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Inflation expectations from index-linked bonds: Correcting for liquidity and inflation risk premia

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ABSTRACT

We propose a novel method to correct break-even inflation rates derived from index-linked bonds for liquidity and inflation risk premia without resorting to survey based measures. In a state-space framework the difference between break-even inflation rates and unobserved true inflation expectation is explained by measures of time-varying liquidity and inflation risk premia. Our results have better forecasting performance for the average annual inflation rate over the following 10 years than raw break-even rates and the Survey of Professional Forecasters.

1. Introduction

In 1997 the US government started to issue a 10-year inflation-linked bond, a treasury inflation-protected security (TIPS).[1] Inflation linked bonds make it possible in principle to observe the real interest rate and furthermore allow to infer the so-called break-even inflation rate (BEIR), which is the difference between the nominal and real yield of a security with the same maturity.

Being a market based measure of inflation expectations, BEIRs provide central banks with additional information to more standard survey-based measures. Thus apart from providing a more complete picture as to market participants' inflationary expectations, BEIRs have the additional advantage that they should be optimal in some profit-maximizing sense, if interpreted correctly, because they are obtained from profit-maximizing agents. They might therefore possibly be closer to the true unobserved inflation expectations (see e.g. D'Amico, Kim, & Wei, 2008, for bias in consumer survey measures). In addition, being obtained from high-frequency financial data inflation expectations from BEIRs are available at monthly and even daily frequency - giving another advantage over survey measures, most of which tend to be available at quarterly or even lower frequency.

However, to extract inflation expectations from BEIRs care must be taken to account for risk premia. In particular, the yield on a nominal bond contains a premium for the risk that inflation changes unexpectedly, which leads the BEIR to overstate inflation expectations *ceteris paribus*. Conversely, the yield on an inflation-linked bond probably contains a premium for liquidity risk, which results in an understatement of inflation expectations when looking at the pure BEIR *ceteris paribus*. Therefore it is essential that one correctly adjusts the BEIR for both premia. This is typically done either in elaborate no-arbitrage models of the term structure possibly combined with some macro variables (see e.g. D'Amico et al., 2008), in joint no-arbitrage linearized macro models (see e.g. Hördahl and Tristani, 2007 and Hördahl and Tristani, 2010) or in more reduced form approaches (e.g. Söderlind, 2009).

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[1] Both coupon and principal payments on TIPS are linked to the urban not-seasonally adjusted US CPI. For a comprehensive introduction to index-linked bonds in the Euro Area see Garcia and van Rixtel (2007). For the US see Gürkaynak, Sack and Wright (2008).

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In this paper we follow the reduced-form approach combined with some very basic structure and assess different methods to adjust break-even rates for liquidity and inflation risk premia. However, we base our analysis on the structural Fisher equation that helps us interpret the relevant risk premia and therefore extract inflation expectations. We believe this mix of reduced-structural approaches is particularly appropriate for studying BEIRs where there is a lot of knowledge and information about the behaviour of financial markets, but where there is much less consensus about how to appropriately model the entire macroeconomy. Basing our method on the widely accepted Fisher equation allows us to use some basic structure, whilst at the same time remaining agnostic as to how the rest of the economy behaves.

Our paper provides some key innovations to the literature. First, we explicitly study the behaviour of inflation and liquidity risk premia in some detail in a fairly model-free environment. Second, to get a feeling for the importance of these risk premia when extracting inflation expectations from BEIRs we carry out preliminary regression analysis where we rely on survey measures of inflation expectations as proxy for true inflation expectations. Third, and most importantly, we propose a new approach to extract inflation expectations from TIPS based on a state-space model to correct BEIRs for both risk premia. Our proposed approach avoids the use of survey-based measures of expected inflation to extract the risk premia.

This is an important improvement for central banks: First, it can serve as a cross-check to the survey measures and it might arguably give a more direct measure of *market*-participants' inflation expectations. Second, because our analysis uses monthly data it delivers inflation expectations that are available to the policy maker at higher frequency than survey measures.[2]

Our results show a considerably lower volatility of expected inflation from autumn 2008 onwards than the unadjusted BEIR would suggest. Accounting for inflation and liquidity risk premia thus seems indeed crucial in making correct inference about inflation expectations from TIPS. Finally, we provide an evaluation of the forecasting performance of the different state-space model specifications. Interestingly, our benchmark model outperforms other standard measures of inflation expectations.

In a recent paper, Söderlind (2009) discusses inflation risk premia and how to extract inflation expectations from BEIRS. It is worth highlighting the main differences to our paper. First, his sample period ends in autumn 2008, while we use data up to mid-2009. This way we can demonstrate that our method is robust to and particularly useful for explaining the recent turmoil period. Moreover, he uses individual uncertainty in the SPF about inflation and real growth as well as disagreement among respondents as proxies for a time-varying inflation risk. In contrast, we use the standard deviations of headline and core inflation. The major difference, however, is that we go beyond survey-based measures and extract expected inflation from TIPS using the Kalman filter on a state-space model. Besides, whilst his focus is on understanding the factors moving the inflation risk premium, we step back and start by firstly looking at the inflation risk premium as such and how it can best be used in extracting information on expected inflation from BEIRs.[3]

Our paper is structured as follows. Section 2 provides a decomposition and discussion of break-even rates into the risk premia and expected inflation. In Section 3 we present empirical measures for time-varying liquidity and inflation risk premia. To get a first understanding of how these measures distort the pure BEIR and how we then need to correct for the premia Section 4 carries out preliminary regression analysis. Section 5 sets up our state-space model and presents new results for estimates of expected inflation. In Section 6 we look at the forecast performance of the different approaches, while Section 7 concludes.

2. Decomposing break-even rates: accounting for inflation and liquidity risk-premia

All our empirical estimations rest on the fundamental Fisher equation that is well known in the literature. The basic version of the Fisher equation relates the riskless nominal yield to the riskless real yield of a bond with the same maturity and similar other characteristics and a term for average expected inflation per annum over the holding period of the bond.[4] Arbitrage by investors in perfect financial markets is thought to equalise these two rates of return:

$$i_t = r_t + E_t\bar{\pi}_{t,t+10} \quad (1)$$

The practical problem in calculating inflation expectations from equation (1) is, however, that we neither observe the riskless rate i_t nor r_t directly. Instead what we observe in actual financial markets with possibly risk-averse investors is the risky yield on a 10-year nominal US Treasury note, i_t^{T-note}, which is in fact given by:

$$i_t^{T-note} = r_t + E_t\bar{\pi}_{t,t+10} + \rho_t^{\pi} \quad (2)$$

where ρ_t^{π} is a possibly time-varying *inflation risk premium* because a risk- averse investor not only wants to be compensated with the expected rate of inflation in addition to the real yield, but demands a compensation for bearing the risk that realised actual inflation might turn out very differently from expected inflation. In other words the investor in the nominal bond demands an inflation risk premium for bearing inflation risk.

On the other hand an investor in a TIPS-bond of the same maturity will most likely demand a *liquidity risk premium* for the fact that the TIPS-market is much less liquid than the market for nominal Treasuries. Thus the investor might, in case of liquidity needs, not necessarily always find a buyer of his TIPS-bond when he wants to sell it or would have to accept a lower price. The observed real yield on TIPS is therefore given by:

$$r_t^{TIPS} = r_t + \rho_t^{LRP} \quad (3)$$

Note that in fact $\rho_t^{LRP} = \rho_t^{LRP/TIPS} - \rho_t^{LRP/T-notes}$ is a measure of the *relative* liquidity premium of TIPS over nominal (off-the-run) T-notes, while ρ_t^{π} is, strictly speaking, the *relative* inflation risk of T-notes over TIPS. However, the inflation risk in TIPS is likely to be negligible as it mainly stems from the time lag in the price index measure with which the principal is adjusted at maturity. We therefore concentrate on the relative liquidity risk in both bonds and assume that only T-note yields contain a practically relevant inflation risk premium.

Combining Eqs. (2) and (3) one obtains the following expression for the nominal yield:

$$i_t^{T-note} = r_t^{TIPS} + E_t\bar{\pi}_{t,t+10} + \rho_t^{\pi} - \rho_t^{LRP} \quad (4)$$

[2] Whilst we use monthly data in our estimations for reasons given below, our approach should in principle also work with daily data.

[3] As a logical next step we would then be concerned with the question of what moves inflation expectations. This is left for future research.

[4] We use constant maturity 10-year yields in all our analysis.