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ARE TREASURY INFLATION PROTECTED SECURITIES REALLY TAX DISADVANTAGED?

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Abstract

In 1997, the U.S. Treasury introduced Inflation Protected Securities, commonly known as TIPS. Several in the finance field have since described these securities as "tax disadvantaged" relative to conventional securities, leading to serious questions regarding their appropriateness outside of tax-deferred accounts. In this article, we develop a framework that demonstrates that at least in a real sense the tax treatment of TIPS is trivially different from that of conventional Treasury securities. Moreover, empirically we find evidence that TIPS generally have after-tax yields comparable to, if not exceeding, conventional fixed-rate Treasury securities. We also show that TIPS have generally outperformed matched-maturity conventional Treasury securities in terms of after-tax rates of return.

JEL Classification: E4, E6, G1, G2, H2

I. Introduction

Treasury Inflation Indexed (or "protected") Securities, commonly known as TIPS, have existed in the United States since 1997. Despite their growing longevity and importance in financial markets, researchers hold conflicting views about the influence of their unique tax treatment on investors. On the one hand, several studies examine the performance of TIPS without mention of their tax treatment. For example, Sacks and Elsasser (2004) compare yields on conventional Treasury securities and yields on TIPS to provide evidence that TIPS yields have been historically high given forecasts of inflation. It is difficult to imagine a similar comparison between conventional Treasury debt and, say, municipal debt. Thus, the relative comparison suggests that Sacks and Elsasser do not see a major difference in the tax treatment of

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TIPS and conventional Treasury securities. Similarly, Campbell, Chan, and Viceira (2003) argue that adding TIPS to traditionally diversified portfolios has significant diversification benefits, over and above portfolios absent inflation protection. As the authors give no special consideration to the tax issue of TIPS versus other investments, they presumably see no tax-related reason to avoid TIPS in diversifying taxable accounts.

On the other hand, many suggest that TIPS have serious tax disadvantages. For example, Reinhart and Keeling (2004) argue that TIPS should be held in tax-deferred accounts rather than taxable accounts because TIPS investors pay tax on increases in principal. Livingston (2002), Fabozzi (2000 a, b), Van Horne (2001), and Sundaresan (2002) all indicate that TIPS have serious tax disadvantages, for various reasons.[1]

The purpose of this article is to address this contradiction by asking if TIPS are truly tax disadvantaged in the United States. The issue is complex in that the tax treatment regarding TIPS is unique. At the same time, we stress that the more relevant question is a relative one: Are TIPS taxed in a manner that makes them less attractive to taxable investors than the alternatives available? The discussion centers primarily on the tax treatment of TIPS in isolation. Here, we emphasize the relative comparison and show that TIPS are not tax disadvantaged relative to the alternatives available, at least under traditional assumptions about inflation and nominal interest rates. We further document that in the past, even with the tax treatment of TIPS in place, there would have been no reason for taxable investors to prefer conventional Treasury securities to TIPS from the perspective of maximizing expected after-tax yields. Finally, we show that investors who had purchased TIPS would have received higher after-tax yields than investors who acquired conventional Treasury securities with a similar maturity.

II. Background

The fundamental difference between TIPS and the Treasury's conventional debt is that TIPS have a fixed real coupon rate and conventional securities have a fixed nominal coupon rate, both of which are fixed at issuance. The Treasury adjusts the principal on TIPS semi-annually by the amount of inflation over the prior six-month period (with a slight lag). Therefore, the nominal coupon payments, equal to the product of the real coupon rate and the inflation-adjusted principal, grow with inflation. By design, these securities provide a hedge against inflation, and the real yield (equal to the real coupon rate) is essentially constant and established at issuance.

[1]This view has spilled into the popular press as well (e.g., see Rekenthaler 2003, p. 44; Clements 2003).

Because of their inflation indexing, the Internal Revenue Service (IRS) has outlined a unique tax treatment for these instruments.[2] Essentially, the ruling indicates that taxes on TIPS must be paid annually on both the interest income and the accrued increase in principal caused by inflation, even when this latter element is an unrealized gain. Therefore, the owner is required to pay taxes on "phantom income" that is not actually received until maturity or upon sale of the bond. This tax treatment has led several leading authorities to characterize TIPS as "tax disadvantaged."

An example of this argument is provided by Clements (2003). He assumes an investor in a 35% tax bracket buys an inflation-protected bond with a real yield of 2.3%. With realized inflation of 4.7%, the nominal yield becomes 7%. After taxes, the investor's nominal yield falls to 4.55%, below the 4.7% inflation rate. Hence, Clements argues that the tax inefficiency leads to a negative after-tax real return.

Clements's (2003) calculations are correct. The TIPS would indeed have a negative after-tax real return in this setting. However, Clements fails to consider other alternatives. Instead, suppose the hypothetical investor chose a conventional security as opposed to TIPS. If we assume that the expectations of inflation are realistic, the nominal yield on the conventional security should be approximately 7% under Fisher assumptions (2.3% real return plus 4.7% compensation for expected inflation, ignoring any cross-product term). The investor would be required to surrender 35% of the annual nominal yield for tax purposes; therefore, he or she would again be left with approximately the same after-tax yield of 4.55%. In other words, TIPS would be no more tax disadvantaged in this situation than the nominal Treasury securities. Those who argue that TIPS are tax disadvantaged essentially ignore how and when inflation is "taxed" for alternative nominal debt instruments. As inflation rises, along with expectations for future inflation, our tax code makes debt holders worse off if nominal rates rise one for one with expected inflation.

Indeed, Darby's (1975) and Feldstein's (1976) main point is that investors need to understand the taxation on inflation and therefore cause nominal rates to rise faster (by $1/(1-T)$) than increases in expected inflation. The central point is that if nominal yields reflect future expected inflation and the cross-product of the real rate and inflation, as in the Fisher framework, TIPS are not tax disadvantaged, at least relative to conventional securities. If the increase in TIPS principal due to inflation were not taxed, TIPS would dominate conventional Treasury securities. This would be the case because nominal interest, which contains an inflation mark-up, is what is taxed on conventional securities. The IRS ruling on TIPS assures that TIPS and conventional Treasury securities are essentially taxed similarly.

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[2]Parker and Vines (2003) provide details on the tax treatment of TIPS as specified by the IRS.

Roll (2004) also provides evidence inconsistent with the notion that TIPS are tax disadvantaged and that taxable investors are better off avoiding them. When Roll regresses changes in (before-tax) real yields on TIPS on changes in the inflation term structure, he finds the coefficient estimates suggest a tax rate of 19% within the real yield responses for short-term TIPS. Therefore, increases in expected inflation lead to large increases in pretax real yields on TIPS. Thus, it appears that market participants price the tax treatment into TIPS in such a way that before-tax real yields increase with inflation sufficiently to cover the inflation-induced increase in taxes.

III. TIPS Versus Conventional Treasury Securities

Ex Post Performance Before Taxes

It is relatively straightforward to compare the ex post performance of TIPS with conventional Treasury debt on a before-tax basis. The basic tenet of the Fisher hypothesis is that the nominal yield on conventional debt is set to exactly compensate for anticipated inflation, thereby providing an acceptable real yield. Assuming that the expected real yield on TIPS equals the expected real yield on (otherwise similar) conventional debt, the difference between the two quoted yields will reflect expected inflation. If the debt is purchased at par, expected inflation will also be reflected by the difference in the coupon rates.[3] In fact, this was one of the arguments put forward by the U.S. Treasury and others as to why these instruments will be beneficial; they will provide indirect evidence on expected inflation. Now, when realized inflation exceeds (is below) expected inflation, the realized real return on fixed-rate debt will be below (above) the expected real yield. Because the real yield on TIPS is established at issuance, unanticipated inflation causes TIPS to outperform their nominal counterparts on a real before-tax basis. Just the opposite occurs when there is unanticipated disinflation or deflation.

Ex Post Performance After Taxes

To compare the ex post performance of TIPS and conventional securities after taxes, we begin by assuming that a one-period bond is purchased at par. The real after-tax return on conventional fixed-rate debt can then be represented as:

$$r_{FR} = C_{FR}(1 - T) - \pi, \tag{1}$$

where

[3] This assumes that the Fisher effect holds, ignoring the cross-product term, and that any inflation risk premium is zero.

r_{FR} = the real after-tax return on fixed-rate debt,
C_{FR} = the nominal coupon rate,
T = the ordinary income tax rate, and
π = the realized inflation rate.

In a similar manner, the real after-tax return on one-period TIPS can be represented as:

$$r_{TIPS} = (C_0)(1 + \pi)(1 - T) - (\pi)(T), \tag{2}$$

where

r_{TIPS} = the real after-tax return on TIPS,
C_0 = the constant real coupon rate and $(C_0)(1 + \pi)$ equals the realized nominal rate,
T = the ordinary income tax rate,
π = the realized inflation rate, and
$(\pi)(T)$ = the tax per \$1 par value due to inflation.

Equation (2) requires that taxes be paid on both the nominal coupon and the nominal increase in principal from inflation. This is what has led some to conclude that TIPS are tax disadvantaged.

Setting equation (1) equal to equation (2) and assuming zero inflation and an equivalent tax rate T applied to both securities, it can be easily shown that $r_{FR} = r_{TIPS}$ only if $C_{FR} = C_0$. That is, the real after-tax returns will be equal, at any T, when the nominal coupon on the fixed-rate security equals the real coupon on the TIPS security. This is consistent with the Fisher framework. With (nonzero) inflation, it can be shown that $r_{FR} = r_{TIPS}$ only if $C_{FR} = C_0 + \pi + C_0\pi$. We note that this relation is independent of the tax rate, as long as the two securities face the same tax rate, as is the case in the United States.

Thus, in this simple one-period setting, TIPS are not tax-disadvantaged relative to nominal instruments as long as the fixed-rate nominal coupon exceeds the TIPS real coupon rate by inflation plus the cross-product of the real rate and inflation. This analysis demonstrates that the difference in before-tax yields reflects the inflation expectations and taxation of the inflation component when the real after-tax yields are equal. The analysis further illustrates that the tax treatment of TIPS does not lead to lower after-tax performance when the market recognizes inflation and the cross-product term, in the manner of the Fisher framework. Moreover, because longer termed TIPS can be viewed as a series of one-period TIPS (just as Separate Trading of Registered Interest and Principal Securities (STRIPS) can be reconstituted to form long-term Treasuries), we can infer that what holds for the one-period setting should also hold for multiperiod settings with regard to tax discrepancies.

An alternative view of the relations between the tax treatment and the after-tax real yields across the two bonds is provided by rewriting equation (1) to allow explicitly for expectations in the Fisher hypothesis. For fixed-rate conventional bonds, we have:

$$r_{FR} = [E(C_{R,FR}) + E(\pi) + E(C_{R,FR}) \times E(\pi)](1 - T) - \pi, \tag{3}$$

where $E(\bullet)$ is the expectation operator, $C_{R,FR}$ is the real coupon rate on the fixed-rate bond, and all other variables are as previously defined. By setting the after-tax real return on TIPS equal to the after-tax real return on fixed-rate debt (i.e., by setting equation (2) equal to equation (3)), the following relation results:

$$(C_0)(1 + \pi) + \pi = E(C_{R,FR}) + E(\pi) + E(C_{R,FR}) \times E(\pi). \tag{4}$$

Equation (4) is then a sufficient condition so that the tax treatment of the two bonds does not influence the equilibration of their real, after-tax yields. Instead, the after-tax real yields will be equal when the sum of the nominal TIPS coupon and actual inflation equals the sum of the expected real fixed-rate coupon, expected inflation, and the cross-product term. From this we can conclude that a taxable investment account would receive no less benefit from holding TIPS than a fixed-rate bond.

From equations (1) and (2), we also know that an unanticipated increase in inflation ($\pi_U = \pi - E[\pi]$) will lead to a reduction in the real after-tax return on TIPS by $(\pi_U)(T)$, which is less than the reduction in the real after-tax return on fixed-rate debt, equal to π_U. Thus, TIPS will outperform fixed-rate debt on a real after-tax basis if actual inflation is higher than expected inflation.

IV. Empirical Evidence: After-Tax Yield Comparisons

In this section we directly compare TIPS and conventional Treasury securities on an after-tax basis in a multiperiod setting. This allows us to consider both the more relevant multiperiod comparison and, more important, to investigate whether tax treatments are priced in the marketplace. Municipal bonds are tax advantaged (relative to Treasury securities) for most taxable investors, but this does not mean that all taxable investors are better off investing in municipal bonds. The reason for this is that the difference in tax treatments is priced in the marketplace, causing the before-tax yields on municipal bonds to be lower than the before-tax yields on Treasury securities. If we assume that TIPS are tax disadvantaged, would a hypothetical taxable investor always be better off investing in conventional Treasury securities as opposed to TIPS of a similar maturity?

We use an after-tax nominal yield comparison because this is easily calculated and directly observable for conventional securities. Van Horne (2001) details

the way taxes affect yields of conventional fixed-rate instruments. To find after-tax nominal yields, Van Horne solves for the discount rate that equates today's security price with the present value of all nominal, after-tax cash flows. For a conventional fixed-rate bond that is held to maturity, Van Horne provides the following:

$$P_{FR} = \sum_{t=1}^{N} \frac{C(1-T)}{(1+R_{FR})^t} + \frac{(100-P_{FR})(1-G)}{(1+R_{FR})^N} + \frac{P_{FR}}{(1+R_{FR})^N}, \tag{5}$$

where

$C =$ the annual (nominal) coupon payment,
$T =$ the ordinary income tax rate,
$G =$ the capital gains tax rate,
$N =$ the number of years to maturity,
$P_{FR} =$ today's price ($100 par value), and
$R_{FR} =$ the nominal, after-tax yield that equates the above relation.

Equation (5) illustrates the calculation of after-tax nominal yields for conventional securities. The right-hand side of the equation is the present value of all after-tax nominal cash flows discounted by the after-tax nominal yield that provides the bond's price. The first term is the present value of all after-tax coupon payments. The second term is the present value of the after-tax capital gain (loss). The last term is the present value of the purchase price, which bears no tax obligation. The last two terms break the par value into two components: (1) the capital gain/loss, and (2) the purchase price. This separation is required by our tax code, which only taxes the capital gain (loss) component of the par value.

Now consider TIPS. Define $P_{A,t}$ to be the inflation-adjusted principal on a TIPS at time t. This can be written as $P_{A,t} = P_{A,t-1}(1 + \pi_t)$, where π_t equals the inflation rate (i.e., $\pi_t = CPI_t/CPI_{t-1} - 1$),[4] and $P_{A,0}$ is par at issuance. As long as one knows the Consumer Price Index for different points in time, the new accrued principal can be found. For the sake of simplifying the discussion, we ignore the complication that going forward one does not know with certainty the future course of the CPI and instead assume that future inflation equals anticipated inflation. This is highly unrealistic at one level, but investors must ask themselves what future inflation will bring when they are estimating nominal yields on TIPS.

Following Van Horne's (2001) development, we can solve for the nominal, after-tax yield for TIPS by equating today's TIPS price, P_{TIPS}, with the present value of all nominal after-tax cash flows:

[4]Here we ignore a slight two-month lag in the inflation adjustment calculation that TIPS require.

$$P_{TIPS} = \sum_{t=1}^{N} \frac{C_t(1-T)}{(1+R_{TIPS})^t} - \sum_{t=1}^{N} \frac{(P_{A,t} - P_{A,t-1})(T)}{(1+R_{TIPS})^t} + \frac{P_{A,N}}{(1+R_{TIPS})^N}, \quad (6)$$

where

$C_t =$ the time t nominal coupon payment; $C_t = (C_0)P_{A,t}$, where C_0 is the constant real coupon rate;
$T =$ the ordinary income tax rate;
$N =$ the number of years to maturity;
$P_{TIPS} =$ today's price;
$P_{A,t} =$ the inflation-adjusted principal on a TIPS at time t, where $P_{A,t} = P_{A,t-1}(1 + \pi_t)$ is defined earlier; and
$R_{TIPS} =$ the nominal, after-tax yield that equates the previous relation.

The right-hand side of equation (6) is the present value of all after-tax cash flows discounted by the after-tax nominal yield that provides the bond's price, assuming some pattern of future inflation. The first term on the right-hand side is the present value of the after-tax nominal coupon payments. The second term is the tax obligation on phantom income due to the inflation adjustment on the principal, and it therefore carries a negative sign.[5] Finally, the third term is the present value of the inflation-adjusted principal at maturity. Because the increase in the principal is taxed annually, there is no additional tax obligation associated with this last payment.

It is the taxation of the phantom income that leads some to suggest that TIPS are tax disadvantaged.[6] Equations (5) and (6), however, allow us to make two important points about this contention. First, the coupon payment for the conventional Treasury security, C, in the first term of equation (5) is a nominal cash flow that investors expect will compensate them for inflation via the Fisher hypothesis (and potentially for the taxation of inflation under the Darby 1975 and Feldstein 1976 framework). Therefore, if participants anticipate higher future inflation, C contains a greater inflation mark-up, which also results in higher nominal taxes. Because taxes on C must be paid annually, the tax treatment of fixed-rate debt securities also requires that taxes be paid annually on an inflation component. Because

[5] To the extent that there is no capital gains tax rate applied to increases in inflation-adjusted principal for TIPS, equation (6) might suggest a slight tax disadvantage relative to the after-tax yield of fixed-rate Treasury securities as described in equation (5). We provide empirical evidence later that this difference is minimal.

[6] With TIPS, a negative net cash flow will occur if the annual tax obligation exceeds the after-tax cash flows received during that year. Some suggest that this possibility represents an important part of the tax disadvantage argument. In the Appendix, we demonstrate that the likelihood of negative net cash flows, at reasonable values for coupon rates, inflation rates, and tax rates, is low. Furthermore, where a negative flow could occur, the values are very small.

the coupon rate on conventional, fixed-rate debt should be greater than the coupon rate on TIPS (by approximately $E(\pi)$ under the Fisher hypothesis, and by approximately $E(\pi)/(1 - T)$ under the Darby and Feldstein framework), the taxes paid every year on coupons over the life of the securities are, at a minimum, greater by $E(\pi)(T)$ on fixed-rate debt than the annual taxes on TIPS. This again suggests no tax disadvantage on TIPS. The inference in the single-period analysis generalizes to the multiperiod setting.

The second important point to consider for TIPS is that the annual taxation of phantom cash flows is offset by the inflation-induced gain in principal that is not taxed at maturity. Thus, there is no new net increase in tax obligations due to inflation for TIPS versus fixed-rate debt. It is simply that the tax obligation of the inflation mark-up comes annually. This treatment (as shown earlier), however, is not different from the annual taxation of the mark-up in the coupon for fixed-rate debt.

After-Tax Yields: Assuming Future Inflation Equals the Difference in Coupon Rates

We use equations (5) and (6) to calculate after-tax nominal yields for a matched sample of conventional Treasury securities and TIPS, respectively. We began with the 10 TIPS that existed at the end of 2002. For each TIPS, we then selected the closest maturity-date-matched/issuance-date-matched conventional Treasury security. Prices, coupon rates, and accrued principal on November 26, 2002, were taken from the *Wall Street Journal* (*WSJ*). Table 1 provides information on each of these securities (ordered by issuance date).

Consider the matched pair at the bottom of Table 1 maturing in July and August 2012. Both securities had been recently issued and were selling reasonably close to par. The July 2012 TIPS has a stated coupon rate of 3.00% and the *WSJ* listed the yield to maturity as 2.53% with accrued principal 1008 ($1,000 face). The August 2012 conventional Treasury note had a coupon rate of 4.375% and the *WSJ* listed the yield to maturity at 4.18%.

Of course, TIPS compensate the investor for future inflation as it occurs. Future inflation is uncertain, but as indicated earlier, to calculate an after-tax nominal yield for TIPS using equation (6), we must make an assumption about future inflation. In our first analysis, we use the difference in the coupon rates (conventional coupon rate less TIPS coupon rate) to reflect the market's expectation of future inflation. Thus, for the July/August 2012 matched pair, annual inflation was assumed to be 1.375% for the next 10 years.[7] We also assumed that all nominal

[7] A weakness with this approach stems from the fact that we are using (the difference in) coupon rates that were established at issuance (i.e., before November 2002) as inflation forecasts in November 2002. We address this potential problem in the next section when using survey inflation forecasts.

TABLE 1. Information on 10 Outstanding Treasury Inflation Protected Securities (TIPS) and Matched Conventional Fixed-Rate Treasury Securities.

Instrument	Issuance Date	Maturity	Coupon Rate	Reference CPI at TIPS Issuance
TIPS	January 1997	January 2007	3.375%	158.43548
Conventional	October 1996	October 2006	6.500%	
TIPS	January 1998	January 2008	3.625%	161.55484
Conventional	February 1998	February 2008	5.500%	
TIPS	April 1998	April 2028	3.625%	161.74000
Conventional	August 1998	August 2028	5.500%	
TIPS	January 1999	January 2009	3.875%	164.00000
Conventional	May 1999	May 2009	5.500%	
TIPS	April 1999	April 2029	3.875%	164.39333
Conventional	February 1999	February 2029	5.250%	
TIPS	January 2000	January 2010	4.250%	168.24516
Conventional	February 2000	February 2010	6.500%	
TIPS	January 2001	January 2011	3.500%	174.04516
Conventional	February 2001	February 2011	5.000%	
TIPS	October 2001	April 2032	3.375%	177.50000
Conventional	February 2001	February 2031	5.375%	
TIPS	January 2002	January 2012	3.375%	177.56452
Conventional	February 2001	February 2012	4.875%	
TIPS	July 2002	July 2012	3.000%	179.80000
Conventional	August 2002	August 2012	4.375%	

Note: For TIPS securities issued in January 1997, January 2000, and January 2001, the actual issuance date was delayed up to three weeks. The dates listed then correspond to the dating of the security for purposes of the reference Consumer Price Index (CPI) and coupon and principal payments.
Source: Bureau of Public Debt Online.

income was taxed at the ordinary income tax rate of 34%, and capital gains were taxed at 20%.[8] With these assumptions, and the security prices from the *WSJ,* we have all of the necessary elements to solve for R_{FR} in equation (5) and R_{TIPS} in equation (6).[9] The use of expected inflation, as we measure it, allows us to characterize the after-tax nominal yields as expected after-tax yields.

Table 2 provides the details of the after-tax nominal yields for the TIPS securities and for their matched conventional Treasury securities. We see in Table 2 that the after-tax nominal yield on the conventional Treasury security is higher than the after-tax nominal yield on the matched TIPS in 6 of the 10 pairs, with an average yield spread of 0.33%. In the 4 remaining matched pairs, however, the TIPS after-tax yield is higher, on average, by 0.515%. This average is heavily influenced by the large yield spread for the January 2007/October 2006-maturity pair, and without this pair the average spread is 0.23%.

[8]The overall implications of the findings remained the same with several alternative tax rates.
[9]The spreadsheets used are available from the authors.

TABLE 2. After-Tax Nominal Yields on Treasury Inflation Protected Securities (TIPS) and Matched Conventional Fixed-Rate Securities on November 26, 2002, Assuming Inflation Equals the Difference in Coupon Rates.

TIPS Maturity (Coupon Rate)	Conventional Treasury Maturity (Coupon Rate)	Expected Inflation	TIPS After-Tax Nominal Yield	Conventional Treasury After-Tax Nominal Yield
January 2007 (3.375%)	October 2006 (6.500%)	3.125%	2.96%	1.60%
January 2008 (3.625%)	February 2008 (5.500%)	1.875%	2.40%	1.89%
January 2009 (3.875%)	May 2009 (5.50%)	1.625%	2.32%	2.22%
January 2010 (4.25%)	February 2010 (6.50%)	2.250%	2.82%	2.42%
January 2011 (3.50%)	February 2011 (5.00%)	1.500%	2.52%	2.66%
January 2012 (3.375%)	February 2012 (4.875%)	1.500%	2.54%	2.76%
July 2012 (3.00%)	August 2012 4.375%)	1.375%	2.56%	2.86%
April 2028 (3.625%)	August 2028 (5.50%)	1.875%	3.10%	3.46%
April 2029 (3.875%)	February 2029 (5.25%)	1.375%	2.72%	3.48%
April 2032 (3.375%)	February 2031 (5.375%)	2.000%	3.16%	3.34%

Note: Expected inflation is estimated as the difference between the conventional Treasury coupon rate and the TIPS coupon rate. After-tax nominal yields are calculated using equations (5) and (6):

$$P_{TIPS} = \sum_{t=1}^{N} \frac{C_t(1-T)}{(1+R_{TIPS})^t} - \sum_{t=1}^{N} \frac{(p_{A,t} - p_{A,t-1})(T)}{(1+R_{TIPS})^t} + \frac{p_{A,N}}{(1+R_{TIPS})^N}$$

or

$$P_{FR} = \sum_{t=1}^{N} \frac{C(1-T)}{(1+R_{FR})^t} + \frac{(100-P_0)(1-G)}{(1+R_{FR})^N} + \frac{P_{FR}}{(1+R_{FR})^N}$$

to solve for R_{TIPS}, the after-tax yield on TIPS, and R_{FR}, the after-tax yield on conventional (fixed-rate) Treasury securities, respectively, based on the security prices on November 26, 2002, and assume a marginal ordinary income tax rate of 34% and a capital gains tax rate of 20%. In the calculations, future inflation is assumed to remain constant at the expected inflation number for the life of the TIPS.

To investigate whether November 26, 2002, was unusual, we went back to the *WSJ* in late November for 2001, 2000, 1999, and 1998 to find the current prices at these times for the existing TIPS and their maturity-matched conventional counterparts. Based on the prices of these securities we then calculated the respective after-tax yields using equations (5) and (6), as done in Table 2, again assuming that expected inflation was identical to the difference in nominal and real coupon rates on otherwise comparable Treasury securities. We do not report the specifics for each

of these years but instead note that the results are consistent with those reported in Table 2 (the details of these comparisons are available from the authors upon request). Examining all matched pairs for 1998, 1999, 2000, and 2001, we find that in 10 of the 22 comparisons the after-tax yield on the TIPS security is higher than the after-tax yield on its conventional counterpart. Overall, we find no evidence that investors should have expected the after-tax yields on TIPS to be substantially less than the after-tax yield on conventional Treasury securities. This evidence suggests that there is nothing unique about the November 2002 comparisons.

As a reminder, the calculations incorporate the TIPS tax disadvantage, as the TIPS investor is required to pay taxes on phantom income. The results suggest either that any tax disadvantage is inconsequential or that TIPS are being priced in the market to reduce the importance of the tax treatment so that anticipated after-tax yields are not substantially different across the two security classes. The evidence in Table 2 also suggests the possibility of some maturity/tax clientele effects. TIPS have the higher after-tax nominal yields for maturities of seven years or less, and conventional instruments have higher expected after-tax nominal yields for longer maturities. The fact that the after-tax yield difference (fixed rate less TIPS) widens with maturity is consistent with fixed-rate investors demanding higher nominal yields to compensate for a greater inflation risk premium, which TIPS investors need not be concerned about.[10] This pattern is also consistent with Roll's (2004) finding that the tax rate implied by long-term TIPS' real yield changes due to changing inflation was much lower than the tax rate implied for short-term TIPS. Roll suggests that this is sensible, as tax-exempt investors such as pension funds would be more likely to choose long-term versus short-term securities.

After-Tax Yields: Assuming Future Inflation Equals the Survey Forecast

In the preceding analysis we use the difference in the coupon rates as our inflation forecast over the remaining life of each of the TIPS. Because the coupon rates are established at issuance (and at a level so that the securities will issue near par value), the difference in the coupon rates is likely to be a better forecast of inflation at the issue date rather than in November 2002. To address this potential problem, we collected an alternative inflation forecast to use in equation (6). Specifically, we use the November 2002 consensus 10-year inflation forecast from the Federal

[10]Using equations (5) and (6), we also calculated for each of the pairs the breakeven inflation rate at which the after-tax nominal yield on the TIPS would equal the after-tax nominal yield on the conventional security. These breakeven inflation rates ranged from 2.47% for the pair maturing in February and April 2029 to 1.12% for the pair maturing in October 2006 and January 2007. Actual inflation rates above (below) the breakeven rate would result in the TIPS having a higher (lower) after-tax yield. For comparison purposes, we note that in November 2002, the consensus 10-year inflation forecast from the Federal Reserve Bank of Philadelphia survey was 2.43%.

TABLE 3. After-Tax Nominal Yields on Treasury Inflation Protected Securities (TIPS) and Matched Conventional Fixed-Rate Securities on November 26, 2002, Assuming Inflation Equals Survey Forecast.

TIPS Maturity (Coupon rate)	Conventional Treasury Maturity (Coupon Rate)	Expected Inflation	TIPS After-Tax Nominal Yield	Conventional Treasury After-Tax Nominal Yield
January 2007 (3.375%)	October 2006 (6.500%)	2.43%	2.50%	1.60%
January 2008 (3.625%)	February 2008 (5.500%)	2.43%	2.78%	1.89%
January 2009 (3.875%)	May 2009 (5.50%)	2.43%	2.89%	2.22%
January 2010 (4.25%)	February 2010 (6.50%)	2.43%	2.94%	2.42%
January 2011 (3.50%)	February 2011 (5.00%)	2.43%	3.15%	2.66%
January 2012 (3.375%)	February 2012 (4.875%)	2.43%	3.16%	2.76%
July 2012 (3.00%)	August 2012 4.375%)	2.43%	3.38%	2.86%

Note: Expected inflation is taken as the November 2002 consensus 10-year inflation forecast from the Federal Reserve Bank of Philadelphia survey. All calculations use equations (5) and (6):

$$P_{TIPS} = \sum_{t=1}^{N} \frac{C_t(1-T)}{(1+R_{TIPS})^t} - \sum_{t=1}^{N} \frac{(p_{A,t} - p_{A,t-1})(T)}{(1+R_{TIPS})^t} + \frac{p_{A,N}}{(1+R_{TIPS})^N}$$

or,

$$P_{FR} = \sum_{t=1}^{N} \frac{C(1-T)}{(1+R_{TIPS})^t} + \frac{(100-P_0)(1-G)}{(1+R_{FR})^N} + \frac{P_{FR}}{(1+R_{FR})^N}$$

to solve for R_{TIPS}, the after-tax yield on TIPS, and R_{FR}, the after-tax yield on conventional (fixed-rate) Treasury securities, respectively, based on the security prices on November 26, 2002, and assume a marginal ordinary income tax rate of 34% and a capital gains tax rate of 20%. In the calculations, future inflation is assumed to remain constant at the expected inflation number for the life of the TIPS.

Reserve Bank of Philadelphia survey, which at the time equaled 2.43%. Because it is a 10-year forecast, we restrict the analysis to the seven security issues that had 10 years or less remaining to maturity as of November 2002.

Table 3 presents the TIPS after-tax yields and the conventional fixed-rate after-tax yields using the survey inflation forecast. For all seven matched pairs, the TIPS after-tax yield exceeds the fixed-rate after-tax yield, with an average difference of 0.63%. Clearly, the tax treatment of TIPS did not cause them to be disadvantaged relative to their fixed-rate counterparts when an inflation forecast from a survey of experts is used. Although we do not present the results, we also used the survey inflation forecasts made in November 2001 (2.52%), 2000 (2.60%), 1999 (2.53%), and 1998 (2.45%) to estimate the after-tax yields on the TIPS and

fixed-rate securities that had 10 years or less to maturity as of these forecast dates. In every instance the TIPS after-tax yield exceeded the after-tax yield on the fixed-rate counterpart. The average yield differences across the matched pairs were: 0.80% in November 2001, 0.68% in November 2000, 0.55% in November 1999, and 1.16% in November 1998.

V. Ex Post Holding-Period Returns

Because the evaluations presented previously rely on inflation projections to compare after-tax yields on TIPS with conventional Treasury securities, we also calculate ex post holding-period returns from issuance dates until early 2003 for a subsample of our matched pairs of securities. This backward-looking analysis does not require any assumptions about future inflation. However, if TIPS are indeed tax disadvantaged, their ex post after-tax holding-period returns should be less than that of conventional Treasury securities. Table 4 provides the annual after-tax holding-period returns for the four maturity-matched pairs that mature in January or February. These four pairs were selected because of the close proximity of their respective maturity dates (i.e., only one month apart). The calculations were made using price data as of early 2003, a tax rate equal to 34%, and the actual reference inflation rates since issuance (for the TIPS).

From Table 4 it is clear that for each of these matched pairs, TIPS have provided higher after-tax holding-period returns than their matched-sample conventional Treasury securities, with the difference getting larger for the more recently issued matched pairs. The overall evidence indicates that even investors with a 34%

TABLE 4. Annual After-Tax Holding-Period Returns (HPR) for the Four Pairs of Conventional Fixed-Rate Treasury Securities (FR) and Treasury Inflation Protected Securities (TIPS) Maturing in January or February.

TIPS Issuance FR Issuance	Maturity Year	Approximate Holding Period	TIPS After-Tax HPR	Conventional FR After-Tax HPR
January 1998 February 1998	2008	5 Years	5.84%	5.04%
January 2000 February 2000	2010	3 Years	9.08%	8.34%
January 2001 February 2001	2011	2 Years	8.22%	6.58%
January 2002 February 2002	2012	1 Year	12.52%	8.68%

Note: The TIPS after-tax holding-period return is calculated as of January 15, 2003. The conventional security after-tax holding-period return is calculated as of February 14, 2003.

marginal tax rate would have been better off buying the TIPS at issuance, as opposed to the conventional Treasury security issued about the same time. Recognize also that inflation was the same for the two securities in each of the four matched pairs, so that the TIPS would also have had higher after-tax real returns.

An important caveat to consider when looking at these results is that changes in the relative levels of real and nominal interest rates over time could have been an important source of these return differences. Nonetheless, over the recent period of relatively stable inflation, all four TIPS issuances that are closely matched on issuance and maturity dates have fared well on an after-tax basis compared with similar conventional Treasury securities. This again suggests that the tax treatment of TIPS is not a disadvantage, as many suggest.

VI. Summary and Conclusions

The U.S. Treasury began issuing inflation indexed (or "protected") securities in 1997. Primarily because TIPS have a well-established benefit as an inflation hedge, several researchers conclude that they can be an important component of most investment portfolios (e.g., see Campbell, Chan, and Viceira 2003), and other researchers are struck by how attractive the before-tax yields on TIPS have been relative to conventional Treasury securities (e.g., Sacks and Elsasser 2004). Contrary to these views that TIPS are useful investment vehicles for most investors, others argue that TIPS are tax disadvantaged and therefore should not be considered for taxable accounts because they are inferior to conventional securities on an after-tax basis.

In this article, we reexamine the tax treatment on TIPS and conventional debt. We show, under realistic assumptions, that the tax treatments of TIPS are similar to alternative investment vehicles. We also challenge the recommendation that even if TIPS are tax disadvantaged, taxable investors should avoid holding TIPS in taxable accounts. Whether this advice is sound would depend on the extent to which this disadvantage is priced in the marketplace. Our empirical results also support the notion that there are trivial differences in expected after-tax yields of TIPS versus conventional Treasury securities, even for investors with relatively high marginal income tax rates. We provide empirical evidence that a sizable proportion of outstanding TIPS actually have higher expected after-tax nominal yields than their conventional Treasury counterparts for such investors.

We also find that after-tax holding-period returns have been higher for TIPS than for their matched-maturity conventional Treasury security counterparts since the introduction of the former securities. Investors, even those in high tax brackets, who ignored the conventional view that TIPS are tax disadvantaged and bought these securities have experienced after-tax returns in excess of those who avoided TIPS and bought conventional Treasury securities. Our evidence further suggests

that previous work considering the portfolio benefits of TIPS and/or the pricing of TIPS need not be revisited because this literature ignores the tax treatment of TIPS.

Appendix: Negative Net Cash Flows with TIPS

We address the possible disadvantage that occurs when the annual tax obligation on phantom income from the inflation-adjusted principal on TIPS is greater than the after-tax cash flow from the coupons received that year. Some researchers suggest that the possibility of a negative net cash flow in any particular year represents an important piece of the tax disadvantage argument (e.g., see Sundaresan 2002). We can easily model the after-tax coupon payment on TIPS, and the tax obligation on the increase in inflation-adjusted principal on TIPS, as

$$C_{AT} = C(1 - T), \tag{A1a}$$

$$TOB = (\pi)(T), \tag{A1b}$$

where

C_{AT} = the after-tax nominal coupon payment,
C = the before-tax nominal coupon payment,
T = the ordinary income tax rate,
π = the inflation rate, and
TOB = the tax obligation per dollar increase in principal due to inflation.

It is clear from equations (A1a) and (A1b) that the net cash flow, $C_{A-T} - TOB$, is smaller when: (1) the inflation rate is higher, (2) the tax rate is higher, or (3) the coupon rate is lower. Tables A1 and A2 present the net cash flow at varying levels of the tax rate (20%, 30%, and 40%) and varying levels of nominal coupon rates (1% and 3%) for 3% and 5% inflation, respectively. The results show that small negative cash flows occur at the low nominal coupon rate of 1% for tax rates of 30% and 40%. However, at the more reasonable coupon rate of 3%, no tax rates lead to negative cash flows when inflation is 3%, and only small negative flows occur at $T = 40\%$ when inflation is 5%. These data suggest that the likelihood of negative net cash flows, at reasonable parameters for today's environment, is relatively low. Furthermore, for parameter values with a negative net cash flow, the amounts are relatively small.

When considering the role of negative net cash flows in the tax disadvantage argument, it is important to recognize that nominal coupon rates on fixed-rate debt are directly related to expected inflation (i.e., issuers typically issue debt near

TABLE A1. Net Cash Flows (per $1,000 Par Value) on Treasury Inflation Protected Securities (TIPS): After-Tax Coupon Payment Minus the Tax Obligation on the Increase in Inflation-Adjusted Principal, at 3% Inflation.

	20% Tax	30% Tax	40% Tax
1% C_T	+$2	−$2	−$6
3% C_T	+$18	+$12	+$6

Note: C_T is the before-tax nominal coupon payment on TIPS, and tax is the ordinary income tax rate.

TABLE A2. Net Cash Flows (per $1,000 Par Value) on Treasury Inflation Protected Securities (TIPS): After-Tax Coupon Payment Minus the Tax Obligation on the Increase in Inflation-Adjusted Principal, at 5% Inflation.

	20% Tax	30% Tax	40% Tax
1% C_T	−$2	−$8	−$14
3% C_T	+$14	+$6	−$2

Note: C_T is the before-tax nominal coupon payment on TIPS, and tax is the ordinary income tax rate.

par value) if, as we presume, the Fisher effect holds. Therefore, because nominal coupons on fixed-rate debt are taxed, higher inflation leads to an increase in inflation taxation. Furthermore, fixed-rate debt holders face the potential of a capital loss if an increase in inflation is unanticipated. Both of these factors will reduce the after-tax return for fixed-rate debtholders. These can be taken as additional factors that abate any perceived tax disadvantage.

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