Inflation-Indexed Bonds: How Do They Work?

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In a *Newsweek* article in 1971, economist and Nobel Laureate Milton Friedman scolded the government for repaying its debt in dollars whose value is eroded by inflation. His prescription was to:

> *"Let the Treasury promise to pay not $1,000 but a sum that will have the same purchasing power as $1,000 had when the security was issued. Let it pay as interest each year not a fixed number of dollars but that number adjusted for any rise in prices."*

Now, 26 years after the urging of Professor Friedman and a host of commentators before and after him, the U.S. Treasury has unveiled an "inflation-protection security." This new security, also known as an inflation-indexed or inflation-linked bond, is designed to protect the purchasing power of an investor's savings by indexing interest and principal payments to consumer prices. If prices go up, so, too, do dollar payments from an indexed bond. Therefore, holders of indexed bonds aren't hurt by inflation.

The Treasury started its indexed bond program in January 1997 by issuing 10-year inflation-protection bonds, with principal and interest payments linked to the consumer price index for all urban consumers (CPI-U). The indexing program will expand to include bonds of different maturities and other types of financial instruments, such as savings bonds. The

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United States joins Canada, Sweden, New Zealand, the United Kingdom, and many other countries that also issue bonds linked to inflation.

This article provides a simple description of the new inflation-protection bonds. We'll consider why indexed bonds can be useful to investors, to the Treasury, and to policymakers in the Federal Reserve.

HOW DO INFLATION-INDEXED BONDS DIFFER FROM CONVENTIONAL BONDS?

Conventional Bonds. Conventional bonds promise fixed dollar payments of interest and principal. The real value, or purchasing power, of a bond's payment is how many goods and services it can buy. However, real values of future dollar payments are not known when a conventional bond is issued because future inflation is unknown. Therefore, both the purchaser and the issuer of a conventional bond face *inflation risk,* the risk of unanticipated changes in the purchasing power of the nominal (dollar) payments promised by the bond.

Consider purchasing for $10,000 a one-year bond that pays back your principal investment plus a nominal return of 5 percent. This bond will pay $10,500 at the end of one year. The real value of the $10,500 received in one year depends on what happens to prices. Suppose you expect inflation to be 3 percent over the year. While the nominal payment will be $10,500 at the end of a year, you expect that it will cost $10,300 then to buy what $10,000 buys at the start of the year. Thus, you expect to have $200 of extra purchasing power at the end of the year—a 1.94 percent *real* increase in purchasing power.[1]

However, suppose inflation turns out to be 5 percent. In this case, the bond generates a zero real return because goods and services that could be obtained with $10,000 at the start of the year end up costing $10,500 at the end of the year. The higher inflation rate eliminates your expected real return. The beneficiary is whoever issued the bond, since the issuer ends up paying a nominal amount whose purchasing power is eroded by unexpectedly high inflation. But if inflation turns out to be unexpectedly low, your real return rises. If inflation is 1 percent, your real return will be $400, or 3.96 percent.

In general, when inflation is higher than expected, bondholders suffer unanticipated losses of purchasing power. Conversely, when inflation turns out to be lower than expected, bondholders receive unanticipated gains of purchasing power. In such cases, those who issue nominal debt lose, since the real cost of paying off conventional nominal debt rises when inflation unexpectedly falls.

Inflation-Indexed Bonds. With an inflation-indexed bond, the real rate of return is known in advance, and the nominal return varies with the rate of inflation realized over the life of the bond. Hence, neither the purchaser nor the issuer faces a risk that an unanticipated increase or decrease in inflation will erode or boost the purchasing power of the bond's payments.

Suppose you are offered a one-year bond that costs $10,000 today and that promises a real return of 1.94 percent, which was the real return you *expected* in the earlier example. The bond promises that, after a year, you will be able to obtain 1.94 percent more goods and services. If inflation turns out to be 3 percent, the face value of the bond will rise to $10,300, and the bond will pay interest equal to 1.94 percent of $10,300, or $200. But if inflation turns out to be 5 percent, the face value of the bond will rise to $10,500, and the interest payment will be $204. In either case, you will be able to buy 1.94 percent more goods and services after a year. (For a more detailed example that compares payments from conventional and indexed bonds with a maturity of more than one year, see *Example of Payments on Nominal and Indexed Bonds.*)

[1] The percentage increase in purchasing power is ($200/$10,300)·100=1.94%.

Example of Payments on Nominal and Indexed Bonds

Consider a 10-year conventional nominal bond and a 10-year inflation-indexed bond. Each bond is purchased at its face, or principal, value of $1000. Although Treasury notes and bonds provide semiannual payments, the bonds in this example are assumed to provide annual coupon payments. Each coupon payment on a conventional bond is the coupon rate stated on the bond times the principal. Each coupon payment on an indexed bond is the coupon rate times the indexed principal. The indexed principal is simply the beginning principal of $1000 scaled up through time at the rate of inflation. We'll assume that the coupon rate on the indexed bond is 3 percent, and that actual inflation over the 10-year horizon turns out to be a steady 2 percent, equal to expected inflation, and that the coupon rate on the conventional bond is 5.06 percent so that its expected real rate of return equals the coupon rate on the indexed bond.

A schedule of nominal and real values of payments on the bonds is given below. The real values give the purchasing power of the nominal payments. For example, suppose a given item today cost $1. With 2 percent inflation, at the end of the year the same item will cost $1.02, and $1 will purchase .98 (1/1.02) units of the item. So, $50.60 received at the end of year 1 from the nominal bond will purchase 49.61 units.

As the schedule of payments shows, the nominal value of the conventional bond's principal stays fixed. The real value is eroding through time because of inflation. When received at maturity, the $1000 principal can purchase 820.35 units of the good. In contrast, when the bond was first purchased, that $1000 could buy 1000 units. The payment schedule also shows how the fixed nominal payment of $50.60 per year on the nominal bond has a smaller real value over time because of inflation. Note that for the indexed bond, the real values of the principal and interest payments are preserved for the life of the bond. The nominal principal gets scaled up year by year according to inflation. As the principal gets scaled up, so, too, does the nominal coupon payment to preserve the real return of 3 percent. The indexed bond pays less interest than the nominal bond each year, but that is offset by its larger payment of principal at maturity.

Schedule of Payments

	Conventional Bond				Indexed Bond			
Year	Nominal Value of Principal	Real Value of Principal	Nominal Interest Payment	Real Value of Interest Payment	Nominal Value of Principal	Real Value of Principal	Nominal Interest Payment	Real Value
1	$1000	980.39	$50.60	49.61	$1020.00	1000	$30.60	30
2	$1000	961.17	$50.60	48.64	$1040.40	1000	$31.21	30
3	$1000	942.32	$50.60	47.68	$1061.21	1000	$31.84	30
4	$1000	923.85	$50.60	46.75	$1082.43	1000	$32.47	30
5	$1000	905.73	$50.60	45.83	$1104.08	1000	$33.12	30
6	$1000	887.97	$50.60	44.93	$1126.16	1000	$33.78	30
7	$1000	870.56	$50.60	44.05	$1148.69	1000	$34.46	30
8	$1000	853.49	$50.60	43.19	$1171.66	1000	$35.15	30
9	$1000	836.75	$50.60	42.34	$1195.09	1000	$35.85	30
10	$1000	820.35	$50.60	41.51	$1218.99	1000	$36.60	30
	Total Nominal Receipts: $1506 Real Value of Principal at Maturity: $820.35				Total Nominal Receipts: $1554.07 Real Value of Indexed Principal at Maturity: $1000			

WHY WILL INVESTORS BUY INDEXED BONDS?

Investors who desire predictable real cash flows can now include indexed bonds in their portfolios. The certain real return will be attractive to investors who are particularly risk averse. It will also be attractive to savers who want to protect their savings from being eroded by inflation.

More generally, inflation-indexed bonds can be useful in diversifying any portfolio of assets, as investors in other countries have already found. However, markets for indexed bonds in other countries tend to be small and have relatively low amounts of trading activity (see *Experiences in Other Countries*), reflecting the fact that indexed bonds are particularly attractive to specific groups that tend to buy the bonds and hold them until they mature.

WHY DOES THE U.S. TREASURY SELL INDEXED BONDS?

For many years the Treasury opposed issuing indexed debt for two main reasons. One was concern that there would not be strong demand from investors. The second was that some Treasury officials believed that issuing indexed debt could increase borrowing costs by fragmenting ("balkanizing") the overall Treasury bond market.[2] According to this idea, the market for Treasury bonds would fragment and become increasingly tailored to specific classes of investors. As a result, trade across market segments would be reduced, and the liquidity of all Treasury bonds would fall.[3] If Treasury assets become less liquid, investors would demand a premium to compensate for low liquidity, thus raising the Treasury's cost of borrowing. Given its decision to issue indexed bonds, however, the Treasury has evidently concluded that benefits from issuing them outweigh concerns about low demand and balkanization.[4] What are those benefits?

Lower Borrowing Costs. Since the real return on conventional bonds is subject to inflation risk, holders of these bonds demand a "risk premium" in the form of a higher yield relative to an asset with no such risk. Inflation-indexed bonds, however, remove the investor's inflation risk. So by issuing indexed bonds, the Treasury can avoid paying the inflation risk premium found in nominal interest rates on conventional bonds and can thereby lower its borrowing costs.

The size of the inflation risk premium is difficult to measure. Recent academic research suggests that it might be 50 to 100 basis points.[5]

[2] See testimony in "Inflation-Indexed Treasury Debt as an Aid to Monetary Policy," hearings before the Commerce, Consumer, and Monetary Affairs Subcommittee of the Committee on Government Operations, House of Representatives, June 16 and 25, 1992.

[3] Liquidity refers to the ease with which an investor can sell a bond in a secondary market.

[4] Some wonder why inflation-indexed securities have not been issued by the private sector. In fact, they have, but they have not flourished. Some securities, such as variable rate mortgages, are indexed, but not directly to inflation. In the mid-1980s, the Coffee, Sugar, and Cocoa Exchange attempted to trade futures contracts based on the Consumer Price Index. The CPI futures were offered beginning in June 1985, but died in 1991. According to James Bowe, president of the exchange, CPI futures didn't catch on because there was no primary market for inflation to trade against, as there is for futures contracts based on commodities or financial assets. That is, certain arbitrage opportunities were not present. With the new inflation-indexed bonds to trade against, inflation futures or real interest rate futures may become viable. For a discussion of the CPI futures market, see Brian Horrigan, "The CPI Futures Market: The Inflation Hedge That Won't Grow," Federal Reserve Bank of Philadelphia *Business Review*, May/June 1987.

[5] One basis point equals one hundredth of a percentage point. For evidence on the size of the inflation risk premium, see results in John Y. Campbell and Robert Shiller's article "A Scorecard for Indexed Government Debt," National Bureau of Economic Research Working Paper 5587, May 1996.

Experiences in Other Countries

	Israel	U.K.	Sweden	Australia	Canada	New Zealand
Year First Issued	1955	1981	1994	1985	1991	1995
Amount Outstanding (in billions of U.S. dollars)	27.9	71.1	5.7	2.7	4.3	0.1
Indexed Debt as Percent of Country's Total Marketable Debt (percent)	79.0	17.8	4.5	3.8	1.4	0.7
Daily Turnover (average for 1995, in millions of U.S. dollars)	20.2	326.9	Infrequent Trading	24.0	24.0	Very Infrequent Trading

Source: Bank of England, Indexed-Linked Debt, conference packet of papers presented at the Bank of England Conference, September 1995.

The data above show the amount and liquidity (as measured by daily turnover) of indexed debt in other countries as of March 31, 1996. There are three notable features of the data. First, in Israel, where there have been major episodes of high and variable inflation, the majority of government debt is indexed. Second, the United Kingdom issues a significant amount of indexed debt. Most long-term borrowing in the United Kingdom is through indexed bonds known as indexed gilts. Third, markets for indexed debt have low trading activity, which can be seen by comparing daily turnovers with amounts outstanding. A number of other countries have issued indexed debt but are not included in the table because of limitations in the data.

That is, the interest rate paid on conventional nominal bonds is between 0.5 and 1.0 percentage points higher than it would be if investors did not face the risk that unexpected movements in inflation could change the real value of their investments.

At the inaugural auction of indexed bonds on January 29, 1997, the Treasury sold $7 billion of 10-year indexed bonds at a real yield of 3.45 percent. On that date, the yield on conventional 10-year Treasury bonds was 6.63 percent. According to inflation forecasts taken from the November 1996 and February 1997 *Survey of Professional Forecasters*, inflation is expected to average 3.0 percent per year from 1997 to 2007. Those three percentages suggest an inflation risk premium of 18 basis points in the yield on the conventional bond.[6] Therefore, the Treasury saved 18 basis points on the yield of the indexed bond by avoiding the inflation risk premium. It is difficult to predict, however, whether sav-

[6] The risk premium of 18 basis points is calculated as follows: Add 3.0 percent expected inflation to the indexed bond's real yield of 3.45 percent to get an expected nominal yield, without any inflation risk premium, of 6.45 percent. Subtract 6.45 percent from the conventional bond's yield of 6.63 percent to arrive at 18 basis points.

ings in future indexed bond issues will be on the same order, especially since the January 29 auction offered the first indexed bond issue, and market participants may not have been familiar with details of the new bonds.

Let's suppose that the inflation risk premium on conventional Treasury bonds of all maturities eventually settles at 50 basis points—the low end of the range suggested by academic studies. How much could the Treasury save by eliminating the inflation risk premium on even a small fraction of its outstanding debt? Lots, because the Treasury borrows lots of money. The total U.S. government debt held by investors as of September 1996 was about $3.4 *trillion*. If the Treasury over time substitutes inflation-indexed bonds for 15 percent of that debt and, as a consequence, saves the inflation risk premium on 15 percent of $3.4 trillion, it can generate a saving of $2.55 billion in interest payments each year.[7] This kind of potential cost saving helps explain why the Treasury has decided to issue indexed bonds.

While indexed bonds allow the Treasury to avoid paying the inflation risk premium on some of its debt, the Treasury faces the risk of increased nominal costs of debt arising from future inflation. When inflation rises, nominal payments on indexed bonds also rise to preserve the real interest rate promised by the bonds. Thus, with indexed bonds, the Treasury takes on uncertainty over future nominal payments as investors shed it. Many would agree with this transfer on the grounds that the government may be in a better position than investors to handle inflation uncertainty.

Less Volatile Real Costs. The Treasury knows what its real cost of borrowing will be when it issues an indexed bond, but the dollar values of its future interest and principal payments are uncertain. In contrast, the Treasury knows the dollar values of its future payments when it issues a conventional bond, but is uncertain about its real cost of borrowing.

To see how inflation can affect the real cost of borrowing, consider the 10-year bonds issued in January 1997: a 10-year indexed bond with a real yield of 3.45 percent, and a 10-year conventional bond with a nominal yield of 6.63 percent. Suppose that an investor in the indexed bond reinvests interest payments annually at the real yield of 3.45 percent, and that an investor in the conventional bond reinvests interest payments annually at the nominal yield of 6.63 percent. At the end of 10 years, the investor in the indexed bond will be able to purchase goods that cost $14,037.99 in January 1997. That number represents the real value in 10 years of the Treasury's payments on the principal and reinvested interest to the investor. This real value of payments is known to the Treasury and investors when the indexed bond is issued.

The real value of payments on the conventional bond depends on what happens with inflation. Suppose investors expected inflation to average around 3 percent over the 10-year life of the bonds. If inflation turns out to be a steady 3 percent over the 10 years, the investor in the conventional bond will be able to purchase goods that cost $14,139.10 in 1997, close to the purchasing power from the indexed bond. If inflation turns out to be a steady 1 percent—lower than expected—the investor in the conventional bond will be able to purchase $17,202.05 worth of goods in 10 years. In that case, the Treasury will make higher real payments than expected because inflation was lower than expected. If inflation turns out to be a steady 5 percent—higher than expected—the investor will be able to purchase $11,665.44 worth of goods. In that case, the Treasury will

[7] The potential reduction in the budget deficit may be smaller. If the Treasury cuts its gross interest payments by $2.55 billion, it also cuts the tax revenue it would capture by taxing investors' interest earnings. If all investors faced a marginal tax rate of 30 percent and none held government bonds in tax-exempt accounts, the Treasury's saving, net of the tax effect, would be $1.785 billion ($2.55 billion times (1-.3)), still a substantial sum.

make lower real payments than expected.

Thus, with the conventional bond the Treasury faces uncertainty about the real values of the scheduled nominal payments it will make. With the indexed bond, the Treasury does not face volatile future real costs of borrowing. It knows the real cost of its borrowing and faces uncertainty about how many dollars it will be paying to provide a scheduled real return.[8]

FEATURES OF THE NEW BONDS

As we noted, the U.S. Treasury issued its first inflation-indexed bonds—10-year bonds with a 3.45 percent real coupon rate—in January 1997. As with conventional bonds, these inflation-indexed securities provide semiannual coupon payments determined by a fixed rate of interest and return the principal at maturity. In contrast to conventional bonds, the principal on the indexed bond is adjusted by any change in the level of the Consumer Price Index from the date of issue.[9] Each semiannual coupon payment is arrived at by multiplying one-half of the stated annual coupon interest rate by the indexed principal.

The Price Index. For U.S. inflation-indexed bonds, the principal is indexed to the nonseasonally adjusted CPI-U, which tracks prices of a basket of goods purchased by a typical urban consumer. It is announced and published regularly by the Labor Department. Although the Treasury could have chosen a number of other price indexes, it chose the CPI-U because it is well known, is reported regularly, and encompasses a basket of goods representative of what consumers typically purchase.

Different savers have different objectives. Some save for their children's education, while others save for medical care they may need in old age. Consequently, some are concerned about the future prices of higher education, while others are more concerned about the future prices of medical care. If prices that concern a particular saver behave differently from prices captured by the CPI-U, an inflation-indexed bond will not entirely protect the purchasing power of concern to the saver.[10]

Many economists believe that the Consumer Price Index overstates the true rate at which the cost of living is rising.[11] If so, won't indexed bonds tied to the CPI-U overcompensate investors in real terms? Probably not. Participants in the bond market take into account their perceptions of any bias in the CPI-U's measurement of inflation when they price securities. Investors may, however, face some risks if the bias changes over time and the changes are not predictable.

At various times, the federal agencies responsible for compiling price indexes revise their calculation methods. How will revisions to the CPI-U affect indexation adjustments to the new

[8] Aside from saving by eliminating inflation risk premiums, the Treasury would expect to reduce real financing costs by issuing indexed bonds only if its expectations for inflation are lower than investors'. In the long run, such a divergence of expectations is unlikely. Note, also, that any real cost to the Treasury from fixed-rate bonds when inflation falls is also a real benefit to holders of the bonds. The effect on welfare for the economy as a whole is difficult to assess. For a broader discussion of some of the welfare effects, see John Campbell and Robert Shiller's "A Scorecard for Indexed Government Debt," National Bureau of Economic Research Working Paper 5587, May 1996.

[9] More specifically, the adjustment is for the change in the Consumer Price Index from three months before the bond's issue date to three months before the scheduled payment. See the discussion of the indexation lag later in this article.

[10] Over the past 10 years the rate of inflation for college tuition has been close to 8 percent, and for medical care it has been close to 7 percent. These rates are nearly double the rate of CPI-U inflation for the same period.

[11] For a discussion of possible biases in existing price statistics, see Leonard Nakamura, "Measuring Inflation in a High-Tech Age," Federal Reserve Bank of Philadelphia *Business Review,* November/December 1995.

bonds?[12] According to the Treasury, any revision that influences future measures of the CPI-U will be used for future calculations of an indexed bond's payments. Any revision that influences past CPI-U statistics, however, will not change previous calculations of principal or interest, thus ensuring that payments already made will not be changed retroactively by formula changes. If the base year for computing the CPI-U changes, the Treasury plans to continue to use the CPI-U calculated from the base year in effect when the indexed bond was first issued, "as long as that series is published."[13]

There is, of course, always a possibility that prices will decline (deflation). Then, the inflation-adjusted principal and nominal interest payments on inflation-indexed bonds will fall. The inflation-adjusted principal could end up being less than the principal value when the bond or note was issued. At maturity, however, the Treasury will never repay less than the bond's initial face value. The Treasury does not expect to have to implement this "minimum guarantee" because it does not expect a prolonged decline in consumer prices to occur.

Indexation Lag. Like inflation-indexed bonds in other countries, indexed U.S. bonds are subject to an "indexation lag"—bond payments are linked to a lagged value of a price index. The lag for indexed government bonds in the United Kingdom (known as indexed gilts) is eight months. For Canadian indexed bonds and the new U.S. indexed bonds, the lag is three months. The principal value of a new U.S. indexed bond is adjusted semiannually by multiplying the bond's initial principal by an "index ratio" that accounts for movements in the CPI-U. Index ratios are announced by the Treasury.[14]

A three-month lag means that each semiannual interest payment from an indexed bond is determined three months in advance. For example, the October 1 interest payment on an indexed bond issued on April 1 will equal one-half of the bond's annual coupon rate multiplied by the inflation-adjusted principal on October 1. The inflation adjustment from April 1 to October 1 will be based on the change in the CPI-U from January to July.[15] As with conventional bonds, a predetermined nominal payment means inflation risk. In this example, the risk is that inflation from April to October will not equal inflation from January to July; if they differ, the real value of October's coupon payment will be higher or lower than expected. However, the risk of large differences in inflation between overlapping six-month periods is small. In addition, any difference will be made up in the next interest payment, six months later, by the ongoing adjustments made to the indexed bond's principal.

Because of the indexation lag, an indexed bond also lacks inflation protection for a short period right before it matures. The final inflation adjustment to the bond's principal will be determined by the value of the CPI-U for three months before the final nominal payment is made; so, in effect, for those last three months, the nominal payment on the bond is predeter-

[12] Revision of the calculations could mean anything from changing the base period used to construct the price index series to modifying definitions of what goods are in the basket that the price index covers.

[13] Quoted from Treasury Press Release, "Questions and Answers on Marketable Inflation-Protection Securities," May 16, 1996.

[14] Monthly CPI-U data and daily index ratios will be readily available from press releases that can be obtained through automated fax from the Treasury by calling 202-622-2040. Index ratios and reference CPIs can also be obtained on the Internet at the home page for the Bureau of Public Debt at http://www.publicdebt.treas.gov .

[15] Because of the time necessary for collecting price information, the CPI-U for July is reported in August. Thus, the October 1 interest payment is determined by data collected in July, but it isn't known with certainty until August.

mined, just like that for a conventional bond. Of course, on a long-term indexed bond, the final period of inflation risk is very short relative to the bond's entire life.

Trading Indexed Bonds. The Treasury's new indexed bonds, like conventional Treasury notes and bonds, provide semiannual interest payments. Consider a bond trade between a seller and buyer in the middle of the six-month period between interest payments. As part of the trade, the buyer must pay the seller for interest accrued since the last payment.

For a conventional bond, calculation of accrued interest is simple because the amount of the next nominal payment is known. A buyer of a conventional bond halfway through one of the interest periods can simply compensate the seller for one-half of the next interest payment. For indexed bonds, the indexation lag makes it possible for traders to know what the inflation-adjusted face value of the bond is when a trade is being executed. Using this knowlege, buyers of bonds can easily compensate sellers for interest accrued plus any change in principal value during the portion of an interest period in which the seller still held the bond. Making it easy to calculate interest accrued and principal adjustments during the life of a bond means that it will be easier to trade the bonds in secondary markets, thereby enhancing liquidity.

In addition to Treasury indexed bonds, other types of indexed securities have begun to emerge. After the Treasury's initial auction of indexed bonds, several private firms, government-sponsored enterprises, and some municipalities offered inflation-adjusted securities. It is too early to tell whether these recent offerings amount to experimentation with a new asset class or whether the range of indexed security issues will rapidly expand.

Taxes and Types of Investors. As with conventional bonds, the semiannual interest payments on inflation-indexed bonds will be taxable. Investors also will be required to report as income every year any increase in the value of the principal that arises because of inflation, even though the increase in principal is not received until the bond matures or is sold.[16] Because of this tax treatment, the after-tax yield on indexed bonds held in taxable accounts will not be fully insulated from inflation. For this reason, many people have predicted that indexed bonds will be most useful for tax-exempt investors such as pension funds and tax-deferred retirement funds like IRAs or 401k plans.[17] According to the Treasury Department:

> *"We believe that inflation-protection securities would appeal initially to investors saving for retirement in tax-deferred retirement accounts and to entities such as pension funds whose liabilities are sensitive to inflation. Once the market becomes established, other institutional investors, such as insurance companies, might become potential investors if they begin to market new inflation-linked products, such as an inflation-indexed annuity."*[18]

[16] Increases in principal from inflation adjustments are treated as ordinary taxable income each year to ensure parity of tax treatment of indexed bonds with discount bonds sold at prices below their principal values. The Tax Equity and Fiscal Responsibility Act of 1982 requires that some of the discount of corporate and Treasury securities be included as ordinary income each year for tax purposes. This method of taxation also holds for stripped components of Treasury securities.

[17] Pension and retirement funds may prove to be a significant pool of investors. In 1991, for example, private pension funds, state and local government retirement funds, and IRAs totaled over $3 trillion. At the end of 1991, marketable Treasury debt in the form of notes and bonds was close to $2 trillion. If the Treasury had issued 5 percent of this in the form of indexed debt, it would have sought a market base of $100 billion, which was around 3.3 percent of pension and retirement funds.

[18] Treasury Press Release, "Questions and Answers on Marketable Inflation-Protection Securities," May 16, 1996.

The new U.S. inflation-protection securities have virtually the same features as Canadian real return bonds (RRBs), inflation-linked bonds first issued in 1991. In particular, Canadian real return bonds receive the same tax treatment as the new U.S. indexed bonds. Canadian RRBs are held almost exclusively in tax-deferred investment plans. In addition, since RRBs are the only fixed-income asset providing a hedge against inflation in Canada, they are attractive to investors whose liabilities are linked to inflation. According to the Bank of Canada, the major investors in RRBs are pension funds and life insurance companies.[19]

In the United Kingdom as well, the major investors in indexed gilts are pension funds and insurance companies.[20] However, from 1982 until 1996 inflation-related appreciation of an indexed gilt's principal was exempt from taxes because it was treated as a capital gain. Thus, indexed gilts had a tax advantage over conventional gilts.[21] Some investors thought this advantage was important: tax-paying investors held a significant fraction of indexed gilts, especially those with short maturities, though the majority of investors holding indexed gilts were tax-exempt.

Other Details. Indexed U.S. bonds are auctioned quarterly, on the 15th of January, April, July, and October. The auction is a single-price auction in which all bidders pay the same price. The price is stated in terms of the yield investors are willing to accept, and all accepted competitive bids receive the highest accepted real yield on a bond.[22] The minimum denomination is $1000 (value of principal at issuance), and higher denominations must be in multiples of $1000. Indexed bonds are available only in book-entry form, which means that securities are held electronically, not in paper form.[23] Inflation-indexed bonds are also eligible for "stripping." When bond traders strip a bond, they sell claims to its interest payments to some investors and claims to the principal payment to others.

WHY MIGHT POLICYMAKERS LOOK AT RETURNS ON INDEXED BONDS?

Measuring Expectations and Perceptions. Inflation is notoriously difficult to forecast, especially over long horizons. Monetary policymakers find it difficult to gauge public expectations about future inflation and public perceptions about how monetary policy actions will affect inflation. Having both inflation-indexed bonds and conventional nominal bonds can help. Because indexed bonds provide a direct measure of real returns, they make it pos-

Note that the tax liability on an indexed bond held in a tax-deferred account is postponed but will still depend positively on inflation adjustments to the bond's principal.

[19] See "Inflation Expectations and Real Return Bonds," *Bank of Canada Review,* Summer 1996.

[20] See Gabriel de Kock, "Expected Inflation and Real Interest Rates Based on Index-Linked Bond Prices: The U.K. Experience," Federal Reserve Bank of New York *Quarterly Review,* Autumn 1991.

[21] For many tax-paying investors, the tax advantage of indexed gilts is outweighed by other factors. One important factor is that the volume of trade in secondary markets for indexed gilts is far smaller than that for conventional nominal gilts. Consequently, investors may find it easier to sell nominal gilts in secondary markets. See Francis Breedon's article, "Bond Prices and Market Expectations of Inflation," Bank of England *Quarterly Bulletin,* May 1995.

[22] For a discussion of how Treasury auctions work, see Loretta J. Mester, "There's More Than One Way to Sell a Security: The Treasury's Auction Experiment," Federal Reserve Bank of Philadelphia *Business Review,* July/August 1995.

[23] The indexed securities are available through the commercial book-entry system (TRADES) or through TREASURY DIRECT for investors who have a direct account with the Treasury. TREASURY DIRECT is operated by Federal Reserve Banks acting as fiscal agents for the Treasury.

sible to infer information about expected inflation.

We can think of a nominal interest rate on a conventional bond as being approximately equal to the sum of an expected real interest rate and expected inflation. The real interest rate, in turn, is the sum of a risk-free real rate and an inflation risk premium.[24] Policymakers looking only at interest rates on conventional nominal bonds lack information about each separate component. Without such information, policymakers cannot tell whether movements in nominal interest rates reflect changes in market expectations about inflation, changes in real interest rates, or even changes in inflation risk premiums.

Some Measures Already Exist. Monetary policymakers already have indirect measures of inflation expectations. For example, there are statistical estimates of inflation expectations based on yield curves for existing conventional Treasury securities. However, these estimates are imprecise. Policymakers can also use measures of expected inflation as reported in surveys. Survey respondents do not, however, always have the incentive or ability to provide accurate responses.[25] In addition, since surveys are taken infrequently, policymakers rarely have up-to-date measures of market expectations of inflation or of short-run changes in expected inflation.

Indexed Bonds Can Provide Additional Information. How do yields on conventional and indexed bonds provide information about inflation expectations and real returns? If the real yield promised by an inflation-indexed bond equals the expected real yield on a conventional bond of like maturity, the difference between the conventional bond's nominal yield and the indexed bond's real yield roughly equals expected inflation plus the inflation risk premium. Thus, assuming an unchanged inflation risk premium, if conventional bond yields rise and indexed bond yields are unchanged, we can infer that there has been a rise in inflation expectations. If yields on conventional and indexed bonds rise by the same amount, we can infer that real interest rates have risen with no change in expected inflation. Looking at conventional and indexed Treasury bonds with various maturities, we can obtain information about real interest rates and market expectations of inflation over various horizons. The experiences of the Bank of England and the Bank of Canada with estimating inflation expectations, however, reveal that things are more difficult than simply subtracting an indexed bond's yield from a nominal bond's yield (see *Measuring Inflation Expectations from Conventional and Indexed Bonds*).

Information Can Be Useful to Monetary Policymakers. While there are practical difficulties in estimating expected inflation and real interest rates from yields on nominal and indexed bonds, information about expected inflation and real rates can be useful to monetary policymakers. Such information can help a policymaker interpret current conditions and forecast future conditions.[26] Information about real rates and expected inflation could, for example, allow a policymaker to decide whether increases in long-term bond yields reflect rising inflation expectations or expectations that real interest rates will rise. An accurate estimate of expected inflation could help in interpreting observed movements in various asset

[24] For bonds other than U.S. government bonds, the real interest rate may also include a premium for the risk of default.

[25] For a discussion of the reliability and accuracy of survey forecasts, see the article by Dean Croushore, "Inflation Forecasts: How Good Are They?" Federal Reserve Bank of Philadelphia *Business Review,* May/June 1996.

[26] For further discussion, see Donald Mullineaux and Aris Protopapadakis, "Revealing Real Interest Rates: Let the Market Do It," Federal Reserve Bank of Philadelphia *Business Review,* March/April 1984.

Measuring Inflation Expectations From Conventional And Indexed Bonds

Two relationships are useful for obtaining measures of market expectations about inflation from yields on conventional and indexed bonds: the expectations theory of the yield curve and the Fisher relation.

The Expectations Theory of the Yield Curve. This theory suggests that the yield on a long-term bond reflects expectations of future yields on short-term bonds. In choosing between a long- and short-term bond, an investor compares the long-term yield with what she expects to be able to obtain from a sequence of short-term securities over the long-term bond's life. If she expects, for example, that short-term yields will increase next year, she will demand a higher yield now on a two-year bond than on a one-year bond because she expects that in a year's time, the one-year bond's yield will be higher. Unless the yield on the current two-year bond is higher than the yield on the one-year bond, she would be better off investing in a sequence of two one-year bonds. The expectations theory of the yield curve allows us to infer the market's expectation of the one-year interest rate in 1998 from observations of one- and two-year interest rates in 1997. Similarly, it allows us to infer the market's expectation of the one-year interest rate in 1999 from observations of two- and three-year interest rates in 1997, and so on.

The Fisher Relation. The Fisher relation specifies that the nominal interest rate equals the sum of the expected real interest rate and the rate of inflation. This reflects our discussion that a conventional nominal bond yield consists of a real yield that an investor expects plus compensation for expected average inflation over the bond's life. As we discussed in the text, expected real interest rates may include inflation risk premiums, so an extended Fisher relation says that a nominal interest rate equals the sum of a riskless expected real interest rate, expected inflation, and an inflation risk premium. (Technically, the Fisher relation is exactly correct only for continuous rates of return and inflation. For annual rates, it is approximately correct.)

Practical Difficulties in Measuring Inflation Expectations. In practice, the expectations theory may not hold exactly. For a variety of reasons, long-term yields aren't only averages of actual and expected future short-term yields. It is also unlikely that the difference between the yields on a conventional and an indexed bond contains only a measure of expected inflation plus an inflation risk premium. So, in practice, measuring inflation expectations is more difficult than simple subtraction. Practical difficulties include the following.

Coupon payments. Different bonds have different coupon payments. Consequently, yields on conventional and indexed bonds trading in the market with different coupons have to be calculated on a comparable basis. The Bank of England does this by calculating a zero-coupon equivalent yield, which is the

yield on a hypothetical bond that has no coupon and makes only one future payment.[a] Looking at *zero-coupon* nominal and real yields at various maturities, the Bank of England constructs a series of average inflation expectations over the next year, two years, and so on. These expectations are then converted into implied forward rates that represent inflation expected in each future year. The Bank of Canada, which has a shorter experience with indexed bonds than the United Kingdom, uses a similar approach to measure expected inflation.[b]

Limited number of indexed bonds. There are a limited number of indexed bonds, so not all maturities are covered.

Indexation lag. Because of this lag, there remains a small amount of inflation risk in indexed bonds, which needs to be removed to accurately measure the bonds' real yields.

Market size and liquidity risk. Secondary markets for indexed bonds are small and not as liquid as markets for conventional bonds largely because of how the bonds are taxed and the investment objectives of participants. Investors in indexed bonds may demand a premium in the form of a higher real return relative to that expected from conventional bonds to compensate for low volume of trading activity and the small size of the indexed bond market. Consequently, the difference in yields between conventional and indexed bonds will measure the liquidity risk premium as well as expected inflation and inflation risk premiums.

Nature of investors. Investors in indexed bonds include people with a particular aversion to inflation risk. These investors may be willing to obtain a lower real return on indexed bonds than average investors. The effect such investors have on yields can make the differential between conventional and indexed bonds overstate inflation expected by an average person.

Tax treatment. As mentioned in the text, changes in the principal on U.S. indexed bonds from inflation adjustments will be taxed when the adjustments are made. For tax-paying investors who buy indexed bonds, the taxation of inflation adjustments means that their after-tax returns are not fully insulated from inflation. Such investors may seek compensation for the effects of expected inflation on their after-tax yields in the form of higher before-tax yields on the indexed bonds. If indexed bond yields are affected, the difference between conventional and indexed bonds will include a tax effect as well as expected inflation and inflation risk premiums.

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[a] U.S. indexed bonds will be strippable into separate claims on interest and on principal payments. A claim on one future payment is a zero-coupon bond. Thus, market data on zero-coupon yields in the United States will be available from indexed bond strips.

[b] For technical details about the Bank of England's estimates of inflation expectations, see Francis Breedon, "Bond Prices and Market Expectations of Inflation," Bank of England *Quarterly Bulletin*, May 1995, Volume 35, Number 2, pp. 160-65. For procedures used by the Bank of Canada, see Agathe Côte, Jocelyn Jacob, John Nelmes, and Miles Whittingham, "Inflation Expectations and Real Return Bonds," *Bank of Canada Review,* Summer 1996, pp. 41-53. The articles also assess how well measures of expected inflation forecast actual future inflation.

yields, since expected inflation matters for investors' decisions about asset allocations. An accurate estimate of real interest rates might help in forecasting future economic activity and inflation. Perceived real interest rates determine the real cost of capital for business investment, which is an important determinant of economic activity and growth.

Indexed bonds together with conventional bonds may provide policymakers in the United States with useful information about real returns and expectations about inflation. If so, such information will add to the available data about the state of the economy and expectations about the future. As Alan Greenspan, chairman of the Federal Reserve, has remarked:

> *"...I am confident that we would make use of new market-based indicators of inflation and real interest rates that would be made available by the issue of indexed bonds. Such measures may not mark the way as unambiguously as promised by their most vocal adherents, but they would help."*[27]

CONCLUSION

The new inflation-indexed bonds issued by the U.S. Treasury offer an interesting and useful financial innovation. For the Treasury, indexed bonds promise to lower some costs associated with financing U.S. debt. For policymakers interested in inflation expectations and real interest rates, yields on the new indexed bonds can be informative. And for investors, indexed bonds offer additional investment opportunities and protection against unanticipated real losses and gains that arise with nominal debt and unexpected movements in inflation.

[27] Excerpt from Alan Greenspan's Statement to the Commerce, Consumer, and Monetary Affairs Subcommittee of the House Committee on Government Operations, June 16, 1992.

How Capital Taxes Harm Economic Growth: Britain Versus the United States

*Lee E. Ohanian**

To finance expenditures on goods and services and government programs, governments levy taxes on many different economic activities. Large countries tend to raise much of their revenue by taxing income. For example, in the United States, taxes are levied on *capital income,* such as profits and interest, and also on *labor income,* such as wages and salaries.

Taxes on income affect economic activity, since they change the incentives individuals and enterprises have to produce, consume, save, and invest. Taxes on capital income have potentially important implications for economic growth, since they change the incentives to accumulate capital goods. For example, increasing taxes on capital income reduces the *rate of return* to capital investment. A decline in the rate of return may lead to less investment and, consequently, slower growth in a nation's stock of productive capital. Slower growth in the stock of capital means fewer new factories, office buildings, computers, and other types of equipment and structures available to produce output, which can lead to slower economic growth.

This argument suggests that an important factor in setting capital taxes is the sensitivity

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of investment to capital taxation. If investment is *insensitive* to capital taxation, taxing capital will not affect the capital stock or economic growth appreciably. If investment is *sensitive* to capital taxation, however, even relatively modest taxation may reduce economic growth considerably. While most economists agree that increasing capital taxes will lead to reduced investment, there is no consensus on how large that effect might be.

This article uses historical differences in capital income taxation between the United Kingdom and the United States to help shed light on how capital income taxes harm economic growth. Over much of the postwar period, capital income taxes in the United Kingdom were much higher than those in the United States. The genesis of this difference lies in the policies these countries used to finance World War II. Following the advice of the influential British economist John Maynard Keynes, the United Kingdom increased income taxes, particularly those on capital income, significantly during World War II. While some of the same sentiments that helped Keynes persuade the United Kingdom to raise taxes were also present in the United States, the increase in U.S. taxes during the war was small relative to the increase in the United Kingdom.

The differences in capital income taxation in these countries during the war and the postwar period provide a natural experiment that can be used to evaluate the economic consequences of capital income taxation. To gain an understanding of how capital income taxes affect economic growth, this article discusses the *qualitative* mechanisms underlying the possible growth effects of taxes, contrasts the economic performance of the United States and the United Kingdom over the postwar period, and uses differences in taxation to interpret the differences in economic performance between the countries after the war.

This article also discusses the evolution of war-finance policies in the two countries. Although the United States and the United Kingdom ultimately used very different policies to finance World War II, I argue that during the 1940s—and even into the 1950s—the United States came close to adopting the type of policies used by the United Kingdom. Thus, if not for stubborn U.S. lawmakers who were unwilling to adopt President Roosevelt's recommendations, tax policies—and perhaps economic performance—in the United States may have been very similar to the British experience.[1]

TAX SMOOTHING AND WAR FINANCE

One of the most important questions that confront government policymakers is: how should wars be financed? Wars are times of national emergency and often require enormous increases in government expenditures. As a result, wars are periods in which output needs to be high, so *economic inefficiencies* associated with a poorly designed tax system could be very costly during these episodes. The economic inefficiency created by a tax is the extent to which taxation causes a decline in the level of the taxed economic activity. For example, high taxation of capital income reduces the incentive to invest, since it reduces the rate of return. Similarly, high taxation of labor income reduces the incentive to work, since it reduces aftertax wages. By reducing the level of economic activity, taxes prevent mutually beneficial trades that would otherwise have taken place and thereby make all parties who would have either bought or sold that good or service worse off.

How can a government raise revenue to finance the war effort while at the same time keeping economic inefficiency low? Two aspects of war can influence the design of tax policies

[1] This article draws from earlier work of mine, including "The Macroeconomic Effects of War Finance in the United States: World War II and the Korean War," and "Postwar British Economic Growth and the Legacy of Keynes," with Thomas F. Cooley.

that minimize economic inefficiencies: the level of government expenditures and the duration of the war. During wars, substantial resources are transferred from households to government. Thus, as the level of government expenditures rises during wars, fewer goods are available for private consumption. This specific outcome is referred to as the *income effect of taxation,* since the transfer of resources from households to the government through taxation effectively reduces household income. To compensate for this loss of income, households tend to work harder and produce more goods and services.

The duration of a war also plays an important role. The shorter the war, the more likely households and firms will try to avoid taxes by substituting nontaxed activities, such as leisure, for taxed ones, such as labor. This is called the *substitution effect of taxation.* The size of the substitution effect is a key factor in determining the economic inefficiency of a tax. If the substitution effect is large, taxes can lead to a significant decline in the taxed activity and a big increase in economic inefficiency. For example, suppose income tax rates were very high for only one day. In this case, we would expect households and firms to avoid temporarily high taxes by reducing work and production on that day. As a result, tax revenue on that day may be low, despite high tax rates.

A number of economists have studied the effects of these two factors on the design of efficient plans for war finance. The best known work in this area is by Robert Barro, who argues that to minimize economic inefficiency, wars should be financed primarily by government debt and that the debt should be gradually paid off after the war. This policy is known as *tax smoothing.*

To understand how tax smoothing works, consider the alternative policy: financing a war while maintaining a *balanced budget.* The key feature of a balanced-budget policy is that no debt is issued to pay for government expenditures. Since expenditures are high during wars, taxes would need to be raised substantially to ensure that expenditures do not exceed revenues. However, high tax rates will lead to significant economic inefficiency unless the substitution effect is small. Recall that the size of the substitution effect will depend in an important way on the expected duration of the war. In particular, if the war is expected to be short, the substitution effect will be very high because individuals can avoid temporarily high income taxes by working less, changing their consumption behavior, and using savings to help finance their expenditures during the short period in which taxes are high. If the war is expected to last many years, however, it becomes much more difficult for individuals to avoid taxes, and thus the substitution effect will tend to be smaller.

Based on the duration of most major U.S. wars, Barro has argued that it is reasonable to expect that the substitution effect will be large during these episodes. Given the presumption of large substitution effects, Barro's analysis suggests using government debt to pay for most war expenditures. This policy leaves the efficiency of the tax system roughly unchanged during a war and does not reduce incentives to produce. After the war is over, taxes are raised slightly to gradually retire the debt. This tax increase after a war does not increase economic inefficiency much, since the increase is fairly small and is long-lasting. The benefit of financing wars with government debt is that debt can be used to smooth out tax distortions over time, leading to a better outcome than the alternative of having very high inefficiencies for a short period.

HISTORICAL TAX POLICIES IN THE U.K. AND THE U.S.

Historically, tax policies in the United Kingdom and the United States have been characterized by tax smoothing. Robert Barro and others have argued that U.K. wars prior to World War II were financed primarily by debt, and that

wartime debt was paid off gradually after the specific war. For example, Cooley and Ohanian (1997) report that about 70 percent of U.K. government expenditures during World War I were financed by debt, and this percentage appears to be even higher for many earlier wars.

During World War II, however, there was a sharp change in the type of war finance policies used in the United Kingdom. Britain largely abandoned its historical policy of tax smoothing in favor of a policy designed to finance as much of the war as possible from contemporaneous taxation. This departure from the standard policy was due to the influence of John Maynard Keynes, one of the best known economists of the 20th century.[2]

Keynes was strongly opposed to the use of debt to finance war expenditures. Keynes opposed deficit financing because of the difficulties faced by several countries in repaying debts after World War I and also because government debt was owned primarily by wealthy households. Keynes thought that wars should be periods of sacrifice and not a time when the wealthy benefited by earning interest on war bonds. Instead, Keynes favored a balanced-budget policy, in which tax revenue was sufficient to finance government expenditures and no debt was required to finance the war effort.

Keynes detailed his opposition to the standard practice of tax-smoothing policies and constructed a specific alternative plan to finance the war in his monograph *How to Pay for the War: A Radical Proposal to the Chancellor of the Exchequer.* Keynes's objective was to pay for the war without using deficit financing. Keynes's interest in maintaining a balanced budget during wartime differed sharply from the modern theory of war finance developed by Barro and others. However, Keynes had additional motivations in favoring a policy of higher taxes over a tax-smoothing one. He recommended not only that taxes be raised substantially to finance the war but also that wealthy households exclusively should bear the burden of these taxes. In Keynes's view, economic inequality in Britain was too high, and his plan to finance the war effectively redistributed income from wealthy households to poor ones.

But such a plan would not raise sufficient revenue unless it also involved taxing the income of households at all income levels. Keynes's solution to this problem was to propose a system of sharply rising levies on all incomes in excess of a small minimum, with the highest incomes paying a marginal rate of 85 percent. For nonwealthy households, these levies were to be regarded as compulsory savings, credited to a savings institution of the individual's choice, that would be rebated with interest beginning in the first postwar recession. The rebates were to be financed by a wealth tax that would begin following the war.[3] Keynes also had hoped that the wealth tax would become a permanent part of the U.K. tax code.

How a wealth tax affects investment depends on whether households expect the tax. If households expect that their assets will be taxed in the future, the expected rate of return to investment will decline, and investment will fall. Some economists recognized this potential problem with the Keynes plan and criticized this component. Sir John Hicks, another leading British economist of the period, argued that the imposition of a wealth tax would lead to high economic inefficiencies, as wealthy households altered their behavior to try to avoid the tax. Although Keynes understood the logic of this argument, he claimed that households would not change their behavior significantly in response to a future wealth tax.

[2] Keynes's book *The General Theory of Employment, Interest, and Money,* published in 1936, was a widely used text in graduate economics education for much of the postwar period.

[3] A wealth tax is a levy based on the value of household assets.

Keynes also worked hard to persuade British Treasury officials that his proposals should replace the standard war finance policy of tax smoothing. Some government officials viewed the proposals advanced in *How to Pay for the War* skeptically. The Treasury initially rejected the proposals, fearing that higher taxes might jeopardize the increased level of production required for the war effort. However, Keynes was ultimately able to persuade the Chancellor of the Exchequer that his plan was superior to the conventional type of war financing.

Consequently, Keynes heavily influenced the 1941 budget statement. The budget contained most of the tax changes Keynes had advocated, including sharp increases in income taxes—a standard rate of 50 percent and a top marginal rate of 97.5 percent. The United Kingdom did not adopt the large compulsory savings program that had been a key factor of the Keynes plan. Instead, the budget included a very modest compulsory savings plan that promised rebates of a small portion of the taxes at the end of the war.

The adoption of these policies changed the aftertax income distribution considerably in the United Kingdom. For example, in 1938, the top 289,000 households had an average aftertax income of nearly 2000 pounds. By 1949, only the top 11,000 households had an average aftertax (inflation-adjusted) income of that magnitude, a decline of 96 percent in the number of households at that net income level.[4]

Despite these sharp increases in taxes, the United Kingdom still needed to issue debt to help finance World War II. Thomas Cooley and Lee Ohanian report that about 60 percent of expenditures were financed with tax revenue, and just under 40 percent were financed with debt.

The United States also has traditionally financed wars with tax-smoothing policies. For example, before World War II, the United States fought six wars financed with a mixture of direct taxes, debt, and seignorage.[5] Claudia Goldin has documented the relative importance of these different sources of revenue (Table). These statistics suggest that, with the exception of the Spanish-American War, the United States financed the six wars prior to World War II primarily with debt.[6]

During World War II, a greater fraction of

[4] See Cooley and Ohanian (1997).

[5] Seignorage is the revenue the government receives by printing new money.

[6] It should be noted that Goldin does not distinguish between debt finance and seignorage and that the United States made considerable use of seignorage during the Revolutionary War.

TABLE

War Financing in the United States

	Percent of expenditures financed by direct taxes	Percent of expenditures financed by debt and seignorage
Revolutionary War	13.1	86.9
War of 1812	21.0	79.0
Mexican War	41.8	58.2
Civil War - Union	9.3	90.7
Civil War - Confederacy	13.0	87.0
Spanish-American War	66.0	34.0
World War I	24.0	76.0
World War II	41.0	59.0
Korean War	100.0	0.0

Source: Claudia Goldin, 1980, pp. 938-940.

U.S. war expenditures was financed by direct taxation (though still a far smaller fraction than in the United Kingdom). This is broadly consistent with Barro's idea, since the war was relatively long, and expenditures were high. However, as noted by Paul Studenski and Herman Kroos (1963), a number of government officials, including President Roosevelt and Treasury Secretary Henry Morgenthau, pushed for even higher taxes. As military expenditures began to rise in 1941, Morgenthau urged Congress to finance at least two-thirds of defense purchases with taxes, recommending high taxes on capital income.[7]

By 1942, President Roosevelt also believed that the war should be financed with higher taxes. He fought for a substantial tax increase and proposed a ceiling of $25,000 on aftertax household incomes.[8] Moreover, he recommended that Congress consider a forced savings plan similar to that designed by Keynes. Although Congress did raise taxes during World War II, it did not implement the draconian changes recommended by the President and his Cabinet. After Roosevelt's budget message of 1944, in which he chastised Congress for failing to adopt his recommendations, Senator Walter George, chairman of the Finance Committee, stated "We have reached about the bottom of the barrel as far as existing taxes are concerned."[9]

The administration and Congress continued to clash over tax policy during 1944 and 1945, but Congress continued to oppose Roosevelt's recommendations, and taxes were raised only modestly over the balance of the war. Thus, while Roosevelt's views on war finance were similar to those of Keynes, and may have even been shaped by Keynes, he was not nearly as successful in influencing tax policy during World War II.

Even after World War II, support for balanced-budget policies remained high in the United States. President Truman was a staunch believer in maintaining balanced budgets. Studenski and Kroos note that Truman continuously urged Congress "...to finance the greatest possible amount by taxation," and that he "...hoped to maintain a balanced budget, even if military costs doubled."[10] Truman felt that the policy of using debt to finance World War II was a mistake: "During World War II we borrowed too much and did not tax enough."[11] President Truman was much more successful than President Roosevelt in persuading Congress to raise taxes in wartime: Goldin estimates that the entire Korean War was financed with taxes on labor and capital income.

U.S. AND U.K. MACROECONOMIC PERFORMANCE

At the outbreak of World War II, the macroeconomic performance of the United States and that of the United Kingdom were similar in several ways: both were wealthy countries and both had relatively skilled labor forces. In addition, both faced similar patterns in the demands that war placed on their economies. For example, between 1939 and 1944, inflation-adjusted expenditures of the central government in the United Kingdom rose by a factor of about 8; over that same period, inflation-adjusted expenditures of the federal government in the United States rose by a factor of about 9.

Despite the similarity between the increases in government expenditures in these two countries, their macroeconomic performance was

[7] See Studenski and Kroos, page 438.

[8] This recommendation implies a 100 percent marginal tax rate on high income households.

[9] See Studenski and Kroos, page 449.

[10] See Studenski and Kroos, page 490.

[11] See Studenski and Kroos, page 490.

strikingly different (Figure 1).[12] There are several important differences in the behavior of output in the two countries. A large gap in output between the two countries emerged during this period. The gap grew considerably during the war, and narrowed afterward as U.S. output of military equipment and supplies fell. The gap also widened somewhat in the 1950s. Between 1939 and 1959, real output per capita in the United Kingdom grew at an average rate of 1.5 percent per year, while that in the United States grew at the rate of nearly 3 percent per year.

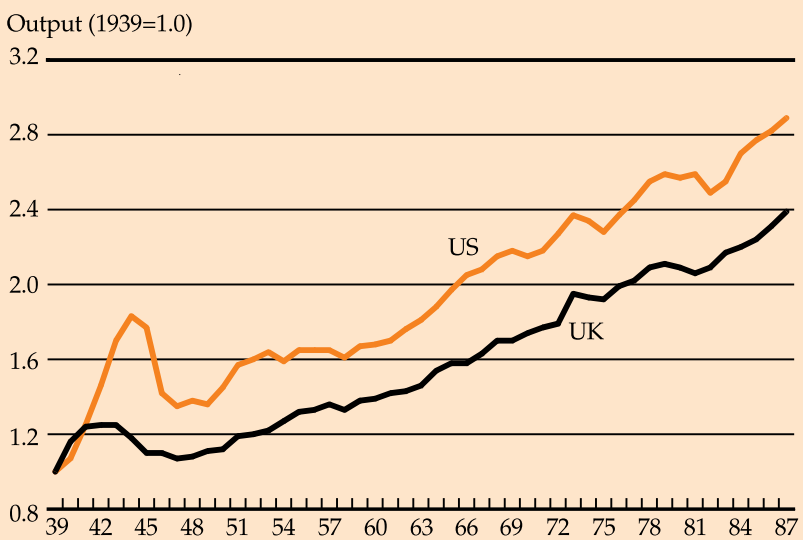
The output picture in the two countries changed considerably, however, after the war (Figure 1). The gap between the two countries continued to develop as the United States grew faster in the early 1960s, but this gap narrowed by the end of the decade. Moreover, from the 1970s on, growth rates in the two countries were very similar as U.S. output and U.K. output moved almost in lockstep.

Similar differences between the United States and the United Kingdom are seen in the behavior of private business investment in plant and equipment. The United States experienced a sharp drop in business investment spending during the war, which reflects the fact that not many goods were available for private use. As a result, individuals chose to consume a rising share of the smaller amount of goods, rather than forgo additional consumption and invest. In the U. K., investment also dropped steadily throughout the war (Figure 2).

[12] Output in both countries is measured relative to its 1939 level.

FIGURE 1

Real Per Capita Output: U.S. and U.K. 1939-87



After the war, however, sharp differences in the behavior of investment arose between the two countries. In the United States, investment rose quickly, from around 4 percent to about 16 percent of GNP, and fluctuated around that value over the rest of the postwar period. In the United Kingdom, however, private investment rose modestly after the war, from about 3 percent at the end of the war to about 7 percent a year later. However, private investment in the United Kingdom continued to rise gradually over the postwar period, and by 1980, the rate of investment in the United Kingdom was similar to that in the United States.

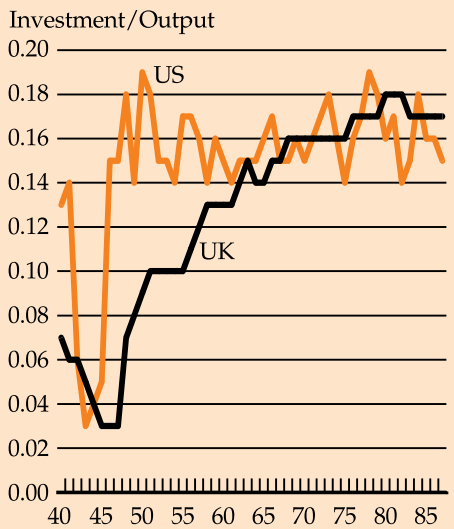
These data indicate that the United Kingdom grew at a much slower rate during World War II and for the first half of the postwar period. In addition, the period of slow output growth coincided with a period of low investment and low growth in the capital stock. What are the reasons for this particular pattern of macroeconomic performance in the United Kingdom? In particular, are there any simple explanations consistent with both the poor early performance and the improved performance later?

While many factors can affect economic performance, I highlight one simple difference between these two countries that is consistent with the different early and late postwar macroeconomic behavior: large differences in taxation of capital income.

Figure 3 provides a measure of the average tax rate on capital income.[13] Perhaps the most

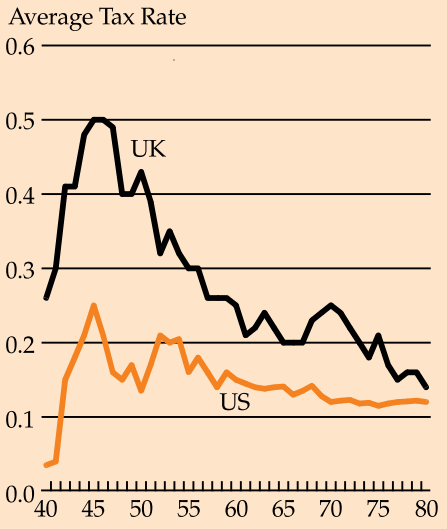
[13] Economists often distinguish between gross and net capital income. Gross capital income is total capital income, and net capital income is gross income less the value of depreciated capital.

FIGURE 2
Investment/Output: 1940-87



Source: Cooley and Ohanian (1997).

FIGURE 3
Average Capital Tax Rate: 1940-80



Source: Cooley and Ohanian (1997).

striking aspect of Figure 3 is that capital tax rates in the United Kingdom during World War II and the early postwar period are substantially higher than those in the United States. For example, capital tax rates in the United Kingdom approach 50 percent at the peak of the war, which is double the U.S. tax rate of 25 percent. Note also that capital tax rates in the United Kingdom decline consistently over the course of the postwar period, from the peak of 50 percent in 1946 to about 17 percent by 1980. Thus, the data in Figure 3 indicate that the very high rates of capital income taxation put in place at Keynes's recommendation during the war remained in place in the early postwar period and were only gradually reversed. In the United States, the capital income tax rate declines quickly from 25 percent at the peak of the war to about 15 percent by 1950. Although the tax rate increased during the Korean War (1950-53), it declined modestly over the post-Korean War period, to about 12 percent.

The very different pattern of these tax rates, along with the basic theory of how changes in capital tax rates can affect investment, has important implications for macroeconomic performance in the United Kingdom and the United States. First, the differences in investment between these two countries immediately after the war suggest that investment is quite sensitive to capital income taxation. In 1946, capital income taxes in the United Kingdom were about twice as high as those in the United States, and the rate of investment in the United Kingdom was only about one-third the rate in the United States. My interpretation of this difference is that high capital taxes led households to substitute lower taxed activities for saving and investment.

A look at both the behavior of capital taxes and the investment rate over the entire postwar period sheds further light on the effects of capital taxes. In the United Kingdom, the steady decline in the rate of capital income taxation from 50 percent to about 15 percent resulted in a significant increase in the rate of return to investment. This is consistent with the smooth increase in the investment rate in the United Kingdom over the postwar period. As the rate of return gradually rose, the rate of investment increased, reflecting the higher aftertax reward to investing.

In the United States, the capital tax rate declined from 15 percent immediately after the Korean War to about 12 percent by 1980. Since the capital tax rate did not change much over this period, basic theory predicts that the investment rate should also not change much. This is consistent with the steady investment rate in the United States over the postwar period.

The historical differences in capital income taxation between these two countries account for these three distinctive features: (1) the enormous difference in the rate of investment between the United Kingdom and the United States at the end of the war, (2) the steady rate of investment in the United States over the postwar period, and (3) the persistent increase in the rate of investment in the United Kingdom over the postwar period. The main implication for economic growth is that the low rate of investment during the early postwar period in the United Kingdom led to slower growth in the capital stock. This observation can help to account for the low growth rate of U.K. output during the immediate postwar period.

By the early 1960s, the investment rate in the United Kingdom had caught up to the investment rate in the United States, resulting in a pickup in growth in the U.K.'s capital stock. This catching up also helps explain the fact that the growth rates for output in the United Kingdom and the United States were virtually the same after the mid-1960s. But for the United Kingdom, the period of slow growth in the 1940s and 1950s left the level of real per capita output persistently lower than that in the United States.

CONCLUSION

Historical differences in capital income taxation and the investment rate between the United Kingdom and the United States suggest that investment in capital goods is sensitive to taxation of capital income. This analysis concludes that large increases in capital income taxation, such as the increase that occurred in the United Kingdom during World War II, can lead to sharp declines in investment and future economic growth.

The United Kingdom followed the recommendations of John Maynard Keynes in substantially increasing capital income taxes to finance the war. In Keynes's day, a common view in economics was that investment was not very sensitive to capital income taxation. This view suggests that financing the war with high capital taxes would not affect investment or economic growth very much and thus helps explain Keynes's recommendations.

But further analysis suggests that this view was wrong and implies that Britain would have had a significantly higher standard of living had a tax-smoothing policy been used to finance World War II. Moreover, Britain might have been much worse off had it adopted all of Keynes's recommendations, which included a permanent wealth tax. Although that policy may have furthered Keynes's objective of reducing economic inequality, it's likely that investment and growth would have been even lower over the postwar period.

As in Britain, there was considerable pressure to increase taxes in the United States during World War II. In fact, President Roosevelt's views on war finance were quite similar to those of Keynes: both argued against debt finance, felt that the war should be financed by high-income households, and viewed a forced savings policy as a potentially important component of war finance. However, unlike their British counterparts, lawmakers in the United States were not persuaded by these arguments and instead financed the war primarily through issuing debt, much as previous wars had been financed.

Even though Congress did follow President Truman's recommendations for higher taxes to finance the Korean War, the relatively low level of military expenditures during that war did not require huge increases in tax rates. In recent work, I have found that the economic inefficiency of following a balanced-budget policy during the Korean War rather than a tax-smoothing policy was about 0.5 percent of real GNP per year. However, had the United States used a balanced-budget policy during World War II, economic inefficiency could have been as high as 5 percent of real GNP per year (Ohanian, 1997). This suggests that the United States was fortunate to have resisted pressure to raise taxes substantially during World War II. Otherwise, postwar economic performance in the United States may been much more like that of the United Kingdom.

REFERENCES

Barro, Robert. "Government Spending, Interest Rates, Prices and Budget Deficits in the United Kingdom, 1701-1918," *Journal of Monetary Economics,* 20, pp. 221-47.

Cooley, Thomas F., and Lee E. Ohanian. "Postwar British Economic Growth and the Legacy of Keynes," *Journal of Political Economy,* June 1997.

Goldin, Claudia. "War," in Glenn Porter, ed., *Encyclopedia of American Economic History.* New York: Scribner's, 1980, pp. 935-57.

Keynes, John M. *How to Pay for the War: A Radical Proposal to the Chancellor of the Exchequer. Vol 9, The Collected Writings of John Maynard Keynes,* London: Macmillan, 1972.

Keynes, John M. *The General Theory of Employment, Interest, and Money.* New York: Harcourt Brace, 1936.

Ohanian, Lee E. "The Macroeconomic Effects of War Finance in the United States: World War II and the Korean War," *American Economic Review,* March 1997.

Studenski, Paul, and Herman E. Kroos. *Financial History of the United States.* New York: McGraw Hill, 1963.