Can TIPS Help Identify Long-Term Inflation Expectations?

By Pu Shen and Jonathan Corning

Investors and policymakers have long hoped that Treasury Inflation Protected Securities (TIPS) would provide an accurate measure of long-term market inflation expectations. To make informed decisions and to ensure that inflation does not erode the purchasing power of their assets, investors need to assess the rate of inflation expected by other market participants. Having an accurate measure of market inflation expectations can also help policymakers assess their effectiveness in controlling long-term inflation, as well as their credibility among market participants. Until recently, however, the only sources of information about long-term inflation expectations were surveys and the term structure of interest rates, neither of which were considered highly reliable. With the introduction of TIPS in 1997, it was hoped that a new measure of market inflation expectations—the difference in yields between conventional Treasuries and TIPS—would become available.

The yield difference between conventional Treasuries and TIPS may provide an accurate measure of market inflation expectations because inflation has very different effects on the returns to the two kinds of securities. The yield on a conventional Treasury must compensate the buyer for any expected erosion in purchasing power due to future inflation. In contrast, the buyer of an inflation protected Treasury need not worry about future inflation because the principal and interest payments are both

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indexed to inflation. As a result, the yield difference between conventional and inflation protected Treasuries of given maturity should reveal the rate of future inflation expected by market participants.

Not everyone agrees, however, that the yield difference provides an accurate measure of expected inflation. Skeptics point out that the yield difference may depend on other factors, such as the liquidity difference between the two kinds of Treasuries, making it difficult to extract information about market inflation expectations.

This article examines the empirical evidence on the behavior of the yield difference and the liquidity of the TIPS market. The article finds that the yield difference has not provided a good measure of market inflation expectations because of the large and variable liquidity premium on TIPS. Still, the yield difference may become a better measure of market inflation expectations as liquidity conditions in the two kinds of Treasury markets move closer in the future.

The first section of the article explains why the yield difference between conventional Treasuries and TIPS might provide a good measure of market inflation expectations. The second section examines the actual behavior of the yield difference since TIPS were introduced and points out that the yield difference appears to be influenced by factors other than market inflation expectations. The third section investigates the role of market liquidity and concludes that the difference in liquidity between the two types of Treasuries has kept the yield difference from becoming a good measure of expected inflation. The fourth section suggests that the yield difference between conventional and inflation protected Treasuries may approximate market inflation expectations better in the future.

I. WHAT ARE YIELD SPREADS AND MIGHT THEY TRACK MARKET INFLATION EXPECTATIONS?

As TIPS are relatively new to many investors, this section briefly describes their main features. The section then examines the different components of the yield difference, or spread, between conventional and inflation protected Treasuries. The section shows that the expected rate of future inflation is the main component of the yield spread. The section also shows, however, that other components, such as the inflation

risk premium and the liquidity premium may also be important, complicating the task of extracting information about market inflation expectations.

What are TIPS?

Since 1997, the U.S. Treasury has been issuing debt instruments, the payoffs of which are tied to the inflation rates during the lives of the instruments. They are called Treasury Inflation Protected Securities, as they protect investors from the risk of unexpected inflation.[1]

The first indexed Treasury was issued in January 1997, with a maturity of ten years. Since then, the U.S. Treasury has regularly issued 10-year TIPS every January and sold additional quantities of the January issue later in the year.[2] The Treasury has also issued TIPS with 5-year and 30-year maturities, but with less regularity.[3] Currently, there are about $135 billion worth of TIPS outstanding, compared with more than $2.8 trillion worth of conventional Treasuries. Thus, TIPS constitute less than 5 percent of the total outstanding value of Treasuries.[4] Within the universe of indexed Treasuries, 10-year TIPS make up more than half of the outstanding total.

The most important feature of TIPS is that investors in these Treasuries are protected from the risk of unexpected inflation. To understand this, first it is helpful to appreciate the inflation risk embedded in conventional Treasuries. In a conventional Treasury security, the coupon rate is fixed at a nominal rate at the auction. Consequently, the nominal return to holding such a Treasury to maturity is fixed at the time of purchase.[5] As what matters to investors is the purchasing power of their investment, investors focus on the *real* return, which is the difference between the nominal return and the inflation rate during the life of the investment. For example, if an investor buys a 10-year conventional Treasury at its par value with a coupon rate of 6 percent, and inflation turns out to average 2 percent for the next ten years, then the real return on this investment is 4 percent. On the other hand, if inflation turns out to be 4 percent, then the *real* return is only 2 percent.[6] In other words, an investor in conventional Treasuries is exposed to inflation risk in the sense that the real return is inversely related to the actual rate of inflation during the life of the security.

In contrast to conventional Treasuries, the real return to investors on a TIPS is fixed at auction time and is unaffected by the actual rate of inflation during the life of the security. This happens because the coupon rate on an indexed Treasury is fixed in real terms, and the dollar value of the principal grows with inflation over the life of the TIPS. For example, in January 2001, the U.S. Treasury issued a 10-year indexed security with a coupon rate of 3.5 percent. If an investor buys this security at par in January and holds it to maturity, and if actual Consumer Price Index (CPI) inflation turns out to average 2.5 percent in the next ten years, the real return to the investor is 3.5 percent even though the average nominal yield is 6 percent.[7] If instead, inflation turns out to average 5 percent, the investor's real return is still 3.5 percent, although the nominal yield is 8.5 percent. In both scenarios the real yield, or the rate of return to the investor in terms of purchasing power, is identical and unaffected by inflation.[8]

Why is expected inflation a component of the yield spread?

The difference between the quoted yields on a conventional and an indexed Treasury security with similar maturity is usually referred to as the yield spread between the two securities. In the bond market, the commonly quoted yield on a conventional Treasury is the nominal yield, while the most commonly quoted yield on an indexed Treasury is the real yield.[9] Therefore, yield spreads are differences between nominal yields and real yields.

In a world where investors are indifferent to risks, only expected real yields matter. In such a world, yield spreads mainly reflect the average rate of future inflation expected by bond market participants, that is, the market inflation expectation, which is sometimes called expected inflation. Investors will always purchase the Treasury with a higher real yield, causing prices to adjust, which results in both nominal and indexed Treasuries ending up with the same expected real yield. In this world, the yield spread is an accurate measure of expected inflation. That is,

$$y^n - y^r = \pi^e ,$$

where y^n is the nominal yield on a 10-year conventional Treasury, y^r is the real yield on a 10-year indexed Treasury, and ^{e} is the average of market participants' expected rates of future inflation for the next ten years.

In this world, the yield spread provides a quick, reliable, and timely measure of expected inflation, which is highly valuable to consumers, investors, as well as policymakers. Accurate measures of market inflation expectation are difficult to come by. Before the existence of the inflation protected Treasuries, the most commonly used measures of expected inflation were forecasts based on survey responses. But survey measures of expected inflation only cover a very small portion of the population and are updated infrequently. Further, such measures may not be completely reliable if survey respondents answer questions casually. In contrast, the yield spread is based on investment decisions of large numbers of investors who risk their own money for such decisions. Further, this information is updated every day when financial markets are open and trading occurs freely. Thus, in a world in which investors care only about expected real yields, yield spreads should be a better measure of market inflation expectations than survey forecasts.[10]

Why the yield spread may have other components

In the real world, other factors may affect yield spreads because investors may care about more than just the expected real yields. In particular, one thing investors may care about besides the expected real yield is *inflation risk*. This is the risk that the real return on a security turns out to be different from what investors expected because inflation turns out to be higher or lower than expected. As noted earlier, TIPS have no inflation risk. In contrast, a conventional Treasury can have considerable inflation risk because the real return on such a security moves inversely with the actual rate of inflation during the life of the security. As a result, a conventional security will generally have to carry a higher expected real yield than an indexed Treasury just to be equally attractive to investors. This additional yield is usually called the *inflation risk premium*, as it is a premium to compensate investors for taking on the risk.

Another thing investors may care about besides the expected real yield is *liquidity risk*. The liquidity risk of an asset is the risk that investors may incur large costs buying or selling the asset in a secondary

market. The need to raise cash or make other portfolio adjustments may force an investor to buy or sell a security in the secondary market. As a result, investors need to consider the likely costs associated with such trading. Some of the costs are known, such as brokerage fees and commissions. These kinds of costs are ignored in the discussion, as investors tend to face similar brokerage fees and commissions for trading conventional and indexed Treasuries.[11] Other costs are related to the ease and convenience of trading, which are more uncertain in nature. For example, for less liquid assets, a seller of a large-dollar value of securities may have to accept a lower price to complete the sale in a timely fashion. Since the probability of incurring such costs is inversely related to the liquidity of the asset, the less liquid asset carries higher liquidity risk. Consequently, the less liquid asset needs to carry a higher compensating yield in order to attract investors. This additional yield is commonly referred to as a *liquidity premium*.[12]

Liquidity risk is more relevant to investors in TIPS than to investors in conventional Treasuries. As the market for conventional Treasury securities is the most liquid asset market in the United States, the liquidity risk for conventional Treasuries can be considered to be zero.[13] The market for TIPS, on the other hand, is less liquid. As a result, it is likely that part of the yield on an indexed Treasury is a liquidity premium.

In this more realistic world where investors are concerned about risk, the yield spread between a conventional and an indexed Treasury is no longer an accurate measure of market inflation expectation. The yield spread now equals: (1) the expected inflation rate over the life of the security, plus (2) the inflation risk premium on the conventional Treasury, minus (3) the liquidity premium on the TIPS. More formally, the yield spread is

$$y^n - y^r = \pi^e + p(\pi) - p(l),$$

where $p(\pi)$ is the inflation risk premium on the conventional Treasury, and $p(l)$ is the liquidity premium on the indexed Treasury.[14]

In this world, the yield spread can be higher or lower than expected inflation. If the inflation risk premium exceeds the liquidity premium, the yield spread will be higher than expected inflation. If, on the other hand, the inflation risk premium is smaller than the liquidity premium, the yield spread will be lower than expected inflation. Only when the

inflation risk premium is the same size as the liquidity premium will the yield spread equal the expected rate of inflation. Note, however, that if both premia are small relative to expected inflation, their difference will be even smaller, and the yield spread will be a close approximation of expected inflation. Furthermore, even if the yield spread is an inaccurate measure of expected inflation, the change in the spread may still be a good measure of the change in market inflation expectations. This will be the case if both the inflation risk premium and the liquidity premium are roughly constant over time.

II. HOW CLOSELY DO YIELD SPREADS TRACK MARKET INFLATION EXPECTATIONS?

This section examines actual data to show how well the yield spread and the change in the yield spread perform as measures of market inflation expectations. First, examination of the level of yield spread since the inception of TIPS reveals that the level is generally lower than the plausible level of expected inflation. Next, examination of the changes in the yield spread shows that the changes appear to be too volatile to reflect only changes in expected inflation.

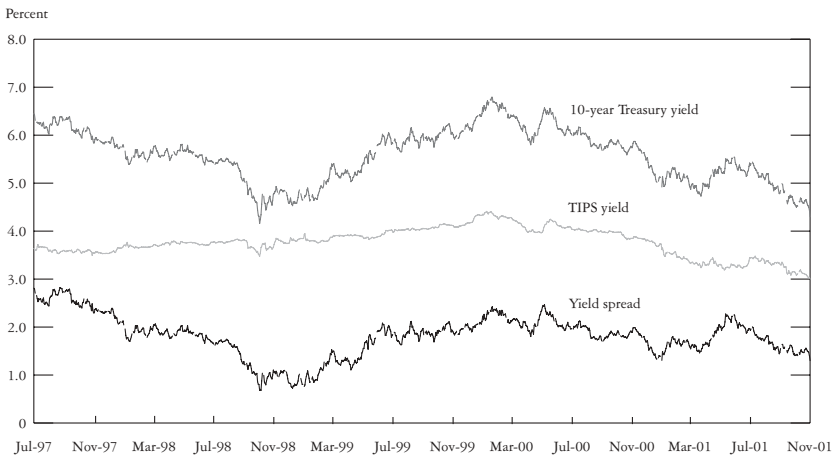
Is the level of the yield spread a good proxy for expected inflation?

To evaluate the yield spread as a measure of inflation expectations, we focus on the yield spread between the most active 10-year conventional and inflation-indexed Treasuries.[15] Ten-year conventional Treasury notes are auctioned regularly by the U.S. Treasury, and the secondary market for those securities is well developed and very liquid. Ten-year indexed Treasury notes are also the most liquid within the universe of TIPS. Chart 1 shows the nominal yield on the 10-year conventional Treasury note, the real yield on the 10-year TIPS, and the yield spread, from July 1997 to November 2001.[16]

Comparison of yield spread with actual inflation. In principle, one way to evaluate how well yield spreads approximate market inflation expectations would be to see how well the spreads forecast actual inflation. The idea is that expected inflation should be a good forecast of actual future inflation. Thus, any proxy for market inflation expectations

Chart 1

YIELDS ON 10-YEAR CONVENTIONAL VS. INDEXED TREASURIES



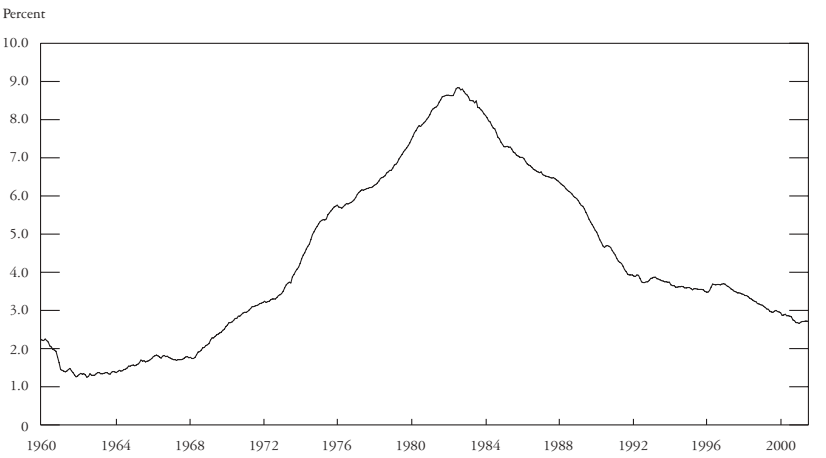
Source: Board of Governors

should also be a good forecast of actual future inflation. Market inflation expectations should be a good forecast of inflation because they are an average of market participants' forecasts. Since investors suffer financial losses when their forecasts err, it seems reasonable to assume that market participants will try to forecast future inflation as accurately as possible. Further, while an individual investor's forecast may deviate widely from the actual outcome, the market average of all individuals' best efforts should produce a reasonably good forecast.[17]

Unfortunately, the short history of TIPS makes it difficult to assess the performance of the spread as a forecast for inflation. If several decades of data were available, it would be a simple matter to look back over the period and statistically compare the ten-year forecast with realized ten-year average inflation. However, with less than a five-year history, we are still more than five years away from knowing the actual average of inflation over the ten-year period starting in 1997. As it stands, the elapsed four-and-a-half-year period is just too short for a meaningful comparison.

Chart 2

10-YEAR AVERAGE CONSUMER PRICE INDEX INFLATION



Source: Bureau of Labor Statistics

There are, however, some alternatives to comparing the yield spread to realized inflation that might be useful in judging the predictive ability of the yield spread. The most obvious approach is to use *past* inflation rates to get a sense of some realistic ranges for *future* inflation. What have the historical averages of CPI inflation been over ten-year periods since 1950?[18] These decade averages are computed monthly and plotted in Chart 2. Each data point in the chart represents the actual average inflation rate for the past ten years ending at that month. For example, the data point for September 1998 is 3.18 percent, which means that the ten-year average CPI inflation rate from October 1988 through September 1998 was 3.18 percent. Over the period of more than 50 years, we can calculate about 500 overlapping monthly averages of actual ten-year inflation rates, with the first average starting at January 1960.

Compared with the experience of the past 50 years, it appears that yield spreads have been predicting exceptionally low inflation for the ten-year period ahead. As shown in Chart 2, the actual ten-year average inflation rate has exceeded 2.5 percent for the last 30 years and has

never fallen below 1.0 percent. In stark contrast, the yield spread has been well below 2.5 percent during most of the short history of TIPS. As Chart 1 shows, the yield spread started out quite wide, at slightly lower than 3 percent, but then narrowed rapidly to a low of 0.84 percent at the end of 1998. From there the spread increased but never came close to crossing the 2.5 percent level. In fact, the gap narrowed again to a local low of 1.5 percent in December 2000. Clearly the spread has been predicting much lower rates of inflation than have been experienced over most of the last 50 years.[19]

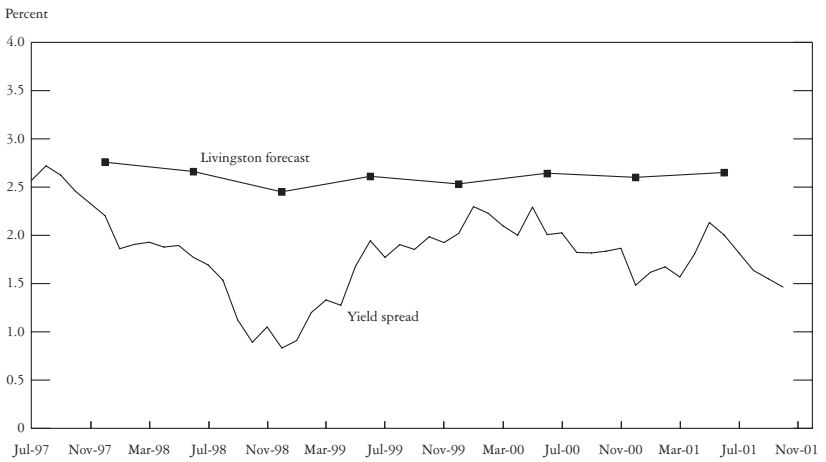
While the forecast of future inflation based on yield spreads appears to be unrealistically low compared with historical experience, the possibility cannot be ruled out that the future inflation outlook may be different from historical averages. For example, market participants may believe that the Federal Reserve has learned from experience, so that inflationary episodes of the past will not recur. An example of such an episode is the late 1970s and early 1980s, when double-digit annual inflation pushed the ten-year averages above 5 percent. Such inflationary episodes have not been repeated, suggesting that they should perhaps be excluded in estimating the most likely range of future inflation.[20]

Comparison of yield spreads with survey forecasts. How does the yield spread as a measure of expected inflation compare with other forward-looking forecasts, such as survey based forecasts? As noted earlier, survey based forecasts are subject to the criticisms that the survey respondents may represent only a small portion of the population, may be surveyed infrequently, and may answer questions casually instead of giving their best efforts. Nevertheless, comparing the yield spread to survey forecasts may provide additional evidence on how reasonable the spread is as a measure of expected inflation.

One widely followed inflation forecast is based on the Livingston Survey of economists in industry, government, banking, and academia, which is maintained by the Federal Reserve Bank of Philadelphia. Twice a year, the participants forecast the ten-year-ahead level of the CPI as well as many other economic variables. The consensus of the Survey forecast for CPI inflation is plotted in Chart 3, as is the level of the yield spread. It is immediately clear that the yield spread bears little relation to the future average inflation rate projected by the consensus of the survey. Throughout the period, the yield spread was consistently lower than the

Chart 3

LIVINGSTON TEN-YEAR INFLATION FORECAST VS. THE YIELD SPREAD



Sources: Federal Reserve Bank of Philadelphia and Board of Governors

rate of inflation predicted by the consensus of the Livingston Survey. The difference ranges from a high of 1.61 percentage points in December 1998 to a low of 0.5 percentage point one year later. For the period as a whole, the survey participants' forecast of ten-year inflation averaged 2.61 percent, while the yield spread averaged only 1.74 percent.

Have changes in the yield spread been good proxies for changes in expected inflation?

As noted at the end of the first section, even if the liquidity premium is much bigger than the inflation risk premium, *changes* in the yield spread may still approximate *changes* in market inflation expectations if both premia are stable over time. In principle, one way to determine if changes in the yield spread reflect changes in expected inflation would be to see if they do a good job of forecasting changes in actual inflation. As was true for the level of the spread, however, TIPS have not been around long enough to perform such an exercise. The best that

can be done is to look at changes in the yield spread to see if they have been about the right magnitude—that is, neither too small nor too big to plausibly reflect changes in inflation expectations.

One way to determine if changes in the yield spread are about right is to see whether changes in the yield spread are similar in size to changes in survey forecasts. For the Livingston Survey, the average absolute annual change in the ten-year consensus inflation forecast has been only 0.17 percentage points throughout the past decade. In contrast, the average annual change in the TIPS yield spread from July 1997 to July 2001 has been 0.66 percentage point. For example, the Livingston forecast edged down from 2.76 percent at the end of 1997 to 2.45 percent a year later and then crept back up to 2.53 percent by the end of 1999. Over the same period, the yield spread changed much more dramatically, from 2.46 percent in late 1997 to an astonishing low of 0.89 percent a year later, only to climb back to 2.00 percent at the end of 1999. Compared with changes in the survey forecast, the yield spread appears to be too volatile to be a reliable proxy of changes in expected inflation.

Another reason for doubting that changes in the yield spread are a good proxy for changes in expected inflation is that the fundamental factors affecting the long-term inflation outlook are unlikely to fluctuate back and forth to the same degree the yield spread has. Federal Reserve monetary policy determines the rate of inflation in the long run. Therefore, a perceived increase in the Federal Reserve's commitment to price stability would likely lead to a decline in long-term market inflation expectations. In contrast, a reduction in the Federal Reserve's inflation fighting credibility would likely be associated with an increase in long-term inflation expectations. It is difficult to argue, however, that there were fundamental changes from late 1997 to 1998 that vastly improved the credibility of the Federal Reserve. It is even more difficult to argue that other fundamental changes led to a comparable deterioration in the Federal Reserve's credibility in the following year.

To summarize, it appears that the level of the yield spread does not approximate expected inflation, nor do changes in the yield spread approximate changes in expected inflation. The level of the yield spread has been lower than both the historical average of inflation and survey forecasts of future inflation, suggesting that the liquidity premium on TIPS is larger than the inflation risk premium on conventional Trea-

suries. Further, changes in the yield spread appear too big to be due solely to changes in expected inflation, suggesting that either the liquidity premium or the inflation risk premium varies considerably over time.

III. CAN THE LIQUIDITY PREMIUM EXPLAIN THE POOR PERFORMANCE OF YIELD SPREADS AS A MEASURE OF EXPECTED INFLATION?

This section examines liquidity in more detail. First, it focuses on the liquidity difference between conventional Treasuries and TIPS. Then it examines the yield difference between the most liquid and some less liquid conventional Treasuries. The liquidity premium on TIPS is likely both sizable and highly volatile, suggesting that it is largely responsible for the poor performance of the yield spread in approximating either the level of expected inflation or the change in expected inflation.

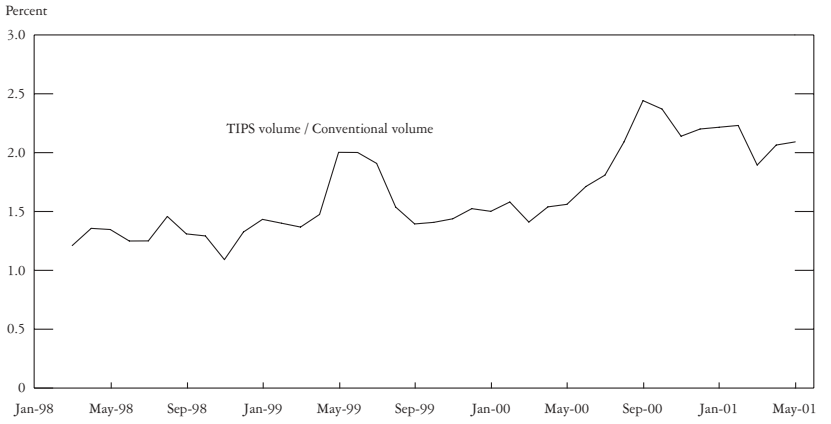
What do differences in trading volumes between conventional Treasuries and TIPS reveal?

Trading volume is much lower for TIPS than conventional Treasuries, suggesting that the TIPS market is considerably less liquid. The secondary market for conventional U.S. Treasuries is one of the most active financial markets in the world. Billions of dollars of conventional Treasuries are traded every day.[21] In contrast, the trading volume for TIPS is small due to their limited availability and their unfamiliarity to investors, who have been able to purchase and trade them only since 1997. As shown in Chart 4, in 1998 the monthly trading volume of TIPS was usually only about 1.3 percent of the trading volume of conventional Treasuries.[22] The ratio has since increased but is still very small, at around 2 percent.

The big difference in trading volumes between conventional and indexed Treasuries may be a good indicator of their relative market liquidity for two reasons. First, it is generally easier for investors to adjust their individual positions in a security with higher trading volume, because their trading actions are less likely to have an adverse impact on the price of the security. Second, high trading volume may itself be a result of higher liquidity in the underlying market. This is due to the fact

Chart 4

RATIO OF TRADING VOLUMES OF INDEXED AND CONVENTIONAL TREASURIES



Notes: Data are ratios of 3-month centered moving average volumes. Conventional volumes are for Treasuries with 5-year or more coupon maturity, and TIPS volumes are for all TIPS.

Sources: Board of Governors and authors' calculations

that, everything else equal, investors are more likely to trade in an asset that they perceive to have a more liquid market in order to save on liquidity costs. Thus, the enormous disparity in trading volumes between conventional Treasuries and TIPS suggests that investors perceive TIPS to be considerably less liquid than conventional Treasuries, and may thus require a sizable compensating liquidity premium to hold TIPS.

The disparity in trading volume between TIPS and conventional Treasuries also varies considerably over time, suggesting that the liquidity premium on TIPS may also be highly variable. As shown in Chart 4, the ratio of trading volumes can fluctuate by as much as 25 percent within a few months. For example, during the height of the financial market crisis in the fall of 1998, the ratio of trading volume plummeted from around 1.3 percent to about 1 percent, due to both increased trading in conventional Treasuries and reduced trading in TIPS. This drop suggests that investors' appreciation of liquidity risk may have changed significantly during the crisis. Indeed, the yield spread between conven-

tional and indexed Treasuries reached its lowest point in the fall of 1998, which was consistent with a sharp increase in the liquidity premium on TIPS.

What does the liquidity premium on less liquid conventional Treasuries reveal?

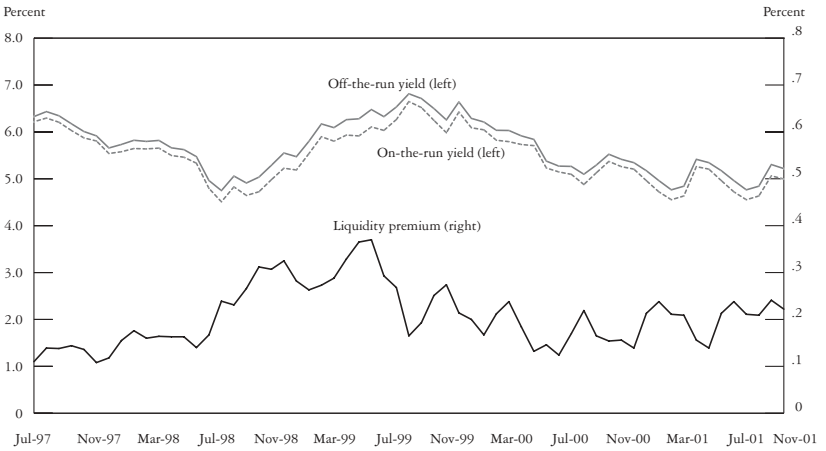
It is difficult to directly quantify the liquidity premium in the yield spread between conventional Treasuries and TIPS because the spread also depends on market expected inflation and inflation risk. A lower bound for the liquidity premium on TIPS can be determined by examining the liquidity premium on less liquid *conventional* Treasury securities. As it turns out, sizable differences in yields exist among conventional Treasury securities with a similar time to maturity and newly issued securities that are highly liquid bearing lower yields than less liquid, "aged" securities.

In the previous discussion, yield spreads were calculated using the yields of "benchmark" conventional and indexed 10-year Treasuries. A benchmark 10-year Treasury is the most recently auctioned 10-year Treasury, which is also called an "on-the-run" issue. A previously auctioned Treasury is called an "off-the-run" Treasury. Considerable differences exist between the market liquidity of on-the-run and off-the-run Treasuries. Typically, on-the-run Treasuries are traded the most and enjoy the most liquid market. An off-the-run Treasury, even though it may be identical in terms of maturity and cash flow to an on-the-run Treasury, is traded less frequently and therefore has lower market liquidity. For example, an off-the-run 30-year Treasury auctioned 20 years ago will be less liquid than a recently issued on-the-run 10-year Treasury.

Because on-the-run and off-the-run conventional Treasuries with similar time to maturity are almost identical except for their liquidity, the yield difference between the two types of Treasuries provides a clean measure of the liquidity premium built into off-the-run conventional Treasuries. The top of Chart 5 shows the average yields of 10-year off-the-run Treasuries and of 10-year on-the-run Treasuries. The bottom of the chart shows the yield difference, which is basically the liquidity premium on off-the-run Treasuries.[23]

Chart 5

YIELDS OF ON-THE-RUN VS. OFF-THE-RUN CONVENTIONAL TREASURIES



Source: Board of Governors

The liquidity premium on off-the-run conventional Treasuries has ranged between 0.1 and 0.4 percentage point since mid-1997. Before 1998, the liquidity premium was a little above 0.10 percentage point. During the height of the financial crisis in the fall of 1998, the liquidity premium increased to twice its pre-crisis average.[24] The premium remained large over the next year, but fell somewhat in 2000.[25] The average liquidity premium before the fall of 1998 was 0.14 percentage point, while the average since then has been about 0.23 percentage point, more than 50 percent higher. Many analysts believe that market participants have a new appreciation of liquidity risk after observing the events in the fall of 1998, and that consequently the liquidity premium on many financial assets has increased. The evidence in Chart 5 is consistent with this view.

The liquidity premium for off-the-run conventional Treasuries provides a lower bound for the liquidity premium in TIPS, since TIPS are even less liquid than off-the-run conventional Treasuries. Specifically, Chart 5 suggests that the average liquidity premium on TIPS has been at least 0.23 percentage point since the fall of 1998. Unfortunately,

accurate data are unavailable on the relative trading volumes of TIPS and off-the-run Treasuries. However, there are good reasons for believing that TIPS are considerably less liquid than off-the-run Treasuries, so that the liquidity premium on TIPS exceeds the lower bound of 0.23 percentage point by a substantial margin. First, TIPS are relatively new, which means they are less familiar to investors than off-the-run Treasuries and less likely to be traded frequently. Second, TIPS are the only security free from inflation risk, which means no other security is directly comparable to them. This uniqueness makes TIPS more difficult to use in hedge transactions than off-the-run Treasuries, reducing their trading volume still further.[26]

The fact that the liquidity premium on off-the-run Treasuries varies considerably over time suggests that the liquidity premium on TIPS is also highly variable. Liquidity conditions in individual asset markets tend to evolve independently in the long run. In the short run, however, a common factor can cause large, simultaneous changes in liquidity in many separate asset markets. To the extent such broad disturbances account for the high volatility in the off-the-run liquidity premium, the TIPS liquidity premium should be highly volatile as well. Additional support for this view comes from the fact that monthly changes in the yield spread between conventional Treasuries and TIPS have been highly correlated with monthly changes in the off-the-run liquidity premium. Over the period shown in Chart 5, for example, the correlation coefficient between the two variables was slightly more than 0.5, which is a relatively high number.

Changes in the liquidity premium on off-the-run Treasuries can also provide valuable insight into specific changes in the TIPS yield spreads. As noted earlier, the spread between conventional Treasuries and TIPS plunged during the financial market crisis in the fall of 1998. As shown in Chart 5, the liquidity premium on off-the-run Treasuries more than trebled at the same time, as investors flew to safety and market liquidity deteriorated for almost all assets except on-the-run Treasuries. The fact that the yield spread decreased and the off-the-run liquidity premium increased at the same time reinforces the evidence from trading volumes that the drop in the yield spread during this episode was mainly due to an increase in the TIPS liquidity premium.[27]

To summarize, the evidence on relative trading volumes and the evidence on the yield difference between on-the-run and off-the-run conventional Treasuries both suggest there is a large and volatile liquidity premium on TIPS. It seems likely that this liquidity premium has been largely responsible for the yield spread being a poor measure of market expected inflation.

IV. CAN YIELD SPREADS STILL BE USEFUL FOR ASSESSING INFLATION EXPECTATIONS?

The large and variable liquidity premium in indexed Treasury securities appears to have diminished the reliability of the yield spread as an indicator of market inflation expectations. This does not mean, however, that the yield spread will never provide useful information about inflation expectations. Even now, the yield spread may still provide insight into market inflation expectations when complemented by other independent information. Further, as time goes on, the liquidity difference between conventional and indexed Treasuries is likely to become smaller, reducing the liquidity premium on TIPS and improving the accuracy of the yield spread as a measure of expected inflation.

As suggested in the previous section, one important case in which independent information can be used to improve inferences from the yield spreads about expected inflation is when liquidity premia are observed to increase on a broad range of assets. In the fall of 1998, for example, the liquidity premia on financial assets other than on-the-run Treasuries were increasing. In such circumstances, it would have clearly been unwise to interpret the decline in the yield spread between the conventional and indexed Treasuries as evidence that expected inflation had fallen. In other times, however, we may observe declines in the yield spread without any noticeable changes in the liquidity premia on other assets. In these instances, the decline in the yield spread is likely to be an indication that expected inflation has decreased.

In the future, the continuing reduction in liquidity differences between conventional and indexed Treasuries should also improve the usefulness of the yield spreads. The ratio of trading volumes of TIPS to conventional Treasuries has been trending upward (Chart 4). Several factors have contributed to this trend and should continue to reduce the

liquidity differences between the two types of Treasuries over time. First, as investors become more familiar with inflation indexed Treasuries, their confidence and understanding will grow, leading to greater demand for and trading in TIPS. Second, because only conventional Treasuries are presently maturing, the total volume of outstanding TIPS relative to the total volume of outstanding conventional Treasuries continues to increase.[28] Such an increase in outstanding volume leads to a deeper and more liquid market, reducing the liquidity disparity between the two kinds of Treasuries. Finally, the simple mechanics of indexing causes the principal of TIPS to grow at the rate of inflation while the principal of conventional Treasuries remains fixed. This causes the total dollar volume of TIPS outstanding to grow relative to the total dollar volume of conventional Treasuries, which again deepens the TIPS market and reduces the liquidity premium on TIPS.

The experience of the UK (see appendix for more details) supports the view that the gradual increase in the liquidity of indexed bonds will reduce the liquidity premium in the yield spread between conventional and indexed securities. The indexed government debt market in the UK is still somewhat less liquid than the conventional government debt market. However, the trading volume for indexed government debt is usually more than one-tenth the trading volume for conventional government debt, suggesting that the liquidity difference there is much smaller than in the U.S. Furthermore, the yield spread is typically higher than survey forecasts of inflation, implying that in contrast to the U.S., the liquidity premium on indexed debt is smaller than the inflation risk premium on conventional debt. Such evidence offers hope that the liquidity of TIPS will improve and that the liquidity premium may eventually become small enough for the yield spread to provide valuable information about inflation expectations.

V. CONCLUSION

The yield spread between conventional and inflation indexed Treasuries contains useful information about market expectations of future inflation. The task of disentangling this information has been complicated, however, by other components in the yield spreads—in particular, the inflation risk premium on conventional Treasuries and the

liquidity premium on indexed Treasuries. The liquidity premium has been especially important, causing the yield spread to understate market inflation expectations. The liquidity premium has also been highly volatile, causing the yield spread to vary too widely to reflect only changes in inflation expectations. Nevertheless, if current trends continue, indexed Treasuries should become more liquid and the liquidity premium should gradually decline, allowing the yield spread to more closely approximate market inflation expectations. Even if this happens, though, the yield spread may never be a perfect measure of expected inflation because both the inflation risk premium and the liquidity premium may still vary over time. As a result, it will always be advisable to combine yield spreads with other information to best estimate market expectations of future inflation.

APPENDIX

What Can We Learn from the UK Experience?

In 1981 the Bank of England began issuing government debt instruments that protect investors from the adverse effects of inflation by indexing both the principal and coupon payments to inflation. Called index-linked Gilts, these bonds pay a prespecified real coupon rate and adjust the cash flow for changes in the General Index of Retail Prices (RPI). By comparing the RPI at the time of the payment with the RPI when the bond was issued, the return to investors is adjusted for changes in the general price level.[29]

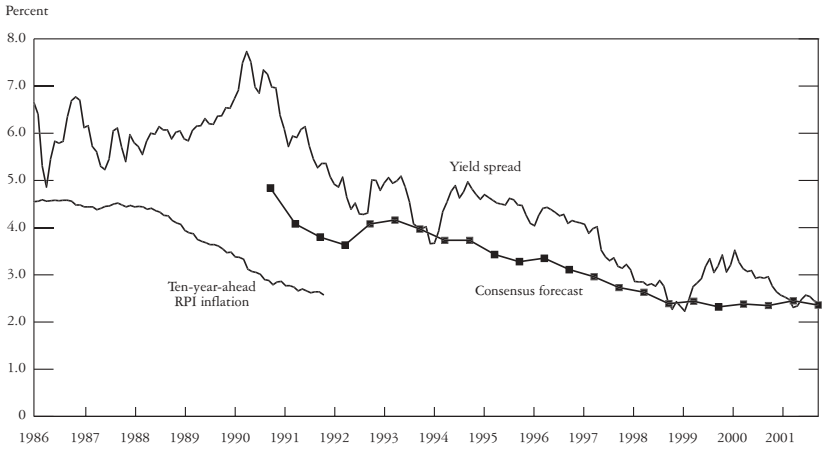
Because index-linked Gilts have been in existence far longer than TIPS, they provide a useful reference against which to compare the performance of the TIPS spread as a measure of expected inflation. Until 1991, for example, it was possible to directly compare the 10-year Gilt yield spread to realized average inflation for the following ten years. In contrast, the short history of TIPS makes it impossible to compare the TIPS spread with realized ten-year inflation.

The appendix chart shows the Gilt yield spread, realized ten-year average inflation, and the survey-based forecast of inflation compiled by Consensus Economics Inc. In sharp contrast with the U.S. experience, the UK yield spread has been consistently higher than either the actual realization of inflation or the forecast of inflation based on survey data. This suggests that in the UK, the inflation risk premium on conventional bonds dominates the liquidity premium on indexed bonds, and that the liquidity difference between conventional and indexed government bonds is much smaller there.

Data on trading volumes provide additional evidence that the liquidity difference between indexed and conventional bonds is smaller in the UK than the United States. In recent years, the ratio of the trading volume of indexed Gilts to that of conventional Gilts has usually been more than 10 percent. In contrast, the ratio of trading volumes for indexed and conventional U.S. Treasuries has ranged from 1 to 2½ percent. One reason there is less disparity in trading volumes in the UK is that the UK began issuing indexed debt earlier. As a result of this ear-

Appendix Chart

THE UK EXPERIENCE WITH INDEX LINKED GILTS



Sources: Bank of England, Consensus Economics Inc., and National Statistics

lier start, indexed debt constitutes a much larger portion of government debt in the UK—around 30 percent compared with less than 5 percent for the United States.

The fact that the yield spread in the UK appears to generally *exceed* expected inflation due to the inflation risk premium might seem to reduce the usefulness of the yield spread as indicator of market inflation expectations. For monetary policymakers, however, the distinction between an increase in market inflation expectations and an increase in the inflation risk premium may not be that important, as they both point to weakened public confidence in the central bank's ability to control inflation.[30] Therefore, for central banks, the variability of the inflation risk premium is less problematic than the variability of the liquidity premium because the knowledge of the change of the sum of inflation expectation and the inflation risk premium is as useful as the knowledge of the change in inflation expectation alone.

To summarize, the experience of the UK suggests that if the U.S. Treasury keeps issuing inflation indexed Treasuries and their liquidity continues to improve, the liquidity premium will decline over time.

That should allow the yield spread to better approximate market expected inflation, at least in noncrisis times.

ENDNOTES

[1] TIPS are officially called Treasury Inflation Indexed Securities (TIIS).

[2] For example, the first 10-year TIPS was issued in January 1997, with a total issuance of $7 billion. The issuance was "reopened" in April of the same year, at which time an additional $8 billion was auctioned off. Shen (1995), and Dupont and Sack provide detailed explanations of TIPS. Additional details can be found on the Treasury Department website, http://www.treasurydirect.gov/bpd/bpdhome.htm.

[3] On October 31, 2001, the Treasury suspended future auctions of both conventional and indexed 30-year Treasury securities.

[4] The numbers are based on the monthly statement of public debt at the end of September 2001, which can be found at http://www.treasurydirect.gov/opd/opdhisms.htm. Excluding debt instruments with maturities of less than one year (Treasury bills), the share represented by TIPS rises to 7 percent. Note that the ratio of the outstanding value of TIPS to the outstanding value of conventional Treasuries is higher than the ratio of *par* values because the principal of TIPS grows with inflation.

[5] In most of the article, we focus on the yield to maturity. If a debt instrument is sold before its maturity, its return may differ from the yield to maturity.

[6] The effects of inflation are especially serious when the security has a long maturity. For example, many investors bought 40-year Treasury bonds issued in 1955, which had a fixed nominal coupon rate of 3 percent. Because inflation averaged 4.4 percent for the next 40 years, investors who bought this bond at full price and held it to maturity *lost*, in terms of purchasing power, more than 43 percent in real terms. In other words, for every dollar investors lent to the government in 1955, all the interest payments and principal redemption in the following 40 years amounted to a total of less than 57 cents in terms of 1955 purchasing power.

[7] Strictly speaking, it is the average inflation from November 2000 to October 2010 that should be used in the calculation as the Treasury uses the CPI with a three-month lag when making the inflation adjustment.

[8] The discussion in the text ignores the effect of income tax. As income tax is levied on nominal investment incomes, all non tax-exempt investors are exposed to some inflation risk, including investors in TIPS. Nevertheless, the inflation risk is still smaller to TIPS investors than to investors in conventional Treasuries. For a detailed discussion of the tax effect, see Shen (1995).

[9] Nominal (real) yield is calculated by using the nominal (real) coupon rate of the Treasury and the market price for the par principal, assuming it is held to maturity.

[10] Another group of measures of market expected inflation use statistical models and observations on the term structure of interest rates. These measures, however, often provide a wide range of estimates and rely heavily on many explicit and implicit assumptions, making the results difficult to interpret.

[11] For example, the fee for selling both conventional and indexed Treasuries held in Treasury Direct accounts through the Federal Reserve Bank of Chicago is $34.

[12] Yet another risk associated with selling a debt instrument before its maturity is price risk. Theoretically, the price risk of an indexed Treasury can either be higher or lower than that of a conventional Treasury. For an indexed Treasury, the main price risk is due to changes in the market prevailing real interest rate. For a conventional Treasury, price risk can be caused by either changes in the real inter-

est rate or changes in market expected inflation. On one hand, conventional Treasuries may have higher price risk as their values are exposed to more kinds of risk. On the other hand, a given change in the real interest rate tends to have a bigger impact on the price of an indexed Treasury, because the cash payments of an indexed Treasury are more back-loaded. The empirical evidence in the UK government debt market suggests that the first effect outweighs the second, causing the price risk of an inflation indexed security to be lower than that of a conventional one (Shen 1998).

[13] The third section shows that the liquidity risks of different conventional Treasuries differ enough so that it is sometimes useful to distinguish among them.

[14] An additional complication is that the market for conventional Treasuries and the market for TIPS may serve two very different investing clienteles, which means that the yield difference may reflect differences in the expectations of the two groups. This factor may have been particularly important when the TIPS market was small and relatively new. As time goes by, presumably the clientele effect should decline as more and more investors get familiar with the market.

[15] As the spread is based on securities with different vintages, there may be a slight maturity difference between the conventional and inflation-indexed Treasuries. For example, in December, the yield on the TIPS issued in January of the same year is the yield on a security with nine years and one month to maturity. In contrast, the yield on the conventional Treasury has been adjusted so that it has exactly ten years to maturity.

[16] Although TIPS were first introduced in January 1997, the first few months of data are likely of poor quality because TIPS were a new instrument to the market. During this time, the market may have needed to adjust to and learn about the new security. For example, TIPS yields were initially low because of both high demand due to their novelty and small supply.

[17] For reasons why the average of all forecasts may be better than most individual forecasts, see Granger and Newbold (pp. 266-67).

[18] Various measures of inflation are available. This article focuses on CPI inflation is because TIPS are indexed to the CPI.

[19] While it is still too early to compare the yield spread with realized inflation, we can compute how low future inflation will have to be for the earlier forecast to be accurate. For example, the average yield spread was 1.53 percent in 1998. Actual inflation from 1998 to 2001 has averaged about 2.6 percent. Therefore, inflation from 2002 to 2007 will have to average only 0.8 percent for the forecast of yield spreads to hold.

[20] An alternative way to evaluate the yield spread as a measure of expected inflation is to compare the yield spread to recent inflation. Statistically, this approach is equivalent to assuming that future average inflation will be the same as the average of recent realized inflation. This approach also suggests that the yield spread has been too low to be a reasonable forecast of inflation.

[21] There are, however, still important differences in liquidity among conventional Treasuries, in particular, between those that are newly issued and those that are "aged." Later in the section, these differences will be explored.

[22] The ratio in Chart 4 uses the volume of conventional Treasuries with coupons due in more than five years. This is the relevant measure because available TIPS volume data include all maturities, most of which are greater than five years.

[23] These yields were kindly provided by Brian Sack at the Federal Reserve Board of Governors, who used off-the-run notes and bonds to create an off-the-run yield.

[24] The crisis started when Russia defaulted on its sovereign debt in late August and was further intensified by the near default of a hedge fund, Long Term Capital Management, in late September. The deterioration of financial market functions continued until mid-October. Market conditions gradually improved in November and December and the crisis was largely over by the spring of 1999.

[25] The yield difference declined sharply in February 2000, when investors suddenly came to the realization that an ever expanding federal budget surplus would render all Treasury securities scarce, including both on-the-run and off-the-run. The announcement of a Treasury buy-back program may also have helped the liquidity of some off-the-run securities.

[26] See Sack for a useful discussion of liquidity conditions in Treasury markets.

[27] Another way to exploit information on the off-the-run liquidity premium is to compute the yield spread using the yield on off-the-run Treasuries rather than the yield on on-the-run Treasuries. This alternative approach was used by Sack, who also adjusted in his study for the small difference in duration between 10-year TIPS and conventional Treasuries. This article ignores the issue of duration because first, as Sack showed in his study, it made little difference. Second, the concept of duration is not particularly applicable to inflation indexed securities (Shen, 1995).

[28] The first TIPS to mature were issued in July 1997 as a 5-year security. The next TIPS to mature were issued in January 1997 as a 10-year security. In addition, the Treasury could conceivably make a concerted effort to reduce the TIPS liquidity premium still further by increasing the quantity and frequency of new TIPS issues. Currently, new issues are heavily skewed toward conventional Treasuries. A slight shift toward increased TIPS issuance would be relatively easy to implement and would help to reduce the liquidity disparity between the two.

[29] Actually, the RPI figures used are from the month eight months prior to the relevant date. This lag allows for the time lag in the release of the RPI data and ensures that the nominal value of the next coupon payment is known before the start of that period. This long lag weakens the inflation protection for Gilts that are approaching their maturity. In contrast, the U.S. TIPS are indexed to CPI lagged by only three months.

[30] The Bank of England has regularly used the yield spread as one of the indicators to its credibility of meeting the inflation target. Deacon and Derry provide useful background information and many technical details. Barr and Campbell provide empirical analysis of the yield spread.

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