The Quarterly Review of Economics and Finance 53 (2013) 125–139

Contents lists available at SciVerse ScienceDirect

The Quarterly Review of Economics and Finance

journal homepage: www.elsevier.com/locate/qref

# New tips from TIPS: Identifying inflation expectations and the risk premia of break-even inflation

Zheng Zeng*

*Bowling Green State University, United States*

ARTICLE INFO

*Article history:*
Received 18 February 2012
Received in revised form 3 February 2013
Accepted 27 February 2013
Available online 17 March 2013

*JEL classification:*
G12
C32
E43
E31

*Keywords:*
Treasury inflation protected security
Break-even inflation
Inflation expectation
Risk premium
Common factor model
ARCH

ABSTRACT

This paper decomposes the break-even inflation rates derived from inflation-indexed bonds into inflation risk premia, liquidity risk premia, and inflation expectations. I estimate a common factor model with autoregressive conditionally heteroscedastic (ARCH) errors that extracts co-movements from twenty-two monthly and quarterly indicators to identify these three components. The results indicate that the sharp declines in the 10-year and 5-year break-even inflation rates in 2009 reflect a substantial increase in liquidity risk rather than a decrease in inflation expectations. Break-even inflation rates underestimate inflation expectations over nearly the entire sample due to the liquidity risk premia carried by the inflation indexed bond yields. Also, the model-implied inflation expectations show better forecast performance for the average annual inflation rates than raw break-even inflation rates, the Survey of Professional Forecasters, and the Surveys of Consumers inflation forecasts.



## 1. Introduction

In 1997, the U.S. Treasury began issuing Treasury Inflation Protected Securities (TIPS),[1] whose coupon and principal payments are indexed to the Consumer Price Index for All Urban Consumers (CPI-U) inflation rates. As the market for TIPS grew substantially, the prices of these securities became a rich source of information for academic researchers and market participants (Bernanke, 2004). In particular, the yields on these "real bonds" are considered to have direct implications for real interest rates. The yield differential between nominal treasuries and TIPS, or the so-called break-even inflation, has often been used as a proxy for inflation expectations.

However, this differential can be more complicated than it appears. Even if we assume investors are exposed to zero default (real) risk from holding treasuries, a nominal treasury yield still includes an inflation risk premium as well as the real rate and expected inflation rate. TIPS yields contain no inflation risk[2] but do carry a liquidity risk premium due to liquidity differences between the nominal and TIPS markets. Generally speaking, this liquidity risk stems from the costs to purchase or sell the security in a secondary market. In treasury markets, an investor who needs to make portfolio adjustments before the maturity of a treasury security will consider some likely costs associated with trading. The costs common to both nominal treasuries and TIPS holders, such as brokerage fees and commissions, are unimportant. Other costs that relate to the ease and convenience of matching buyers and sellers can be quite different for these two markets. Even though it has been expanding, the TIPS market is still relatively new and has low market depth compared to the market for nominal treasuries. The average daily trading volume of the entire TIPS market in 2010 was 6.45 billion dollars, only 1/40 of the trading volume for nominal treasury securities with maturities of less than 10 years.

* Correspondence address: Department of Economics, Bowling Green State University, Bowling Green, OH 43403, United States. Tel.: +1 419 372 8397.
*E-mail address:* zzeng@bgsu.edu

[1] Initially they were called Treasury Inflation Protected Securities (TIPS) but later the name was changed to Treasury Inflation Indexed Securities (TIIS). I use "TIPS" in this paper.

[2] In fact, TIPS are indexed to CPI-U with a 3-month indexation lag. They are technically not real bonds and carry a small amount of inflation risk. My model takes this indexation lag into account.

1062-9769/$ – see front matter 
http://dx.doi.org/10.1016/j.qref.2013.02.005

This relatively low depth of the TIPS market might correspond to a non-negligible liquidity risk premium.

In order to be used as a proxy for inflation expectations, break-even inflation rates need to be adjusted for inflation and liquidity risk premia. There of course exist studies in the literature that attempt to make such adjustments. However, accounting for unknowns due to liquidity risk, inflation risk, and inflation expectations proves difficult in one model, so most of the studies choose to ignore either the liquidity risk premium (Grishchenko & Huang, 2008; Hördahl, 2008; Joyce, Lildholdt, & Sorensen, 2010; Shen, 1998) or the inflation risk premium (Shen, 2006). Carlstrom and Fuerst (2004) is the first paper that considers both inflation risk and liquidity risk premia. However, two assumptions are made in their model: First, the inflation risk premium is assumed to be constant. Second, the liquidity risk associated with holding TIPS is assumed to be an increasing function of the liquidity risk associated with holding nominal treasury securities. That is, if there is no liquidity risk in the nominal treasury market, then there will be no liquidity risk in the TIPS market. As previously mentioned, ignoring the liquidity risk associated with the TIPS market relative to the nominal treasury market results in inaccurate measures of inflation expectations. In mid-2008, break-even inflation rates dropped rapidly and even went below zero. Instead of indicating an extremely low level of expected inflation, this severe decline was likely due to a sharp rise in the liquidity risk premium required to invest in TIPS over nominal treasuries, because liquidity tends to be a big concern during economic crises when investors need to frequently adjust their portfolios. This relative change in the liquidity risk premium was not captured by the Carlstrom and Fuerst model, which provided negative expected inflation beginning in mid-2008.

In this paper, I seek an alternative method to identify the unobserved liquidity and inflation risk premia contained in the break-even inflation rates and thus the implied expected inflation. I estimate a common factor model using twenty-two monthly and quarterly indicators. Given indicators of each unobservable (state) variable, a common factor model can identify the unknown states by capturing the co-movements of these indicators. In particular, each unobservable state is a linear combination of these indicators. One is able to estimate the weight (the coefficient) of each indicator in this linear combination and filter the unobservable factors (state variables) based on the proposed evolution of each state and interactions among them. In the common factor model proposed in this paper, the unobservable states are the expected inflation, the inflation risk premium, and the liquidity risk premium. A break-even inflation rate is an indicator of all three unobservable states.

The research that comes closest to what I undertake in this paper is Kajuth and Watzka (2011), who decompose break-even inflation rates into inflation expectations, inflation risk and liquidity risk premia using linear state space modeling. The model that I use in this paper differs from Kajuth and Watzka (2011) in that I allow inflation expectations and the risk premia to enter the model as three unobservable factors, while Kajuth and Watzka (2011) estimate a single-factor model with inflation expectations as the only state variable. More importantly, in this paper I allow nonlinear interactions between inflation risk and expected inflation. Although it is reasonable to let the liquidity risk premium be a linear combination of its indicators (as in Shen, 2006), the same assumption is not suitable for identifying inflation risk. For example, current (actual) inflation rates often indicate both expected inflation and inflation risk, but the relation between current inflation and inflation risk should not be described using a linear function. The source of inflation risk is the unpredictability of inflation, which can be defined as the gap between actual and expected inflation. The more stable the unexpected inflation, the lower the risk, and vice versa. Therefore, inflation risk should be measured using the volatility of the unexpected inflation, which is not a linear function of current inflation rates. Accordingly, I set up a common factor model with ARCH disturbances. Specifically, the model includes CPI inflation, which consists of a permanent (trend) component and a temporary (cyclical) component.[3] Assuming rational expectations, the conditional means of the trend and cyclical components reflect inflation expectations. The time-varying conditional variances of both components measure the inflation risk that a nominal bond may carry. The ARCH model, in which higher volatilities are triggered by larger levels of innovations, is chosen to model time-variant volatility, so that the inflation risk reflects only the new information (shocks) from the unexpected change of inflation.

I apply the methods of Maximum Likelihood Estimation (MLE) and Kalman filter to estimate model parameters and the unobservable states. The results show that the estimated liquidity risk premium rose smoothly following the 2000 stock market crash, remained low from late 2005 to late 2007 when the economy experienced an expansion, and jumped sharply following the subprime mortgage crisis in 2008. During the 2008–2010 Great Recession, the liquidity risk premium increased dramatically as investors frequently adjusted their portfolios. The steep declines in the 10-year and 5-year break-even inflation rates in 2009 (which fell below zero) are due to this significant rise in liquidity risk, rather than lowered inflation expectations. In fact, the result shows that the break-even inflation rates underestimate inflation expectations over nearly the entire sample. Note that Pflueger and Viceira (2011) also find that the average inflation risk premium carried by U.S. TIPS is smaller than the liquidity risk premium over their sample.[4] The only time period when the break-even inflation rates overestimate the expected inflation is between late 2005 and late 2006, when housing prices peaked and the economy experienced an expansion. High inflation risk triggered by the real estate bubble caused the inflation risk premium to exceed the liquidity risk premium, and, hence, resulted in break-even inflation overstating inflation expectations. Kajuth and Watzka (2011) also find that inflation risk spikes substantially during this period. Additionally, the estimated inflation risk from my model rises during the oil crisis of late 2003 to early 2004.

Once the model-implied inflation expectation at each horizon is obtained, I compare its forecast performance with the raw break-even inflation rates and other inflation forecast survey data. I find that the model-implied inflation expectations outperform all proposed survey forecasts and break-even inflation rates at 3-month, 6-month, 9-month, 1-year, and 5-year forecast horizons.

The rest of the paper is structured as follows: Section 2 presents the yield curves of nominal bonds and TIPS as well as the implied structure of break-even inflation. This background introduction provides theoretical support for my model. Also, the CPI inflation decomposition using the trend-cycle model as well as the interactions between expected inflation and inflation risk are introduced. In Section 3, I present a common factor model with ARCH disturbances, the selection of indicators, and the restrictions imposed on the factor loadings. Section 4 summarizes the empirical results and Section 5 concludes.

[3] Using this trend-cycle model to decompose inflation is well-known in the literature, e.g., Harvey (1989, 1990, 1993), Koopman, Harvey, Doornik, and Shephard (2000), and Stock and Watson (2007).

[4] The data sample in Pflueger and Viceira (2011) is similar to what I use in this paper. It runs from April 1999 to December 2009.