THE REAL RATE OF INTEREST FROM 1800-1990: A STUDY OF THE U.S. AND U.K.

by

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ABSTRACT

Spurred by the work of Mehra and Prescott (M-P), economists have been attempting to explain the surprisingly low levels of real interest rates in light of the behavior of aggregate consumption. This paper constructs a continuous "risk-free" interest rate series for the United States and the United Kingdom from the beginning of the nineteenth century, extending the period analyzed by M-P, 1889-1978, both backward and forward. It is found that the real rate of return on both long and short-term bonds was over 400 basis points lower during the M-P period than outside that period and that this result holds for the U.K. as well as the U.S. In contrast, equities show almost identical real returns over the whole sample so that the equity premium is only about one-third as large outside the M-P period as within the period. These new data help reconcile the behavior of consumption and the real rate and reveal that the data from 1889-1979 were subject to factors or events, not well-understood, which depressed real interest rates.

free short-term rate is constructed for the United States. I conclude that both long and short-term real rates of interest were significantly lower during the 1889-1979 period for the United Kingdom as well as the United States. Furthermore, the real rate of interest follows a remarkably similar pattern in both the United States and England during *both* the nineteenth and twentieth century. This suggests that the real risk-free rate of interest is subject to substantial long-term swings which appear to have common elements across economies.

II. Long-term U.S. Bond Yields in Nineteenth Century

A. U.S. Government Bonds

There was an active market for long-term U.S. government bonds over most of the nineteenth century, except for the years 1835 through 1841, when prior budget surpluses eliminated all federal government debt outstanding. A series of long-term government yields is presented by Sidney Homer (1963) in his classic work, *A History of Interest Rates*. Because long-term government bond issues were not numerous during the nineteenth century, the yields collected on these securities have a maturity which generally range from three to twenty years, although some bonds had no fixed duration.[3] Figure 1 displays the interest rates on long-term U.S. government bonds, joining the Homer series with the Ibbotson and Sinquefield (1989) series which begins in 1926. Table 1 (Panel D) reports summary statistics for the nominal returns on this government bonds series over various time periods. The table reports the total return and its components: the coupon yield and the capital gain or loss resulting from changing market rates of interest.[4]

B. Municipal Bonds

There are many reasons why municipal bonds may be more representative of a high grade bond series during much of the nineteenth and early twentieth century than federal

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[3] The yields are taken from Homer, Table 38, "Selected Market Yields." The first federal government debt was the Hamilton refunding 6s of 1790 which was "redeemable at the pleasure of the government at 100 in an amount not exceeding 2% a year."

[4] It is assumed that the bonds have a uniform maturity of twenty years so that they are comparable with the more recent calculations of bond returns taken from Ibbotson and Sinquefield (1990). From Table 1, it can be seen that virtually all the average return on bonds comes from the coupon income, and very little from the capital gain, so that the maturity assumption is not critical in calculating mean returns.

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I. Introduction

In a seminal article, Mehra and Prescott (1985) concluded that standard representative agent models of the aggregate economy could not rationalize both the historically high average return on equity and the low level of the risk-free rate of interest over the period 1889 to 1978. These empirical findings have become known as the "Equity Premium Puzzle," and the "Real Rate Puzzle."[1] The current paper presents evidence that the real rate of interest was significantly higher both before and after the period analyzed by Mehra and Prescott (the M-P period), and that this conclusion holds for the United Kingdom as well as the United States. The real rates of interest found outside the M-P period will be shown to be far more consistent with aggregate consumption data and suggest that the period from 1925, which is so frequently analyzed by financial economists, may not be representative of the long-term returns on fixed-income assets.

One reason researchers have not examined interest rates before 1889 is the lack of reliable data on the "risk-free" rate of interest. This is particularly true for short-term instruments in the United States. The data that are available in the nineteenth century come primarily from quotations on commercial paper from New York and Boston, which appear to possess large and volatile risk premia.[2] Even the data available on long-term government bonds must be carefully examined because of distortions caused by special risk and regulatory features.

By utilizing historical data from the United Kingdom, where markets for fixed income instruments were highly developed by the nineteenth century, a hypothetical risk-

[1] For other explanations of these findings see Abel (1990), Constantinides (1990), Mankiw (1986), and Weil (1989) to name just a few.

[2] The interest rate series used by Mehra and Prescott are prime commercial paper from 1889 through 1919 and then on treasury bills, which were first issued in 1920.

government bonds. Some of the municipal bonds issued during the early nineteenth century, particularly those of the Commonwealth of Massachusetts and the City of Boston, were often considered of higher quality than those of the federal government, and hence traded at a lower yield.[5] Risk of default increased on federal government bonds during both the War of 1812 and the Civil War, and hence yields on federal debt rose during those years above the yields on comparable high grade municipals.[6] Furthermore, these high-grade municipal bonds promised to pay interest and principal only in gold, thereby bypassing the "bimetallic" option that some claim have biased the yields of the federal government bonds upward.[7]

From the Civil War to 1920, the yields on government bonds are biased downward because banks were permitted to issue circulating bank notes against government bonds held as reserves. These rights, called "circulation privileges", caused the price of government bonds to be bid up by the banks above other comparable high grade securities. The effect of this bias is particularly evident in Figure 1. In 1920 the circulation privileges were abolished and the yield on federal government bonds jumped to the level of high-grade municipals.[8] The municipal bond yields are also displayed in Figure 1.

C. High Grade Bond Series

A representative high-grade long-term interest rate series is constructed which attempts to avoid the problems with federal government bond yields noted above. This series utilizes the minimum of the federal bonds and high-grade municipal bond yields from 1800 to 1865, and the high-grade municipal yield from 1865 to 1917, when government bonds without circulation privileges became available. This high-grade bond series is depicted in Figure 1 and its statistics summarized in Table 1B.

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[5] See Homer (1963), pp. 296 and 301 and Martin (1871, p. 84) for a description of these municipal bonds. The lower yield for municipals was not due to any tax advantage, since tax considerations emerged in the early twentieth century with the establishment of the U.S. income tax.

[6] The Greenback period, when the government issued notes not redeemable in specie, provides a fascinating episode in monetary theory. See Roll (1972) for further discussion.

[7] This bimetallic option gave the government the option of redeeming principal in *either* gold or silver. For a discussion of the issues involved in the bimetallic standard, see Garber (1986).

[8] This magnitude of this distortion can be seen by examining the yields on government bonds from 1917-1920 issued with and without circulation privileges (see Table 46, Homer (1963)). The yield differential between bonds with and without circulation privileges ranged from 50 to 100 basis points.

D. U.S. Price Levels Used To Compute Real Rates

1. Price Data After 1850.

From the mid nineteenth century, the cost of living index (later called the consumer price index) has been compiled by the Bureau of Labor Statistics. From 1850 through 1890 the BLS used a price series collected by Ethel Hoover (1960), which was linked to an index computed by Albert Rees (1961) until 1914.[9] The Hoover data was the average of retail prices for 58 commodities reported by one or two storekeepers in approximately forty cities. Data for these commodities were supplemented with estimates of price changes for services, such as shoe repairs and medical care. The Rees index combined estimates of commodity prices with prices for fuel, rent, clothing, and housefurnishings. The BLS started complete and comprehensive price surveys in 1914, which later became known as the consumer price index.

Mehra and Prescott, as well as other researchers, have used the data on the GNP consumption deflator, which was originally constructed by Kendrick and Kuznets in 1961.[10] However, recent research by Balke and Gordon (1989) has criticized these data on the basis that Kuznets ignored consumer price data collected by Hoover and Rees, and relied principally on wholesale price data. Indeed, this is confirmed by our analysis and by reference to Figure 2 where the consumption deflator from 1889 until 1914 is shown to follow the Warren and Pearson wholesale price series, which is described below, extremely closely. For this reason, I have chosen the BLS series which fully incorporates the Hoover-Rees data as a more representative consumer price index.

2. Price Data before 1850.

Data on wholesale prices are readily available throughout the nineteenth century. Wholesale price data dating from 1720 have been carefully collected and compiled by George Warren and Frank Pearson (1933). The primary goal of this series was to present monthly comprehensive indices comparable to those compiled by the Bureau of Labor Statistics (BLS) for wholesale prices since World War I.

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[9] The Hoover data were originally collected until 1880 and later extended to 1890. See *Historical Statistics* (1975), pages 192-93, and Balke and Gordon (1989) for a fuller description of this series.

[10] See Shiller (1982) for a more detailed description of these series.

The reliability of consumer price data gathered before 1850 is uncertain. All evidence points to deflation in the cost of living, but the degree of deflation depends on the series chosen. There are three series available: one reported by the BLS, one by the Federal Reserve Bank of New York, and the third computed by Carl Snyder and R. S. Tucker. The BLS series is based on prices paid by families of farmers in Vermont, but the source or method by which this data was collected is unclear.[11] This series exhibits the greatest deflation between the years 1800 and 1850, averaging 1.42% per year at a compound rate. The Federal Reserve Bank of New York series, which begins in 1820, was based primarily on wholesale prices collected by researchers before Warren and Pearson.

The third price index, compiled in various articles written by Carl Snyder (1924) and Rufus Tucker (1934), appears to have passed more rigorous academic scrutiny. Their studies have been published in the *Journal of the American Statistical Association*, *The Review of Ecoomic Statistics*, and elsewhere.[12] These series are described to "measure the average price of goods, services, and property, based on commodity prices at wholesale, wages, cost of living, and rents with weights of 20, 35, 35, and 10 respectively."[13] This index, which declines at an average compound rate of 0.53% from 1800 to 1850, possesses the smallest average rate of defation of any of the prices series, retail or wholesale. Because of the better scientific basis of the Snyder-Tucker series, it is chosen to represent consumer prices in the early period and is linked with the BLS series in 1850. Because the Snyder-Tucker series experienced the smallest deflation before 1850, the choice of this series instead of the others noted above results in a smaller average real rate of interest, and hence may understate the true difference in real rates inside and outside the M-P period.

Figure 2 plots the consumer price index chosen in our analysis, the wholesale price index, the recently-constructed Balke-Gordon index of the GNP deflator, which was calculated from 1872, and the GNP consumption deflator, which was used by Mehra and Prescott. Despite the careful compilation of a price index used to compute real returns, it turns out that the differences in the real rates before and after 1889 are so great that none of the conclusions derived in this study is sensitive to the price index chosen. It is important, however, to verify that the long-term swings in real interest rates do not depend on the

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[11] This series is presented in the *Handbook of Labor Statistics, 1973*, Bulletin 1790 and reproduced in series E 135 in the *Historical Statistics of the U.S.* (1975)

[12] More information on references are give in *Historical Statistics* (1949), page 226.

[13] *Historical Statistics* (1949), page 226.

price level index employed. Summary statistics on price inflation calculated by the various indices are given in Table 1C.

E. Real Long-Term Returns

The real returns on long-term bonds are displayed (using thirty year moving averages) in Figure 3 and summary statistics are reported in Table 1A.[14] It can be seen from Figure 3 that real yields are substantially lower within the M-P period (1889-1978) than either before or after. During the M-P period the average real return is 1.48%, while outside the period, the average is 5.71%. From 1800 through 1888 the average real return is 5.75%. A regression of the real U.S. long return on its own lagged value, with dummy variables for the M-P period, are shown in Table 2. Each dummy variable is significant at the 95% level, and the hypothesis that the process is identical within and without the M-P period is decisively rejected. This conclusion is robust to the choice of interest rate series: Statistical tests, using either municipal or Federal government bond yields, also reject the hypothesis of equality of mean returns across periods.

III. Prices and Interest Rates in the U.K. during the Nineteenth Century

A. Price Level Behavior

Since both Britain and the U.S. were on a gold standard during most of the nineteenth century and there were substantial capital flows between the two countries, interest rates on short and long-term English securities may be useful in analyzing the U.S. data. As shown in Figure 2, the general trends in the price level behavior of the U.S. and Great Britain are quite similar during the entire period.[15] The U.S. experienced, on average, slightly more inflation from 1800 until World War I, while Britain had more inflation afterwards. Given the fall in the price of gold in England, while the price rose in the U.S., it is not surprising that Britain experienced more deflation than the United States during the nineteenth century.[16] From 1800 through 1888, the average geometric rate of

[14] The real return, r, can be expressed in term of the nominal return, n, and the rate of inflation π; $r = (n - \pi)/(1 + \pi)$, where n, r, and π are all expressed in annual rates.

[15] The price level data is taken from Mitchell (1988). See data appendix for details.

[16] The U.S. experienced a 6% total increase in the gold price from 1800 through 1888, having returned to the gold standard in 1878 at a price of $20.67 per ounce, slightly above the $19.39 price which prevailed for gold before the Civil War. In 1821, after the Napoleonic Wars, Britain resumed convertibility with gold at 3.89 pounds sterling to the ounce, a rate which prevailed for one hundred years. In contrast to the U.S., Britain experienced a cumulative *decrease* of 9% in the gold price of the pound sterling from 1800 to 1888.

deflation in the U.S. was 0.30%, while it was 0.97% in the U.K. Summary statistics for inflation in the U.K. is found in Table 1C.

B. Interest Rates

Since London emerged as the world financial center in the nineteenth century, capital markets in Great Britain were far more developed than in the United States. The British consol, which was first floated in 1729, has long been used by economists to provide a continuous and homogeneous interest rate series stretching over two-hundred and fifty years.[17] The summary statistics for the total return on the British consol (referred to as the U.K. long return) are reported in Table 1.

There are two historical series of short-term rates in Britain in the nineteenth century. The first is the "bank rate," which is best described as a penalty discount rate of the Bank of England, while the second is the "open-market rate" at which high quality commercial paper was discounted.[18] Unfortunately, a usury ceiling of 5% (which did not apply to consols) clearly imparted a downward bias to the yields on the short-term securities during the Napoleonic Wars, since it was not until 1817 that the average annual reported open-market rate fell below the usury ceiling.

Heim and Mirowski (1987) present an alternative short term security for Britain in the late eighteenth and early nineteenth century that was exempt from these usury ceilings. High quality bonds were issued by the East India Company to finance its local efforts to sell its output. These securities, which were semi-private debt instruments issued for six-month maturities, were described as the short-term instrument of choice for many investors because of their credit worthiness and liquidity. I have therefore substituted this series for the open market discount series from 1800 to 1817, when the usury ceiling was in effect.[19] These discount yields were then converted to investment yields. To obtain a series analogous to the risk-free rate available on U.K. treasury bills, 23 basis points, the average difference between the rate on high-grade commercial papers and treasury bills from 1925

[17] Although a complete list of references using the consol rate is too lengthy to cite, representative articles are Shiller and Siegel (1975), Barsky and Summers (1988), and Barro (1987).

[18] These series can be found in Homer (1963), Table 23, who describes the paper as "of nonuniform maturity of a few months" before 1855 and thereafter "three month bills." These series are based on data compiled by the N.B.E.R. from British Parliamentary papers and from various editions of *The Economist*, 1858-1900. The Bank Rate is taken from Hawtrey (1938).

[19] After 1817 the rates on the India bonds fell below the open market discount rate, but returned to the open market level by the mid 1820s.

through 1989, was subtracted from these investment yields.[20] The risk-free U.K. short rate is depicted in Figure 4 and summarized in Table 1.

C. Comparison of U.S. and U.K. Yields

As Figure 1 shows, from 1800 until World War I the nominal rate on long-term U.K. bonds was almost always less than U.S. rates, but this situation reversed in the twentieth century. In contrast, the behavior of the real returns on long-term bonds in Britain and the U.S., as depicted in Figure 3, was remarkably similar over the entire time period. Statistical tests cannot reject the hypothesis that each coefficient of the return process reported in Table 2 was identical for both real long and short-term interest rates in the U.S. and U.K. over the entire period. From 1800-1888, the average real return on the U.S. long bond exceeded that on the U.K. long bond by 50 basis points, and by 29 basis points during the M-P period, 1889-1978. The stochastic characterization of real returns on British long and short-term securities are reported in Table 2, which again show significant differences within and without the M-P period. There is no statistical difference, however, between the coefficients characterizing the return generating process in the U.S. and U.K., either during the M-P period or outside of it.

IV. U.S. Short-term Interest Rates in the Nineteenth Century

A. Available Data

Most of the early data on short-term interest rates in the United States are taken from commercial paper rates quoted by Macaulay (1938).[21] The data for this commercial paper series are shown in Figure 4 and summarized in Table 1D. It is clear from examining the raw data that the earlier years, especially prior to 1875, were periods of a substantial risk premium on commercial paper. These premia often developed during or just prior liquidity and financial crises marked by the N.B.E.R. designated recessions. Despite the obvious shortcomings of these data, there are few other short-term rates available in the

[20] The 23 basis point correction for U.K. paper is lower than the average difference between U.S. commercial paper and treasury bills, which averages 75 basis points from 1926 to 1989. The greater difference in the U.S. is partly due to the state tax advantages afforded U.S. government securities which are not relevant to British treasury securities.

[21] Macaulay (1938) reported rates for choice 60 to 90 day commercial paper after 1856, while data from 1831 through 1856 were collected from Bigelow (1862), which covers "Street rates on First class paper in Boston and New York, at the beginning, middle, and end of the month." The paper floated in Boston is said to be of three to six months in duration. See Macaulay (1938), page A341 for a more detailed discussion of these sources.

early nineteenth century, and those which are available cover far shorter periods.[22,23] In order to construct a "risk-free" interest rate series for the U.S., I examine the interest rate data from the United Kingdom, where capital markets were far more developed.

B. Construction of "Risk-Free" Short Rate

1. Deriving the Average Level of the Short Rate

Since data on high-grade short-term securities are available for the U.K. during the nineteenth century, and both the U.S. and the U.K. were on the gold standard during most of that period, it is tempting to use the U.K. short-rate as representative of the risk-free U.S. rate for most of the years under study. To do this implies that the actual U.S. short-rates differ from those in Great Britain only by default premia, and not by differences in inflationary expectations, growth, or other factors impinging on real rates. Since such assumptions do not appear justified, this paper utilizes the available data on U.S. long-term government securities and commercial paper as well as U.K. rates in order to construct the short rate.

Two steps are followed to create a short-term, "risk-free" U.S. rate series in the nineteenth and early twentieth century. The first step involves establishing the *average level* of the risk-free short-rate, free of the default premia present in the commercial paper data. It is assumed that the average term structure premia on long-term, high-grade securities (based on a five year, centered moving average), are the same in the U.S. as in the U.K., where both high-grade short and long-term bonds are available. Since a series of long-term high grade bond yields has been derived for the U.S. over this period, this procedure allows us to establish the level of short-term rates.

Fragmentary data available on high-grade short-rates, taken from the prices of U.S. government bonds nearing maturity, strongly support these term structure assumptions.

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[22] Lance Davis (1960) provides an alternative data set for U.S. short-term interest rates based on the borrowing records of New England textile mills from 1840 through 1860. The mills tapped funds from a wide variety of sources, such as commercial and savings banks, trust and insurance companies, and individuals. The average rate on these loans is 6.28%, 1.92% below the Bigelow rate over the same period. However, Olmstead (1974) provides some evidence that these mill rates are below the true market rate for loans of this type because of usury ceilings and other factors.

[23] Another series available from 1857 are the call money rates quoted on the New York Stock Exchange. Call money constitutes demand loans collateralized against stock purchases. These rates were highly variable, but generally from fifty to one hundred basis points lower than commercial paper rates.

Nine observations on yields on long-term government bonds with one year to maturity were taken from Garber (1986) in the early and middle nineteenth century. The average yield on this series is 5.04%, remarkably close to 5.03% found for the short-term interest rate series derived by the methodology described above.[24] It should be noted that the hypothetical short-rates constructed here reduce the average interest rates that are reported in other studies, such as Mehra and Prescott, which use commercial paper for the short-term rate before 1920.[25]

2. Establishing the Variability of the Short Rate

Although the above assumption is sufficient to set the level of short-rates during most of the nineteenth century, it does not utilize data available on commercial paper. In order to incorporate this information, a second step is taken, which establishes the *variability* of the constructed short-term interest rate series.

From 1833 to 1920 the amplitude of the commercial paper series is reduced to the level which existed for similar high quality paper in Great Britain. This amplitude adjustment rests on the assumption that the excess variability of U.S. short rates was due primarily to volatile default premia. From 1802 to 1833, when no short-term rates are available, the amplitude of the derived long-term bond yields was enhanced to the level derived in the post-1833 period. It should be noted that the equity premium and real rates puzzles depend on the average level of the real interest rate, which is not influenced by these adjustments to variability. Details on the construction of this rate are provided in Appendix B. The constructed short-term series, along with other available short-term rates are shown in Figure 4.

3. Behavior of Real Short Rate

The behavior of the real U.S. short-term rate, displayed in Figure 5, is quite similar to that of the real long-term rate of return over the entire period. The average real

[24] Since government bonds were issued infrequently, using the yields on nearly-maturing bonds cannot form a complete series. Furthermore, some of the near term data may be distorted by redemption privileges which gave holders of maturing government bonds rights to buy any newly-issued debt at discounts from the market price.

[25] The average short-term interest rate during the M-P period using actual commercial paper before 1820 is 3.45% compared to 3.04% for our series. M-P report a lower *real* rate since they use the consumption deflator, which, as was noted above, yields a higher rate of inflation early in the period than the consumer price index used in this study.

return for the U.S. risk-free asset is .91% during the M-P period, but averaged 5.29% outside that period (5.62% from 1800 to 1888). Similarly, the risk-free real return on U.K. securities averaged only .86% during the M-P period, but 4.90% outside the period. These data confirm that the broad movements of both the real short-term and long-term returns on fixed income securities are similar over time in Britain and the U.S. Table 1A characterizes the real U.S. short-term return, which, like the long-term real return, shows significant difference within and without the M-P period. However, like the real long-term bond return, there is no significant difference between the processes generating these returns in the U.S. and U.K.

V. Conformity with Mehra-Prescott Findings

A. Real Rate Puzzle

When attempting to reconcile these data with the model used by Mehra-Prescott, it is important to note that data on consumption during the early and mid-nineteenth century is not available in sufficient quality to derive a reliable consumption process used to calculate equilibrium asset prices. Therefore, the following analysis is predicated on the assumption that the consumption process followed the same pattern outside the M-P period as within.

The data presented in this paper on the real rate can be made consistent with the parameters fitted to the Mehra-Prescott economy with a positive rate of time preference. Outside the M-P period, the real rate is consistent with positive rates of time preference ($\beta < 1$) when the degree of relative risk aversion (α) is less than 3.3, while inside the M-P period, α must be less than 0.5 for positive time preference to prevail. Thus the data presented here help reconcile what has been termed the "Real Rate Puzzle."[26]

B. Return on Equity and the Equity Premium

In contrast to the behavior of the real rates of return on fixed income securities, the real rate of return on equities exhibits no apparent difference inside and outside the M-P period. This is confirmed by the regression analysis presented in Table 2. Utilizing the

[26] See Weil (1989) for a discussion of the difference between the equity premium puzzle and real rate puzzle. Kocherlakota (1990) and Benninga and Protopapadakis (1990) provide solutions to the real rate puzzle employing discount rates greater than unity.

data on nominal stock returns computed by Schwert (1990) and the data on the price level developed in this paper, the real returns on U.S. stocks are summarized in Table 1C and displayed, along with the real bond returns, in Figures 4 and 5. The average arithmetic annual real return on stocks outside the M-P period is 7.75%, almost identical to the 7.87% return within the M-P period. The average arithmetic return to holding stocks for the entire period, 1800-1990 is 7.81%.[27]

Although level of the equity premium is substantially lower outside the M-P period than within the period, the premium is still above the one percent that M-P found was consistent with a level of relative risk aversion between one and ten. However, the premium to be explained is reduced from 6.96% within the M-P period to only 2.48% when the years outside the M-P period are chosen. Although this premium is still higher than derived by Mehra and Prescott for low levels of risk aversion, it is about one-third the premium calculated in the M-P period. The level of the equity risk premium over time is displayed in Figure 6.

VI. Interpretation of Results

It is not readily apparent why the behavior of real rates of interest has changed so significantly over time, while the return to equity has remained largely unchanged. From the turn of the twentieth century through 1980 the price level was, on average, increasing, while the nineteenth century was characterized by deflation and the 1980s by *dis*inflation. Although in some economic models the steady state real rate of interest is negatively related to the expected rate of inflation, this relation certainly does not explain the high real returns since 1980. It is also difficult to believe that investors habitually overestimated future price level changes in the nineteenth century, and then systematically underestimated inflation during most of the twentieth century (until 1980). Holders of long-term securities may have experienced *ex post* lower real returns during the inflation after World War II and the 1970s, but the holders of three month bills had ample time to adjust to the new inflationary environment.[28]

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[27] The average *geometric* real return on stocks over this period is 6.24%. Arithmetic returns are calculated here since they are the returns studied in the equity premium puzzle.

[28] Short-run autocorrelation of the inflation rates renders the "peso problem," where the price level can unexpectedly jump by a large amount, an inadequate explanation of the swings in real returns for *short-dated* securities.

Perhaps the low real rate of interest that prevailed during most of the twentieth century was caused by specific events, such as the Great Depression, the controlled rates during World War II, and regulated deposit rates until 1980. Economic growth, particularly from immigration, may have been greater in the nineteenth century which may have contributed to higher real rates. One might also mention the large redistribution programs undertaken by the federal government since the Great Depression. To the extent that this redistribution was directed towards relatively risk-adverse individuals, this may have lowered the real rate of interest during most of this century.

However, there are equally persuasive reasons why the real rates of interest should have been *higher* in the twentieth century. The advent of the FDIC insurance increased the effective supply of short-term risk-free assets by creating hundreds of billions of dollars of safe deposits. Furthermore, some may claim that the increase in government debt (to the extent it is not nullified by Ricardian discounting) should have increased real rates. Finally, one might expect that the increase in the income tax rates in the twentieth century might have *increased* the before-tax real rates of interest, raising them above the levels experienced in the nineteenth century.

Although the period since 1978 is short compared to the entire period studied, there is accumulating evidence that real rates in the past ten years have increased substantially from the levels experienced earlier this century, as is summarized in Table 1. From 1979 through 1990 the real short-term risk-free has averaged 2.73% (and 3.57% if the period 1981-90 is chosen), which is significantly higher than the real rate during the M-P period. There are numerous reasons given for the high real rates during this period, ranging from large budget deficits, disinflationary monetary policy, tax law changes, and other factors relating to international capital demands.[29] The past decade of high real rates, which has been characterized as atypical by many economists, may actually be more representative of future real rates than the low real rates experienced from 1889 to 1979.

VII. Conclusion

This research constructs a continuous "risk-free" interest rate series for the United States and United Kingdom from the early nineteenth century. It is found that the real rate of interest on both long and short-term securities is significantly lower during the period

[29] See Barro and Martin (1990), Hendershott and Peek (1989), and Wilcox (1983).

studied by Mehra and Prescott (1889-1979) than either before or after. However, the behavior of the real return on equities shows no significant difference between the periods. It is also shown that the behavior of the real rate of interest in remarkably similar in the U.S. and U.K. during *both* the nineteenth and twentieth century. No ready explanation can be offered for change in the stochastic process for real bond returns, although several directions for further research are suggested.

The higher real returns derived in this paper are, in contrast to the data during the M-P period, consistent with the standard "representative agent" model with relatively low risk-aversion and positive rates of time preference. Although the risk premium on equity is still too high, its level outside the M-P period is about one-third its value during that period. This research is suggestive that the period from 1925 through 1980, which is so often studied by finance economists, may be uncharacteristic of long-term returns on fixed income securities.

APPENDIX A

SOURCES OF DATA

U.S. Stock Returns:

Period:

1802-1987	Schwert (1990), which is, in turn, taken from,
1802-1862	Smith and Cole (1935)
1863-1870	Macaulay (1938)
1871-1925	Dow Jones portfolio plus dividend yield from Cowles (1938)
1926-1987	Center for Research in Security Prices

United States Consumer Price Index:

1800-1850	The Snyder-Tucker Series, L1, reported in *Historical Statistics* (1949)
1850-1925	The BLS Series, Series E135, *Historical Statistics* (1975) as modified slightly by Wilson and Jones (1987)
1926-1989	Ibbotson and Sinquefield, *SBBI* (1989)

United States Long-Term Rates:

1802-1861	Homer (1963). Minimum of Federal Government Bonds, Selected Market Yields and New England Municipal bonds, Table 38.
1862-1920	New England Municipal Bonds, Table 38, and High-Grade Municipal Bonds, Table 45.
1857-1920	U.S. Prime Corporate Bonds, Macaulay (1938), Table 10
1921-1925	Long-Term Governments, Table 48.
1926-1988	Ibbotson and Sinquefield, *SBBI* (1989)

U.S. Short Rates:

Yields from 1831-1920 constructed from U.S. commercial paper, U.S. long bonds, and U.K. long and short-term bonds as described in Appendix B.

Commercial Paper:

1831-1929	Homer (1963), Table 44 and 51
1929-1989	*Economic Report of the President*, var. eds.

Treasury Bills:

1920-1926	Homer (1963) Table 51
1926-1989	Ibbotson and Sinquefield, *SBBI* (1989)

Indices for United Kingdom:

Price Index:

1800-1870	The average of the Rousseaux index and Gayer-Rostow-Schwartz index and the and the spliced value of the Sauerbeck-Statist index. These are taken from Mitchell (1988), Price Series #3, #2 and #4 respectively, pp. 714-726.
1871-1955	Wholesale Board Index (Table 5, p. 728) from Mitchell (1988)
1956-1980	Retail Price Index (Table 10E, p. 740), Mitchell (1988)
1981-1989	OECD (1990), p. 712.

U.K. Long-Term Rates (Consols)

1800-1962	Homer (1963), Tables 19 and 57.
1962-1988	OECD (1973), p. 475, OECD (1990) p. 712.

U.K. Short-Term Rates

1800-1816	U.K. India Bonds, Heim and Mirowski (1987)
1817-1924	Homer (1963): Open Market rate of Discount, Tables 23 and 59, converted to yield basis less 23 basis points risk premia.
1925-1954	Treasury Bill Yields from the *Economist*, var. eds.
1955-1988	OECD (1973), p. 475, OECD (1990) p. 712.

Data for 1989 and 1990 updated from various on-line sources.

APPENDIX B

CONSTRUCTION OF SHORT-TERM U.S. INTEREST RATE

The following assumptions are made to synthesize a short-term risk-free rate utilizing the long and short-term U.S. and U.K. data.

(1) From 1800 to 1920 the average level of the short-term and long-term high-grade (or risk-free) interest rate bore the same general relation in the U.S. as the short-term and long-term British consol rate did in the U.K. This relation is based on five-year moving averages of the U.K. term structure.

(2) The *variability* of the short-term risk-free rate displayed the same variability in the United States it did in the U.K., where capital markets were far more developed. From 1833-1920 the variability of the U.S. commercial paper rate was dampened to that of the U.K. rate (using a factor of .41), and from 1800-1832 the variability of the U.S. long-rate was enhanced to simulate a short-rate over this period.

(3) The short-rate (constructed by (1) and (2) above is not allowed to exceed the actual commercial paper rate plus 18 basis points (the minimum by which commercial paper exceeded treasury bills in the post 1920 period). This condition is rarely binding, but assures that the risk premium on the constructed series does not exceed that on the raw commercial paper rate minus its minimum risk premium. Ten basis points are subtracted from the 1802-1832 data to eliminate a bias caused by the time-averaging procedure.

Let i_t^{US} be the constructed short-term U.S. rate.

Let i_t^{UK} be the short-term U.K. rate
Let CP_t^{US} be the U.S. commercial paper rate
Let I_t^{US} be the high-grade U.S. long-term interest rate
Let I_t^{UK} be the U.K. long-term interest rate
Let the superscript "A" indicate the five-year, centered moving average of the variable in question.
Let β be the coefficient which reduces the standard deviation of the U.S. commercial paper rate to that of the U.K. risk free rate to the from 1831 through 1920.
$\beta = 0.41$ from 1833-1919 and $\beta^* = 5.65$ from 1802-1832.

From 1833-1919:

$$i_t^{US} = \min \{ CP_t^{US} - 0.18,\ {}^{A}i_t^{UK} - {}^{A}I_t^{UK} + {}^{A}I_t^{US} + \beta\,[CP_t^{US} - {}^{A}CP_t^{US}] \}.$$

From 1802-1832:

$$i_t^{US} = {}^{A}i_t^{UK} - {}^{A}I_t^{UK} + {}^{A}I_t^{US} + \beta^*[I_t^{US} - {}^{A}I_t^{US}] - 0.10.$$

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TABLE 1

SUMMARY STATISTICS

Bold Figure = Arithmetic/Geometric Mean of Series
(Parenthesis) = Standard Error
[Bracket] = t-statistic for hypothesis that mean return is identical to that of M-P period;
* significant at 90% level, ** significant at 95% level

		TIME PERIODS				
	VARIABLE	1889-1978 M-P PERIOD	1800-1888	1979-1990	1800-1888 & 1979-1990	1800-1990
PANEL A	REAL US SHORT RETURN	0.91/0.80 (4.72)	5.62/5.38 (6.98) [5.28]**	2.73/2.71 (2.23) [2.25]**	5.27/5.05 (6.65) [5.23]**	3.28/3.00 (6.21)
	REAL US LONG RETURN	1.48/1.23 (7.20)	5.75/5.47 (7.63) [3.86]**	5.38/4.39 (14.64) [0.91]	5.71/5.34 (8.78) [3.66]**	3.70/3.36 (8.34)
	REAL UK SHORT RETURN	0.86/0.41 (10.07)	5.13/4.90 (7.01) [3.29]**	3.51/3.47 (2.83) [1.74]*	4.94/4.73 (6.68) [3.22]**	3.00/2.65 (8.70)
	REAL UK LONG RETURN	1.19/0.54 (11.95)	5.25/4.96 (7.90) [2.67]**	3.69/3.35 (7.01) [1.73]*	5.06/4.76 (7.79) [2.74]**	3.21/2.73 (10.19)
	REAL US STOCK RETURN	7.87/5.87 (20.73)	7.52/6.29 (16.56) [-0.13]	9.44/8.65 (12.97) [0.36]	7.75/6.57 (16.18) [-0.04]	7.81/6.24 (18.49)
PANEL B	NOMINAL US SHORT RETURN	3.04/3.02 (1.83)	5.08/5.07 (1.19) [8.82]**	8.92/8.89 (2.49) [7.91]**	5.54/5.53 (1.89) [9.26]**	4.35/4.33 (2.24)
	NOMINAL US LONG RETURN	3.57/3.46 (4.75)	5.29/5.16 (2.76) [2.96]**	11.47/10.68 (13.63) [1.99]**	6.02/5.82 (5.73) [3.23]**	4.87/4.69 (5.43)
	NOMINAL UK SHORT RETURN	3.64/3.60 (2.76)	3.91/3.88 (1.11) [0.85]	11.78/11.75 (2.42) [10.76]**	4.84/4.81 (2.88) [2.95]**	4.28/4.23 (2.89)
	NOMINAL UK LONG RETURN	3.88/3.74 (5.42)	3.97/3.94 (2.92) [0.14]	11.84/11.63 (6.93) [3.83]**	4.91/4.84 (4.44) [1.42]	4.42/4.32 (4.96)
	NOMINAL US STOCK RETURN	10.08/8.21 (19.93)	6.96/5.98 (15.32) [-1.18]	15.92/15.19 (12.74) [1.38]	8.05/7.05 (15.32) [-0.78]	9.02/7.60 (17.69)

TABLE 1

SUMMARY STATISTICS

(Continued)

Bold Figure = Arithmetic/Geometric Mean of Series

(Parenthesis) = Standard Error

[Bracket] = t-statistic for hypothesis that mean return is identical to that of M-P period;

* significant at 90% level, ** significant at 95% level

		TIME PERIODS				
	VARIABLE	1889–1978 M-P PERIOD	1800–1888	1979–1990	1800–1888 & 1979–1990	1800–1990
PANEL C	US CONSUMER PRICE INFLATION	2.33/2.21 (4.99)	0.04/–0.30 (6.76) [–2.57]**	6.08/6.02 (3.51) [3.29]**	0.76/0.45 (6.75) [–1.84]*	1.50/1.28 (6.04)
	US WHOLESALE PRICE INDEX	2.47/2.10 (8.53)	0.00/–0.43 (9.58) [–2.75]**	4.70/4.61 (4.27) [1.46]	0.56/0.16 (9.24) [–1.49]	1.46/1.07 (8.17)
	US GNP DEFLATOR	2.70/2.55 (5.51)	– – –	5.21/5.18 (2.46) [2.74]**	– – –	– –
	US CONSUMPTION DEFLATOR	2.52/2.39 (5.22)	– – –	5.66/5.64 (2.30) [3.63]**	– – –	– –
	UK CONSUMER PRICE INFLATION	3.64/3.18 (9.62)	–0.69/–0.97 (6.47) [–3.53]**	8.09/8.00 (4.26) [2.79]**	0.37/0.08 (6.86) [–2.68]**	1.92/1.54 (8.44)
PANEL D	NOMINAL US GOVT BOND TOTAL RETURN	2.93/2.77 (5.52)	5.78/5.56 (4.53) [3.79]**	11.47/10.68 (13.63) [2.15]**	6.46/6.16 (6.60) [4.03]**	4.79/4.54 (6.37)
	NOMINAL US GOVT BOND COUPON	3.41/3.40 (1.48)	4.86/4.81 (1.15) [7.29]**	10.01/10.00 (1.65) [13.16]**	5.47/5.42 (2.06) [7.97]**	4.50/4.46 (2.08)
	REAL US GOVT BOND TOTAL RETURN	0.81/0.55 (7.20)	6.21/5.87 (8.57) [4.56]**	5.38/4.39 (14.64) [1.07]	6.11/5.69 (9.52) [4.37]**	3.59/3.21 (8.90)
	NOMINAL UK CONSOL COUPON	4.68/4.64 (2.79)	3.60/3.57 (0.65) [–3.56]**	10.67/10.66 (1.16) [13.41]**	4.44/4.41 (2.40) [–0.63]	4.55/4.52 (2.59)
	NOMINAL US COMMERCIAL PAPER^	3.90/3.88 (2.05)	7.63/7.59 (2.91) [8.48]**	9.55/9.52 (2.40) [7.79]**	7.96/7.92 (2.92) [9.87]**	5.67/5.63 (3.19)
	REAL US COMMERCIAL PAPER^	1.76/1.63 (4.97)	7.67/7.47 (6.46) [5.93]**	3.47/3.30 (2.13) [2.12]**	7.00/6.74 (6.18) [5.79]**	4.03/3.84 (6.11)

^Commercial Paper data is available from 1831.

TABLE 2

Test of Stochastic behavior of real rates and real stock returns within and without the Mehra-Prescott Period

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 DUM_t + \alpha_3 (DUM_t \cdot R_{t-1}) + \epsilon_t$$

$$DUM_t = 1 \text{ for } 1889 \leq t \leq 1978$$

$$DUM_t = 0 \text{ for } t < 1889 \text{ and } t > 1978$$

t-statistics in parenthesis

Variable	α_0	α_1	α_2	α_3	$\bar{R}^2$	SEE	DW	Reject Hyp $(\alpha_2,\alpha_3)=0$
US Real Short Return	3.49 (5.34)	.309 (4.06)	-3.24 (3.81)	.389 (2.85)	.312	5.05	1.71	>.99
US Real Long Return	3.29 (5.13)	.323 (4.24)	-2.73 (3.21)	.339 (2.49)	.271	4.99	1.69	>.99
UK Real Short Return	4.64 (4.52)	.0624 (.506)	-.407 (3.03)	.290 (1.93)	.121	8.20	1.93	>.99
UK Real Long Return	4.19 (4.20)	.0812 (.662)	-2.95 (2.22)	.258 (1.72)	.088	8.19	1.92	.94
US Real Stock Return	7.81 (3.71)	-.015 (.13)	-.066 (.02)	.031 (.201)	.000	18.65	1.98	.024

FIGURE 1.

LONG TERM INTEREST RATES

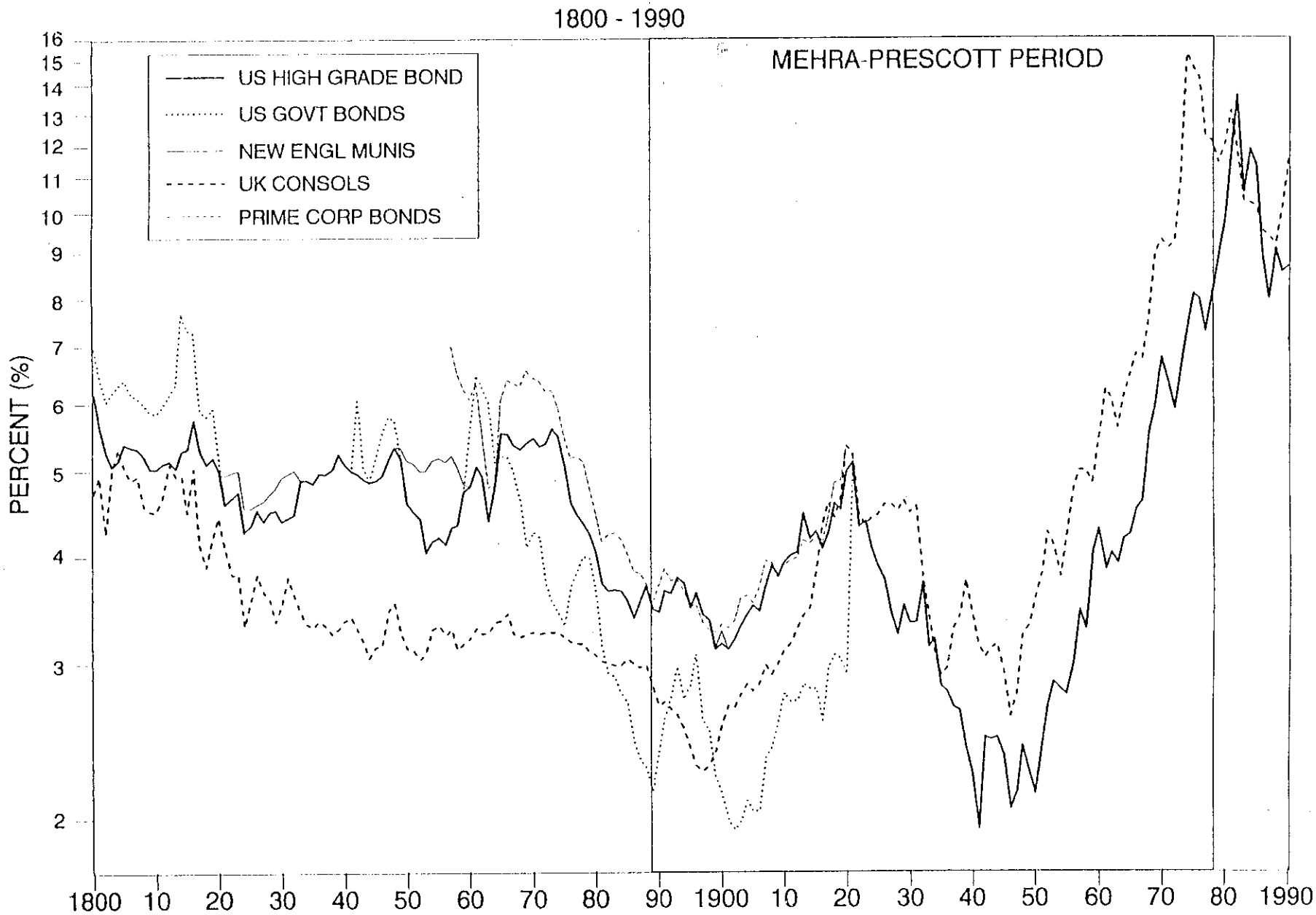

FIGURE 2.

PRICE INDICES

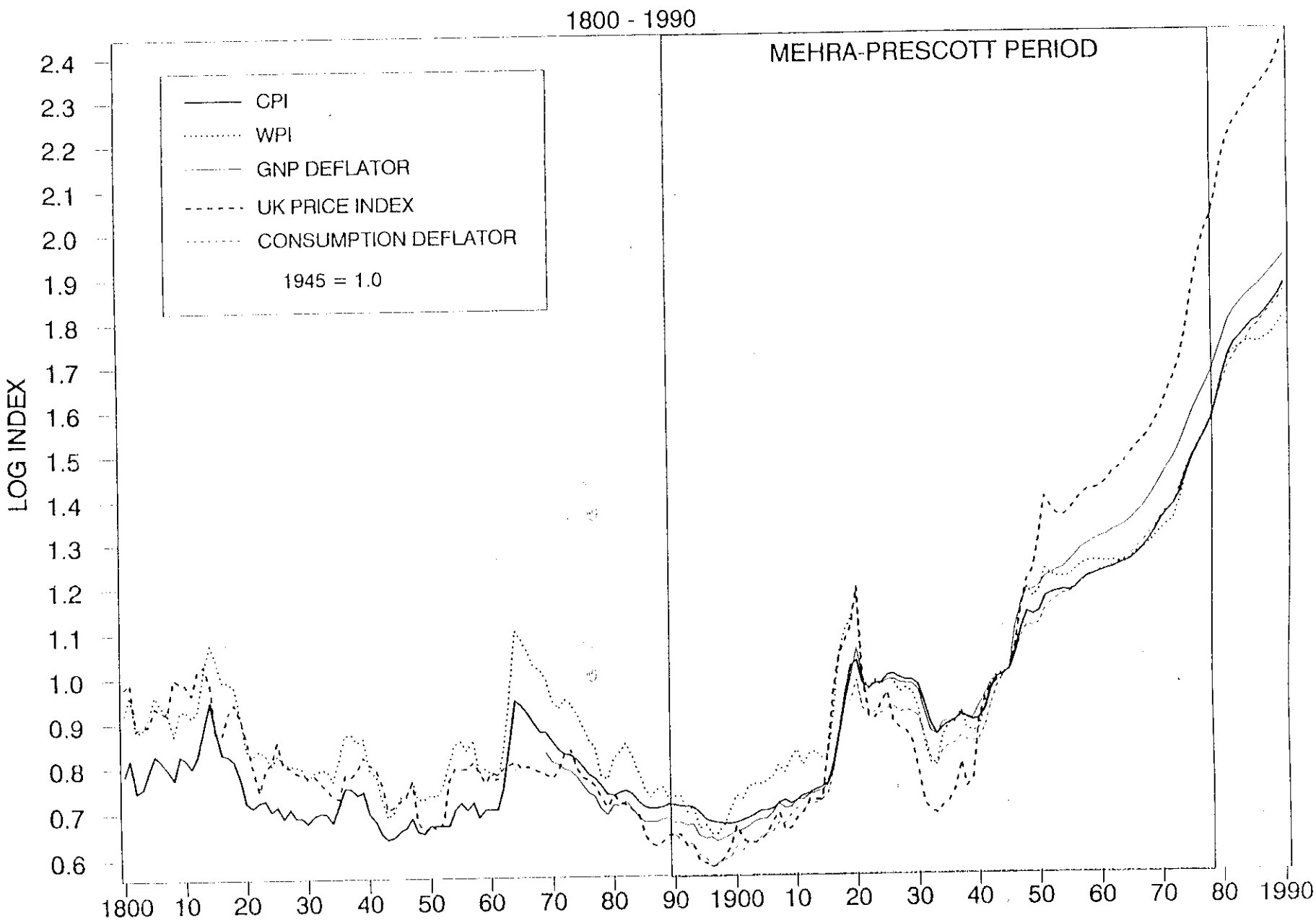

FIGURE 3. **REAL RETURNS - STOCKS AND LONG BONDS**

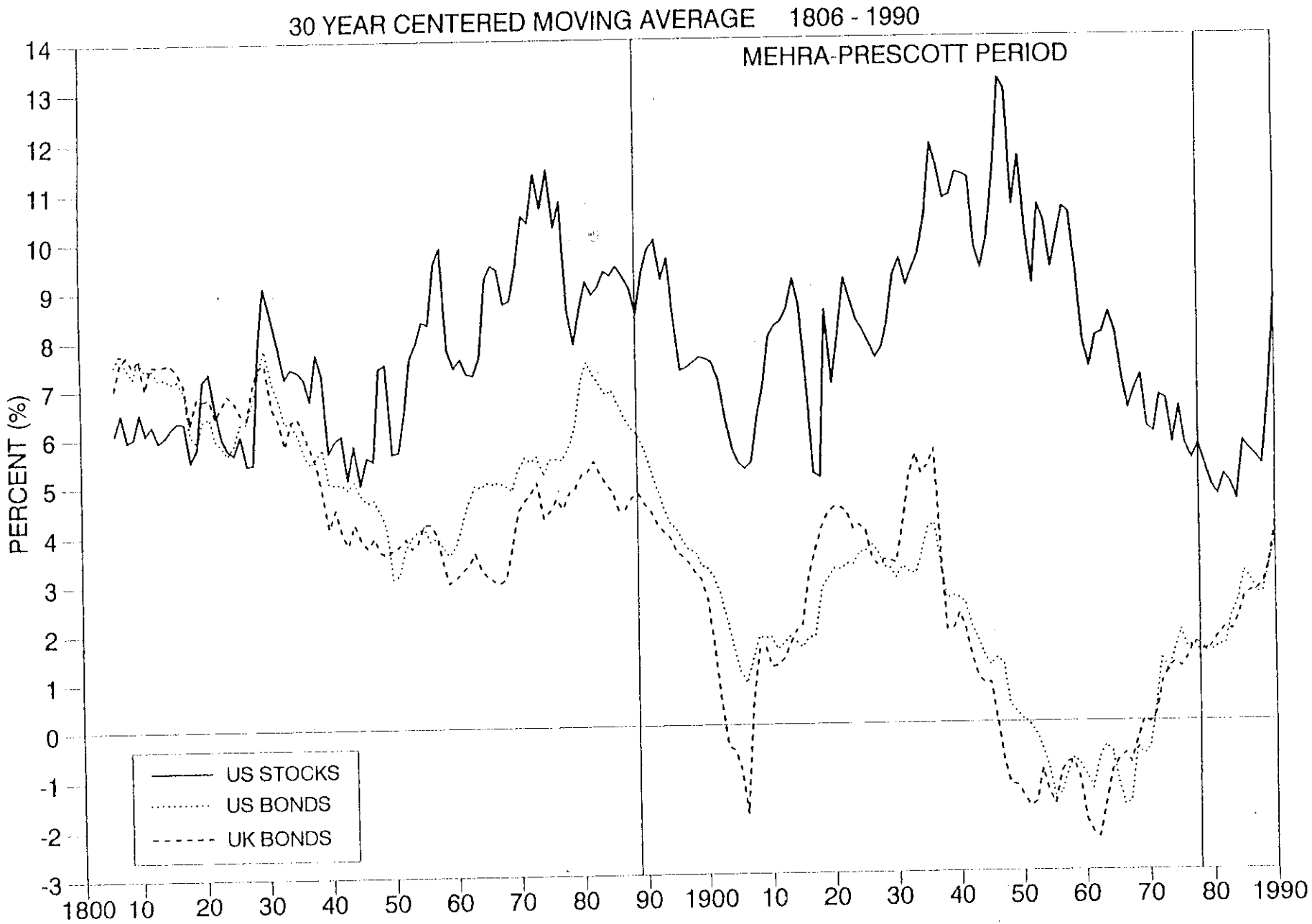

FIGURE 4.

SHORT TERM INTEREST RATES

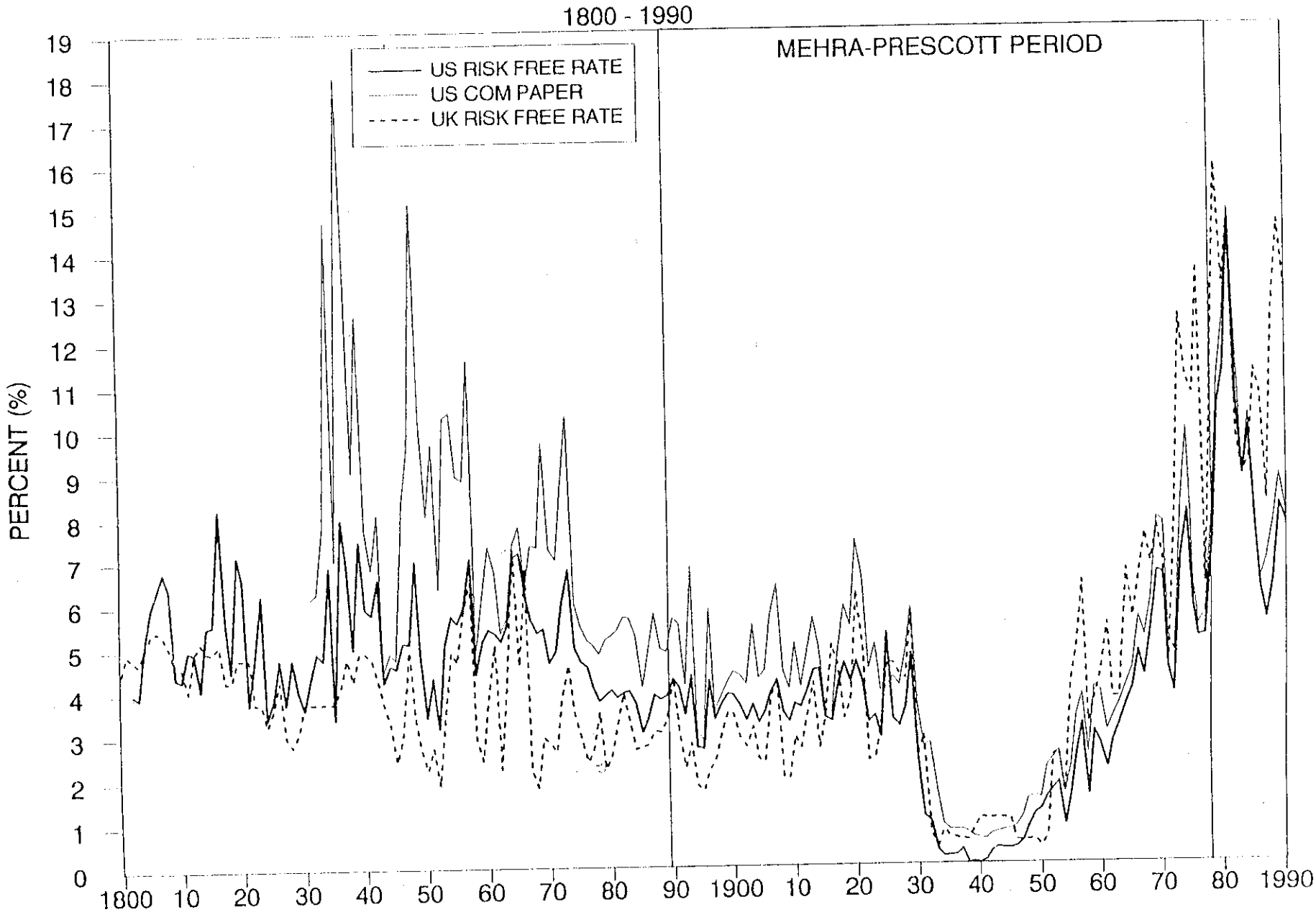

FIGURE 5. **REAL RETURNS - STOCKS AND SHORT BONDS**

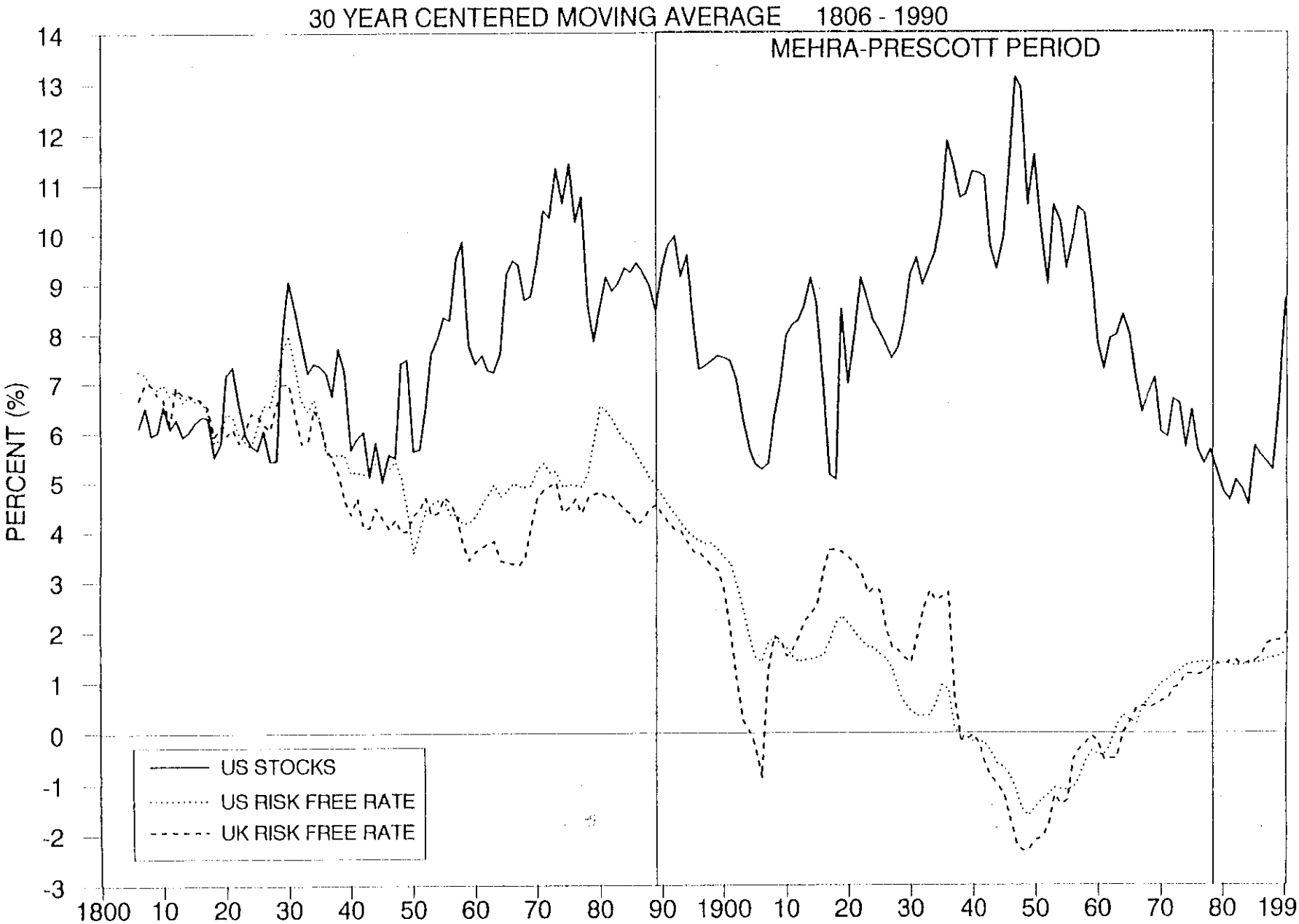

FIGURE 6.

EQUITY RISK PREMIUM