Stock Earnings and Bond Yields in the US 1871 - 2017: The Story of a Changing Relationship

Valeriy Zakamulin* and John A. Hunnes†

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Abstract

Using historical data that spans almost 150 years, we examine whether there is a long-run equilibrium relationship between the stock’s earnings and bond yields. The novelty of our econometric methodology consists in using a vector error correction model where we allow multiple structural breaks in the equilibrium relationship. The results of our analysis suggest the existence of equilibrium relationship over 1871-1929 and 1958-2017. On the two historical segments, our analysis finds that the stock’s earnings yield followed the bond yield in both the short- and long-run, but not the other way around. Perhaps the most important and surprising finding of our empirical study is that, after the break in 1929, a completely new equilibrium relationship re-emerged in 1958 that was later termed as the “Fed model.” Our main argument for the emergence of a new equilibrium relationship is that a major “paradigm shift” in the stock valuation theory occurred in the late 1950s. To support our argument, we highlight the main historical events that potentially could have caused the transition from the old to the new paradigm. Finally, we identify the primary impetus for the paradigm shift.

Key words: equity valuation model, equilibrium relationship, Granger causality, vector error correction, structural break analysis, historical development, monetary policy

JEL classification: C32, C52, G12, N21, N22, O16, O38

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*School of Business and Law, University of Agder, Service Box 422, 4604 Kristiansand, Norway, E-mail: valeri.zakamouline@uia.no
†School of Business and Law, University of Agder, Service Box 422, 4604 Kristiansand, Norway, E-mail: john.a.hunnes@uia.no
1 Introduction

The majority of academics and investment professionals agree that there should be a positive relationship between the stock’s earnings yield and bond yield. There are two strong arguments that support this rationale. The first argument is based on the idea that stocks and bonds are two major asset classes that compete for investors’ capital. Hence, if the bond yield increases, stock prices should decrease in order the stock’s earnings yield to increase to maintain the competitiveness of stocks. The second argument is grounded on the idea that the stock price is the discounted present value of its future cash flow. Therefore, if interest rates fall the present value rises and, consequently, the stock’s earnings yield decreases.

The most widespread model among the investment professionals is the so-called “Fed model” which postulates that the stock’s earnings yield should be approximately equal to the long-term bond yield. Formally, the Fed model postulates

\[ \frac{E}{P} = Y, \]  

where \( E/P \) is the stock market earnings-to-price ratio and \( Y \) is the yield on the long-term (government) bonds. However, even though the empirical support for this model is found in many academic studies, there are two serious problems with the Fed model. First, the Fed model lacks a solid theoretical underpinning. Specifically, the main theoretical problem with the Fed model is the absence of risk premium for holding stocks. Second, several academic studies report that the Fed model is supported by data that starts from around 1960 only. Prior to this date, there is no empirical support for the Fed model.

The Fed model is very restrictive and was first mentioned for the US in a July 1997 Federal Reserve Monetary Policy Report to Congress by Alan Greenspan. Long before Alan Greenspan’s mentioning of the Fed model, Graham and Dodd (1934) advocated for a much less restrictive relationship between the stock’s earnings and bond yields. Specifically, they presumed that the stock market yield should be equal to the bond yield times a suitable “multiplier”

\[ \frac{E}{P} = M \times Y, \]  

where \( M > 1 \) denotes a multiplier on \( Y \). The rationale for this multiplier is that stocks are
riskier than bonds and therefore investors should require compensation for bearing the risk.

Understanding the historical relationship between the stock’s earnings yield and bond yield is very crucial in many aspects. First, the knowledge of the relationship provides important insights to both investment professionals and academics on how investors have been valuing stocks versus bonds and how this valuation has been changing over time. Second, financial markets play a more and more important role in the economy. Typically, a financial crisis is followed by an economic recession. The Fed uses monetary policy to offset the effects of a recession. Therefore, it is necessary to understand the effects of monetary policy on asset prices. In this regard, it is particularly interesting to investigate the causality relation between the stock’s earnings and bond yields. The knowledge of the causality relationship is paramount for academics, investment professionals, and monetary policymakers. In particular, armed with the knowledge of the causality relationship between the stock’s earnings and bond yields, monetary policymakers are able to predict the effect of a new monetary policy on the stock prices and yields. At the same time, investment professionals are able to make optimal capital allocation decisions, and academics are able to refine their theories.

This paper aims to examine the empirical validity of the Graham and Dodd model using US data that spans a very long historical period, 1871 - 2017. Regarding the econometric methodology, we use a cointegrated vector auto-regressive model, also known as a Vector Error Correction Model (VECM), which allows us to investigate both the short-term and long-term dynamics of the relationship between the stock’s earnings and bond yields. The latter is the most important for our study because our hypothesis is that there is a long-run equilibrium relationship between the stock’s earnings yield and the bond yield. Specifically, the existence of a long-run equilibrium relationship implies that a deviation from the long-run equilibrium, the error, serves as the restoring force that brings the relationship back toward equilibrium. A VECM also helps us to establish the causality relationship between variables. In particular, our econometric methodology allows us to find out which of the two yields is the cause of the change in the value of the other yield in the relationship.

Although there are already several empirical studies on testing the Fed model using a cointegration analysis (Koivu, Pennanen, and Ziemba (2005), Estrada (2009)), the novelty of our econometric methodology is twofold. First, we use a much longer historical period that spans almost 150 years. Second, we allow multiple structural breaks in the equilibrium
relationship.\textsuperscript{1} Specifically, in all previous studies the researchers focus their attention on the relatively recent period that starts from the early 1960s or even later. In our study, on the other hand, the historical period starts from 1871. Whereas in all preceding studies no structural breaks in the relationship between the two yields were allowed, we employ the modern methodology of testing for multiple structural changes. This methodology of detecting multiple breakpoints was developed in the late 1990s (Bai (1997), Bai and Perron (1998)). However, efficient and robust algorithms of dating multiple structural changes were developed in the early 2000s only (Bai and Perron (2003), Zeileis, Kleiber, Krämer, and Hornik (2003)). As a result, the broad practical application of the methodology for dating multiple structural changes has started relatively recently.

The uniqueness of our analysis can be summarized as follows. Our working hypothesis is that there is a long-run equilibrium relationship between the stock’s earnings and bond yields, but this relationship is subject to structural changes over time. Given the very long historical data, the goal of this paper is to find the structural breaks in the relationship, investigate the direction of causality in the relationship, and try to explain the causes of the breaks.

The first contribution of this paper is to provide statistically significant evidence in support of our working hypothesis. The main empirical findings in the paper can be summarized as follows. Our structural break analysis identifies two major breaks in the relationship between the stock’s earnings and bond yields: in 1929 and in 1958. Moreover, our co-integration analysis advocates for the presence of the equilibrium relationship between the two yields over the periods 1871-1929 and 1958-2017. That is, the relationship broke down in 1929 and was later re-established in 1958. On both historical segments 1871-1929 and 1958-2017, our analysis finds a unidirectional short- and long-run Granger causality running from the bond yield to the stock’s earnings yield. In other words, on both segments the stock’s earnings yield followed the bond yield in both the short-run and the long-run, but not the other way around. Perhaps the most important and surprising finding of our empirical study is that the multiplier in the relationship $E/P = M \times Y$ has changed from $M \approx 2$ over the period from 1871 to 1929 to $M \approx 1$ over the period from 1958 to 2017.

\textsuperscript{1}In brief, the motivation for allowing multiple structural breaks is as follows. Over a very long run, the dynamics of financial markets are subject to evolutionary changes (Lo (2004), Evstigneev, Hens, and Schenk-Hoppe (2009), Lo (2017)). Therefore, the equilibrium relationship between the two yields can also be subject to evolutionary changes.
The second contribution of this paper is to provide answers to the following two major questions. The first major question is: Why there was no relationship between the stock’s earnings yield and the bond yield over the period from 1929 to 1958? Answering this question also requires answering the following two sub-questions: Why the break in the relationship occurred in 1929? Why the relationship re-established in 1958? The second major question is: Why the multiplier in the equilibrium relationship has changed from $M \approx 2$ to $M \approx 1$?

In brief, our story goes as follows. The breakdown of the equilibrium relationship in 1929 is explained by the stock market crash and the following Great Depression forcing the Fed to start conducting an expansionary monetary policy by lowering the short-term interest rate to nearly zero and decreasing substantially the long-term interest rate. Due to the government needs to finance the WWII and subsequent recession that ended in 1949, the interest rates were de-regulated only in 1951 (the 1951 Treasury-Fed Accord). It is much more challenging to explain the re-establishment of a completely new equilibrium relationship between the stock’s earnings and bond yields in 1958. Our main argument is that a major “paradigm shift” in the stock valuation theory occurred in the late 1950s. To support our argument and explain the transition from the old to the new paradigm, we highlight the main historical events, which took place during 1910-1960, that potentially could have caused the transition from one paradigm to another. Finally, we identify the primary impetus for the paradigm shift.

The remainder of this paper is organized as follows. Section 2 reviews the theoretical and empirical literature, while Section 3 describes the data employed in the paper. Section 4 presents the econometric methodology. Section 5 identifies the breaks in the relationship using structural break analysis and investigates the direction of causality in the relationship. Section 6 suggests the key forces behind the breaks in the relationship between earnings and bond yields. Section 7 provides the reader with the explanations of the breaks. Finally, Section 8 concludes the paper.

2 Review of the Theoretical and Empirical Literature

Graham and Dodd (1934) distinguish between the “old-fashioned” (or “traditional”) theory of stock investing and the “modern-era” theory. According to Graham and Dodd, the shift from the traditional approach to stock selection to the new one occurred somewhere in 1927.
In the traditional theory the chief emphasis was laid upon the stability of dividends and earnings in the durable past and reasonable relation between the earnings and the price. Specifically, the stock investors at that time sought to place themselves as nearly as possible in the position of the bond investors. In other words, they aimed primarily at a steady income return from common stocks. Since common stocks were perceived to be much riskier than bonds, the investors required that the income from common stocks must be greater than that from bonds. That is, the stock dividend yield (a.k.a. dividend-to-price ratio, D/P ratio) must be greater than the bond yield. Formally, \( D/P > Y \), where \( Y \) is the bond yield. As Graham put it:

“In the ordinary common stock, bought for investment under normal conditions, the margin of safety lies in an expected earning power considerably above the going rate for bonds.” (Graham (1949), page 243)

In his books, Graham advocated\(^2\) that the investors should adhere to the “margin of safety” investment principle which is based “upon thorough analysis [that] promises safety of principal and an adequate return”. First of all, the investor had to find a safe and reliable company that was able to provide a stable flow of dividends in the foreseeable future. But should the shares of such a company be bought at any price? The answer provided by Graham was a clear “No”. Specifically, Graham developed a concept known as the “fair” (or “intrinsic”) value of a stock and emphasized the fact that the value of a stock usually differs from its price. For example, there are recurrent fluctuations in the stock market known as the bull and bear markets. During bull markets the investors are optimistic about the economy and the stock prices are high. Conversely, during bear markets the investors are pessimistic about the economy and the stock prices are low. As a result, in a well-defined bull (bear) market the stocks are “overvalued” (“undervalued”).

Graham promoted the idea that common stocks should be bought mainly during bear markets when they are undervalued. To find out whether the stock market is overvalued or undervalued, Graham suggested using the methodology previously employed by Roger Babson\(^3\) (see Graham and Dodd, 1934, Chapter 50). This methodology consisted in using the stocks in the Dow Jones Industrial Average and:

\(^2\)We conjecture that Graham presented the prevailing approach to stock valuation at that time.

\(^3\)Roger Babson was an American entrepreneur, economist, and business theorist in the first half of the 20th century. He is famous for predicting the stock market crash of 1929.
“determine an indicated “normal” value for this group by applying a suitable multi-
tiplier to average earnings. The multiplier might be equivalent to capitalizing the
earnings at, say, twice the current interest rate on highest grade industrial bonds.”
(Graham and Dodd (1934), page 693)

Put differently, Graham advocated that, under “normal” conditions, the relationship between
the stock earnings yield (E/P) and the bond yield must be $E/P = 2 \times Y$.

According to Graham, in 1927 the interest in common stocks reached its height and the
traditional theory was replaced by the modern-era theory:

“during the postwar period, and particularly during the latter stage of the bull
market culminating in 1929, the public acquired a completely different attitude
towards the investment merits of common stocks... The new theory or principle
may be summed up in the sentence: *The value of a common stock depends entirely
upon what it will earn in the future.*” (Graham and Dodd (1934), page 355, our
emphasis)

That is, whereas in the traditional theory the approach to stock selection was “backward
looking”, in the new era theory the approach to stock selection was “forward looking”. Specifically, “the analyst sought to look into the future and to select the industries or the individual
companies that were likely to show the most rapid growth” (Graham and Dodd (1934), page
353). That is, the analysts turned their attention from the company’s dividends, earnings, and
asset values to exclusively the earnings trend in the recent past; this earnings trend was then
projected into the observable future.

Even though the idea that “the value of a common stock depends entirely upon what it
will earn in the future” emerged in the late 1920s, the first stock valuation formula based on
this idea appeared a decade later in the book by Williams (1938). According to Bernstein
(1992), Williams applied to common stocks the “intrinsic value definition” developed earlier
by Irving Fisher. All current stock valuation models are variations of Williams’ basic formula,
which may be expressed mathematically as follows:

$$P = \sum_{t=1}^{\infty} \frac{D_t}{(1 + k)^t},$$  \hspace{1cm} (3)
where \( P \) is the current “intrinsic” stock price, \( D_t \) is the estimated cash dividend in period \( t \), and \( k \) is the appropriate discount rate. This valuation method was later called the Dividend Discount Model (DDM).

The application of the formula given by equation (3) is cumbersome because the analysts need to estimate the amount of the cash dividends in all future. To facilitate the computation of the intrinsic stock price, Gordon and Shapiro (1956) assumed that the dividend growth is constant. Under this assumption, the stock valuation formula simplifies to

\[
P = \frac{D}{k - g},
\]

where \( D \) is the next period dividends and \( g \) is the dividend growth rate. This valuation formula is known as the Gordon Growth Model (GGM). The valuation formula can be written alternatively using earnings instead of dividends:

\[
P = \frac{b \times E}{k - g},
\]

where \( E \) is the next period earnings and \( b \) is the payout ratio \((0 \leq b \leq 1)\). The earnings growth rate \( g \) is computed as the retention rate \((1 - b)\) times the return on new investment \( k^* \):

\[
g = (1 - b)k^*.
\]

Thus, the stock valuation formula can be written as

\[
P = \frac{b \times E}{k - (1 - b)k^*}.
\]

In case \( k^* = k \), the firm’s dividend policy does not matter and the stock valuation formula reduces to \( P = E/k \) that can be rewritten as

\[
\frac{E}{P} = k.
\]

As applied to the stock market as a whole, the formula above says that the stock market earnings yield should equal the required return on the market. However, there is no common
agreement among financial analysts about how to determine the appropriate market return. Williams (1938) suggested that, in choosing the appropriate rate, the return on alternative and less risky assets like Treasury bills and bonds must be taken into account, as well as the uncertainty inherent in the long-run estimate of future cash dividends. The idea was that the appropriate market return had to compensate investors for the risk taken; the market return should therefore exceed the rate on less risky assets. Since bonds are considered to be less risky than stocks, and denoting by \( RP \) the risk premium for holding stocks, equation (8) can be restated as

\[
\frac{E}{P} = Y + RP = \left(1 + \frac{RP}{Y}\right)Y = M \times Y,
\]

where \( M = 1 + \frac{RP}{Y} \) denotes a multiplier on \( Y \). In the Graham and Dodd model \( M \geq 1 \) because the risk premium is strictly positive. On the other hand, in its most popular form, the Fed model states that in equilibrium the stock market earnings yield should equal the long-term bond yield

\[
\frac{E}{P} = Y.
\]

Apparently, the Fed model is a special case of the DDM. The Fed model can be reconciled with the existing financial theory under very restrictive assumptions. Specifically, the Fed model is valid when either all earnings are paid out as dividends \( (E = D) \) or the return on new investment equals the required rate of return \( (k^* = k) \), there is no growth in dividends \( (g = 0) \), and the investors require no more return from stocks than from bonds \( (RP = 0) \). Additionally, the Fed model can be justified in a special case where \( k - g = Y \), that is, when the bond yield equals the required rate of return less the growth rate of dividends.

In sum, most of the academics have concluded that the Fed model is inconsistent with a rational valuation of the stock market (see, for instance, Ritter and Warr (2002), Asness (2003), Campbell and Vuolteenaho (2004), Estrada (2006), Estrada (2009), Sharpe (2002), and Feinman (2005)). From a theoretical point of view, the Fed model can be partially explained by the “money illusion” hypothesis (see Campbell and Vuolteenaho (2004), Cohen, Polk, and Vuolteenaho (2005), and Feinman (2005)). Money illusion is the tendency of investors to discount future cash flows using nominal, rather than real, interest rates. In our context, if investors project future dividends in real terms but discount them using nominal rates, they arrive to a lower estimate for the earnings yield. Bekaert and Engstrom (2010) demonstrate
that the Fed model can be reconciled with modern asset pricing theory under assumptions that
the investors exhibit habit-based risk aversion and expect increased inflation during recessions.
Finally, Asness (2000) and Asness (2003) present a behavioral explanation for the Fed model.
Specifically, Asness conjectures that the relation between stock earnings and bond yields is
influenced by the experience of each generation of investors with each asset class. Asness
shows that starting from the mid-1950s the riskiness of stocks have been decreasing while the
riskiness of bonds have been increasing. As a result, starting from 1960s the investors might
perceived stocks and bonds to be of similar riskiness.

Even though the Fed model has often been criticized on theoretical grounds, empirical sup-
port for this model is found in many academic studies (Lander, Orphanides, and Douvogiannis
(1997), Koivu et al. (2005), Berge, Consigli, and Ziemba (2008), Maio (2013), Lleo and Ziemba
(2015), Lleo and Ziemba (2017)). However, several academic studies report that the Fed model
is supported by data that starts from around 1960 only (Asness (2000), Asness (2003), Estrada
(2006), Estrada (2009)). Prior to this date, there is no empirical support for the Fed model.

3 Data

The data for the study in this paper are the quarterly price of the Standard and Poor’s
Composite stock price index, earnings on this index, and the long-term government bond
yield. The data spans the long-run historical period from the 1st quarter of 1871 till the 4th
quarter of 2017. The data on the earnings on the S&P Composite index and the long-term
government bond yield are provided by Robert Shiller. The data on the S&P Composite index
come from two sources. The price index for the period 1926 to 2017 is from the Center for
Research in Security Prices (CRSP); these data are provided by Amit Goyal. The price index
for the period 1871 to 1925 is provided by Goetzmann, Ibbotson, and Peng (2001). Using the

4See http://www.econ.yale.edu/~shiller/data.htm.
5Even though Robert Shiller also provides data on the S&P Composite stock price index, these data cannot
be used in our analysis. The reason is that Robert Shiller constructs the price index using the average of high
and low monthly prices. Averaging high and low prices introduces a large first-order serial correlation problem
for stock returns, see Working (1960).
6Downloaded from http://www.hec.unil.ch/agoyal/. These data were used in the widely cited paper by
Goyal and Welch (2008).
7See https://som.yale.edu/faculty-research/our-centers-initiatives/international-center-finance/data/historical-newyork. To check the robustness of our findings, we also used the price data for
the period 1871 to 1925 provided by Schwert (1990). We found that regardless of the choice of the price index
for the period 1871 to 1925, our empirical results remain intact.
earnings and prices we compute the Earnings-to-Price ratio (E/P). Figure 1 plots the original data series.

Figure 1: The original data series: quarterly Earnings-to-Price ratio (E/P) and the long-term government bond yield (Yield).

4 Econometric Methodology

4.1 Testing for Structural Breaks

Consider the standard linear regression model

$$y_t = x'_t \beta_t + u_t, \quad t = 1, \ldots, T,$$

where at time $t$, $y_t$ is the observation of the dependent variable, $x_t$ is the $k \times 1$ vector of observations of the independent variables, $\beta_t$ is the $k \times 1$ vector of unknown regression coefficients, and $u_t$ is an unobservable disturbance term. We are interested in the null hypothesis that $\beta_t = \beta_0$ for all $t$ against the alternative that $\beta_t$ varies over time. To test the null hypothesis, we employ the recursive CUSUM test (Brown, Durbin, and Evans (1975), Krämer, Ploberger, and Alt (1988), Ploberger and Krämer (1992)).

The recursive CUSUM test starts with the recursive least-squares estimates of $\hat{\beta}_n$ based on the first $n$ observations, $n = k + 1, \ldots, T$. This procedure gives $T - k$ estimates ($\hat{\beta}_{k+1}, \ldots, \hat{\beta}_T$).
Each of the estimates is obtained using

\[ \hat{\beta}_n = (X'_nX_n)^{-1}X'_ny_n, \quad n = k + 1, \ldots, T, \]

where \( X_n \) is the \( n \times k \) matrix of observations of the independent variables up to time \( n \) and \( y_n \) is the \( n \times 1 \) vector of observations of the dependent variable up to time \( n \). Visual examination of the graph of the recursive estimates of \( \hat{\beta}_n \) can be useful in evaluating the stability of the model parameters. If \( \beta_t \) is constant over time, then \( \hat{\beta}_n \) should quickly stabilize at some level.

The recursive CUSUM test uses the standardized errors from the recursive one-step ahead forecast of \( y_t \) based on \( \hat{\beta}_{t-1} \)

\[ w_t = \frac{y_t - x'_t\hat{\beta}_{t-1}}{\sqrt{1 + x'_t(X'_{t-1}X_{t-1})^{-1}x_t}}. \]

The recursive CUSUM statistics is defined by

\[ CUSUM_t = \frac{1}{\hat{\sigma}_w\sqrt{T-k}} \sum_{n=k+1}^{t} w_n, \quad t = k + 1, \ldots, T, \]

where \( \hat{\sigma}_w = \frac{1}{T-k} \sum_{n=k+1}^{T} (w_n - \bar{w})^2 \) is the estimated standard deviation of \( w_n \) and \( \bar{w} \) is the average value of \( w_n \). When the number of observations increases, \( CUSUM_t \) converges in distribution to the standard Wiener process (a.k.a. Brownian motion). Under the null hypothesis of no structural breaks, the mean value of \( CUSUM_t \) is zero and the standard deviation is \( \sqrt{T-k} \). Therefore, the p-value of the test is determined by the probability of a Wiener process crossing the standard pair of linear boundaries \( b_t = \lambda(1+2t) \) or \( b_t = -\lambda(1+2t) \), where \( \lambda \) depends on the significance level \( \alpha \) of the test (Brown et al. (1975)). Visual examination of the graph of CUSUM can be useful in identifying the structural breaks. Specifically, straight lines in a graph correspond to periods of no structural change, whereas sustained changes in CUSUM slope signify that a change has occurred. The slope inflection point indicates when the change happened (or became observable).
4.2 Detecting the Breakpoints

The foundation for estimating a single break in time series regression models was given by Bai (1994) and was further extended to multiple breaks by Bai (1997), Bai and Perron (1998), and Bai and Perron (2003). We assume that there are \( m \) breakpoints in the standard linear regression model given by equation (9), where the coefficients shift from one stable regression relationship to a different one. Specifically, we assume that there are \( m + 1 \) segments in which the regression coefficients are constant, and model (9) can be rewritten as

\[
y_t = x_t' \beta_j + u_t, \quad t = t_{j-1} + 1, \ldots, t_j, \quad j = 1, \ldots, m, \tag{10}
\]

where \( j \) is the segment index and \( t_1, \ldots, t_m \) denotes the set of the breakpoints (this set is also called \( m \)-partition). By convention \( t_0 = 0 \) and \( t_{m+1} = T \).

The dating of structural changes is performed as follows. Given an \( m \)-partition \( t_1, \ldots, t_m \), the least-squares estimates for the \( \beta_j \) can easily be obtained. The resulting total residual sum of squares is given by

\[
\text{RSS}(t_1, \ldots, t_m) = \sum_{j=1}^{m+1} \text{rss}(t_{j-1} + 1, t_j),
\]

where \( \text{rss}(t_{j-1} + 1, t_j) \) is the residual sum of squares in the \( j \)th segment. The problem of dating structural changes is to find the breakpoints \( \hat{t}_1, \ldots, \hat{t}_m \) that minimize the following objective function

\[
(\hat{t}_1, \ldots, \hat{t}_m) = \arg \min_{t_1, \ldots, t_m} \text{RSS}(t_1, \ldots, t_m)
\]

over all feasible partitions \( (t_1, \ldots, t_m) \). To find the global minimum of the objective function, we employ the dynamic programming approach suggested by Bai and Perron (2003).

4.2.1 Vector Error Correction Model

Two non-stationary data series \( x_t \) and \( y_t \) are said to be co-integrated if their linear combination is stationary. In our context, the evidence of co-integration is established if the disturbance term, \( u_t \), in the linear regression

\[
y_t = \beta x_t + u_t, \tag{11}
\]

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is stationary. If we find this to be the case, the condition $y_t = \beta x_t$ is interpreted as the long-run equilibrium relationship between the two data series, whereas the disturbance term $u_t$ is interpreted as the deviation from the long-run equilibrium.

Engle and Granger (1987) provide a representation theorem stating that, if two data series are co-integrated, then there exists a vector error correction representation taking the following form:

$$
\Delta x_t = c_1 + \text{lagged}(\Delta x_t, \Delta y_t) + \gamma_1 u_{t-1} + \varepsilon_{1,t},
$$

$$
\Delta y_t = c_2 + \text{lagged}(\Delta x_t, \Delta y_t) + \gamma_2 u_{t-1} + \varepsilon_{2,t},
$$

where either $\gamma_1 \neq 0$ or $\gamma_2 \neq 0$ or both. The vector error correction model (VECM) given by (12) is the vector autoregressive model (VAR) in the first differences with one lagged error correction term. In the VECM above, the changes in $\Delta x_t$ and $\Delta y_t$ are caused by the previous changes in these variables and the changes in $u_{t-1}$. The $\gamma_i$ coefficients are the error-correction coefficients. They measure the response of each variable to the degree of deviation from long-run equilibrium in the previous period. We expect $\gamma_i < 0$. This is because if, for example, $y_{t-1}$ is above its long-run value in relation to $x_{t-1}$, then the error-correction term is positive and this should lead, other things being constant, to downward movement in $y_t$.

In a VECM, there are two possible sources of causality (Granger (1988)). For example, the change in $\Delta y_t$ may be caused by the changes in the lagged values of $\Delta x_t$ and/or by the changes in $u_{t-1}$ if $\gamma_2 \neq 0$. The first source of causality if often interpreted as a “short-run” causality in the sense that the dependent variable responds to the short-term shocks in the independent variable. The second source of causality if often interpreted as a “long-run” causality in the sense that the dependent variable responds to the deviations from the long-run equilibrium.
5 Empirical Analysis of the Relationship Between Stock Earnings and Bond Yields

5.1 Structural Breaks in the Relationships

Our linear regression model is given by

\[ \ln \left( \frac{E_t}{P_t} \right) = \beta \ln(Y_t) + u_t. \] (13)

We perform the recursive beta estimates and plot the estimated beta, \( \hat{\beta} \), as well as the boundaries of the 95% confidence interval for beta, in Figure 2, Panel A. We also compute the recursive CUSUM process and plot it with the boundaries of the 5% significance level in Figure 2, Panel B. The graph in Panel A shows that the recursive beta is not stable. On the contrary, there are substantial time-variations in its value. Specifically, its value generally increases till the late 1950s (except the period from the mid 1880 to the mid 1910s) and decreases rather sharply afterwards. Thus, the recursive beta indicates that a major structural change occurred in the late 1950s. The recursive CUSUM process in Panel B exceeds its boundary. Hence, there is evidence for a structural change (this evidence becomes apparent around the year 1940). Furthermore, the process seems to indicate three major changes: the first one in the mid-1930s, the second one in the late 1950s, and the third one around the year 2010. Overall, both graphs indicate that a very substantial structural change occurred in the late 1950s.

5.2 Breakpoints Detection

We implement the procedure of detecting the breakpoints for \( m = 0, \ldots, 4 \). Table 1 reports the breakpoints for \( m \)-segmented models as well as the associated total residual sum of squares (RSS) and the Bayesian information criterion (BIC). In principle, both RSS and BIC can be used as a model selection criterion. However, Bai and Perron (2003) advocate for employing BIC as the most suitable model selection criterion. The results of the breakpoint detection procedure can be summarized as follows. The most important breakpoint (when \( m = 1 \)) is detected in the year 1958. The date of this breakpoint agrees very well with the results of both the recursive beta and CUSUM tests. The BIC selects a model with \( m = 2 \) breakpoints where
Figure 2: Panel A plots the recursive beta estimates for $\ln \left( \frac{E_t}{P_t} \right) = \beta \ln(Y_t) + u_t$. Shaded area highlights the boundaries of the 95% confidence interval for beta. Panel B plots the recursive CUSUM process for $\ln \left( \frac{E_t}{P_t} \right) = \beta \ln(Y_t) + u_t$. Shaded area highlights the boundaries of the 5% significance level.

The breakpoint of secondary importance is identified in the year 1929.

To sum up, our analysis identifies 2 major breakpoints in the relationship between the price-to-earnings ratio and the bond yield. These 2 breakpoints divide the total historical period into 3 segments. Table 2 reports the estimated value of $\beta$ for each segment of the model with $m = 2$ breakpoints. Figure 3 plots the original data series and the fitted model for each segment.

| $m$ | Breakdates | BIC  | RSS |
|-----|------------|------|-----|
| 0   |            | 1135.71 | 232.44 |
| 1   | 1958 Q3    | 820.23 | 133.01 |
| 2   | 1929 Q2 1958 Q2 | 645.85 | 96.75 |
| 3   | 1900 Q1 1929 Q2 1958 Q3 | 648.53 | 95.11 |
| 4   | 1900 Q1 1929 Q2 1958 Q3 1987 Q4 | 654.44 | 94.01 |

Table 1: Results of detecting multiple breakpoints. $m$ denotes the number of breakpoints. BIC denotes the Bayesian information criterion. RSS denotes the total residual sum of squares.

| Historical segment | $\beta$ |
|--------------------|---------|
| 1871 Q1 - 1929 Q2  | 1.42    |
| 1929 Q3 - 1958 Q3  | 2.05    |
| 1958 Q4 - 2017 Q4  | 0.99    |

Table 2: Results of the estimation of $\ln \left( \frac{E_t}{P_t} \right) = \beta \ln(Y_t) + u_t$ over 4 historical segments associated with 3 breakpoints. For all historical segments, $\beta$ is statistically significantly different from zero at the 1% level.
5.3 Causality Relationship Between the Stock’s Earnings and Bond Yields

Our hypothesis is that there exists an equilibrium relationship between the stock market E/P ratio and the bond yield. This relationship is given by equation (13). The results reported in the previous sections provide the evidence of existence of two major breaks in this relationship. Therefore, our refined hypothesis is that there exists a particular equilibrium relationship between the stock market E/P ratio and the bond yield over each of the three following segments of historical data: 1871 Q1 - 1929 Q2, 1929 Q3 - 1958 Q3, and 1958 Q4 - 2017 Q4. On each segment, the error correction term is obtained from the linear regression given by equation (13)

\[ u_t = \ln \left( \frac{E_t}{P_t} \right) - \beta \ln(Y_t). \]  

The first step in the estimating VECM is to study the stationarity properties of our variables: \( \ln \left( \frac{E_t}{P_t} \right), \ln(Y_t), u_t, \Delta \ln \left( \frac{E_t}{P_t} \right), \) and \( \Delta \ln(Y_t). \) This is done by performing the augmented Dickey-Fuller (ADF) unit root test (Dickey and Fuller (1979)) which results are reported in Table 3. The results of the unit root tests are very similar for the 1st and 3rd segments. Specifically, on each of these two segments the log of the E/P ratio and the log of the bond yield are non-stationary, whereas their first differences are stationary. We can reject the null hypothesis of unit root in the error correction term at the 1% significance level. When
it comes to the 2nd segment of data, we cannot reject the null hypothesis of unit root in the error correction term. Consequently, the unit root test suggests that there is an equilibrium relationship between the stock market E/P ratio and the bond yield on the 1st and 3rd segments of data, but there is no equilibrium relationship on the 2nd segment of data.

| Historical segment | ADF test statistics |
|--------------------|---------------------|
|                    | ln \((E_t/P_t)\) | ln\((Y_t)\) | \(u_t\) | \(\Delta \ln (E_t/P_t)\) | \(\Delta \ln (Y_t)\) |
| 1871 Q1 - 1929 Q2  | -0.62              | -1.10         | -3.44    | -8.44          | -7.14          |
| 1929 Q3 - 1958 Q3  | -0.51              | 0.16          | -1.45    | -7.92          | -6.65          |
| 1958 Q4 - 2017 Q4  | -0.97              | -0.62         | -3.68    | -9.34          | -12.55         |

Table 3: Results of the augmented Dickey-Fuller unit root test. Critical values of the test statistics are -2.58, -1.95, and -1.62 at the 1%, 5%, and 10% significance level respectively.

We determine the number of lags in the VECM given by equation (12) using BIC as the selection criterion and setting the maximum lag length of 5. On each historical segment, BIC selects 1 lag. As a result, our VECM is given by

\[
\Delta \ln (E_t/P_t) = c_1 + \alpha_1 \Delta \ln (E_{t-1}/P_{t-1}) + \theta_1 \Delta \ln (Y_{t-1}) + \gamma_1 u_{t-1} + \varepsilon_{1,t},
\]

\[
\Delta \ln (Y_t) = c_2 + \alpha_2 \Delta \ln (E_{t-1}/P_{t-1}) + \theta_2 \Delta \ln (Y_{t-1}) + \gamma_2 u_{t-1} + \varepsilon_{2,t}.
\]

Table 4 presents the results of the estimation of VECM given by (15) on each of the three historical segments. In particular, this table reports parameter estimates and p-values (in parenthesis) from the VECM for three historical segments. As summary equation statistics, the table reports R-squared \((R^2)\) and p-values of F-statistic for testing the joint significance of the regressors \((\text{Prob}(F\text{-statistics}))\). The \(R^2\) statistic measures the success of the regression in predicting the values of the dependent variable and may be interpreted as the fraction of the variance of the dependent variable explained by the regressors. The reported F-statistic p-values are from a test of the hypothesis that all the coefficients (excluding the intercept) in a regression are zero. If the p-value is less than a specified significance level, say 5%, the null hypothesis, that all equation coefficients are equal to zero, is rejected.

The results of the estimation of the VECM indicate the presence of persistence in the changes of \(\Delta \ln (Y_t)\) on the 1st and 2nd historical segments, and in the changes of \(\Delta \ln (E_t/P_t)\) on the 1st and 3rd segments. Specifically, the autoregressive term in the equation for \(\Delta \ln (Y_t)\) is positive and statistically significant at the 1% level on the 1st and 2nd segment. In addition,
The autoregressive term in the equation for $\Delta \ln (E_t/P_t)$ is positive and statistically significant at the 1% level on the 1st and 3rd segment. Therefore, on the 1st and 2nd segments the changes in the bond yield can be partially explained by its lagged values. Similarly, on the 1st and 3rd segments the changes in the E/P ratio can be partially explained by its lagged values.

Our primary interest in using VECM is to find out whether there is evidence of Granger causality between the two variables and, if the answer is affirmative, to investigate the direction of causality. Since in our VECM there is only one lag of each of the independent variables, the evidence of Granger causality can be established through the significance of the regression coefficients. For example, the evidence of the short-run causality from the E/P ratio to the bond yield becomes apparent if the coefficient $\alpha_2$ is statistically significantly different from zero. Similarly, the evidence of the long-run causality from the error correction term to the bond yield can be established if the coefficient $\gamma_2$ is statistically significantly different from zero.

Table 5 reports the results on the Granger causality between the two variables. These results can be summarized as follows. On the 2nd historical segment of data, there is neither short-run nor long-run causality between the stock market E/P ratio and the bond yield. On the 1st and 3rd segments of data, both the changes in the bond yield and the error correction term Granger-cause the changes in the stock market E/P ratio. Specifically, in the short-run there is Granger causality running from the bond yield to the E/P ratio and in the long-
run there is Granger causality running from the error correction term to the E/P ratio. The regression coefficients have the correct signs: $\theta_1 > 0$ and $\gamma_1 < 0$. This fact tells us that the changes in the bond yield cause the adjustments in the P/E ratio both in the short-run and the long-run. In particular, an increase in the bond yield in period $t - 1$ tends to cause an increase in the E/P ratio through itself and through the error correction term.

In contrast, our results suggest that there is no Granger causality running from the stock market E/P ratio to the bond yield. The coefficient of the error correction term, $\gamma_2$, is never statistically significantly different from zero. Thus, there is no long-run causality running from the error correction term to the bond yield. Similarly, the coefficient $\alpha_2$ is never statistically significantly different from zero. Consequently, there is no short-run causality running from the P/E ratio to the bond yield. Therefore, the bond yield can be considered as an exogenous variable.

Overall, our results advocate that there was equilibrium relationship between the stock market E/P ratio and the bond yield on the 1st and 3rd segment of historical data. On both segments, there was a unidirectional short- and long-run Granger causality running from the bond yield to the E/P ratio. In other words, on both segments the E/P ratio followed the bond yield in both the short-run and the long-run, but not the other way around. On the 2nd segment of data, on the other hand, there was no relationship between the stock market E/P ratio and the bond yield.

Table 5: Results of the Granger causality test. The null hypothesis is the absence of Granger causality. “Yes” denotes the rejection of the null hypothesis, whereas “No” denotes that we cannot reject the null hypothesis.

| Historical segment | Granger causality | Short-run | Long-run |
|--------------------|------------------|-----------|----------|
| Panel A : Dependent variable $\Delta \ln \left( \frac{E_t}{P_t} \right)$ | | | |
| 1871 Q1 - 1929 Q3 | Yes | Yes |
| 1929 Q4 - 1958 Q3 | No | No |
| 1958 Q4 - 2017 Q4 | Yes | Yes |
| Panel B : Dependent variable $\Delta \ln (Y_t)$ | | | |
| 1871 Q1 - 1929 Q3 | No | No |
| 1929 Q4 - 1958 Q3 | No | No |
| 1958 Q4 - 2017 Q4 | No | No |

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6 Key Forces Behind the Breaks in the Relationship Between Earnings and Bond Yields

This is the first of two sections devoted to explain what caused the breaks in the relationship between earnings and bond yields. We start in this section with investigating (1) the monetary policy and historical evolution of interest rates, and (2) the evolution of income tax rates and corporate dividend policy. The results from these two investigations are used and further analyzed, together with the “paradigm shift” in stock valuation theory, in our narrative discussion in subsequent Section 7.

6.1 Monetary Policy and the Evolution of Interest Rates

In our study we use exclusively government bonds which are debt securities issued by a government to support government spending. These securities are considered default-free. The US government borrows funds by means of selling Treasury bills (T-bills), Treasury notes (T-notes), and Treasury bonds (T-bonds). T-bills represent simple zero-coupon bonds with maturities ranging from 28 to 182 days. Both T-notes and T-bonds are coupon bonds. T-note maturities range up to 10 years, whereas T-bonds are issued with maturities ranging from 10 to 30 years.

Bond yield (a.k.a. yield to maturity, YTM) is a measure of the average bond return to an investor who purchases the bond and holds it until its maturity date. Because various bonds have different maturity dates, bond yields generally depend on the time to maturity. In our empirical study we use long-term bond yields. The average time to maturity of these bonds equals 10 years. Consequently, the time-\(t\) long-term bond yield represents the average bond return over the subsequent 10 years. The data on the long-term bond yields are provided by Robert Shiller.

In addition to the long-term bond yield, in this section we also consider the short-term interest rate. The data on the short-term interest rate is provided by Amit Goyal.\(^8\) The short-term interest rate for the period from 1920 to 2017 is the yield on the T-bills with time to maturity of about 1 month. Because there was no risk-free short-term debt prior to the 1920s,

\(^8\)Downloaded from \url{http://www.hec.unil.ch/agoyal/}. These data were used in the widely cited paper by Goyal and Welch (2008).
Goyal and Welch (2008) estimate it using the data for the Commercial Paper rates for New York.

In the context of our study, the short-term interest rate is highly relevant since in modern finance theory this rate serves as a proxy for the risk-free rate of return. This is because short-term government-issued securities have virtually zero risk of default and the return from these securities is known in advance with high precision. In contrast, the return from the long-term bonds is risk-free only when the investor holds them until maturity. If the investor sells long-term bonds before maturity, their (holding period) return is unknown in advance. Moreover, this return can be negative. This is why in modern finance the bonds with time to maturity longer than 3 months are considered risky.

Figure 4 plots the evolution of both the long-term bond yields and the short-term interest rates over the period from 1871 to 2017. The following observations can be made regarding the relationship between the short-term interest rate and the long-term bond yield/rate. First, both the interest rates tend to move in tandem. However, the relationship between the rates is not stable over time. Over the period from 1871 to about 1930, both interest rates moved largely together; the short interest rate was much more volatile than the long interest rate. Over the period from about 1930 to the end of 1940s, the short interest rate was much below the long-term bond yield. Starting from the early 1950s, both interest rates have again moved in tandem, but this time the short interest rate tended to lie below the long-term bond yield.

To sum up, our visual observation of the co-movements between the long-term bond yield and the short-term interest rate suggests that they tend to move in tandem, but the relationship is not stable over time. Therefore, it is interesting to analyze the breakpoints in the relationship

\[ R_t = \beta Y_t + u_t, \]

where \( R_t \) and \( Y_t \) denote the time-\( t \) short interest rate and long-term bond yield respectively. We implement the procedure of detecting the breakpoints for \( m = 0, \ldots, 3 \); the same procedure used to detect the breakpoints in the relationship between the stock earnings and bond yields. Table 6 reports the breakpoints for \( m \)-segmented models as well as the values of the associated RSS and BIC. The most relevant result of the breakpoint detection procedure is the following: the two major breakpoints in the relationship between the long-term bond yield and the short-
Figure 4: The long-term bond yields versus the short-term interest rates. Vertical dashed lines show the location of the two major breakpoints in the relationship between the short and long interest rates ($R_t = \beta Y_t + u_t$).

term interest rate are 1930 Q1 and 1959 Q1; these breakpoints largely coincide with the two major breakpoints in the relationship between the stock earnings and bond yields.

Table 6: Results of detecting multiple breakpoints. \( m \) denotes the number of breakpoints. BIC denotes the Bayesian information criterion. RSS denotes the total residual sum of squares.

| \( m \) | Breakdates | BIC     | RSS   |
|--------|------------|---------|-------|
| 0      | 1908 Q2    | 2074.4  | 1187.7|
| 1      | 1930 Q1    | 1968.1  | 967.4 |
| 2      | 1928 Q4    | 1986 Q4 | 1884.6| 801.7 |

Table 7 reports the estimated value of \( \beta \) for each segment of the model with \( m = 2 \) breakpoints. It is interesting to observe that before 1930 the relationship was \( R = 1.04 \times Y \). That is, the short interest rate was slightly above the long interest rate. Starting from 1959, the relationship became \( R = 0.80 \times Y \). In words, the short interest rate have been notable below the long interest rate. Judging by the goodness of fit (the value of R-squared statistics), the relationship between the short interest rate and the long-term bond yield was very strong before 1930 and after 1959.

To understand the historical evolution of interest rates, we need to learn who determines them. In the US, the level of interest rates is determined by the Federal Reserve System (a.k.a. the Federal Reserve or simply the Fed), which represents the central banking system. The Fed
Table 7: Results of the estimation of $R_t = \beta Y_t + u_t$ over 3 historical segments associated with 2 major breakpoints. For all historical segments, $\beta$ is statistically significantly different from zero at the 1% level. $R^2$ denotes the goodness of fit (R-squared statistics).

| Historical segment       | $\beta$ | $R^2$ |
|--------------------------|---------|-------|
| 1871 Q1 - 1930 Q1        | 1.04    | 0.93  |
| 1930 Q2 - 1959 Q1        | 0.38    | 0.61  |
| 1959 Q2 - 2017 Q4        | 0.80    | 0.94  |

was created on December 23, 1913. Over the period from 1871 to 1914 the level of interest rates was determined chiefly by market forces of supply and demand. The level of interest rates was rather stable mainly due to the existence of the gold standard.

As specified by the US Congress in the Federal Reserve Act (from December 23, 1913), the Fed should conduct the appropriate monetary policy in order to achieve: maximum employment, stable prices, and moderate long-term interest rates. The Fed conducts the monetary policy by managing the level of short-term interest rates and influencing the availability and cost of credit in the economy. Monetary policy directly affects the level of short and long interest rates and indirectly affects the US dollar exchange rates. Through these channels, monetary policy influences spending, investment, production, employment, and inflation in the US.

In particular, when an economy is in a recession, the Fed conducts an expansionary policy by lowering the short-term interest rate and increasing the money supply. In contrast, when an economy is in a state where growth is at a rate that is getting out of control, the Fed conducts a contractionary policy by increasing the short-term interest rate and reducing the money supply. The Fed is also able to influence the level of long-term interest rates by buying or selling long-term government bonds.

In the aftermath of the stock market crash of 1929 and the beginning of the Great Depression, the Fed started to decrease the short-term interest rate. Specifically, the short-term interest rate fell from about 5% in the late 1920s to less than 1% in the early 1930s. The long-term bond yield was also reduced by half (from about 5% to approximately 2.5%) over the same period. In April 1942, about five months after the US entered the World War II (WWII), the Department of Treasury requested the Fed to commit to (pegging) an interest rate of 3/8 per cent on Treasury bills. The rate on long-term bonds was capped at 2.5% (Hetzel and Leach (2001)). This low interest rate was requested to accommodate the war financing.
The WWII was also financed by creating new money. As a result, from 1941 to 1948 the average annualized inflation rate in the US was 7%.

After the war, the authorities were afraid of a new depression, but the real threat to the economy turned out to be high inflation. From 1946 to 1948 the average inflation rate was 11% (Hetzel and Leach (2001)). In July 1947, the pegged rate on Treasury bills was increased, but not enough given the economic conditions. President Harry Truman was convinced that the “government had a moral obligation to protect the market value of the war bonds purchased by patriotic citizens” (Hetzel and Leach (2001)). In other words, the president wanted to have a low, pegged interest rate.

The opposing views of the president and the Treasury, which wanted to peg the interest rate, and the Fed, which saw the need for an increase in the interest rate, turned into a tense relationship. The beginning of the Korean war in June 1950, and a possible conflict with China and the Soviet Union, pushed the inflation even higher. In February 1951, the annualized inflation rate was 21%, and the pressure to raise the interest rate and remove the pegging on the Treasury bills increased. The Fed announced it would no longer support the policy outlined by the Treasury. Finally, the Treasury and the Fed came to an agreement on March 4, 1951. “The Treasury and the Federal Reserve System have reached full accord with respect to debt-management and monetary policies to be pursued in furthering their common purpose to assure the successful financing of the Government’s requirements and, at the same time, to minimize monetization of the public debt”. (March 4th, 1951 statement quoted in Hetzel and Leach (2001), page 51). And finally, the Fed “succeeded in freeing itself from the shackles with which the Treasury had earlier bound it and reattained its long desired former independence” (Friedman and Schwartz (1963), page 625).

Finally in this section we would like to summarize the reasons for the two major structural breaks in the relationship between the short-term interest rates and the long-term bond yields. Until 1914, the level of interest rates was determined by market forces of supply and demand. The short-term interest rate was slightly above the long-term interest rate. After the creation of the Fed, it started to pursue an active monetary policy. Since the major goal of the Fed is to support the economy during the periods of economic crisis, expansionary economic policy (when the Fed lowers the short-term interest rate) predominates over the contractionary economic policy (when the Fed increases the short-term interest rate). The first major Fed intervention
occurred in the early 1930s when the Fed decreased substantially the level of the short-term interest rate. Since that time, the short-term interest rate has been notably below the long-term bond yield. Because of the Great Depression during the decade of 1930s and the subsequent World War II, both the short-term and long-term interest rates were kept on artificially lower levels until the early 1950s. The Fed monetary policy is responsible for the break in the relationship in 1930 and the establishment of the new weaker relationship between the short-term and long-term interest rates. From the early 1950s the fixed income markets in the US were deregulated and both the short-term and long-term interest rates started to increase. However, according to our structural break analysis, the re-establishment of the modern strong relationship occurred only by the end of 1950s.

6.2 Evolution of Income Tax Rates and Corporate Dividend Policy

In the US, the modern individual tax era was born in 1913 when the states ratified the 16th Amendment to the Constitution that authorized Congress to “collect taxes on incomes, from whatever source derived, without apportionment among the several states, and without regard to any census or enumeration.” Since that time, the income tax in the US has been determined by applying a tax rate, which increases as income increases. For example, in 1913 the individuals with the lowest income had to pay 1% income tax (lowest bracket), whereas the individuals with the highest income were bound to pay 7% income tax (highest bracket or top rate). Figure 5 plots the evolution of the top individual income tax rates on dividends, long-term capital gains, and all other income\(^9\) in the US from 1913 to 2017.

First, let us consider the evolution of the top individual tax rate on all income but the dividends and capital gains from stock and bond investment. To finance the WWI, the US government increased the top income tax rate to 15% in 1916 and then to 77% in 1918. For the US, the WWI officially ended in 1921 when it signed separate peace treaties with Germany, Austria, and Hungary. The top marginal tax rate was reduced to 58% in 1922, to 25% in 1925, and finally to 24% in 1929. After the stock market bubble burst in 1929, the US fell into its worst economic period of the twentieth century, the Great Depression. In 1932 the top marginal tax rate was increased to 63% and then to 79% in 1936. During the period from

\(^9\)Data sources are: https://fred.stlouisfed.org/, http://www.worldtaxdatabase.org/, and http://www.insidegov.com/;
1940 to 1945, the top marginal income tax rate was further increased to 94% to finance the WWII. Even though the WWII ended in 1945, it took two decades before the income tax rates were lowered. Starting with the Revenue Act of 1964, the top marginal tax rate was lowered to 77%, and then to about 70% over the period from 1965 to 1981. The top marginal tax rate for individuals was lowered to 50% for tax years 1982 through 1986. In 1988 the top tax rate dropped to 28%. Finally, over the period from 1993 to 2017 the top marginal tax rate lied in between 35% and 40%.

Second, consider the evolution of the top individual income tax rate on interest on bonds and stock dividends. In the beginning of the modern individual tax era, interest on bonds and dividends paid to shareholders were exempt from taxation to 1953, except for a four-year period from 1936 to 1939 where dividends were taxed at an individual’s income tax rate. Beginning from 1954, dividends started to be fully taxed at an individual’s income tax rate. Only in 2003 the dividend tax rate was lowered to 15%.

Third, examine the evolution of the top individual tax rate on long-term capital gains on financial securities (bonds and stocks held for more than a year). Whereas any profits recognized from short-term gains are taxed as ordinary income, long-term gains are taxed at a much lower rate. Only in the beginning of the modern individual tax era the capital gains were taxed at a rate greater or equal to that for interest and dividends. From 1954 to 2003,
long-term capital gains were taxed at one-half, or less, of the rate applicable to interest and dividends. Over the period from 1954 to 1969, the interest and dividends were taxed at a rate that was at least three times as high as that for the long-term capital gains.

In the rest of this section we argue that the key event that significantly altered the corporate dividend policy in the US was the sudden introduction of extremely large income taxes on stock dividends in 1954. In particular, beginning from 1954 the income on stock dividends was taxed at an individual’s income tax rate; from 1954 to 1963 the top marginal tax rate was 91%. In contrast, the tax rate on long-term capital gains was only 25%. “Hence, tax considerations introduced a bias in favour of price appreciation and against current dividend income” (Vatter (1963), page 200). Buying high paying dividend common stocks no longer made sense for wealthy investors. In response to the huge income taxes on dividends, the firms took action to protect their shareholders’ income first by reducing the dividends and then by replacing dividends by share repurchase.

Specifically, in order to protect the shareholders’ income, the firms’ goal was to increase capital gains (that is, share price growth) at the expense of reducing dividends. The valuation formula given by equation (7) suggests that as long as the return on new investment is greater than the required rate of return, \( k^* > k \), decreasing the payout ratio increases the stock price.\(^{10}\) Put differently, by retaining more of its earnings the firm can increase its growth rate and, hence, increase the share price. Even if the return on new investment is lower than the required rate of return, the firm can increase share price by share repurchase.\(^{11}\) In the seminal paper by Miller and Modigliani (1961), the authors showed that the firm’s dividend policy is irrelevant as long as the firm holds a fixed investment policy. Therefore, the stock valuation formula given by equation (5) remains valid when the firm uses the amount of \( D = b \times E \) for share repurchase instead of paying this amount as dividends.

In sum, in order to increase capital gains at the expense of reducing dividends, the firms had two policies at their disposition: either to invest more in new projects or undertake share repurchase. However, although share repurchase programs have never been explicitly prohibited in the US, firms were reluctant to repurchase shares because of the potential risk of

\(^{10}\)In particular, the sign of the first-order derivative of \( P \) with respect to \( b \) is determined by \( k - k^* \). If \( k^* > k \), then the sign is negative. This means that increasing the payout ratio decreases the stock price. Conversely, decreasing the payout ratio increases the stock price.

\(^{11}\)Share repurchase increases the price of the remaining shares. The investors can subsequently sell shares to create a “homemade dividend”. The homemade dividend is then taxed according to the capital gains tax rate.
being charged with illegal market manipulation.\footnote{In accordance with the antimanipulative provisions of the Securities Exchange Act of 1934, the SEC has occasionally charged companies with illegally manipulating their stock prices during share repurchase programs.} “Only in 1982 the SEC adopted Rule 10b-18, which provides a safe harbor for repurchasing firms against the antimanipulative provisions of the Securities Exchange Act (SEA) of 1934” (Grullon and Michaely (2002)). A study from Straehl and Ibbotson (2017) showed that this rule really “opened up the floodgates for firms to start repurchasing their stock en masse.”

The introduction of huge income taxes on dividends in 1954 and the adoption of Rule 10b-18 in 1982 had critical spillover effects. In particular, these two events exerted a significant impact on the dynamics of several relationships and caused structural breaks in these relationships. Below in this section we apply the econometric methodology of detecting structural breaks to demonstrate the spillover effects of these two events.

Lettau and Nieuwerburgh (2008) and Favero, Gozluklu, and Tamoni (2011) find that there are two statistically significant structural breaks in the mean of the log D/P ratio over the period from 1920 to 2008. We replicate their studies using a longer historical sample that spans the period from 1871 to 2017. Our linear regression model is given by

\[
\ln \left( \frac{D_t}{P_t} \right) = \alpha + u_t. \tag{16}
\]

We test the null hypothesis that the log of the dividend yield is constant through time \(\alpha = \alpha_0\) versus the alternative that \(\alpha\) varies over time. Table 8 reports the breakpoints for \(m\)-segmented models as well as the associated RSS and BIC. Both RSS and BIC select the model with 3 breakpoints. Table 9 reports the estimated value of \(\alpha\) for each segment of the model with \(m = 3\) breakpoints. Figure 6 plots the original data series and the fitted model for each segment.

| \(m\) | Breakdates   | BIC    | RSS   |
|------|--------------|--------|-------|
| 0    | 1988 Q3      | 701.02 | 110.98|
| 1    | 1988 Q3      | 272.86 | 52.43 |
| 2    | 1955 Q1, 1988 Q3 | 201.30 | 45.43 |
| 3    | 1915 Q4, 1954 Q2, 1988 Q3 | 138.51 | 39.95 |
| 4    | 1900 Q1, 1929 Q2, 1958 Q3, 1988 Q3 | 218.04 | 44.76 |

Table 8: Results of detecting multiple breakpoints for \(\ln \left( \frac{D_t}{P_t} \right) = \alpha + u_t\). \(m\) denotes the number of breakpoints. \(\text{BIC}\) denotes the Bayesian information criterion. \(\text{RSS}\) denotes the total residual sum of squares.

The most relevant results of this breakpoint detection procedure are as follows. One major
| Historical segment       | $\alpha$ |
|--------------------------|----------|
| 1871 Q1 - 1915 Q4        | 1.46     |
| 1916 Q1 - 1954 Q2        | 1.72     |
| 1954 Q3 - 1988 Q3        | 1.31     |
| 1988 Q4 - 2017 Q4        | 0.71     |

Table 9: Results of the estimation of $\ln \left( \frac{D_t}{P_t} \right) = \alpha + u_t$ over 4 historical segments associated with 3 breakpoints. For all historical segments, $\alpha$ is statistically significantly different from zero at the 1% level.

breakpoint in the constant log dividend yield model is 1954 Q2 which coincides with the introduction of the large taxes on dividends. As compared to the period prior to 1954 Q2, the dividend yield decreased notably. Another major breakpoint in the model is 1988 Q3. After this date, the dividend yield decreased almost by half. It is natural to attribute this decrease to massive share repurchase programs that took off after the adoption of Rule 10b-18 in 1982.

Figure 6: Original data series and fitted model for $\ln \left( \frac{D_t}{P_t} \right) = \alpha + u_t$ with 3 breakpoints. Vertical dashed lines show the location of the breakpoints.

So far the evidence shows that the mean dividend yield decreased two times since the mid-1910s. The question that remains unanswered is whether the reduction in the dividends was due to reduction in earnings or due to reduction in the retention rate or share repurchase programs. To answer this question, we consider the relationship between the logs of the
dividend and earnings yields

\[ \ln \left( \frac{D_t}{P_t} \right) = \beta \ln \left( \frac{E_t}{P_t} \right) + u_t. \]  

(17)

We test the null hypothesis that \( \beta = \beta_0 \) versus the alternative that \( \beta \) varies over time. Table 10 reports the breakpoints for \( m \)-segmented models as well as the associated RSS and BIC. Both RSS and BIC select the model with 3 breakpoints. Table 11 reports the estimated value of \( \beta \) for each segment of the model with \( m = 3 \) breakpoints.

| \( m \) | Breakdates | BIC  | RSS |
|-------|------------|------|-----|
| 0     |            | 298.83 | 56.00 |
| 1     | 1988 Q1   | 13.53 | 33.73 |
| 2     | 1946 Q4   | 1988 Q3 | 26.17 |
| 3     | 1900 Q1   | 1954 Q3 | 1988 Q3 | -123.09 | 26.17 |
| 4     | 1900 Q1   | 1929 Q2 | 1958 Q3 | 1988 Q3 | -100.22 | 26.05 |

Table 10: Results of detecting multiple breakpoints for \( \ln \left( \frac{D_t}{P_t} \right) = \beta \ln \left( \frac{E_t}{P_t} \right) + u_t \). \( m \) denotes the number of breakpoints. BIC denotes the Bayesian information criterion. RSS denotes the total residual sum of squares.

| Historical segment | \( \beta \) |
|--------------------|------------|
| 1871 Q1 - 1900 Q1 | 0.83       |
| 1900 Q2 - 1954 Q3 | 0.78       |
| 1954 Q4 - 1988 Q3 | 0.66       |
| 1988 Q4 - 2017 Q4 | 0.45       |

Table 11: Results of the estimation of \( \ln \left( \frac{D_t}{P_t} \right) = \beta \ln \left( \frac{E_t}{P_t} \right) + u_t \) over 4 historical segments associated with 3 breakpoints. For all historical segments, \( \beta \) is statistically significantly different from zero at the 1% level.

Again, our breakpoint detection procedure identifies two major breaks in 1954 Q3 and 1988 Q3. After each break, the dividend yield decreased with respect to the earnings yield. Apparently, the dividends were decreased with respect to earnings. This result verifies that the decrease in the dividend yield was caused first by increase in the retention rate and subsequently by replacing the dividends by share repurchase programs.

Finally in this section we want to demonstrate that since the introduction of huge taxes on dividends in 1954, the changes in the corporate dividend policy did manage to boost the share price growth. For this purpose we consider the following linear growth model for the log

\[ \text{One alternative possibility is to examine the model } D_t = \beta E_t + u_t. \]  

The problem with this model is that both \( D_t \) and \( E_t \) are non-stationary variables. It is well known that models with non-stationary variables often produce spurious results.
of the stock price

\[ \ln(P_t) = \delta + \gamma t + u_t. \]  \hspace{1cm} (18) 

The null hypothesis is that the log of the price growths with a constant rate \( \gamma = \gamma_0 \) versus the alternative that \( \gamma \) varies over time. Table 12 reports the breakpoints for \( m \)-segmented models as well as the associated RSS and BIC. For one more time, both RSS and BIC select the model with 3 breakpoints. Table 13 reports the estimated value of \( \gamma \) for each segment of the model with \( m = 3 \) breakpoints. Figure 7 plots the original data series and the fitted model for each segment.

| m | Breakdates | BIC | RSS |
|---|------------|-----|-----|
| 0 |            | 1162.99 | 240.86 |
| 1 | 1931 Q3 | 158.64 | 42.25 |
| 2 | 1954 Q1, 1954 Q4 | 74.79 | 35.46 |
| 3 | 1913 Q3, 1954 Q1, 1985 Q1, 1985 Q4 | 54.30 | 33.15 |
| 4 | 1900 Q3, 1930 Q1, 1954 Q1, 1988 Q3, 1988 Q1 | 115.43 | 35.61 |

Table 12: Results of detecting multiple breakpoints for \( \ln(P_t) = \delta + \gamma t + u_t \). \( m \) denotes the number of breakpoints. BIC denotes the Bayesian information criterion. RSS denotes the total residual sum of squares.

| Historical segment | \( \gamma \) |
|--------------------|-------------|
| 1871 Q1 - 1913 Q3 | 0.0062      |
| 1913 Q4 - 1954 Q1 | 0.0050      |
| 1954 Q2 - 1985 Q4 | 0.0101      |
| 1986 Q1 - 2017 Q4 | 0.0166      |

Table 13: Results of the estimation of \( \ln(P_t) = \delta + \gamma t + u_t \) over 4 historical segments associated with 3 breakpoints. For all historical segments, \( \gamma \) is statistically significantly different from zero at the 1% level.

Besides a break in 1913 Q3, our breakpoint detection procedure identifies two major breaks in 1954 Q1 and 1985 Q4. As compared to the second historical segment, after the break in 1954 Q1 the share price growth and, hence, the capital gain return had doubled. This break date coincides with the introduction of the large taxes on dividends. After the subsequent break in 1985 Q4, the share price growth has further increased by more than 60%. It is natural to attribute this additional boost in the share price growth to massive share repurchase programs that took off after 1982.

At the end of this section we would like to sum up the spillover effects caused by the introduction of taxes on dividends. Until 1954, the firms distributed income to their share-
holders in form of dividends that were virtually tax-exempt. The sudden introduction of huge taxes on dividends in 1954 created a substantial bias in favor of price appreciation and against dividend income. This bias made firms to change the corporate dividend policy. Since the introduction of taxes on dividends happened during the postwar economic boom (the period 1945-1970 is often called the “Golden Age of Capitalism”), the growth potential was substantial. After 1954, the corporation started to retain more of their earnings that were invested in new projects. This policy decreased the dividend yield but boosted the share prices. In the absence of growth potential, the firms could increase the share price by share repurchase programs. However, until 1982 the firms that were repurchasing shares could be accused of price manipulation. The adoption of new rule in 1982 provided a safe harbor for repurchasing firms. Since that time many firms started repurchasing own shares. These repurchase programs decreased additionally the dividend yield and increased price growth. In sum, the introduction of taxes on dividends in 1954 had an immediate effects in the form of a break in several relationships. The subsequent adoption of Rule 10b-18 in 1982 is also responsible for a break in several relationships that occurred during 1985-1988.
The aim of this section is to provide answers to the following two major questions. The first major question is: Why there was no relationship between the stock market E/P ratio and the bond yield over the period from 1929 to 1958? Answering this question also requires answering the following two sub-questions: Why the break in the relationship occurred in 1929? Why the relationship re-established in 1958? The second major question is: Why the multiplier in the relationship\(^{14}\) \( \frac{E}{P} = M \times Y \) has changed from \( M \approx 2 \) over the period from 1871 to 1929 to \( M \approx 1 \) over the period from 1958 to 2017? At first glance, it seems like starting from 1958 the investors have not required compensation for bearing the stock risk. However, such a straightforward conclusion apparently contradicts the modern finance theory because: (a) the dominant view among both academics and practitioners is that stocks are riskier than bonds and (b) the finance theory assumes that the investors require compensation for taking on risk.

The first sub-question, “Why the break in the relationship between the earnings and bond yields occurred in 1929?” is easy to answer. After the stock market crash in 1929 and the onset of the Great Depression, the Fed started to conduct an expansionary monetary policy by lowering the short-term interest rate to nearly zero and decreasing substantially the long-term interest rate. Due to the government needs to finance the WWII and subsequent recession that ended in 1949, the interest rates were de-regulated only in 1951. After the de-regulation, both short- and long-term rates started to increase.

To sum up, during the period from 1929 to 1951 the Fed held all interest rates on historically low and stable levels. This Fed policy explains the absence of the relationship between the earnings and bond yields over the aforementioned period. The second sub-question, “Why the relationship between the earnings and bond yields re-established in 1958?” is more difficult to answer given the fact that the interest rates were de-regulated earlier, in 1951. One possible answer is provided by our structural break analysis in the relationship between the short-term interest rate and the long-term bond yield. In particular, this structural break analysis revealed that, after the break in 1930, the relationship between the short-term interest rate and the long-term bond yield was fully re-established only in 1959. Both the breakpoints (1930 and

\(^{14}\)Note that in our empirical study we examine the relationship between the logs of variables \( \ln(E/P) \) and \( \ln(Y) \). That is, we examine the following relationship \( \ln(E/P) = \beta \ln(Y) \). For the sake of convenience, in this section we write the relationship without logs: \( E/P = M \times Y \), where \( M \) denotes the multiplier factor.
1959) largely coincide with those in the relationship between the earnings and bond yields. Therefore, one plausible explanation for the absence of the relationship between the earnings and bond yields over the period from 1929 to 1958 is the abnormal behavior of the short- and long-term interest rates that was caused by the Fed monetary policy.

However, in our opinion the re-establishment of the relationship between the short-term interest rate and the long-term bond yield is not the only key reason for the re-establishment of the relationship between the stock earnings and bond yields. The problem with this explanation is that the re-establishment of the relationship between the short-term interest rate and the long-term bond yield in 1959 seemingly has nothing to do with the re-appearance of the completely new relationship between the earnings and bond yields. Put differently, we believe that the answer to the question, “Why the relationship re-emerged in 1958”, should help us answering the second major question “Why the multiplier in the relationship $E/P = M \times Y$ has changed from $M \approx 2$ over the period from 1871 to 1929 to $M \approx 1$ over the period from 1958 to 2017?”

We argue that the dividend yield had been an important equity valuation benchmark for investors till 1958. However, in response to the introduction of huge income taxes on dividends in 1954, the firms took action to protect their shareholders’ income first by reducing the dividends and then by replacing dividends with share repurchase. A dramatic reduction in stock dividend yield made impossible using the traditional equity valuation benchmark at a point in time when an equity valuation benchmark was highly needed: near the end of the secular bull market of 1942-1965 that was characterized by a speculative bubble. During a speculative bubble, stock prices increase rapidly and substantially and, subsequently, investors start to question whether the high prices can be justified by economic fundamentals. By the end of the 1950s, because the old valuation standards could no longer be used, a new valuation benchmark emerged. In the rest of this section, we present our story with all details.

Our argumentation starts with the observation that prior to the mid-1950s the earnings and dividends were highly correlated and co-integrated. As a result, before 1930 there was a causal relationship both between the earnings yield and the bond yield, as well as between the dividend yield and the bond yield. Figure 8 plots the dividend-to-price ratio (dividend yield, $D/P$) versus the long-term government bond yield. Over the period from 1871 to 1929, the estimated relationship between the dividend and bond yields was $D/P = 1.35 \times Y$. In
words, this relationship suggests that prior to 1930 the investors required on average the stock dividend yield to be 35% higher than the bond yield. In periods of economic expansions and bull markets the stock prices increased and, consequently, the dividend yield decreased. However, a visual observation of the relationship between the dividend and bond yields reveals that, over the period from 1871 to 1958, the dividend yield was virtually always above the bond yield.

The rationale for the inequality \( \frac{D}{P} \geq Y \) is that stocks are riskier than bonds and, therefore, dividend yield should be greater than the bond yield. There were many bull markets in stocks prior to 1930, but almost always there was a major market correction after the dividend yield decreased to the bond yield. Before 1958, the dividend yield was below the bond yield only once: over a rather short period right before the stock market crash of 1929.

![Figure 8: Dividend-to-price ratio (D/P) versus the long-term government bond yield.](image)

In the US, the post-WWII historical period 1945-1970 was a period of accelerated economic growth. As a result, as it always happens during a prolonged period of economic boom, both the stock prices and investor optimism on the economy had been rising. The secular bull market in stocks\(^{15}\) of the period from 1942 to 1965 is associated with the post-WWII economic

\(^{15}\)When financial analysts talk about bull and bear markets, they mainly talk about the so-called “primary markets” (a.k.a. “cyclical trends”); the length of these markets generally varies from one to five years. Besides the primary market trends, in each financial market one can easily observe the long-term trends known as “secular markets” or trends. A secular trend lasts from one to three decades. There is an extensive literature on the secular stock market trends, see, among others, Gartley (1935), Alexander (2000), Easterling (2005), Rogers (2005), Katsenelson (2007), and Hirsch (2012).
boom. It is worth noting that the end of a secular bull market is usually characterized by a speculative bubble. This phenomenon is coined “speculative mania” (a.k.a. “speculative orgy” or “irrational exuberance”). According to Shiller (2005):

“A speculative bubble is a situation in which news of price increases spurs investor enthusiasm, which spreads by psychological contagion from person to person, and, in the process, amplifies stories that might justify the price increase and brings in a larger and larger class of investors, who despite doubts about the real value of the investment, are drawn to it partly through envy of others’ successes and partly through a gambler’s excitement.” (Shiller, 2005)

Because of the rapid economic growth during the decades of 1940s and 1950s, from about the mid-1950s the investors became “obsessed with growth”. According to the GGM, the stock price depends heavily on the growth rate of dividends. The majority of financial analysts valued stocks on the basis on the naive extrapolation of recent dividend growth into the indefinite future. Such approach to stock valuation pushed the stock prices higher and higher during the decade of 1950s. However, as long as the dividend yield was larger than the bond yield, there was a general feeling that the stock market was not overvalued.

In 1954 the US government suddenly imposed huge income taxes on stock dividends. Income on stock dividends was taxed at an individual’s income tax rate; from 1954 to 1963 the top marginal tax rate was 91%. In contrast, the tax rate on long-term capital gains was only 25%. Buying high paying dividend common stocks no longer made sense for wealthy investors. Therefore, high paying dividend stocks went out of favor, and stayed out of favor, beginning from the mid-1950s. As a consequence, from 1955 firms sharply reduced the amount of dividends.

In 1958 the stock dividend yield decreased below the bond yield. Since that time, the dividend yield has been staying below the bond yield. The new relationship between the dividend and bond yields puzzled the financial analysts.

“Orthodox investment theory required stock yields that exceeded bond yields to compensate holders of stocks for the fact that equities were more risky than bonds. But fear of inflation, and a growing willingness to consider potential future earnings growth when valuing stocks, resulted in a fundamental readjustment of traditional
standards. ” (Smith (2003), page 162, our emphasis).

The same sentiment is expressed by Ezra Merkin who, in the Introduction to Part III of the book by Graham and Dodd (2009), writes:

“In 1958, equity dividend yields fell below bond yields for the first time....This time, it really was different. From the safe perspective of a half century, it seems incontrovertible that a new valuation benchmark had been established... The 1958 investor who waited for the century-old relationship between dividend yields and bond market yields to reassert itself is still waiting too. Once reversed, that relationship has moved ever farther apart.” (Graham and Dodd, 2009, page 282)

Another similar remark is made by the legendary investment manager Peter Bernstein:

“My older partners, hard-bitten veterans of the Great Depression with memories that reached back even further, could not believe what was happening. Stocks are riskier than bonds; so stocks should be valued more cheaply than bonds. They assured me that matters would soon come right and that we should stay as far away from the stock market as we could.

The spread between bond and stock valuations has never returned to the traditional relationship. The only world my partners had ever known, the world that had prevailed in the capital markets for more than a hundred years, had come to an end.” (Bernstein, 1992, page 255)

At the same time, as it always happens in periods where investors are obsessed with growth, some academics warned about the possibility that the stock prices were unreasonably high. For example, Durand (1957) expressed concerns that the DDM does not provide reliable evaluations of stock prices and, in the case of growth stocks, can justify any price no matter how high. According to Graham (1960), the stock market was highly overvalued by the end of 1950s.

Thereby at the end of 1950s the investors and financial analysts were in a state which is known in the field of psychology as “cognitive dissonance” (see Festinger (1957)). In our context, a cognitive dissonance is the mental discomfort that occurs when a person is confronted with new information that contradicts prior beliefs. On the one hand, the investors saw the strong economic growth which was supposed to sustain in the observable future. The stock
earnings grew rapidly, and this growth justified high stock prices. On the other hand, the stock dividend yield was notably below the long-term bond yield and, therefore, according to the traditional valuation benchmark the stock market was substantially overvalued.

Cognitive dissonance theory suggests that people seek psychological consistency between their prior beliefs and the new information that contradicts these beliefs. That is, in order to function normally, people tend to reduce the cognitive dissonance. One possible way to reduce the cognitive dissonance experienced by the investors in the late 1950s was to find a new valuation benchmark that could justify high stock prices. One problem that had to be urgently resolved was to find out how to value stocks in situations where firms do not pay dividends. The ingenious solution was presented in the seminal paper by Miller and Modigliani (1961). In this paper the authors showed that, in perfect capital markets, the firm’s dividend policy is irrelevant as long as the firm holds a fixed investment policy. When the stock dividend yield decreased dramatically by the end of 1950s, the investors gradually switched their attention from dividends to earnings: earnings growth and earnings yield.

All in all, our explanation for the establishment of the new relationship between earnings and bond yields is based on the idea that before the mid-1950s the investors used the dividend yield as the ultimate benchmark to judge whether the stock market is overvalued or not. Specifically, the stock market had been considered as highly overvalued when the dividend yield decreased to the bond yield. The introduction of huge income taxes on dividends forced firms to reduce the amount of dividends paid out. When the dividend yield fell below the bond yield, the investors could no longer use the dividend yield as a valuation benchmark and they switched their attention to the earnings yield instead.

Finally, we need to explain why from the late 1950s the investors compared earnings yield with the bond yield to decide whether the stock market is overvalued or not. At first glance, the “new normal” relationship $\frac{E}{P} = Y$ can be explained only if the investors consider stocks and bonds to be equally risky. However, the problem is that all modern textbooks on investments and finance present the evidence that stocks are riskier than bonds. How to reconcile the modern perception of the riskiness of stocks and bonds with the empirical evidence that from about 1958 the earnings yield had been following the bond yield?

16We remind the reader that our co-integration analysis revealed a unidirectional Granger causality running from the bond yield to the E/P ratio. In plain words, it means that the earnings yield has been following the bond yield but not the other way around; changes in the bond yield cased changes in the E/P ratio.

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When financial textbooks present stocks to be substantially riskier than bonds, this evidence is based on using nominal stock and bond returns (returns before inflation and taxes) over the very long-term historical period that spans almost a century or even longer. However, by the end of 1950s the investors might well perceive bonds and stocks as equally risky assets. Below we list a number of arguments that aim at showing that the perception of riskiness of bonds and stocks underwent a dramatic change from the early 1920s to the early 1980s. In addition, we point to the fact that using nominal returns is incorrect; in order to get a correct picture of the relationship between stock earnings and bond yields, one needs to use after-tax real rates of returns.

Regarding the investment practice in the early 1910s, Graham (1949) writes that most individual investors bought exclusively high-quality corporate bonds that provided an annual return of about 5%; the income from corporate bonds was fully tax-exempt at that time. He commented further that “There was admittedly such a thing as investment in common stocks; but for the ordinary investor it was either taboo or practiced on a small scale and restricted to a limited number of choice issues”. When investors did select some common stocks to invest in, they preferred stocks that provided high and stable dividend income. From this information we can conclude that till about 1915 the investors considered stocks as highly risky securities. In contrast, the investors regarded high-grade corporate bonds as almost riskless securities because: the bond default rate was virtually zero, the interest rates were rather stable over time, and the inflation rates were small and often negative. However, by the late 1950s the investors’ perception of the riskiness of stocks and bonds underwent dramatic changes. We argue that due to these changes the investors began to treat bonds as rather risky securities because:

- The bond yields over the period from 1930 to the late 1950s were unusually low (see Figure 8).
- Starting from 1915, there have been many periods of high inflation. Specifically, the inflation increased dramatically because of deficit financing during WWI and WWII. In particular, from 1913 to 1920 the average annualized inflation rate was 11%, whereas from 1941 to 1948 the average annualized inflation rate was 7%.17 During these periods the

17These data are available online, see https://www.measuringworth.com/
bond yields were substantially lower than the inflation rates. As a result, the investors realized that bonds often fail to protect investors from inflation.

- From about 1950, a new secular bear market in bonds began; this secular bear market lasted till 1982. During a bear market in bonds, the yields on newly issued bonds increase and, thus, the prices of existing bonds decrease. As a consequence, even though the bond yields were rising steadily, the total bond return (which is the sum of the capital gain return and coupon yield) was relatively modest.

In sum, starting from the early 1910s bonds often provided low return that was below the inflation rate over prolonged periods of time. This perception, that bonds are risky assets, was reflected in the fact that in the original Modern Portfolio Theory developed by Harry Markowitz during 1950s (see Markowitz (1952, 1959)), there was no such thing as a risk-free asset. The modern theoretical definition of a riskless asset appeared later in the seminal works by William Sharpe (see Sharpe (1963, 1964)). Beginning from the paper by Black, Jensen, and Scholes (1972) it became customary to use the yield on the T-bills with time to maturity of about 1 month as the proxy for the risk-free rate of return.

In addition, Asness (2000, 2003) convincingly demonstrates that starting from the early 1950s the stock volatility has been decreasing while the bond volatility has been increasing. Therefore, the riskiness of stocks (bonds) has been decreasing (increasing) from the early 1950s. In addition, as argued by Warren Buffet, the riskiness of a financial asset cannot be attributed solely to volatility because of the following consideration:

“The riskiness of an investment is ... measured by ... the probability ... of that investment causing its owner a loss of purchasing power over his contemplated holding period. Assets can fluctuate greatly in price and not be risky as long as they are reasonably certain to deliver increased purchasing power over the holding period. And ... a non-fluctuating asset can be laden with risk” (Warren Buffet, Fortune magazine, February 9, 2012)

That is, according to Buffet, the asset is risky when its nominal return can be below the inflation rate. In this regard, bonds were riskier than stocks during the period from the mid-1910s to the late 1950s.

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Considered all aforesaid, we believe that by the late 1950s the investors perceived bonds as a highly risky asset class. On the other hand, at the same time the investors were very well familiar with stock investment and began to treat stocks as a less risky asset class (in contrast to their attitude to stocks before 1920s) because:

- Starting from the early 1940s, the stock returns were high and of much less volatility than the decade before.

- Alfred Cowles founded in 1932 the Cowles Commission for Research in Economics. The Cowles Commission gathered the stock price data starting from 1871. The stock price history from 1871 advocated that over a long run the stock prices increase; the average stock return is way above the average bond return. The common perception, that over a long run stocks are less risky than bonds (see, for example, Siegel (2002)), probably appeared already in the 1950s.

- The stocks seemed to be a natural hedge against inflation.

To summarize, by the end of 1950s the investors considered stocks to be a more attractive asset class than bonds because of changed riskiness. Last but not least, the stocks were considered to be more attractive investment than bonds because of the tax considerations. In particular, the income from bond investing was taxed at the individual income tax rate that was very high starting from the early 1930s. Even though the US government introduced high taxes on stock dividends in 1954, firms quickly adopted a new dividend policy: they decreased the dividends and increased the capital gain return that was taxed at a much lower rate than dividends.

The bottom line is that, in our opinion, the relationship $E/P = Y$ is misleading because it is stated in nominal terms. Put differently, in order to access the pros and cons of stocks versus bonds, one has to take into account taxes and inflation protection provided by each asset class. It is true that, stated in nominal terms, bond returns are less risky than stock returns. However, after taxes, for many investors stock returns are higher than bond returns and, hence, higher stock risk is compensated by higher returns. Even though from the early 1960s the bond yield has been highly positively correlated with inflation and, thus, bondholders have been protected from losing purchasing power, their experience before the early 1960s tells
them about the possibility of negative real returns on bonds. We hypothesize that the investors still believe that bonds are riskier than stocks in terms of the potential loss of purchasing power. Summarising the aforesaid, we believe that after-tax real rates of returns to bonds and stocks do satisfy the correct risk-return relationship.

8 Conclusions

Since stocks and bonds are two major competing assets, it seems reasonable to conjecture that there should be an equilibrium relationship between the stock’s earnings and bond yields. Over a very long run, however, the dynamics of financial markets are subject to evolutionary changes. Therefore, the equilibrium relationship between the two yields can also be subject to evolutionary changes. These two considerations motivate the study presented in this paper. In particular, given the very long historical data for the US, the goal of this paper is to find the structural breaks in the relationship between the stock’s earnings and bond yields, investigate the direction of causality in the relationship, and try to explain the causes of the breaks.

The main empirical findings in the paper can be summarized as follows. Over the period from 1871 to 2017, our structural break analysis finds the presence of two different equilibrium relationships between the stock’s earnings and bond yields. The first long-run equilibrium relationship existed from 1871 (the start of our sample) and broke up in 1929. Afterwards, the relationship between the two yields was absent during almost three decades. Finally, a completely new long-run equilibrium relationship re-emerged in 1958. Specifically, our analysis reveals that, whereas over 1871-1929 the equilibrium relationship was \( E/P \approx 2Y \), over 1958-2017 the equilibrium relationship has been \( E/P \approx Y \). On both historical segments 1871-1929 and 1958-2017, our analysis finds a unidirectional short- and long-run Granger causality running from the bond yield to the stock’s earnings yield. In other words, on both segments the stock’s earnings yield followed the bond yield in both the short-run and the long-run, but not the other way around.

A large part of the paper is devoted to providing answers to the following two major questions: “Why there was no relationship between the stock’s earnings yield and the bond yield over the period from 1929 to 1958?” and “Why the multiplier in the equilibrium relationship has changed from \( M \approx 2 \) to \( M \approx 1 \)?” In brief, our story goes as follows. The breakdown of the
equilibrium relationship in 1929 is explained by the stock market crash and the following severe depression forcing the Fed to start conducting an expansionary monetary policy by lowering the short-term interest rate to nearly zero and decreasing substantially the long-term interest rate. The fixed-income markets in the US were de-regulated only in the early 1950s. We demonstrate that the Fed monetary policy was responsible for the abnormal relationship between the short- and long-term interest rates over the period from 1930 to 1959. However, our main argument for the re-establishment of a completely new equilibrium relationship between the stock’s earnings and bond yields is that a major “paradigm shift” in the stock valuation theory occurred in the late 1950s. To support our argument and explain the transition from the old to the new paradigm, we review a number of important changes, which took place during 1910-1960, that potentially could have caused the paradigm shift.

Under the old paradigm, bonds were almost risk-free and provided a stable and relatively high return, inflation rate was moderate, and income taxes were absent or very low. Stocks, on the other hand, were considered as highly risky. As a consequence, in order to attract investors to stocks, their earnings yield had to be notably higher than the bond yield. Under the new paradigm, the bond return was low, risky, and did not protect investors from inflation. In addition, the income on bonds was taxed at a high rate. All these considerations made investors to draw their attention to stocks that provided a higher return than bonds, stocks seemed to be a natural hedge against inflation, and the capital gain stock return was taxed at a low rate. As a result, stated in nominal before-tax terms, the stock’s earnings yield descended to a level comparable to that of the bond yield.

More specifically, we demonstrate that the decades of 1950s and 1980s witnessed two critical events that dramatically changed the corporate dividend policy in the US. The first critical event was the introduction of huge income taxes on dividends in 1954. The second critical event, which took place in 1982, was the adoption of SEC Rule 10b-18 which provided a safe harbor for companies buying back their own stock. In response to the huge income taxes on dividends, the firms first reduced the dividends and subsequently replaced the dividends with share repurchase. Our econometric analysis reveals that these two critical events exerted a significant impact (in the form of structural breaks) on the dynamics of dividend yield, the relation between the dividend and earnings yields, and the capital gain return of the stock market. A dramatic reduction in stock dividend yield made impossible using the traditional
equity valuation benchmark at a point in time when an equity valuation benchmark was highly needed: near the end of the secular bull market of 1942-1965 that was characterized by a developing speculative bubble. As a consequence, by the end of 1950s, because the old valuation standards could no longer be used, a new valuation benchmark emerged.

Overall, the results of our study suggest the following important conclusions. When the two yields are in equilibrium, the stock’s earnings yield follows the bond yield. This causality relation has a major implication for monetary policy: if the Fed lowers (increases) the level of interest rates, the stock prices will increase (decrease). However, in periods where the short-term interest rate is virtually zero, there is no equilibrium relationship between the stock’s earnings and bond yields. One such period in the US history lasted from 1929 to the end of 1950s. Relatively recently by historical standards, to combat the Global Financial Crisis of 2007-08, from about 2009 the Fed lowered the short-term interest rate (a.k.a. the federal funds rate) to virtually zero. A visual observation of the graph in Figure 2, Panel B, reveals an inflection point around 2010; this observation suggests that a new break in the equilibrium relationship occurred in 2010. As a result of the recent break in the equilibrium relationship, the investors have lost an important stock valuation benchmark. A prolonged period of very turbulent stock market times is one of the potential consequences of this loss (because of the investors’ uncertainty in the fundamental stock values).

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