Benefits and Limitations of Inflation Indexed Treasury Bonds

By Pu Shen

In recent years, members of Congress and academia have repeatedly urged the U.S. Treasury to issue some portion of its debt in the form of inflation indexed bonds. With an indexed bond, the interest and maturity value are adjusted by the rate of inflation over the life of the bond. Because the cash flow of an indexed bond is adjusted for inflation, the bond's real value does not vary with inflation, protecting investors and issuers alike from inflation risk.

Inflation indexed bonds would be a fundamental innovation in U.S. financial markets, providing benefits to investors, the Treasury, and policymakers. Despite the potential benefits, the U.S. Treasury has never issued indexed bonds. In fact, only a handful of industrialized countries, including the United Kingdom and Canada, have issued inflation indexed government bonds.

This article discusses the benefits of inflation indexed Treasury bonds and points out some of their limitations. The first section shows how indexed bonds differ from conventional bonds. The second section discusses why investors, the Treasury, and policymakers would benefit from adding indexed bonds to the spectrum of U.S. Treasury debt instruments. The third section discusses some of the technical limitations of the bonds. The article concludes that, if carefully designed, inflation indexed Treasury bonds are likely to be beneficial.

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WHAT ARE INFLATION INDEXED BONDS?

An inflation indexed bond protects both investors and issuers from the uncertainty of inflation over the life of the bond.[1] Like conventional bonds, indexed bonds pay interest at fixed intervals and return the principal at maturity. The fundamental difference is that while conventional bonds make payments that are fixed in nominal dollars (and thus are called nominal bonds), indexed bonds make payments that are fixed in real terms (and thus are called real bonds). Because the purchasing power of fixed nominal cash flows is reduced by inflation, nominal bonds expose both investors and issuers to the risk of changes in inflation, while real bonds do not.

To understand the advantages of inflation indexed bonds over nominal bonds, it is useful to examine the yield of a nominal bond under several inflation scenarios. For illustrative purposes, assume an investor buys a $100, 10-year bond that pays interest annually and $100 at maturity. In the first scenario, which is characterized by zero inflation, the bond

pays $3 in interest each year. Hence, the nominal yield of the bond is 3 percent.[2] The real (inflation adjusted) yield is also 3 percent because the real cash flow and the nominal cash flow are equal when there is no inflation.

In the second scenario, inflation is assumed to be 4 percent, but there is still no uncertainty about inflation. Because inflation erodes the purchasing power of nominal payments, the relevant yield to examine is not the nominal yield, but the real yield. The real yield *(r)* that corresponds to a nominal yield *(i)* when the actual inflation rate *(p)* is known is given by the Fisher identity: $r = i - p$, which states the real yield equals the nominal yield less the inflation rate.[3] In this case, to keep the real yield on the nominal bond at 3 percent, the same as under the no-inflation scenario, the nominal yield on the bond has to rise to 7 percent $(i = r + p = 3 + 4)$. Thus, with positive inflation but no uncertainty about its level, bond issuers simply raise the nominal coupon rate to 7 percent so that the real yield to investors (and real cost to issuers) remains the same as in the zero-inflation scenario.[4]

In the real world, however, inflation uncertainty creates a risk for both investors and issuers. Whenever actual inflation differs from what was expected, the real yield of the bond also differs from what was expected. In the third scenario, actual inflation doubles to 8 percent soon after the bond is issued and remains steady for the life of the bond. In this case, investors lose since the real yield of the bond becomes a *negative* 1 percent (7 - 8 = -1), which is much less than the 3 percent expected by investors. By contrast, in the fourth scenario, actual inflation drops to 2 percent after the bond is issued and remains steady. In this case, issuers lose since the real yield, and thus the real cost of servicing the bond, becomes 5 percent (7 - 2 = 5), which is much more than the issuers were prepared to pay.

These last two scenarios illustrate the inflation risk of nominal bonds. While the nominal yield of a bond can be adjusted to account for expected inflation at the time the bond is issued, the bond's actual real yield varies with actual inflation, which can be quite different from what was expected. If actual inflation rises unexpectedly, the real rate falls; and if inflation declines unexpectedly, the real rate increases. Because it is impossible to know with certainty the actual rate of future inflation, inflation risk is intrinsic to nominal bonds and cannot be eliminated.

In contrast to nominal bonds, inflation indexed or real bonds have no inflation risk. By design, the nominal cash flow of a real bond is adjusted by the cumulative rate of inflation to insulate its real cash flow, and therefore its real yield, from changes in inflation. In other words, while a nominal bond's cash flow and nominal yield are adjusted by expected inflation when the bond is issued, the coupon payments and maturity value of a real bond are adjusted over the entire life of the bond. The adjustment is made after inflation occurs to achieve the real yield that investors and issuers agreed upon at the time of issuance.

Table 1 shows why indexed bonds have no inflation risk even when actual inflation differs from what was expected. The table shows the real and nominal cash flows of a 10-year, $100 indexed bond that has a 3 percent coupon rate under the four inflation scenarios discussed above.[5] The real cash flow is shown just once since it is the same regardless of the actual level of inflation. Notice that when inflation is zero, the nominal cash flow and real cash flow of the indexed bond are exactly the same. As inflation rises, both the nominal coupon payments and maturity value rise to maintain the 3 percent real yield.[6]

While indexing insulates all bonds from inflation risk, the advantage of indexing is greater for long-term bonds than for short-term bonds, due mainly to differences in inflation risk. Inflation risk for long-term nominal bonds is significant, while infla-

Table 1

REAL AND NOMINAL CASH FLOW OF AN INDEXED BOND

(Dollars)

Year	Real cash flow	Nominal cash flow under various inflation rates			
		0	2	4	8
1	3	3	3.06	3.12	3.24
2	3	3	3.12	3.24	3.50
3	3	3	3.18	3.37	3.78
4	3	3	3.25	3.51	4.08
...	...	...	...	...	...
10	3	3	3.66	4.44	6.48
(principal)	100	100	121.90	148.02	215.90

Note: Except for the last row, all of the cash flows are coupon payments. The nominal cash flow in year k when inflation is p equals the real cash flow times $(1 + p)^k$.

tion risk for short-term nominal bonds is relatively minor. One reason for this difference is that inflation is much easier to forecast in the short term.[7] In other words, the difference between actual and expected inflation is much smaller for short-term forecasts of inflation. Another reason that short-term nominal bonds have less inflation risk is that changes in inflation will affect the value of a short-term bond much less than a long-term bond due to the effect of compounding. For example, consider two nominal bonds that, for expositional simplicity, have no coupon payments and pay back $100 at maturity. One bond has a one-year maturity and the other has a ten-year maturity. With inflation at 4 percent, the real principal of the 1-year bond is $96.15 (100/1.04); with inflation at 8 percent, the real principal falls to $92.59 (100/1.08). Thus, for this short-term bond, the doubling of inflation reduces the real value by less than 4 percent. For the 10-year bond, in contrast, the doubling of inflation reduces the real value of the bond from $67.56 ($100/1.04^{10}$) to $46.32 ($100/1.08^{10}$), which is a 37 percent decline.[8]

Because long-term nominal bonds carry substantial inflation risk while short-term nominal bonds carry little inflation risk, investors and issuers are more likely to be interested in long-term indexed bonds than short-term bonds.[9]

Surprisingly, few industrialized countries have issued indexed bonds. Australia, Canada, Sweden, and the United Kingdom have issued indexed government bonds (Table 2). New Zealand has indicated an interest in doing so.[10] The United Kingdom has issued the greatest amount of indexed bonds. The UK government began issuing indexed bonds, called index-linked gilts, in 1981. Because short-term nominal bonds carry little inflation risk, it is not surprising that the majority of indexed bonds in the United Kingdom are long-term bonds with maturities of at least 15 years. Currently, there are 13 such bonds outstanding, with (remaining) maturity ranging from 2 to 35 years. The total face value of these indexed bonds is over 20 billion pounds, or about 11 percent of the total face value of the UK's

Table 2

GOVERNMENT-ISSUED DOMESTIC CURRENCY DEBT

(Face value on March 31, 1995)

	Inflation indexed (billions of U.S. dollars)	Nominal (billions of U.S. dollars)	Inflation indexed as percent of total
United Kingdom	37.4	315.9	11.8
Sweden	1.6	74.8	2.1
Australia	2.2	72.4	3.0
Canada	3.2	279.2	1.1

Source: Bank of England (Butler).

outstanding government debt. In terms of market value, the indexed bonds account for about 15 percent of the UK's outstanding government debt.

POTENTIAL BENEFITS OF INFLATION INDEXED BONDS

Because inflation risk is generally a problem only for long-term nominal bonds, the benefits of indexed bonds are largely associated with long-term bonds. This section discusses the benefits of such bonds to investors, the Treasury, and policymakers.

Benefits to investors

The primary benefit to investors of long-term indexed Treasury bonds is that they would give investors a long-term asset with a fixed long-term real yield that is free from inflation risk.[11] Historically, investors in long-term Treasury bonds have been exposed to substantial inflation risk. In 1955, for example, the Treasury issued a 40-year bond with a coupon rate of 3 percent. Because the actual inflation rate over the past 40 years was 4.4 percent, an investor who bought this bond at full price and held it to maturity received a *negative* 1.4 percent yield on this investment (3 - 4.4 = -1.4).

While all investors would benefit from long-term indexed bonds, such bonds would be particularly desirable to the growing number of small, inexperienced investors who have to make long-term investments for retirement. The number of such investors is rising partly due to increasing public awareness of the uncertain future of social security benefits. In addition, many more small investors are having to make long-term investment decisions due to the trend of private pension plans switching from traditional defined-benefit plans to defined-contribution plans, where individual employees decide on their pension investments instead of a pension fund manager.[12]

Some people argue that indexed bonds are unnecessary because there are other ways to eliminate inflation risk. For example, some suggest that purchasing and then rolling over short-term Treasury securities, such as 3-month or 30-day Treasury bills, is a close alternative to investing in long-term indexed bonds. Such a strategy has little inflation risk

because, first, short-term debt instruments have little inflation risk, and second, the nominal yield of such a portfolio would change to the market rate whenever the portfolio rolls over. Others suggest that investing in "real" assets, such as stocks, commodities, and real estate, would reduce inflation risk considerably. None of these alternatives, however, is capable of offering investors fixed long-term real yields that are free from inflation risk.

Rolling over 3-month Treasury bills is inferior to investing in long-term indexed bonds if the intended investment horizon is long term. One problem with this strategy is that instead of locking into a known, fixed long-term yield, investors face uncertain future short-term yields, and therefore, an uncertain overall long-term yield. In essence, such a strategy exchanges inflation risk for the risk of uncertain real yields. Another problem with the strategy is that the real yields on these short-term assets are historically very low. For example, the average annualized real yield on 30-day Treasury bills from 1929 to 1994 was a mere 0.7 percent, compared with a 2 percent real yield on 20-year Treasury bonds over the same period (SBBI 1995 Yearbook).[13]

Investing in real assets would be an even less satisfactory substitute for investing in indexed Treasury bonds. First, none of the assets mentioned above provide good protection against inflation. The correlation between the yields on these assets and inflation, which measures how closely the yields vary with inflation, is typically quite low. Over the postwar period, for example, the correlation between inflation and the growth in the price of gold, which many consider to be a relatively good hedge against inflation, is only 0.47. Over the same period, the correlation between inflation and the yield on the S&P 500 index is a *negative* 0.30.

Another reason that "real assets" would be poor substitutes for indexed Treasury bonds is that they all carry other risks unrelated to inflation that are hard to eliminate. For example, a firm's stock is exposed both to risks associated with the particular firm and with the overall market.[14] Commodity and real estate prices are influenced by demand and supply as well as by their individual inventory conditions. Moreover, diversifying risks in commodities and real estate is costly. In short, investing in "real assets" simply means trading inflation risk for other risks.[15]

Benefits to the U.S. Treasury

Like investors, the U.S. Treasury would benefit from the inflation risk protection provided by indexed bonds. In addition, the Treasury might benefit from savings on its interest expense.

The U.S. Treasury, currently the biggest issuer of nominal bonds, bears considerable inflation risk in servicing its debt. For example, the Treasury continues to pay double-digit coupon rates on bonds issued during the high-inflation era of the late 1970s and early 1980s. The most notable example is a 20-year bond issued in 1981 with a 15.75 percent coupon rate. The real cost to the Treasury of this bond was 6.85 percent in 1981, when inflation was 8.9 percent (15.75 - 8.9 = 6.85). But the real cost soared to 13.05 percent last year, when inflation was 2.7 percent. If all of the Treasury's outstanding debt were indexed, the real cost of servicing its debt would not vary inversely with inflation.[16]

Indexed bonds would also save the Treasury money by eliminating an inflation risk premium that is often part of the yield on nominal bonds. A risk premium is the difference in the yields of two assets due to differences in the riskiness of the assets. Because investors do not like risk, issuers of riskier assets typically have to pay higher yields to compensate investors for taking on the additional risk. Corporate bonds, for example, pay higher yields than Treasury bonds with comparable maturities since corporate bonds have default risk and Treasury bonds do not. In other words, corporate bonds carry a default risk premium. Similarly, because

nominal Treasury bonds expose investors to considerable inflation risk, part of their yields could be an inflation risk premium. Specifically, the nominal yield on a conventional Treasury bond, i, would be the sum of three components: the real yield, r, the expected average inflation rate over the bond's life, $\hat{p}$, and the inflation risk premium, *prem* ($i = r + \hat{p} + prem$).[17] Because indexed bonds are free of inflation risk, their nominal yields do not contain an inflation risk premium ($i = r + p$). Assuming that, on average, actual inflation equals expected inflation ($p = \hat{p}$), the cost of indexed bonds would be lower by the size of the inflation risk premium. Thus, by issuing indexed bonds instead of nominal bonds, the Treasury would, on average, save money by eliminating any inflation risk premium that might exist.[18]

Unfortunately, evidence on the size of the inflation risk premium on government bonds is scarce and inconclusive because of the lack of data on real yields and expected inflation. John Campbell, a prominent financial economist, estimates that the lower bound of the inflation risk premium is a negative 0.25 percent and that the upper bound is 1.35 percent.[19] The most likely number, he suggests, is 0.5 percent.[20]

While the size of the inflation risk premium in nominal bonds is uncertain, indexed bonds would save U.S. taxpayers a lot of money as long as it is positive because the Treasury borrows on an enormous scale. Currently, the outstanding federal debt held by the public is about $4 trillion, and the Treasury has been borrowing about $200 billion each year. Even if only 10 percent of the new borrowings were through indexed bonds, the Treasury would save $100 million a year if the inflation risk premium is 0.5 percent ($200 billion times 10 percent times 0.5 percent). And if the Treasury could eventually replace 10 percent of its existing debt with indexed bonds, which could be as large as $5 trillion by the end of the century, a 0.5 percent savings would save taxpayers *$25 billion* in interest payments each year.

Benefits to policymakers

Policymakers would benefit from indexed bonds by gaining information about real interest rates and the market's inflation expectations. A liquid market for indexed Treasury bonds would provide accurate information on real interest rates. Because the nominal interest rate on a nominal Treasury bond is the sum of the real interest rate, expected future inflation, and the inflation risk premium, the difference between the rates on nominal and indexed bonds is the sum of the expected rate of inflation and the inflation risk premium. If the inflation risk premium is relatively constant over time, changes in the difference between the rates on nominal and indexed bonds would largely reflect changes in expected inflation.

Data from UK bond markets provide a good example of the information policymakers might gain from the addition of indexed bonds (Table 3). On April 5, 1995, the real yield of an indexed UK government bond maturing in 2001 (2½pc'01) was 3.95 percent, while the nominal yield of a conventional bond maturing in the same year (7pc2001) was 8.40 percent. The difference between the two rates, 4.45 percent, is the sum of the average expected inflation rate over the next six years and the inflation risk premium.[21] By June 12, both the nominal and real rates had fallen by about 0.4 percentage points. As a result, the difference between the two rates was an almost identical 4.48 percent. Thus, the change in expected inflation was negligible. Without these data on the real yield, policymakers would not be able to tell whether the 0.4 percentage point decline in the nominal rate between April and June was due to an improved inflation outlook or to changes in the real rate—a question always facing U.S. policymakers.

Currently, without direct data on real interest rates, policymakers in the United States have to rely on surveys or statistical models to estimate inflation expectations. These methods are inferior to esti-

Table 3

CHANGES IN INFLATION EXPECTATIONS

(Percent)

Date (1)	Real yield (2)	Nominal yield (3)	$\hat{p}$ + prem (4)=(3)-(2)	Change in $\hat{p}$ (5) = change in (4)
April 5, 1995	3.95	8.40	4.45	—
June 12, 1995	3.51	7.99	4.48	.03

Note: The real yield in column (2) is the yield on an inflation-indexed UK government bond ($2^1/_2$ pc'01) that matures in 2001. The nominal yield in column (3) is the yield on a nominal UK government bond (7pc2001) that also matures in 2001. $\hat{p}$ is expected inflation and *prem* is the inflation risk premium. Column (5) assumes that *prem* is constant over the period from April 5 to June 12.

mates from market data on nominal and indexed bonds. In fact, survey data cannot be used to determine whether changes in nominal rates are caused by changes in real rates or inflation expectations over short time periods because they take a long time to process and are only available for a limited number of time horizons. In addition, surveys can cover only a small group of people and often reflect off-the-cuff answers. In contrast, data on Treasury bonds are available as soon as trades occur, are available for a range of time horizons, incorporate opinions from all investors who are interested in Treasury bonds, and reflect investors' true beliefs that are backed by their money. Furthermore, while statistical models have many hidden assumptions that make the results hard to interpret, using indexed bonds requires few and explicit assumptions.

The information provided by indexed bonds would be especially valuable to monetary policymakers. Information on expected inflation and its changes, for example, would help monetary policymakers better understand inflationary pressures in the economy, allowing them to make better adjustments to monetary policy. Knowledge of inflationary pressures is useful since inflation expectations are somewhat self-fulfilling: businesses are more likely to raise prices if they think inflation will be higher, and consumers are more likely to accept the higher prices if they perceive the increases are consistent with the general inflation rate. As a result, if policymakers could detect an increase in inflation expectations, they would be able to take steps to counter such a change more effectively.

The monetary authorities could also use information about expected inflation and its changes to assess the credibility of their anti-inflation policies. Whether their credibility is strong or weak is important for determining appropriate policy actions. When credibility is strong, a slight tightening of policy may be enough to convince people that inflation is under control and, therefore, enough to reduce inflation expectations. On the other hand, when credibility is weak, a more severe tightening might be required to affect inflation expectations.

Fiscal policymakers, businesses, and consumers could also benefit from information about real interest rates and expected inflation. For example, Congress could use the information on changes in real interest rates to assess the credibility of their

efforts to balance the budget. Overall, the information provided by indexed bonds would allow both the private sector and policymakers to make better economic decisions.

LIMITATIONS OF THE BENEFITS OF INFLATION INDEXED BONDS

While inflation indexed Treasury bonds could provide many benefits, these benefits could be partially offset by some limitations arising from the design and issuance of the bonds. Some of the limitations are small and would not have much effect on the benefits. Others are more serious, but their effects could be minimized if addressed properly during the design and issuance of indexed bonds.

Limitations related to indexing

The previous discussion of the benefits was based on the assumption that there is a single, immediately available, and perfect measure of inflation. In reality, there are many inflation indexes, and none meets the ideal conditions. Different indexes are better measures of inflation for different sectors of society. For example, an index that measures the inflation rate facing investors most accurately might not be a good measure of the inflation rate relevant to the Treasury. Moreover, they all have some measurement bias. Finally, because none of the indexes are immediately available, a lagged index must be used. While the lack of a single, ideal index might reduce some of the benefits, the overall effect would be small.

Limitations due to the choice of the inflation index. If the Treasury issues indexed bonds, the benefits to investors, the Treasury, and policymakers would vary with the index actually used. The choices include the implicit and fixed-weight GDP price deflators, the producer price index (PPI), the consumer price index (CPI), and the consumer price index excluding food and energy (the core CPI). Each of these indexes provides a different measure of inflation because of differences in the baskets of goods whose prices are being measured and in the weights used to average the prices.

Since some indexes are better measures of inflation for certain groups than for others, the benefits for each group would vary with the choice of index. For the Treasury, for example, the best measure of inflation is the GDP deflator, because the Treasury's revenue is closely related to national income. Therefore, if the main goal of issuing indexed bonds is to protect the Treasury from inflation, the implicit GDP deflator should be used. But because this is not the best measure of inflation for consumers, the benefits to investors would be reduced. On the other hand, if the primary goal of issuing indexed bonds is to protect investors from inflation, the CPI is the most suitable index to use.[22]

While the benefits to different groups would vary with the choice of the index, the differences are likely to be small since the differences among the indexes are small. The nominal maturity value, for example, of a $100 real bond issued at the end of 1970 that matured at the end of 1994 would have been $397.36 if it were adjusted by the CPI and $369.86 if it were adjusted by the implicit GDP deflator—a difference of a mere 7 percent.

Measurement biases of the inflation index. Another potential problem is that whichever index is chosen, it is likely to be a biased measure of inflation. Recently, concern has been voiced about measurement biases in inflation indexes. Chairman Greenspan, for example, testified in Congress that he believed the CPI, on average, overstated inflation by 0.5 to 1.5 percentage points every year. If the chosen index is biased upward, indexed bonds will pay out a higher inflation adjustment than necessary. In addition, the extracted information about real interest rates and expected inflation could also be biased. As it turns out, however, these problems would have little effect on the benefits.

Even if the chosen index, such as the CPI, overstates inflation, it does not necessarily mean that the total payments on indexed bonds would be too large. If there is an active market for indexed bonds and people are aware of the bias, investors should be willing to accept a lower real yield because they expect inflation adjusted interest and principal payments to be greater than justified. For the indexed bond in Table 1, for example, when the inflation index is not biased, investors require a 3 percent real rate. With a 4 percent inflation rate, the Treasury's total nominal interest expense is 7 percent. Now suppose that the chosen index, on average, overstates inflation by one percentage point a year. In this case, market competition would drive the real coupon rate on the indexed bond down to 2 percent. As a result, the Treasury would pay a 2 percent real rate on the indexed bond, plus a 5 percent CPI adjustment, which is again 7 percent. Therefore, if there is a competitive market for indexed bonds, biases in the inflation index will not raise the Treasury's total payments.[23]

The bias in the index would not reduce the information benefit to policymakers either, as long as the bias remains stable over time. The important information for policymakers is not the absolute levels of either the real interest rate or inflation expectations; rather, it is how they change in response to policy actions and changes in economic conditions. If the bias is stable over time, then the information about changes in real rates and expected inflation from indexed and nominal bonds would be accurate. Suppose, for example, that the inflation index used in Table 3 overstates the UK's inflation by one percentage point on both dates. In this case, the true real yield would be 4.95 percent on April 5 and 4.51 percent on June 12, one percentage point higher than measured. The change in the true real yield is 0.44 percent, the same as the change in the measured real yield. In addition, because the change in the measured real yield is correct, the change in the measured inflation expectations would also be accurate.

Limitations caused by the lag of indexation. While the choice of the index and the measurement bias would not have much effect on the benefits from indexed bonds, the practical necessity of lags in indexation would have a more noticeable effect. Lags in indexation are necessary because the value of an index is known only with a lag. The CPI for a given month, for example, is not known until the middle of the following month, while the GDP deflator in a given quarter is not known until the end of the first month of the following quarter. As a result, perfect indexing and full protection from inflation is not possible.

In general, the lags are not very long and thus, by themselves, are not a big problem. The lags become a greater problem, however, due to the institutional arrangements for trading and settling bonds between coupon payment dates. Currently, when a bond is traded between coupon payment dates, the buyer pays the seller the agreed-upon price of the bond and the accrued interest. For example, if a bond paying $2 interest on the first of February and August (semiannually) is sold on the first of May, the buyer will pay the seller $1 in addition to the bond's price. Then on the first of August, the buyer simply keeps all of the $2 interest payment. This arrangement allows bonds to be traded many times without the need to keep track of every owner for the six months prior to a coupon payment. With indexed bonds, however, the next coupon payment, and thus the accrued interest, cannot be known until two months after the coupon payment date, which can be up to eight months after the bond is sold, because actual inflation cannot be known until then.

The institutional arrangements necessary to allow the trading and settling of indexed bonds greatly extend the necessary length of the indexation lags. The institutional arrangement adopted by the United Kingdom, for example, is to use an eight-month lagged index. That is, the coupon payments and the maturity value of an indexed bond are adjusted by the inflation rate eight months before

the payment date. With this solution, however, investors are not protected from inflation risk over the last eight months of an indexed bond's life, because an indexed bond with less than eight months to maturity essentially becomes a nominal bond.

Another problem is that the lag in indexation makes it more difficult to extract near-term information on real interest rates and inflation expectations. Because of the lag, an indexed bond with less than, say, two years to maturity still exposes investors to inflation risk because it is a nominal bond for a third of its remaining life. Thus, its yield will no longer reflect the true two-year real interest rate. This is a significant problem for monetary policymakers whose policy actions are often based on the economic outlook over horizons of one to two years.

While having to use a lagged index would reduce some of the benefits of indexed bonds, the reduction would be relatively small for several reasons. First, while indexation lags would eliminate the protection against inflation for the last eight months before a bond's maturity, the inflation risk over an eight-month period is small. Second, even though the yield on a short-term indexed bond would no longer truly reflect the short-term real interest rate, it would provide some useful information. Moreover, the information on longer term real yields and inflation expectations would still be accurate. And finally, the Treasury could minimize the effect of indexation lags by issuing indexed bonds with more frequent coupon payments. For example, instead of paying coupons semiannually, indexed bonds could pay coupons monthly, thereby reducing the necessary length of the indexation lag from eight months to three months.

Limitations due to taxation

Taxation could also limit the benefits of indexed bonds. Taxation could reintroduce some inflation risk to indexed bonds. And, due to the tax treatment, the demand for indexed bonds might fall.

Taxation could reintroduce inflation risk to indexed bonds because the current U.S. tax code does not distinguish increases in real income from increases in nominal income due to inflation. As a result, even if real yields do not change, an increase in nominal income due to an increase in inflation would boost an investor's tax liabilities, thereby reducing after-tax real yields.

Table 4 shows how the tax code could lead to inflation risk in indexed bonds. The first row in the table shows that initially, the inflation rate is 1 percent and the before-tax real yield is 3 percent so that the before-tax nominal yield is 4 percent. With a 30 percent flat tax rate, the tax burden is 1.2 percent (30 percent of the 4 percent nominal yield); the after-tax nominal yield is 2.8 percent (before-tax yield of 4 percent minus tax burden of 1.2 percent); and the after-tax real yield is 1.8 percent (after-tax nominal yield of 2.8 percent minus the inflation rate of 1 percent). In the second row, inflation unexpectedly surges to 7 percent. Since the cash payments of the indexed bond are adjusted for inflation, the before-tax nominal yield rises to 10 percent. This gain in the nominal yield, however, increases the investor's tax burden to 3 percent so that the after-tax nominal yield is 7 percent, the same as the inflation rate. Thus, the after-tax real yield declines to zero. Because the increase in inflation increases the nominal yield of an indexed bond and, therefore, the tax burden of investors, even an indexed bond with perfect indexation exposes its investors to some inflation risk.

The inflation risk, however, would be smaller for indexed bonds than for nominal bonds. For a nominal bond, the decline in the real yield caused by an increase in inflation is one for one, while for an indexed bond, the decline in the real yield is scaled down by the tax rate. For example, in Table 4, the six percentage point rise in inflation reduces the after-tax real yield of the indexed bond by 1.8 percentage points (6 percent times the tax rate of 30 percent). In contrast, for a nominal bond, an unex-

Table 4

EFFECT OF TAXES

(Percent)

Bond	Inflation rate (1)	Before-tax real yield (2)	Before-tax nominal yield (3)=(1)+(2)	Tax burden (4)=(3)x30%	After-tax nominal yield (5)=(3)-(4)	After-tax real yield (6)=(5)-(1)	Change in after-tax real yield (7)=change in (6)
Indexed	1	3	4	1.2	2.8	1.8	—
	7	3	10	3	7	0	-1.8
Nominal	1	3	4	1.2	2.8	1.8	—
	7	-3	4	1.2	2.8	-4.2	-6.0

pected six percentage point increase in inflation would reduce both the before-tax and after-tax real yield by the full six percentage points, as shown in the last two rows of Table 4.[24]

While taxation reintroduces inflation risk to indexed bonds, the information benefit to policymakers remains. In general, when investment income is taxable, the observed yields of both nominal and indexed bonds would be adjusted by the market to compensate investors for the tax burden. The adjustments for nominal and indexed bonds are the same since both bonds are treated the same way for tax purposes. As a result, when the difference between nominal and indexed bond yields is used to determine changes in real rates and inflation expectations, the tax adjustments would cancel each other out.[25]

The second way taxation could reduce the benefits of indexed bonds is that the proposed method of taxation could reduce the demand for them. The Treasury has indicated that, if issued, the increase in the maturity value of the principal of an indexed bond due to the inflation adjustment would be treated as current income for tax purposes even though the increase would not be paid out until maturity.[26] By taxing income that has not been received, the demand for indexed bonds may be reduced to a narrow sector of investors, namely, those who are exempted from taxes, such as IRAs and pension funds.[27]

Reducing the demand for indexed bonds to such a narrow sector could result in a much less liquid market for indexed bonds, thus reducing the benefits of indexed bonds for two reasons. First, the extracted information on real yields and inflation expectations could be of lower quality since it would reflect only the views of a narrow sector of investors. Second, a less liquid market could reduce the savings to the Treasury. The effect of market liquidity is discussed in detail in the next section.

Effect of market liquidity

While the likely tax treatment for indexed bonds could limit the liquidity of the market, experience abroad suggests the indexed bond market would be less liquid than the nominal bond market even

without the tax effect. In the United Kingdom, for example, the nominal increase in the principal of an indexed bond is not taxed.[28] Nevertheless, indexed UK government bonds are less liquid than nominal bonds—indexed bonds are turned over only about one-third as often as nominal bonds (Butler). With the tax effect, it is even more likely that the U.S. market for indexed Treasury bonds would be less liquid than the market for nominal Treasury bonds.

If it turns out that the market for indexed Treasury bonds is much less liquid, the Treasury might have to pay a liquidity premium when issuing indexed bonds. A liquidity premium is the additional yield an issuer pays to compensate investors for investing in a less liquid asset. In a world full of uncertainties, investors frequently need to adjust their holdings of a security. Because it is more costly to adjust the holdings of an illiquid asset than a similar but liquid asset, the issuer must compensate investors by paying a higher yield. This additional yield is a liquidity premium for investors and an additional interest expense for the issuer. In the case of indexed bonds, this additional expense would reduce the savings to the Treasury from issuing them.[29]

While it is possible that an indexed bond market would be less liquid than a nominal bond market, it is not clear that liquidity would be a serious problem. Theoretically, there is no obvious reason why one market should be intrinsically much less liquid than the other. Even if there is some difference in liquidity, the difference may not be great enough to warrant a sizable liquidity premium.[30] Furthermore, the Treasury could use its expertise to design indexed bonds to maximize market liquidity and thus minimize any liquidity premium. The Treasury has considerable experience in creating and maintaining liquid markets. Over the years, the Treasury has successfully designed the composition and auctions for its nominal bonds to ensure a liquid market. In fact, the U.S. Treasury bond market is currently one of the most liquid markets in the world.[31]

CONCLUSION

Inflation indexed Treasury bonds would be a valuable innovation in U.S. financial markets, providing benefits to investors, the Treasury, and policymakers. Not only could they protect both investors and issuers from inflation risk, but they could also save the Treasury interest expense on its debt. Moreover, combined with nominal bonds, indexed bonds would provide policymakers with additional information on real interest rates and inflation expectations.

While complications arising from the actual design and issuance of indexed bonds could limit these benefits, the limitations are not sufficient to completely offset the benefits. The choice of the inflation index and the measurement bias of the index would have little effect on the benefits, and the effect of the indexation lags could be minimized by issuing indexed bonds with monthly coupon payments. Although the current tax code would not allow indexed bonds to be completely free of inflation risk, the inflation risk associated with indexed bonds would still be much less than for nominal bonds. The tax code, however, might slightly reduce the quality of information extracted from the bonds, but only if the tax treatment effectively restricts the demand for the bonds to a narrow sector of investors. Finally, the Treasury could design indexed bonds to maximize market liquidity, which would minimize the loss of savings due to the liquidity premium.

On balance, the conclusion reached here is that inflation indexed Treasury bonds could be a valuable addition to the spectrum of Treasury debt instruments.

ENDNOTES

[1] This article only discusses indexed bonds issued by the U.S. Treasury even though much of the discussion applies to the private sector. For a discussion of the possible explanations for the lack of private issuance of indexed bonds, see Weiner.

[2] The "yield" of a bond is the discount rate that equates its current price with the present value of its future cash flow. This rate is also called the "internal rate of return" or "yield to maturity." If P is the price, N is the years left to maturity, C is the coupon rate, and M is the maturity value, then the rate of return or yield, r, solves the equation:

$$P = \sum_{k=1}^{N} \frac{C * M}{(1+r)^k} + \frac{M}{(1+r)^N} .$$

In the example in the text (and in the rest of this section), P is assumed to equal M for expositional simplicity. Thus, the yield of the bond equals its coupon rate. When the maturity value and price are expressed in nominal terms, r is the nominal yield, and when the maturity value and price are expressed in real terms, r is the real yield.

[3] The Fisher identity used in the text assumes the interest payments are compounded continuously. For discrete compounding, the Fisher identity is $r = (i - p)/(1 + p)$. When the inflation rate, p, is less than 10 percent, the difference between the two versions is small. Thus, the continuously compounded version is used in the text for expositional simplicity.

[4] Although the effect of inflation on the real yield can be countered by a higher nominal coupon rate, inflation still changes the pattern of the real cash flow—namely, the real coupon payments decline over time and the real maturity value is less than $100.

[5] Using the terminology of Stanley Fischer, this article focuses on "indexed principal bonds," as opposed to "indexed interest bonds." Indexed principal bonds are currently available in countries such as Canada and the United Kingdom that have issued indexed bonds. An indexed interest bond is a bond with a fixed nominal maturity value that pays out increases in nominal principal due to inflation along with the coupon payments. The real yields of the two types of indexed bonds, however, are exactly the same, even though their cash flows are quite different.

[6] The nominal cash flow is simply the real cash flow plus an inflation adjustment, which is the cumulative inflation rate times the real cash flow.

[7] Statistically, inflation is an I(1) or near I(1) series when measured in short time intervals.

[8] This change in real value due to a change in inflation is the pure inflation risk caused by changes in the purchasing power of the maturity value of a bond. It is conceptually different from the price risk of a bond, which is related to the discounting of future payments.

[9] There are some other minor differences between indexed and nominal bonds. For example, indexed bonds have longer durations than nominal bonds with the same maturity. When there is inflation (even a fully anticipated inflation), the nominal bond pays part of its principal out as higher coupon payments, whereas the indexed bond maintains its principal. It is also worth noting that duration is essentially a nominal concept, and thus can be quite misleading. For example, for nominal bonds, duration represents the price risk caused by changes in interest rates. But for indexed bonds, their prices do not change if the change in nominal interest rates is caused by a change in inflation.

[10] Many other countries have also issued indexed bonds, but they are mostly developing countries that have experienced hyperinflation.

[11] Actually, the real yield is fixed only if the bond is held to maturity because the bond is still exposed to price risk, the risk that its price will change due to changes in the real interest rate. This risk can be avoided if a bond is held until it matures. It is also worth noting that the price risk of a real bond will likely be smaller than the price risk of a nominal bond because the price of a real bond will react to changes in the real interest rate but not to changes in inflation.

[12] To further help small, inexperienced investors, the U.S. Treasury could issue inflation indexed savings bonds (Kane).

[13] Some people might consider this term premium to be an inflation risk premium. However, it is possible that at least part of the premium is a reward for holding a long-term asset for a long period. If this is the case, investing in short-term Treasury bills for inflation protection forces investors to sacrifice this portion of the term premium, whereas the issuance of indexed bonds allows investors to separate the choice of the riskiness of assets from the choice of the time horizon of assets.

[14] A well-diversified portfolio of stocks can eliminate firm specific risk but has no effect on general market risk.

[15] This observation reveals another reason that investors

would benefit from the issuance of indexed Treasury bonds, namely, if both indexed and nominal Treasury bonds are available, investors can combine them to create a portfolio that has only inflation risk. Such a portfolio allows investors to unbundle inflation risk and manage risk more efficiently. Therefore, even sophisticated investors who are not directly interested in long-term inflation-risk-free assets *per se* would benefit from indexed bonds.

16 It is especially desirable for the Treasury to stabilize the real cost of its debt since its real tax revenue moves together with inflation. Ideally, all tax brackets, deductions, and exemptions should be fully adjusted for inflation so that the Treasury's real revenue would not vary with inflation. In this ideal case, if the Treasury's real cost of debt was also independent of inflation, the Treasury would not bear any inflation risk. In reality, the tax codes are only partially adjusted for inflation, causing the Treasury's real revenue to move together with inflation. As a result, when inflation declines, the Treasury's real tax revenue declines while the real cost of servicing its debt rises. The imperfect indexation of the Treasury's revenue makes the case for indexed bonds even stronger because the real interest cost of servicing indexed bonds would then not rise and, therefore, would not exacerbate the effect of declining real revenue.

17 In other words, the Fisher identity, which always holds for realized nominal yields, realized real yields, and realized inflation rates, will not hold *ex ante* if there is uncertainty.

18 The savings can be even greater if a government's anti-inflation policy is not credible. In such a case, expected inflation, $\hat{p}$, will on average be greater than actual inflation so that the Treasury's savings would be $prem + (\hat{p} - p)$. This situation actually occurred in the United Kingdom in the early 1980s. Because investors did not believe the government's commitment to reducing inflation, issuing indexed bonds allowed the UK government to pay at least two percentage points less on the yields of its real debt (Walters). This savings from incorrect inflation expectations, however, is different from the savings from the elimination of the inflation risk premium. First, the savings is temporary since it will disappear when the government's policy becomes credible. Second, there is no net benefit to society because the government's savings on its interest expense is lost interest income to investors.

19 It is possible that the inflation risk premium is negative because bond issuers are also exposed to inflation risk and thus could be compensated by paying a lower yield on their bonds. If the issuers dislike inflation risk more than investors, the inflation risk premium would be negative. While plausible, this is highly unlikely. It is more probable that the Treasury is less risk averse to inflation than general investors. In this case, the inflation risk premium in Treasury bond yields would be positive.

20 Recently, economists have used yields from UK government indexed bonds and nominal bonds to estimate the inflation risk premium (Deacon and Derry). They typically find that the inflation risk premium is much higher, in the range of 3 to 5 percent, but that it is not statistically different from zero. Given that there is only about ten years of data, it is not surprising that the estimates are not statistically significant. It is also possible that there would have been a significant inflation risk premium in nominal UK government bond yields if there had been no indexed bonds. Theoretically, it is plausible that investors who dislike inflation risk the most have all been accommodated by indexed bonds, and thus nominal bonds are mostly held by investors who do not care about inflation risk. Consequently, the inflation risk premium disappears. If this is indeed the case, then there would be two sources of savings to the Treasury from issuing indexed bonds. The first is the savings on the indexed bonds themselves. The second is a savings on the nominal bonds since the risk premium on nominal bonds would also fall.

21 If one is willing to make an assumption about the size of the inflation risk premium, then subtracting this risk premium from 4.45 gives an estimate of expected future inflation.

22 A related problem with indexing is that almost all indexes are regularly rebased, which is necessary to accurately reflect the changing production and consumption patterns in a changing economy. Rebasing the index chosen for indexed bonds could create a credibility problem for the government. For example, investors might fear that the government would purposely rebase the index to reduce its interest payments. This is not likely, however, because many of the government's payments, such as social security benefits, are already indexed to the CPI and there have been few complaints. Another solution adopted by the United Kingdom is to allow investors to redeem their bonds prior to maturity if a rebasing reduces the payments on an indexed bond. This solution, however, exposes the Treasury to a prepayment risk.

23 The Treasury's total payments on nonmarketable inflation indexed savings bonds would not rise either, as long as their real yields are set with the guidance of actively traded indexed bonds.

24 It is possible to change the tax code so that it does not create inflation risk for indexed bonds. For example, replacing income taxes with consumption taxes would solve the problem because the increase in the nominal yield would not automatically increase the tax burden of investors. Short of this, it is still possible to reduce the effect of taxes by piecemeal changes in the tax code. For UK indexed

government bonds, for example, the tax effect is smaller since capital gains in the United Kingdom are only taxed after adjusting for inflation. In the case of indexed bonds, the increase in the nominal maturity value of the principal due to inflation is treated as a capital gain and, therefore, is nontaxable.

[25] There could also be an inflation risk premium term in the yields of indexed bonds since, with taxes, even indexed bonds have inflation risk. This term will not be canceled out by taking the difference between nominal and indexed bond yields because the sizes of the inflation risk premiums would probably be different. As long as the risk premiums are relatively stable over time, however, they will disappear when the change in the difference between the nominal and indexed bond yields is used to calculate the change in expected inflation.

[26] This is also how the increase in the maturity value of the principal of a zero-coupon bond is treated. While it is desirable to have different Treasury debt instruments treated the same way for tax purposes, it is not clear that this is the best way to treat them.

[27] This restrictive effect has occurred for zero-coupon bonds. There are reasons to believe, however, that the restrictive effect for indexed bonds would be smaller than that for zero-coupon bonds. In the case of indexed bonds, there are current coupon payments that could be used to pay taxes. For example, for an indexed bond with a 3 percent coupon rate, if inflation is 4 percent, the principal becomes $104 after a year, and the investor's total taxable income from the bond is the sum of the coupon payment, $3.12 (104*.03 = 3.12), and the increase in principal, $4, which is $7.12. If the tax rate is 30 percent, the investor's total tax liability from the bond is $7.12*0.3 = $2.14, which can be paid by the coupon income from the bond. Because of the coupon payments, indexed bonds should attract more investors than zero-coupon bonds.

[28] See note 24.

[29] The presence of a liquidity premium would not have much effect on the quality of the extracted information on real interest rates and inflation expectations. Just as in the discussion about the effect of measurement errors in the inflation index, the estimated changes in real yields and inflation expectations would be informative and unbiased as long as the liquidity premium does not change over time.

[30] In fact, the Treasury may not need to pay a liquidity premium even if the indexed bond market is less liquid. The liquidity premium depends on both the transaction cost of trading and the expected frequency of trading. For example, if a nominal bond is expected to be traded 20 times in its lifetime, and the transaction cost for each trade is 0.05 percent, using backward deduction, 1 percent (20 times 0.05) of the yield in the initial auction of the bond is to cover the transaction cost. The transaction cost associated with each trade of a comparable indexed bond, on the other hand, could be 0.1 percent, twice as high. But if the indexed bond is only expected to be traded ten times in its lifetime, the total transaction cost in its auction yield is also 1 percent (ten times 0.1). In this case, there is no liquidity premium for the issuer of the indexed bond, even though its market is less liquid.

[31] Another effect of market liquidity is that it could make experimental issuance of indexed bonds useless. Because experimental issuance would typically be associated with a very illiquid market, the liquidity premium would be high and the information from such a market would not be representative.

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