MIMS – Research Area

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Different approaches to measuring inflation expectations

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Introduction

Inflation became the main economic topic of the recent years. Financial markets have been displaying high sensitivity to surging inflation and rising interest rates. While nowadays it remains one of the main factors of making economic decisions, it is important to understand how economic agents form their inflation expectations and how these expectations correspond with reality. The following report outlines the main survey- and market-based approaches to measuring inflation expectations, i.e., inflation expectations surveys, inflation-indexed bonds, and inflation-linked swaps. It examines the main strengths and limitations of these approaches and, eventually, compares them in relation to actual historical inflation rates.

Inflation Expectation Surveys

The first, and probably most obvious way to measure inflation expectations is through specialized surveys. Inflation expectations surveys are an important tool to gain insights on future inflation rates. These surveys poll both consumers and professional forecasters. Surveying consumers provides a sense of how individuals perceive current and future inflation, which can affect spending habits and wage demands. At the same time, surveying professional economists and analysts offers a more thoughtful forecast based on data and other insights. Both types of inflation expectations surveys help central banks and policymakers monitor sentiment around future inflation.

Main inflation expectation surveys available

There are several inflation expectations surveys conducted by different institutions, the most renowned ones are:

The Federal Reserve Bank of New York's Survey of Consumer Expectations.

This is a monthly survey that collects information on the American households' views on inflation, labor market conditions, and household finance. To derive inflation expectations, the consumers are asked the following questions: "What do you expect the rate of inflation/deflation to be over the next 12 months? Please give your best guess", "What would you say is the percent chance that, over the next 12 months: the rate of inflation will be 12% or higher; the rate of inflation will be between 8% and 12%; …".

The University of Michigan's Survey of Consumers.

This monthly survey collects data on various indicators related to consumer confidence, among which we find expectations for inflation. The two main questions asked are: "During the next 12 months, do you think that prices in general will go up, or go down, or stay where they are now?" and "By what percent do you expect prices to go up, on the average, during the next 12 months?".

Federal Reserve Bank of Philadelphia Survey of Professional Forecasters.

This is the oldest quarterly survey of macroeconomic forecasts in the United States. In the survey form the forecasters are expected to give their quarterly and annual CPI inflation projections over the next one-, two-, five- and ten-year periods.

The European Central Bank's Survey of Professional Forecasters.

Unlike the previously mentioned surveys, this one is a quarterly survey that gathers inflation expectations from a panel of professional forecasters in the euro area. The survey asks participants for their expectations for inflation over the next one, two, and five years. Forecasters are expected to provide "Point estimate of euro area inflation expectations" and "Probabilities of euro area HICP (Harmonized Index of Consumer Prices) inflation".

Strength and limitations of surveys when extracting inflation expectations

When it comes to forecasting inflation rates, inflation expectations surveys have considerable strengths as well as some limitations. The main strengths of the inflation expectations surveys are timeliness, broad coverage, and better model training.

Timeliness. Since they are conducted in a regular way, they provide timely information on the public's expectations for future inflation, allowing policymakers to quickly assess changes in inflation expectations and answer accordingly.

Broad Coverage. Inflation expectations surveys usually cover a broad range of respondents, including households, consumers, and professional forecasters, which allows to consider a wide spectrum of opinions and expectations. However, it also has its downsides as mentioned later.

Better model training. Inflation expectation surveys can also be used to improve rational expectation models since they can provide a more accurate measure of how agents form expectations about future inflation. According to this model, individuals use all the information available to form and update their expectations about various economic factors (Ormeno & Molnar, 2015). On the other hand, behavioral economic models suggest that individuals do not form inflation expectations in a fully rational way based on available information since they may be influenced by emotions, cognitive biases, or other factors.

At the same time, when it comes to making forecasts, inflation expectations surveys have some limitations that are mainly related to their subjective nature and limited comparability.

Subjective Nature. Answers in surveys are based purely on the subjective opinions of respondents, which may not always accurately reflect the underlying economic conditions. This subjectivity can introduce biases. For example, consumers may rely on their past experiences price changes (downward or upward biases) when forming their expectations about future inflation. This can lead to biases in their inflation expectations, as they may overestimate or underestimate the likelihood of similar price changes occurring in the future. Another source of bias is the "availability heuristic", this term reflects the tendency of individuals to rely on easily available information when making judgments or decisions. According to Bruine de Bruin et al. (2011) the biasing effect was found to be stronger for individuals with lower levels of education and income, and for those with a stronger tendency to rely on heuristics in decision making.

Limited Comparability. Different surveys may use different methodologies, question formats, and sample sizes, making it difficult to directly compare their results. This can complicate the interpretation of survey results and hinder their use as a consistent tool for forecasting inflation rates.

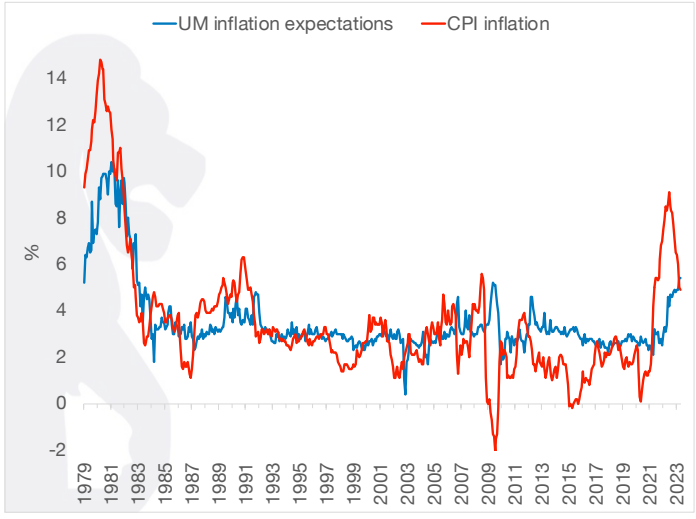
Consumer inflation expectations and actual inflation rates

To understand how well consumers' inflation expectations reflect the real inflation rates in the future it is worth considering historical expectations in comparison with actual realizations (Figure 1). As for CPI inflation rate, we use the 12-Month Unadjusted Percent Change in the CPI for All Urban Consumers provided by the U.S. Bureau of Labor Statistics. The data for expectations comes from The University of Michigan's Survey of Consumers available online, we consider a time series of the expected percentage change in prices for the following year. We specifically consider the median (and not the mean) of all monthly estimates since it is more robust with respect to outliers. Indeed, the mean would be a lot higher than the median since the distributions of expectations is right skewed (meaning that it has a longer left tail). This phenomenon is called "upward bias" and can be due to people's exposure to heterogeneous price signals, psychological factors and how they perceive inflationary pressure in general.

Another interesting insight comes from the fact that steep inflation drops (and some high peaks) are usually not forecasted by consumers. This can be explained by both the presence of unforeseen events, the upward bias mentioned above, and macro factors not considered by households. Indeed, unconventional monetary policies like forward guidance are complex to understand since they require a broader knowledge of macroeconomic mechanisms and very often central banks communications do not reach ordinary households.

Figure 1

The University of Michigan's Survey of Consumers inflation expectations and actual rates of CPI inflation



Source: The University of Michigan's Survey of Consumers, Federal Reserve Bank of St. Louis.

Inflation-indexed bonds and bond yield curve

Another approach to measuring inflation expectations consists in deriving them from the market data. In this section we explore how the inflation-indexed bonds (IIBs) can be used as a tool to measure inflation expectations.

Break-even inflation rate

Inflation-indexed bonds are financial instruments the principal and interest payments of which are adjusted for changes in inflation. These bonds provide a unique opportunity to measure inflation expectations as they offer a real yield that reflects market participants' inflation expectations. One of the most common approaches to measuring inflation expectations using IIBs is to compare the nominal yield on conventional bonds to the real yield on IIBs: the spread between the yields of the bonds of the same maturity is known as the break-even inflation rate (BEIR). Risk premia aside, this spread would be the hypothetical rate of inflation at which the expected return from the two bonds would be the same (Ciccarelli & García, 2009).

To better understand how the difference between nominal yields and real yields can give us inflation expectations, it is worth recalling the Fisher equation, which connects nominal interest rates, real interest rates, and inflation:

real interest rate ≈ nominal interest rate – inflation rate

Rearranging this equation, we can isolate the expected inflation rate:

$$E\pi_t = i_t - r_t$$

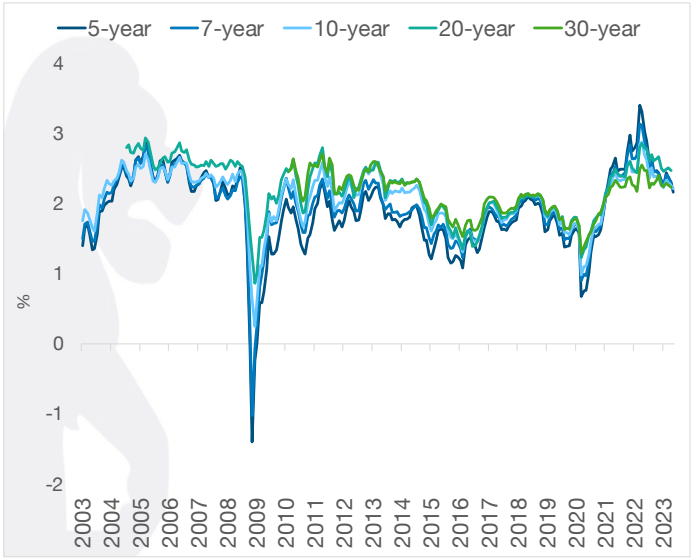
Here, the nominal interest rate is the interest rate that is actually paid on a bond, while the real interest rate is the nominal interest rate adjusted for inflation. Inflation-indexed bonds, such as TIPS (Treasury Inflation-Protected Securities), are designed to provide a real rate of return by adjusting the nominal rate of interest for changes in inflation. The breakeven inflation rate represents the market's expectation of average annual inflation over the bond's remaining term. For example, suppose a 10-year Treasury bond has a nominal yield of 3% and a 10-year TIPS has a real yield of 1%. In this case, the breakeven inflation rate would be 2%. This implies that the market expects inflation to average 2% per year over the next 10 years.

Figure 2 below illustrates BEIR derived from the US treasury securities of different maturities (namely, 5, 7, 10, 20 and 30 years). Here, the breakeven inflation rate is derived from Treasury Securities and Treasury Inflation-Indexed Securities with the same maturity. Intuitively, the latest value implies what market participants expect inflation to be in the next 5, 7, 10, 20 and 30 years respectively, on average.

Quite naturally, the graph shows that the longer is the maturity of the bonds, the less volatile is the expected inflation rate and vice versa.

Figure 2

Breakeven Inflation Rates derived from bonds of different maturities



Source: Federal Reserve Bank of St. Louis

Strengths and limitations of IIBs when extracting inflation expectations

When it comes to forecasting inflation rates, IIBs have both strengths and limitations. The main strengths of BEIR as a source of information on private sector inflation expectations relate to timeliness and availability for different time horizons.

Timeliness. Inflation-indexed bonds are the timeliest source of information on inflation expectations since they are available in real time every trading day.

Availability for different time horizons. As conventional and inflation-linked bonds are issued over a variety of maturities, they in principle allow for obtaining inflation expectations at several horizons, which is of considerable interest for researchers, central banks, and private investors (Ciccarelli & García, 2009).

Although the breakeven inflation rate has become a widely used measure of inflation expectations, there are several factors that can affect its accuracy, namely, the liquidity risk premia and imprecision in estimating inflation trend and volatility. The liquidity risk premia is the subject of special attention among those studying inflation expectations.

Liquidity risk premia. IIBs' liquidity, supply, and demand conditions can distort market participants' inflation expectations. Therefore, accurately inferring market expectations of inflation from yield spreads may be difficult due to the differences in market liquidity conditions between nominal and inflation indexed Treasury securities (Shen, 2006).

In more detail, the yield of an inflation indexed security usually consists of two components: a real yield and a liquidity risk premium to compensate investors for the risk of having to pay more (than in the case of nominal Treasuries) to liquidate the TIPS before its maturity. The liquidity risk of a security consists in the fact that investors may incur large costs to buy or sell the security in a secondary market. Some of the costs are similar for both nominal Treasuries and TIPS, such as brokerage fees and commissions, while other costs relate to the ease and convenience of trading, which are more uncertain in nature and usually relate inversely to the liquidity of the market. For example, a seller of a large amount of nominal Treasury securities, say $2 billion, may be able to find a buyer and complete the transaction in minutes. Selling $2 billion worth of TIPS may require a lot more time to search for a buyer or selling at somewhat lower prices to complete the sale in a timely fashion. Thus, the less liquid security carries higher liquidity risk, and thus must carry a higher yield to attract investors. This additional yield is the liquidity risk premium. This means that the yield spread should be equal to the market expected rate of inflation minus a liquidity risk premium:

$$i_t - r_t = E\pi_t - RP_t^L$$

Consequently, simply attributing changes in yield spreads to changes in market inflation expectations and ignoring the liquidity risk premium could lead to overstated inflation expectations.

Imprecision. Moreover, the breakeven inflation rate reflects the expected average inflation rate over the bond's maturity period, but it does not capture the market's expectation about future inflation trends or volatility. In fact, survey-based approach is often believed to better capture the expectations, as in this case one can directly ask those who set the price of and buy goods and services, i.e., business managers and households (Alcidi, Gros & Shamsfakhr, 2022). However, one can argue that the survey respondents have no strong incentive to make the right prediction, as the replies have no real implications for them. On the other hand, the advantage of market-based measures is that the investors have a strong incentive to get the result right and reflect market participants' actual economic decisions rather than their subjective opinions.

Overall, inflation-indexed bonds and breakeven inflation rate offer a valuable tool for measuring inflation expectations. Although this approach has its limitations, it still offers some insights when measuring inflation expectations.

BEIR and actual inflation rate

To evaluate how well the breakeven inflation rate estimates the actual inflation, it is useful to analyze, for a specific horizon, the spread between the former (derived from TIPS) and the latter (i.e., annualized CPI inflation rate). Figure 3 considers the period from July 2003 to January 2018, showing the differences between the two rates calculated for different maturity horizons (from 6-month to 15-year).

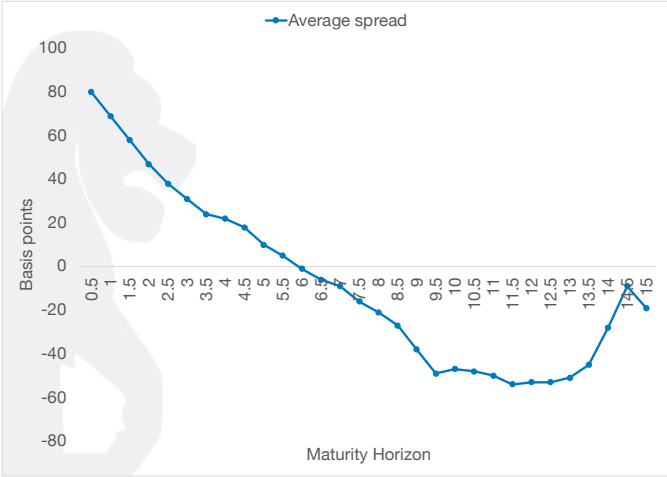
At least two insights may be derived from the data:

- The average deviation between breakeven inflation rates and annualized CPI inflation never exceeded 80 basis point for any 6-month increment: this shows a particular accuracy of the technique during the period observed

- Breakeven inflation expectations "overshoot" actual inflation for short maturity horizons, while they "undershoot" for long maturity horizons

Figure 3

Average difference between Breakeven rates and CPI inflation rates (maturity horizons from 6 months to 15 years: July 2003-January 2018)



Source: U.S. Bureau of Labor Statistics Working Paper 511

The bond yield curve and Inflation expectations

Another important market-based measure that allows us to make assumptions about inflation expectations, though, in more general terms, is the bond yield curve. Empirical evidence (Estrella & Mishkin, 1991) proves the predictive power of the bond yield curve with reference to the expected inflation trend.

Recalling the definition of the yield curve, it plots the interest rates of bonds with the same credit quality but different maturities: it shows the changes of the interest rates as the term increases.

Thus, the slope of the yield curve tells us how the bond market expects short-term interest rates to move in the future based on investors' expectations about economic activity and inflation. This phenomenon is explained by an "indirect effect", which refers to the monetary policies run by the central banks and especially the expectations on these policies. In fact, as Blough (1990) underlined, "the term structure should reflect expectations of future interest rates; the term structure should be useful in forecasting changes in inflation only if it is useful in forecasting changes in interest rates and changes in interest rates are, to a substantial extent, driven by changes in inflation".

In a situation of economic expansion, the expected consequence is an increase of the inflation rate due to the increase in demand and output, requiring central banks to raise interest rates with a restrictive monetary policy to keep inflation as close to the target as possible. This expected higher short-term interest rate for the future implies that the long-term yield, which is supposed to be about the average of the short-term current rate and the expected ones, will be higher as the maturity increases. In a nutshell, an upward curve can be considered as a synonym of a higher expected inflation rate, while a downward curve responds to expectations of lower inflation rates (with a consequent drop of interest rates by the central banks to stimulate the real economy). This link becomes very useful to estimate in general terms if an increase or a reduction in inflation rate is expected, but so far, the result within the estimation is only qualitative.

To calculate the expected inflation, it is necessary to recall again the Fisher equation ($r_t = i_t - E\pi_t$).
According to the expectations theory, as the forward rate approximates the expected future spot rate, the forward-spot spread should approximately equal the expected change in the spot interest rate: so, substituting in the fisher equation, the spread forecasts the sum of the expected change in inflation and the expected change in the real rate of interest for the following period. Nevertheless, the main problem is that the term structure cannot be linked to expected inflation without consideration of the real rate (which is difficult to estimate: the unique way consists of using a regression based on historical changes of the rate based on the forward-spot difference). In conclusion, it can be said that the forward-spot spread reflects the expected change in the spot rate, which in turn reflects both expected changes in inflation and expected changes in the real rate of interest. Recalling that $r_{t+1} = i_t - \pi_{t+1}$ we can formalize all said above in the following way ("forward unbiasedness condition"):

$$(f_t - i_t) = E_t(\Delta i_{t+1}) = E_t(\Delta\pi_{t+2}) + E_t(\Delta r_{t+2})$$

where i_t - nominal one-year spot rate, f_t - one-year ahead one-year forward rate, r_(t+1) - ex post real rate of interest, E_t (Δr_(t+2)) - expected change in real interest from t+1 to t+2, E_t (Δπ_(t+2)) - expected change in inflation for t+2.

The equation can thus be then rearranged as:

$$E_t(\Delta\pi_{t+2}) = (f_t - i_t) - E_t(\Delta r_{t+2})$$

One can notice that the forward-spot spread will directly measure expected changes in inflation only if the real rate is expected to remain unchanged. Within the most in-depth analysis run by Estrella and Hardouvelis (1991), the used forward-spot spread was the one between the interest rates on the 10-year Treasury note (long-term) and the 3-month Treasury bill (short-term).

These tests have been able also to predict the upcoming recovery from the recession of the 90's. Mishkin and Estrella also used probit model to estimate the probability of recession to the yield curve spread (based on the data from the first quarter of 1960 to the first quarter of 1995). Table 1 perfectly illustrates the relationship identified.

Table 1

Estimated Recession Probabilities for Probit Model Using the Yield Curve Spread, Four Quarters Ahead

Recession Probability (Percent)	Value of Spread (Percentage Points)
5	1.21
10	0.76
15	0.46
20	0.22
25	0.02
30	-0.17
40	-0.50
50	-0.82
60	-1.13
70	-1.46
80	-1.85
90	-2.40

Note*: The yield curve spread is defined as the spread between the interest rates on the ten-year Treasury note and the three-month Treasury bill.*
Source: Estrella and Hardouvelis (1991)

Inflation-linked swaps

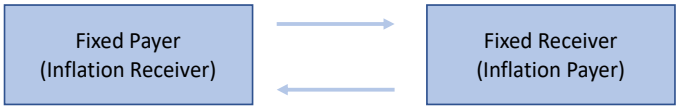
Another market-based measure of inflation expectations are inflation-linked swaps (ILSs). An inflation-linked swap is a type of financial derivative where one party agrees to exchange fixed payments for floating payments based on an inflation index, such as the Consumer Price Index (CPI).

The purpose of this exchange is to transfer inflation risk from one party to another. The swap rate, or fixed rate, is determined in the market and no cash flows are exchanged at the inception of the swap. The most common type of inflation swap is the zero-coupon swap, which means that cash flows are exchanged only at the maturity of the contract. The inflation payer will make a payment equal to the notional amount of the contract times the realized inflation rate over the contract term, while the fixed payer will make a payment equal to the notional amount times the fixed rate, as shown in the Figure 4.

Figure 4

Zero-Coupon Inflation Cash Flows at Maturity

$$Notional \times [(1 + swap\ rate)^{tenor} - 1]$$



$$Notional \times \left(\frac{Inflation\ index\ at\ maturity}{Inflation\ index\ at\ start} - 1\right)$$

Inferring inflation expectations from inflation swaps

ILSs represent the market's collective view of future inflation. The fixed rate on an ILS reflects the market's expectations of inflation, while the floating rate is tied to the actual inflation rate over the contract period, which is represented by an inflation index (e.g., Consumer Price Index).

Due to their nature, ILSs are commonly used to hedge against the risk of inflation by entities with obligations exposed to it, such as pension funds and insurance companies. Conversely, entities with assets exposed to inflation, such as utility companies, can use inflation swaps to hedge against the risk of inflation increasing their costs. Additionally, some investors may choose to take on inflation risk for speculative or diversification purposes. Inflation swaps trade in a dealer-based overthe counter (OTC) market. The predominant market makers are the G14 dealers (the G14 refers to a group of 14 major international banks that participate in the derivatives market), which trade with one another and with their customers.

Strength and limitations of surveys when extracting inflation expectations

ILSs have several strengths compared to IIBs when it comes to deriving inflation expectations. Unlike inflation-protected securities such as TIPS, inflation swaps offer more flexibility in terms of contract maturity, notional amount, and other terms that can be customized to meet specific investor needs.

However, just as in the case of IIBs, inflation swaps rate has some noise in the data, and so they do not provide a perfect representation of the market expectations of inflation.

Liquidity risk premia. In contrast to BEIR derived from inflation-linked and nominal sovereign bonds inflation swaps rates are less influenced by market liquidity problems (Burban et al., 2021).

Inflation risk premia. On the contrary, inflation-linked swap rates are influenced by the presence of inflation risk premiums which can be attributed to the cautious nature of financial market participants and their need to navigate uncertainties. Inflation risk premiums tend to be positive during periods dominated by supply shocks and negative during periods dominated by demand shocks. When adverse supply shocks occur, they contribute to positive inflation risk premiums because they indicate an increase in inflation when real asset payoffs are highly valued, such as during a decline in real economic activity and an increase in the marginal utility of consumption.

Which is worth noting, inflation swaps rates observed since mid-2020 are primarily driven by inflation risk premiums rather than inflation expectations. This implies that the rise is mainly linked to a change in the perceived risks associated with inflation, shifting from lower-than-expected risks to higher-than-expected risks

Inflation swaps and actual inflation rates

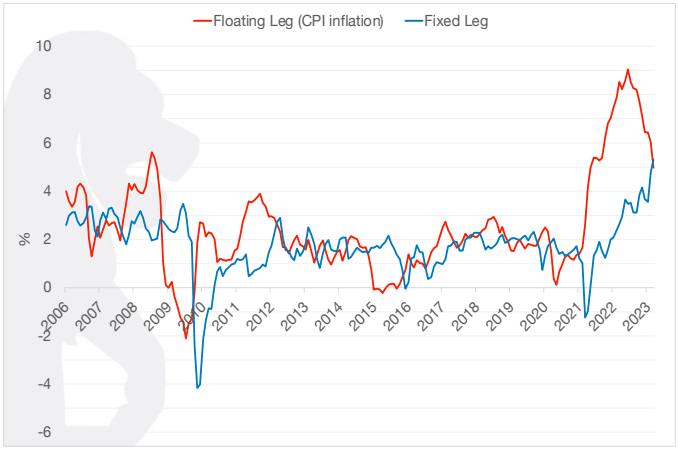
To assess the accuracy of the market-based measure for future inflation levels, we analyzed the historical relationship between inflation expectations (based on the fixed leg of the inflation swap) and actual inflation rate. Specifically, we analyzed U.S. 1-year zero-coupon inflation swaps data as it is generally considered to be one of the most liquid types of inflation swaps, it is actively traded in many markets, and is frequently used as a benchmark for other inflation swaps.

Since the floating leg of this type of swap is based on the CPI Urban Consumer index not adjusted for seasonal fluctuations in prices that occur each year, which tracks the prices of goods and services purchased by urban consumers over time, we used this index instead of the more commonly used CPI. The index is published monthly by the U.S. Bureau of Labor Statistics and reflects the spending patterns of a wide range of people, including urban wage earners, professionals, the self-employed, and retirees. It covers a diverse set of goods and services, such as food, housing, transportation, and medical care.

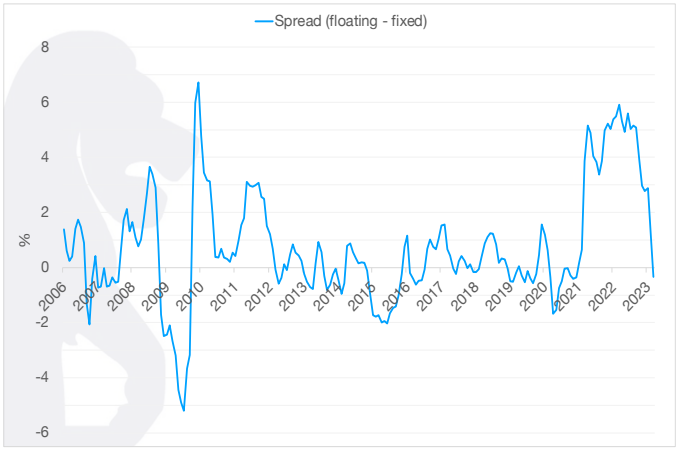
Figure 5.a shows the expected inflation rate for that moment derived from ILSs against the actual inflation rate, while **Figure 5.b** shows the spread between the two.

Figure 5

a. *The ILS rates and actual rates of CPI Urban Consumer index inflation*



b. Spread between the actual and the expected inflation rates



Source: Bloomberg, U.S. Bureau of Labor Statistics

To further develop our analysis on how well the market predicts inflation we need to consider the data below, describing statistical properties of the spread between expected and actual inflation.

Table 2

Descriptive statistics of the spread between expected and actual inflation rates

Average	0,72%
Std. Deviation	2,07%
Skewness	0,53
Min	-5,20%
25%	-0,41%
Median	0,37%
75%	1,52%
Max	6,72%

On average, the market's predictions of inflation one year ahead are not exact, as indicated by both the average and median values being above zero at 0.72% and 0.37% respectively. This suggests that investors who choose the fixed leg of the swap will generally benefit, as the CPI-linked-leg is slightly above expectations. Moreover, the distribution is positively skewed, implying that the probability of a CPI value greater than the fixed leg is higher. However, the data's range of values spans from -5.20% to 6.72%, with a standard deviation of 2.07%, indicating the market's inaccuracy in predicting future inflation values. It's worth noting that the time series includes the 2007-2009 financial crisis period, characterized by a lack of liquidity in the inflation swap market, and quantitative easing, as well as the post-Covid-19 inflation surge. Thus, one could make the compelling argument that this sample includes outliers, nonetheless, as an instrument of hedging, investors cannot disregard the possibility of an exogenous shock that renders the instrument ineffective in mitigating inflation risk.

Comparative analysis: simple approaches to forecasting inflation

After carrying out a high-level analysis of various approaches to estimating inflation expectations the question that arises is whether we can quantitively assess which approach works better when forecasting inflation. To compare different methods, we use a simple technique of naïve specifications (Pasaogullari & Meyer, 2010). It implies that the forecast over a year ahead is simply the expectation regarding the future rate today:

$$\pi_{t+12} = \pi^{e}_{t+12|t}$$

Where $\pi^{e}_{t+12|t}$ is expectation at time t for 12 months ahead π_{t+12} is the actual rate of inflation in 12 months.

Then, to estimate the accuracy of the estimations, we compute the root mean squared error (RMSE), a measure of forecast error, that can be expressed as

$$RMSE = \sqrt{\frac{\sum_{t=1}^{N}(\pi_t - \pi_t^e)}{N}}$$

where N is the number of periods under consideration, π_t is the actual rate of inflation at time t, and π_t^e is the corresponding inflation expectation.

In each case when we compare the expectations against the actual inflation, for the actual inflation rates we use the 12-Month Percent Change in the CPI for All Urban Consumers provided by the U.S. Bureau of Labor Statistics. We use the unadjusted data for CPI inflation as it accurately reflects the actual change in prices that concerns the consumers and forecasters.

We divide the observations into 6 sub-periods (each of 10 years approximately) to ensure consistency of comparison due to data availability of various specifications.

Firstly, we investigate two readily available survey measures: University of Michigan's Survey of Consumers (UM) and Federal Reserve Bank of Philadelphia Survey of Professional Forecasters (SPF). We specifically pick these two measures as the former reports the median inflation expectations according to consumers, while the latter is based on the estimates of professional forecasters. We then explore the accuracy of inflation expectations incorporated in inflation-linked swaps.

It is worth noting that the breakeven inflation rate has not been used when estimating different approaches as the shortest maturity of the Treasury Inflation Protected Securities is 5 years, which implies that the BEIR in that case represents a measure of expected inflation in the next 5 years on average. This, in turn, makes deriving the 1-year ahead inflation expectations quite burdensome given the nature of this high-level analysis.
Table 3 details the RMSEs for the different specifications.

The highest-performing measures in each period are highlighted in green. The performance of various approaches to inflation forecasting varies over time. Though, we can derive some interesting insights from the data. Firstly, we find that survey measures of inflation expectations tend to outperform the market related measure (i.e., inflation-linked swaps). This conclusion might be consistent with the limitations of the ILSs stated previously in the following report (namely, the fact that ILSs returns embody the component of the inflation risk premia which makes it more difficult to derive properly the component of inflation expectations).

Table 3

Accuracy of Forecasts Based on Inflation Expectations based on RMSE measure

	1982:Q3-1989:Q4	1990:Q1-1999:Q4	2000:Q1-2005:Q4	2006:Q1-2009:Q4	2010:Q1-2019:Q4	2020:Q1-2023:Q1
Inflation expectations surveys						
Naïve forecast with UM inflation expectations	1.26	0.94	0.90	2.79	1.53	2.77
Naïve forecast with SPF inflation expectations	1.65	0.80	0.94	1.97	1.21	3.76
Inflation-linked swaps						
Naïve forecast with ILSs	n.a.	n.a.	n.a.	2.48	1.26	3.60

Secondly, an interesting conclusion comes from the fact that the naïve forecast with UM inflation expectations outperforms the other measures in half of the periods (namely, 1982-1989, 2000-2005 and 2020-2023).
The fact that consumers forecast inflation better in some periods might appear quite intuitive: while professional forecasters use comprehensive statistical models, these models are based on past observations, which makes the forecasts much more persistent. Thus, statistical models cannot detect new directions that are inconsistent with past relationships.

This is especially true for the period of 2020-2023 that can be characterized by several unpredictable events and thus, extremely high volatility (i.e., in that period inflation was driven by events such as the pandemic of Covid-19 and Russia's invasion of Ukraine that created major supply shocks in international economy). On the other hand, the fact that the consumers' expectations perform relatively well is again consistent with the advantages stated previously in the following report and rational expectations theory.

However, it should be noted that the consumers expectations significantly underperformed during the period of 2006-2009, which was marked by the financial crisis and the Great Recession in the U.S.

Median year-ahead inflation expectations from the Survey of Professional Forecasters tend to forecast relatively well. The naïve forecast with SPF inflation expectations outperforms other approaches in the periods of 1990-1999 and 2006-2019. The Naïve forecast with ILSs performed relatively well in the period of 2010-2019.

While the approach to estimating different measures of inflation expectations was quite simple, it yielded some interesting conclusions. Surveys in general perform better in forecasting inflation than the market-based measures (i.e., ILSs). Consumers expectations perform relatively well despite their subjective nature and lack of technical backing (i.e., no statistical models). At the same time, for the purposes of further research in the field of inflation expectations and inflation forecasting, it might be particularly interesting to investigate in more detail other market-based measures such as inflation-indexed bonds (which require more analytical work when it comes to properly deriving inflation expectations).
Moreover, other measures which were not mentioned in the following report can be of interest for future investigation when creating robust forecasts of inflation (e.g., macroeconomic factors, core inflation measures etc.).

Sources

Alcidi, C. & Gros, D. & Shamsfakhr, F. (2022). Inflation expectations: models and measures. Publication for the committee on Economic and Monetary Affairs, Policy Department for Economic, Scientific and Quality of Life Policies, European Parliament. Available at: https://www.europarl.europa.eu/RegData/etudes/IDAN/2022/703338/IPOL_IDA(2022)703338_EN.pdf

Bańnkowska, Katarzyna & Borlescu, Ana Maria & Charalambakis, Evangelos & Da Silva, António Dias & Di Laurea, Davide & Dossche, Maarten & Georgarakos, Dimitris & Honkkila, Juha & Kennedy, Neale & Kenny. (2021). ECB Consumer Expectations Survey: an overview and first evaluation. *Occasional Paper Series 287, European Central Bank.* DOI: http://dx.doi.org/10.2139/ssrn.3981218

Blough, S. R. (1994). Yield curve forecasts of inflation: A cautionary tale. New England Economic Review, (May), 3-16. Available at: https://www.bostonfed.org/publications/new-england-economic-review/1994-issues/issue-may-june-1994/yield-curve-forecasts-of-inflation-a-cautionary-tale.aspx

Burban, V. & De Backer, B & Schupp, F. & Vladu, A. L. (2022). Decomposing market-based measures of inflation compensation into inflation expectations and risk premia. *Economic Bulletin Boxes, European Central Bank*, vol. 8. Available at: https://www.ecb.europa.eu/pub/pdf/ecbu/eb202108.en.pdf

Burke, M. A., & Manz, M. (2014). Economic Literacy and Inflation Expectations: Evidence from a Laboratory Experiment. *Journal of Money, Credit and Banking*, 46(7), 1421–1456. Available at: http://www.jstor.org/stable/24499140

Ciccarelli M. & García J. A. (2009). What drives euro area break-even inflation rates? European Central Bank, Working Paper Series No 996. Available at: https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp996.pdf

Estrella, A. (2005). Why does the yield curve predict output and inflation? The Economic Journal, 115(505), 722-744. Available at: https://www.jstor.org/stable/3590455

Estrella, A., & Hardouvelis, G. A. (1991). The term structure as a predictor of real economic activity. The journal of Finance, 46(2), 555-576. Available at: https://www.jstor.org/stable/2328836

Estrella, A., & Mishkin, F. S. (1996). The yield curve as a predictor of US recessions. Current issues in economics and finance, 2(7). Available at: https://www.newyorkfed.org/medialibrary/media/research/current_issues/ci2-7.pdf

Fleming, M. J. & Sporn, J. (2013). Trading Activity and Price Transparency in the Inflation Swap Market. *Economic Policy Review*, Vol. 19, No. 1. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2324235#

Garner, C. A. (1987). The yield curve and inflation expectations. Economic Review-Federal Reserve Bank of Kansas City, 72(8), 3. Available at: https://www.kansascityfed.org/documents/1043/1987-The%20Yield%20Curve%20And%20Inflation%20Expectations.pdf

Haubrich, J., Pennacchi, G., & Ritchken, P. (2012). Inflation Expectations, Real Rates, and Risk Premia: Evidence from Inflation Swaps. The Review of Financial Studies, 25(5), 1588–1629. Available at: http://www.jstor.org/stable/41485536

Ormeño, A., & Molnár, K. (2015). Using Survey Data of Inflation Expectations in the Estimation of Learning and Rational Expectations Models. *Journal of Money, Credit and Banking*, 47(4), 673–699. Available at: http://www.jstor.org/stable/24500907

Pasaogullari, M., & Brent M. (2010). Simple Ways to Forecast Inflation: What Works Best? *Federal Reserve Bank of Cleveland, Economic Commentary 2010-17*. DOI: https://doi.org/10.26509/frbc-ec-201017

Rumler, F. & Valderrama, M. T. (2020). Inflation literacy and inflation expectations: Evidence from Austrian household survey data. Economic Modelling, Elsevier, vol. 87(C), pages 8-23. DOI: https://doi.org/10.1016/j.econmod.2019.06.016

Shen, P. (2006). Liquidity risk premia and breakeven inflation rates. Economic Review, Federal Reserve Bank of Kansas City, vol. 91(Q II). Available at: https://core.ac.uk/download/pdf/6799502.pdf