 reports the results on forecast accuracy for the full sample. The top panel shows results for the one-year horizon, while the bottom panel does so for the two-year horizon. In the first row of each panel, the table shows the results we reported in the original version of our *Economic Letter*, without lag adjustment of the forecast horizon. The third row, labeled "Lag-adjusted (quarterly), RMSE" reports the results that we show in the revised version of our *Economic Letter*. For the one-year horizon, adjusting for the indexation lag improves the relative performance of the inflation swaps, while for the two-year forecasts it has only a small effect. From now on, we focus on the lag-adjusted results.

For the one-year forecast horizon, inflation swaps perform worse than survey-based forecasts, the constant forecast, and the moving-average forecast. This holds true in both the quarterly and the monthly samples. They also perform worse than the no-change forecast in the monthly sample. With the only exception of the no-change forecast in the quarterly sample, inflation swaps have the worst forecast performance. This is true both for RMSEs as well as for MAEs, although when considering MAEs as the measure of forecast accuracy the differences become smaller, indicating that there might be a few large forecast errors.

For the two-year forecasts the differences in forecast performance are smaller than for the one-year forecasts. Inflation swaps, SPF forecasts, and the moving average forecasts perform worst, while the no-change and constant forecasts do better. Judging from MAEs instead of RMSEs further shrinks the differences in forecast accuracy.

The subsample analysis shows that the findings for the full sample generally hold true in both of the two subperiods: Inflation swaps generally are among the worst forecast methods, and never achieve the best forecast accuracy. Their relative accuracy is highest in the second subsample for the two-year horizon, where only the constant forecast has lower MAE, but the differences between forecasting methods are very small.

Overall, these results show that the finding of a low forecast accuracy of inflation swaps is quite robust. In almost all cases shown in Tables 1 and 2, their performance is either the worst or among the worst of the different forecasting methods. The constant forecast consistently does quite well, which is in line with the results of Grothe and Meyler (2015), who also find that a constant forecast does better than inflation swaps, both in the euro area and in the U.S. markets.

**Statistical significance**

As is evident from the results, the differences in forecasting accuracy are generally quite small. In addition, the sample period is short as it includes only ten years of data. Importantly, there are only a few non-overlapping observations—for example, there are only four non-overlapping observations for the two-year forecast horizons. As a consequence, the differences in forecast accuracy are highly unlikely to be statistically significant. While we do not carry out statistical tests of the forecast accuracy, given that they are likely unreliable in such small samples, we note that the descriptive statistics provided here should not be interpreted as strongly favoring one forecasting method over others.

## References


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Table 1: Comparison of forecast accuracy in the full sample

| | | Inflation Swap | Blue Chip* | SPF* | No change | Constant | 15y MA |
|---|---|---|---|---|---|---|---|
| **One-year horizon** | | | | | | | |
| Original results (quarterly) | RMSE | 1.99 | 1.60 | 1.63 | 1.71 | 1.53 | 1.59 |
| | MAE | 1.50 | 1.17 | 1.21 | 1.28 | 1.16 | 1.21 |
| Lag-Adjusted (quarterly) | RMSE | 1.83 | 1.60 | 1.63 | 1.85 | 1.66 | 1.70 |
| | MAE | 1.28 | 1.17 | 1.21 | 1.33 | 1.24 | 1.25 |
| Lag-Adjusted (monthly) | RMSE | 1.95 | 1.58 | n.a. | 1.82 | 1.65 | 1.69 |
| | MAE | 1.42 | 1.17 | n.a. | 1.31 | 1.22 | 1.26 |
| **Two-year horizon** | | | | | | | |
| Original results (quarterly) | RMSE | 1.75 | n.a. | 1.63 | 1.66 | 1.65 | 1.71 |
| | MAE | 1.36 | n.a. | 1.26 | 1.32 | 1.32 | 1.34 |
| Lag-Adjusted (quarterly) | RMSE | 1.63 | n.a. | 1.63 | 1.55 | 1.55 | 1.61 |
| | MAE | 1.26 | n.a. | 1.26 | 1.25 | 1.22 | 1.31 |
| Lag-Adjusted (monthly) | RMSE | 1.66 | n.a. | n.a. | 1.61 | 1.59 | 1.66 |
| | MAE | 1.28 | n.a. | n.a. | 1.29 | 1.25 | 1.30 |

* Horizon for forecast and future realized inflation is exactly one year and two years from the forecast date, without lag adjustment.

Table 2: Comparison of forecast accuracy in two subsamples

| | | Inflation Swap | Blue Chip* | No change | Constant | 15y MA |
|---|---|---|---|---|---|---|
| **2005-2008** | | | | | | |
| One-year horizon | RMSE | 2.42 | 2.00 | 2.15 | 2.11 | 2.16 |
| | MAE | 1.98 | 1.58 | 1.61 | 1.58 | 1.60 |
| Two-year horizon | RMSE | 2.02 | n.a. | 1.91 | 1.95 | 2.02 |
| | MAE | 1.61 | n.a. | 1.55 | 1.56 | 1.61 |
| **2009-2013** | | | | | | |
| One-year horizon | RMSE | 1.29 | 0.96 | 1.40 | 0.96 | 1.02 |
| | MAE | 0.84 | 0.75 | 1.01 | 0.84 | 0.91 |
| Two-year horizon | RMSE | 1.19 | n.a. | 1.22 | 1.12 | 1.17 |
| | MAE | 0.95 | n.a. | 1.02 | 0.93 | 0.99 |

Monthly frequency; lag-adjusted horizon. * Horizon for forecast and future realized inflation is exactly one year and two years from the forecast date, without lag adjustment.