A FULL CENTURY OF MONTHLY CANADIAN STOCK PRICE INDEX RETURNS: A REVIEW OF THE FISHER HYPOTHESIS AND SOME ANOMALIES

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ABSTRACT

A Full Century of Monthly Canadian Stock Price Index Returns:
A Review of the Fisher Hypothesis and Some Anomalies

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New primary data on the behaviour of Canadian stock prices since the turn of the 19th century are combined with the existing Toronto Stock Exchange Stock Price Return Index to provide a stock price index that spans the full length of the 20th century. Although long period returns have been available for several countries, to date no such data have been published for Canadian markets notwithstanding the fact that equity trading was quite active during this period, especially in Montreal. With these data we are in a position to address for the first time a number of anomalies associated with long horizon returns and irregularities that have been reported for other countries, such as the Gibson Paradox and the January effect. Results only partially support the Fisher hypothesis, but suggest that both the Gibson Paradox and the January effect no longer hold. A December effect appears to have replaced the January effect in the last decade of the 20th century.

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Table of Content

Introduction

The U.S. financial market has served as the focal point for most long term stock market studies, as a consequence of readily available long term time series [Shiller, (2000); Campbell & Shiller (1998); Cole & Laster, (1996); Goetzmann, & Jorion, (1993); Barsky & De Long, (1992); Jones, Lee, & Apenbrink, (1991)]. Long data series are necessary to extend the power of statistical tests on financial data.

As a consequence of lack of data, long term market studies for other countries have not received much attention. The main purpose of this study is to introduce new primary data series for the Canadian stock market. We combine the newly compiled historical data series with existing data sets and provide a stock price index that spans the full length of the 20th century.

Although long period returns have been available for several countries, to date no such data have been published for Canadian markets notwithstanding the fact that equity trading was quite active during this period, especially in Montreal. With these data we are in a position to address for the first time a number of anomalies associated with long horizon returns and irregularities that have been reported for other countries, such as the Gibson Paradox and the January effect.

Results only partially support the Fisher hypothesis, but suggest that both the Gibson Paradox and the January effect no longer hold. A December effect appears to have replaced the January effect in the last decade of the 20th century.

The thesis is divided in five sections. The first section reviews the literature and presents the hypotheses tested in this thesis. Section II presents the data in some details and performs univariate statistical tests to confirm the basic properties of the series.

Section III presents the methodology. Section IV presents the empirical results and section V concludes the thesis.

Note that all tables and charts are presented in the appendix at the end of the thesis.

I. Literature Review, Theory, and Hypotheses

Stock Price Returns and Inflation

The seminal work of Fisher (1930) establishes one of the oldest and most widely investigated hypotheses in finance that inflation is incorporated into asset market returns as a premium. The basic Fisher hypothesis states that an increase in expected inflation will be incorporated in higher nominal interest rates leaving the relative return and purchasing power unaffected (in the long run at least). Extended to stock price returns, this theory states that inflation should be one of the premia built-into securities returns, making common stocks hedges against inflation. However, empirical research has generally not supported this hypothesis.

The 1970s and early 1980s see a great deal of empirical research on the Fisher hypothesis involving common stock returns. The more recent research from the late 1980s and the 1990s almost exclusively concentrates on the Fisher hypothesis as it relates to interest rates.

Early Studies (1970s to mid-1980s)

John Lintner (1975) points out that the Fisher rule "implicitly assumes the absence of risk-aversion on the part of all investors acting on preferences over real outcomes" leading to a serious bias when inflation is uncertain. This bias has been evident in several studies from the seventies and eighties that shows that in the short-run the Fisher relation does not appear to hold. [Oudet (1973), Bodie (1976), Nelson (1976), Fama and Schwert (1977), Gultekin (1983)] These papers, which see much work done on the relationship between stock prices and inflation, all start from the Fisher Hypothesis and test for either or both anticipated and unanticipated inflation. All use the relatively short and inflationary time periods ranging from the fifties to the late seventies.

Van Horne and Glassmire (1972) test for inflation's effect on individual common stocks. They find that when prices, wages and other costs change in step with unexpected inflation, the change in the price of the securities depends on "whether the firm [is] a net debtor or creditor and by the tax impact of expected depreciation."(pp.1090-1091) However, they find that these factors are significantly less important than the lead or lag of adjustments in the cost of goods and services and sales revenues with respect to inflation and lead only to moderate effects.

Bruno A. Oudet (1973), stimulated by the apparent unresponsiveness of stock prices to the high-inflation of the sixties, studies portfolio returns as opposed to Van Horne and Glassmire's 1972 work on individual securities. He starts with the premise that the theory predicting a unitary correlation between nominal stock returns and inflation erroneously focuses only on the numerator of the valuation equation driving stock prices. He concludes that there is no strong evidence to suggest that investors adjusted their earnings expectations in response to inflation news. Consequently, Oudet essentially concludes that a change in the discount rate leads investors to lower stock prices in order to make room for the higher discount rate needed when increases in inflation are detected.

Bodie (1976) offers no possible explanation for why he is unable to support the Fisher Hypothesis as he looks at the inflation hedge properties of common stocks.

Though he uses a definition of hedging different from the more common form used by Branch (1974), Fama (1974) and Oudet (1973) by using securities to remove the fluctuations in the real return of default-free bonds as opposed to assuming that the real returns of securities will naturally be hedged against inflation by being independent of the rate of inflation while the nominal returns will exhibit perfect correlation with the inflation rate, he is nevertheless forced to conclude that common stocks do not hedge against inflation in the short-run.

Nelson (1976) tests the Fisher hypothesis more directly. Going one step further than previous studies by testing for both anticipated and unanticipated inflation, he finds that both variables yield negative correlations. These results force him to conclude that the Fisher Hypothesis does not appear to hold.

Donald A. Nichols (1976), discussing the papers of Bodie and Nelson, cautions that the negative results do not necessarily depart from asset pricing theories. One of Nichols' arguments (which in part motivates this thesis) is that the positive and negative adjustments to inflation may operate on entirely different time frames with positive adjustments taking much longer to catch up with initial capital losses and that, as such, the length of the periods used by those studies are likely much too short. The investment horizon of investors would then determine whether or not stocks can be considered hedged or not. If positive adjustments take effect only over relatively long horizons, then the hedge properties probably disappear for short run investors.

Subsequent research by Fama & Schwert (1977), Fama (1981), and Schwert (1981) among others further confirms the apparently anomalous negative correlation between stock returns and inflation, both expected and unexpected.

Fama & Schwert (1977) find that t-bills returns, but not common stock returns, provide a hedge against inflation. In fact, they show that stock returns are significantly negatively related to expected inflation. As for unexpected inflation, they can only state that the relationship is probably also negative.

Schwert (1981) shows that the market does react to announcements on inflation, which means about one month after the prices have been collected by the Bureau of Labor Statistics. However, though the reactions are negative, they are neither strong, nor generally statistically significant.

For his part, Fama (1981) essentially argues that the real activities of firms are likely to override any change in inflation premiums. Additionally, real activity may be expected to be under pressure when inflation rises thereby reducing expected earnings negatively affecting prices and returns.

Not everyone agrees with Fama however. Ram and Spencer (1983) object to Fama's conclusions on real activity. Their research indicates the "reverse" of Fama's results. Namely, they find that, on the whole, inflation is positively related to real activity while real activity is negatively associated with stock returns. The end result of which is to keep the question about inflation wide open.

International studies for the most part also observe negative correlations. Cohn and Lessard (1981) are forced to reach the same conclusions as American studies with one exception. Over the 1970-79 period studied, Canada shows a positive, though not statistically significant, correlation between stock prices, earnings and dividend yields and inflation. Gultekin (1983) studying the period from 1959 to 1979 finds a negative beta for Canada as well as for most of the other countries he surveys. His results, however, are not statistically significant at the 5% level.

The impact of many other economic variables is also studied. Nominal contracting and historical-value-based accounting, for example, are found not to significantly affect stock valuations. French, Ruback & Schwert (1983) examine "the effects of unexpected inflation on the returns to the common stock of companies with different short-term monetary positions, different long-term monetary positions, and different amount of tax shields", come to the conclusion that these effects are negligible factors after all (p.70). Since they used a large portfolio to test for these effects, it is safe to assume that the same would apply for the index used in this study.

Finally, by the mid-eighties the possibility that there truly is no systematic relationship between inflation and stock prices is raised by French, Ruback & Schwert who go so far as suggesting that it may be "inappropriate to attribute a causal relationship between inflation and the behavior of stock prices"(p.94), by claiming that Fama's (1981) conclusion about real activity may be the most accurate.

Recent Studies (mid-1980s to 1990s)

Recent work on the Fisher hypothesis has restricted itself mostly to interest rates. Statistical developments involving non-stationary series lead Rose (1988) to consider the previous work on the Fisher Hypothesis misspecified, thus leading to spurious results. His results demonstrate the US interest rate series to be integrated of order one and as such to be non-stationary while the US inflation series has no unit root and is stationary.

Mishkin (1992) disputes Rose's (1998) claims on stationarity for the inflation rate series but finds support for a stationary real interest rate in the US leading him, based on cointegration, to finally conclude that while there isn't any empirical support for a short-run Fisher effect, a long-run effect is present.

Evans and Lewis (1995) add the possibility of shifts in the inflation series. While these results display correlations lower than expected from theory they nevertheless find that they cannot reject the null hypothesis of the Fisher effect.

Crowder and Hoffman (1996) start from the premise that interest rate and inflation series are non-stationary sharing a common stochastic trend. Their results find interest rates and inflation to be cointegrated and support a traditional "tax-adjusted" Fisher hypothesis. They further argue that the non-stationarity of interest rates and inflation series stems from an accumulation of permanent random-walk innovations to the inflation rate.

Kandel, Ofer and Sarig (1996) remove the premise that the real rate of interest is fixed and find a negative correlation between the real rate of interest and expected inflation. Additionally, they find that "nominal rates of interest include an inflation risk premium that is positively related to a proxy for inflation uncertainty." (p.222) The presence of correlation between a real return and the rate of inflation contradicts the Fisher Hypothesis.

Beyond the issues of proper statistical specifications, another controversy affecting the Fisher hypothesis surfaces in the mid-1980s – the inverted Fisher hypothesis. Carmichael and Stebbing (1983) first propose the concept that it is the real rate of return which correlates with inflation instead of the nominal rate of return, when their empirical results suggest that inflation is not "reflected" in after-tax nominal interest rates. Gallagher (1986) concludes it is too "stringent" to argue that the nominal rate remains fixed while the real rate moves in line with inflation. His results show that while it is possible to conclude that the after-tax nominal rate of interest is not contemporaneously correlated with inflation, it is impossible to conclude that they are not intertemporally correlated, leaving the door open for the presence of a long-run relationship.

Fred C. Graham (1988) argues that the methodology used by Carmichael and Stebbing (1983) is flawed. After re-specifying the problem his results reject the inverted Fisher hypothesis, though they also reject the Fisher hypothesis. He is however unable to reject a partial Fisher Effect.

Empirical results on the presence of an inverted Fisher effect continue to differ. Gupta (1991) finds it holds for the period 1968 to 1985. Thies and Crawford (1997) for their part not only reject the inverted Fisher Hypothesis, they find support for the original Fisher hypothesis.

Studies using Canadian data have for the most part been more favourable to the Fisher hypothesis though not universally so. Viren (1987) with data covering from 1960 to 1982 concludes that the long-run the Fisher hypothesis cannot be rejected though the results are "somewhat conflicting" (p.55).

MacDonald and Murphy (1989) also get mixed results. They show evidence of cointegration between the inflation and the nominal interest rate, but their results are nevertheless too weak to draw any significant conclusion about the presence of any long-run relationship as their results vary greatly depending on the time period observed.

Strauss and Terell (1995) suggest that the "failure of cointegration tests to find a stationary combination of interest rates and inflation does not imply the absence of a long-run equilibrium relationship", but rather may simply point to the need for a "richer model specification." (p.1047) Using quarterly data from 1973 to 1989, they find support for the Fisher hypothesis in Canada.

Grenier (1993) finds evidence for an inverted Fisher relationship in Canada. Implicit in his results is an estimate of the Fisher hypothesis which is lower than predicted by theory.

Dutt and Gosh (1995), like MacDonald and Murphy (1989) assume a fixed real interest rate using quarterly data from 1960 to 1993, making a distinction between fixed and floating exchange rate regimes in the second quarter of 1973. Their empirical results reject the Fisher hypothesis.

The latest study on Canadian data (Crowder, 1997) "supports the tax-adjusted Fisher hypothesis" though the relationship over the three decades of 1960s, 70s and 80s was not "entirely stable." (pp.1126 & 1139) They further argue that the presence of income tax should amplify the effect of inflation on interest rates leading to a Fisher effect of anywhere from 1.52 to 1.95 in Canada.

A recent study of the Fisher hypothesis (Matsumoto, Andoh and Hoban, Jr., 1994) using rates of return on art objects finds partial support for the hypothesis. The relationship is less than one-to-one but is nevertheless positive. They also find that unanticipated inflation tends to correlate negatively with the rates of return.

Except for one study, none use data series exceeding much more than twenty-five years. Mozzami and Gupta (1995) present the only truly long-run study. They use annual data from 1915 to 1989. Their results show support for the Fisher Hypothesis in six industrialised countries including Canada. They also find support for the neutrality of money.

The Hypotheses

The remainder of this section presents the theoretical picture starting with the two main hypotheses of this thesis. Despite the more recent and more sophisticated empirical tests of the 1990s, the end results of empirical tests on the Fisher hypothesis today remain inconclusive. The new very long-run and relatively high frequency data series used here allows another perspective on the Fisher hypothesis. The problems of non-stationarity experienced with interest rates do not apply when dealing with securities returns since they test stationary. Hence, OLS estimates are used.

The main hypothesis of this thesis is that the traditional Fisher hypothesis will hold over the long-run and that, as believed by monetarists, money will be neutral in the long-run. It is furthermore hypothesised that one-way Granger-causality from inflation to stock-returns will also hold. Inflation must affect nominal stock price returns, but the reverse should not hold.

The model as applied here rests on three primary assumptions. First, rational expectations describes the behaviour of investors. Perfect foresight is not expected, but non-systematic errors are. Second, the real rate of interest is expected to remain constant. Thirdly, money is assumed to be neutral in the long-run.

The hypothesised relationship between stock price returns and inflation is similar to that between interest rates and inflation. Fisher (1930) hypothesised that the nominal rate of interest consists of a real return plus an inflation premium in the case of the short-term risk free rate. The only difference between the two comes mainly from the amount of risk the holder is expected to bear.

Gibson Paradox

One major empirical problem with the Fisher Hypothesis surfaced from day one. The interest rate and the price index in its level have demonstrated a stronger and anomalous empirical relationship with each other than the interest rate has with inflation – the Gibson Paradox. The existence of this paradox undermines the very foundations of the Fisher Hypothesis. To complement the results of the tests on the Fisher hypothesis for stock price returns, a review of the Gibson Paradox is also pursued using both a long-term interest rate series and the stock price and return series.

The empirical existence of the Gibson Paradox has seriously challenged Fisher's theory. Fisher (1930) himself attempted to explain the process by arguing that expected inflation was really a moving average process. However, he had to incorporate far too many lags of past values to explain away the Paradox. He ended up effectively using the price level itself (Siegel and Shiller, 1977).

Benjamin and Kochin (1984) for their part argue that the relationship between the nominal interest rate and the price level as observed is in fact a spurious one and therefore not indicative of any actual processes. Neither the price level series nor the interest rate series can pass the test rejecting the presence of Unit Roots. It is then likely that any observed relationship between these two series may be caused more by the weaknesses inherent in least squares regressions than by any real phenomenon. Corbae and Ouliaris (1989) fail to find any cointegration between the interest rate and the price level.

According to Barsky and Summers (1988) the paradox is merely apparent in the sense that it is caused by the constraining effect of a Gold Standard on the money supply and, therefore, indirectly on prices. Remove the gold standard and the relationship in the levels disappears. However, Dowd and Sampson (1993) and Sumner (1993) both find Barsky and Summers' model to be misspecified. Yet, neither of these two studies dispute the existence of the Paradox.

Milne and Torous (1984) have shown the existence of the Gibson Paradox in Canada. Their results, though based on obscure statistical methods, are doubly believable since they take the trouble of filtering the raw Canadian data for external influences first from Britain and then from the United States. Their results allow the tests performed in this thesis to proceed without fear of measuring a process driven by external forces.

Finally, the Gibson paradox can exist only as long as the rate of change for both series is either simultaneously positive or simultaneously negative. From the 1980s on this has not been the case. Interest rates in the West reached historical highs. When they descended back to more reasonable levels, the price level did not follow suit by dropping into deflation, it merely slowed downed to lower rates of inflation.

It is hoped that tests on long-run monthly data, as performed here, should have a better chance of testing for the presence of the Paradox in the 20th century. In fact, it is hypothesised that the Gibson Paradox will not be shown to hold for the whole of the century. It is also hypothesised that the paradox will hold similarly for the prices of common stocks.

January Effect or Turn-of-the-Year Anomaly

The January effect or turn-of-the-year anomaly, an apparently systematic yet anomalous phenomenon whereby abnormally high returns are earned in January, also undermines the tests and main hypothesis of this thesis regarding inflation and stock price returns. Market efficiency alone should preclude the existence of such anomalous behaviour.

Richard H. Thaler (1987) summarises the research on the January Effect. The picture he paints shows the anomaly to be a small firm phenomenon with a quarter of the excess returns being earned in the first five days of January. Tax-loss selling has been proposed as a possible explanation but international evidence suggests that it cannot explain all of the anomaly since many countries without capital gain taxes or with fiscal year-ends different from January also experience a January effect. However, since no studies measure to what extent American investment in foreign countries could be sufficient to generate a January Effect in their stock markets, taxes may still be playing a significant role. Regardless, such an explanation would also be an affront the efficient market hypothesis and arbitrage processes.

Berges, McConnell and Schlarbaum (1984) report that a January effect is present in Canada between the years 1951 and 1980. Moreover, given that Canada only introduced a capital gains tax in 1973, the effect of taxes appears irrelevant unless foreign investors were responsible for the tax-loss effect before 1973. Unlike in the United States, they find that the anomaly is not restricted to small firms, though small firms show greater sensitivity to the anomaly. Another Canadian study (Tinic, Barone-Adesi and West, 1987) supports the view that tax-loss selling, while intuitively appealing, does not add up.

More recently, Jones, Lee and Apenbrink (1991), using US stock prices going back to 1899, find that the high significance of the observable turn-of-the-year effect follows the introduction of significant incomes taxes following the War Revenue Act of 1917. Sias and Starks (1997) using data covering from 1978 to 1992 also find support for the tax-loss selling hypothesis for individual investors. Their results show that the first four days of January represent the highest returns. Johnston and Cox (1996) also find evidence to support tax-loss selling. The tax-loss selling argument however is not upheld by Raj and Thurston (1994) studying the New Zealand stock market. In this case, the fact that the New Zealand market is highly skewed by a few high capitalization stocks and relatively low trading volumes may weaken the conclusions.

Johnston and Cox (1996), whose argument hinges on the rebalancing activities of institutional funds, find that significant portfolio rebalancing exists in the US. Athanassakos and Schnabel (1994) also argue that portfolio rebalancing on the part of the professional fund managers is responsible for the January effect by inducing a bidding up of stock prices.

On the other hand, James A. Ligon (1997) finds no evidence of window dressing from professional managers. Also, Eakins and Sewell (1994) find no evidence of rebalancing from small capitalization stocks to large ones. Their results point to a third quarter anomaly which they are unable to explain. Finally, Chatterjee and Maniam (1997) find a January effect linked to small-capitalization securities for the period from 1978 to 1992.

This paper repeats a test of the hypothesis that all monthly returns are equal to one another and hence there should not be any January effect. The full century of data makes it possible to see whether the effect has been around since the beginning of the century and whether it has continued up to the end of the century by which point one would expect that with all the attention brought to it in the eighties, arbitrage should have made it disappear.

II. Data and Its Descriptive Statistics

The absence of a stock index for Canadian Common Stocks for the years 1900 to 1915 matched with a desire to put the relationship between inflation and stock prices to an overdue long-run test provides the initial impetus for this study. Indeed, no Canadian stock index could be found that covered the beginning of the 20th century on either a yearly or monthly basis.

The first step therefore consists in compiling a monthly Canadian stock index for the first fifteen years of the 20th century. This index is then combined with two other existing historical indexes to generate a single Canadian index spanning the full century.

Canadian monthly wholesale price and long-term interest rate data that span the entire century were discovered from both Statistics Canada and its predecessor, the Dominion Bureau of Statistics. However, because in all cases no single original series span the full century and splicing is required to obtain full century series, a more detailed description of the data follows. Basic univariate descriptive statistical analyses of each of the series used in testing the hypotheses of this study are presented in this section to provide a quick glance at the series' properties. The autoregressive properties of the series, namely whether the series are stationary or not, is also presented.

Each data sub-section covers the perceived limitations of the data for the purposes of this study. Yet, since all series are monthly and cover at least a full century, it is assumed that there is room to manoeuvre without perilously sacrificing degrees of freedom at any step.

Monthly Canadian Stock-Price Index (1899 to 2000)

Composition

Compiling a full century of monthly Canadian stock price returns into a single index involves a number of compromises which should be clearly understood. These compromises stem first from a need to rely on a consistent, if imperfect, source of prices and the difficulty of cost effectively accessing historical stock price data for the beginning of the 20th century.

To generate ultimately a single combined stock-price index, three indexes are spliced together. For the Period 1956 to 2000 the TSE 300 Stock-Price Index is used. For the period from 1915 to 1956, the stock price index compiled by the Dominion Bureau of Statistics is used. Finally, to cover the first fourteen years of the century a capital weighted index is compiled "in-house."

The Index from the Dominion Bureau of Statistics tracks only stock prices and does not include dividends. Additionally, compiling an index "in-house" to produce a total return index covering from 1900 to 1956 (the first year of data for the TSE300) would have been too time consuming and costly. Hence it has been necessary to restrict the TSE index to stock price data to maintain as much continuity as possible.

Complicating matters is the practice followed by most corporations of issuing their dividends on the same months as each other. This leads to a particular seasonality in the data which would not have been experienced by investors holding the securities. Stock prices fall on the ex-dividend date. This regular drop shows up clearly in the series though an investor would obviously not have experienced a concurrent drop in wealth.

Nevertheless, the TSE has shown that both its Total Return and Total Price return behave otherwise very similarly. Moreover, as long as dividend policy is not directly affected by changes in inflation, their omission should not affect the results obtained here.

Over the 20th century, the Canadian stock market increased in both real market value and number of securities traded. The number of securities in the two available indexes also increased over time. The index from the Dominion Bureau only included fifty-six securities but the main Toronto Stock Exchange index includes three-hundred securities. For the portion compiled "in-house", thirty securities are used. This number was chosen before compiling the index. While it was arbitrarily chosen, the fact that the Dow Jones uses thirty played a great part in the decision, including the fact it represented a tenth the number of securities of the TSE 300. Fortunately, the number of traded securities with any liquidity at the beginning of the century allows the index to be compiled with 30 securities.

Possibly the greatest weakness of the final index comes from the first fifteen years compiled "in-house". Tracing the last trades for each month for each security would have proved too expensive. Trading was not sufficiently liquid for all, or even most, securities to have traded on the last couple of business days of each month. Consequently, as a compromise, monthly High/Low prices as published in the Annual Financial Review are used. Their average for each month is used as the monthly closing price.

The same capital-weighted formula used by the TSE 300 is used to compile the "in-house" index. The 30 stocks with the largest capital weights are selected at the beginning of every year. The capitalization information is gathered for all corporations trading on the Montreal Stock Exchange from the annual reports published in the Annual Financial Review.

With one exception, prices from the Montreal market make up the index from 1899 to 1914. One of the bank stocks traded heavily in Toronto, but only lightly in Montreal and to minimise distortions the Toronto prices were used. The Dominion Index includes prices from both Montreal and Toronto. The TSE 300 includes only prices from the Toronto Stock Exchange. The fact that arbitrage would relatively quickly have made any difference in price from either market disappear, even at the beginning of the 20th century, suggests that this limitation should not present any significant bias.

However, the use of the average of the highs and lows as opposed to the last trade may have muffled the actual volatility of stock prices. Also, when there has not been any trade for a given month, the price data from the previous month with a trade is used.

With two exceptions, the TSE 300 formula is used to compile the "in-house" index. First, the base year of 1899 is calculated using only end of year prices for 1899 instead of for the whole year. Secondly, capitalization is based on total outstanding common stock. It is impossible to remove any "controlling" interest from the numbers.

A few additional notes regarding the index from 1899 to 1914 need to be mentioned. All securities, but one, were traded in Canadian dollars. The Bank of British North America traded in Pounds. Given that historical foreign exchange rates are difficult to come by, a single rate is used for the entire fifteen years. Any distortion introduced by this shortcoming should nevertheless be insignificant.

A few additional idiosyncrasies are unavoidable. For the Canadian General Electric security the Toronto prices up to and including 1911 are used with Montreal prices used from 1912 on. The Sovereign Bank securities were discontinued in 1907 even though the official liquidation was initiated in January 1908. The merger of Montreal Gas and Royal Electric into the Montreal Light and Power in May of 1901 gave 250$ par shares for each 100$ par owned in either of the previous two companies. However, the Montreal Gas shares had a par value listed of 40$ yet the shares finished trading at 250$ as though each share had been treated as a 100$ par share given the number of shares outstanding. At this point, the assumption is made that each Montreal Gas share was treated as being worth 100$ par. Nothing in the price history suggests that the number of shares changed. More puzzling is the fact that the number of Montreal L&P shares did not match the shares exchange ratios. Therefore, it was necessary to set the number of shares in MTL L&P at the time of merger to yield the same market capitalization as the combined market capitalization of the two companies for which shares were exchanged. This number of shares is revised downward at the next yearly review and is set to have no effect on the base calculations. The merger of the Dominion Coal and Dominion Iron & Steel into the Dominion Steel Corp. involved a 1:1 share exchange of all 100$ par plus a 4$ cash payment. This payment was announced Dec 31, 1910. As such, the cash payment was already factored into the price of the shares. Especially since Dom. Steel Corp. treated the cash payment as a dividend. Therefore, the last six months of Dom. Iron & Steel and Dom. Coal for 1910 use the price of the Dom. Steel corp. shares plus $4 (which was the cash payment made by the new corp.) The merger of the Montreal Street Railway into the Montreal Tramways involved a 5:1 share exchange plus cash and debt payments. The offer was made on October 11, 1911. By Dec 31st 1911, the share prices were equal based on a 5:1 exchange. For purposes of the index the Montreal Street

Railway stops existing at the end of 1911. By then, Montreal Tramways' capitalization was no longer sufficient to keep it in the index, removing the need to adjust the index's base and QMV.

Lastly, the full index was started at 100 at the end of 1899 and spliced together based on the ratio of the last month and first month of each of the respective indexes. The percentage change in the price level of the index is thus unaffected, only the nominal level of the index is.

Descriptive Statistics

The resulting combined stock price return index series has 1200 observations (not including the opening value of December 1899 set at 100). To make it possible to simply add the returns yielded by tests producing average returns as well as consistency throughout the tests, the natural log of the return series plus one are used. In the level, the natural log of the price index value is used.

Over the 20th Century, the index yielded an average monthly return of 0.004859 for a yearly non-compounded average of 5.83% without dividends. The monthly standard deviation was 0.04267. A few other basic descriptive statistics for the returns and the price level series follow.

Stock Index Returns – $\ln(p_t/p_{t-1})$

From inspection, Chart 1[1] suggests that the use of high and low prices for the period ranging from 1900 to 1914 has not introduced a discernible bias in volatility since

[1] See the appendix at the end of the thesis for all charts and tables.

the period from 1915 to 1929 appears indistinguishable from the period from 1900 to 1914. The Unit Root Test in Table 2a shows the return series can be considered stationary behaving like white noise. A caution is raised by the Q-statistics from the correlogram in Table 1a which do not support stationarity and indirectly agree with Ding, Granger and Engle (1993) who argue that the observed stationarity in stock returns is misleading. They demonstrate that while U.S. stock returns do not display significant serial correlation, their absolute value does display significant serial correlation. However, if stock returns were generated by an i.i.d. process, as is presumed in this case, a transformation of these returns should also be i.i.d. The correlogram in Table 1b clearly shows the presence of autocorrelation in the Canadian absolute returns, though the transformed series still fails to test positive for the presence of a unit root (Table 2b).

Chart 2 shows that the index return series doesn't pass formal tests of normality. From inspection however, it doesn't depart from normality sufficiently wildly to discard the use of the assumption of normality.

Stock Index Price Level – ln(p_t)

As should be expected at the price level the index is not stationary and is definitely not normally distributed as is clearly indicated by Chart 3 and Chart 4. Table 3 shows the high degree of autocorrelation present in the series. Similarly, in Table 4 the presence of a unit root cannot be rejected.

Monthly Wholesale Price Index (1895 to 2000)

The choice of a proxy for inflation presents many difficulties. While it should represent a uniform change in the monetary prices of all goods and services in a given economy, prices do not vary uniformly. Moreover, different economic entities are affected differently by different prices. Given that industrial prices represent the largest proportion of transactions engaged by common stock issuing publicly held corporations, the Wholesale Price Index is probably more representative than the Consumer Price Index. Our forebears may have thought so too for the only source of monthly data available going back to the late 1890s is a Wholesale Price Index computed by the Dominion Bureau of Statistics. Statistics Canada publishes the descendent of this index which is currently known as the Industrial Production Price Index. Consequently, the Old WPI is spliced with the current IPPI to yield the monthly price index from which monthly inflation rates are calculated.

Composition

Two indexes are spliced together to yield a single Wholesale Price Index. The Dominion Bureau of Statistics kept a monthly Wholesale Price Index from 1890 to 1962. Statistics Canada has an Equivalent Series named Industrial Production Price Index starting in 1956 and going to 2000.

The Wholesale Price Index is used and preferred for two reasons. First, it is more likely to represent the prices affecting businesses than the consumer price index. Second, it is the only price index available going back far enough for the purposes of this thesis.

Over time the construction and name of the Wholesale Price Index has changed. The closest index to the original Wholesale Price Index today is the Industrial Product Price Index published by Statistics Canada. Consequently, while the old and new indexes are not directly comparable, together they should nevertheless paint a reasonably continuous picture. However, the fact that the IPPI includes many more prices than the old WPI did, suggests the possibility that a diversification effect may be involved which would change the volatility of the series. Nevertheless, for the period covered by the two indexes during which they overlap (i.e. 1956 to 1962), they track each other almost perfectly suggesting that continuity is not a problem after all[2].

There are some further considerations to keep in mind. First, the inflation series is not adjusted for seasonality. Second, to make it possible to calculate lags on the price level to yield anticipated and unanticipated inflation, the price index is traced back to 1895.

Third, the ex-post inflation is published about a month after its measurement. Consequently, the market does not likely know in real-time how the official inflation is acting. Except perhaps in the case of wealthy investors who can, in principal, gauge inflation on a real-time basis. The immediate consequences of this phenomenon leads to at least two, non-exclusive, possibilities. First, investors will likely develop a belief about expected inflation. This belief will undeniably depart from the realised ex-post inflation which implies the presence of unexpected inflation. Secondly, it is reasonable to believe that investors will somehow attempt to filter out the noise from the series and come up

[2] Note however that, by inspection alone, the volatility of the series before the splice point is nevertheless greater than that after the splice point. It is ultimately impossible to say whether this difference is due to a structural shift in the economy or simply to a difference inherent in the different make-up of the two initial series.

with a "smoothed" expected rate of inflation. Unexpected inflation must also suffer from noise and this noise can indeed be expected to be much more significant on the margin where unexpected inflation must inevitably be measured. Based on rational expectations investors are not expected to make systematic forecasting errors. Therefore, unexpected inflation must by definition have an expected value of zero and behave as a white noise series. These last deductions are used in creating anticipated and unanticipated inflation series. In other words, the expected and unexpected inflation can only be proxied by the inflation series itself. In this thesis, three methodologies are used to produce three separate sets of anticipated and unanticipated inflation series used in testing the Fisher Hypothesis. The generation of these is discussed in more detail below.

Finally, it must be noted that because it is impossible to obtain unrevised figures for the wholesale price index, contemporaneous matching of the inflation and return series might yet offer the most consistent results. Besides, Schwert (1981) found that there was considerable leaking for the 15 days previous to the announcement of inflation figures when there was any reaction at all.

Generating the Anticipated and Unanticipated Inflation Series

Expected (or anticipated) and unexpected (or unanticipated) inflation series are "extracted" from the inflation series because theory suggests that investors are likely to differentiate between the two. Although Fama (1975) has shown that short-term t-bill rates can provide a good estimator of inflation, such data is not available here. Consequently, the only fall back is some kind of distributed lag of past inflation values in an attempt to simulate the "smoothing" and forecasting process of investors.

The risk of subjectivity in generating the anticipated and unanticipated inflation series given the aggregate nature of the primary data available for this study is minimised; first, by using the Akaike and Schwarz information criteria to help determine the length of the look-back period (i.e. number of lags); secondly, by employing three methodologies producing three separate pairs of series; thirdly, by subjecting each anticipated and unanticipated inflation series resulting from each of these three methods to the same set of regressions.

The Akaike and Schwarz criteria for the inflation series in Table 5a suggest that 5 months lags provide the most information about future inflation values. Similarly, French, Ruback & Schwert (1983, p.73 note 5) have found that an AR(3) on quarterly data led to the best fit for the 1947-79 period for inflation suggesting that six to twelve months would be appropriate. We have used several alternative lag structures ranging from 6 to 12 months in the analyses. The results are robust to alternative specifications.

We employ two methodologies to extract an anticipated and an unanticipated inflation series from the inflation series. The first method is based on the following ARMA(5,6) model:

1) $$\ln(1+I)_t = \sum_{p=1}^{5} \rho_p \ \ln(1+I)_{t-p} + \varepsilon_t + \sum_{q=1}^{6} \theta_q \varepsilon_{t-q}$$

Where I = Monthly Inflation
ρ = AR term coefficients
θ = MA term coefficients
ε = residulas

where the fitted value represent the expected inflation and the residuals represent the unexpected inflation. The appropriate ARMA terms to use are determined using the Akaike and Schwarz information criteria. The ARMA parameters which yielded the lowest Akaike (-5.993536) and Schwarz (-5.942907) factors are (5,6). These numbers agree with other Akaike and Schwarz results obtained earlier. Moreover, 6 months makes intuitive sense for the inflation memory of participants.

The second method, which is calculated once with a six-month lag period and once using a 12 month lag period, involves a straight line forecast one month ahead. Since an average can only represent ex-post inflation, while we are seeking a proxy for expected inflation given that investors must be forecasting inflation, a one month trend line forecast on the past six or twelve months stands in as a proxy for anticipated inflation. Unanticipated inflation is then calculated as the difference between the forecasted value and the realised inflation for the forecasted month.

The ARMA series, not surprisingly, yields the best results based on lower expected value for the unanticipated inflation and minimum variance. Only with the expected value of anticipated inflation does it depart the most from the overall inflation average. The series yielded by the six months trend-line forecasting method produces an unanticipated inflation series with an average which is closer to an expected value of zero than the twelve months series, but with a higher standard deviation (see Tables 5b and 5c).

Descriptive Statistics

For the 20th Century as a whole, inflation was 0.002607 per month on average for a non-compounded 3.13% per annum and a monthly standard deviation of 1.24%. Similarly to the index return series, Chart 6 suggests that the inflation series while not strictly normal does nevertheless maintain a bell shape curve and as such the assumption of normality is retained.

The natural log of (1 + undifferentiated inflation) is used in the case of the inflation series to make it possible to compare directly with the natural log of (1 + Stock Index Returns) The average monthly inflation is then .02530 with a standard deviation of 1.31%. In the case of the price level the natural logarithm of the price index is used.

Inflation – $\ln(I_t/I_{t-1})$

As can be seen from the unit root test (Table 7), the inflation series can be considered stationary. Similarly to the index return series, the Q-Statistics (Table 6) for the inflation series do not formally support the claim of stationarity, yet by inspection the corrolelogram nevertheless shows rapidly decreasing autocorrelation. It is therefore appropriate to calculate a proxy for expected inflation with an ARMA process.

Chart 5 seems to suggest that volatility changed over time. However, it is impossible to know whether this apparent reduction in volatility is due to a systemic change in the economy or to a diversification effect due to the greater number of prices tracked by the latter portfolio of the IPPI.

Price Level – $\ln(I_t)$

Similarly to the stock price index, the wholesale price index is not stationary (see Table 9). Chart 7 clearly displays a growing series while Chart 8 displays a distinctly non-normal series. Not surprisingly, as shown by Table 8, the series displays strong levels of autocorrelation and the unit root test fails to reject the presence of a unit root when tested (see table 9).

Monthly Long-Term Bond Yield Series (1900 to 2000)

Composition

The third index used in this study is an index of return levels for long-term government bonds. For this series, compromises are also required to yield a continuous series spanning the full century as two distinct series tracking different bonds with different frequencies are used.

For the years 1900 to 1919 a Quarterly Ontario Government Long-Term Bond Yield Index is used to generate a monthly series that is then spliced with a Monthly Canadian Government Long-term Bond Yield Series. The fact that the two series overlap for over 16 years and track each other almost perfectly over those years shows them to be sufficiently compatible. They also track on a monthly basis for the years 1925 to 1935. Consequently, no harm is seen in splicing the two together. In both cases, long-term is defined as bonds with a maturity of 10 years or more.[3]

Descriptive Statistics

The natural log of (B_t/B_{t-1}) is used as the proxy for the bond return series for consistency. The characteristics of this series are quite different from those of the previous two series.

Bond Yields

The series does not qualify as stationary, yet neither can it qualify as a random walk since its upper and lower values are constrained (see Chart 9 and Table 11). Moreover, it is definitely not normally distributed (see Chart 10) and displays strong autocorrelation (see Table 10).

Of note is the fact that the interest rates are from bonds with ten years or more of maturation, hence risk premia over and above inflation are also involved though the magnitude or fluctuation of these premia cannot be corrected for.

First Difference of Bond Yields – $r_{b,t}-r_{b,t-1}$

The series is fairly stable up to the last twenty years of the century at which point volatility appears to increase significantly. The first difference rejects the hypothesis of a unit root (see Table 13). Nevertheless, as in all the other series, the test for autocorrelation fails to reject the presence of autocorrelation (see Table 12). However, as with the autocorrelation and partial correlation graphs of all series which reject the hypothesis of the unit root, the autocorrelation and partial correlation appear to be

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[3] The Canadian Bond series published by the Bank of Canada is itself a spliced series and reflects a discontinuity on December 1936 as the composition of the series changes.

negligible, or at least relatively so. Consequently, the first difference is considered stationary and approximately normally distributed (see Chart 12).

III. Methodology

The Fisher Hypothesis calls only for a linear relationship between nominal stock returns and inflation. The Gibson Paradox involves a relationship between interest rates and the wholesale price index. The January Effect involves an above average market return for the month of January when all monthly returns should be statistically equivalent. Given that most of the series involved are stationary, or that previous studies assumed linear relationships, the tests utilized here all use Ordinary Least Square regressions. Each of the three main hypothesis under study are grouped into individual sections. In the first section we provide regressions testing the two hypotheses about stock-price returns and inflation – Fisher hypothesis and one-way causality. Since it is necessary to look at the century both as a whole and as sub-periods as well as to look beyond overall inflation to differentiate between anticipated and unanticipated inflation. a battery of regressions are performed to test the null hypothesis that the beta coefficient equals one on both the undifferentiated inflation series as well as its anticipated and unanticipated components. To avoid arbitrariness or data mining effects in the selection of sub-periods, the century is divided in two fifty year sub-periods and four twenty-five year sub-periods. The subsequent two sections test, respectively, for the existence of the Gibson Paradox and the January Effect anomalies.

A final preparatory step prior to conducting the empirical analyses involves testing for the appropriate lag structures to be used in the tests.

Stock Price Index Returns and Inflation: The Regressions

The potential contribution of lagged values of the inflation index series when added to the basic contemporaneous regression model used to test the Fisher hypothesis has to be determined first in order to adequately set-up the battery of subsequent regression tests. Accordingly, the first regressions performed on the data are a series of contemporaneous regressions are run with various multiple lag structures and the Akaike and Schwarz information criteria tests are performed for each. The results from these initial regressions make it possible to reach initial conclusions on the lag structure from which the subsequent regressions of the hypothesis tests are to be performed.

The goals in this initial step are to confirm if, as expected, it is reasonable to contemporaneously match the series based on rational expectations theory and to verify how much information past months of inflation contribute to regressions, because there is likely to be a certain amount of autocorrelation in the inflation returns going back a few months. The Akaike and Schwarz information criteria are used to determine the best number of lags. In all cases the natural log of one plus the return of the series is used. Ordinary Least Square regressions are used in all the tests given that the stock returns series and inflation series are stationary and approximately normally distributed.[4]

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[4] In a perfect world ex-post Stock Price Index Returns and Inflation would correlate contemporaneously. While reality departs from perfection, contemporaneous matching of the series is nevertheless used throughout this thesis for many reasons. First, there is the presumed existence of wealthy investors capable of gauging inflation before the release of the official statistical figure. Second, there's rational expectations which states that investors will not make systematic forecasting errors and hence leads to an expected value of zero for investors' forecasting errors. The fact that the results from the first battery of tests on the lag structure show a better fit from contemporaneous regressions suggests that the theory of rational expectations can be applied (see Table 14). Obviously, these assumptions imply that either perfect foresight is expected from investors, on average, or that investors do not make systematic forecasting errors. Third there's the fact that the release dates of information at the beginning of the century are not available making it safer to work contemporaneously than to match series based on presumed release dates. Moreover, the series were most likely revised and corrected after their initial publishing, but the originally

The Fisher Hypothesis, which states that stock price returns should follow a nominal one-to-one relationship with inflation implying that a regression of the two series should produce a beta coefficient of one, makes up the bulk of the tests. With the lag structure determined (see Table 14), which in this case is either zero or one lag, the regressions between stock returns and inflation used to test for the hypothesised relationships are broken-down into three groups. First, contemporaneous regressions between inflation and stock market returns are performed over the full century as well as over fifty and twenty-five year sub-periods using equation 2.

2) $$\ln(1+MR)_t = \alpha + \beta \ln(1+I)_t + \varepsilon_t$$

Where MR = Monthly Stock Market Index Return
I = Monthly Inflation
α = Constant
β = Coefficients of regression
ε = residuals

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published figures are unavailable. Also, although the inflation series display very little autocorrelation, the first lag autocorrelation is nevertheless not zero suggesting the presence of at least some information seepage in the past, further blurring the difference between the impact of the first lagged inflation figure over the contemporaneous. Finally, while some previous studies (e.g. Schwert 1981) tested for the reaction of the stock market to the release of inflation news, they showed only weak interaction spread over 15 days around the release date. Moreover, at the beginning of the century the markets are likely to have been still less efficient.

At any rate, a lagged test is performed to compare the contemporaneous tests with a one lag difference involved in a model which would assume that investors react solely on publication of the official figures and attempt no forecasting of these figures. The results section will only show the regression performed with lag 1 upon the full century. It is worth noting that a regression involving lags 1 and 2, which is not shown, yields for the full century a highly insignificant beta for the second lag whereas as can be seen in Table 14 the beta of the first lag in the contemporaneous regression for the full century is only significant at the 10% level (p=0.0895). Given this result, the logic just described is assumed to hold and all tests are accordingly performed contemporaneously.

Second, the same regressions are repeated with the first lag also included as suggested by the Akaike information criterion obtained during the very first set of regressions on the full century (equation 3)[5].

3) $$\ln(1+MR)_t = \alpha + \beta_0 \ln(1+I)_t + \beta_1 \ln(1+I)_{t-1} + \varepsilon_t$$

Where MR = Monthly Stock Market Index Return
I = Monthly Inflation
α = Constant
β = Coefficients of regression
ε = residuals

Third, contemporaneous regressions using the three distinct pairs of anticipated and unanticipated inflation series are performed on the full century and sub-periods of fifty and twenty-five years (equation 4).

4) $$\ln(1+MR)_t = \alpha + \beta_1 \ln(1+AI)_t + \beta_2 \ln(1+UI)_t + \varepsilon_t$$

Where MR = Monthly Stock Market Index Return
AI = Monthly Anticipated Inflation
UI = Monthly Unanticipated Inflation
α = Constant
β = Coefficients of regression
ε = residuals

using an ARMA(5,6) series (see table 17)
using a 6 months Trend-line forecasted series. (see table 18)
using a 12 months Trend-line forecasted series. (see table 19)

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[5] The Schwarz criterion differs from the Akaike and supports the contemporaneous regressions without any additional lags.

Granger-causality tests probing the expected presence of a one-way Granger-causality relationship between inflation and stock price returns are performed next. The Akaike and Scharwz criteria are used to determine, in each case, the optimal number of lags to include in the individual tests. Granger-causality is tested in both directions for the full century and each of the six sub-periods.

Lastly, cointegration tests are performed on the contemporaneous inflation and stock returns series as an additional measure of the theory to identify the presence of a systematic relationship. Dickey-Fuller and Philips-Perron statistics are calculated from the residuals of the regressions between inflation and stock price returns for the full century and each of the six sub-periods. For these tests, at the 1% level of significance, the critical value is approximately –3.42 for the Dickey-Fuller tests. The series can be considered cointegrated if the DF test statistic is more negative than the critical value. With the R-squares of the previous regressions likely quite low and with the series and residuals unlikely to pass strict tests of normality, cointegration tests should help to identify the presence of a non-spurious relationship between stock-price returns and inflation.

Gibson Paradox

The presence of the empirical anomalous relationship between the interest rate in its level and the wholesale price index, known as the Gibson Paradox, along with the possible existence of a similar paradox involving the wholesale price index and stock market returns in Canadian data, are tested with a series of Ordinary Least Square regressions. Given the expectation that the Gibson Paradox will be present in the data, three periods are scrutinized from the full century, to the first eighty years and finally the last twenty years of the twentieth century. Because some of the data is non-stationary, cointegration tests are also performed to allay the danger of observing spurious relationships with ordinary least square regressions. The regressions are applied contemporaneously on the natural log of either the level or (1+return), but otherwise non-transformed series. The residuals of all the regressions are tested for the presence of a unit root.

In all, to allow for comparisons and completeness, eight different regressions repeated on each of the three periods are computed:

1) OLS regression between wpi and stock index *(potential cointegration)*

2) OLS regression between wpi and stock index return *(Alternate Gibson Paradox)*

3) OLS regression between wpi and interest rates *(Gibson Paradox)*

4) OLS regression between wpi and first difference of interest rates *(Gibson Paradox, spurious results still possible)*

5) OLS regression between inflation and stock index *(no relation)*

6) OLS regression between inflation and stock index return *(Fisher Theory)*

7) OLS regression between inflation and interest rates *(Fisher Theory)*

8) OLS regression between inflation and first difference of interest rates *(Fisher Theory, also present if relationship is not spurious)*

The two sub-periods are not chosen arbitrarily. The Gibson Paradox has one crucial weakness. It does not allow for prices to rise while the interest rate is falling. Since it is well known that the high interest rate of the early eighties came back down dramatically during the last two decades of the 20th century, it is reasonable to expect the paradox to have disappeared during that period.

Finally, the fact that the price indexes and the interest rate series are not stationary suggests that Ordinary Least Square regressions may produce spurious results. Therefore, for all the regressions performed, an Augmented Dickey-Fuller unit root test is performed on the residuals. This way it will be possible to confirm if the models reasonably fit the assumptions of ordinary least square regressions and to test for the presence of cointegration.

January Effect or Turn-of-the-Year Anomaly

Lastly, the Canadian securities returns data is tested for the presence of the January Effect with the hypothesis that the January effect should either not exist or should at least disappear in the last decade of the 20th century. In this case, a series of ordinary least square regressions with dummy variables for the twelve months are performed using equation 5. The resulting monthly averages and their standard errors are then compared to identify the systematic and anomalous presence of above average returns.

5) $$\ln(1+MR)_t = \sum_{n=1}^{12} \beta_n D_{n,t} + \varepsilon_t$$

Where MR = Monthly Stock Market Index Return
D = Dummy variable set to 1 for January and so on.
β = Coefficients of regression
ε = residuals

This test is performed on the whole century as well on each of the ten decades using the natural logarithm of one plus the stock index return.

Note that the periodic dividend payments show up clearly as a seasonal pattern. yet this effect is not corrected for. An Augmented Dickey-Fuller Unit root test is performed on the residuals of each of the eleven regressions to test for the absence of autocorrelation.

IV. Results

Stock Price Index Returns and Inflation

The key results for six contemporaneous regressions ranging from zero to five lags as well as the results of the one month lagged regression with zero additional lags[6] are presented in Table 14. They are used to determine the appropriate lag structure and they demonstrate that the contemporaneous regressions, with either zero or one lag included, offer the best fit. All seven regressions were performed on the full century. The Akaike criterion suggests that the contemporaneous regression with one lag included provides the most information, while the Schwarz criterion suggests that the contemporaneous regression with no lag included is the one providing the most information. A quick look at the R-square, the t-test for the beta, and the F-test suggests that the regression with the best overall fit is the contemporaneous one with zero lags. These results conform to the rational expectations and inflation theories underpinning this thesis.

Consequently, with the exception of the regressions for the sub-periods involving the undifferentiated inflation series which are also performed with the first lag added, all further tests are performed contemporaneously with zero lags. The exception is considered for two reasons. First, the Akaike Information Criterion suggests that the next best fit would come by adding one lag. Secondly, because many of the previous studies

[6] The lagged regressions were also performed with up to five additional lags but their results are not presented here because they were weaker than those for the contemporaneous regressions.

were performed using lagged values of inflation to match official inflation figure release dates with market returns it seems wise to also look at the contribution of that first lag.

Beyond the optimal lag structure, the first over all impression presented by the results suggests that, as expected, inflation is most likely not the primary element affecting stock returns given R-squares hovering around 1%. The assumptions of the regression model are fairly well supported. The Durbin-Watson statistic suggests that the residuals show little autocorrelation. A unit-root test on the residuals rejects the presence of a unit root. Though a strict test of normality fails, a histogram of the residuals nevertheless approximates a bell-shaped curve. The F-statistic supports a linear relationship. Overall, apart from the low R-square or non-strict normality, the model holds.

A few additional results can be noted from the initial set of regressions. The contemporaneous and first lag betas of the regressions are consistently greater than zero. The contemporaneous beta is significantly different than zero in all cases at the 1% level. Except on its own, the first lag beta is never significantly different from zero even at the 5% level though it is always positive. However, while neither of the contemporaneous and first lag betas are negative, neither are they equal to one. Indeed, in all cases the null of beta equal to one must be rejected even at the 10% level of significance.

These preliminary results are followed by results in Tables 15 and 16 which repeat the contemporaneous regression with zero lags and the contemporaneous regression with one lag for the six sub-periods to identify if the results observed for the full century apply equally over the sub-periods of the century. They do not.

In the sub-periods glaring differences surface. However, the results in tables 15 to 19 consistently show the same picture. The sub-periods behave markedly differently from one another while across the different sets of tests the picture painted by the results remains the same for any given sub-period.

<u>Contemporaneous Regressions of Sub-Periods with Zero or One Lag</u>

Equations 2 and 3 use the undifferentiated inflation series and are applied to two sub-periods of fifty years and four sub-periods of twenty-five years in addition to the full century. The results appear in Tables 15 and 16.

The most indicative and perplexing result is that apart from the full century regressions, only the two sub-periods encompassing the second quarter of the century yield significant F-tests. In Table 15, none of the other sub-periods come even close with p-values ranging from 80% to 95% for the F-test. The gap is even more striking in Table 16 where the p-value of the F-test of the first half century is practically zero, while that of the later half of the century is virtually 100% and its corresponding R-square is virtually zero.

Not surprisingly, given the F-test result, the beta coefficients for the regressions which fail the F-test are all statistically indistinguishable from zero. In other words, statistically, for the first twenty-five years and the last fifty years of the century, the returns of securities were uncorrelated with inflation. The R-squares are also virtually zero.

The contemporaneous beta coefficient remains positive in all sub-periods but the last one which covers the last twenty-five years of the century. The negative beta for the years 1975 to 1999 matches the results obtained in the American studies for similar periods. However, in our case the beta is only mildly negative at either -.13 or -.23 and it is statistically indifferent from zero.

The sub-period of the second quarter century, on the other hand, behaves almost in perfect opposition to the other three quarters of the century and in perfect unison with the Fisher Hypothesis. Not only is the F-test extremely significant with a p-value of essentially zero and a beta coefficient different from zero, but the hypothesized null of a beta of one cannot be rejected. The R-square even exceeds 10%. Better yet, the betas of 1.46 or 1.33, depending on the lag structure involved, even support the tax-adjusted Fisher hypothesis as proposed by Crowder (1997).

Equally striking are the contemporaneous inflation betas in the two twenty-five year sub-periods of the later half of the century in either set of regressions. In both those cases, the hypothesized null of unity is barely rejected. For the years 1950 to 1974 in Table 16 it is not rejected based on the t-statistic alone, though the corresponding confidence interval includes zero.

Regressions of Stock Index Return on Anticipated and Unanticipated Inflation

All the regressions involving the three sets of differentiated series yield results similar to those from the previous undifferentiated series. In table 17 the results for the regressions involving equation 4 and using the ARMA(5,6) generated anticipated and unanticipated series show the second quarter of the century as the only one supporting the

Fisher hypothesis. For either the first fifty years or the years from 1925 to 1949, the null hypothesis of unity for the anticipated beta cannot be rejected. Surprisingly, a null of one also cannot be rejected for the unanticipated beta for the years from 1925 to 1949.

Three of the regressions are significant at the 1% or 5% levels. In the most significant regression both the anticipated inflation beta and the unanticipated inflation beta are significant at the 1% level. Interestingly, the R-square reaches 10% for the sub-period covering the second quarter century. In that case, like in all the other cases, the constant is not significantly different from zero at the 5% level.

The Durbin-Watson statistic is reasonable at 1.66 only for the full century. For the sub-periods however, while it does not depart wildly from the hoped for 1.66 value it nevertheless ranges from 1.43 to 1.86. Finally, while strict tests of normality fail, unit root tests on the residuals of the regressions reject the presence of unit roots and histograms of the residuals show them to approximate a bell shape curve.[7]

For the sub-period covering the years from 1925 to 1949, the Fisher Hypothesis cannot be rejected. Evidently, the results for the first half of the century as well as for the full century are driven by the extremely strong relationship during the second quarter of the century. The regression for the years 1900 to 1949 using the 6-month forecasted series yield a near singular matrix.

It appears obvious that the strong linear relationship observed during the years 1925 to 1949 clearly dominate even the results for the full century since separately the sub-periods 1900 to 1924 and 1950 to 1999 do not show any significant correlation. It is almost as though having just read about Fisher's theory all market participants made sure they took inflation into account before the Second World War made them forget.

However, it is more likely that the Great Depression and the Second World War combined saw more government intervention in the economy than ever before which may have accounted for a greater correlation between inflation and market returns.

Granger-Causality Tests on Contemporaneous Series

As per theory, table 20 demonstrates that one-way Granger-causality is found to be present between stock returns and inflation for the full century. However the picture muddies when sub-periods are studied. During the first half of the century, inflation Granger-causes the index return at the 5% level. For the second half, not only does this relationship not even come close to hold, the reverse almost holds. In fact, according to the numbers, for the twenty-five years following the Second World War the index return appears to Granger-cause the inflation. While this last result is not significant at the 5% level it's p-value is nevertheless 0.0577. During the last twenty-five years of the century, neither the inflation nor the index appears to hold any sway over the other.

The Granger-causality results all support the same general picture as the previous regressions tests. The pre and post World War II economies are highly dissimilar and the post-Gold Standard years are themselves highly dissimilar from the first seventy-five years of the century.

Overall, the empirical results support the hypothesis of one-way Granger causality for those years during which a relationship between inflation and stock returns is observed.

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7 These test results and graphs are not shown, nor included in the appendix.

Cointegration Results for Full Century and Sub-Periods Using DF and PP Tests[8]

While the regressions reject the Fisher Hypothesis for the most part with F-tests strongly rejecting the null of a linear relationship and R-squares less than 1%, the index returns and inflation are nevertheless cointegrated. Cointegration holds for all the sub-periods as well as for the full century. Therefore, while the link between inflation and stock returns may be relatively weak it may nevertheless not be nil.

On the whole it would appear that common stocks have not provided a hedge against inflation. However, they have provided immunization from inflation. Add the fact that, on average, common stocks have outpaced inflation and why markets still appear to view common stocks as safe from the ravages of inflation explains itself.

The results presented here also support the idea that inflation does not affect nominal stock returns. In other words, the nominal return remains unaffected, while the real return presumably fluctuates. This would suggest that the inverted Fisher hypothesis holds for common stocks returns for most of the 20th century in Canada.

Arguably, the Fisher Hypothesis is only weakly supported by the results presented here. Nevertheless, since many factors which could not be isolated could be over-powering inflation's interaction, it may not yet be wise to discard it. Certainly, the Canadian numbers do not paint as bleak a picture as those from the United States of America.

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[8] On residuals, 3 lags included in all cases.

Gibson Paradox

For the first eighty years of the 20th century, the period during which the Gibson Paradox has been observed for interest rates, the paradox also held just as strongly for the Canadian stock market (see Tables 22 & 23). Indeed, the wholesale price series and stock prices may very well be driven in part by similar return generating processes. After all, if nominal wholesale prices climb it is reasonable to assume that nominal revenues of corporations will also increase. Ceteris paribus nominal earnings would also increase justifying an increase in stock prices.

At first glance the Gibson Paradox appears to hold strong for the 20th century as a whole. However, a close inspection shows that the residuals of the regressions one to four representing the paradox depart wildly from the OLS assumptions suggesting that the model is misspecified. The residuals display extreme serial correlation. Additionally, the third regression shows a significant negative relationship for the last twenty years which is untenable with the Gibson Paradox. A further glance at the results shows that the inflation regressions six, seven and eight also yield positive betas many of which are significant.[9]

It is ironic that the relationship between the price levels and interest rates is stronger during the negative correlation period of the last twenty years of the century than during the first eighty years of the century which have been used to point to the existence of the Paradox. Even more ironic is the fact that a mere twenty years should be able to invalidate a phenomenon observed for more than one hundred years. Put another way, up

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9 The ordering of the regressions follows from the work done by Barsky and Summers (1988). Intuitively, it would have made more sense to treat the inflation and wholesale price index as the

to 1980 both the price level and the long-term bond yield series behave as explosive AR(1) processes. However, when the last twenty years of the century are included, only the price level still behaves like an explosive AR(1) process. The long-term yield series starts to look stationary with a theta<1. This points to the Gibson Paradox being little more than a long running coincidence.

Where the Alternate Gibson Paradox is concerned, the picture remains puzzling. In all three periods the relationship between the Wholesale Price Index and Stock returns is positive. While it becomes smaller in the last twenty years it gains in statistical significance. This behaviour certainly underscores the extent to which the stock markets appear to pick-up news value from the movement in the inflation if nothing else. Then again, interest rates are governed by different pressures than those governing prices of either stocks or goods. The two later may most likely be affected by similar return generating processes.

January Effect or Turn-of-the-Year Anomaly

The January effect appears to have disappeared in the last decade of the 20th Century to be replaced by a December effect (see Table 24). The average return for January reaches its lowest point during the last decade and is statistically indistinguishable from zero. The opposite is true for the average return of the month of December during the last decade. Not only is that last December average return significantly different from zero, it is the second highest December average return for the

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independent variable, but to enable some comparison of results with Barsky and Summers, their ordering whole century and well above the full century average for that month. The fact that it is one of the ex-dividend months underlines the strength of the anomaly in that month.

Despite the appearance of an End of the Year Effect, the only coefficients ever significant at the 1% level are the ones for January. The second most frequently significant month is December. Interestingly, the anomaly is visible as early as the beginning of the century. Especially in 1920 when the index returned 3.34% the most of any decade. The 1970s come second with 3.04%. For the century as a whole, the month of January is significant at the 1% level with an average return of 1.8% effectively twice as high as the second best performing month exceeding December by 0.87%. In the 1990s, December exceeds other months by at least 2.0% and is significant at the 5% level. The monthly average is 0.3926 % (continuously compounded) for a yearly average of 4.7% (continuously compounded).

Finally, it is easy to see the impact of the dividend payments usually made by many corporations in the months of March, June and September. The fact that this drop does not show up in December suggests that its positive average is even more anomalous than expected and appears to have gained in intensity with the advent of capital gain taxes in the 1970s.

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has been maintained.

V. Conclusion

Despite the mixed results, it may still be unreasonable to dismiss the Fisher Hypothesis. One thing is certain, it is not unreasonable for investors to view securities in a positive light when considering inflation. Depending on the period one is looking at, securities returns either move in line with inflation or are essentially uncorrelated to inflation. Assuming that markets are able to determine which of the two states is in effect, it should be possible to either hedge against inflation with stocks or hold a portfolio of stocks effectively immunized from inflation assuming that investors have relatively long investment horizons. If investors have short investment horizons, the interaction of inflation with securities on, say, a yearly basis may yet be different from that observed over quarter-centuries.

Structural mechanisms such as the adjustments to the discount rate applied to securities by investors on news about inflation forcing a one time negative relationship between stock returns and inflation may account for the measured beta being less than 1 in periods of dramatically changing inflation. The initial fluctuation in the opposite direction may likely reduce the visible effect of inflation in the short-term. If it were possible to measure and filter the presence and magnitude of the "drops" as well as isolate the influence from overpowering micro and macro-economic variables, it is likely that the beta for the Fisher relationship would become closer to unity.

The fact that Granger-causality tests show one-way causality going from inflation to stock returns during those periods where inflation does display a relationship with stock returns further suggests that the Fisher Hypothesis may yet have life left in it. Moreover, cointegration tests also support the presence of a relationship between inflation and stock returns. It may be that the relationship between either differentiated inflation series and stock returns displays no particular coherence other than generally agreeing with the results for tests performed with undifferentiated inflation because the proxies for anticipated and unanticipated inflation may have been inadequate.

The Gibson paradox doesn't stand up to the last twenty years of the 20th century. The alternate Gibson paradox involving the stock price index however, is never statistically significant; yet, interestingly, while its beta moves closer to zero in the last twenty years of the century it nevertheless doesn't become negative the same way the beta of the Gibson paradox does. However, as the prices of securities are likely to be affected in great part by similar pressures as those affecting the prices of goods it may not be entirely surprising that they move in similar directions. Indeed, with an R-square of 93% for the full Century, the relationship between index prices and the WPI is in some ways more pronounced than that of the Gibson paradox. Despite the apparent relation between the two series in the price levels, for the last twenty years of the century, inflation showed zero correlation with stock returns. Therefore, the paradox, if not dead in the water, certainly has much less wind in its sails.

The January effect also appears to have abated. However, it appears to have been replaced by an end-of-the-year effect. In this case the anomaly may not be so anomalous as it might first appear. The dramatic emergence of the December (or end-of-year) effect coincides with the introduction of capital gains tax. Fiscal policy may very well single-handedly explain this distortion unless there exists a sufficiently wealthy sector which is not subject to income taxes.

Any future research in this area would benefit from the ability to isolate the various macro-economic variables apparently swamping the interaction between inflation and stock returns. The ability to break-down both the inflation series and the portfolio by removing certain products or industries might also lead to a more detailed and clearer picture. However, it is unlikely that such research would be able to go as far back in time as is accomplished here.

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Appendix

Tables and Charts

Monthly Stock Price Returns Index Series: $\ln(p_t/p_{t-1})$

Chart 1 – Line Graph for $\ln(p_t/p_{t-1})$ Series for 20th Century

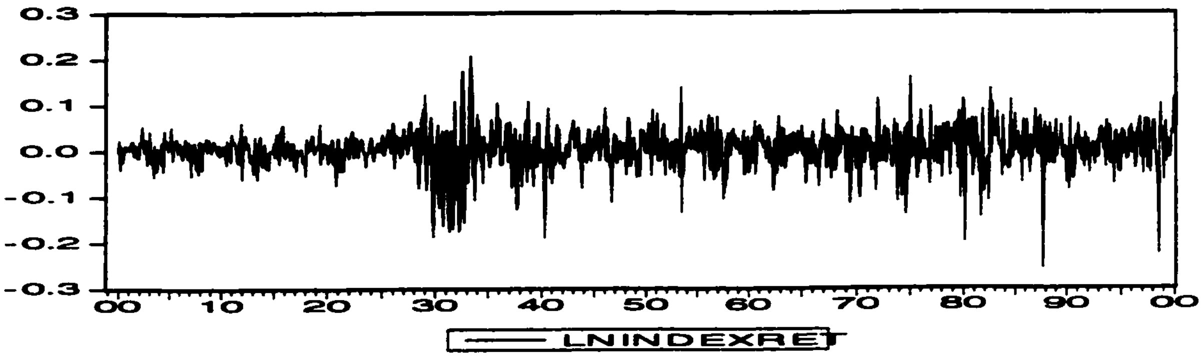
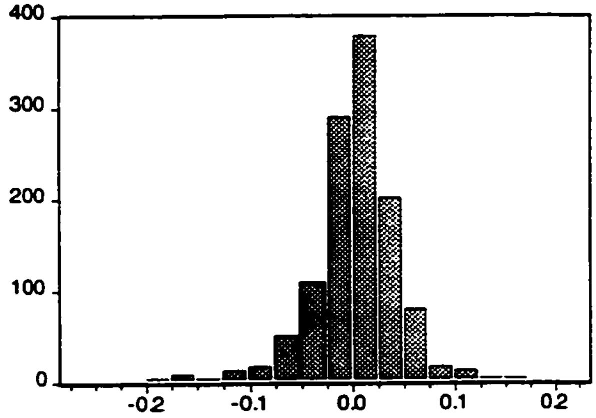


Chart 2 – Histogram and Basic Statistics for $\ln(p_t/p_{t-1})$ Series for 20th Century



Series:LNINDEXRET	
Sample 1900:01 1999:12	
Observations 1200	
Mean	0.003926
Median	0.006154
Maximum	0.206602
Minimum	-0.256568
Std. Dev.	0.043104
Skewness	-0.795611
Kurtosis	7.677397
Jarque-Bera	1220.501
Probability	0.000000

Table 1a – Correlogram for $\ln(p_t/p_{t-1})$ Series for 20th Century

Correlogram of ln(1+indexreturn)

Included observations: 1200, Sample: 1899:12 2000:01

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|* |	.|* |	1	0.175	0.175	36.827	0.000
.| |	*| |	2	-0.039	-0.071	38.619	0.000
.| |	.| |	3	-0.053	-0.035	42.034	0.000
.| |	.| |	4	0.005	0.019	42.062	0.000
.| |	.| |	5	0.065	0.059	47.234	0.000
.| |	.| |	6	0.051	0.029	50.400	0.000
.| |	.| |	7	0.014	0.006	50.625	0.000
.| |	.| |	8	0.010	0.016	50.739	0.000
.| |	.|* |	9	0.066	0.067	55.935	0.000
.| |	.| |	10	0.042	0.017	58.070	0.000
.| |	.| |	11	0.046	0.039	60.618	0.000
.| |	.| |	12	0.018	0.010	61.022	0.000
.| |	.| |	13	-0.053	-0.056	64.384	0.000
*| |	*| |	14	-0.080	-0.068	72.216	0.000
*| |	.| |	15	-0.067	-0.057	77.626	0.000
.| |	.| |	16	0.018	0.021	78.039	0.000
.| |	.| |	17	0.057	0.034	82.015	0.000
.| |	.| |	18	0.065	0.049	87.187	0.000
*| |	*| |	19	-0.074	-0.083	93.834	0.000
*| |	.| |	20	-0.082	-0.042	102.12	0.000
*| |	*| |	21	-0.077	-0.062	109.30	0.000
.| |	.| |	22	-0.013	-0.002	109.51	0.000
.| |	.| |	23	0.022	0.018	110.09	0.000
.| |	.| |	24	0.011	0.020	110.24	0.000
.| |	.| |	25	-0.049	-0.036	113.17	0.000
.| |	.| |	26	-0.005	0.022	113.20	0.000
.| |	.| |	27	0.021	0.007	113.74	0.000
.| |	.| |	28	-0.013	-0.028	113.94	0.000
.| |	.| |	29	0.027	0.039	114.86	0.000
.| |	.| |	30	0.014	0.027	115.11	0.000
.| |	.| |	31	-0.036	-0.017	116.68	0.000
.| |	.| |	32	-0.020	-0.001	117.19	0.000
.| |	.| |	33	-0.030	-0.040	118.28	0.000
.| |	.| |	34	-0.029	-0.049	119.31	0.000
.| |	.| |	35	0.016	0.005	119.64	0.000
.| |	.| |	36	0.037	0.030	121.35	0.000

Table 1b – Correlogram for abs(ln(p_t/p_{t-1})) Series for 20[th] Century

Date: 04/07/01 Time: 18:19

Sample: 1898:12 2000:01

Included observations: 1200

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|**	.|**	1	0.222	0.222	59.359	0.000
.|*	.|*	2	0.186	0.144	101.22	0.000
.|*	.|	3	0.114	0.050	116.80	0.000
.|*	.|*	4	0.155	0.105	145.62	0.000
.|*	.|*	5	0.140	0.076	169.14	0.000
.|*	.|	6	0.135	0.062	191.02	0.000
.|*	.|*	7	0.155	0.087	220.25	0.000
.|*	.|*	8	0.159	0.079	250.88	0.000
.|**	.|*	9	0.200	0.116	299.36	0.000
.|*	.|	10	0.145	0.039	324.68	0.000
.|*	.|*	11	0.172	0.075	360.60	0.000
.|*	.|*	12	0.172	0.075	396.61	0.000
.|*	.|	13	0.162	0.049	428.36	0.000
.|*	.|	14	0.113	-0.001	443.94	0.000
.|*	.|	15	0.127	0.026	463.50	0.000
.|	*|	16	0.056	-0.059	467.31	0.000
.|*	.|	17	0.134	0.047	489.29	0.000
.|*	.|	18	0.114	0.013	505.26	0.000
.|*	.|	19	0.140	0.036	529.34	0.000
.|*	.|	20	0.073	-0.040	535.91	0.000
.|*	.|	21	0.101	0.005	548.31	0.000
.|*	.|	22	0.119	0.031	565.57	0.000
.|*	.|	23	0.117	0.024	582.37	0.000
.|*	.|	24	0.117	0.023	599.23	0.000
.|*	.|	25	0.107	0.025	613.30	0.000
.|*	.|	26	0.103	0.006	626.28	0.000
.|*	.|	27	0.081	-0.002	634.40	0.000
.|*	.|	28	0.068	-0.016	640.04	0.000
.|*	.|	29	0.076	0.008	647.22	0.000
.|*	.|	30	0.101	0.019	659.74	0.000
.|*	.|	31	0.111	0.032	674.97	0.000
.|*	.|	32	0.119	0.031	692.33	0.000
.|*	.|	33	0.114	0.034	708.42	0.000
.|*	.|	34	0.094	0.000	719.43	0.000
.|*	.|	35	0.109	0.033	734.21	0.000
.|*	.|	36	0.074	-0.023	740.91	0.000

Table 2a – Unit Root Test for $\ln(p_t/p_{t-1})$ Series for 20th Century

ADF Test Statistic	-14.45914	1%	Critical Value*	-3.9708
		5%	Critical Value	-3.4160
		10%	Critical Value	-3.1299

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNINDEXRET)
Method: Least Squares
Date: 07/19/00 Time: 16:40
Sample(adjusted): 1900:06 1999:12
Included observations: 1195 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNINDEXRET(-1)	-0.848659	0.058694	-14.45914	0.0000
D(LNINDEXRET(-1))	0.033838	0.052606	0.643246	0.5202
D(LNINDEXRET(-2))	-0.029633	0.045379	-0.653004	0.5139
D(LNINDEXRET(-3))	-0.064547	0.037467	-1.722749	0.0852
D(LNINDEXRET(-4))	-0.057625	0.029030	-1.985016	0.0474
C	0.000797	0.002469	0.322827	0.7469
@TREND(1899:12)	4.27E-06	3.56E-06	1.198289	0.2310

R-squared	0.417035	Mean dependent var	9.98E-05
Adjusted R-squared	0.414091	S.D. dependent var	0.055339
S.E. of regression	0.042359	Akaike info criterion	-3.479424
Sum squared resid	2.131627	Schwarz criterion	-3.449632
Log likelihood	2085.956	F-statistic	141.6430
Durbin-Watson stat	1.998411	Prob(F-statistic)	0.000000

Table 2b – Unit Root Test for abs(ln(p_t/p_{t-1})) Series for 20th Century

ADF Test Statistic	-11.07368	1% Critical Value*	-3.4386
		5% Critical Value	-2.8644
		10% Critical Value	-2.5683

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(ABSLNINDESRET)
Method: Least Squares
Date: 04/07/01 Time: 18:23
Sample(adjusted): 1900:06 1999:12
Included observations: 1195 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ABSLNINDESRET(-1)	-0.522358	0.047171	-11.07368	0.0000
D(ABSLNINDESRET(-1))	-0.307334	0.046028	-6.677047	0.0000
D(ABSLNINDESRET(-2))	-0.187937	0.042410	-4.431467	0.0000
D(ABSLNINDESRET(-3))	-0.167143	0.037430	-4.465461	0.0000
D(ABSLNINDESRET(-4))	-0.075640	0.029007	-2.607685	0.0092
C	0.015985	0.001669	9.578733	0.0000

R-squared	0.411234	Mean dependent var	8.74E-05
Adjusted R-squared	0.408759	S.D. dependent var	0.038326
S.E. of regression	0.029470	Akaike info criterion	-4.205875
Sum squared resid	1.032629	Schwarz criterion	-4.180339
Log likelihood	2519.010	F-statistic	166.0959
Durbin-Watson stat	2.002634	Prob(F-statistic)	0.000000

Monthly Stock Price Index Series: Price Level – ln(price index)

Chart 3 – Line Graph for $\ln(p_t)$ Series for 20th Century

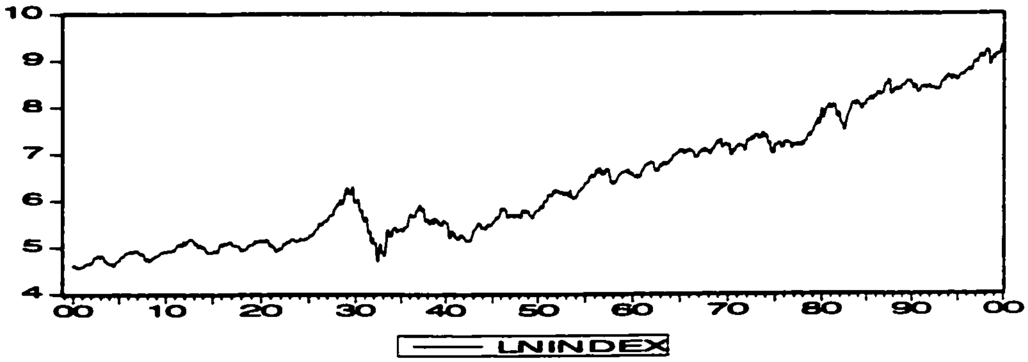


Chart 4 – Histogram and Basic Statistics for $\ln(p_t)$ Series for 20th Century

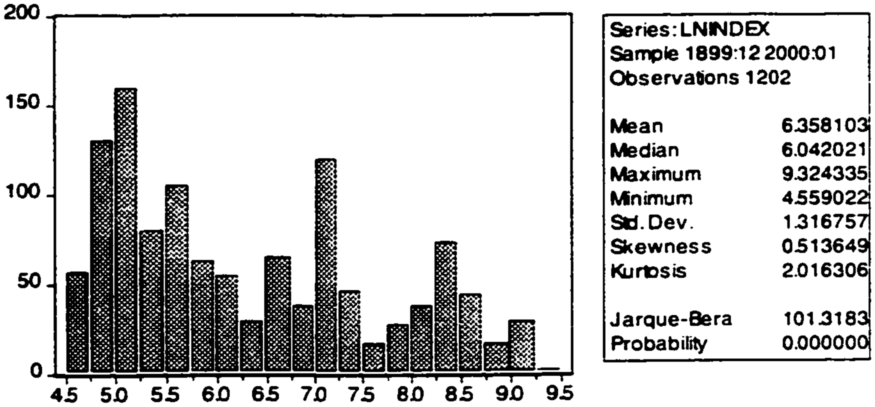


Table 3 – Corrolelogram for $\ln(p_t)$ Series for 20th Century

Sample: 1899:12 2000:01
Included observations: 1202

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|********	.|********	1	0.997	0.997	1196.8	0.000
.|********	.| |	2	0.993	-0.029	2386.1	0.000
.|********	.| |	3	0.990	0.030	3568.3	0.000
.|********	.| |	4	0.986	0.006	4743.6	0.000
.|********	.| |	5	0.983	0.007	5912.2	0.000
.|********	.| |	6	0.980	-0.015	7073.8	0.000
.|********	.| |	7	0.976	-0.016	8228.3	0.000
.|*******|	.| |	8	0.973	-0.004	9375.6	0.000
.|*******|	.| |	9	0.969	-0.001	10516.	0.000
.|*******|	.| |	10	0.966	-0.018	11649.	0.000
.|*******|	.| |	11	0.962	0.005	12774.	0.000
.|*******|	.| |	12	0.959	-0.001	13892.	0.000
.|*******|	.| |	13	0.955	-0.019	15003.	0.000
.|*******|	.| |	14	0.952	0.015	16107.	0.000
.|*******|	.| |	15	0.948	0.013	17204.	0.000
.|*******|	.| |	16	0.945	0.013	18294.	0.000
.|*******|	.| |	17	0.942	0.018	19377.	0.000
.|*******|	.| |	18	0.939	-0.005	20455.	0.000
.|*******|	*| |	19	0.935	-0.057	21525.	0.000
.|*******|	.| |	20	0.932	-0.003	22587.	0.000
.|*******|	.| |	21	0.928	0.001	23643.	0.000
.|*******|	.| |	22	0.925	0.006	24691.	0.000
.|*******|	.| |	23	0.921	-0.002	25733.	0.000
.|*******|	.| |	24	0.918	0.010	26768.	0.000
.|*******|	.| |	25	0.914	0.007	27796.	0.000
.|*******|	.| |	26	0.911	0.007	28817.	0.000
.|*******|	.| |	27	0.908	0.006	29832.	0.000
.|*******|	.| |	28	0.904	-0.013	30841.	0.000
.|*******|	.| |	29	0.901	0.000	31843.	0.000
.|*******|	.| |	30	0.898	0.009	32838.	0.000
.|*******|	.| |	31	0.895	-0.011	33827.	0.000
.|*******|	.| |	32	0.891	0.016	34810.	0.000
.|*******|	.| |	33	0.888	0.001	35787.	0.000
.|*******|	.| |	34	0.885	0.018	36758.	0.000
.|*******|	.| |	35	0.882	0.000	37723.	0.000
.|*******|	.| |	36	0.879	-0.015	38682.	0.000

Table 4 – Unit Root Test for $\ln(p_t)$ Series for 20th Century

ADF Test Statistic	0.690486	1% Critical Value*	-3.4386
		5% Critical Value	-2.8644
		10% Critical Value	-2.5683

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNINDEX)
Method: Least Squares
Date: 07/19/00 Time: 16:52
Sample(adjusted): 1900:05 2000:01
Included observations: 1197 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNINDEX(-1)	0.000648	0.000939	0.690486	0.4900
D(LNINDEX(-1))	0.185705	0.029006	6.402279	0.0000
D(LNINDEX(-2))	-0.065333	0.029533	-2.212210	0.0271
D(LNINDEX(-3))	-0.039050	0.029521	-1.322791	0.1862
D(LNINDEX(-4))	0.017829	0.029071	0.613284	0.5398
C	-0.000579	0.006081	-0.095161	0.9242

R-squared	0.037866	Mean dependent var	0.003948
Adjusted R-squared	0.033827	S.D. dependent var	0.043135
S.E. of regression	0.042399	Akaike info criterion	-3.478362
Sum squared resid	2.141078	Schwarz criterion	-3.452861
Log likelihood	2087.800	F-statistic	9.374768
Durbin-Watson stat	2.001656	Prob(F-statistic)	0.000000

TABLE 5a – Akaike and Schwarz Information Criteria results for Inflation series regressed on itself for up to 240 lags.

LAGS	AKAIKE	SCHWARZ
1	-2447.2295	-2437.4956
2	-2465.2407	-2450.6399
3	-2484.8852	-2465.4175
4	-2503.5078	-2479.1731
5	**-2513.3365**	**-2484.1349**
6	-2511.3380	-2477.2695
7	-2511.9944	-2473.0590
8	-2511.9879	-2468.1855
9	-2510.1403	-2461.4710
10	-2508.3042	-2454.7679

Table 5b – Descriptive Statistics of the Differentiated Inflation Series for the 20th Century

	Inflation	ARMA Anticipated-inflation	ARMA Unantici.-inflation	F12M-Anticipated inflation	F12M-Unantici. inflation	F6M-Anticipated inflation	F6M-Unantici. Inflation
Mean	0.002530	0.002494	4.61E-08	0.002512	-1.26E-05	0.002509	-9.74E-06
Std. Dev.	0.013073	0.005185	0.011972	0.010457	0.012873	0.012808	0.014171

Note: all figures are natural logarithms.

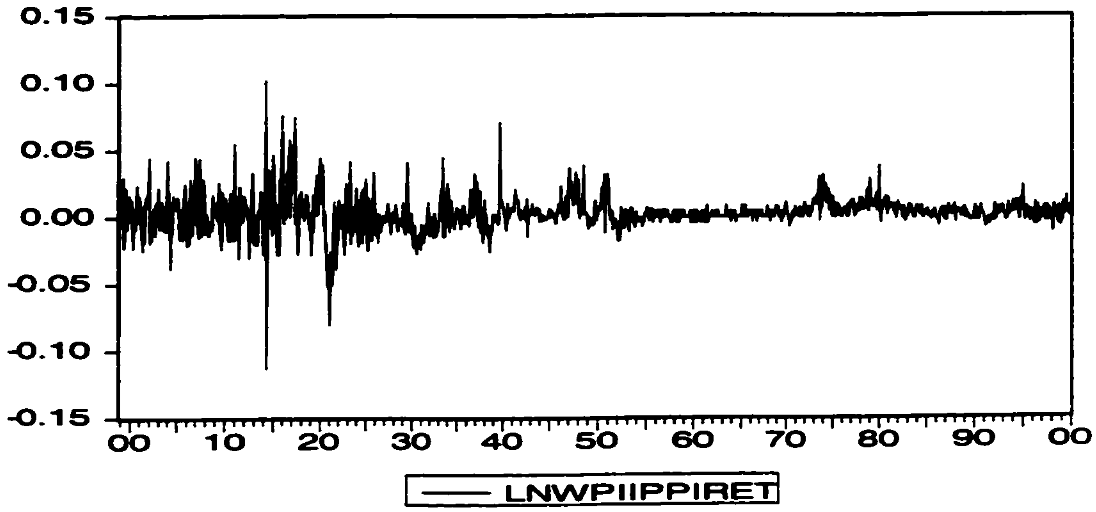
Table 5c – Descriptive Statistics of the Index Return Series for the 20th Century for comparison

	LN (index return)
Mean	0.003926
Std. Dev.	0.043104

Note: all figures are natural logarithms.

Monthly Inflation Series: $\ln(I_t/I_{t-1})$

<u>Chart 5 – Line Graph for $\ln(I_t/I_{t-1})$ Series for the 20th Century</u>



<u>Chart 6 – Histogram and Basic Statistics for $\ln(I_t/I_{t-1})$ Series for the 20th Century</u>

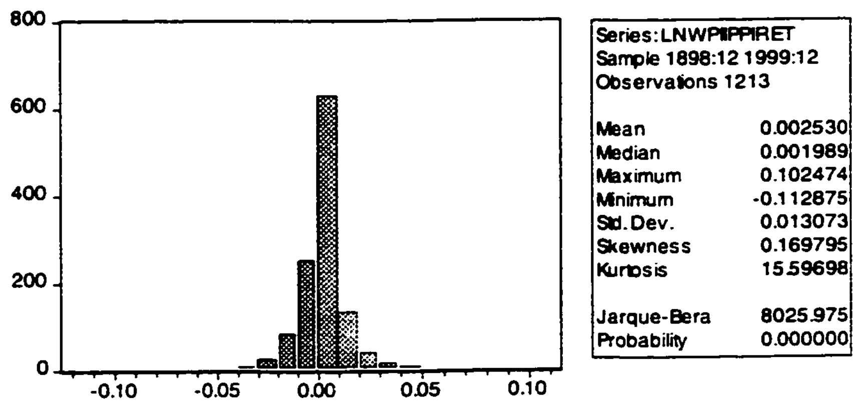


Table 6 – Corrolelogram for $\ln(I_t/I_{t-1})$ Series for 20th Century

<table>
<tr><td colspan="7">Sample: 1899:12 2000:01
Included observations: 1200</td></tr>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.|** |</td><td>.|** |</td><td>1</td><td>0.284</td><td>0.284</td><td>96.730</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|* |</td><td>2</td><td>0.230</td><td>0.163</td><td>160.58</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|* |</td><td>3</td><td>0.196</td><td>0.106</td><td>206.90</td><td>0.000</td></tr>
<tr><td>.|** |</td><td>.|* |</td><td>4</td><td>0.207</td><td>0.115</td><td>258.35</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|* |</td><td>5</td><td>0.190</td><td>0.082</td><td>301.89</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.| |</td><td>6</td><td>0.141</td><td>0.023</td><td>325.98</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.| |</td><td>7</td><td>0.092</td><td>-0.017</td><td>336.12</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.| |</td><td>8</td><td>0.070</td><td>-0.017</td><td>342.05</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|* |</td><td>9</td><td>0.144</td><td>0.088</td><td>367.05</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.| |</td><td>10</td><td>0.117</td><td>0.035</td><td>383.51</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.| |</td><td>11</td><td>0.078</td><td>-0.005</td><td>390.83</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.| |</td><td>12</td><td>0.114</td><td>0.058</td><td>406.62</td><td>0.000</td></tr>
<tr><td>.| |</td><td>*| |</td><td>13</td><td>-0.006</td><td>-0.101</td><td>406.66</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>14</td><td>0.006</td><td>-0.045</td><td>406.71</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.| |</td><td>15</td><td>0.073</td><td>0.059</td><td>413.21</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>16</td><td>0.034</td><td>-0.005</td><td>414.65</td><td>0.000</td></tr>
<tr><td>.| |</td><td>*| |</td><td>17</td><td>-0.038</td><td>-0.069</td><td>416.39</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>18</td><td>-0.003</td><td>0.008</td><td>416.40</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>19</td><td>0.019</td><td>0.023</td><td>416.84</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>20</td><td>-0.006</td><td>-0.023</td><td>416.88</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>21</td><td>0.053</td><td>0.051</td><td>420.34</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|* |</td><td>22</td><td>0.079</td><td>0.089</td><td>428.03</td><td>0.000</td></tr>
<tr><td>.| |</td><td>*| |</td><td>23</td><td>-0.028</td><td>-0.067</td><td>428.96</td><td>0.000</td></tr>
<tr><td>.|* |</td><td>.|* |</td><td>24</td><td>0.089</td><td>0.081</td><td>438.72</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>25</td><td>0.036</td><td>-0.002</td><td>440.33</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>26</td><td>0.062</td><td>0.027</td><td>444.98</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>27</td><td>0.054</td><td>0.006</td><td>448.51</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>28</td><td>0.034</td><td>-0.003</td><td>449.91</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>29</td><td>-0.014</td><td>-0.040</td><td>450.16</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>30</td><td>0.042</td><td>0.013</td><td>452.36</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>31</td><td>0.039</td><td>-0.011</td><td>454.23</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>32</td><td>0.001</td><td>-0.009</td><td>454.23</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>33</td><td>0.051</td><td>0.037</td><td>457.51</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>34</td><td>0.063</td><td>0.030</td><td>462.42</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>35</td><td>0.055</td><td>0.040</td><td>466.22</td><td>0.000</td></tr>
<tr><td>.| |</td><td>.| |</td><td>36</td><td>0.060</td><td>-0.002</td><td>470.76</td><td>0.000</td></tr>
</table>

Table 7 – Unit Root Test for $\ln(I_t/I_{t-1})$ Series for 20th Century

ADF Test Statistic	-10.12734	1% Critical Value*	-3.4386
		5% Critical Value	-2.8644
		10% Critical Value	-2.5683

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNWPIIPPIRET)
Method: Least Squares
Date: 07/19/00 Time: 16:47
Sample(adjusted): 1900:06 1999:12
Included observations: 1195 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNWPIIPPIRET(-1)	-0.435123	0.042965	-10.12734	0.0000
D(LNWPIIPPIRET(-1))	-0.366769	0.043464	-8.438422	0.0000
D(LNWPIIPPIRET(-2))	-0.249973	0.041037	-6.091338	0.0000
D(LNWPIIPPIRET(-3))	-0.179864	0.036639	-4.909149	0.0000
D(LNWPIIPPIRET(-4))	-0.082309	0.028837	-2.854262	0.0044
C	0.001111	0.000368	3.016022	0.0026

R-squared	0.395564	Mean dependent var	2.53E-05
Adjusted R-squared	0.393022	S.D. dependent var	0.015633
S.E. of regression	0.012180	Akaike info criterion	-5.973069
Sum squared resid	0.176385	Schwarz criterion	-5.947533
Log likelihood	3574.909	F-statistic	155.6244
Durbin-Watson stat	2.002816	Prob(F-statistic)	0.000000

Monthly Wholesale Price Index Series: Price Level $\ln(I_t)$

Chart 7 – Line Graph for $\ln(I_t)$ Series for 20th Century

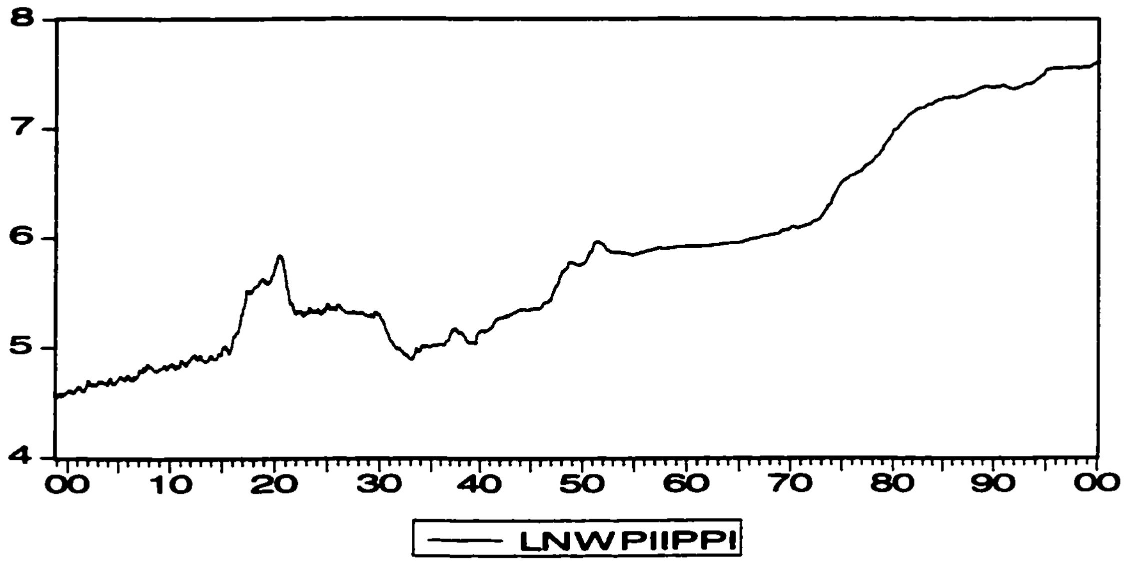


Chart 8 – Histogram and Basic Statistics for $\ln(I_t)$ Series for 20th Century

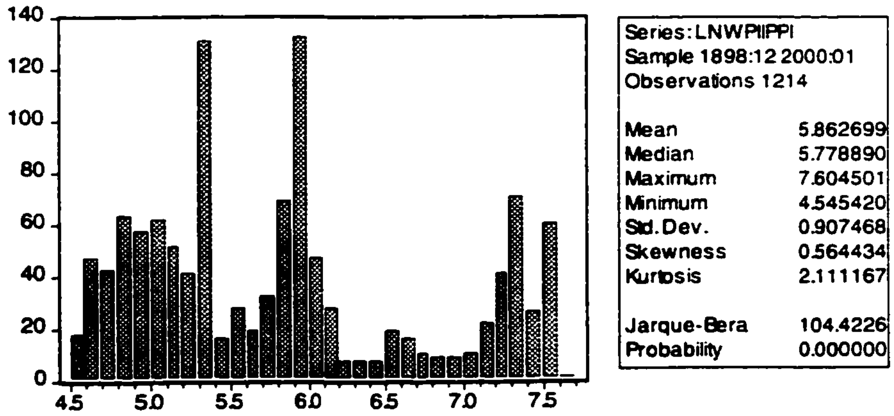


Table 8 – Corrolelogram for ln (I_t) Series for 20th Century

<table>
<tr><td colspan="7">Sample: 1899:12 2000:01
Included observations: 1202</td></tr>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.|********</td><td>.|********</td><td>1</td><td>0.998</td><td>0.998</td><td>1199.1</td><td>0.000</td></tr>
<tr><td>.|********</td><td>.| |</td><td>2</td><td>0.995</td><td>-0.014</td><td>2393.1</td><td>0.000</td></tr>
<tr><td>.|********</td><td>.| |</td><td>3</td><td>0.992</td><td>-0.010</td><td>3581.9</td><td>0.000</td></tr>
<tr><td>.|********</td><td>.| |</td><td>4</td><td>0.990</td><td>-0.008</td><td>4765.5</td><td>0.000</td></tr>
<tr><td>.|********</td><td>.| |</td><td>5</td><td>0.987</td><td>-0.012</td><td>5943.8</td><td>0.000</td></tr>
<tr><td>.|********</td><td>.| |</td><td>6</td><td>0.984</td><td>-0.015</td><td>7116.5</td><td>0.000</td></tr>
<tr><td>.|********</td><td>.| |</td><td>7</td><td>0.982</td><td>-0.007</td><td>8283.7</td><td>0.000</td></tr>
<tr><td>.|********</td><td>.| |</td><td>8</td><td>0.979</td><td>0.000</td><td>9445.3</td><td>0.000</td></tr>
<tr><td>.|********</td><td>.| |</td><td>9</td><td>0.976</td><td>-0.007</td><td>10601.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>10</td><td>0.973</td><td>-0.006</td><td>11752.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>11</td><td>0.971</td><td>-0.001</td><td>12896.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>12</td><td>0.968</td><td>-0.003</td><td>14035.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>13</td><td>0.965</td><td>-0.005</td><td>15169.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>14</td><td>0.962</td><td>0.001</td><td>16296.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>15</td><td>0.959</td><td>-0.006</td><td>17418.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>16</td><td>0.956</td><td>-0.007</td><td>18534.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>17</td><td>0.954</td><td>-0.004</td><td>19645.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>18</td><td>0.951</td><td>-0.010</td><td>20749.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>19</td><td>0.948</td><td>0.001</td><td>21848.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>20</td><td>0.945</td><td>-0.007</td><td>22941.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>21</td><td>0.942</td><td>0.000</td><td>24027.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>22</td><td>0.939</td><td>-0.002</td><td>25108.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>23</td><td>0.936</td><td>0.001</td><td>26184.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>24</td><td>0.933</td><td>-0.002</td><td>27253.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>25</td><td>0.930</td><td>-0.003</td><td>28316.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>26</td><td>0.927</td><td>0.007</td><td>29374.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>27</td><td>0.924</td><td>-0.012</td><td>30426.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>28</td><td>0.921</td><td>-0.004</td><td>31472.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>29</td><td>0.918</td><td>-0.010</td><td>32512.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>30</td><td>0.915</td><td>-0.005</td><td>33547.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>31</td><td>0.912</td><td>-0.002</td><td>34575.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>32</td><td>0.909</td><td>-0.003</td><td>35597.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>33</td><td>0.906</td><td>-0.004</td><td>36613.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>34</td><td>0.903</td><td>-0.009</td><td>37624.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>35</td><td>0.900</td><td>0.000</td><td>38628.</td><td>0.000</td></tr>
<tr><td>.|*******|</td><td>.| |</td><td>36</td><td>0.897</td><td>-0.004</td><td>39626.</td><td>0.000</td></tr>
</table>

Table 9 – Unit Root Test for $\ln(I_t)$ Series for 20th Century

ADF Test Statistic	0.361022	1% Critical Value*	-3.4386
		5% Critical Value	-2.8644
		10% Critical Value	-2.5683

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNWPIIPPI)
Method: Least Squares
Date: 07/19/00 Time: 16:54
Sample(adjusted): 1900:05 2000:01
Included observations: 1197 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNWPIIPPI(-1)	0.000142	0.000395	0.361022	0.7181
D(LNWPIIPPI(-1))	0.208143	0.028793	7.228932	0.0000
D(LNWPIIPPI(-2))	0.121409	0.029315	4.141531	0.0000
D(LNWPIIPPI(-3))	0.080663	0.029316	2.751487	0.0060
D(LNWPIIPPI(-4))	0.114248	0.028795	3.967621	0.0001
C	0.000350	0.002340	0.149622	0.8811

R-squared	0.126977	Mean dependent var	0.002497
Adjusted R-squared	0.123312	S.D. dependent var	0.013065
S.E. of regression	0.012233	Akaike info criterion	-5.964386
Sum squared resid	0.178224	Schwarz criterion	-5.938885
Log likelihood	3575.685	F-statistic	34.64503
Durbin-Watson stat	2.017054	Prob(F-statistic)	0.000000

Monthly Long-Term Bond Yields Series: $\ln(B_t/B_{t-1})$

Chart 9 – Line Graph for $\ln(B_t/B_{t-1})$ Series for 20th Century

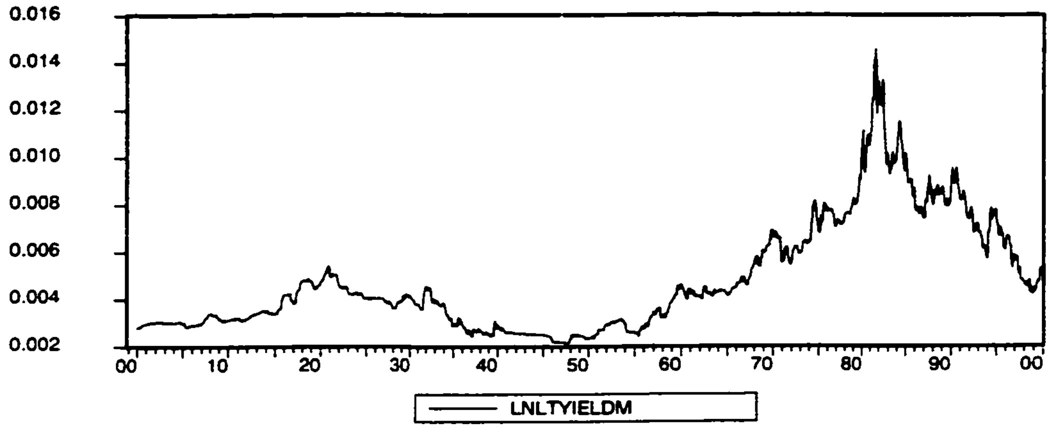
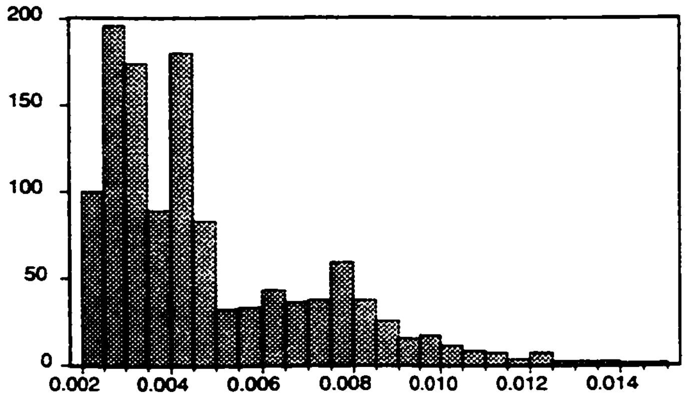


Chart 10 – Histogram and Basic Statistics for $\ln(B_t/B_{t-1})$ Series for 20th Century



Series: LNLTYIELDM
Sample 1900:01 1999:12
Observations 1200

Mean	0.004792
Median	0.004096
Maximum	0.014609
Minimum	0.002123
Std. Dev.	0.002348
Skewness	1.274666
Kurtosis	4.183445
Jarque-Bera	394.9816
Probability	0.000000

Table 10 – Corrolellogram for $\ln(B_t/B_{t-1})$ Series for 20th Century

Date: 05/02/01 Time: 20:52
Sample: 1898:12 2000:01
Included observations: 1200

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|********	.|********	1	0.996	0.996	1194.3	0.000
.|********	*| |	2	0.992	-0.082	2379.4	0.000
.|********	.| |	3	0.988	0.038	3556.1	0.000
.|********	.| |	4	0.984	-0.042	4723.8	0.000
.|********	.|* |	5	0.980	0.091	5883.8	0.000
.|********	.| |	6	0.977	-0.056	7035.8	0.000
.|*******|	.| |	7	0.972	-0.008	8179.2	0.000
.|*******|	.| |	8	0.969	0.065	9315.4	0.000
.|*******|	.| |	9	0.966	0.016	10445.	0.000
.|*******|	*| |	10	0.962	-0.096	11566.	0.000
.|*******|	.| |	11	0.958	0.038	12679.	0.000
.|*******|	*| |	12	0.953	-0.097	13783.	0.000
.|*******|	.| |	13	0.949	-0.025	14876.	0.000
.|*******|	.| |	14	0.944	0.047	15961.	0.000
.|*******|	.| |	15	0.940	0.015	17037.	0.000
.|*******|	.| |	16	0.937	0.065	18106.	0.000
.|*******|	.| |	17	0.933	0.026	19167.	0.000
.|*******|	.| |	18	0.930	0.053	20223.	0.000
.|*******|	*| |	19	0.927	-0.095	21272.	0.000
.|*******|	.| |	20	0.923	-0.007	22313.	0.000
.|*******|	.|* |	21	0.920	0.078	23348.	0.000
.|*******|	.| |	22	0.917	0.057	24378.	0.000
.|*******|	.| |	23	0.914	-0.051	25401.	0.000
.|*******|	*| |	24	0.910	-0.058	26418.	0.000
.|*******|	.| |	25	0.907	-0.009	27427.	0.000
.|*******|	.| |	26	0.903	0.059	28430.	0.000
.|*******|	.| |	27	0.900	-0.046	29426.	0.000
.|*******|	.| |	28	0.897	0.008	30417.	0.000
.|*******|	.| |	29	0.894	-0.003	31401.	0.000
.|*******|	.| |	30	0.891	0.012	32379.	0.000
.|*******|	.| |	31	0.887	0.021	33350.	0.000
.|*******|	.| |	32	0.884	-0.042	34316.	0.000
.|*******|	.| |	33	0.881	0.028	35275.	0.000
.|*******|	.| |	34	0.878	-0.045	36228.	0.000
.|*******|	.| |	35	0.874	-0.011	37174.	0.000
.|*******|	.| |	36	0.870	0.004	38113.	0.000

Table 11 – Unit Root Test for $\ln(B_t/B_{t-1})$ Series for 20th Century

ADF Test Statistic	-1.517506	1% Critical Value*	-3.4386
		5% Critical Value	-2.8644
		10% Critical Value	-2.5683

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNLTYIELDM)
Method: Least Squares
Date: 05/02/01 Time: 20:52
Sample(adjusted): 1900:06 1999:12
Included observations: 1195 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNLTYIELDM(-1)	-0.003554	0.002342	-1.517506	0.1294
D(LNLTYIELDM(-1))	0.102899	0.028843	3.567592	0.0004
D(LNLTYIELDM(-2))	-0.055361	0.028971	-1.910892	0.0563
D(LNLTYIELDM(-3))	0.060964	0.029016	2.101002	0.0359
D(LNLTYIELDM(-4))	-0.100851	0.028927	-3.486437	0.0005
C	1.90E-05	1.25E-05	1.520477	0.1287

R-squared	0.024893	Mean dependent var	1.97E-06
Adjusted R-squared	0.020792	S.D. dependent var	0.000192
S.E. of regression	0.000190	Akaike info criterion	-14.29839
Sum squared resid	4.27E-05	Schwarz criterion	-14.27285
Log likelihood	8549.288	F-statistic	6.070653
Durbin-Watson stat	1.986524	Prob(F-statistic)	0.000015

First Difference of Long-Term Bond Yields Series: $(r_{b,t}-r_{b,t-1})$

Chart 11 – Line Graph for $(r_{b,t}-r_{b,t-1})$ Series for 20th Century

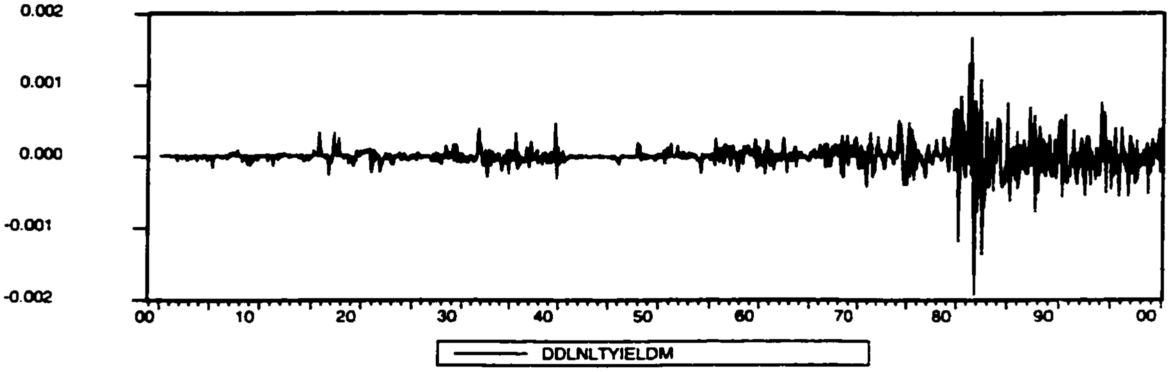
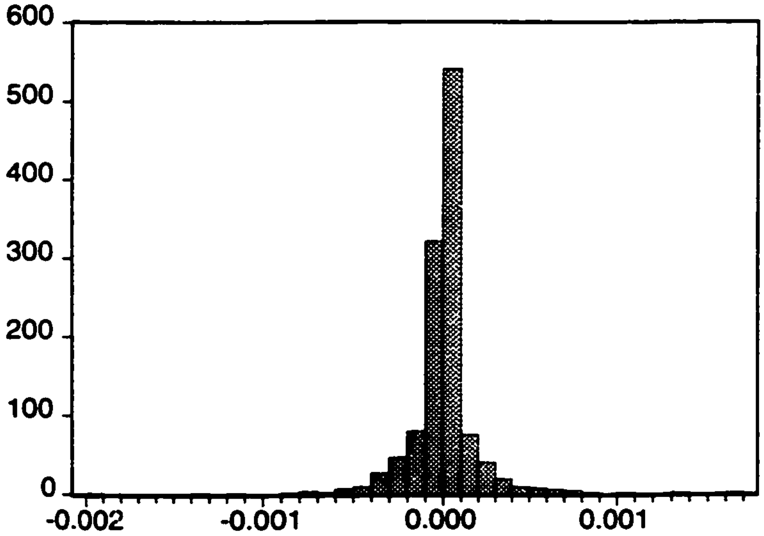


Chart 12 – Histogram and Basic Statistics for $(r_{b,t}-r_{b,t-1})$ Series for 20th Century



Series: DDLNLTYIELDM	
Sample 1900:02 1999:12	
Observations 1199	
Mean	2.01E-06
Median	0.000000
Maximum	0.001678
Minimum	-0.001925
Std. Dev.	0.000191
Skewness	-0.202570
Kurtosis	24.21706
Jarque-Bera	22497.63
Probability	0.000000

Table 12 – Corrolelogram for ($r_{b,t}-r_{b,t-1}$) Series for 20th Century

Date: 05/02/01 Time: 20:50
Sample: 1898:12 2000:01
Included observations: 1199

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.|* |	.|* |	1	0.090	0.090	9.6952	0.002
.| |	.| |	2	-0.038	-0.047	11.472	0.003
.| |	.| |	3	0.041	0.049	13.457	0.004
*| |	*| |	4	-0.090	-0.102	23.316	0.000
.| |	.| |	5	0.039	0.063	25.104	0.000
.| |	.| |	6	0.027	0.005	25.971	0.000
*| |	*| |	7	-0.080	-0.070	33.623	0.000
.| |	.| |	8	-0.020	-0.017	34.091	0.000
.|* |	.|* |	9	0.098	0.106	45.747	0.000
.| |	.| |	10	-0.030	-0.047	46.868	0.000
.|* |	.|* |	11	0.102	0.110	59.564	0.000
.| |	.| |	12	0.051	0.019	62.774	0.000
*| |	.| |	13	-0.079	-0.051	70.358	0.000
.| |	.| |	14	-0.005	-0.021	70.394	0.000
*| |	*| |	15	-0.079	-0.072	77.963	0.000
*| |	.| |	16	-0.063	-0.034	82.849	0.000
.| |	*| |	17	-0.040	-0.059	84.804	0.000
.|* |	.|* |	18	0.081	0.107	92.835	0.000
.| |	.| |	19	0.017	0.004	93.194	0.000
*| |	*| |	20	-0.067	-0.091	98.634	0.000
*| |	*| |	21	-0.064	-0.065	103.71	0.000
.| |	.| |	22	0.027	0.057	104.61	0.000
.|* |	.| |	23	0.090	0.059	114.47	0.000
.| |	.| |	24	0.013	0.008	114.69	0.000
*| |	*| |	25	-0.075	-0.065	121.60	0.000
.| |	.| |	26	0.001	0.055	121.60	0.000
.| |	.| |	27	0.003	-0.018	121.62	0.000
.| |	.| |	28	0.002	0.000	121.62	0.000
.| |	.| |	29	0.007	-0.016	121.68	0.000
.| |	.| |	30	-0.032	-0.027	122.98	0.000
.| |	.| |	31	0.021	0.043	123.52	0.000
.| |	.| |	32	-0.014	-0.033	123.74	0.000
.| |	.| |	33	0.035	0.048	125.22	0.000
.| |	.| |	34	0.033	0.007	126.55	0.000
.| |	.| |	35	-0.006	-0.011	126.60	0.000
.| |	.| |	36	0.010	0.007	126.72	0.000

Table 13 – Unit Root Test for $(r_{b,t}-r_{b,t-1})$ Series for 20th Century

ADF Test Statistic	-15.21940	1%	Critical Value*	-3.4386
		5%	Critical Value	-2.8644
		10%	Critical Value	-2.5683

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DDLNLTYIELDM)
Method: Least Squares
Date: 05/02/01 Time: 20:51
Sample(adjusted): 1900:07 1999:12
Included observations: 1194 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DDLNLTYIELDM(-1)	-0.935722	0.061482	-15.21940	0.0000
D(DDLNLTYIELDM(-1))	0.043623	0.054239	0.804281	0.4214
D(DDLNLTYIELDM(-2))	-0.017190	0.047737	-0.360099	0.7188
D(DDLNLTYIELDM(-3))	0.045848	0.038897	1.178701	0.2388
D(DDLNLTYIELDM(-4))	-0.063335	0.029037	-2.181194	0.0294
C	1.84E-06	5.48E-06	0.334735	0.7379

R-squared	0.465379	Mean dependent var	6.94E-08
Adjusted R-squared	0.463129	S.D. dependent var	0.000259
S.E. of regression	0.000189	Akaike info criterion	-14.29962
Sum squared resid	4.27E-05	Schwarz criterion	-14.27406
Log likelihood	8542.872	F-statistic	206.8272
Durbin-Watson stat	2.000235	Prob(F-statistic)	0.000000

TABLE 14 – Regression Results for Full Century at Various Lag Structures

Variable		Beta	Std. Error	t-Statistic null b=0	Prob.	t-Statistic null b=1	R-squared	F-statistic	Prob(F-statistic)	Durbin-Watson stat	Alkaike Information Criterion	Schwarz Information Criterion
Inflation	-1	0.246349	0.0951	***2.590412***	0.0097	7.924826	0.00557	***6.7102***	0.009702	1.6601	-3.4535	-3.4450
Inflation	0	0.324191	0.094943	***3.414565***	0.0007	7.118050	0.009638	***11.6593***	0.00066	1.661221	-3.457578	***-3.449***
Inflation	0	0.276558	0.098925	***2.795633***	0.0053	7.313032	0.0120208	***7.2820***	0.000719	1.6601139	***-3.4583***	-3.44559
	-1	0.168000	0.098886	1.698930	0.0895	8.413769						
Inflation	0	0.273148	0.100299	***2.723333***	0.0066	7.246826	0.012057	***4.8654***	0.002283	1.659428	-3.4566	-3.4397
	-1	0.163022	0.101750	1.602189	0.1094	8.225863						
	-2	0.020963	0.100263	0.209077	0.8344	9.764710						
Inflation	0	0.293158	0.100776	***2.909003***	0.0037	7.013993	0.014894	***4.5168***	0.001264	1.661304	-3.4579	-3.4367
	-1	0.188727	0.102586	1.839695	0.0661	7.908222						
	-2	0.062074	0.102583	0.605109	0.5452	9.143082						
	-3	-0.186871	0.100736	-1.855062	0.0638	11.78205						
Inflation	0	0.303270	0.101451	***2.989338***	0.0029	6.867681	0.015521	***3.764893***	0.002185	1.662281	-3.4569	-3.4314
	-1	0.195885	0.102924	1.903201	0.0573	7.812718						
	-2	0.072868	0.103337	0.705151	0.4809	8.971934						
	-3	-0.168526	0.102917	-1.637493	0.1018	11.35406						
	-4	-0.088417	0.101356	-0.872339	0.3832	10.73851						
Inflation	0	0.309143	0.101806	***3.036572***	0.0024	6.785985	0.015939	***3.220530***	0.003838	1.661550	-3+4556	-3.4259
	-1	0.202952	0.103423	***1.962351***	0.0500	7.706677						
	-2	0.078014	0.103611	0.752951	0.4516	8.898548						
	-3	-0.160167	0.103606	-1.545920	0.1224	11.19785						
	-4	-0.074075	0.103361	-0.716663	0.4737	10.39149						
	-5	-0.072387	0.101712	-0.711685	0.4768	10.54339						

Given the slightly conflicting results from the Aikaike and Schwarz criteria the model, the remaining regressions on sub-periods for the first section are performed both with the contemporaneous and the first lag as well as only contemporaneously. Bold and italic figures are significant at the 1% level.

TABLE 15 – Regression Results for Full Century and Sub-Periods for Contemporaneous/Zero Lag Structure.

Variable	Beta	Std. Error	t-Statistic null b=0	Prob.	t-Statistic null b=1	R-squared	F-statistic	Prob(F-statistic)	Durbin-Watson stat
Inflation 00 to 00	0.324191	0.094943	***3.414565***	0.0007	7.118015	0.009638	***11.65925***	0.0006602	1.661221
Inflation 00 to 50	0.355030	0.097035	***3.658791***	0.0003	6.6467911	0.021896	***13.38675***	0.0002758	1.438168
Inflation 50 to 00	0.021735	0.295867	0.073462	0.9415	3.3064385	9.02E-06	0.005397	0.9414633	1.85928
Inflation 00 to 25	0.003919	0.059101	0.066318	0.9472	16.853773	1.48E-05	0.004398	0.9471692	1.571882
Inflation 25 to 50	1.45605	0.248713	***5.854321***	1.263E-08	1.8336254	0.103147	***34.27308***	1.263E-08	1.438464
Inflation 50 to 75	0.079895	0.352831	0.22644	0.8210	2.6077782	0.000172	0.051275	0.8210141	1.801899
Inflation 75 to 00	-0.12752	0.499526	-0.255291	0.7987	2.2571887	0.000219	0.065173	0.7986746	1.856434

Bold and italic figures are significant at the 1% level. Bold only figures are significant at the 5% level. Underlined figure cannot be rejected at the 5% level.

TABLE 16 – Regression Results for Full Century and Sub-Periods for Contemporaneous and One Lag Structure

Variable	Beta	Std. Error	t-Statistic null b=0	Prob.	t-Statistic null b=1	R-squared	F-statistic	Prob(F-statistic)	Durbin-Watson stat
Inflation 00 to 00	0.276558	0.098925	***2.795633***	0.0053	7.313032	0.0120208	***7.2820***	0.000719	1.6601139
Inflation 00 to 00(-1)	0.168000	0.098886	1.698930	0.0895	8.413769				
Inflation 00 to 50	0.304917	0.100427	***3.036203***	0.0025	6.9212762	0.027659	***8.491197***	0.000231	1.436958
Inflation 00 to 50(-1)	0.188826	0.100377	1.881172	0.0604	8.0812736				
Inflation 50 to 00	0.023705	0.325904	0.072736	0.942	2.9956521	0.000009	0.002799	0.997205	1.859343
Inflation 50 to 00(-1)	-0.004715	0.325806	-0.014472	0.9885	3.083783				
Inflation 00 to 25	-0.01192	0.060311	-0.197643	0.8435	16.778365	0.00554	0.827237	0.438261	1.583633
Inflation 00 to 25(-1)	0.077503	0.060335	1.284549	0.2	15.289583				
Inflation 25 to 50	1.33064	0.278687	***4.774684***	0	1.1864206	0.106142	***17.63371***	0	1.432699
Inflation 25 to 50(-1)	0.276965	0.27767	0.997461	0.3194	2.6039363				
Inflation 50 to 75	0.240855	0.401335	0.600134	0.5489	1.8915495	0.002559	0.380914	0.68357	1.805832
Inflation 50 to 75(-1)	-0.33807	0.401045	-0.842973	0.3999	3.3364585				
Inflation 75 to 00	-0.234156	0.528607	-0.442968	0.6581	2.3347326	0.00152	0.225995	0.797859	1.848449
Inflation 75 to 00(-1)	0.328814	0.528594	0.622054	0.5344	1.2697571				

Bold and italic figures are significant at the 1% level. Bold only figures are significant at the 5% level. Underlined figure cannot be rejected at the 5% level.

TABLE 17 – Regression Results for the Full Century and Sub-Periods using the ARMA(5,6) Generated Series

Variable	Beta	Std. Error	t-Statistic null b=0	Prob.	t-Statistic null b=1	R-squared	F-statistic	Prob(F-statistic)	Durbin-Watson stat
ARMA56_FIT_LNWR 00to00	0.49940	0.241023	***2.071986***	0.03848	2.0769996	0.010156	***6.140560***	0.0022222	1.658436
ARMA56_RES_LNWR 00to00	0.291390	0.10362	**2.812093**	0.00500	6.8385354				
ARMAAN0050	0.626146	0.251699	**2.487674**	0.01313	1.4853216	0.024123	***7.37875***	0.000683	1.429494
ARMAUN0050	0.308501	0.104875	***2.9416***	0.00339	6.5935328				
ARMAAN5000	-0.35727	0.65483	-0.545593	0.58555	2.0727072	0.000714	0.213208	0.8080496	1.860919
ARMAUN5000	0.141868	0.349142	0.406333	0.68464	2.4578304				
ARMAAN0025	0.178923	0.158966	1.125541	0.26127	5.1651209	0.004726	0.705218	0.4948261	1.570057
ARMAUN0025	-0.02209	0.063002	-0.350583	0.72615	16.223083				
ARMAAN2550	1.545840	0.587149	***2.632791***	0.00891	0.9296457	0.103233	***17.09493***	9.395E-08	1.434704
ARMAUN2550	1.433892	0.281547	***5.092914***	6.276E-07	1.5411035				
ARMAAN5075	-1.18307	0.790281	-1.497029	0.13545	2.7624007	0.010777	1.617858	0.2000659	1.833068
ARMAUN5075	0.508027	0.425618	1.193622	0.23358	1.1559026				
ARMAAN7500	0.404833	1.10112	0.367655	0.7134	0.5405104	0.001209	0.179756	0.8355647	1.859515
ARMAUN7500	-0.27211	0.566662	-0.4802	0.63144	2.244921				

Bold and italic figures are significant at the 1% level. Bold only figures are significant at the 5% level. Underlined figure cannot be rejected at the 5% level.

TABLE 18 – Regression Results for the Full Century and Sub-Periods Using the 6M Horizon Forecast

Variable	Beta	Std. Error	t-Statistic null b=0	Prob.	t-Statistic null b=1	R-squared	F-statistic	Prob(F-statistic)	Durbin-Watson stat
F6MANWR	0.421309	0.119628	***3.521818***	0.00044	4.8374097	0.011992	***7.2644481***	0.0007313	1.66024
F6MUNWR	0.3516536	0.108125	***3.25228***	0.00118	5.9962537				
F6AN0050	NEAR SINGULAR MATRIX								
F6UN0050									
F6AN5000	-0.207549	0.351846	-0.589884	0.55549	3.4320329	0.002427	0.726334	0.4841057	1.867509
F6UN5000	0.1866142	0.325969	0.572491	0.56720	2.4952892				
F6AN0025	0.0854021	0.077073	1.108071	0.26873	11.866691	0.007548	1.1294486	0.3245956	1.584023
F6UN0025	-0.010675	0.069031	-0.154644	0.87721	14.640895				
F6AN2550	1.5644466	0.293626	***5.328022***	1.966E-07	<u>1.9223307</u>	0.104608	***17.34917***	7.481E-08	1.434238
F6UN2550	1.3887311	0.267053	***5.200203***	3.714E-07	<u>1.4556313</u>				
F6AN5075	-0.237737	0.407195	-0.583839	0.55977	3.0396632	0.008212	1.2295918	0.2938961	1.821055
F6UN5075	0.3702888	0.398659	0.928835	0.35373	<u>1.5795717</u>				
F6AN7500	-0.248580	0.623302	-0.398811	0.69032	2.0031694	0.000575	0.0854967	0.9180788	1.859987
F6UN7500	-0.069249	0.531329	-0.130332	0.89639	2.0124058				

Bold and italic figures are significant at the 1% level. Bold only figures are significant at the 5% level. Underlined figure cannot be rejected at the 5% level.

TABLE 19 – Regression Results for the Full Century and Sub-Periods Using the 12M Horizon Forecast

Variable	Beta	Std. Error	t-Statistic null b=0	Prob.	t-Statistic null b=1	R-squared	F-statistic	Prob(F-statistic)	Durbin-Watson stat
F12MANWR 00 to 00	0.376122	0.133439	***2.818671***	0.00490	4.6753638	0.011621	***7.03674315***	0.0009158	1.661403
F12MUNWR 00 to 00	0.378869	0.10839	***3.495414***	0.00049	5.7305121				
F12AN0050	0.441764	0.138371	***3.192602***	0.00148	4.0343314	0.026963	***8.27162622***	0.0002861	1.435582
F12UN0050	0.41250	0.110596	***3.729762***	0.00021	5.3121316				
F12AN5000	-0.12262	0.375524	-0.326539	0.74413	2.9894843	0.000662	0.19784919	0.8205474	1.861473
F12UN5000	0.129279	0.342431	0.377533	0.70591	2.542765				
F12AN0025	0.139539	0.086971	1.604426	0.10968	9.8936539	0.013403	2.01734426	0.1348268	1.583336
F12UN0025	-0.01955	0.06823	-0.286461	0.77472	14.942806				
F12AN2550	1.177749	0.323104	***3.645105***	0.00032	<u>0.550129</u>	0.10859	***18.0900842***	3.859E-08	1.457646
F12UN2550	1.600786	0.270632	***5.914994***	9.121E-09	2.2199389				
F12AN5075	-0.35242	0.418313	-0.842479	0.40020	3.2330318	0.012222	1.83748424	0.1610229	1.830784
F12UN5075	0.547207	0.428574	1.276809	0.20267	<u>1.0565109</u>				
F12AN7500	0.304446	0.709071	0.429359	0.66797	<u>0.9809373</u>	0.002695	0.40127762	0.6698266	1.858154
F12UN7500	-0.30365	0.540195	-0.56211	0.57447	2.4132938				

Bold and italic figures are significant at the 1% level. Bold only figures are significant at the 5% level. Underlined figure cannot be rejected at the 5% level.

Table 20 –Granger Causality Results

From Inflation to Index

Period	F-test	Significance Level	Granger-causlity
Full century	5.38813	0. 02044192	**YES**
00 to 49	4.13516	0.04244516	**YES**
50 to 99	0.00717	0.93255849	NO
00 to 24	2.41762	0.12105289	NO
25 to 49	3.35658	0.06794845	NO
50 to 74	0.33564	0.56279937	NO
75 to 99	0.40960	0.52267304	NO

From Index to Inflation

Period	F-test	Significance Level	Granger-causlity
Full century	0.18979	0.66316948	NO
00 to 49	0.00352	0.95272800	NO
50 to 99	2.09701	0.14812045	NO
00 to 24	0.05367	0.81696577	NO
25 to 49	0.00073	0.97783791	NO
50 to 74	3.62995	0.05774424	NO
75 to 99	0.44490	0.50530203	NO

The Null Hypothesis used : The Following Coefficients Are Zero

* The Akaike and Schwarz Information Criteria results calculated to determine the number of lags to use in the Granger-causality test both suggested that 5 lags would be ideal for the inflation series and 1 lag for the index series. However, to maintain a certain continuity 6 lags (i.e. months) were used for the inflation series and 1 lag for the index series.:
** at the 5% level

Table 21 – Cointegration – DF & PP Test Statistics

Periods	Dickey-Fuller	Philips-Perron	Sample Size
1900 – 2000	-17.24153	-28.93404	1200*
1900 – 1950	-11.56439	-17.92667	600*
1950 – 2000	-12.19829	-22.75697	600*
1900 – 1925	-7.20217	-13.92184	300*
1925 – 1950	-8.39117	-12.66450	300*
1950 – 1975	-7.78582	-15.64131	300*
1975 – 2000	-9.10293	-16.62910	300*

* significant at the 5% level (critical value –3.42 for the DF test statistic)

TABLE 22 – Regression Results for Gibson Paradox and Related Regressions

			Beta			Constant		
			Full Century	1900-1979	1980-1999	Full Century	1900-1979	1980-1999
Ln(Wholesale Price Index)								
1st	Ln(Stock Price Index)	coef.	***0.660731***	***0.576528***	***0.354547***	***1.674585***	***2.136719***	***4.376486***
		std.err.	0.005279	0.008882	0.010237	0.034278	0.052429	0.086452
2nd	Ln(Stock Return Index)	coef.	0.964116	0.597485	0.094745	***5.871412***	***5.500174***	***7.366773***
		std.err.	0.603515	0.43501	0.203999	0.026111	0.018115	0.010041
3rd	Ln(Long-Term Bond Yields)	coef.	***299.8361***	***265.4390***	***-60.35101***	***4.438364***	***4.452774***	***7.859050***
		std.err.	6.925001	8.815055	2.282629	0.036952	0.037179	0.019262
4th	D(ln(Long-Term Bond Yields))	coef.	-81.58336	***658.6009***	-22.38255	***5.876419***	***5.498545***	***7.366988***
		std.err.	136.1283	185.3939	26.14651	0.026029	0.017997	0.009956
Ln(Inflation Index)								
5th	Ln(Stock Price Index)	coef.	0.000387	**0.003118**	***0.007044***	4.96E-05	-0.00393	0.028676
		std.err.	0.000287	0.000528	0.000834	0.00186	0.001092	-0.00308
6th	Ln(Stock Return Index)	coef.	***0.029731***	***0.041433***	-0.004321	***0.002383***	***0.002307***	***0.002748***
		std.err.	0.008707	0.011089	0.006952	0.000377	0.000462	0.000342
7th	Ln(Long-Term Bond Yields)	coef.	0.300461	0.517320	***0.595057***	0.001060	0.000399	-0.002127
		std.err.	0.160376	0.315019	0.149501	0.000856	0.001329	0.001262
8th	D(ln(Long-Term Bond Yields))	coef.	***5.910347***	***16.91090***	***3.118337***	***0.002488***	***0.002328***	***0.002775***
		std.err.	1.965911	4.761828	0.869492	0.000376	0.000462	0.000331

Bold is significant at the 5% level.
Bold and Italic is significant at the 1% level.

Table 23 – Gibson Paradox Regressions and Cointegration Tests

Period	Dependent		Independent	Beta	T-test	F-test	Ad-R-sq	D/W	D-F test
1900 to 1999	ln(Wholesale Price Index)	1	ln(stock index)	0.661	***124.796***	***15574.100***	0.929	0.015	-2.414
		2	ln(stock index return)	0.964	1.598	2.552	0.001	0.004	0.386
		3	ln(ltyield)	299.836	***43.298***	***1874.685***	0.610	0.010	-0.771
		4	1st diff (ln(ltyield))	-81.583	-0.599	0.359	-0.001	0.001	0.600
	ln(Inflation)	5	ln(stock index)	0.000	1.393	1.939	0.001	1.435	***-10.141***
		6	ln(stock index return)	0.030	***3.415***	***11.659***	0.009	1.449	***-10.101***
		7	ln(ltyield)	0.300	1.873	3.510	0.002	1.437	***-10.159***
		8	1st diff (ln(ltyield))	5.910	***3.006***	***9.039***	0.007	1448	***-10.138***
1900 to 1979	ln(Wholesale Price Index)	1	ln(stock index)	0.576	***64.909***	***4213.120***	0.815	0.012	-1.945
		2	ln(stock index return)	0.597	1.373	1.886	0.001	0.004	0.915
		3	ln(ltyield)	265.439	***30.112***	***906.733***	0.486	0.005	-1.846
		4	1st diff (ln(ltyield))	658.6001	***3.552***	***12.620***	0.012	0.021	-0.163
	ln(Inflation)	5	ln(stock index)	0.001	**2.068**	***4.277***	0.003	1.467	***-9.073***
		6	ln(stock index return)	0.041	***3.736***	***13.961***	0.013	1.454	***-8.971***
		7	ln(ltyield)	0.517	1.642	2.697	0.002	1.434	***-9.070***
		8	1st diff (ln(ltyield))	16.911	***3.551***	***12.612***	0.012	1.454	***-9.145***
1980 to 1999	ln(Wholesale Price Index)	1	ln(stock index)	0.355	***34.634***	***1199.526***	0.834	0.086	**-3.362**
		2	ln(stock index return)	0.095	0.464	0.216	-0.003	0.003	**-2.972**
		3	ln(ltyield)	-60.351	***-26.439***	***699.034***	0.745	0.098	***-4.408***
		4	1st diff (ln(ltyield))	-22.383	-0.856	0.733	-0.001	0.007	**-3.421**
	ln(Inflation)	5	ln(stock index)	-0.003	***-3.689***	***13.607***	0.05	1.434	***-4.738***
		6	ln(stock index return)	-0.004	-0.622	0.386	-0.003	1.362	***-4.469***
		7	ln(ltyield)	0.595	***3.980***	***15.843***	0.058	1.451	***-4.779***
		8	1st diff (ln(ltyield))	3.118	***3.586***	***12.862***	0.047	1.484	***-4.462***

Bold figures significant at the 5% level, Bold and italic figures significant at the 1% level

Table 24 – January Effect: Regression Results

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ADF*	R-squared	F-statistic	Prob (Fstatistic)
1900-1999	***0.017942***	0.004577	-9.28E-05	0.004507	0.000762	-0.00341	**0.008657**	0.004767	-0.00107	-0.00707	0.008331	**0.009211**	1%	0.02215	***2.446412***	0.00508
1900-1909	0.010102	0.002187	-0.010433	**0.015203**	0.001077	-0.00804	0.009787	0.009109	0.005717	-0.00593	-0.00231	0.004178	5%	0.139157	1.587126	0.112624
1910-1919	-0.007684	-0.00314	-0.000808	0.012711	0.010476	-0.00816	-0.00824	0.009792	0.010647	0.007889	0.004865	**-0.0052**	5%	0.118556	1.32056	0.222909
1920-1929	***0.033429***	0.01584	-0.007865	0.004879	0.006663	-0.00802	0.003567	0.018812	**0.025408**	-0.00428	**-0.01061**	0.00555	1%	0.124395	1.394847	0.185623
1930-1939	0.0243	0.011499	-0.008406	-0.029975	-0.01874	-0.00834	0.031629	0.004523	-0.01582	-0.03412	0.023834	-0.02407	1%	0.097556	1.061369	0.399224
1940-1949	0.019673	-0.01246	-0.00974	0.007468	-0.010455	0.000756	0.01282	-0.00201	0.004662	0.005022	0.004687	0.004125	1%	0.055214	0.573786	0.846408
1950-1959	0.022103	0.010602	0.011608	0.011149	0.00549	0.025592	0.002544	0.000154	-0.00788	-0.01545	0.001651	0.013681	1%	0.080247	0.856616	0.584624
1960-1969	**0.021512**	-0.01506	0.010165	**0.025025**	-0.004511	-0.02393	-0.00455	0.011317	0.000722	0.003806	0.018856	0.017462	1%	0.176283	**2.101179**	0.026015
1970-1979	**0.030423**	0.019962	0.006058	-0.015769	-0.014658	0.00593	0.018942	-0.00217	-0.00367	**-0.03086**	0.007262	**0.036099**	1%	0.153809	1.78461	0.065332
1980-1989	0.01849	0.008152	0.000678	0.00943	0.00944	0.00045	0.01094	0.023942	-0.02506	-0.01958	0.030419	0.011058	1%	0.080575	0.860426	0.580939
1990-1999	0.007075	0.008181	0.007816	0.004943	0.022834	-0.01032	0.009135	-0.02581	-0.00545	0.022829	0.004647	**0.029233**	1%	0.114875	1.274246	0.249043

Bold is significant at the 5% level. Bold and Italic is significant at the 1% level.

* ADF represents the significance level of the Augmented Dickey-Fuller UNIT ROOT TEST ON RESIDUALS FOR Ln(1+indexreturn) = D1 + D2 + D3 + D4 + D5 + D6 + D7 + D8 + D9 + D10 + D11 + D12 + e at which the null hypothesis of the presence of a Unit Root can be rejected.

NO UNIT ROOTS and MEAN ZERO (Though normality test fails)

ADF Test Statistic	-14.27531
1% Critical Value*	-3.4386