A NEW HISTORICAL DATABASE FOR THE NYSE 1815 TO 1925: PERFORMANCE AND PREDICTABILITY

William N. Goetzmann

Roger G. Ibbotson

Liang Peng

Yale School of Management

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A New Historical Database for the NYSE 1815 to 1925: Performance and Predictability♦

William N. Goetzmann*, Roger G. Ibbotson, and Liang Peng

International Center for Finance, Yale University, New Haven, CT 06520, USA

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Abstract

In this paper, we collect individual stock prices for NYSE stocks over the period 1815 to 1925 and individual dividend data over the period 1825 to 1870. We use monthly price and dividend information on more than 600 individual securities over the period to estimate a stock price index and total return series that extends virtually to the beginning of the New York Stock Exchange. We use this data to estimate the power of past returns and dividend yields to forecast future long-horizon returns. We find some evidence of predictability in sub-periods but little predictability over the long term. We estimate the time-varying volatility of the U.S. market over the period 1815 to 1925 and find evidence of a leverage effect on risk. This new database will allow future researchers to test a broad range of hypotheses about the U.S. capital markets in a rich, untouched sample.

JEL Classification: G1, N2

Keywords: New York Stock Exchange, Financial Market History

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* Corresponding author. Yale School of Management, Box 208200, New Haven, CT 06520-8200. Tel.: +1-203-432-5950.
E-mail address: william.goetzmann@yale.edu

1. Introduction

The University of Chicago Center for Security Prices [CRSP] database of U.S. stock prices is widely used in financial economics to address fundamental questions about the risk and return to equity investment. The CRSP data begins in 1926, shortly before the Great Crash. Prior to the current paper, no broad pre-CRSP database of U.S. security prices has ever been available -- with the exception of the data assembled by Alfred Cowles to construct his famous indices of U.S. stock prices from 1871 to 1937. Unfortunately the Cowles data, said to have been one of the earliest uses of Hollerith cards for financial research were lost.[1]

In this paper, we collect individual stock prices on NYSE stocks over the period 1815 to 1925 and individual dividend data over the period 1825 to 1870. We use monthly price and dividend information on more than 600 individual securities over most of the 19th century and the first quarter of the 20th century to estimate a stock price index and total return series that extends virtually to the beginning of the New York Stock Exchange. Our hope is that this new database will allow future researchers to test a broad range of hypotheses about the U.S. capital markets in a rich, untouched sample. In addition we hope that the long times series we created will lead to a better understanding of how the NYSE evolved from an emerging market at the turn of the 18th century to the largest capital market in the world today. In the current paper, we consider just a few hypotheses of interest, however, we intend to make the data available electronically to other researchers to address interests of their own.

Much recent research has focused on the very long-term performance of equity markets.[2] Studies of markets over the span of the twentieth century, and even longer, give some measure of

[1] See Peter Bernstein, 1992, *Capital Ideas*, p.31.

[2] See for example, Boudoukh and Richardson, 1992, Campbell and Shiller, 1988, Fama and French, 1988a and 1988b, Fisher and Lorie, 1968, Goetzmann, 1993, Ibbotson and Brinson,

the historical equity premium, and studies of the long-horizon predictability of stock returns by necessity require long time series. For U.S. studies extending back to 1926, high quality United States financial data on individual securities are available from CRSP. For the period 1871 to 1926, researchers are able to use the Cowles (1939) indices, with corrections by Wilson and Jones (1987, 2000). For researchers interested in the dynamics of the U.S. capital markets over earlier decades, it has been necessary to rely upon indices of uneven quality. Goetzmann (1993), Schwert (1990) and Siegel (1992) note many of the problems with U.S. stock indices extending back to 1802. All are spliced from several sources such as Burgess (1932), Cole and Frickey (1928), the Cleveland Trust Company Indices, Macauley (1938), Matthews (1926) and Cole and Smith (1935). None of these are broad-based, and most of them effectively condition upon the continuity of price records and non-quantifiable features such as "representativeness." Even the Cowles indices, despite being carefully constructed in many ways, are based upon the average of high and low stock prices through the month, rather than month-end transactions.

The ultimate goal of our project is to assemble a CRSP-like database for the New York Stock Exchange, over the period prior to 1926, when CRSP begins. This goal is now largely complete for stock prices and partially complete for dividends. In our efforts to create a complete database, we have encountered a number of methodological challenges caused by the infrequent trading of securities and the lack of an official dividend record. Past efforts to create NYSE price indices from primary data for the early period typically relied upon frequently traded securities or securities for which long, unbroken price sequences were available. The selection bias in conditioning on continuity is well known, but not easily addressed econometrically. By collecting all available NYSE data from official records to the mid-19th

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1993, Ibbotson and Sinquefield, 1976, Shiller, 1989, Schwert, 1990, Siegel, 1992 and Wilson and Jones 1987. Other uses of long-term stock market indices are legion.

century, and all available prices in financial periodicals to 1925, we hope to alleviate concerns about selection bias, and to provide a database for widespread future research.

We use this data to address some issues of long-standing interest to empirical research. First, we estimate the stability of long-term measures of risk and return for the U.S. stock market. In particular, we measure the equity premium for the NYSE index over the century preceding CRSP. We find that the risk and return of the U.S. market before 1926 are relatively different from the post-1926 data -- the price-weighted NYSE index grew at a geometric monthly average of .10% from 1815 to 1925, compared to .54% for the S&P from 1926 through 1999. Figure 1 shows the capital appreciation index of a dollar invested in the NYSE from 1815. Under certain assumptions about dividend payments detailed below, we calculate total returns using our capital appreciation index to 1871, our dividend series from 1825 to 1870 and Cowles' dividends to 1925.

Next, we examine the predictability of long-horizon returns using both past returns and dividend yields. Using bootstrap methods to estimate standard errors, we find the evidence for predictability using either measure is marginal over the entire span. Finally, we examine the extent to which the volatility of the U.S. market is time-varying, using GARCH estimation. We find that positive shocks and negative shocks have different predictability for future volatility. Specifically, negative shocks tend to introduce more volatility than positive shocks.

The paper is organized as follows. Section 2 describes the data sources and our collection methods. Section 3 explains the methodology used for price index estimation. Section 4 summarizes what the data tell us about the risk and return of the NYSE over the long term. Section 5 reports evidence on the long-horizon predictability of returns. Section 6 reports evidence on the time variation in volatility. Section 7 concludes.

2. Data Sources and Collection Methods

2.1. Share Prices

We hand-collected all end of month equity prices for companies listed on the New York Stock Exchange from three different journals published over the period January, 1815 to December, 1870. From 1871 through 1925, we collected end-of-month prices for NYSE stocks from the major New York newspapers. *The New York Shipping List*, later called *The New York Shipping and Commercial*, is our principal source up to 1855. It was a current price list for a broad range of commodities shipped through the port of New York. It quoted bid and ask prices, as well as transaction prices with share quantity two times per week from 1815 through the mid 1850's, for securities traded on the New York Stock Exchange. During much of this period, the periodical had rights to publish the official price list as established in the resolutions of the New York Stock Exchange Board minutes of November 29, 1817. Apparently, both stocks and bonds were quoted in *The New York Shipping List*, and equity prices and transactions were denominated in shares, while bond prices and transactions were denominated in dollars of face value. In the mid-1850's the official "NYS&EB" price list designation disappeared from the stock market quotes, and *The New York Shipping List* reported prices for fewer and fewer stocks. Thus, for the period 1855 through 1925, we collected price quotes from *The New York Herald* and *The New York Times*. While neither of these claimed to be the official list for the NYSE, the number of securities quoted by each far exceeded the number quoted by *The New York Shipping List.* We hand collected prices from bound volumes of *The New York Shipping List* in the Yale Beinecke Rare Book Library, and from microfiche copies of the *Herald* and the *Times*. The month-end prices were obtained by searching the end-of-month issues for the last transaction price for each stock that month. When no transaction took place in the last week, the latest bid and ask prices were averaged. In total, we collected at least two prices from 664 companies. From a low number of 8 firms in 1815, the number of firms in the index reached a high point in the May 1883 with 114 listed firms. The fact that the number of firms concurrently listed peaked at under 120, while the total number of firms in the database exceeded 600 indicates that, not only did firms appear during the sample period, they also disappeared.

For the period up to the mid-1850's, *The New York Shipping List* regularly and repeatedly listed a set of securities, even when there was no bid, ask or transaction in the period. Apart from the claim to publishing the official NYSE list, this suggests that it represented a fairly comprehensive list of NYSE securities, not simply those stocks that happened to have traded. After the mid-fifties, the coverage of the sources is less clear, however the securities covered in the *Herald* and the *Times* corresponded closely, suggesting that we obtained a broad, if unofficial sample in the later years.

There are several categories of equity shares. The first, and the largest category is common stock. In addition, shares were listed as "old", "new", "preferred" and as "scrip." Shares listed as "old" traded concurrently with shares of the same name, and thus we assume that "old" and "new" represent different classes of stock for the same corporation. The new shares are presumably a second issue. "Preferred" likely meant what it means today. "Scrip" represented certificates that were not fully paid in subscriptions for shares -- convertible into shares at a future date when fully paid-in but receiving no dividends until conversion. All share types are included in our index.

There are a few missing months in our data that create gaps in the analysis. Some of these are institutional. As is well known, the NYSE was closed from July 1914 to December 1914 due to the war. We also have additional gaps. We are missing returns for 1822, part of 1848 and 1849, parts of 1866, all of 1867 and January 1868. We do not know whether the late 1860's missing records are due to the Civil War, but the NYSE was certainly open at that time -- among other things, it was the era of heated speculation and stock price manipulation by legendary financiers Gould, Fisk and Drew. We hope further data collection will fill in these missing records. The number of available security records after 1871 was lower than immediately before that year. This probably does not indicate a decrease in the number of listed securities, only a change in the range of coverage by the financial press.

When possible, companies were categorized by industry. In 1815, the index was about evenly split between banks and insurance companies. By the 1850's however, banks, transportation firms (primarily canals and railroads) and insurance companies were all about equally common. By the end of the sample period, insurance, bank, mining and utility companies had nearly disappeared from the price lists, so that transport companies and other industrials made up almost all the index.

One interesting feature of the data is that prices for much of the period remained around 100, as can be seen by Figure 2. Text discussions of price fluctuations suggest that 100 was the typical par value of shares.   Dividends were quoted as a percent of par. We found no reports of stock splits over the period of data, and a single notice of a stock dividend (the railroad Auburn and Syracuse declared a stock dividend of 50% on 10-1-48). Although other such splits were possible, we found no suspicious 50% price drops in the monthly data up to 1848, which might imply a stock split. The distribution of stock prices in the sample is dramatically skewed left with only a tiny fraction of stocks trading above 150% of par value. The mode of the distribution is at $110 with a secondary mode in the $10 to $20 range. The distribution suggests that management maintained an upper bound on stock prices by paying dividends when prices rose. This policy may have something to do with the tax treatment of dividends. For virtually the entire period of this sample, capital gains and dividends were treated equally for tax purposes.

2.2. Dividends

We collected dividend data for the period 1825-1870 by identifying the semi-annual dividend announcements for equity securities as reported in *The New York Commercial, The Banker's Magazine, The New York Times* and *The New York Herald*.   Since we do not know whether these journals always reported dividends for all NYSE stocks, we do not know whether exclusions of dividends meant that they were not paid, or whether we failed to find them. We were able to find dividend records for more than 500 stocks in our sample, although the number of stocks for which were have an unbroken series of semi-annual dividend observations is small. We found that most stocks paid dividends semi-annually. Thus, when we found two dividend payments per year, we presumed that the dividend record was complete. In addition, some firms paid extraordinary dividends. These were occasionally identified as a "surplus" dividend, and added to the last regular dividend of the year. Other times it was paid separately. Despite the limitations of our sample, there is no other we are aware of that is as comprehensive. The most widely cited study of 19th century dividends is Anna Schwartz' (1960) survey of dividend payments at multiple-year intervals.

By gathering dividend information on a wide range of companies, we are able to infer something about the total return to equity investors over the period and differences in this return across industries. In addition, we find some interesting features of dividend payouts in the nineteenth century that make it difficult to generalize occasional dividend observations into a consistent time series. For example, liquidating dividends were not uncommon. The highest dividends in our sample were attributed to "winding up" or "final" dividends, indicating the closure of the company. Many, but not all of these final dividends were paid to "receivers" or "creditors" implying that the company was in receivership. This receivership may not have been due to the failure of the corporation, but merely to the loss of its charter. For instance, a notice in the August 1, 1852 issue of the *New York Commercial* records that "The Trustees of the City Bank (the charter of which has expired...have declared a dividend of 10% out of surplus finds, the capital stock having been previously refunded." That same year, the December 1, 1852 issue notes that "Charters for the City and Butchers and Drovers Bank expire. Business to continue under association of the same name." Thus, large occasional dividends recorded in our sources typically represent terminal payments to shareholders. The latter case is particularly troublesome for calculation of statistics of interest, since it implies a dividend yield (i.e. D_t/P_t) of infinity. We found 33 dividend payments noted as a final dividend, or payment to receivers or creditors.

2.3. Low Dividend Return Estimate

In order to estimate a lower bound on the income return for each year, we sum all the dividends paid in a given year by firms whose prices were observed in preceding year, then divide by the sum of the last available in preceding year prices for those firms. From year 1825 to 1870, numbers of firms that have price data for the preceding year range from 28 for year 1849 to 162 for year 1854. On average, there are about 76 firms that have price data for each year. The percentage of them that paid dividends ranges from 21.7% for year 1855 to 52.4% for year 1833. The average of the percentage is 41.2%. Counting only the dividends we found and assuming zero otherwise gives an average of 3.77% income return per year over the period 1825 through 1870 -- lower than the 1926 - 1999 average of 4.45%. This almost certainly provides a lower bound on the estimate of the income return for the index since we may not have found all dividends for all firms that pay them. It is about 100 basis points lower than the estimate of income returns in Schwert (1990).

2.4. High Dividend Return Estimate

Another approach is to restrict our attention to firms which we know to pay regular dividends,[3] and for which we have price data. Using this approach, we find the dividend yields

[3] We restrict the sample to firms that have two years of dividend payments (four semi-annual dividends), and for which we have a price observation.

to be high, by modern standards. Most yields were between 9% and 11% during the period. This was in a period when high quality corporate bond yields average 5% to 7% (see Homer and Sylla, 1992). Even considering the selection bias that may have led us to collect only dividends from high-yield equity securities, this discrepancy between equity yields and bond yields over the course of a decade in our sample period suggests that dividend policy was quite different in the 19th century than it was in the 20th century. The high yields and the fact that many stocks traded near par suggest that most companies paid out a large share of their profits, rather than retaining them. In fact, when we look at the time distribution of dividend changes over this period, we find that dividend decreases were only slightly less common than increases, suggesting that managers may have been less averse to cutting the dividend than they are today. Perhaps in the pre-income tax environment of the 19th century, investors had a preference for income returns, as opposed to capital appreciation. Whether this pattern characterizes the entirety of the 19th century is a question for future research. The implications of the existence of high NYSE dividends for certain stocks suggests that the dividend process has evolved over the past two centuries, and that assumptions based upon projecting current dividend policy into the past may not be correct. This trend is potentially relevant to current research on the U.S. market. Fama and French (1998) document a recent twenty-year trend in propensity of stocks not to pay dividends. This recent trend may be part of a two-century evolution in the nature of equities.

3. Estimation Methodology

A major difficulty with using indices spliced from historical sources is a lack of certainty about the procedures used by researchers to construct indices. Another major potential concern is the effect that bid-ask bounce might have on equal-weighted return indices. Suppose an illiquid stock trades either at $1 or $2 per share. When it goes from $1 to $2 it goes up 100%, while when it goes from \$2 to \$1, it drops 50%. Equally weighting these returns can induce a substantial upward bias.

Blume and Stambaugh (1983) and Canina et al (1998) point out the extreme effects that the micro-structure of returns may have on the calculation of long-term means. Even though we are using monthly data, NYSE shares traded much less frequently in the 19th century than they do today creating a serious potential problem. Indeed, we have calculated an equal-weighted index of returns for our sample, and report it in the appendix. It is obvious that the magnitude of the bias is extraordinary.

The procedure we use for calculating our price-weighted index is simple. For each month in our sample, we calculate monthly returns for all stocks that trade in two consecutive periods. We weight these returns by the price at the beginning of the two periods. The return of the price-weighted market index over period t, r_t^m, is defined as

$$r_t^m \equiv \sum_{i=1}^{N} \left(r_t^i \cdot w_t^i \right) = \sum_{i=1}^{N} \left(\frac{P_t^i}{P_{t-1}^i} \cdot \frac{P_{t-1}^i}{\sum_{j=1}^{N} P_{t-1}^j} \right) = \frac{\sum_{i=1}^{N} P_t^i}{\sum_{j=1}^{N} P_{t-1}^j}$$

Here r_t^i represents the return of security i over the period t; w_t^i represents the weight of security i over the period t, which is equal to $\frac{P_{t-1}^i}{\sum_{j=1}^{N} P_{t-1}^j}$ since the index is price-weighted. Notice that return of the price-weighted index closely approximates return to a "buy and hold" portfolio over the period. Buy and hold portfolios are not sensitive to bid-ask bounce bias.

There are many stocks in our data set that do not trade frequently. We only compute the returns when we have two adjacent prices, in a similar manner as CRSP. A common approach to indexing infrequently traded assets is the repeat-sales regression (see, for example, Bailey, Muth and Nourse, 1963, Goetzmann and Spiegel, 1995). Unfortunately, the repeat-sales regression estimates an equal-weighted index. When all securities are infrequently traded, the bid-ask microstructure problems are not serious, but for the NYSE data in this paper, there are enough frequently traded securities that even the repeat-sales regression will be upwardly biased -- although not nearly so much as the simple equal-weighted index. We leave it for future researchers to find repeat sales methods that can make use of all of the scattered prices in the index without biasing the results.

As we show below, the price-weighted index corresponds quite closely to the Cowles value-weighted index over the period 1871-1925 -- and does not suffer from the well-known "Working effect" (Working, 1960) that induces autocorrelation in monthly returns. This suggests the price-weighted index is likely to be equally reliable over the pre-1870 period. Although there may be superior econometric solutions to the problem, the price-weighted index does a fairly good job.

4. Results of Index Estimation

4.1. Price Indices

Table 1 shows summary statistics for the annual capital appreciation return series for the whole period from 1815 to 1999 and breaks out the new data period 1815 to 1870, the Cowles period 1871 to 1925, and the Ibbotson data (based on Ibbotson and Sinquefield, 1976) from 1926 to 1999. Note that the price-weighted index has an annual geometric capital appreciation return from 1815 through 1870 of .84% per year. This is dramatically lower than the 6.62% annual growth experienced by the capital-weighted Ibbotson index of large U.S. stocks over the period 1926 through 1999, and significantly different than the rate of growth in the Cowles period, 1871 to 1925. Note that this is not simply due to using a different methodology, since the price-weighted mean for the Cowles period was only .14% per year less that the value estimated by

Alfred Cowles. It appears more likely that dividend policies evolved over the 185-year period. In the early era, companies appear to have paid out earnings and kept their stock prices lower. In the modern era, appreciation is accepted as a substitute to dividend payments. Evidence on dividends will be discussed in more detail in the next section.

The summary statistics for the monthly capital appreciation returns are reported in Table 2. We compare these to the summary statistics for data supplied by Schwert (1990) -- the best pre-Cowles monthly U.S. index constructed to date.[4] Schwert (1990) constructs a series of monthly stock portfolio returns from 1802 to 1925 by splicing monthly data from different sources, such as Cole and Smith (1935), Macaulay (1938), Cowles (1939), and Dow Jones (1972). It includes bank stocks or bank and insurance stocks for 1802 to 1833, bank, insurance and railroad stocks for 1834-1845, railroad stocks only for 1846-1870, the Cowles portfolio for 1871-1885, and the Dow Jones portfolio for 1885-1925. The index is equal-weighted from 1802 to1862, value-weighted from 1863 to 1885, and price-weighted from March 1885 to the end of 1925. In contrast, our price index to 1925 is based on a single database that contains stock prices of more than 600 stocks. It is representative of the range of securities that comprised the NYSE over the period. Also, our index is price-weighted for the whole period from 1815 to 1925. Note that our monthly geometric price-weighted capital appreciation series is slightly lower than the Schwert index over both the pre-Cowles and Cowles periods. This may be due to the difference between price-weighting and equal-weighting.

It is useful to note that our monthly autocorrelation for the price-weighted estimator over the Cowles period is .0513 compared to .2880 for the Cowles index. This is due to Cowles' use of the average of high and low prices in the month and was first noted by Working (1960). Schwert (1990) econometrically adjusts for the Working effect. Our index requires no adjusting,

[4] Similar long-term series using the same sources are reported in Goetzmann (1993), Ibbotson (1993) and Siegel (1992).

and appears to have reasonable time-series properties. The Cowles period provides a useful benchmark for evaluating the price-weighted index. Figure 3 shows the monthly price-weighted capital appreciation index and the Cowles capital appreciation index over the period 1871 through 1925. Our price-weighted index and the Cowles track fairly closely through the period. In fact, their monthly correlation is .95.

4.2. Income Returns

Figure 4 plots 175 years of annual income returns from 1825 through 1999. Table 1 reports the summary statistics. As we note above, there is no way to really tell what percentage of the dividends we found in our search of the financial press. Thus the figure plots both a high dividend return and a low dividend return series. Table 1 provides summary statistics for both. The low income returns from the pre-Cowles period -- the period for which we collected dividends -- is 3.77% per year -- significantly lower than the 5.33% per year over the Cowles period and slightly lower than Schwert's (1990) estimate of 4.40%. When we consider only the dividend paying stocks during that era, however, we estimate much higher income returns -- 9.27% per year. This higher income return estimate is consistent with the practice of paying out profits to keep stock prices in the early period trading near par values. The true dividend return to a capital-weighted investment in all NYSE stocks in undoubtably somewhere in between these two extremes.

4.3. Total Return

Using the low dividend series we conservatively estimate the lower bound on the total return[5] to a price-weighted investment in the NYSE over the 46-year period from 1825 to 1870 as 4.72% with a standard deviation of 16.86% per year. Using the Cowles income return series we estimate the return from 1871 to 1925 as 7.05% with a 16.04% annual standard deviation. Both of these values are less that the total return to investment in the U.S. market since 1926 of 11.35%. If the high dividend estimate were correct, it would yield a total return in the pre-Cowles period of 10.29%, closer to the post 1926 result, but quite different from the total returns of the Cowles period.

5. Forecasting Equity Returns

Much empirical research in financial economics over the past two decades has focused on the potential to forecast time-variation in the equity premium. For example, Fama and French (1988a&b) investigate evidence for mean reversion in stock prices and the forecasting power of dividend yields in the U.S. market since 1926 and find evidence suggesting that the market return can partially predicted at longer horizons. Scholars since have examined the power of long-horizon statistical tests, the effects of prior beliefs on the tests and the evidence in non-U.S. markets for long-horizon predictability. Although a complete review of the research would take pages, it is fair to say that evidence for mean reversion in U.S. stock prices over the period 1926 to 1999 is marginal -- bootstrapping tests under a random walk null, for example typically cannot reject (c.f. Richardson, 1993), although the sign of the reversion coefficient is generally negative. Because tests on short time series might simply be weak, Goetzmann (1993) extends the analysis to earlier periods in the NYSE and the London Stock Exchange using spliced price series and

[5] We ignore the return of dividend reinvestment by assuming all dividends were paid in December.

finds some long-horizon evidence of persistence in the London market, and marginal evidence in U.S. markets. Nevertheless, spliced data are a serious potential problem in that there are regime shifts due to structural changes in index composition and methodologies used by different researchers. The time-series of NYSE returns developed in this paper allows us to for the first time to revisit the mean-reversion issue using a time-series of returns to the U.S. market with well understood properties. In this section, we perform some standard tests of the predictability of long-horizon returns to show what these new data may tell us about long-standing problems in empirical finance.

The predictive power of dividend yields noted by Fama and French (1988b) is compelling, however the statistical issues involved in testing the forecasting power of yields are subtle. Goetzmann and Jorion (1993 & 1995), find that the distribution of the test statistic in the presence of lagged dependent regressors and survivorship is ill-behaved. They examine the evidence for the forecasting power of dividend yields in the U.S. and U.K. markets over periods back to 1871 using bootstrap statistics and find the evidence is mixed. While not overwhelmingly strong forecasters in the U.S., dividend yields had some forecasting power during sub-periods in the U.K. Campbell and Shiller (1998) argue that the Goetzmann and Jorion simulations are flawed in that they do not build in any reversion of the dividend yield -- effectively turning the yield into an unbounded random walk that, when used as a dependent variable in a regression can be expected to generate odd results. They perform a bootstrap using an autoregressive specification on dividend yields estimated with U.S. annual data from 1871 through 1997. They then add a random-walk stock appreciation series with statistical properties matching those of the real capital appreciation series and transform yields to a artificial total return series. They find that yields at the four-year horizon are significant predictors -- in effect, the way the bootstrap is done appears to make a big difference.

Recent work by Welch and Goyal (1999) suggests that the in-sample predictive power of dividend yields is not matched by the power to predict out of sample due to parameter instability.

They document the erosion of the ability of yields as predictors in the 1990's. Wolf (2000) takes a different approach. He notes that bootstrapping tests in general are *ad hoc* in that they eliminate many of the actual time-series characteristics of the data, besides the predictability of yields. He designs a sub-sampling test that largely eliminates this problem and has attractive small-sample properties. Using post-1926 U.S. data, he finds only marginal evidence of the predictability of yields.

In sum, there has been much recent work on the experimental design of statistical tests of the significance of yield regressions, and it is clear that the method of bootstrapping, the time-period of analysis and the analyst's priors all make a difference to inference. With the new dividend data we have collected over the 1825 -1870 period, it is actually possible to add a bit more data to the debate.

5.1. Mean Reversion

In our first test, we regress annual future long-horizon returns on past long-horizon returns over a number of different intervals. Following Fama and French (1988a) we use overlapping return observations and thus t-values and R^2 are overstated. We rely upon the bootstrap for corrected significance levels and explanatory power. Table 3 reports the results of these regressions, with bold type and stars indicating coefficients lower than the 5% percentile of the bootstrapped distributions.

Using capital appreciation returns only, we find no strong evidence of forecastability over the entire period at horizons of one through ten years, although the coefficients for the four-year through seven-year horizons are negative, consistent with the mean-reversion hypothesis. Using total returns from 1825 (based upon our Low Dividend estimates), we find the results slightly stronger. The reversion coefficient at the 6-year horizon is an outlier with respect to the bootstrapped distribution. Likewise, the 2-year reversion coefficient for the period 1871-1825 is unusually low. At the bottom of the table, we report bootstrapped median and 5th percentile values for the whole time period based upon 1,000 bootstrapped simulations. Returns were independently drawn with replacement from the actual 1825 - 1999 sample. Note the median is slightly negative for all horizons and none of the coefficients in the test cross the 5% percentile. Since small-sample properties of the coefficient distribution are relevant, this bootstrap is useful only for the test over the entire period. Not reported, but used for the sub-period hypothesis tests, are bootstrapped distributions using data drawn only from the relevant sub-period.

The sub period analysis thus tells an interesting story. The 1825 - 1870 and the 1871-1925 data in fact indicate some evidence of mean reversion at different horizons when compared to the bootstrapped distribution. It is only the 1926 to 1999 period that is weak and this affects inferences drawn over the entire period. There is no reason to presume that parameter values for mean reversion are constant over the various sub-periods. Parameter instability, pointed out by Welch and Goyal, may thus be relevant. There appears to be a strong difference in the pattern of mean-reversion pre vs. post 1925. Survival may also be relevant to the analysis. Brown, Goetzmann and Ross (1995) find that survival conditioning may affect estimate of mean reversion. Clearly the young NYSE stock market was more subject to the danger of disappearance than the more mature market post-1925.

In sum, the overall mean-reversion evidence is marginal, but it is occasionally significant over sub-periods. The fact that it is not consistent over time simply may simply mean the periodicity of reversion changes, making forecasts for the U.S. market difficult.

5.2. Dividend Yields

In Table 4, we report the regressions of annual multiple-year horizon returns on past dividend yields. For the entire period 1825 through 1999, the coefficients are positive for horizons over four years, although not significantly so. Uncorrected t-statistics for sub-periods

1871-1925 and 1926 -1999 are of the magnitude of 2 to 4, however these values are consistent with 95th percentile bootstrapped values for t-statistics over longer periods. For our bootstraps, we sample appreciation returns by drawing from the distribution with replacement, and reconstruct a dividend yield series and a total return series conditional upon the actual income returns, using the low dividend series. The dividend yield series we create by dividing the actual income return by the bootstrapped appreciation return each period. The total return we construct by summing the actual income return and the bootstrapped appreciation return each period. The median and 95% quantiles of the bootstrapped distribution for the entire time period are reported at the bottom of Table 4. Not reported are the sub-period bootstrap distributions, but we use them for our p-values in the table.

None of the coefficients in the full-period regressions exceed the bootstrapped 5% critical values -- in fact they deviate little from the median bootstrapped values. The sub-period evidence is more suggestive of possible forecasting power when uncorrected t-statistics are used. However the bootstrapped critical 5% values are a high threshold at longer horizons -- uncorrected t-values exceeding 3 to 5 are expected 5% of the time. On the other hand, for virtually every sub-period, the coefficients are positive and increasing in the investment horizon as would be predicted by dividend forecasting models. Note that we used only the low dividend series for our analysis. We did not use the high dividend series because of the obvious structural change in the income returns displayed in Figure 4. Thus, our negative results may be in part due to incomplete or uneven dividend data.

6. Estimating Time-Varying Volatility

Our long-term data allows us to investigate additional time-series characteristics of equity returns of interest to research in financial economics. Schwert (1989) analyzes the stock volatility using monthly data from 1857 to 1987. He shows that aggregate financial leverage is correlated with stock return volatility. He also demonstrates that stock return volatility is higher during economic recessions than during expansions. While we do not have information about the capital structure of the market over the early period, we are able to condition upon past returns. Presumably, when stock prices drop, leverage increases in the short-term. Using various stochastic volatility models, we investigate the predictability of conditional volatility of the monthly NYSE capital appreciation conditional upon past positive and negative returns from February 1815 to December 1925. We find that higher lagged return shocks and conditional volatility cause higher volatility. At the same time, our results show that negative return shocks cause higher volatility than positive shocks do, which confirms the findings of Schwert (1989).

We obtain the unpredictable part of the capital appreciation returns through a procedure similar to that of Pagan and Schwert (1990) and Engle and Ng (1993). The procedure consists of a month-of-the-year effect adjustment and an autoregression that removes the predictable part of the return series. We first regress the monthly returns on month-of-the-year dummies and then use the residuals in an autoregression. We use the residuals from this autoregression as our unpredictable stock returns. It is interesting to notice that there is some evidence of the January effect in our month-of-the-year regression. January has the highest excess return, 1.05%, with a 1.8 t-statistic (corresponding to about 7% p. value). The lowest excess return appears in June, -0.79%. The results of the month-of-year adjustment are reported in Table 5.

Using the unpredictable stock returns, we estimate four different volatility models. They are the standard GARCH, power GARCH (PGARCH), exponential GARCH (EGARCH) and threshold GARCH (TGARCH). The estimation is performed via quasi-maximum likelihood methods using the BHHH numerical optimization algorithm. We include leverage terms in all models to capture possible asymmetric effects of positive and negative returns. For each model, we estimate both (1,1) and (1,2) settings. However, the TGARCH (1,2) estimation does not converge.

In Table 6 we report the estimation results. The parameters corresponding to the one-period lagged unpredictable return in all models, the constant term in all models except PGARCH, the leverage term in all (1,1) models are significant. In sum, our results show that for NYSE monthly capital appreciation from February 1815 to December 1925, higher lagged return shocks and conditional volatility cause higher volatility. These results are also consistent with the hypothesis that negative return shocks cause higher volatility than positive return shocks, which indicates that the so-called “good news” and “bad-news” asymmetric impacts already existed in the early era of NYSE.

7. Conclusion

Our data collection efforts over the last ten years have yielded a comprehensive database of NYSE security prices over nearly the entire history of the stock exchange. While econometricians, including ourselves, have created indices of stock returns over the 19th century, most have conditioned upon availability, or used average of monthly high and low prices. No one has collected dividends for a broad sample of NYSE stocks over the 19th century. Our goal is to construct a CRSP-like database of NYSE stocks for the entire history of the exchange. The current paper reports on the fruits of our efforts thus far. In particular, we construct a price-weighted index for the entire pre-CRSP era of the U.S. stock market from 1815 to 1925. We find that it closely tracks the widely-used Cowles index over the 1871 to 1925 period, however it does not suffer from the well known bias in the monthly autocorrelation. We believe our index is fairly representative of the behavior of NYSE securities over the early 19th century indices as well.

Over our entire period (1815-1925), our price-weighted capital appreciation is 1.24% per year, which is substantially lower than the Ibbotson and Sinquefield (1926-1999) capital appreciation of 6.62% annual geometric mean (compounded) return. For the period in which we have dividends (1825-1925) our low income annual return is 4.63%, and our high income annual return is 7.09%. Expressed as total returns, our low dividend price-weighted annualized geometric mean return is 5.99%, and our high dividend price-weighted annualized geometric mean return is 8.50%. This compares to the Ibbotson and Sinquefield (1926-1999) annual income return of 4.45% and the total annual geometric mean return of 11.35%.

Our investigation of the forecastablity of long-horizon stock returns using past returns and dividend yields leaves us no closer to rejecting the null of no predictability than researchers were ten years ago. Evidence over sub-periods in the past is tantalizing, but reasonable bootstrap methods fail to clearly reject the hypothesis of no predictability over the entire time period, despite some sub-period evidence.

Our investigation of the conditional volatility of monthly NYSE capital appreciation using various volatility models generally verifies earlier finding in the literature that good news and bad news have different predictability for future volatility. Specifically, all the models except PGARCH find that negative shocks introduce more volatility than positive shocks.

Appendix I

The appendix reports the key annual series used in the paper. The columns are self-explanatory. The method of index construction is described in the text. The total number of securities indicated is the number of different securities that comprised at least part of the monthly price-weighted average returns in the index calculation for that year. Industrial classifications were based upon the company names. Firms were included under Industrials unless otherwise identifiable. These data are available for downloading in spreadsheet format at the website of the International Center for Finance at the Yale School of Management.

Year	Price-weighted Capital Appreciation	Price-weighted Appreciation Index	Low dividend return	High dividend return	Total return with low dividends	Total return with high dividends	Equal-weighted capital appreciation returns	Equal-weighted capital appreciation return index	Total number of securities in index	Insurance	Transpor-tation	Banks	Mining	Utility	Industrials and other
1814		1.00						1.00							
1815	-6.65%	0.93					-6.65%	0.93	8	3	0	5	0	0	0
1816	-1.93%	0.92					-1.69%	0.92	8	3	0	5	0	0	0
1817	19.43%	1.09					19.37%	1.10	8	3	0	5	0	0	0
1818	-3.76%	1.05					23.16%	1.35	13	7	0	6	0	0	0
1819	-8.82%	0.96					-7.45%	1.25	15	9	0	6	0	0	0
1820	9.59%	1.05					10.13%	1.38	15	9	0	6	0	0	0
1821	3.34%	1.09					3.48%	1.42	15	9	0	6	0	0	0
1822	-12.85%	0.95					-6.54%	1.33	6	0	0	0	0	0	0
1823	5.29%	1.00					6.25%	1.41	21	14	0	6	0	1	0
1824	3.70%	1.03					3.92%	1.47	33	22	0	10	0	1	0
1825	-12.99%	0.90	2.53%	5.08%	-10.46%	-7.91%	-13.73%	1.27	32	22	1	9	0	0	0
1826	-1.22%	0.89	2.03%	4.94%	0.81%	3.72%	1.07%	1.28	34	20	1	11	0	1	1
1827	-6.24%	0.83	2.97%	6.18%	-3.28%	-0.06%	-6.86%	1.19	32	19	1	9	0	0	3
1828	-17.95%	0.68	2.82%	5.85%	-15.13%	-12.10%	-21.52%	0.94	29	15	1	10	0	1	2
1829	10.33%	0.75	3.21%	6.99%	13.54%	17.32%	12.10%	1.05	30	18	1	9	0	0	2
1830	27.31%	0.96	2.83%	5.57%	30.14%	32.88%	29.35%	1.36	30	17	1	10	0	0	2
1831	-17.05%	0.80	1.70%	4.44%	-15.35%	-12.60%	-2.55%	1.32	38	17	4	15	0	0	2
1832	8.60%	0.87	3.02%	5.93%	11.62%	14.53%	10.34%	1.46	40	18	4	16	0	0	2
1833	-6.09%	0.81	2.94%	5.54%	-3.16%	-0.55%	-6.56%	1.36	49	22	7	16	0	1	3
1834	8.84%	0.88	2.91%	5.88%	11.75%	14.72%	18.42%	1.61	47	19	6	18	0	1	3

1835	-6.74%	0.82	2.83%	5.93%	-3.91%	-0.81%	-1.60%	1.59	58	23	8	23	0	1	3
1836	4.33%	0.86	1.59%	13.93%	5.92%	18.26%	5.83%	1.68	46	13	8	22	0	1	2
1837	-18.02%	0.71	2.11%	7.08%	-15.91%	-10.94%	-16.65%	1.40	45	16	7	19	0	1	2
1838	12.20%	0.79	6.27%	11.71%	18.47%	23.91%	15.09%	1.61	49	18	6	22	0	1	2
1839	-26.62%	0.58	5.28%	10.01%	-21.34%	-16.61%	-25.59%	1.20	58	21	6	28	0	1	2
1840	3.01%	0.60	3.53%	8.53%	6.54%	11.54%	17.30%	1.41	56	20	6	27	0	1	2
1841	-23.52%	0.46	4.87%	10.05%	-18.66%	-13.47%	-28.65%	1.00	47	12	7	25	0	1	2
1842	2.34%	0.47	5.77%	11.65%	8.11%	13.99%	20.38%	1.21	49	16	7	25	0	1	0
1843	39.16%	0.65	7.18%	25.62%	46.34%	64.78%	72.30%	2.08	47	16	7	22	0	1	1
1844	2.81%	0.67	6.85%	11.74%	9.66%	14.55%	12.11%	2.34	47	13	8	23	0	1	2
1845	-11.61%	0.59	4.16%	6.97%	-7.46%	-4.64%	-10.93%	2.08	36	8	7	18	0	1	2
1846	23.21%	0.73	3.36%	8.04%	26.57%	31.25%	45.80%	3.03	25	0	8	14	0	1	2
1847	7.65%	0.79	5.55%	11.41%	13.20%	19.06%	23.79%	3.75	29	5	7	13	0	2	2
1848	5.28%	0.83	5.17%	9.72%	10.45%	15.00%	5.34%	3.96	11	1	3	7	0	0	0
1849	7.80%	0.89	7.60%	13.68%	15.40%	21.48%	52.51%	6.03	60	6	28	21	0	1	4
1850	10.48%	0.98	3.73%	9.41%	14.21%	19.89%	18.09%	7.12	72	9	34	22	0	2	5
1851	-5.78%	0.93	4.44%	11.04%	-1.35%	5.26%	-2.26%	6.96	76	7	31	29	3	0	6
1852	18.07%	1.10	4.52%	10.09%	22.59%	28.16%	58.34%	11.02	85	6	33	30	8	0	8
1853	-8.15%	1.01	4.11%	9.77%	-4.03%	1.62%	-13.43%	9.54	120	11	42	36	15	2	14
1854	-20.34%	0.80	1.99%	17.42%	-18.35%	-2.92%	-20.35%	7.60	78	0	32	22	10	3	11
1855	16.26%	0.93	2.09%	9.12%	18.34%	25.38%	15.40%	8.77	73	3	33	23	7	1	6
1856	2.49%	0.95	3.00%	9.57%	5.49%	12.05%	3.50%	9.08	71	4	33	24	5	1	4
1857	-24.22%	0.72	3.39%	18.58%	-20.82%	-5.64%	-12.34%	7.96	81	5	31	33	5	1	6
1858	10.38%	0.80	2.83%	10.53%	13.22%	20.92%	137.91%	18.93	82	2	33	34	4	0	9
1859	-0.62%	0.79	2.86%	12.26%	2.24%	11.64%	-4.44%	18.09	65	1	28	30	2	0	4
1860	-3.93%	0.76	2.41%	5.35%	-1.53%	1.41%	63.93%	29.66	62	1	30	24	4	1	2
1861	-3.73%	0.73	3.21%	7.33%	-0.52%	3.60%	3.49%	30.70	56	1	30	20	3	0	2
1862	49.15%	1.09	3.60%	8.10%	52.75%	57.25%	75.22%	53.78	67	2	34	24	5	0	2
1863	40.95%	1.54	3.52%	7.40%	44.47%	48.35%	60.09%	86.11	82	1	40	24	9	2	6
1864	10.53%	1.71	4.18%	7.97%	14.71%	18.50%	4.94%	90.36	91	1	44	23	17	2	4
1865	-1.33%	1.68	3.97%	8.18%	2.64%	6.85%	8.89%	98.39	82	1	37	20	13	1	10
1866	0.46%	1.69	4.39%	9.31%	4.85%	9.77%	5.73%	104.03	94	1	43	24	10	1	15
1867	-2.61%	1.65	4.50%	8.47%	1.88%	5.86%	-5.37%	98.44	35	0	0	0	0	0	0
1868	1.52%	1.67					4.26%	102.63	75	1	42	19	2	1	10
1869	-2.85%	1.62	4.18%	8.87%	1.33%	6.02%	-0.59%	102.03	106	2	55	29	6	2	12

1870	-1.44%	1.60	4.20%	9.12%	2.77%	7.68%	0.63%	102.67	103	1	49	31	7	1	14
1871	3.34%	1.65	5.86%	5.86%	9.20%	9.20%	14.65%	117.71	103	1	50	28	9	2	13
1872	0.50%	1.66	6.33%	6.33%	6.83%	6.83%	23.08%	144.87	26	0	16	0	2	0	8
1873	-17.70%	1.37	6.51%	6.51%	-11.19%	-11.19%	-23.79%	110.41	33	0	17	0	1	0	15
1874	-5.77%	1.29	7.47%	7.47%	1.70%	1.70%	-10.59%	98.72	31	0	17	0	2	0	12
1875	-4.72%	1.23	6.61%	6.61%	1.89%	1.89%	-16.41%	82.52	36	0	19	0	2	0	15
1876	-13.31%	1.07	6.86%	6.86%	-6.45%	-6.45%	-1.55%	81.25	38	0	19	0	2	0	17
1877	1.74%	1.08	5.31%	5.31%	7.05%	7.05%	19.51%	97.10	41	0	24	0	2	0	15
1878	10.50%	1.20	5.54%	5.54%	16.04%	16.04%	24.87%	121.25	48	0	27	0	3	0	18
1879	51.31%	1.81	5.80%	5.80%	57.10%	57.10%	98.27%	240.39	49	0	26	0	3	0	20
1880	19.83%	2.17	5.28%	5.28%	25.12%	25.12%	18.48%	284.81	74	0	24	0	3	0	47
1881	1.88%	2.21	5.48%	5.48%	7.36%	7.36%	10.59%	314.98	67	0	22	0	3	0	42
1882	-9.54%	2.00	5.32%	5.32%	-4.22%	-4.22%	-2.28%	307.81	61	0	22	0	2	0	37
1883	-15.04%	1.70	5.65%	5.65%	-9.39%	-9.39%	-14.67%	262.66	120	0	22	1	2	0	95
1884	-24.28%	1.29	5.81%	5.81%	-18.47%	-18.47%	-24.24%	198.98	116	0	20	1	2	0	93
1885	45.32%	1.87	5.53%	5.53%	50.85%	50.85%	105.41%	408.72	77	0	14	0	0	0	63
1886	12.46%	2.10	4.23%	4.23%	16.69%	16.69%	71.82%	702.27	75	0	14	0	0	0	61
1887	-12.13%	1.85	4.43%	4.43%	-7.70%	-7.70%	-10.75%	626.79	68	0	13	0	0	0	55
1888	2.09%	1.89	4.36%	4.36%	6.45%	6.45%	9.54%	686.62	96	0	19	0	2	0	75
1889	4.49%	1.97	4.28%	4.28%	8.77%	8.77%	15.33%	791.89	89	0	16	0	2	0	71
1890	-10.72%	1.76	4.14%	4.14%	-6.59%	-6.59%	-1.24%	782.06	91	0	15	0	2	0	74
1891	2.95%	1.81	4.78%	4.78%	7.74%	7.74%	15.87%	906.18	83	0	15	0	2	0	66
1892	10.35%	2.00	4.44%	4.44%	14.79%	14.79%	18.64%	1075.08	82	0	15	0	2	0	65
1893	-16.86%	1.66	4.54%	4.54%	-12.33%	-12.33%	-24.23%	814.62	80	0	15	0	2	0	63
1894	-2.82%	1.62	4.76%	4.76%	1.94%	1.94%	9.16%	889.28	75	0	15	0	2	0	58
1895	2.14%	1.65	4.42%	4.42%	6.56%	6.56%	26.41%	1124.09	70	0	14	0	2	0	54
1896	0.69%	1.66	4.17%	4.17%	4.86%	4.86%	7.16%	1204.59	70	0	14	0	2	0	54
1897	14.15%	1.90	4.27%	4.27%	18.41%	18.41%	22.72%	1478.30	65	0	14	0	2	0	49
1898	12.17%	2.13	4.21%	4.21%	16.38%	16.38%	37.60%	2034.16	61	0	13	0	2	0	46
1899	4.17%	2.22	3.72%	3.72%	7.89%	7.89%	10.51%	2247.97	60	0	13	0	2	0	45
1900	17.99%	2.62	4.98%	4.98%	22.97%	22.97%	31.38%	2953.32	70	0	13	0	2	0	55
1901	24.60%	3.26	4.66%	4.66%	29.26%	29.26%	38.60%	4093.24	75	0	12	0	2	0	61
1902	5.29%	3.43	4.15%	4.15%	9.44%	9.44%	6.42%	4355.86	77	0	11	0	2	0	64
1903	-12.88%	2.99	4.35%	4.35%	-8.53%	-8.53%	-17.93%	3574.82	80	0	10	0	2	0	68
1904	14.94%	3.44	4.72%	4.72%	19.66%	19.66%	24.42%	4447.64	81	0	13	0	2	0	66

1905	6.67%	3.66	4.00%	4.00%	10.67%	10.67%	7.88%	4797.96	85	0	13	0	2	0	70
1906	-1.09%	3.62	4.19%	4.19%	3.10%	3.10%	-1.23%	4738.98	89	0	12	0	2	0	75
1907	-26.26%	2.67	4.47%	4.47%	-21.79%	-21.79%	-30.64%	3287.01	92	0	12	0	2	0	78
1908	28.47%	3.43	6.09%	6.09%	34.56%	34.56%	49.62%	4917.94	91	0	13	0	2	0	76
1909	18.12%	4.06	4.87%	4.87%	22.99%	22.99%	22.22%	6010.71	90	0	13	0	2	0	75
1910	-15.50%	3.43	4.56%	4.56%	-10.94%	-10.94%	-15.89%	5055.61	88	0	13	0	0	0	75
1911	2.17%	3.50	5.19%	5.19%	7.37%	7.37%	-1.17%	4996.22	90	0	14	0	0	0	76
1912	0.03%	3.50	5.27%	5.27%	5.30%	5.30%	1.26%	5059.00	88	0	14	0	0	0	74
1913	-14.44%	3.00	5.12%	5.12%	-9.32%	-9.32%	-15.68%	4265.65	88	0	13	0	0	0	75
1914	-8.47%	2.74	5.22%	5.22%	-3.25%	-3.25%	-17.88%	3503.14	85	0	14	0	0	0	71
1915	15.88%	3.18	5.85%	5.85%	21.73%	21.73%	46.05%	5116.33	93	0	13	0	0	0	80
1916	1.29%	3.22	5.91%	5.91%	7.19%	7.19%	12.58%	5760.08	95	0	13	0	0	0	82
1917	-23.48%	2.46	7.04%	7.04%	-16.44%	-16.44%	-24.91%	4325.04	88	0	13	0	0	0	75
1918	2.88%	2.53	8.38%	8.38%	11.27%	11.27%	7.41%	4645.40	89	0	13	0	0	0	76
1919	9.38%	2.77	6.71%	6.71%	16.09%	16.09%	16.38%	5406.37	86	0	13	0	0	0	73
1920	-20.74%	2.20	5.72%	5.72%	-15.02%	-15.02%	-15.94%	4544.77	90	0	12	0	0	0	78
1921	4.26%	2.29	6.75%	6.75%	11.02%	11.02%	15.13%	5232.28	91	0	13	0	0	0	78
1922	19.74%	2.74	6.98%	6.98%	26.72%	26.72%	32.84%	6950.65	89	0	13	0	0	0	76
1923	-2.13%	2.68	6.04%	6.04%	3.90%	3.90%	7.92%	7501.49	89	0	13	0	0	0	76
1924	19.34%	3.20	6.43%	6.43%	25.77%	25.77%	42.58%	10695.73	87	0	13	0	0	0	74
1925	23.22%	3.95	5.91%	5.91%	29.12%	29.12%	22.31%	13081.57	86	0	13	0	0	0	73

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Table 1: Annual Summary Statistics For Capital Appreciation, Income and Total Return to the Price-Weighted NYSE Index and Comparison Indices

The Price-Weighted NYSE appreciation series is calculated by compounding the price-weighted monthly NYSE index as described in the text. The Cowles Indices are the all-stock indices taken from Cowles (1939). The Ibbotson Index is a capital-weighted index of U.S. equities initially constructed by Ibbotson and Sinquefield and updated by Ibbotson Associates. The Low dividend series income return series to 1870 is constructed from the sum of all dividends collected in the year for stocks extant in the previous year divided by the sum of the latest available prices for all stocks comprising the index in the preceding year. The high dividend series is the average of the income returns for those stocks reporting dividends in that year. Total returns from 1871 to 1925 are constructed from the Price-Weighted NYSE and the Cowles Income Return Series.

Annual NYSE Capital Appreciation Return Series

Date	Series	Geometric Mean	Arithmetic Mean	Standard Deviation	Auto-correlation
1815-1925	Price-Weighted NYSE	1.24%	2.38%	15.58%	4.36%
1825-1925	Price-Weighted NYSE	1.34%	2.54%	16.08%	5.35%
1815-1870	Price-Weighted NYSE	0.84%	1.92%	15.27%	-1.11%
1871-1925	Price-Weighted NYSE	1.65%	2.84%	16.01%	9.40%
1871-1925	Cowles Index	1.89%	3.14%	15.94%	-3.04%
1926-1999	Ibbotson Index	6.62%	8.54%	19.55%	2.19%
1815-1999	Price-Weighted+Ibbotson	3.36%	4.84%	17.49%	6.14%
1825-1999	Price-Weighted+Ibbotson	3.54%	5.08%	17.82%	6.34%

Annual NYSE Income Return Series

Date	Series	Geometric Mean	Arithmetic Mean	Standard Deviation	Auto-correlation
1825-1925	Low Income Return +Cowles	4.63%	4.64%	1.45%	73.93%
1825-1925	High Income Return +Cowles	7.09%	7.14%	3.39%	56.68%
1825-1870	Low Income Return	3.77%	3.78%	1.43%	57.92%
1825-1870	High Income Return	9.27%	9.34%	3.95%	29.78%
1871-1925	Cowles	5.33%	5.34%	1.03%	77.51%
1926-1999	Ibbotson	4.45%	4.46%	1.39%	81.78%
1825-1999	Low Dividend+Cowles+Ibbotson	4.55%	4.56%	1.42%	77.49%
1825-1999	High Dividend+Cowles+Ibbotson	5.98%	6.02%	3.03%	67.19%

Annual NYSE Total Return Series with Low and High Dividend Income Returns and Cowles

Date	Series	Geometric Mean	Arithmetic Mean	Standard Deviation	Auto-correlation
1825-1925	Price-weighted NYSE with Low	5.99%	7.19%	16.37%	5.60%
1825-1925	Price-weighted NYSE with High	8.50%	9.69%	16.67%	5.99%
1825-1870	Price-weighted NYSE with Low	4.72%	5.97%	16.86%	2.98%
1825-1870	Price-weighted NYSE with High	10.29%	11.53%	17.41%	1.87%
1871-1925	Price-weighted NYSE & Cowles Div	7.05%	8.18%	16.04%	7.56%
1871-1925	Cowles Total Return	7.28%	8.48%	16.07%	-4.47%
1926-1999	Ibbotson	11.35%	13.28%	20.14%	1.06%
1825-1999	Price-Weighted Low Div. +Ibbotson	8.24%	9.78%	18.26%	5.86%
1825-1999	Price-Weighted High Div.+Ibbotson	9.70%	11.22%	18.26%	4.34%

Table 2: Monthly Summary Statistics For the Price-Weighted NYSE Capital Appreciation Index and Comparison Indices

The Price-Weighted NYSE appreciation series is calculated by compounding the price-weighted monthly NYSE index as described in the text. The Cowles Indices are the all-stock indices taken from Cowles (1939). The Schwert Index is described in Schwert (1992) and downloadable from William Schwert's website. It is constructed from secondary sources with econometric improvements by Schwert.

Monthly NYSE Capital Appreciation Return Series

Date	Series	Geometric Mean	Arithmetic Mean	Standard Deviation	Autocorrelation
2/1815-12/1925	Price-weighted	0.1032%	0.1858%	4.09%	-1.88%
2/1815-12/1925	Schwert	0.1313%	0.2130%	4.03%	7.38%
2/1815-1/1871	Price-weighted	0.0712%	0.1592%	4.24%	-7.76%
2/1815-1/1871	Schwert	0.0933%	0.1701%	3.90%	10.02%
2/1871-12/1925	Price-weighted	0.1358%	0.2128%	3.92%	5.13%
2/1871-12/1925	Schwert	0.1701%	0.2568%	4.16%	4.98%
2/1871-12/1925	Cowles	0.1567%	0.2094%	3.24%	28.80%

Table 3: Tests of Long-Term Mean Reversion in Stock Market Returns

Each panel reports the results of regressing future multiple-horizon overlapping returns on past multiple-horizon overlapping returns, from one to ten years. Total returns are calculated using the low dividend series and the Cowles dividend series before 1925. Medians and 5th percentiles of a bootstrapped distribution are reported in the final two panels. They are bootstrapped under the null of i.i.d. returns drawn with replacement from the entire time period, under the assumption of stationarity of means.

Capital Appreciation Return 1816 - 1999 Price-Weighted Series to 1925, Ibbotson to 1999

horizon	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
intercept	0.071	0.158	0.239	0.347	0.480	0.587	0.707	0.825	0.892	0.952
t int	4.415	5.984	6.759	7.235	8.057	8.534	8.691	8.447	8.079	7.934
coef	0.064	-0.015	-0.004	-0.043	-0.120	-0.124	-0.115	-0.086	-0.012	0.047
t coef	0.857	-0.200	-0.052	-0.552	-1.535	-1.588	-1.475	-1.097	-0.154	0.585
rsq	0.004	0.000	0.000	0.002	0.013	0.015	0.013	0.007	0.000	0.002
n	183.000	181.000	179.000	177.000	175.000	173.000	171.000	169.000	167.000	165.000

Total Return 1825 - 1999 Price-Weighted Series to 1925, Ibbotson to 1999. Low Dividends to 1870, Cowles to 1925

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
intercept	0.116	0.277	0.439	0.639	0.887	1.084	1.254	1.452	1.592	1.771
t int	6.384	8.680	9.581	9.875	10.680	10.850	10.876	10.305	9.657	9.335
coef	0.054	-0.045	-0.054	-0.087	-0.155	-0.141	-0.106	-0.067	0.011	0.059
t coef	0.706	-0.587	-0.689	-1.111	-1.982	-1.833	-1.462	-0.926	0.148	0.800
rsq	0.003	0.002	0.003	0.007	0.023	0.020	0.013	0.005	0.000	0.004
n	174.000	172.000	170.000	168.000	166.000	164.000	162.000	160.000	158.000	156.000

Total Return 1825 -1870 Price-Weighted Series, Low Dividends

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
intercept	0.139	0.357	0.688	1.144	1.833	2.685	3.145	3.440	3.847	4.705
t int	3.075	4.231	5.220	5.641	7.088	9.731	9.956	7.095	6.132	6.256
coef	0.101	0.020	-0.137	-0.268	-0.483	**-0.691***	-0.635	-0.465	-0.353	-0.366
t coef	0.671	0.130	-0.883	-1.672	-3.176	-5.285	-5.355	-3.231	-2.227	-2.189
rsq	0.010	0.000	0.020	0.070	0.224	0.458	0.481	0.265	0.155	0.161
n	45.000	43.000	41.000	39.000	37.000	35.000	33.000	31.000	29.000	27.000

Table 3 (Continued)

Total Return 1871 - 1925. Price-Weighted Series, Cowles Dividends

	1	2	3	4	5	6	7	8	9	10
intercept	0.088	0.227	0.324	0.453	0.653	0.677	0.863	1.138	1.336	1.628
t int	3.499	5.666	6.393	6.823	8.358	7.369	7.991	8.671	9.344	10.587
coef	-0.044	**-0.347***	-0.312	-0.307	-0.474	-0.299	-0.407	-0.550	-0.583	-0.670
t coef	-0.317	-2.531	-2.156	-2.046	-3.348	-2.072	-2.790	-3.758	-4.304	-5.153
rsq	0.002	0.114	0.088	0.083	0.203	0.093	0.163	0.271	0.340	0.439
n	54.000	52.000	50.000	48.000	46.000	44.000	42.000	40.000	38.000	36.000

Total Return 1926 - 1999 Ibbotson Large Stock Series

	1	2	3	4	5	6	7	8	9	10
intercept	0.129	0.311	0.503	0.715	0.837	0.865	1.039	1.409	1.770	2.466
t int	4.648	6.398	7.535	7.961	7.409	6.608	6.522	6.849	6.973	8.120
coef	0.008	-0.141	-0.229	-0.212	-0.035	0.200	0.243	0.141	0.110	-0.063
t coef	0.069	-1.171	-1.885	-1.737	-0.274	1.676	2.048	1.112	0.820	-0.469
rsq	0.000	0.019	0.050	0.044	0.001	0.043	0.065	0.021	0.012	0.004
n	74.000	72.000	70.000	68.000	66.000	64.000	62.000	60.000	58.000	56.000

Bootstrapped Median for 175 Year Period

	1	2	3	4	5	6	7	8	9	10
intercept	0.120	0.257	0.414	0.595	0.786	1.006	1.257	1.545	1.854	2.226
t int	6.626	8.109	8.938	9.334	9.598	9.802	9.981	10.117	10.218	10.230
coef	0.001	-0.016	-0.028	-0.035	-0.040	-0.051	-0.064	-0.076	-0.074	-0.081
t coef	0.010	-0.203	-0.375	-0.442	-0.516	-0.650	-0.805	-0.962	-0.941	-1.044
rsq	0.003	0.005	0.006	0.008	0.009	0.011	0.014	0.016	0.018	0.018
n	174.000	172.000	170.000	168.000	166.000	164.000	162.000	160.000	158.000	156.000

Bootstrapped 5% level for 175 Year Period

	1	2	3	4	5	6	7	8	9	10
intercept	0.091	0.189	0.296	0.417	0.549	0.683	0.828	0.982	1.185	1.371
t int	5.320	6.435	6.897	7.084	7.177	7.215	7.149	7.110	7.014	6.947
coef	-0.128	-0.163	-0.195	-0.227	-0.247	-0.269	-0.280	-0.307	-0.321	-0.331
t coef	-1.690	-2.147	-2.566	-2.992	-3.293	-3.596	-3.695	-4.069	-4.209	-4.347
rsq	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
n	174.000	172.000	170.000	168.000	166.000	164.000	162.000	160.000	158.000	156.000

Table 4: Tests of Dividend Yield Forecasting Power for Long-Horizon Stock Market Returns

Each panel reports the results of regressing future multiple-horizon overlapping returns dividend yields from one to ten year return horizons. Total returns are calculated using the low dividend series and the Cowles dividend series before 1925. Yields are calculated as the sum of the dividends paid during the year divided by the index price at the end of the year. The bootstrap is performed by fixing the income return series as the historical realized value, drawing total returns with replacement and constructing a dividend yield series consistent with both. Medians and 5th percentiles of the bootstrapped distribution are reported in the final two panels.

Yield Regressions from 1825 - 1999

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
intercept	0.135	0.262	0.508	0.629	0.679	0.891	1.111	1.152	1.430	1.796
t int	2.933	3.484	5.059	4.483	3.809	4.268	4.336	3.605	3.900	4.462
coef	-0.286	0.009	-2.121	-0.898	2.243	1.860	1.995	6.856	6.597	4.792
t coef	-0.293	0.006	-0.999	-0.304	0.598	0.424	0.372	1.026	0.862	0.571
rsq	0.000	0.000	0.006	0.001	0.002	0.001	0.001	0.006	0.005	0.002
n	174.000	173.000	172.000	171.000	170.000	169.000	168.000	167.000	166.000	165.000

Yield Regressions from 1825 - 1870 Price-Weighted Series, Low Dividends

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
intercept	0.213	0.449	0.833	1.061	1.013	1.182	1.470	1.199	1.245	1.707
t int	2.109	2.694	3.682	3.223	2.394	2.416	2.442	1.587	1.471	1.942
coef	-1.656	-2.911	-7.615	-6.736	2.611	5.966	7.273	25.896	35.510	33.605
t coef	-0.632	-0.674	-1.299	-0.790	0.238	0.471	0.466	1.324	1.620	1.475
rsq	0.009	0.010	0.037	0.014	0.001	0.005	0.005	0.038	0.056	0.047
n	46.000	46.000	46.000	46.000	46.000	46.000	46.000	46.000	46.000	46.000

Yield Regressions from 1871 - 1925

	1	2	3	4	5	6	7	8	9	10
intercept	0.012	0.004	0.202	0.145	-0.099	-0.099	-0.191	-0.382	-0.261	-0.130
t int	0.135	0.026	1.137	0.628	-0.357	-0.321	-0.542	-0.987	-0.660	-0.318
coef	1.371	3.335	1.609	4.948	11.850	13.891	17.881	24.037	23.954	23.822
t coef	0.840	1.310	0.495	1.175	2.344	2.468	2.769	3.394	3.316	3.181
rsq	0.013	0.031	0.005	0.025	0.094	0.103	0.126	0.179	0.172	0.160
n	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000	55.000

Table 4 (continued)

Yield Regressions from 1926 - 1999

	1	2	3	4	5	6	7	8	9	10
intercept	0.078	0.094	0.180	0.127	0.161	0.323	0.396	0.428	0.676	0.808
t int	1.141	0.864	1.288	0.707	0.736	1.259	1.283	1.143	1.505	1.498
coef	1.206	4.123	5.399	10.238	13.499	14.348	17.952	23.144	24.325	28.914
t coef	0.804	1.748	1.794	2.646	2.893	2.631	2.751	2.934	2.585	2.568
rsq	0.009	0.042	0.045	0.093	0.111	0.095	0.104	0.119	0.096	0.096
n	73.000	72.000	71.000	70.000	69.000	68.000	67.000	66.000	65.000	64.000

Bootstrap Medians 1,000 iterations using Low Dividend Yield, Conditioning upon Actual Yields

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
intercept	0.093	0.198	0.319	0.455	0.600	0.763	0.976	1.191	1.424	1.692
t int	2.357	3.083	3.552	3.918	4.129	4.244	4.412	4.515	4.552	4.577
coef	0.658	1.332	2.054	2.795	3.770	4.670	5.505	6.668	8.342	9.546
t coef	0.755	0.951	1.083	1.142	1.226	1.245	1.195	1.178	1.214	1.208
rsq	0.005	0.007	0.009	0.010	0.012	0.012	0.013	0.013	0.015	0.015
n	174.000	173.000	172.000	171.000	170.000	169.000	168.000	167.000	166.000	165.000

Bootstrapped 95% level with 1,000 iterations using Low Dividend Yield, Conditioning upon Actual Yields

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
intercept	0.160	0.339	0.544	0.788	1.073	1.374	1.747	2.123	2.642	3.240
t int	4.145	5.259	6.068	6.580	6.954	7.338	7.539	7.699	8.039	8.186
coef	2.061	4.010	5.996	8.565	11.905	15.273	19.082	23.399	28.798	35.802
t coef	2.296	2.885	3.182	3.425	3.728	3.852	3.925	4.058	4.097	4.239
rsq	0.030	0.046	0.056	0.065	0.077	0.082	0.086	0.092	0.093	0.099
n	174.000	173.000	172.000	171.000	170.000	169.000	168.000	167.000	166.000	165.000

Table 5: Mean Adjustment Regression

This table reports the results of an adjustment procedure to remove the month-of-year effects from the monthly capital appreciation return of NYSE from February 1815 to December 1925. The procedure is analogous to the one in Pagan and Schwert (1990) and the one in Engle and Ng (1993). First, the monthly return y is regressed on twelve month-of-the-year dummies to get the residual u. Then u is regressed on a constant and some lags whose order is determined by Akaike information criterion (AIC). According to AIC, the optimal order of lag is 0. In the table, the numbers in parentheses (.) are the asymptotic standard errors and the numbers in brackets [.] are the t values.

Coefficients of month-of-the-year dummies

Intercept	**January**	**February**	**March**	**April**	**May**
0.0027	0.0105	-0.0067	0.0035	0.0025	-0.0015
(0.0041)	(0.0059)	(0.0058)	(0.0058)	(0.0058)	(0.0058)
[0.6648]	[1.7922]	[-1.1695]	[0.5993]	[0.4317]	[-0.2664]
June	**July**	**August**	**September**	**October**	**November**
-0.0079	-0.0010	-0.0015	-0.0032	-0.0016	-0.0008
(0.0058)	(0.0058)	(0.0058)	(0.0058)	(0.0058)	(0.0058)
[-1.3765]	[-0.1780]	[-0.2582]	[-0.5490]	[-0.2816]	[-0.1438]

Table 6: GARCH Estimation Results

This table reports the estimation results of various predictable volatility models for the monthly capital appreciation return of the NYSE from January 1815 to December 1925. Month-of-the-year effects and a predictable component have been removed. The estimation is performed by the method of quasi maximum likelihood using the BHHH numerical optimization algorithm. In the table, the numbers in parentheses (.) are the asymptotic standard errors and the numbers in brackets [.] are the t values.

δ_t^2 is the conditional variance on month t and ε_{t-1} is the unpredictable return on month t-1.

GARCH(1,1) Specification

$$\sigma_t^2 = 0.00119 + 0.25884(|\varepsilon_{t-1}| - 0.14507\varepsilon_{t-1})^2 - 0.03929\sigma_{t-1}^2$$

(0.00006) (0.03649) (0.06596) (0.05164)
[18.94] [7.09] [-2.1994] [-0.7609]

EGARCH(1,1) Specification

$$\ln(\sigma_t^2) = -3.91869 + 0.38592 \cdot \frac{|\varepsilon_{t-1}| - 0.15383\varepsilon_{t-1}}{\sigma_{t-1}} + 0.44032 \cdot \ln(\sigma_{t-1}^2)$$

(0.47535) (0.04242) (0.07541) (0.069334)
[-8.244] [9.0983] [-2.039] [6.3508]

PGARCH(1,1) Specification

$$\sigma_t^{1.937} = 0.00127 + 0.2507(|\varepsilon_{t-1}| - 0.185\varepsilon_{t-1})^{1.937} + 0.0717\sigma_{t-1}^{1.937}$$

0.38579) (0.00167) (0.0363) (0.06696) (0.07026)
[5,02] [0.76] [6.91] [-2.76] [1.02]

TGARCH(1,1) Specification

$$\sigma_t^2 = 0.00122 + 0.19028\varepsilon_{t-1}^2 + 0.1396 \cdot S_{t-1}\varepsilon_{t-1}^2 - 0.04155\sigma_{t-1}^2$$

(0.00006) (0.04561) (0.06614) (0.04855)
[20.04] [4.17] [2.11] [-0.86]

Diagnostic Test Results

	GARCH(1,1)	EGARCH(1,1)	PGARCH(1,1)	TGARCH(1,1)
AIC	-4632.491	-4615.057	-4623.691	-4634.422
BIC	-4606.765	-4589.331	-4592.82	-4608.696
Jarque-Bera	40054	53561	44784	39224
Shapiro-Wilk	0.9215	0.912	0.9187	0.922
Ljung-Box(12)[6]	20.13	19.53	20.29	20.09
Ljung-Box(12)[7]	0.4525	0.4514	0.5233	0.4597

[6] Test for standardized residuals.

[7] Test for squared standardized residuals.

Table 6 (continued)

GARCH(1,2)

$$\sigma_t^2 = 0.00112 + 0.24515(|\varepsilon_{t-1}| - 0.07792\varepsilon_{t-1})^2 - 0.22405\sigma_{t-1}^2 + 0.29598\sigma_{t-2}^2$$

(0.00007) (0.00316) (0.04582) (0.02875) (0.5588)
[16.35] [7.77] [-1.70] [-7.79] [5.30]

PGARCH(1,2)

$$\sigma_t^{2.28994} = 0.00034 + 0.23186(|\varepsilon_{t-1}| - 0.06539\varepsilon_{t-1})^{2.28994} - 0.14113\sigma_{t-1}^{2.28994} + 0.29837\sigma_{t-2}^{2.28994}$$

(0.33031)(0.00042)(0.03719) (0.05012) (0.04331) (0.06048)
[6.93] [0.81] [5.23] [-1.30] [-3.26] [4.93]

TGARCH(1,2)

$$\sigma_t^2 = 0.00107 + 0.209\varepsilon_{t-1}^2 + 0.0785 \cdot S_{t-1}\varepsilon_{t-1}^2 - 0.2025\sigma_{t-1}^2 - 0.0785\sigma_{t-2}^2$$

(0.00007) (0.0421) (0.04644) (0.03085) (0.05935)
[14.53] [4.96] [1.69] [-6.56] [4.79]

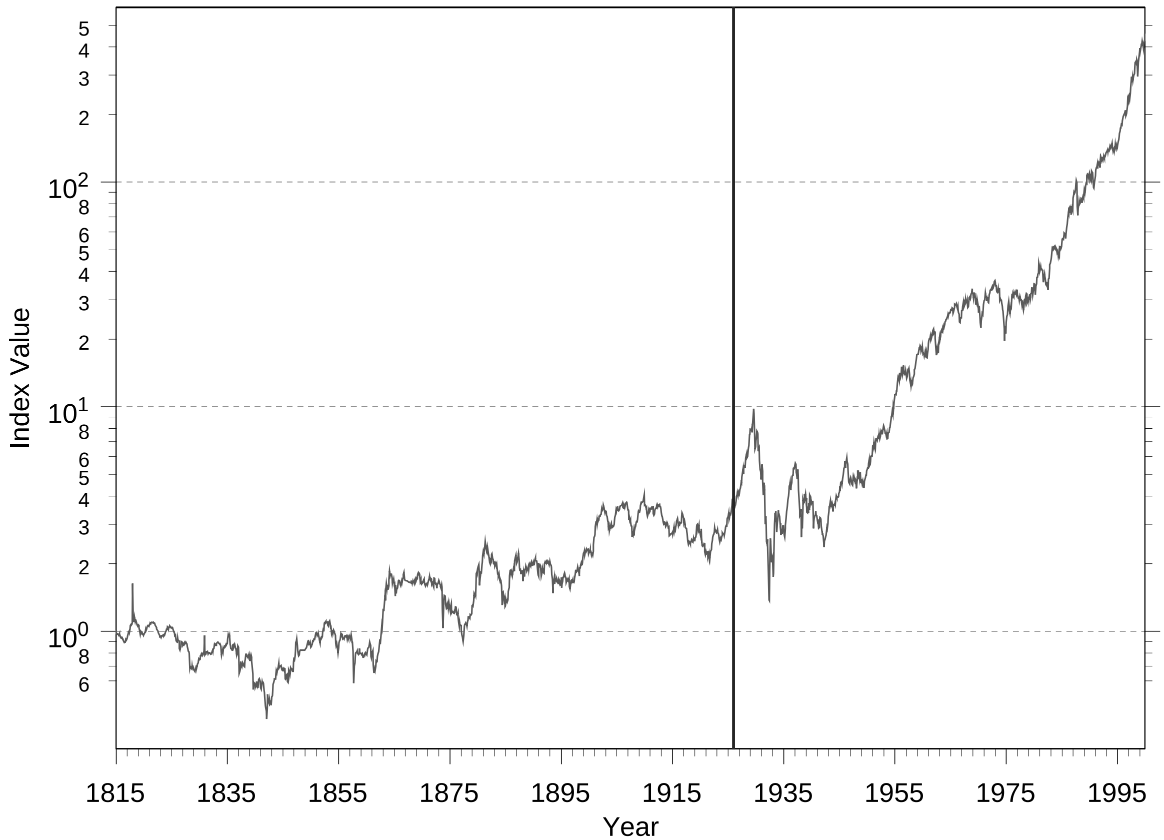
Diagnostic Test Results

	GARCH(1,2)	PGARCH(1,2)	TGARCH(1,2)
AIC	-4631.306	-4623.172	-4629.897
BIC	-4600.435	-4587.156	-4599.026
Jarque-Bera	40227	45248	41595
Shapiro-Wilk	0.9217	0.9188	0.9207
Ljung-Box(12)[8]	20.82	21.36	20.58
Ljung-Box(12)[9]	0.6224	0.6113	0.6039

[8] Test for standardized residuals.

[9] Test for squared standardized residuals.

Figure 1: Monthly Capital Appreciation Index 1/1815-12/1999



Price-weighted NYSE Index (1/1815-12/1925) with Ibbotson and Sinquefield Index (1/1926-12/1999)

Figure 2: Distribution of Raw Stock Prices over 1815-1925

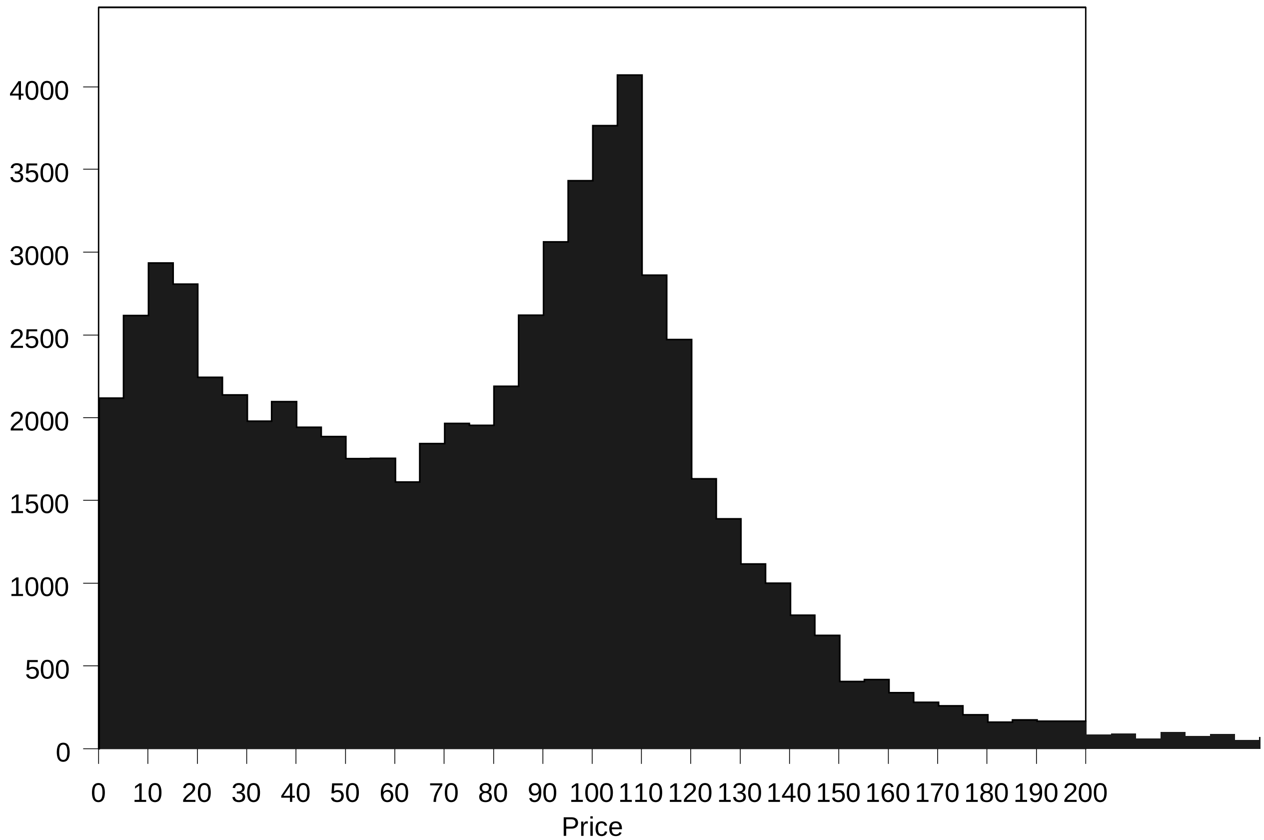
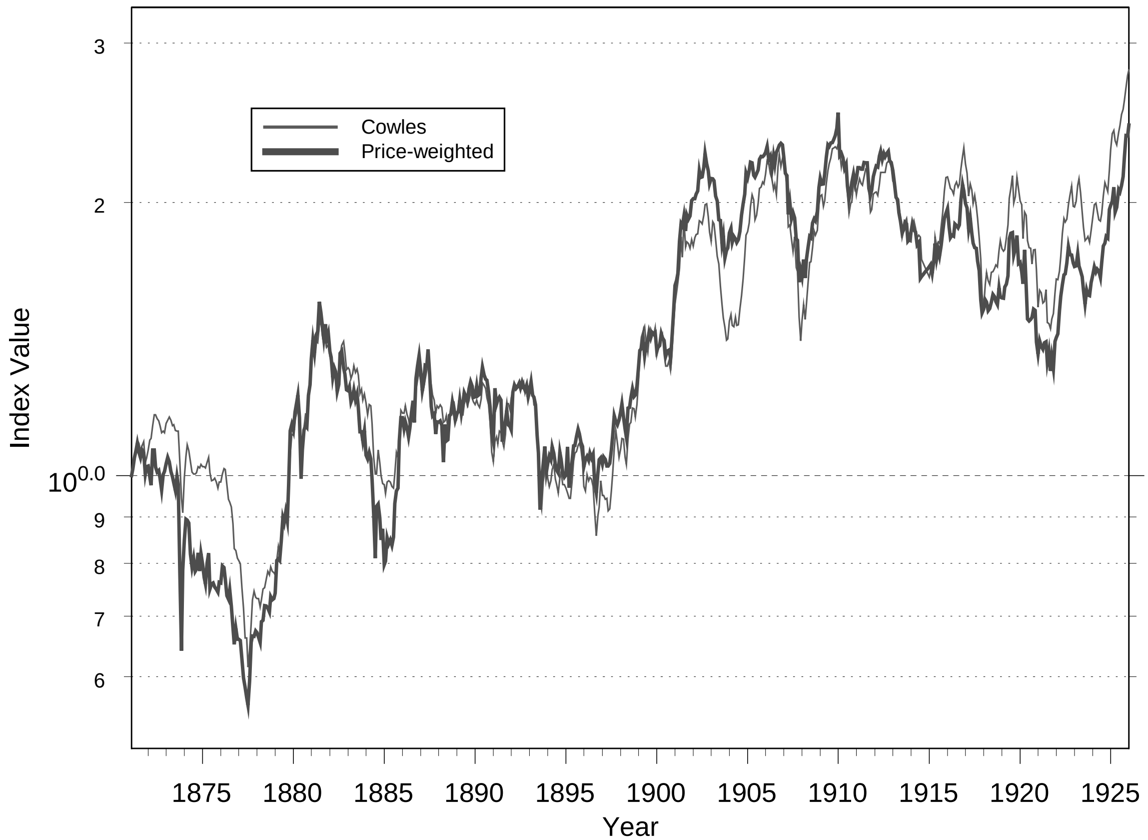


Figure 3: Monthly Capital Appreciation Index Comparison



Price-weighted NYSE Index 1/1871-12/1925 vs. Cowles Index 1/1871-12/1925

Figure 4: Annual NYSE Income Returns in Percent 1825-1999

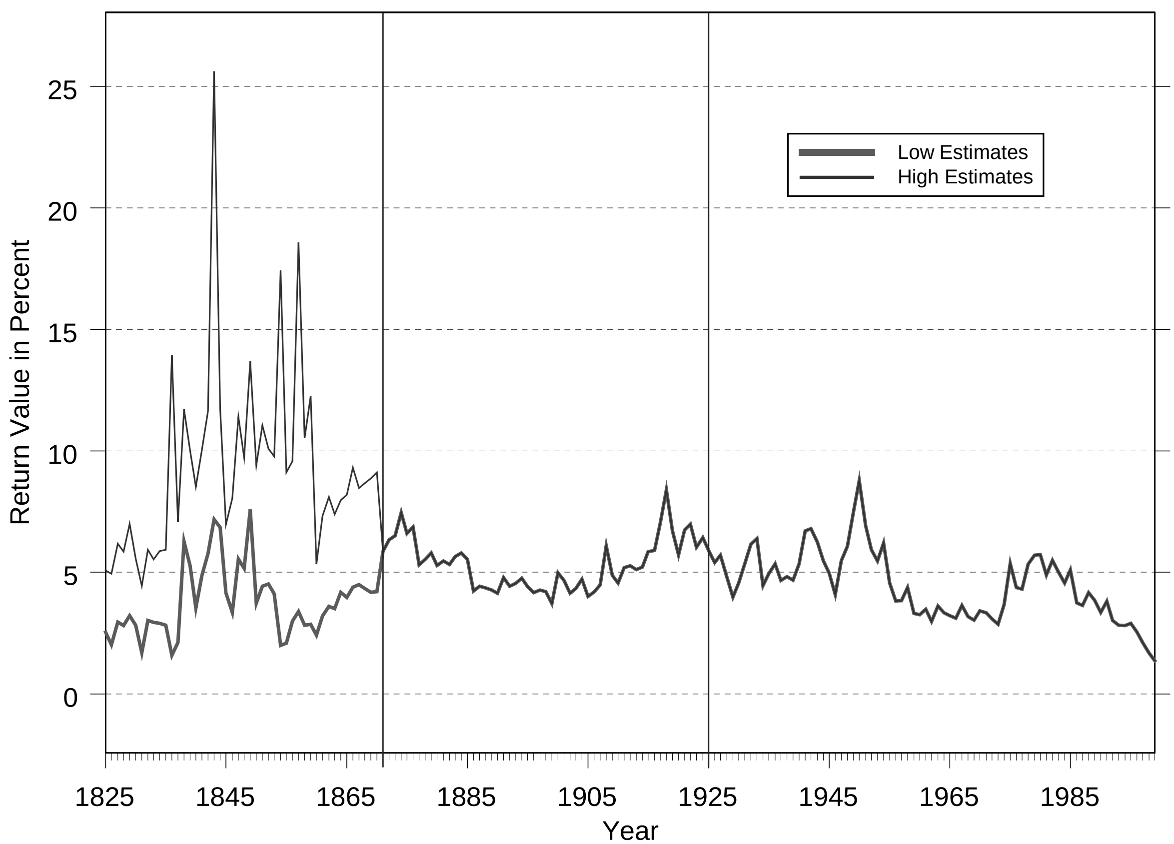


Figure 4: For 1825-1870, low estimates assume zero dividends for missing dividends, high estimates assume missing dividends are at same rate as collected dividend yields. For 1871-1925, both low and high estimates of income returns are equal to the Cowles income returns. For 1926-1999, the Ibbotson and Sinquefield income returns are given.