Stock returns and bond yields in Denmark, 1922-99

Nielsen, Steen; Risager, Ole

Institut for Nationaløkonomi

Handelshøjskolen i København

Working paper 3-2001

STOCK RETURNS AND BOND YIELDS IN DENMARK, 1922-99

Steen Nielsen and Ole Risager

Department of Economics - Copenhagen Business School

Solbjerg Plads 3, DK-2000 Frederiksberg

Stock returns and bond yields in Denmark, 1922-99*

Steen Nielsen and Ole Risager

Department of Economics
Copenhagen Business School
Solbjerg Plads 3, C 5
2000 Frederiksberg
DENMARK
Telephone: +45 3815 2605 and +45 3815 2592
E-mail: Sn.eco@cbs.dk and Or.eco@cbs.dk

Abstract: *This paper presents long time series of stock and bond returns for Denmark from 1922 to 1999. Average stock returns are low in an international context, but returns (and volatility) have increased sharply since 1983 which may be explained by major changes in economic policy and liberalizations of capital flows. On the other hand, Danish bond yields are high in general, and in particular from the late 1960s to the mid 1980s. Thus, there are several periods in which bonds have given higher returns than stocks. Over the entire sample, however, equity clearly outperforms bonds.*

* Parts of the contents of this paper have been presented in seminars at the following institutions: University of Lund, George Washington University, Washington D.C., Danmarks Nationalbank, Jurister og Økonomers Pensionskasse, and Copenhagen Business School. Valuable comments from Mike Staunton and two anonymous referees are gratefully acknowledged. We also thank Christoffer Koch-Sørensen, Mikael Mosekilde, Trung Hieu Nguyen, Jan Overgaard Olesen and Ian Valsted for research assistance. The research of Ole Risager is financed by Statens Samfundsvidenskabelige Forskningsråd. An electronic version of the data appendix is available on e-mail request to our secretary, Ida Lyngby, il.eco@cbs.dk.

1. Introduction

The main purpose of this paper is to report long time series of stock and bond returns for Denmark and thereby make these series available for the research community. Along with this, the paper also analyzes and presents a number of stylized facts that apply to the two asset markets.

Long time series are useful for many purposes in economics and finance; the data set offered in this paper has therefore many applications. Thus, by studying historical movements of stock and bond returns, we get a yardstick for the future, assuming that economies change only gradually and that we therefore can learn from history. Long time series also make it possible to study specific time series patterns in the data. For example, a number of researchers, like Poterba and Summers (1988) and Fama and French (1988), have argued that high stock returns tend to be followed by low returns and vice versa, and that stocks because of this tendency to mean revert are not as risky in the long run as in the short run. This controversial view is also addressed in Campbell, Lo and MacKinlay (1997) who give an insightful review of the mean reversion literature. Balvers, Wu and Gilliland (2000) extend the mean reversion analysis to a cross-section analysis of 18 countries and argue that there is mean reversion across countries. Consistent time series of stock returns and consumer price inflation also enable us to analyze whether, and to what extent, stocks provide a hedge against inflation? That is another issue which has implications for the riskiness of stocks. Modigliani and Cohn (1979) were among the first to address this question, using US data, and Barnes, Boyd and Smith (1999) have recently reexamined the inflation hedge issue in a cross country study consisting of 15 large and small, developed and less developed countries. Furthermore, data on stock returns and government bond yields allow researchers to estimate the risk premium on stocks, defined as the difference between the return on stocks and the yield on short risk-free government papers. This has led to an extensive literature on the Consumption-CAPM and other asset pricing theories which attempt to explain the equity premium, see the seminal paper by Mehra and Prescott (1985) and the survey by Kocherlakota (1996). Finally, the stock market's interaction with the real sector in the economy is also an

issue that can be addressed using the data laid out in this paper. Thus, by combining the stock market data with firms' real investment expenditures we may obtain insight into the validity of the Tobin's q model of investment, and by examining the relationship between consumer expenditures and the stock market, the magnitude of the wealth effect in the consumption function may be analyzed. Insight into the stock market's effect on fixed real investment and real consumption provides the necessary tools for assessing how a prolonged bear market, which several economists predict for the near future (see e.g. Shiller, 2000), will be transmitted to the real economy.

Long financial time series are scarce in the Danish context. As regards the stock market, Hansen (1974) reports stock returns based on a sample of firms for the period 1900-74, but Hansen only estimates the returns for consecutive 10-year periods (decades) and for the (remaining) 1970-74 period. These data can therefore hardly be used for time series analyses. Statistics Denmark has for many years reported a price index (the socalled totalindeks) for a large sample of firms, but this index is exclusive of dividends and can therefore not be used to calculate stock returns. In this paper, we report an annual total stock return series, defined as the sum of the dividend yield and the capital gain. The dividend yield is based on our own sample of stocks from different sectors and of different sizes over the period 1922-99, whereas the capital gain is based on the series published by Statistics Denmark. Because there are a large number of both small and large caps in the sample, returns are likely to be representative for the whole market. Lund (1992) has constructed a large cap index in the sense that he has picked 16 stocks with the explicit purpose of maximizing total capitalization. Finally, Jennergren and Sørensen (1988) study daily and weekly returns of 25 Danish stocks in the 1890s. Other stock return series for Denmark have build on the aforementioned studies or on pilot studies by various ministeries. In a nordic context, Frennberg and Hansson (1992) have constructed monthly return indices for the Swedish stock and bond markets.

To put the stock return series into perspective, we report comparable time series of 1-, 5- and 10-year yields to maturity on government bonds. Due to the thinness of the

government bond market in the beginning of the sample period, it is not always possible to find a bond with the desired time to maturity. Therefore, we have taken a pragmatic approach by choosing the paper that comes closest in terms of expiration date.

The paper is organized as follows. Section 2 describes the stock market data. In this section, we also address the socalled survivorship bias often neglected in the literature. Section 3 describes the 1-, 5- and 10-year yields to maturity on government bonds and discusses weaknesses of the bond yields. Section 4 presents stylized facts on Danish stock returns. Section 5 presents the bond yields, and the excess return on stocks relative to bonds. Section 6 concludes the paper.

2. Annual Stock returns

The stock market data are from two sources. Dividend yields are from our own sample of the listed stocks on the Copenhagen Stock Exchange, whereas capital gains are calculated on the basis of the market index published by Statistics Denmark. The two series should be regarded as estimates of true market values, ie., market dividend yield and market capital gain, respectively. Thus, our portfolio of firms are sampled to reflect the composition of firms on the market. In view of this objective, the fact that Statistics Denmark's and our portfolio are different is not a matter of concern as long as they are representative. Our estimate of total annual stock return equals the sum of the dividend yield and the capital gain; stock returns are calculated for the period 1922 to 1999.

2.1 Dividends

The dividend yield is estimated on the basis of a large sample of stocks listed below in Table 1. These stocks represent the five sectors on the exchange, namely banking, insurance, services, shipping and industry. We have both small and large caps in the portfolio. The sample consists of 102 stocks in total, accounting for 50 to 80 per cent of the total market capitalization on the exchange ("Hovedbørsen" and later "Børs I") in the sample period.

Table 1

Compared to a previous study by Hansen (1974) we estimate the yield for each year, whereas Hansen only supplies estimates for 10-year periods. Lund (1992) has set up another Danish database. His index contains 16 large caps deliberately chosen such as to maximize total capitalization.

The dividend yield is defined as dividends paid out during the calendar year divided by the stock price quoted at the end of the previous year (late December). Thus, it is assumed that dividends are not reinvested within the year they are paid out. In the rare case of a secondary issue at a price below the market price and with dividend rights in the year of the issuance, we have made a correction of the yield to make sure that the dividend yield always measures the value of total dividends relative to the stock market value at the end of the last year.

The dividend yield on the market portfolio of stocks is a weighted average of the yields on the different stocks, where the weights each year equal the share of the total market capitalization. Thus, our return index is a value-weighted index.

2.2 Capital gains

To construct the capital gain component of the return, we use the Danish Share Price Index (Totalindekset). This index is published by Statistics Denmark, and captures the price movement of a large sample of stocks. The size of the sample has gradually expanded from around 50 companies in 1921 to all listed companies (except mutual funds and a few other holding companies) from 1983 and onwards. The actual portfolio of firms is not available. This index is also value-weighted. Weights are adjusted at new issuances and withdrawals from the exchange.

2.3 Potential Biases

The dividend yield: This component may be underestimated due to the assumption that dividends are not reinvested within the year. To get an idea of the magnitude of

this bias, we consider a number of examples. To this end, it is first useful to note that over the entire sample period 1922-99, the average (arithmetic) dividend yield is 4.6% under the assumption that dividends are not reinvested within the year. The average capital gain equals 7.1%. The average total return is thus 11.7%. The second important feature is that dividends in most cases are paid out during the first 6 months of the year.

Case 1. Suppose that dividends are paid out after 6 months and that shareprices increase linearly such that the semiannual capital gain on average equals 3.6%. In case dividends are reinvested when paid out, the yield associated with dividend payments and reinvestment of these funds equals 4.8%, or 0.2% more than the estimate without reinvestment of dividends.

Case 2. Suppose dividends are paid out after 3 months. Under the assumption of linear capital gains, the growth rate in three quarters equals 5.3%. The bias is greater than in the previous case but the difference disappears due to rounding. Thus, the bias is 0.2%.

The two cases demonstrate that the bias is 0.2% and fairly robust to the timing of dividends. Prior to 1982, dividends made up a larger share of total return. However, this does not imply that the bias due to non-reinvestment of dividends was larger, because capital gains at the same time were smaller. Thus, from 1922 to 1982, the average dividend yield is 5.4% and the capital gain is 4.2%. Hence, under the assumption that dividends are paid after 6 (3) months, the bias in this period can be shown to equal 0.1% (0.2%).

Rights issues at a discount: From 1983 and onwards, Statistics Denmark has made a correction of the price index in case of right issues at prices below the market price. The reason is of course that a rights issue with a discount to existing shareholders will make the price of each share go down, and in case there is no correction the estimate of the capital gain will be downward biased (in the year where the stock issue takes

place). As Statistics Denmark has neglected this correction prior to 1983, the capital gain component is underestimated. The bias is, however, likely to be small because of a low frequency of secondary issues with price discounts.

Survivor bias: Another source of error is an incorrect statistical treatment of bankruptcies; an issue which is seldomly treated in the literature. Bankruptcies were widespread in Denmark in the beginning of the 1920s. The most famous case is the default of Landmandsbanken (the largest bank) in 1922. Statistics Denmark reports two shareprice indices; one without and one with Landmandsbanken, where the latter takes into account the losses associated with the bankruptcy of Landmandsbanken. We use of course the latter index in the calculation of the capital gain component. On the basis of our own data, we have also checked Statistics Denmarks calculation of the fall in the share price from December 1921 to December 1922 (equals 29.1 %). By calculating the value-weighted fall in share prices using the 26 shares we have for this year and using all available information including the bankruptcy of Landmandsbanken and (partial) bankruptcy of other firms, e.g. Superfos, we arrive at exactly the same estimate as Statistics Denmark.

Statistics Denmark does not, however, report how it has dealt with this problem subsequently. Hence, it is possible that the shareprice index is upward biased (in case there has not been proper adjustments for business failures). We have looked at the late 1980s and the beginning of the 1990s and found that the bias on average was 0.4 % during this period. This is an upper limit of the survivor bias because the Danish economy at that time experienced a deep recession.

Hence, it seems that the bias due to non-reinvestment of dividends within the year more or less cancels out with the bankruptcy bias, which of course is a desirable feature of the data. In the Danish case, there is therefore no reason to believe that returns are grossly miscalculated due to these biases.

For later reference equation (1) below defines the 1-year stock return. The nominal 1-

year return in the period from time t to time t+1, denoted $S1(t)$, equals the dividend yield $D(t+1)/Q(t)$ plus the capital gain $(Q(t+1)-Q(t))/Q(t)$, where $D(t+1)$ are dividends from time t to t+1, and $Q(t)$ is the stock price at date t. The corresponding 1-year real return $SR1(t)$ is defined by (2), where $C(t)$ is the Consumer Price Index (CPI) at time t. It is important to note that the real return defined by (2) is only approximately equal to the more common but less exact definition of the real return given as the nominal return $S1$ less the annual rate of CPI inflation. For future reference, it is also worth noticing that e.g. the 5-year nominal return equals the geometric average of the consecutive annual nominal returns. The formula for the 5-year nominal return is thus given by (3). The formula for the 5-year real return is defined analogously (with CPI at time t and t+5) and is therefore omitted.

$$S1(t) = \frac{D(t+1)}{Q(t)} + \frac{Q(t+1)-Q(t)}{Q(t)} \tag{1}$$

$$1+SR1(t) = (1+S1(t))\frac{C(t)}{C(t+1)} \tag{2}$$

$$1+S5(t) = \left((1+S1(t))\cdot\ldots\cdot(1+S(t+4))\right)^{1/5} \tag{3}$$

3. Bond Yields

It is of interest to compare stock investments to other investment opportunities and in particular to government bonds because that gives information about risk premia. In the Danish case there has been very little work on the latter issue; there are, however, data on private mortgage bond yields, see Olsen and Hoffmeyer (1968), but mortgage bonds are first of all different from government bonds and, secondly, Olsen and Hoffmeyer estimate their yields as average yields on bonds with very different time to maturity. Christiansen and Lystbæk (1994) also construct a mortgage bond return series but their series is based on bonds with 30-years to maturity. As we need government bond yields for holding periods of fixed length, we have estimated bond yields for the 1-, 5- and 10-year investment horizon.

1-, 5- and 10-Year Yield to Maturity

These yields are defined as the yield to maturity at each investment horizon using the standard definition of yield to maturity, see e.g. Campbell, Lo and MacKinlay (1997). Because there were not that many government bonds outstanding in the past, it has not always been possible to find a bond with the desired time to maturity; in such cases we have taken a pragmatic approach, which means that we used the bond which is closest in terms of maturity. For what we shall dub the 1-year interest rate series, the typical maturity is between 9 and 12 months. The shortest maturity is 2 $^{1}/_{2}$ months (in 1941) and the longest maturity is close to 3 years (in 1973). For the socalled 5-year bond, the horizon typically varies between 4 and 6 years. The lowest maturity is 1 year and 7 months and the highest is 10 years and 8 months, both occurring in the thirties where the outstanding stock of Government debt was exceptionally low. The typical maturity of the 10-year bond is between 9 and 11 years, the shortest maturity is 6 years and 9 months (in 1925) and the longest is 14 years and 5 months (in 1933). From 1960 and onwards, observations for the 10-year series are from OECD Statistical Compendium, various issues.

The yield to maturity is in all cases calculated on the basis of the price of the bond on the last trading day in December, the coupon and the timing of coupon payments. In the calculation of the yield to maturity we have taken account of the fact that bonds sellers are paid for accrued interest at the day where trade takes place (Vedhængende rente). Also, in case of a sinking fund (when the government is buying back securities regularly), the future payments' stream is affected, and in this case we use the expected payments stream in the estimation of the yield to maturity.

The time to maturity on the three bonds is as mentioned only approximative due to lack of data, which of course is a weakness. It should also be noted that despite the popularity of the yield to maturity concept in economics and the financial press, it is not without shortcomings as it assumes a flat yield curve (coupons can be reinvested at the constant yield). The latter assumption has bearings for the volatility of the bond yields. Thus, it is likely that this return concept leads to an underestimation of the

volatility/riskiness of bond investments, whereas the effect on the average bond yield is likely to be small as the yield curve sometimes is upward sloping and sometimes downward sloping. Hence, we believe that the average excess return on stocks relative to bonds (to be presented below) is not particular sensitive to this assumption.

Let $B1(t)$, $B5(t)$, $B10(t)$ denote the annualized 1-, 5- and 10-year nominal bond yields from date t to $t+1$, from t to $t+5$, and from t to $t+10$, respectively. The 1-year real bond yield $BR1(t)$ is

$$1+BR1(t) = (1+B1(t))\frac{C(t)}{C(t+1)} \tag{4}$$

and the 5- and 10-year real bond yields, $BR5$ and $BR10$, are defined analogously.

4. Basic Results and Insights for the Stock Market

Now follows a brief presentation of basic results, summary statistics and a short account of the overall stock market development along with a presentation of outstanding years.

4.1 Summary Statistics and Changing Regimes

Table 2 below presents the average stock return and its components. Over the whole sample period 1922-99, the average annual dividend yield equals 4.6%, the capital gain amounts to 7.1% and, hence, the average stock return equals 11.7% with a standard deviation of 22.9%.[1] The movement of the annual stock return is illustrated in Figure 1. The figure shows that the nominal return has fluctuated in a relatively stable manner around a constant mean until the beginning of the 1980s with the high yield in 1972 as a clear outlier. From the beginning of the 1980s and until the end of the millennium, both the mean return and the variance of stock returns have increased substantially. These observations are confirmed by the simple summary statistics listed

[1] This is the arithmetic return. The average geometric return equals 9.8%, see Table 2.

for the two subperiods 1922-82 and 1983-99.[2] The average nominal return has thus increased from 9.6% in 1922-82 to 19.3% in 1983-99. Along with a rise in the average return, Table 2 also shows that the standard deviation has more than doubled. The stock market has thus become much more volatile in the short term. It is, however, interesting to note that the return-risk ratio, defined by the mean return divided by the associated standard deviation, has stayed more or less constant over the two subperiods.

Table 2

Figure 1

The real stock return has displayed roughly the same behaviour as the nominal return. Thus, the mean return has increased from 5.3% in 1922-82 to 15.3% in 1983-99 along with more than a doubling of the standard deviation. The shift towards the recent regime with high returns and high volatility is associated with a spectacular rise in capital gains whereas dividends nowadays only account for a minor share of the stock return, see Table 2 and Figure 2 which depicts the dividend yield. In contrast to our results for nominal returns, the real return-risk ratio increases considerably (from 32% to 45%) in the latter subsample.

Figure 2

4.2 A Brief account of the Movement of the Stock Market and Major Events

Figure 3 gives further insight into the role of price movements in the market. This diagram presents the stock price index (exclusive of dividends) deflated by the Consumer Price Index. The 1920s are characterized by an upward trend in the real stock price index but also with considerable declines in 1922 and 1924, which in part

[2] The motivation for this particular sample split is twofold. First, major changes in economic policy took place in 1983, see also below. Second, statistical analysis in Nielsen and Olesen (1999) based on the Markov regime-switching model indicates that returns enter a new regime with higher mean and volatility in the beginning of the 1980s.

reflects a tough monetary policy that aimed at restoring the real value of the Krone. Thus, the CPI fell by 20% from 1920-24. The sharp deflation was accompanied by several collapses of major banks and industrial companies, see Olsen and Hoffmeyer (1968). The Wall Street crash in 1929 is associated with a minor fall in the Danish index in 1930. The major adjustment occurs in 1931, where the real index went down by 17%. The recovery sets in immediately after the crash, and the stock market reaches a new peak in 1936. Thereafter, the stock market displays a remarkable trendwise decline until the beginning of the 1980s. The only major interruption to this decline is 1972, which is the year when Denmark joined the EEC (now the EU). The declining index contributed of course negatively to stock returns, but high dividend yields in this period kept them on the positive scale. Following a long period with a declining real stock index, the stock market went up by 100% in real terms in 1983. In 1987, stock markets were worldwide characterized by steep declines, and the Danish index is no exception as the real stock price falls by 9%, but that is immediately followed by a 43% increase in 1988. The first five years in the 1990s are characterized by temporary ups and downs along a fairly constant mean. From 1995 and onwards the market has been on a strong upward trend with 1998 as the only exception. Thus, from 1995 to 1999, the real index has gone up by 100%, which corresponds to an annual (arithmetic) mean increase of 25%. Thus, the Danish market has like many other markets been very bullish in recent years.

Figure 3

Following this overview of the market history it is worthwile commenting on spectacular events. Let us pick the bad years first. The bad years are 1931 (17% real price decline) and that has of course to do with the Great Depression which had worldwide effects. Following Germany's occupation of Denmark, the market went down by 20% in 1940. But it is interesting to note that the sharpest declines have occured in modern times, which underscores the point that the stock market nowadays is much more volatile than in the past. Thus, the real index declined by 32% in 1974, which is likely to be due to the first OPEC shock, relatively high inflation and large wage increases.

In 1984, the market declined by 27% in real terms, which is more difficult to explain. It may, however, reflect a correction of the huge upturn in the previous year. Thus, it is possible that the market overeacted in 1983, where it went up by 100% in real terms. In 1992, the real index declined by 27%, which in turn may be related to the Gulf crisis. The sharp declines in 1974 and 1984 followed immediately after spectacular bull markets, indicating that the Danish stock market may display excess volatility. This hypothesis was first proposed for US stock markets by Grossman and Shiller (1981) and later discussed by Kleidon (1986).

There are two years in the history of the market that are outstanding, namely, 1972 and 1983. In 1972, the real index went up by 77%, and most of this increase came after October 2 where a referendum resulted in Danish membership of the EEC. Along with this, the stock exchange was opened up for foreign investors in 1973, which in turn may have been anticipated and hence discounted by the market. The sharp increase in the index in 1983 is the largest jump that has occurred since World War I. It is natural to attribute the 1983 jump to three factors. First, there is a shift in economic policy in late 1982 towards a non-accomodation strategy with tight fiscal policy and fixed exchange rate policy as key elements, see Andersen and Risager (1988). This change in economic policy was accompanied by a fall in the long interest rates by around 7 percentage points, cf. also the next session. Along with a fall in interest rates it is also possible that the risk premium declined reflecting the success of the macroeconomic strategy and the associated stability gains. Altogether, there is no doubt that investors' discount rate declined and that is an important factor in explaining the upturn in the market. Second, a new tax on institutional investors' real bond yields was passed by Parliament in 1983 to be phased in from 1984 and onwards. Because stocks were not subject to this tax, the current and anticipated after tax return to equity increased sharply relative to bond investments and this will also lead to higher stock prices both through increased demand and through the anticipation that institutional investors would increase the proportion of stocks in their portfolios in the future, which indeed has proved to be correct. Third, capital market liberalizations resulted in a lifting of all restrictions on Danish investors' foreign equity placements in 1984, see Eskesen et al.

(1984), whereas the Danish stock market had been open to foreigners since 1973. The liberalizations may have enlarged the window to the rest of the world, and because many markets experienced very high returns in these years this may have had spillover effects to the Copenhagen Stock Exchange. We are, however, still short of formal tests of the importance of the various explanations.

5. Bond Yields and the Equity Premium

The 1- and 10-year interest rates are recorded in Figure 4. From the beginning of the sample to the late 1960s, bond yields fluctuate around a fairly constant mean. Then follows a period with rising yields, reflecting higher inflation and a loose exchange rate and fiscal policy. The turnaround of the Danish economy took place in late 1982 and this is also demonstrated by the large declines in interest rates. Thus from 1982 to 1983, the 1-, 5- and 10-year interest rate decline by 6.4, 6.8 and 6.3 percentage points, respectively. These are the largest declines that have occured in the 20th century in Denmark. Following the considerable downward jump, interest rates continue falling, albeit much more smoothly, until they stabilize at the same level as before the inflationary regime which began in the late 1960s.

Figure 4

Table 3 summarizes the average nominal and real bond yields as well as the associated standard deviations. Whereas the average 5- and 10 year yields are almost identical there is evidence of an upward sloping yield curve from the 1- to the 5-year horizon insofar as the 1-year interest rate is on average about 0.5-0.8 percentage points below the long interest rates.

Table 3

Table 4 presents the 1-year equity premium, defined as the average stock return minus the average government bond yield. On average over the period 1924-99, the equity

premium equals 4.1% per year. In an international perspective, the Danish equity premium is at the low end of the scale. Thus, by comparing the Danish premium to the 11 other countries (Australia, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, USA, UK) in the millennium study of Dimson, Marsh and Staunton (2000), it turns out that the Danish premium is the lowest premium recorded. That reflects both a low stock return but also a relatively high bond yield, see Table 7 in Dimson, Marsh and Staunton (2000).

Table 4

Figure 5

Despite the fact that stocks on average have given a higher return than bonds, it is important to mention that there are several periods in which bonds have outperformed stocks. That is shown in Figure 5, which illustrates the 5-year equity premium. Figure 5 shows that the premium displays a cyclical behaviour, that is, the premium varies between positive and negative values. There are seven periods in the data where the equity premium has been negative for more than one year. As shown, a negative premium is in particular a characteristic of the 1980s due to the high interest rates we have in this period. Notwithstanding this, stocks have over long periods performed better than bonds. To illustrate this in further detail, consider the cumulative total return indices in Figure 6 (note that the scale is logarithmic).

Figure 6

Figure 6 shows how an investment in the market portfolio of stocks in late 1924 has grown over time, assuming that the annual payoff (dividend and capital gain) is reinvested each year. Similarly, the diagram shows the outcome of repeated investments in 1-year bonds. For both investment strategies, we ignore transaction costs and taxes. At the end of 1999, 1 Krone in stocks (bonds) would have grown to 1,200 (210) Kroner. Another bond strategy is to invest in 10-year bonds. Consider therefore the

case where the first investment is made in 1924, the next in 1934 and so forth. The cumulative 10-year bond index is also shown in Figure 6. In spite long bonds perform better than short bonds, stocks clearly outperform both bond strategies.

The corresponding real return indices are shown in Figure 7. The results show that the purchasing power of investing 1 Krone in stocks, in 1-year and 10-year bonds would have increased by a factor 59, a factor 10 and a factor 22, respectively, from 1924 to 1999. Over this very long period, stocks have thus outperformed long bonds by a factor 3 in real terms. This result would not be weakened by taking investor taxation into account; on the contrary. Thus, for most investors, fixed income securities have been subject to a higher tax rate than equity, but that issue is beyond the scope of this paper.

Figure 7

6. Conclusion

The main achievement of this paper is to report long time series of Danish stock returns and bond yields. This extends previous work by Hansen (1974) who estimates stock returns by decade only and Lund (1992) who calculates a large-cap index. Thus, the present paper provides a well-diversified Danish stock return index for the long historical period 1922-99. This paves the way for a wide range of economic and statistical analyses of the Danish stock market. Besides this, the paper also makes publicly available government bond yields with maturities of 1, 5 and 10 years. Other studies have presented return series for private mortgage bonds, see Olsen and Hoffmeyer (1968) and Christiansen and Lystbæk (1992).

These series allow us to outline important characteristics of the two asset markets. As regards the stock market, the paper shows that the average real stock return is 7.5% per year during the whole sample period, but closer examination shows that there are two apparently distinct regimes. Thus, average return has tripled since 1983 even though dividends have declined to one third of their previous level. Along with this,

the stock market has become much more volatile as witnessed by the doubling of the standard deviation. The high volatility may be due to liberalization of capital markets which took place in the 1970s and the 1980s. This view is supported by Sellin (1996) who finds that the increase in the Swedish stock market volatility is largely due to the opening up of the market to foreign investors. The higher return on stocks since the beginning of the 1980s, which parallels findings for other countries, remains an important topic for future research.

The paper also calculates the yield on bonds and finds that the short real bond yield is about 4% lower than the stock return. Thus, the equity premium is 4.1% per year and that is low in an international context, see also Dimson, Marsh and Staunton (2000). The explanation is both a low stock return and a high interest rate. Thus, bonds have frequently outperformed stocks from the late 1960s to the mid 1980s. Notwithstanding this, stocks have over long periods performed better than bonds. Thus, 1 Krone invested in stocks in 1924 is worth 1,200 Kroner today which is six times the value generated by repeated investment in short bonds.

References

Andersen, T.M. and O. Risager (1988), Stabilization Policies, Credibility, and Interest Rate Determination in a Small Open Economy, *European Economic Review*, 32, pp. 669-79.

Balvers, R., Y. Wu and E. Gilliland (2000), Mean reversion across national stock markets and parametric contrarian investment strategies, *Journal of Finance* (55), pp. 745-72.

Barnes, M., J.H. Boyd and B.D. Smith (1999), Inflation and asset returns, *European Economic Review* 43, pp. 737-754.

Campbell, J.Y., A.W. Lo and A.C. MacKinlay (1997), *The Econometrics of Financial Markets*, Princeton University Press, Princeton, New Jersey.

Christiansen, J. and B. Lystbæk (1994), Afkast og Risiko På Aktier og Obligationer 1915-1993, *Finans/Invest*, pp. 10-13.

Dimson, E., P. Marsh and M. Staunton (2000), *The Millennium Book: A Century of Investment Returns*, ABN Amro/London Business School.

Eskesen, L., F. D. Jensen, E. Rygner and O. Zacchi (1984), *Finansielle Institutioner og Markeder*, Jurist- og Økonomforbundets Forlag, Copenhagen.

Fama, E.F. and K.R. French (1988), Permanent and Temporary Components of Stock Prices, *Journal of Political Economy* 96, no. 2, pp. 246-73.

Frennberg, P. and B. Hansson (1992), Computation of a Monthly Index for Swedish Stock Returns 1919-1989, *Scandinavian Economic History Review* 40 (1), pp. 3-27.

Grossman, S.J. and R. Shiller (1981), The Determinants of the Variability of Stock Market Prices, *American Economic Review*, 71(2), pp. 222-7.

Hansen, K. (1974), *Om Afkastet af Danske Aktier i tiden 1900-1974*, Nordisk Fjerfabriks Jubilæumsskrift, Nordisk Fjerfabrik, pp. 191-220.

Jennergren, L.P. and B.G. Sørensen (1988), Price Formation in the Danish Stock Market in the 1890s, *Scandinavian Economic History Review* 36 (2), pp. 3-24.

Kleidon, A.W. (1986), Variance bounds tests and stock price valuation models, *Journal of Political Economy* 94, pp. 953-1001.

Kocherlakota, N.R. (1996), The Equity Premium: It´s Still a Puzzle, *Journal of Economic Literature*, pp. 42-71.

Lund, J. (1992), Rationelle bobler i de danske aktiekurser 1923-1991 - en empirisk analyse, *Nationaløkonomisk Tidsskrift* 130, pp. 483-97.

Mehra, R. and E. C. Prescott (1985), The Equity Premium: A Puzzle, *Journal of Monetary Econmics*, 15, pp. 145-61.

Modigliani, F. and R.A. Cohn (1979), Inflation, Rational Valuation and the Market, *Financial Analysts Journal*, pp. 24-44.

Nielsen, S. and J.O. Olesen (1999), Regime-Switching Stock Returns and Mean Reversion, working paper, Copenhagen Business School.

Nielsen, S. and O. Risager (1999), Macroeconomic Perspectives on Stock and Bond Investments in Denmark since the First World War, in *Macroeconomic Perspectives on the Danish Economy*, T.M. Andersen, S.E.H. Jensen and O. Risager (eds.), MacMillan, London.

Olsen, E. and E. Hoffmeyer (1968), *Dansk Pengehistorie 1914-1960*, Danmarks Nationalbank, Copenhagen.

Poterba, J.M. and L.H. Summers (1988), Mean Reversion in Stock Prices-Evidence and Implications, *Journal of Financial Economics* 22, pp. 27-59

Sellin, P. (1996), Inviting Excess Volatility? Opening Up a Small Stock Market to International Investors, *Scandinavian Journal of Economics* 98 (4), pp. 603-612.

Shiller, R.J. (2000), *Irrational Exuberance*, Princeton University Press, Princeton, New Jersey.

Appendix

Dividend yields and stock returns refer to the calendar year with which they are given whereas bond yields are measured at the end of the year. For example, the nominal stock return in 1922 (-20.98%) is the return from December 1921 to December 1922 and the 5-year nominal bond yield in 1922 (5.31%) is the yield of a bond with 5 years to maturity as measured in December 1922.

Year	Dividend yield	Nominal Stock Return	Real Stock Return	1-Year Nominal Bond Yield	5-Year Nominal Bond Yield	10-Year Nominal Bond Yield
1922	0.0808	-0.2098	-0.0699	n.a.	0.0531	0.0499
1923	0.0804	0.5564	0.4941	n.a.	0.0638	0.0562
1924	0.0668	-0.0242	-0.0794	0.0692	0.0736	0.0643
1925	0.0715	0.1817	0.2161	0.0506	0.0595	0.0586
1926	0.0530	-0.0198	0.1538	0.0728	0.0598	0.0595
1927	0.0595	0.1588	0.1999	0.0564	0.0563	0.0570
1928	0.0610	0.0283	0.0344	0.0506	0.0518	0.0537
1929	0.0586	0.0904	0.0969	0.0520	0.0521	0.0534
1930	0.0607	-0.0168	0.0326	0.0445	0.0450	0.0507
1931	0.0582	-0.1584	-0.1079	0.0635	0.0678	0.0620
1932	0.0562	0.0342	0.0412	0.0368	0.0427	0.0500
1933	0.0528	0.3482	0.3129	0.0275	0.0418	0.0450
1934	0.0515	0.1503	0.1069	0.0333	0.0406	0.0456
1935	0.0506	0.0792	0.0400	0.0404	0.0504	0.0505
1936	0.0523	0.1683	0.1543	0.0454	0.0543	0.0526
1937	0.0532	-0.0359	-0.0694	0.0461	0.0516	0.0512
1938	0.0602	0.0451	0.0331	0.0373	0.0435	0.0513
1939	0.0596	-0.0002	-0.0280	0.0499	0.0597	0.0597
1940	0.0585	0.0585	-0.1494	0.0107	0.0469	0.0469

Year	Dividend yield	Nominal Stock Return	Real Stock Return	1-Year Nominal Bond Yield	5-Year Nominal Bond Yield	10-Year Nominal Bond Yield
1941	0.0445	0.2445	0.0847	0.0248	0.0466	0.0459
1942	0.0391	0.0562	0.0205	0.0190	0.0319	0.0358
1943	0.0348	0.1777	0.1689	0.0108	0.0208	0.0312
1944	0.0334	0.0040	-0.0180	0.0108	0.0307	0.0330
1945	0.0307	-0.0375	-0.0480	0.0189	0.0274	0.0280
1946	0.0416	0.0904	0.0983	0.0142	0.0258	0.0315
1947	0.0450	0.0062	-0.0222	0.0189	0.0445	0.0205
1948	0.0457	-0.0511	-0.0740	0.0428	0.0374	0.0238
1949	0.0520	0.1055	0.0795	0.0322	0.0333	0.0442
1950	0.0515	0.0939	0.0027	0.0459	0.0450	0.0474
1951	0.0507	-0.0225	-0.1251	0.0363	0.0560	0.0657
1952	0.0606	0.0693	0.0462	0.0468	0.0516	0.0586
1953	0.0623	0.0971	0.1030	0.0688	0.0510	0.0564
1954	0.0629	0.1301	0.1090	0.0589	0.0718	0.0699
1955	0.0705	0.2280	0.1512	0.0549	0.0668	0.0711
1956	0.0561	0.1616	0.1063	0.0591	0.0745	0.0682
1957	0.0526	-0.0754	-0.0862	0.0499	0.0675	0.0694
1958	0.0551	0.2477	0.2261	0.0475	0.0461	0.0504
1959	0.0501	0.0898	0.0674	0.0465	0.0609	0.0369
1960	0.0434	0.0515	0.0280	0.0570	0.0662	0.0630
1961	0.0448	0.0288	-0.0151	0.0584	0.0720	0.0690
1962	0.0498	0.0742	0.0075	0.0704	0.0687	0.0686
1963	0.0490	0.1522	0.0951	0.0670	0.0627	0.0674
1964	0.0449	0.1024	0.0639	0.0845	0.0746	0.0738

Year	Dividend yield	Nominal Stock Return	Real Stock Return	1-Year Nominal Bond Yield	5-Year Nominal Bond Yield	10-Year Nominal Bond Yield
1965	0.0437	0.1127	0.0454	0.0858	0.0875	0.0900
1966	0.0493	0.0171	-0.0471	0.1020	0.1078	0.0912
1967	0.0491	-0.0509	-0.1166	0.1153	0.1137	0.0946
1968	0.0517	0.1628	0.0769	0.0939	0.1075	0.0906
1969	0.0496	0.0580	0.0223	0.1197	0.1000	0.1009
1970	0.0526	-0.0466	-0.1057	0.1378	0.1270	0.1158
1971	0.0612	0.0337	-0.0231	0.0951	0.1009	0.1143
1972	0.0642	0.9510	0.8307	0.1202	0.0935	0.1149
1973	0.0376	0.0376	-0.0507	0.1123	0.1079	0.1311
1974	0.0430	-0.1697	-0.2792	0.1629	0.1292	0.1654
1975	0.0556	0.3934	0.2712	0.0905	0.1093	0.1327
1976	0.0437	0.0437	-0.0426	0.1706	0.1697	0.1558
1977	0.0486	0.0385	-0.0659	0.1706	0.1733	0.1700
1978	0.0521	-0.0091	-0.1991	0.1673	0.1565	0.1823
1979	0.0622	-0.0030	-0.0906	0.1739	0.1785	0.1817
1980	0.0687	0.1908	0.0600	0.1648	0.1889	0.1998
1981	0.0635	0.4583	0.3059	0.1711	0.1926	0.2013
1982	0.0581	0.1817	0.0728	0.1839	0.1935	0.2136
1983	0.0385	1.1785	1.0375	0.1197	0.1254	0.1507
1984	0.0171	-0.2025	-0.2497	0.1246	0.1368	0.1450
1985	0.0286	0.4598	0.3937	0.0872	0.0939	0.1164
1986	0.0202	-0.1722	-0.2011	0.0997	0.1117	0.1010
1987	0.0290	-0.0280	-0.0655	0.1026	0.1009	0.1134
1988	0.0293	0.5238	0.4571	0.0821	0.0898	0.0960

Year	Dividend yield	Nominal Stock Return	Real Stock Return	1-Year Nominal Bond Yield	5-Year Nominal Bond Yield	10-Year Nominal Bond Yield
1989	0.0137	0.3482	0.2869	0.1126	0.1056	0.0977
1990	0.0109	-0.1213	-0.1436	0.1075	0.1071	0.1058
1991	0.0125	0.1331	0.1063	0.1006	0.0908	0.0925
1992	0.0149	-0.2429	-0.2585	0.1089	0.0964	0.0891
1993	0.0130	0.4099	0.3929	0.0622	0.0571	0.0717
1994	0.0102	-0.0362	-0.0554	0.0711	0.0877	0.0794
1995	0.0139	0.0626	0.0408	0.0464	0.0626	0.0825
1996	0.0150	0.3047	0.2778	0.0341	0.0534	0.0710
1997	0.0132	0.4841	0.4522	0.0429	0.0503	0.0565
1998	0.0106	-0.0460	-0.0638	0.0393	0.0391	0.0424
1999	0.0109	0.2256	0.1963	0.0424	0.0513	0.0550

Year	1-Year Real Bond Yield	5-Year Real Bond Yield	10-Year Real Bond Yield
1922	n.a.	0.0803	0.0769
1923	n.a.	0.1015	0.0849
1924	0.1004	0.1261	0.0953
1925	0.2366	0.1158	0.0823
1926	0.1108	0.0930	0.0645
1927	0.0627	0.0832	0.0545
1928	0.0569	0.0717	0.0495
1929	0.1050	0.0624	0.0456

Year	1-Year Real Bond Yield	5-Year Real Bond Yield	10-Year Real Bond Yield
1930	0.1071	0.0373	0.0153
1931	0.0706	0.0451	0.0064
1932	0.0097	0.0120	-0.0092
1933	-0.0112	0.0142	-0.0120
1934	-0.0043	0.0151	-0.0098
1935	0.0279	-0.0119	-0.0025
1936	0.0092	-0.0328	0.0014
1937	0.0342	-0.0351	0.0007
1938	0.0085	-0.0418	-0.0005
1939	-0.1563	-0.0257	0.0079
1940	-0.1190	0.0034	0.0090
1941	-0.0099	0.0325	0.0107
1942	0.0114	0.0191	0.0022
1943	-0.0114	0.0048	-0.0010
1944	-0.0002	0.0143	0.0011
1945	0.0263	-0.0043	-0.0091
1946	-0.0144	-0.0290	-0.0113
1947	-0.0057	-0.0100	-0.0202
1948	0.0182	-0.0109	-0.0155
1949	-0.0538	-0.0138	0.0044
1950	-0.0639	0.0019	0.0140
1951	0.0138	0.0251	0.0387
1952	0.0525	0.0228	0.0274
1953	0.0489	0.0193	0.0195

Year	1-Year Real Bond Yield	5-Year Real Bond Yield	10-Year Real Bond Yield
1954	-0.0072	0.0390	0.0308
1955	0.0047	0.0429	0.0322
1956	0.0466	0.0515	0.0277
1957	0.0401	0.0338	0.0228
1958	0.0260	0.0047	-0.0022
1959	0.0231	0.0159	-0.0163
1960	0.0118	0.0129	0.0043
1961	-0.0073	0.0140	0.0086
1962	0.0174	0.0094	0.0083
1963	0.0297	-0.0015	0.0033
1964	0.0189	0.0099	-0.0012
1965	0.0173	0.0217	0.0108
1966	0.0256	0.0426	0.0098
1967	0.0329	0.0498	0.0095
1968	0.0570	0.0415	0.0039
1969	0.0504	0.0125	0.0076
1970	0.0753	0.0316	0.0159
1971	0.0276	0.0017	0.0091
1972	0.0248	-0.0134	0.0063
1973	-0.0343	-0.0016	0.0232
1974	0.0609	0.0276	0.0627
1975	0.0003	0.0046	0.0376
1976	0.0529	0.0542	0.0641
1977	0.0643	0.0594	0.0844

Year	1-Year Real Bond Yield	5-Year Real Bond Yield	10-Year Real Bond Yield
1978	0.0648	0.0502	0.1013
1979	0.0449	0.0768	0.1058
1980	0.0430	0.1016	0.1330
1981	0.0632	0.1217	0.1442
1982	0.1073	0.1355	0.1647
1983	0.0535	0.0755	0.1105
1984	0.0737	0.0895	0.1095
1985	0.0492	0.0527	0.0845
1986	0.0573	0.0723	0.0712
1987	0.0544	0.0658	0.0851
1988	0.0329	0.0620	0.0709
1989	0.0843	0.0831	0.0750
1990	0.0813	0.0857	n.a.
1991	0.0780	0.0704	n.a.
1992	0.0954	0.0757	n.a.
1993	0.0410	0.0358	n.a.
1994	0.0492	0.0648	n.a.
1995	0.0249	n.a.	n.a.
1996	0.0118	n.a.	n.a.
1997	0.0235	n.a.	n.a.
1998	0.0144	n.a.	n.a.
1999	n.a.	n.a.	n.a.

Table 1. Companies in the database. They provide the basis for the dividend index:

Banking:
Aktivbank
Amagerbanken
Amtssparekassen Fyn
Andelsbanken
C & G Banken
Den Danske Bank
Fyens Disconto Kasse
Handelsbanken
Privatbanken
Provinsbanken
UniDanmark
Aarhus Privatbank

Insurance:
Alm Brand B
Alm Brandass A
Alm Brandass B
Baltica
Codan
Kbh. Reassurance A
Kbh. Reassurance B
Kbh. Reassurance C

Shipping:
DFDS
D/S 1912 A
D/S 1912 B
D/S Bornholm
D/S Dannebrog
D/S Myren
D/S Norden
D/S Orient
D/S Torm
J Lauritzen
D/S Svendborg A
D/S Svendborg B

Service:
Andersen & Martini
Sophus Berendsen A
Sophus Berendsen B
F L Bie
Brdr Dahl
D G Holding B
Dalhoff Larsen & Horneman
Det danske Kulkompagni
Danske Luftfartsselskab
Ford Motor Co
Peder P Hedegaard
ISS A
ISS B
Brdr A & O Johansen
Jydsk Telefon
Korn- og Foderstofkomp.
Københavns Telefon
Nesa
C O Olesen Holding B
Tivoli A
Tivoli B
Wessel og Vett C
Th Wessel og Vett præf.
Østasiatisk Kompagni
ØK Holding

Industry:
Albani A
Albani B
Ove Arkil
Atlas
Bang & Olufsen
Bing & Grøndahl
Burmeister & Wain Stamak.
Calkas A
Calkas B
Cheminova Holding B
Chemitalic B
Christiani & Nielsen B
Coloplast B
CUBIC Modulsystem B
Dancall Radio A
Dancall Radio B
Danisco
Dansk Data Elektronik
Danske Spritfabrikker
Danske Sukkerfabrikker A
Danske Vin- og Konservesf.
Forenede Bryggerier A
Forenede Bryggerier B
Forenede Bryggerier C
Forenede Papirfabrikker
Brdr Hartmann
Incentive
Kastrup Glasværk
Københavns Brødfabrikker
Nordisk Fjerfabrik A
Nordisk Fjerfabrik B
Nordisk Kabel- og Trådf.
Novo Industri
C W Obel B
Royal Copenhagen A
Royal Copenhagen B
Schouw & Co A
Schouw & Co B
F L Smidt A
F L Smidt B
Superfos
Superfos præference
Thrige-Titan A
Thrige-Titan B
Aarhus Oliefabrik A
Aarhus Oliefabrik B

Table 2. Average annual stock return and its components in %

	Dividend yield	Capital gain	Nominal stock return	Standard deviation	Real stock return	Standard deviation
1922-99	4.6	7.1 (5.1)	11.7 (9.8)	22.9	7.5 (5.7)	21.5
1922-82	5.4	4.2 (3.0)	9.6 (8.4)	17.5	5.3 (4.3)	16.4
1983-99	1.8	17.5 (13.0)	19.3 (14.7)	36.0	15.3 (11.1)	33.7

Note: Averages are arithmetic (geometric means in parentheses).

Table 3. Average nominal and real 1-, 5- and 10-year bond yields in %, 1924-99

	Nominal yield	Standard deviation	Real yield	Standard deviation
1-year	7.4	4.5	3.3	5.2
5-year	7.9	4.2	3.5	4.1
10-year	8.2	4.5	3.3	4.4

Note: The sample for real bond yield is only until 1994 (1989) at the 5-year (10-year) horizon because we use forward-looking inflation data.

Table 4. Nominal equity premium in %

	Equity premium	Standard deviation
1924-99	4.1	22.6
1924-82	2.1	16.6
1983-99	11.2	36.4

Figure 1. Annual Nominal Stock Return, 1922-99

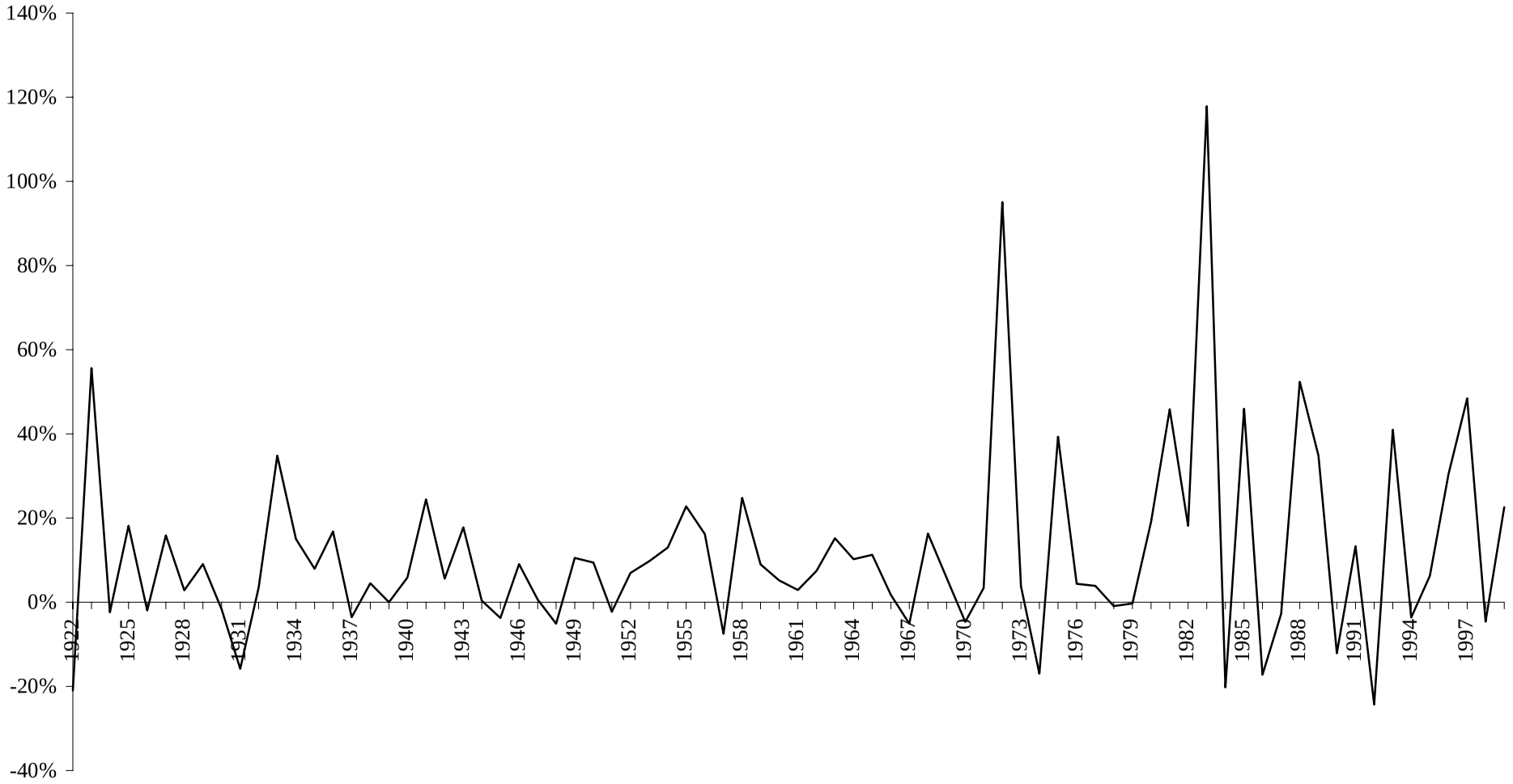

Figure 2. Dividend yield, 1922-99

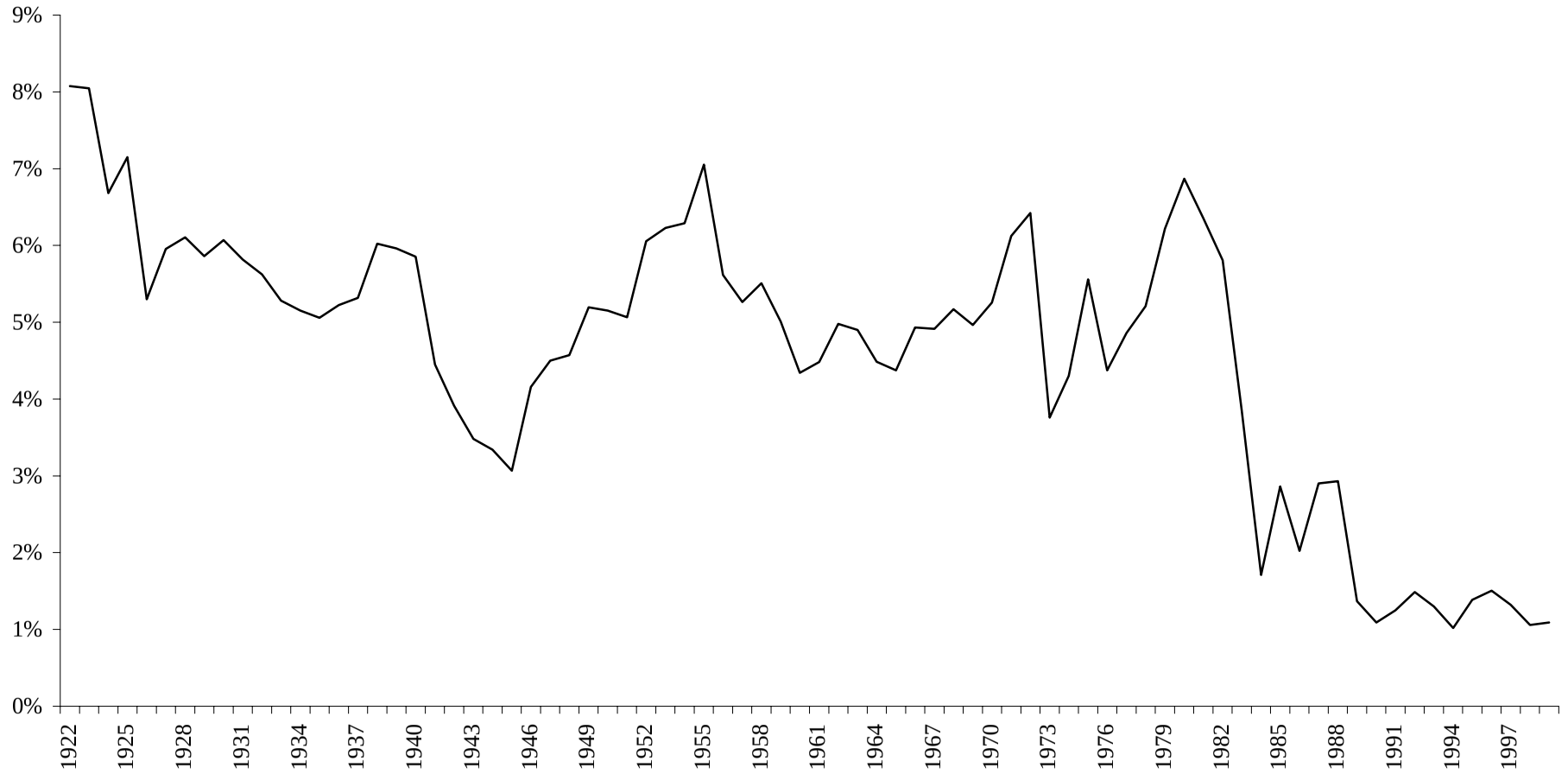

Figure 3. Real Stock Price index, 1921-99

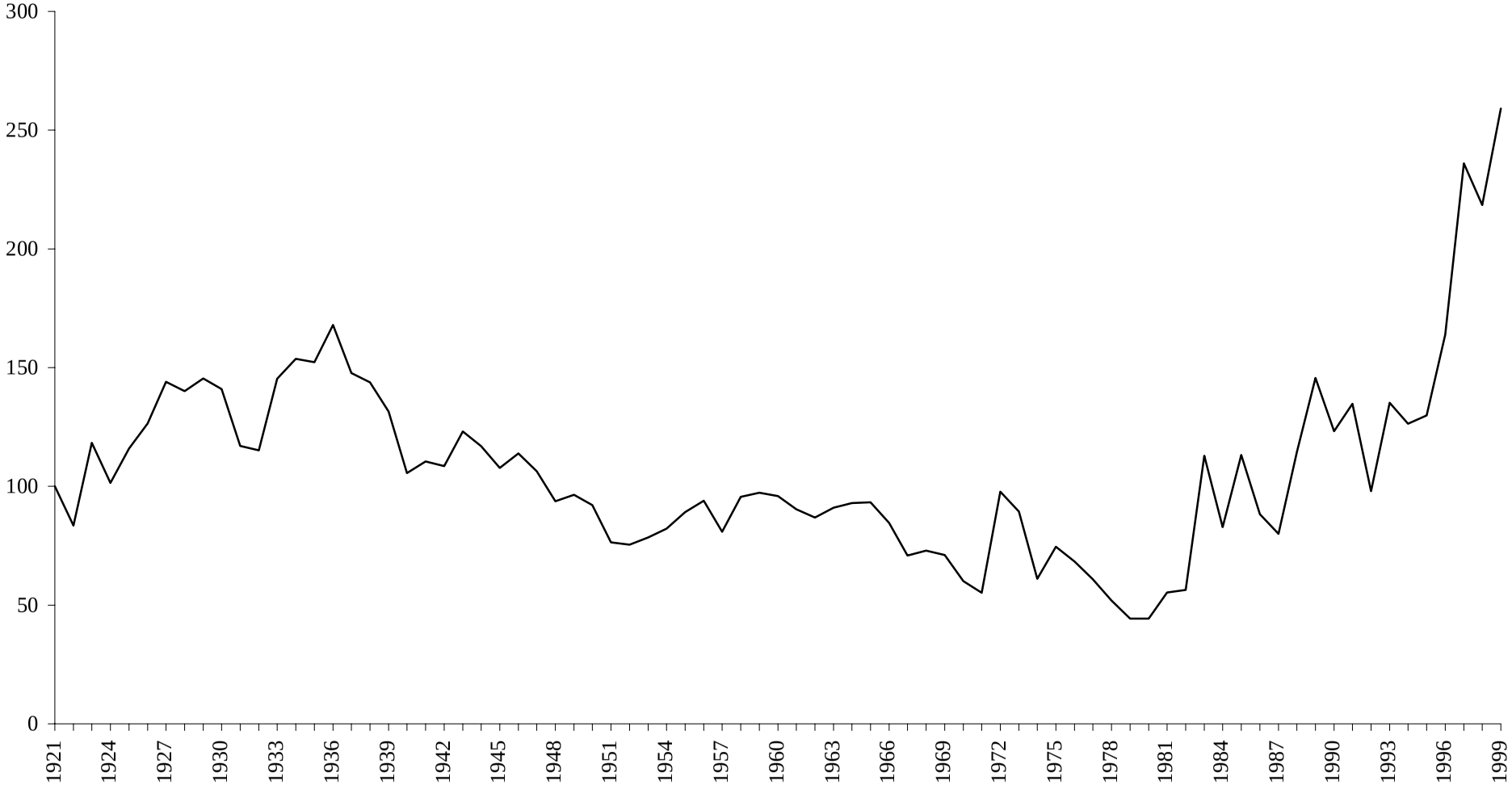

Figure 4. 1- and 10-year bond yields, 1924-99

Figure 5. 5-year equity premium, 1922-94

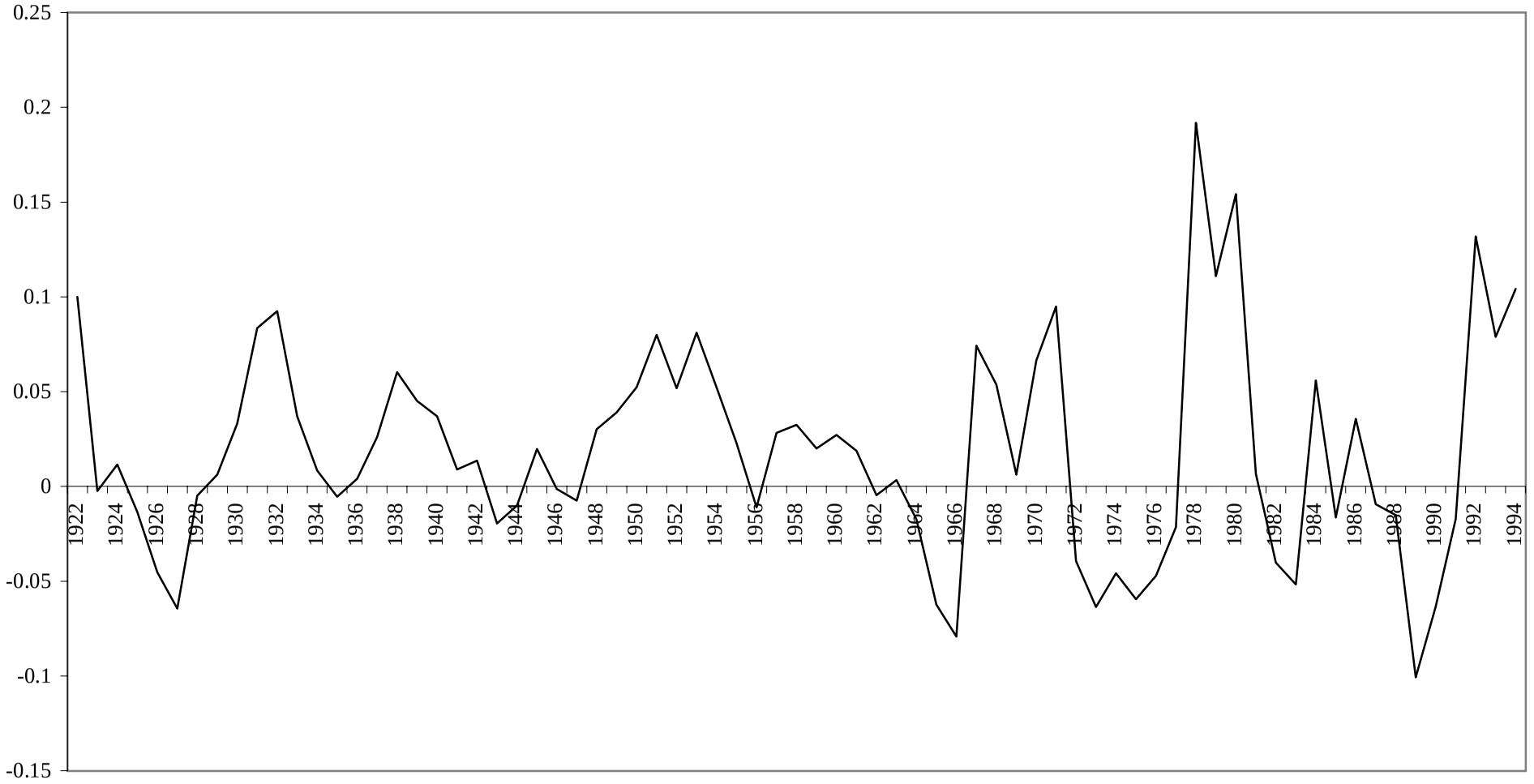

Figure 6. Cumulative nominal return indices for stocks and bonds, 1924-99 (logarithmic scale)

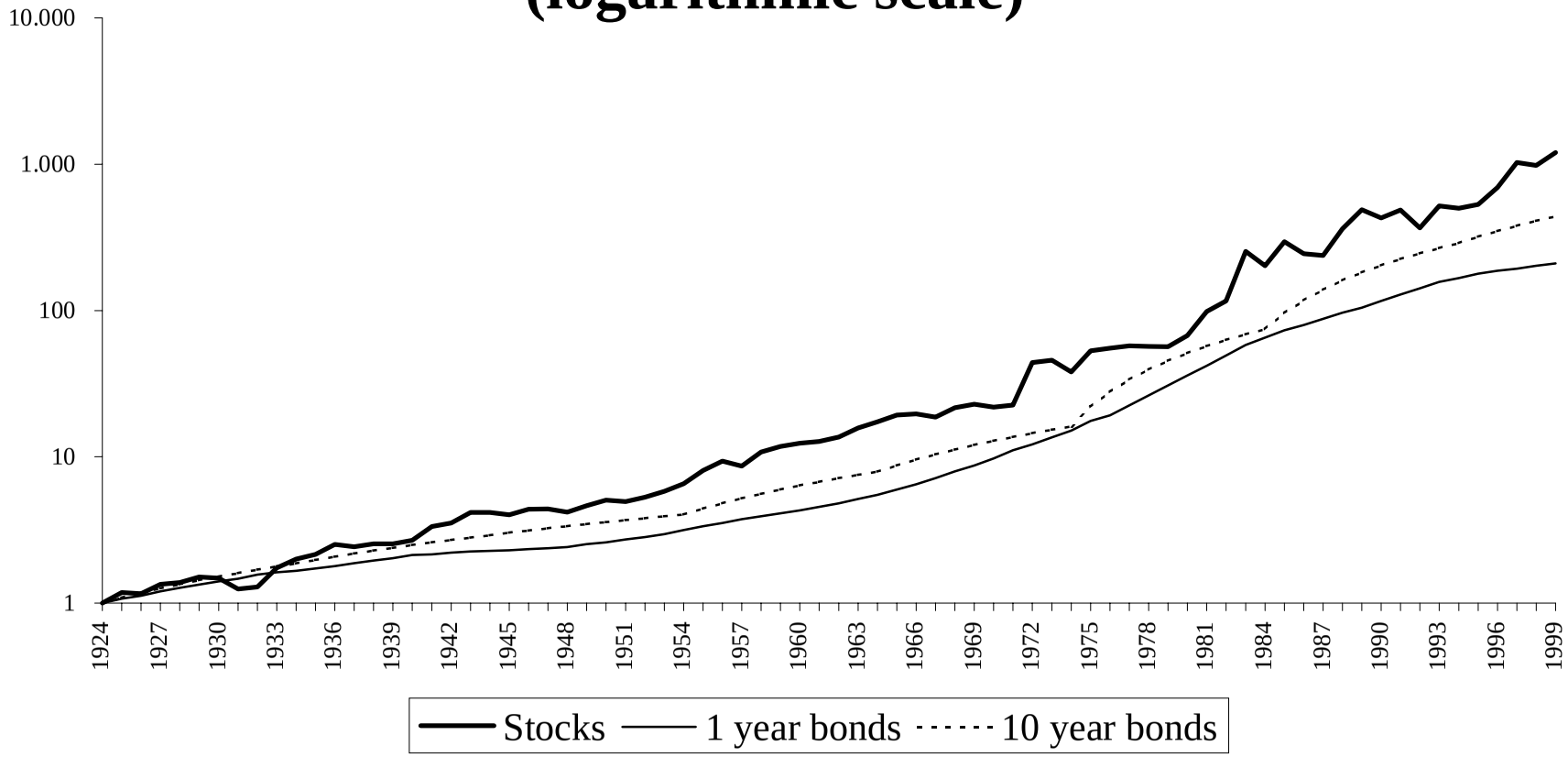

Figure 7. Cumulative real return indices for stocks and bonds, 1924-99 (logarithmic scale)