The Fixed Income Digest

TIPS primer

Bank of America Merrill Lynch

Primer

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TIPS preserve a real yield

Treasury Inflation Protected Securities (TIPS) shield investors from most, if not all, of the risk of erosion of income and principal value from inflation – usually the major risk involved in holding a high-quality bond.

Principal value of TIPS rises with inflation

The principal value of TIPS moves proportionally with the Consumer Price Index (CPI). The coupon rate is applied to the principal value, which enables the coupon payment to also move with CPI. The investor receives the full inflation-adjusted principal when the bond matures or is sold. In the event of deflation, the principal value could fall below par, but the investor is assured of getting at least the initial par value at maturity. The quoted yield on a TIPS security is the *real* (i.e. inflation-adjusted) yield. The actual yield to maturity will approximate the real yield plus the annualized inflation through maturity. Prior to maturity, the price of TIPS will vary with market expectations about inflation and real yields.

TIPS have interest rate risks

TIPS' prices tend to move in the same direction as nominal bonds, and while not always, TIPS' prices are often less volatile than nominal bond prices. Sensitivity of real yields to changes in the nominal interest rates, i.e., the yield betas for TIPS, is incrementally higher when maturities extend. Durations of TIPS tend to be shorter than comparable nominal bonds.

TIPS funds can avoid phantom income taxation

The tax treatment of TIPS is a disadvantage for investors who want income for current spending purposes, although the increase in the principal value that occurs with inflation ultimately compensates the investor. Cash flow considerations might make TIPS better suited for tax-deferred accounts. Investors can avoid the unfavorable tax consequences of individual TIPS securities through exchange-traded funds and closed-end funds that specialize in TIPS, although investors should be aware of other considerations with these funds.

Table 1: TIPS Basics

Index ratio on day t is the growth in the CPI since the issuance date.
Index ratio = $CPI_t / CPI_{at\ issuance}$
Principal rises with CPI
Principal = Index ratio * price at issuance
Coupon payment is the fixed coupon rate * principal value.
Price will vary with real Treasury yields (nominal yield minus inflation expectations). Price will converge to par at maturity
Market value = Inflation adjusted principal * price divided by 100
Yield to maturity = real yield (nominal yield - expected inflation). If the bond is held to maturity, the realized yield will approximate the yield to maturity minus average inflation rate.
TIPS' tax treatment makes them better suited for tax-deferred accounts unless purchased through funds.

Source: BofA Merrill Lynch Global Research

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The ABCs of TIPS

Treasury Inflation Protection Securities (TIPS) shield investors from most, if not, all of the risk from unexpected inflation. Unexpected inflation is a main cause of price declines for high quality bonds, and can reduce the purchasing power of both the coupon payments and principal value of a bond. As with fixed-rate or "nominal" Treasuries, the payments on TIPS are backed by the US government and the income is exempt from state taxation. Table 1 on the cover page defines the key elements of TIPS. We will discuss each in more detail in the following pages.

A promised dollar amount vs. a promised inflation-adjusted amount

A typical "nominal" bond promises a fixed coupon payment and the return of a fixed principal when the bond matures. Barring default, investors know what the dollar payments on the bond will be, but not what the *purchasing power* of those payments will be. That depends upon the degree to which inflation erodes the purchasing power of the payments. Although the market yield on a nominal bond factors in an expectation of future inflation, investors are subject to both pleasant and unpleasant surprises.

With TIPS, however, investors are promised a specified degree of purchasing power. The yield is a specific percentage return above or below inflation. Barring a federal government default, TIPS holders can be sure that the purchasing power of the interest payments and return of principal will track the Consumer Price Index (CPI). Since the fixed coupon rate on TIPS represents the payment after the inflation adjustment, the quoted yield is lower than for an otherwise similar nominal bond.

The principal value of TIPS rises with CPI. The coupon rate is applied to the CPI-adjusted principal.

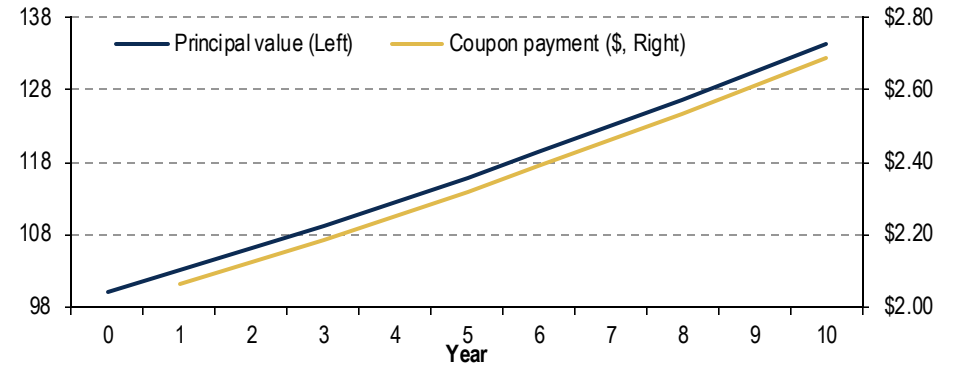
Coupon rate fixed, principal adjusts with CPI

TIPS pay a fixed coupon rate that is applied to a principal value that moves proportionately with consumer prices. The relevant price measure is the not seasonally-adjusted Consumer Price Index for Urban Consumers (CPI-U), published by the Bureau of Labor Statistics. Our references to the CPI throughout this publication will refer to that price measure. Inflation is the rate of change in the CPI.

Below, Chart 1 illustrates how TIPS work. This example uses a 10-year maturity, a 2% coupon and 3% annual inflation. The dark (blue) line shows the principal value, which rises by 3% each year, reflecting inflation. The light (yellow) line shows the coupon payment, or the 2% coupon multiplied by the principal value. The principal value and the coupon payment both rise proportionately to annual inflation.

Chart 1: TIPS inflation adjusted principal and coupon payment, 3% annual inflation

Principal and coupon rise proportionately with inflation



Source: BofA Merrill Lynch Global Research

TIPS cash flow example

Table 2 below digs a little deeper by showing the cash flows associated with TIPS. The calculations take into account the tax treatment of TIPS, which we will discuss below. The example shows a five-year TIPS that is issued with an initial value of $1,000 and an annual coupon rate of 1.5%. For simplicity, we assume that consumer prices rise by 1.0% for each six-month period, which compounds to an annual 2.01% rate.

With a 1.0% rise in the CPI in the first six months, the principal value also rises by 1.0% to $1,010. The first semi-annual coupon payment is 0.75% (the coupon rate divided by two), or $7.58. The principal value continues to rise with CPI for the life of the bond, and the coupon payment rises accordingly. For the full five-year period, the after-tax yield on the TIPS is 2.38%.

For TIPS purchased in the secondary market, the *index ratio* – which is typically reported in the bond description – is the ratio of the present CPI to the CPI when the bond was issued. That ratio, minus 1, represents the percentage change in the CPI that has occurred since the bond was issued. In our example, the index ratio at the first semi-annual adjustment period is 1.0100. See page 12 for more details.

The actual inflation adjustment in TIPS is a bit more involved than Table 2 shows. The Appendix on pages 12-14 gives the full details.

Table 2: TIPS cash flow example

Initial investment	$1,000
Annual fixed coupon rate	1.50%
Semi-annual inflation rate	1.00%
Federal tax rate	32%

Year	Semi-annual period	Principal value	Pre-tax coupon payment	Federal tax of coupon and changes in principal values	After tax coupon payment
	1	$1,010.00	$7.58	$5.62	$1.95
1	2	$1,020.10	$7.65	$5.68	$1.97
	3	$1,030.30	$7.73	$5.74	$1.99
2	4	$1,040.60	$7.80	$5.79	$2.01
	3	$1,051.01	$7.88	$5.85	$2.03
3	6	$1,061.52	$7.96	$5.91	$2.05
	7	$1,072.14	$8.04	$5.97	$2.07
4	4	$1,082.86	$8.12	$6.03	$2.09
	9	$1,093.69	$8.20	$6.09	$2.11
5	10	$1,104.62	$8.28	$6.15	$2.13
		Totals	$79.25	$58.84	$20.41

	Total after-tax payments
Principal at maturity	$1,104.62
Coupons	$20.41
Total	$1,1125.03
After-tax yield (internal rate of return)	2.38%

Source: BofA Merrill Lynch Global Research

Federal tax treatment

The tax treatment for TIPS is a drawback for investors seeking near-term cash flow. Even though the TIPS structure ultimately makes up for that drawback, most investors might prefer to holds TIPS in funds or in tax-deferred accounts.

Phantom income tax

The increase in the principal stemming from inflation is taxable income for federal purposes even though the investor does not actually receive the income until the bond is sold or matures. The tax on the rise in the principal value that is not realized until maturity is often referred to as a tax on "phantom income."

Investors are taxed on income that is not received until the bond matures or is sold. The tax treatment makes a case for holding TIPS in funds or tax-deferred accounts.

Returning to the top section of Table 2, in the first period, the investor is taxed on the $10 increase in the principal value of the bond (from $1,000 to $1,010), as well as the $7.58 coupon. With a 32% tax rate, the tax liability is $5.62. As the final column of the table shows, the after-tax coupon payment in the first period shrinks from $7.58 to $1.95.

Tax liability might exceed coupon income in early years

If the coupon rate is low enough, the investor could actually owe *more* in taxes than he/she receives in income in a given year before the bond matures. That situation has prevailed for many newly issued shorter maturity TIPS during the past few years.

Tax treatment less damaging than it appears

The tax treatment for TIPS is a drawback for investors seeking near-term cash flow. Ultimately though, the TIPS structure makes up for that drawback even after accounting for the time value of money.

We demonstrate this below in Table 3 by showing the return on a nominal bond with the same pre-tax yield as the TIPS security illustrated in Table 2. The realized pre-tax yield on TIPS can be approximated as the sum of the fixed coupon rate and the annualized inflation rate. In the example in Table 2 on page 2, those figures add to 3.52% (= 1.50% + 2.01%).[1]

Using a par-priced bond as an example, our nominal bond in Table 3 has the same 3.52% as the TIPS in Table 2, and the investor is taxed on the coupon payment each year. The bottom of the table shows that with a 32% federal tax rate, the investor winds up with an after-tax 2.29% return, *slightly less than that for TIPS in a cash account* shown in Table 2.

Ultimately the rise in principal value compensates for the tax treatment.

In other words, the same increase in the principal value that generates the phantom income tax also enables the return on the TIPS to approximate the return on the nominal security, despite the taxation. For the nominal bond in Table 3, the coupon payments are higher than for the TIPS in Table 2, especially in the early years, because the coupon rate is 3.52% compared to 1.50% for the TIPS. But at maturity, the principal value of the TIPS is higher by the amount of the CPI growth over the life of the bond. Additionally, the coupon payments on the TIPS rise over time along with the principal value.

On a present value basis (accounting for the time value of money), the two cash flow streams are roughly equivalent. That also means that the ultimate advantage of a TIPS in an Individual Retirement Account (IRA) versus a cash account stems from the benefits of deferring taxes and is little different than the advantage of a nominal bond in an IRA versus a cash account.

The case for holding TIPS in an IRA

We have argued that the tax drawback of TIPS arises from the low, or perhaps negative, cash flow in the early years, but the investor is ultimately made whole. Our argument for holding individual TIPS in tax-deferred accounts such as IRAs is simply that in many cases, if investors are going to be deprived of some cash flows in the early years, they might prefer to keep the securities in an IRA where the returns will build tax free. Going back to Table 2, the return on the TIPS held in an IRA would be 3.43% rather than 2.38%.

[1] More precisely, the realized yield is a bit higher than that because of the interaction between the coupon rate and the rise in the principal value. A better approximation of the return is (1+y) * (1+i), where y is the yield on the TIPS and i is annual inflation.

Investors can also address the phantom income tax issue by holding TIPS in funds that generate income to match the tax liability. See page 11.

This information is not intended to provide tax advice or to be used by any person to give tax advice.

This information was provided to support the analysis of financial instruments or transactions discussed in the report and clients are urged to seek tax advice based on their particular circumstances from an independent and professional tax advisor.

Realized yield and inflation

Negative yields on TIPS

The stated yields on many TIPS with shorter maturities have been negative for most of the past few years. A negative yield on TIPS arises when inflation expectations are higher than nominal Treasury yields for the remaining maturity of the bond.

A negative TIPS yield means that the investor is not fully compensated for inflation.

A negative yield means that the investor who holds to maturity would earn a total rate of return that is below the rate of inflation over the remaining life of the bond by approximately the absolute value of the yield. For example, if the real yield were -1% and annual inflation averaged 3% over the life of the bond, then the annual return over the life of the bond would be 2% (-1% + 3% = 2%). In other words, the yield on TIPS represents the "real" yield, or the yield after subtracting inflation.

Table 3: Cash flows on a nominal (fixed-rate) five-year security

Initial investment	$1,000.00
Annual fixed coupon rate	3.52%
Federal tax rate	32%

Year	Semi-annual period	Principal value	Pre-tax coupon payment	Federal tax of coupon and changes in principal value	After-tax coupon payment
	1	$1,000.00	$17.60	$5.63	$11.97
1	2	$1,000.00	$17.60	$5.63	$11.97
	3	$1,000.00	$17.60	$5.63	$11.97
2	4	$1,000.00	$17.60	$5.63	$11.97
	5	$1,000.00	$17.60	$5.63	$11.97
3	6	$1,000.00	$17.60	$5.63	$11.97
	7	$1,000.00	$17.60	$5.63	$11.97
4	8	$1,000.00	$17.60	$5.63	$11.97
	9	$1,000.00	$17.60	$5.63	$11.97
5	10	$1,000.00	$17.60	$5.63	$11.97
		Totals	$178.64	$56.32	$119.68

	Total after-tax payments
Principal at maturity	$1,000.00
Coupons	$119.68
Total	$1,119.68
After-tax yield (internal rate of return)	2.29%

Source: BofA Merrill Lynch Global Research

TIPS and deflation

Deflation is an actual decline in the price level, not just a slower rate of increase in the price level (which is a decline in inflation, or disinflation). Deflation is rare in the US: since 1947, the CPI has declined for a full year only three times in 1949, 1954 and 2008.

In the event of deflation, the principal value of TIPS would decline, and the coupon payment would be calculated off of that lower principal value. However, the Treasury

guarantees that the investor will receive no less than the original face amount (par price of 100) upon maturity.

TIPS payments rise by the percentage change in the CPI. With deflation, the payment would decline.

Table 4 shows how the payments on TIPS would vary with different rates of inflation, using the same simplifications as in Tables 2 and 3. The TIPS pays a 2% coupon. In the first year, CPI inflation is 5%, and the principal value rises by that percentage to $1,050. The annual coupon payment is 2% of the new principal value, or $21.00. In the next year, the rate of inflation slows to 2%. The principal value rises by that amount, and the coupon payment rises again. Year 3 has 3% deflation; that is, the CPI declines by 3%. Now the principal value declines by 3%, and so does the coupon payment.

The principal value could fall below $1,000 if deflation is severe enough or happens early enough in the life of the bond. In that case, the coupon would still be calculated off the principal value. If, for example, the principal value declined to $990, the coupon payment would be 2% of that amount. But again, the par value would be at least $1,000 at maturity.

Investors who are concerned about prolonged declines in CPI but still want to buy TIPS should favor TIPS that have a par value close to 100 (i.e., the index ratio is close to 1.00, see page 12) because the price of those securities would have less room to fall.

Table 4: How TIPS payments and principal value change with CPI

TIPS coupon rate: 2%
Initial principal value: $1,000

	Annual inflation	Principal	Coupon*
Year 1	5%	$1,050	$21.00
Year 2	2%	$1,071	$21.42
Year 3	-3%	$1,039	$20.78

Source: BofA Merrill Lynch Global Research. Note: We assume annual payments for simplicity. TIPS pay coupons semi-annually, based upon the lagged change in the CPI.

Prices of TIPS can fluctuate

As with nominal bonds, there are two components to TIPS' returns: the income return and the price return. Until now, we have focused on income returns, which depends largely upon the coupon rate and the course of inflation. We turn now to price returns.

As with all bonds, the price of TIPS varies with market yields. The relevant yields for TIPS though are *real* yields rather than nominal yields. Here we define a real yield as the nominal yield minus the expected rate of inflation over the holding period.

Changes in market real yields could offset some of the impact of changes in inflation on TIPS returns. But ultimately the course of inflation dominates.

Prices of TIPS could decline as inflation rises because real yields sometimes move in the same direction as inflation. For example, if inflation rises, the Federal Reserve might begin to hike interest rates in order to dampen expectations of future inflation. The rise in rates and the associated decline in inflation expectations could pull down the price of TIPS even as it boosts the income payments.

Similarly, weakness in the economy that drags down inflation could prompt the Fed to cut real interest rates. In such circumstances, prices of TIPS could rise. That was the case for most of the period from 2009-2012. TIPS did well over that stretch even though inflation remained low.

As with a nominal bond, the sensitivity of the price of TIPS to changes in real yields is greater the longer the maturity of the bond and the lower its coupon.

Table 5, below, shows how a 10-year TIPS would fare under different assumptions for changes in inflation and changes in real yields over the course of one year. The best case for TIPS is when inflation is high and real yields decline. For example, a 50 basis point (bps) decline in real yields combined with a 2% inflation rate over the course of a year would bring an 8.3% total return. This is calculated as follows.

First, with a 2% inflation, the inflation-adjusted principal at the end of the first year would be $100 * (1+2%) = $102. A 50bp decline in real yield would cause the market price of the bond to rise to $104.19. The value of the bond position would be $104.19 * 102/100 = $106.274. Combined with the $2 coupon income, the total position would be $106.27 + $2 = $108.274. So the total return at the end of the first year would be $108.27 / $100 = 8.27%.

Movements in inflation and real rates in the same direction have opposing effects on TIPS' returns. The worst case is the combination of deflation (negative inflation/price declines) and rising real yields.

Over time income dominates

Investors who plan to hold to maturity should think more about what inflation will be over the holding period than what will happen to real interest rates. As with a nominal bond, the price will reach the par value at maturity. As the time horizon lengthens, the path of inflation becomes more important than changes in real yields in determining the return from TIPS.

Table 5: How return on a 10-year TIPS varies with inflation and changes in real yield

(One-year horizon, coupon = 2%, initial value = 100)

Change in real yield (bps)	Annual inflation				
	-1%	0%	1%	2%	3%
-100	9.5%	10.6%	11.7%	12.8%	13.9%
-50	5.1%	6.2%	7.3%	8.3%	9.4%
0	1.0%	2.0%	3.0%	4.0%	5.1%
50	-3.0%	-2.0%	-1.0%	0.0%	0.9%
100	-6.8%	-5.8%	-4.9%	-4.0%	-3.0%

Source: BofA Merrill Lynch Global Research

The longer you hold TIPS, the more important inflation becomes in relation to changes in real yields.

Putting it together

Principal, coupon income, price and market value

We have discussed how the principal value and coupon income of TIPS move proportionately with inflation and the price moves with real yields. The final missing piece is the market value. The market value is the principal value of the TIPS times the price. That is what an investor pays when he/she buys a TIPS in the secondary market.

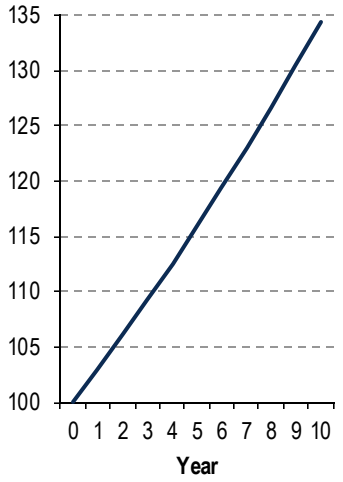
The charts on the next page put all the pieces together. The Charts apply to a 10-year TIPS with a 2% coupon rate and a 3% annual inflation rate.

The principal value of TIPS rises proportionately with the CPI – 3% annually in our example. We show that in Table 2 on the left.

The price of TIPS will rise as real yields decline and decline as real yields rise, but will also converge to par as maturity approaches. Chart 3, in the middle, illustrates those points. The dark (blue) line shows the price for when the yield drops from 2% to 1% in the first year and stays there until maturity. The light (yellow) line in Chart 3 shows the same calculation for a rise in yield from to 3%. For the decline in yield, the price climbs above par, and for the rise in yield the price falls below par. In both cases, the price converges to par (100) at maturity.

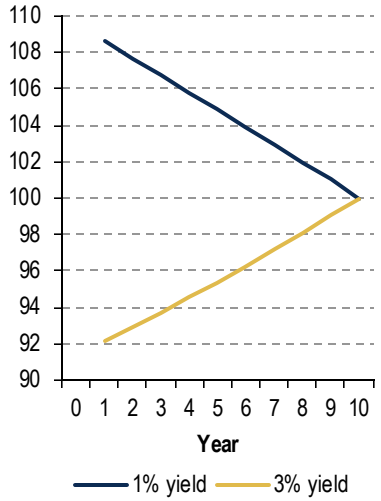
The market value combines both the principal value and the price. We will consider the case where the yield declines to 1% at the end of the first year. The dark (blue) line in Chart 4, which replicates the dark (blue) line in Chart 3, indicates how the price initially rises but converges towards 100 at maturity. The market value is shown with the light (yellow) line in Chart 4, and is price times the principal value (which, again, is the dark (blue) line in Chart 2).

Chart 2: TIPS inflation adjusted, 3% annual inflation
Principal and coupon rise proportionately with inflation



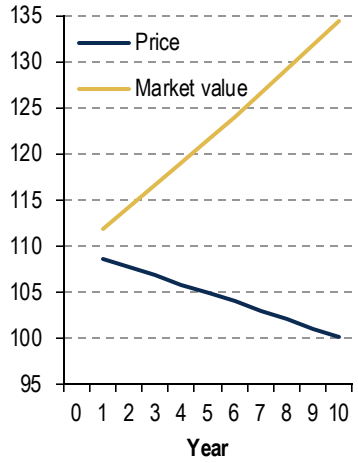
Source: BofA Merrill Lynch Global Research

Chart 3: Price of 10-year TIPS, 2.0% coupon, 1% and 3% yield
Price converges to 100 at maturity



Source: BofA Merrill Lynch Global Research

Chart 4: Price and market value, 10 year maturity, 2% coupon, 3% yield, 3% annual inflation,
Market value = Price * Principal value



Source: BofA Merrill Lynch Global Research

For example, at the end of the fifth year, the principal value is 115.9 (100 scaled up by 3% inflation compounded over five years), and the price is 104.9 (the price of a bond with five years remaining to maturity, a 2% coupon and 1% yield). The market value is the product of the two, which after adjusting for the units comes out 121.6, or $1,216 for an initial par value of $1,000.

Comparing TIPS and nominal Treasuries

Chart 5: Breakeven inflation rate on 10-year TIPS

Source: Bloomberg

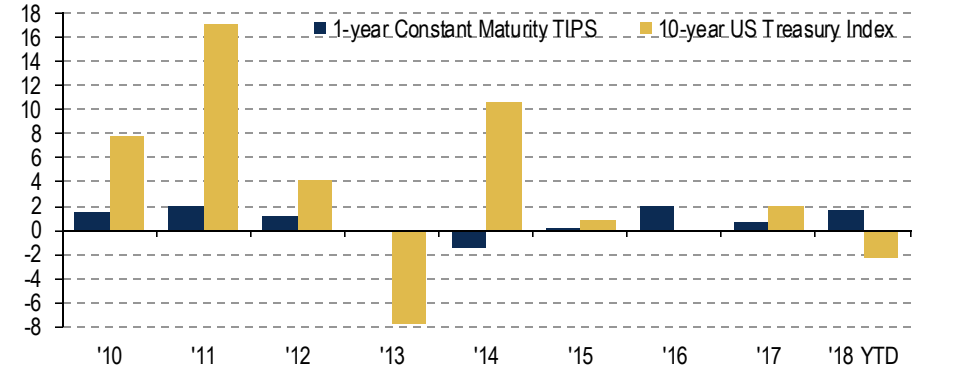
The breakeven inflation rate is a good measure for comparing TIPS' attractiveness with a nominal Treasury security. The breakeven inflation rate is approximately the difference in yield between a nominal security and an inflation-linked security with the same maturity.

The breakeven inflation rate is a good estimate for assessing the attractiveness of TIPS in relation to nominal Treasury securities.

For example, if the yield on a nominal Treasury security is 3%, and the TIPS yield on the same maturity is 2%, the breakeven inflation rate would be about 1%. If inflation is higher than that over the next 10 years, the TIPS will provide a better income return than the nominal bond.

Chart 5 on the previous page shows the historical breakeven inflation rate for 10-year TIPS. The Chart implies that even in times of low inflation or deflation, TIPS could be attractive investments because the breakeven inflation rate could be low. The key consideration is whether the investor believes that inflation will be higher than what the market is pricing in.

Chart 6: Annual returns of 1-year TIPS versus 10-year US Treasury (%)



Source: Bloomberg; BofA Merrill Lynch Global Research. Data as of 6 September 2018

Professional investors often evaluate the performance of the TIPS market by the direction of the breakeven inflation rate. If breakeven inflation rate is rising, that means that TIPS are outperforming nominal Treasuries: TIPS yields are declining more (or rising less) than nominal Treasury yields.

TIPS have interest rate risks

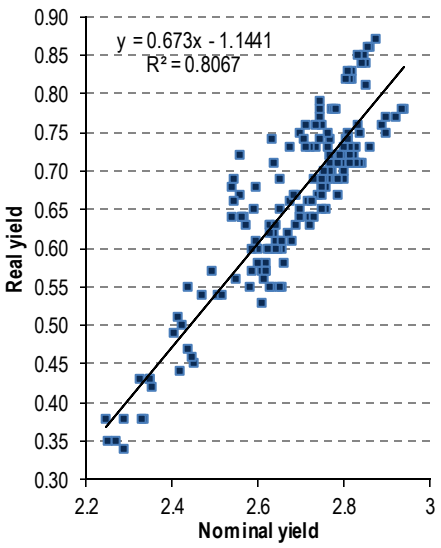
While TIPS are designed to protect purchasing power, they are fixed income instruments with interest rate risk. In this case, the interest rate risk is the risk of changes in the real rate of interest when nominal interest rates change.

We can quantify the real and nominal yield through the *yield beta*. The *yield beta* is the sensitivity of the real rate of interest to changes in the nominal rate of interest. That sensitivity varies through time and with the maturity of the bonds. Chart 7, Chart 8 and Chart 9 all show that the relationship is reasonably high.

For our sample period from 1 January 2018 to 29 August 2018, a 10bp increase in nominal rates in the 10-year maturity would result in an average increase of 7.3 basis points in the real yield.

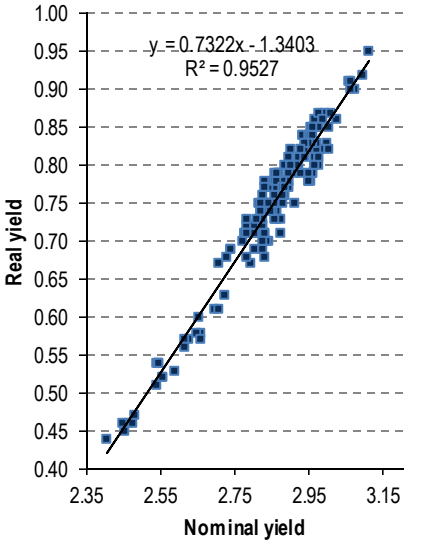
Two things should be noted, however. As these are positive correlations, TIPS' prices tend to move in the same direction as nominal bonds, and while not always, TIPS' prices are often less volatile than nominal bond prices.

Chart 7: Regression of real and nominal yields for 5-year Treasuries



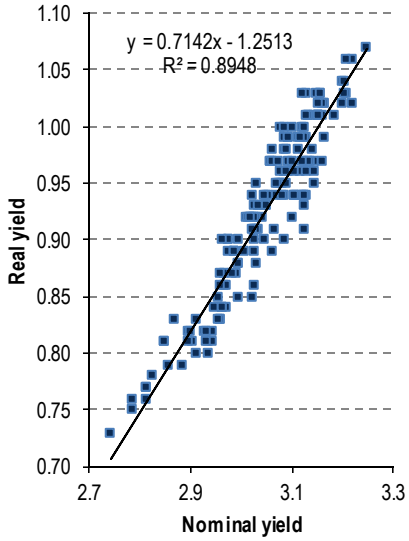
Source: Bloomberg; BofA Merrill Lynch Global Research. Data as of 29 August 2018

Chart 8: Regression of real and nominal yields for 10-year Treasuries



Source: Bloomberg; BofA Merrill Lynch Global Research. Data as of 29 August 2018

Chart 9: Regression of real and nominal yields for 30-year Treasuries



Source: Bloomberg; BofA Merrill Lynch Global Research. Data as of 29 August 2018

Second, when pricing nominal bonds, we discount the coupons and face value by the nominal yield to get the present value or price of the bond. The same process is used for TIPS, but the discount rate is the real yield. One can immediately see that the nominal and real yields are related by the implied rate of inflation.

Table 6: Calculating TIPS duration, given TIPS β

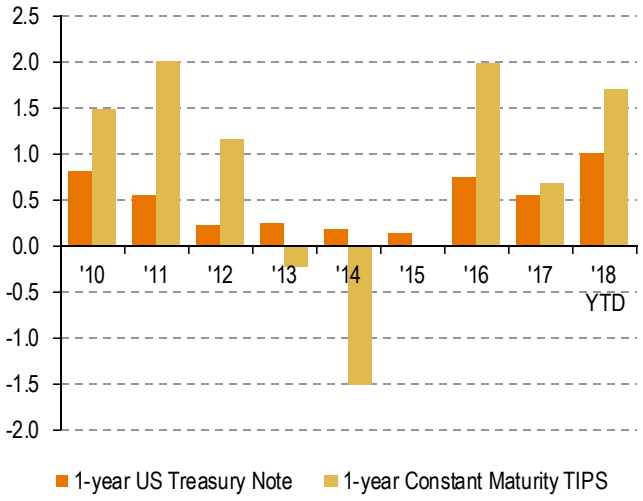
	Duration nominal	TIPS β	Duration TIPS
5-year	4.64	0.67	3.11
10-year	8.60	0.73	6.28
30-year	19.62	0.71	13.93

Source: BofA Merrill Lynch Global Research; Bloomberg. Data as of 29 August 2018

Table 6 shows how these can be used to convert the duration of TIPS to those of nominal bonds. For example, on average the 10 year TIPS behaves like a 6.28 duration nominal bond (8.60 x 0.73).

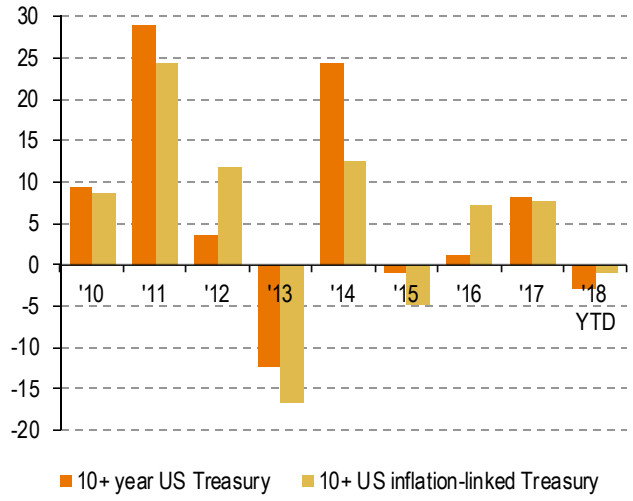
As TIPS duration's are lower than those of the nominal bonds, TIPS can reduce portfolio risk relative to an entirely nominal bond portfolio. Still, the nominal and real yields are highly correlated; this suggests that, on average, TIPS bond prices will tend to move in the same direction as nominal bond prices. Chart 10 and Chart 11 illustrate this dependency from a total return viewpoint.

Chart 10: Reviewing 1-year TIPS vs Treasury notes (%)



Source: Bloomberg; BofA Merrill Lynch Global Research. Data as of 6 September 2018

Chart 11: Annual returns of 10+ TIPS vs 10+ yr US Treasury (%)



Source: Bloomberg; BofA Merrill Lynch Global Research. Data as of 6 September 2018

TIPS funds

There are three closed-end funds (CEFs) and several hundred exchange-traded funds (ETFs) containing TIPS. Please note that ETFs are generally pegged to a particular index, rather than actively managed.

Both the CEFs and ETFs attempt to avoid phantom income taxation by selling portions of their portfolios in order to generate actual income to match the tax liability that arises from the increase in the principal value of their TIPS. In that way, the investor is taxed only on the income actually received. It is possible that the sales of assets could result in a federal and state capital gains liability or be treated as a return of capital, but such instances are rare. Also, to the extent that a fund owns securities other than TIPS, some of the interest income could be subject to state taxation.

Investors should also be aware that the market price of a TIPS fund will not converge towards par as the bond approaches maturity, as is the case with a directly-held individual security. The price of a TIPS fund will vary with market conditions.

Summary table

The following Table compares TIPS held in a cash account with TIPS held in an IRA, and nominal Treasury securities held in a cash account.

Table 7: TIPS vs. nominal Treasuries

				Taxation of coupons			
TIPS	Coupon payment	Payment frequency	"Phantom" income tax?	Federal?	State & local?	When is coupon income taxed?	Credit backing
Cash account	Fixed rate applied to principal value that rises with the CPI	Semi-annual	Yes	Yes	No	When received	US government
Tax-deferred account	Fixed rate applied to principal value that rises with the CPI	Semi-annual	No	Yes*	No	*See below	US government
ETF or CEF	Varies with CPI and possibly leverage	Usually monthly	Usually no	Yes	Usually no	When received	US government, corporate
Nominal Treasury note/bond (cash account)	Fixed rate	Semi-annual	No	Yes	No	When received	US government

Source: BofA Merrill Lynch Global Research. *In a conventional IRA, the initial deposit comes from pre-tax dollars, and the full value, including coupon payments, is taxed upon withdrawal. In a Roth IRA, the initial deposit comes from after-tax dollars, and there is no taxation upon withdrawal. All else equal, the after-tax return for a given pre-tax amount is identical for the two types of accounts.

Appendix: The mechanics of TIPS

On pages 2-3, we gave a simple illustration of how the inflation adjustment on TIPS works. Here we go into more detail.

Table 8: TIPS basics

Index ratio on day t is the growth in the CPI since the issuance date.
Index ratio = $CPI_t / CPI_{at\ issuance}$
Principal rises with CPI
Principal = Index ratio * price at issuance
Coupon payment is the fixed coupon rate * principal value.
Price will vary with real Treasury yields (nominal yield minus inflation expectations). Price will converge to par at maturity
Market value = Inflation adjusted principal * price divided by 100
Yield to maturity = real yield (nominal yield - expected inflation). If the bond is held to maturity, the realized yield will approximate the yield to maturity minus average inflation rate.

Source: BofA Merrill Lynch Global Research

We will illustrate the pricing of TIPS with the 2.125% TIPS that matures on 2/15/40, with a face (principal) value of $10,000. Table 9 on the following page goes through the details.

Suppose the bond was purchased in the secondary market on 31 August 2017, when the yield was 0.81%. The *market price* can be determined from a bond calculator, based upon the coupon rate, the yield to maturity, and the maturity and settlement dates. In our example, the market price is $126.93. The price is above par because the yield is below the coupon.

The *Index Ratio* captures the increase in prices since the security was issued. The inflation measure used is the not seasonally adjusted Consumer Price Index for Urban Consumers (CPI-U NSA). The index ratio for a given TIPS security is available at www.treasurydirect.gov/instit/annceresult/tipscpi/tipscpi.htm.

As shown in the top half of Table 9, the Index Ratio on the purchase date is 1.133, because the reference CPI rose 13% (1.13329 / 1.0000 = ~13%) since the bond was issued. The *principal value* is the initial par value of 100 (divided by 100), multiplied by the Index Ratio and the quantity purchased, or $11,333. The annual income at this point is the coupon rate of 2.125% multiplied by that principal value or ~$241.

The *market value* on the purchase date is the price of $126.93 multiplied by the index ratio 1.133, and the face amount. That amounts to about $14,385. The full price that the investor pays will be this amount plus any accrued interest and commission.

The next half of Table 9 shows what happens one year later. The two key events over this one-year period are: the new index ratio is 1.166, implying roughly a 2.87% rise in consumer prices ((1.166 / 1.133) - 1), and the real interest rate rose to 4.94%.

The new market price of the security is $124.88. The decline from the original price is due to the rise in the yield over the period. With the index ratio at 1.166, the principal value is now $11,658. Similarly, the annual income has risen to about $248, as the 2.215% coupon rate is applied to the higher principal amount. The market value is again the product of the market price and the principal value, adjusted for the $10,000 face amount, or $14,559 ($124.88 x 1.166 x 100).

In short, there are two components of a TIPS' *market value*: the *principal value*, which moves with inflation, and the *market price*, which is determined by movements in real yields.[2] The *market value* is the product of the two.

[2] For a bond priced at a premium, the market price will compress to par over time. Investors can amortize the premium for federal tax purposes, and are taxed on the accrual of market discounts. Consult your tax advisor for full details.

Table 9: Dissecting TIPS

Purchase Information: 2.125% TIPS maturing 2/15/2040, Quantity: 10,000

Purchase Date (8/31/2017)		
Real yield	**0.81%**	
Price	**$126.93**	Calculated as for normal bond, based on coupon, time to maturity, and real yield
Index ratio	**1.133**	Based on growth in CPI since bond was issued (i.e. CPI rose 29.4% since bond was issued)
Principal value	**$11,333**	Face value (10,000) times Index Ratio
Annual income	**$241**	Principal value times 2.125% coupon rate
Market value	**$14,385**	Principal value times price (divided by 100)
		The *cost basis* is the market value plus commission
One year later (8/31/2018)		
Real yield	**0.85%**	Market yield has risen from 0.81% a year ago
Price	**$124.88**	The price decrease from purchase date is due to rise in real yield
Index ratio	**1.166**	Percentage change from index value at purchase date (1.5%) reflects inflation
Principal value	**$11,658**	Rises by same percentage as index value, again reflecting inflation
Annual income	**$248**	Also rises with the CPI. Interest income is taxable at federal level
Market value	**$14,559**	The change in the market value from the purchase date reflects the change in the market price and the change in the index ratio
Unrealized gain/loss	**-$174**	The change in the market value ($14,559 - $14,385) less the change in the principal value ($11,658 - $11,333). The loss reflects the rise in market yield.

Source: BofA Merrill Lynch Global Research

Here are the tax considerations:

- The $325 increase in principal value ($11,658 - $11,333) from the CPI increase is taxable as ordinary income at the federal level. So is the annual coupon income. In this case the taxable income is divided between tax years 2017 and 2018. This income is not taxable at the state level.

- Since the market yield has risen, the market price has declined. The investor who sells prior to maturity would face a potential capital loss at both the federal and state levels on the price movement. The investor who holds to maturity would not face a taxable event on the capital gain/loss.

As with a nominal bond, the purchase price of TIPS also includes the *accrued interest*. For example, if a bond is purchased three months after the last coupon payment, the accrued interest is approximately half the semi-annual payment.

If the investor holds to maturity, the capital gains or losses would go away, as the market price would return to par. The *market value* of the TIPS at maturity (what the investor actually gets back) would depend upon the index ratio at that time, which represents the movement in CPI since the bond was issued. (In the event of deflation, the Treasury guarantees that the price will not fall below the initial par amount of 100.)

Staying with our example in Table 9, suppose that the consumer price index rises another 10% during the time remaining to the January 2040 maturity. The index ratio would then rise to 1.282 (1.166 x 1.10), so the value at maturity would be $12,824. The investor would get that amount at maturity, plus the coupon payments along the way. The federal taxable income in the final year would be the coupon payments plus the increase in the principal value in that year.

Calculating the Index Ratio

The Index Ratio measures the change in the CPI in the period since the bond was issued. The Index Ratio is then used to determine the inflation-adjusted Principal Value, which determines the coupon payment and the accrued interest on a TIPS.

The calculation of the index ratio begins with the Reference CPI-U

The Reference CPI is an estimate of the Consumer Price index for a particular day. Since the CPI is released on a monthly basis, and with a lag, the reference CPI-U for any day during a given month is determined by linear interpolation of the figures for two and three months prior. For example, the CPI for the days during July would be determined by a linear interpolation of the monthly figures for April and May. The formula is:

$$\text{Reference CPI}_{\text{month t, day n}} = \text{CPI-U}_{\text{t-3 months}} + (\text{n-1 days/ number of days in month t}) \times (\text{CPI-U}_{\text{t-2 months}} - \text{CPI-U}_{\text{t-3 months}})$$

For example, here is how you would calculate the Reference CPI for April 15, 2013. Start with the not seasonally adjusted CPI-U readings for the two and three months prior: the CPI-U readings for January and February 2013 are 230.28 and 232.166 respectively. Note that April has 30 days.

$$\begin{aligned}\text{Reference CPI}_{4/15/13} &= 230.280 + ((14/30) \times (232.166 - 230.280)) \\ &= 231.160\end{aligned}$$

The Reference CPI figures for particular TIPS are available at the Treasury's web site at http://www.treasurydirect.gov/instit/annceresult/tipscpi/tipscpi.htm.

Here is the equation used for calculating the index ratio:

$$\text{Index Ratio}_{\text{Day t}} = \text{Reference CPI-U}_{\text{Day t}} \div \text{Reference CPI-U on Issue Date}$$

To calculate the Inflation-Adjusted Principal Value, multiply the Index Ratio by the original principal value. For example, suppose an investor purchased a new issue TIPS on 4/15/13. We just calculated the Reference CPI for that day to be 231.160. Suppose that one year later, on 4/15/14, the Reference CPI is 238.095. The Index Ratio on that day would be:

$$\text{Index Ratio}_{4/15/13} = 238.085 / 231.160 = 1.0300$$

For a bond purchased on 4/15/13 at $1,000, the Principal Value on 4/15/14 would be: 1.0300 x $1,000, or $1,030.

For investors who purchase/sell TIPS in the secondary market, the Index Ratio also determines the accrued inflation interest owed to the seller of the TIPS.

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