"Excess Volatility" and the German Stock Market, 1876–1990

J. Bradford De Long
Harvard University and NBER

Marco Becht
European University Institute

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Abstract

This paper uses long-run real price and dividends series to investigate for the German stock market the questions asked of the U.S. market by Shiller (1989). It tries to determine in what periods and to what degree the German stock market has also possessed "excess volatility" in the past century. It finds no evidence of excess volatility in the pre-World War I German stock market. By contrast, there is some evidence of excess volatility in the post-World War II German stock market. The role played by the German *Großbanken* in the pre-World War I stock market might be the cause of the low comparative volatility of German stock indices before 1914.

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I. Introduction

This paper examines "excess volatility" in the German stock market, investigating for that market the issues examined by Robert Shiller (1981, 1986, 1989) for the U.S. stock market.[2] It finds some evidence that post-World War II German stock index prices have been too volatile (relative to naïve

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[1]J. Bradford De Long is Danziger Associate Professor of Economics at Harvard University. Marco Becht is a Ph.D. candidate at the European University Institute. This research was partially supported by the National Science Foundation, by the NBER, and by the EUI. We would like to thank Robert Barsky, George Bulkley, Daniel Raff, Robert Shiller, Peter Temin, and Robert Waldmann for helpful discussions, and the Frankfurter Wertpapierbörse AG, the Commerzbank AG, the Siemens Museum Munich, the Library of the Frankfurter Industrie- und Handelskammer, the Statistisches Bundesamt and the *Frankfurter Allgemeine Zeitung* for helpful assistance with long-run stock price data.

[2]The literature sparked by Shiller and by LeRoy and Porter (1981) has for the most part assumed that the real interest rate at which future dividends are discounted is a constant. This assumption is surely false: for example, the *ex ante* real rate of discount for the U.S. stock market at the end of World War I was on the order of thirty percent per year for the first two years after the war in anticipation of the forthcoming postwar deflation. Thus it was much higher than the discount rate during normal times. However, investigators have had little success accounting for stock price volatility via shifts in the real riskless rate, or in the real spread between riskless and market rates of discount driven by changes in risk tolerance (see Shiller, 1989).

estimates of fundamentals) to have been rational forecasts of the present value of future dividends. Alternatively, pre-World War I stock prices were not volatile enough (relative to naïve estimates of fundamentals).[3] In either case, the efficient markets hypothesis appears inconsistent with observed behavior in one or the other of the periods.[4] The focus of this paper is on the divergence of market outcomes in the two periods, and the difficulty of reconciling *both* patterns simultaneously with the efficient markets hypothesis.

This paper examines the volatility of prices relative to dividends in order to avoid most of the biases in estimated volatility ratios generated by Shiller's (1981) original tests. Thus normalized, the pre-World War I German stock market shows not excess but deficient volatility: the market price-dividend ratio is surprisingly far down in the lower tail of the distribution under the null hypothesis that prices are rational forecasts of fundamentals. Throughout the pre-World War I era, the market average dividend yield fluctuates in a narrow band between four and a half and five and a percent. By contrast, the post-World War II stock market (and especially the post-*Wirtschaftswunder* market) shows some evidence of "excess" volatility. The evidence of excess volatility in post-World War II German data is weaker than but of the same order of magnitude as the evidence using U.S. post-World War II data.

The behavior of the pre-World War I German stock market thus is in sharp contrast to the behavior of the post-World War II German stock market, and to the behavior of the U.S. stock market in either the pre-World War I or the post-World War II period. We speculate that the dominance of the German *Großbanken* in the securities industry in the years before World War I may be the cause of the exceptional behavior of the pre-World War I German market.

After this introduction, the second section of this paper describes the data used. The third section explains the approach used and documents the divergence between the pre-World War I and the post-World War II behavior of German stock market aggregates. The generating processes necessary to reconcile the post-World War II behavior of German stock index prices with the efficient markets hypothesis lead to the conclusion that the market's small degree of volatility in the pre-World War I era is anomalous. Generating processes that fit the market's low pre-World War I volatility lead to the

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[3]Understood to also include the ancillary assumption of a constant real discount rate.

[4]Little can be said about the relative excess volatility of the German stock market over 1914–50; there are too many "peso problems" present for any analysis to be convincing; see Eichengreen (1991).

conclusion that the post-World War II market exhibits excess volatility. Unless the specification of the dividend process is itself a free variable that shifts substantially from World War I to post-World War II reconstruction, it is very difficult to reconcile *both* periods with the dividend discount model.

Section IV provides a brief summary of the argument. Appendices discuss the choices made in constructing the data, and the statistical significance of some of the results obtained.

II. German Data

Donner (1934) compiles and reports a monthly nominal share price index—with attached estimates of average yearly dividend yields for the companies included in his aggregate index—for the German stock market from January 1870 to December 1913. His index covers only twelve companies from 1870 to 1875.[5] The number of companies covered reaches twenty-one in 1876 and is nearly sixty by 1890. The original twelve companies covered in 1870 include four banks, four railroads, and four mining companies.[6] Railroads disappear from the index with their nationalization in 1890. Companies in other industries are added as industrialization proceeds.[7]

Especially in the years from 1890 on, the Donner index is a sample of Germany's largest companies, weighted toward those heavy industries in which Germany's companies were largest and its international comparative advantage greatest. We begin our study in 1876, when the number of companies in the index rises above twenty.

Donner's index ends with the beginning of World War I. An official index—unfortunately without dividends attached—covers the period from 1914 up to the 1923–24 hyperinflation (Statistisches Reichsamt, 1922a, 1922b). A second official index covering three hundred corporations extends from 1924 to the middle of World War II, reporting both the stock index price and a dividend yield (Statistisches Reichsamt, 1928, 1929). We splice the first official *Statistisches Reichsamt* (National Bureau of Statistics) series onto Donner's in 1914 to track the course of the German stock

[5]Earlier indices covering the 1856–70 period are also available from Däbritz (1929). Unfortunately, they too are based on a very small sample of securities.

[6]Two mining companies—the Bochumer Verein für Bergbau and Gußstahlfabrik and the Hoerder Bergwerks- und Hüttenverein—also had metal fabrication or railway divisions.

[7]On the eve of World War I, the index covers eight banks, two shipping companies, fourteen mining and steel producers, four electrical machinery manufacturers, four utilities, nine metalworking manufacturers, six in chemicals, seven in textiles, two in paper and wood products, three makers of building materials, two construction companies, three glass and porcelein manufacturers, and four breweries.

market up to the hyperinflation. We splice the second *Reichsamt* index onto the first to provide information about the course of the German stock market between the hyperinflation and the middle of World War II.

For the post-World War II period, the stock price series we use links four official portfolio index series constructed by the post-World War II *Statistisches Bundesamt* (Federal Bureau of Statistics). We link from each series to the next in the first year in which the following sequence becomes available (see Herrman, 1956; Spellerberg and Schneider, 1967; Silberman, 1974; Lützel and Jung, 1984; Statistisches Bundesamt, 1985).

For the later interwar and the post-World War II periods, the yield series used is the yield on all traded stocks. Thus the yield is calculated from a different and larger sample of corporations than are the price indices. Nevertheless, the post-World War II dividend series—calculated by multiplying price and yield—is a good estimate of the dividend corresponding to the index.[8]

The nominal price and dividend series are deflated by the German consumer price index endorsed by the Deutsche Bundesbank (1976). This index runs continuously, with one gap covering World War II and the post-war reconstruction period.[9]

Appendix 1 presents the various alternative stock price and dividend yield series available for the German market. Its table A.1 reports the underlying real stock price, yield, and consumer price index series used here. In all cases we use annual average prices and annual average dividend yields. The ways in which earlier authors report their results make annual average data more readily available than point-in-time data. Moreover, markets for many of the securities in the indices are thin. Transitory episodes of market disruption—like the liquidity crunch that followed the bankruptcy of the Austrian Creditanstalt during the Great Depression—are not uncommon. With point in time data, such events could introduce noise into a market that may be exhibiting relatively good performance

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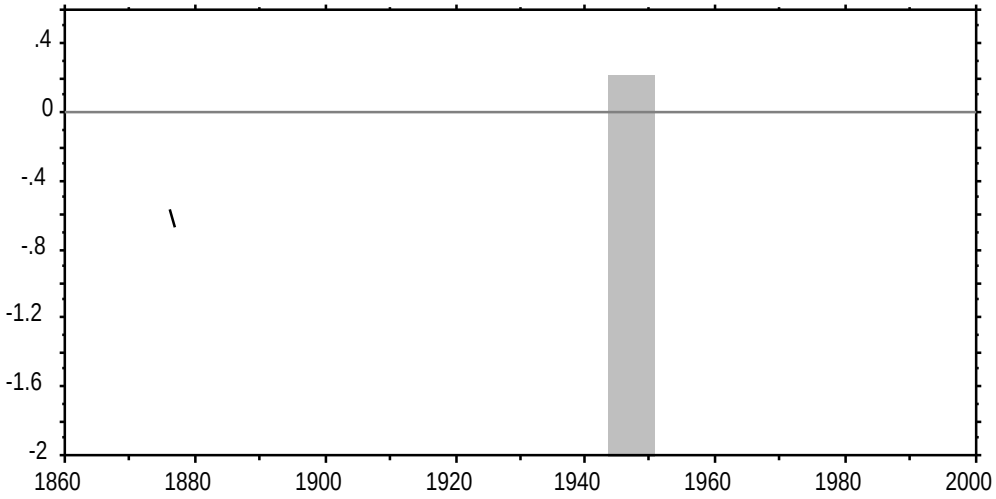
[8]The post-World War II price index series covers close to ninety-five percent of the par value of stocks traded on the German exchanges.

[9]It was assembled from four different sources. Up until 1914 the cost of living figures come from Kuczynski (1947), who investigated the standard of living of Geman workers since 1800. Kuczynski's cost of living index consists of estimates of food prices and housing costs. From 1915 to 1919 the index is derived from calculations by the *Statistisches Bundesamt*, the Federal Statistical Bureau of post-World War II West Germany, made after World War II in order to close the gap between Kuczynski's and the subsequent indices. From 1920 to 1940 the cost of living index is that compiled for a five-person working-class household by the *Statistisches Reichsamt*, the National Statistical Bureau of first the Weimar Republic and then the Third Reich. For the post-World War II years from 1949 to the present, the cost of living index used is that calculated for a four-person middle-class household by the *Statistisches Bundesamt* (1990). The different consumer price series have different base years. They chart the changes in the price level for different consumption bundles, and are not completely consistent. The Deutsche Bundesbank (1976) reports similar indices for wholesale prices, and a less complete national product deflator.

save for transitory disruptions of its microstructures.

Figure 1
German Real Stock Prices and Dividends 1876–1990
(Log Scale)



larger proportional magnitudes than decade-by-decade fluctuations in real price indices. In this respect the pre-World War II German stock market is different from the United States, where decade-by-decade price fluctuations are proportionally larger than dividend fluctuations (see Barsky and De Long, 1989 and 1990).

Post-World War II data begin in 1951. Throughout the 1950's real prices and dividends rise very rapidly—by a factor of eight—with the price-dividend ratio reaching a high near fifty in 1960. Since 1960 the index has recorded relatively slow growth in real prices and dividends. Even so, price changes have been substantial: the real stock index falls by nearly half between 1960 and 1966. It more than doubles over the short four year period between 1981 and 1985.

From 1960 on, fluctuations in prices have been proportionately larger than fluctuations in dividends. Over 1960–66, the log of real stock prices falls by 0.55 while log real dividends fall by only 0.2; over 1966–72, log prices rise by 0.3 while log dividends rise by 0.2; over 1972–82, log prices fall once again by 0.55 while log dividends fall by only 0.15; and over 1982–1990 log prices rise by 1.1 while log dividends rise by 0.8. This post-*Wirtschaftswunder* pattern, in which swings in dividend levels are paced by more than proportional swings in prices, is reminiscent of the behavior of the U.S. stock market, as analyzed by Barsky and De Long (1989). It suggests that investors value the market by extrapolating recent dividend changes into the future.

The real stock price series constructed here has a gap covering the second half of World War II and the postwar reconstruction period from 1943–1950. We have been unable to recover sufficient data on dividend yields and price indices to link the series across this period. The real price indices are *not* comparable across the break at the end of World War II.[11]

The real dividend series has two breaks. One covers World War I and the interwar period up to the hyperinflation. The second covers the end of World War II and the postwar reconstruction period. Thus we do not have enough data to conduct Shiller-like analyses of the era from the beginning of World War I to the beginning of the 1950's.

This paper analyzes the pre-World War I and the post-World War II periods separately. For the

[11]The failure of the German stock market to fall in real terms during the war or during the approach to war is somewhat surprising. To some degree, wartime prices are false prices. Although trading on the Frankfurt exchange continues until three days before the arrival of the American army, prices on the exchange are frozen in March 1943. Foreign quotations on the market had been prohibited as early as 1937. And dividends had been regulated from early in the National Socialist era. After December 1934 dividend payments to shareholders could not exceed six percent. Any excess was paid into a "Patriotic Fund." Although credited to shareholders' accounts with the "Patriotic Fund," such forced loans were not liquid—and of course were never repaid.

pre-World War I period, it takes 1913 as its terminal condition: the level of real stock prices in 1913 is a proxy for the rational expectation, on the eve of the unexpected coming of World War I, of the fundamental value of German securities. The level of stock prices in 1990 stands in for the rational expectation of the expected value of German securities today.

III. Excess Volatility and the German Stock Market

Shiller's (1981, 1989) first key insight was that the level of the stock market is a forecast of the *ex post* perfect-foresight fundamental. An investor who buys and holds, and pays less than the *ex post* fundamental, receives a supernormal return. Arbitrage, therefore, pushes prices in an efficient market to be efficient forecasts of the perfect-foresight fundamental.

Shiller's second key insight was to apply the principal that efficient forecasts are less volatile than the *ex post* realized values of the quantities being forecast. If a forecast is more volatile, a better forecast could be constructed easily: shrink the original forecast toward its *ex ante* unconditional mean, and the resulting improved forecast will have a smaller mean squared error. These two insights imply that if the efficient markets hypothesis holds then stock prices should be less volatile—relative to their *ex ante* unconditional means, a notion that needs to be made precise—than the realized track of the *ex post* perfect-foresight fundamental.

Biases in Testing for Excess Volatility

As Flavin (1985), Scott (1985), Kleidon (1986a and 1986b), Mankiw, Romer, and Shapiro (1985, 1991), and many others have argued, Shiller's (1981) original comparison of the variance of detrended prices and of detrended *ex post* perfect-foresight fundamentals is subject to biases. Especially in small samples, such tests may well find apparent excess volatility even if in fact the efficient markets hypothesis holds.

It is easiest to understand the source of these biases by examining the trading strategies associated with tests of excess volatility and return predictability. Each test of market rationality is implicitly associated with a portfolio strategy. If prices are too volatile relative to trend, investors at the time could have made better forecasts of *ex post* fundamentals—and earned high profits—by

taking as their forecast some linear combination of the market price and a time trend, and betting that returns would be low whenever the market price was above the trend. If returns are predictable from a variable like the price-dividend ratio (Scott, 1985), investors could have earned supernormal profits by buying when the ratio was low and selling when it was high.

If investors could in fact have followed the trading strategy implicit in the tests of market efficiency—and did not—then the rejection of market efficiency is genuine. But under some conditions the implicit trading strategy could not have been followed because it required more information for its execution than investors at the time possessed. In such a case, the rejection of market efficiency may well be spurious: investors may well have taken advantage of all profit opportunities open to them, and given the information at their disposal prices may have been the best available forecasts of the present value of fundamentals.

For example, suppose log dividends follow a random walk with drift:

(1) $$d_t = d_{t-1} + g + \varepsilon_t$$

Where g is the long-run upward rate of drift of dividends, and ε_t is an innovation, unforecastable before period t. With a constant discount rate r, the efficient markets log real stock price will be:

(2) $$p_t = -\ln(r-g) + d_t$$

Suppose an *ex post* time trend π is fitted to the first and last observations, t=0 and t=T:

(3) $$\pi_t = p_0 + \frac{t}{T}\left(p_T - p_0\right)$$

Calculate the covariance between the one-year realized return $r^*_t{}^1$:

(4) $$r^*_t{}^1 = r + \varepsilon_t$$

and the price relative to the *ex post* time trend (conditional on knowledge of the current price p_t and of the current value π_t of the *ex post* trend):

(5) $$E\left\{ r^*_t{}^1(p_t-\pi_t) \mid p_t-\pi_t \right\} = -\left\{ \frac{t}{T} \right\} E\left\{ \varepsilon^2_{t+1} \mid p_t-\pi_t \right\}$$

Equation (5) shows that there are excess returns from buying when the price is low relative to the *ex post* trend, and selling when it is high. Such a strategy eans excess returns off of the correlation between the deviation of the price from the *ex post* trend and future innovations.

Why don't rational investors take advantage of this correlation? Because at the time they must

trade they do not yet know what the end-of-sample value π_T will be, and so cannot calculate the current value of the *ex post* time trend π_t. Investors would love to know π_T—such knowledge would allow them to calculate the value of the sum of the ε innovations yet to come. But they do not.

The return predictability in equation (5) comes solely from the use of the realized values of future shocks—shocks dated later than t—in constructing the value π_t of the time trend, and in assessing whether prices are relatively low or high. Without this use of information about the realizations of future shocks, there are no excess returns to be earned: returns are uncorrelated with the deviation of the price from an *ex ante* time trend π'_t constructed by extrapolating drift from the series starting point.

(6) $$\pi'_t = p_0 + tg$$

(7) $$E\{r^{*1}_t(p_t - \pi'_t) \mid p_t, \pi'_t\} = 0$$

In this example, a regression of returns on prices and an *ex post* time trend is indeed likely to find significant return predictability and excess volatility. But such a finding is spurious: it arises from an implicit assumption that rational investors had more information about future shocks than they in fact possessed future shocks.

Normalizing by the Level of Dividends

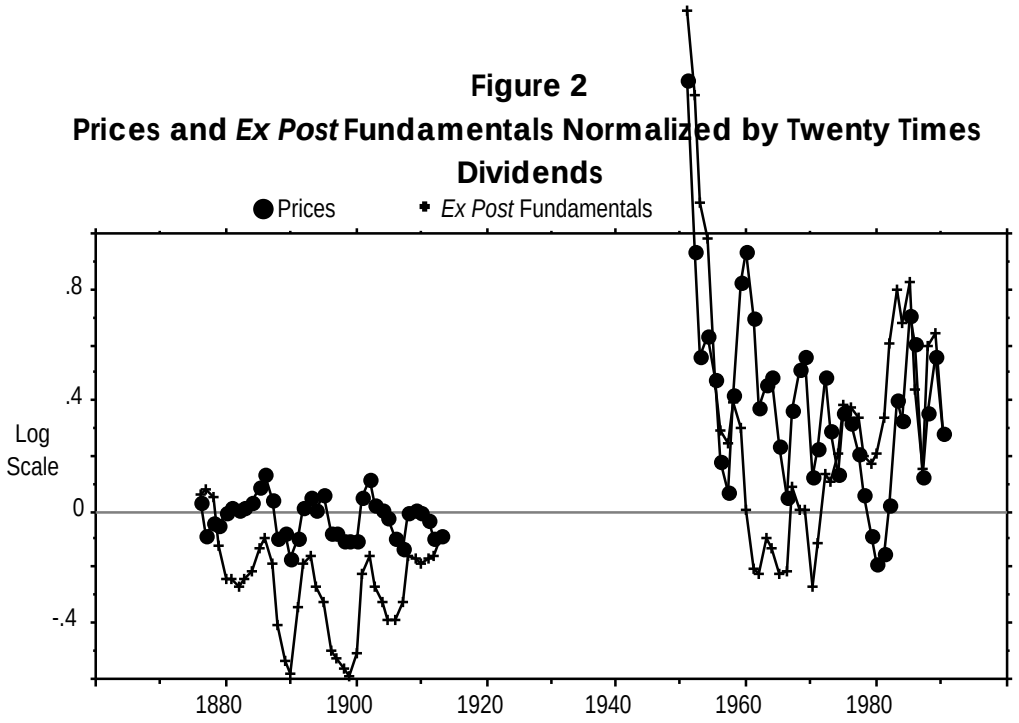
To compensate for such biases, Mankiw, Romer, and Shapiro (1985 and 1991) proposed an alternative benchmark for the calculation of excess volatility. They argued that it is plausible that past investors knew naïve forecasts of perfect-foresight fundamentals made by assuming them to be a constant dividend multiple. Tests of excess volatility relative to this alternative naïve-forecast benchmark that takes fundamentals to be a constant multiple of dividends assume less in terms of investors' knowledge of the parameters and outcomes of the dividend process.

This paper uses such a naïve constant dividend multiple forecast as the benchmark against which to evaluate the efficient markets hypothesis.[12] It normalizes real prices and *ex post* fundamentals by the current level of dividends. Figure 2 plots real prices and *ex post* fundamentals normalized by a

[12]Note, however, that it is possible to imagine situations—especially in circumstances of rapid development and uncertain long-run growth paths—in which even the assumption that investors know *ex ante* of the average price/dividend ratio is incorrect, and in fact attributes to past investors information that they do not but would dearly wish to know. See Barsky and De Long (1989).

constant—twenty—multiple of dividends, for a real discount rate of 8 percent chosen to match real returns over the century as a whole.

In figure 2 the pre-World War I stock market does not appear excessively volatile to the eye: the volatility of prices relative to the benchmark of twenty times dividends is smaller than the volatility of *ex post* fundamentals. The post-World War II market does see a larger volatility for prices relative to the twenty times dividends benchmark than for *ex post* fundamentals after 1960. The decade before 1960 sees both prices and *ex post* fundamentals very far from normal multiples of dividends.



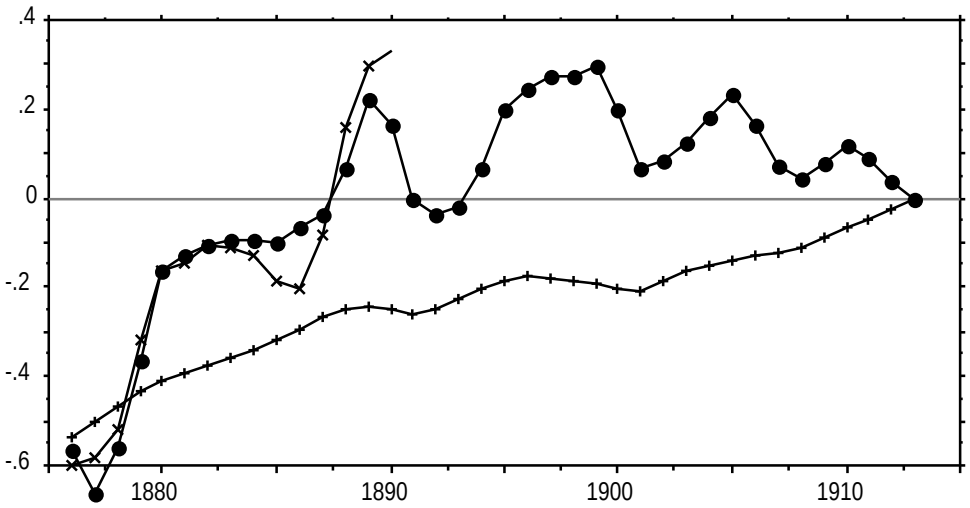
Pre-World War I and Post-World War II Prices, and Perfect-Foresight Fundamentals

Figures 3 and 4 provide individual looks at the behavior of prices, dividends, and perfect-foresight fundamentals in the pre-World War I and post-World War II periods. They plot for each of these periods the log levels of prices, the log *ex post* perfect-foresight fundamental (calculated using an eight percent per year real discount rate), and also the log level of dividends (multiplied by twenty in order to place it on the same scale as the other two series).

Note the wider variability of stock prices in the post-World War II period that leads figure 4 to

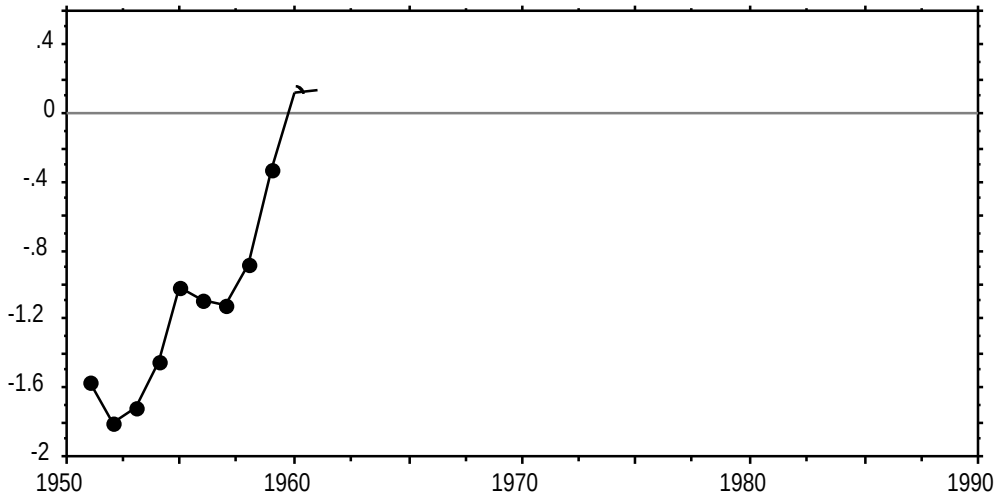
have a much larger vertical scale than figure 3. Figure 3 has a vertical scale that shows less than a tripling of real prices and dividends. By contrast, figure 4 has a vertical scale that captures a twelvefold multiplication in the level. Figure 3 shows that stock price and dividend indices move together throughout the pre-World War I period. The mean price-dividend ratio is approximately twenty. The maximum proportional deviation of the price-dividend ratio from its mean is less than a tenth; from 1876 to 1913 the dividend yield stays in a restricted range between four and a half and five and a half percent.

Figure 3
German Real Stock Market Values, Perfect-Foresight Fundamentals, and Dividends for the Pre-World War I Period
(8% Discount Rate; Terminal Condition in 1913)



period of the "economic miracle." In 1955 real dividends are five times their 1951 level. In 1960 real dividends are eighty percent above their 1955 levels. Real prices rise rapidly from 1951 to 1960, rising by a cumulative factor of more than eight over the decade. The price-dividend ratio is almost one hundred at the beginning of the 1950's as firms skimp on payouts to increase capital available for reinvestment. The price-dividend ratio falls until 1957, reaching a value in the low twenties. It then rises and reaches another peak, near fifty, at the end of the 1950's.

Figure 4
German Real Stock Market Value, Perfect-Foresight Fundamentals, and Dividends for the Post-World War II Period
(8% Discount Rate; Terminal Condition in 1990)



Volatility Ratios

Table 1 presents summary statistics on the volatility of the German stock market. For comparative purposes it reports similar statistics for the United States stock market as well. If actual prices were rational estimates of fundamentals, they should exhibit less volatility relative to some naïve forecast than do the *ex post* perfect-foresight fundamentals themselves.[14]

Table 1
Volatility Tests for the German and American Stock Markets

Germany	Pre-WWI (1876–1913)	Post-WWII (1951–90)	Post-Miracle (1960–90)	Pre-WWI and Post-WWII
Volatility of p-p*…	0.082	0.168	0.182	0.123
Volatility of p-d…	0.005	0.264	0.171	0.136
Volatility of p*-d…	0.101	0.324	0.142	0.159
Volatility ratio: p-d and p*-d…	0.05	0.81	1.20	0.77
Volatility ratio: p-p* and p*-d…	0.81	0.62	1.28	0.86
Sum of ratios	0.86	1.43	2.48	1.63
Significance: IMA(1,6)	0.98	0.01	0.01	0.02
Significance: ECM (θ=0.5)	0.99	0.07	0.01	0.03

United States	Pre-WWI	Post-WWII	Entire Century
Volatility of p-p*…	0.041	0.157	0.131
Volatility of p-d…	0.029	0.057	0.062
Volatility of p*-d…	0.019	0.056	0.055
Volatility ratio: p-d and p*-d…	1.53	1.02	1.13

[14] Mankiw, Romer, and Shapiro have an illuminating discussion distinguishing between "variance ratios" and "volatility ratios." Volatility ratios are mean squared errors around *ex ante* means or naïve forecasts. Variance ratios are mean squared deviations from *ex post* sample averages. The difference between them can be neglected only if the *ex post* sample average is a very good and precise measure of the *ex ante* mean.

Volatility ratio: p-p* and p*-d	2.16	2.80	2.38
Sum of ratios	3.69	3.82	3.51
Significance: IMA(1,6)	0.01	0.01	0.01
Significance: ECM (θ=0.5)	0.01	0.01	0.01

Table 1 follows Mankiw, Romer, and Shapiro by normalizing prices and *ex post* fundamentals by the value of dividends: implicitly take the "naïve" forecast to be a constant multiple—twenty—times dividends. Such a forecast based on dividends and the average price-dividend ratio was available to investors at the time under the relatively weak assumptions that investors knew the required rate of return and the average annual upward rate of drift—not the *ex post* time trend—of dividends.

The third column of table 1 analyzes the post-*Wirtschaftswunder* period on its own. This is motivated by the likelihood that the rapid postwar-recovery régime and economic structure found in Germany in the 1950's had different characteristics than the rest of the post-World War II period. In the 1950's real dividends were very low and dividend growth was very high, as corporations sought to retain earnings and plow them back into investment. The assumption that even a naïve forecast of fundamentals would take them to be the same multiple of dividends in the 1950's as later is potentially hazardous. In addition, the nearly twenty percent per year average realized rate of return in the 1950's is far from the eight percent per year realized rate of return found on average in the pre-World War I and post-1960 periods, and suggests a different underlying structure.

The first line of table 1 shows the volatility of log prices (p) around the log of the perfect-foresight fundamental (p*), calculated using an eight percent per year real discount rate. Volatility about perfect-foresight fundamentals is smaller before World War I than after World War II by a factor of three. This difference does not arise from the period of rapid stock market price and dividend growth in the 1950's. When the *Wirtschaftswunder* decade of the 1950's is excluded from the post-World War II sample, the mean squared error of log prices around perfect-foresight fundamentals is almost unchanged.[15]

[15]The variance is smaller before World War I than after World War II in the United States stock market as well.

The second line shows the volatility of the log price-dividend ratio (p - d) around a fixed constant of twenty, the average *ex post* price-dividend ratio for the pre-World War I period. The second line thus calculates the volatility of prices about the "naïve" forecast that would have been made by an investor who knew the mean trend drift of dividends and the required rate of return over the pre-World War I period, and nothing more. The price-dividend ratio shows almost no volatility in the pre-World War I period, and considerable volatility in the post-World War II period. The third line of table 1 shows the volatility of the log *ex post* perfect-foresight fundamental to dividend ratio (p* - d), about the same constant of twenty.

If prices are more volatile relative to "naïve" forecasts than perfect-foresight fundamentals, investors could and should have constructed a better forecast: a weighted average of the market price and the naïve forecast would have generated smaller forecast errors. Thus the second line of the table, the volatility of the price-dividend ratio, should under the efficient markets hypothesis be smaller than the third line, the volatility of *ex post* perfect-foresight fundamentals about the naïve constant dividend multiple forecast. Line four reports this volatility ratio.

Line five in table 1 calculates another volatility ratio. The volatility of the perfect-foresight fundamental about the actual price should be less than the volatility of the perfect-foresight fundamental about the naïve forecast. If this is not so, the actual price is a worse estimate of fundamentals than the naïve forecast.

A final implication of the efficient markets hypothesis is that the two ratios of lines four and five—the sum reported in line six—should add up to one. If not, the log difference between the price and the perfect-foresight fundamental (p - p*) is correlated with the log price-dividend ratio (p - d). Profits could have been earned by trading on this correlation of the price-dividend ratio and value relative to price. Lines seven and eight report monte carlo estimated significance levels for tests of the efficient markets hypothesis using the volatility ratio in line 6, assuming that log dividends follow either an IMA(1, 6) or an error correction model. These monte carlo significance levels are discussed at greater length below.

The bottom panel of table 1 reports analogous statistics for the United States stock market, for analogous periods.

Much of the excess volatility literature over the past decade has been concerned with the finite-

sample distributions of volatility ratios like those in table 1. Advocates of the efficient markets hypothesis have argued that high volatility ratios are not strong evidence against it because test statistics have large tails under the efficient-markets null.

Believers in the efficient markets hypothesis have no need to resort to such defensive arguments in the case of pre-World War I Germany. Both the volatility ratios in lines four and five are less than one. The volatility ratios in lines 4 and 5 for the pre-World War I period are smaller than on average under the null. Prices are not too volatile relative to dividends, they are insufficiently volatile. Prices are much less volatile than perfect-foresight fundamentals relative to the naïve forecast. The market price is a better estimate of the perfect-foresight fundamental than is the naïve constant dividend multiple forecast. Thus tests based on market volatility ratios show no traces at all of excess volatility in the German stock market before World War I.

The post-World War II German stock market does show volatility ratios in line 6 of table 1 greater than one, and thus might provide some evidence of excess volatility. Table 1 also reports monte carlo estimates of the finite-sample statistical significance of the volatility ratios reported in line 6. Significance levels are calculated for two sets of assumptions about the true process generating dividends: first, that the log level of dividends follows an IMA(1, 6) with coefficients known to investors; second, that the log level of dividends follows an error-correction model—in which each year brings a shock to the fundamental value of the market, and the market's dividend level adjusts to close half of the gap between last year's dividend and the current sustainable dividend/price ratio—set out in appendix 2.

The IMA(1, 6) process was chosen because its integrated component allows shocks to the level of dividends to persist permanently, yet its inclusion of six moving-average coefficients provides the monte carlo dividend process with sufficient flexibility to closely match the actual short-run dividend impulse response function. The error correction process (with its adjustment parameter θ=0.5) was chosen because it was the process used by Mankiw, Romer, and Shapiro (1991), because it was used by Merton and Marsh (1986) in their critique of Shiller, and because it can, with sufficiently slow adjustment, generate very persistent shifts in rates of dividend growth close to those postulated by Barsky and De Long's (1989) interpretation of U.S. long-run stock market fluctuations.

The post-World War II period considered as a whole generates volatility ratios that are significant

rejections of the null hypothesis on the high side for the two generating processes considered.[16]

There is a strong argument that the post-World War II *Wirtschaftswunder* decade of the 1950's sees the German stock market following a different stochastic process than the later years of slower growth. When the post-*Wirtschaftswunder* 1960–90 period is considered in isolation, its volatility ratios are high enough to be very significant rejections of the null hypothesis.

As appendix 2 shows, the distributions of these test statistics are sensitively dependent on the assumed parameters of the generating process. Sufficient smoothness in the dividend level and instability in dividend growth, for example, can lead to high estimated volatility ratios even if the null efficient markets hypothesis holds. But shifting to a dividend generating process that possesses larger and more persistent changes in dividend growth does not make German data fit the efficient markets hypothesis more closely: the pre-World War I era would then exhibit deficient, not excess volatility.

There are surely dividend process that have a high probability of generating volatility ratios as large as those observed for the post-*Wirtschaftswunder* period. But for such a process, volatility ratios as low as those observed for the pre-World War I era are extraordinarily unlikely. Similarly, assuming a dividend process that generates volatility ratios as low as the values observed for the pre-World War I era would magnify the significance of the excess volatility of the post-*Wirtschaftswunder* era. Only under the assumption of a major shift from a dividend process nearly a random walk before World War I to a process with substantial dividend smoothing after World War II would there be any possibility of using the efficient markets hypothesis to account for the behavior in both periods—and there is no sign in dividend autocorrelations of such a major shift in the dividend process between the pre-World War I period and the post-1960 period.

An Alternative Benchmark

assess volatility. Shiller (1990) argues that the use of a constant multiple of a long moving average of dividends as a naïve forecast benchmark is preferable to the use of current dividends. In the U.S. dividends appear to have a substantial short-run mean-reverting component, and a long moving average of lagged dividends is a lower variance estimate of *ex post* fundamental values. Shiller (1990) finds stronger violations of volatility bounds using such a smoothed naïve forecast benchmark.

Table 2 presents volatility ratios using a ten-year moving average of lagged dividends as a benchmark. The substantive conclusions are unchanged: the post-World War II era shows some evidence of excess volatility, while the pre-World War I era shows no such evidence. Using the Shiller (1990) benchmark pre-World War I era German stock market indices no longer appear insufficiently volatile to be efficient market estimates of fundamentals, but the volatility ratios for the pre-World War I period are close to the center of the distributions calculated in the monte carlo simulations. As noted above, calculated significance levels should be regarded with suspicion, and used gingerly. Nevertheless, the sharp difference in the characteristics of the pre-World War I and the post-*Wirtschaftswunder* markets remains.

Table 2
Volatility Tests for the German Market Using a Moving Average of Lagged Dividends as the Naïve Forecast Benchmark

p^0 a 10-Year Moving Average of Dividends	Pre-WWI (1876–1913)	Post-WWII (1951–90)	Post-Miracle (1960–1990)
Volatility of p-p*…	0.082	0.164	0.176
Volatility of p-p^0…	0.023	0.316	0.204
Volatility of p*-p^0…	0.090	0.338	0.109
Volatility ratio: p-p^0 and p*-p^0…	0.26	0.93	1.86
Volatility ratio: p-p* and p*-p^0…	0.91	0.49	1.59
Sum of ratios	1.17	1.42	3.45
Significance: IMA(1,6)	0.27	0.06	0.01
Significance: ECM (θ=0.5)	0.38	0.08	0.01

Still other naïve forecast benchmarks could be used. Few today would argue for Shiller's (1981) original *ex post* time trend as an admissable naïve forecast benchmark. But some might argue that the constant dividend multiple benchmarks themselves attribute to investors in the past knowledge that they did not in fact possess (see Barsky and De Long, 1989; Bulkley and Tonks, 1989). If the long-run growth rate of the economy, and of dividends, and if future real interest rates are not known with certainty, how then could past investors calculate the appropriate multiple by which to mark up current dividends? Bulkley and Tonks (1989) argued that apparent violations of volatility bounds on the post-World War I London market did not exist in fact once it was recognized that investors had to estimate the parameters of the dividend process, and did not know them *ex ante.*

Such arguments, however, tend to explain away apparent excess volatility where it appears: they would, if anything, make the existence of *deficient* volatility as seen in the pre-World War I German market even more anomalous.

IV. Conclusion

This paper has used German data to investigate issues similar to those that Shiller (1989) has investigated in his studies of the United States stock market. The German data give different answers. There is some evidence of excess volatility in the post-World War II German stock market. But there is no sign at all of excess volatility in the pre-World War I German stock market. Relative to a naïve forecast benchmark that takes fundamental values to be a constant multiple of dividends, the pre-World War I German stock market stands in contrast to both the post-World War II German market, and to the American market in either the pre-World War I or the post-World War II period.

The substantive results of this paper suggest two additional lines of thought. The first is that in a sense the absence of excess volatility in the German stock market before World War I strengthens Shiller's conclusions for the United States. It is harder to maintain that Shiller's findings of violations of market efficiency are due primarily to biases in test procedures or to inappropriate assumptions about the stochastic character of generating processes when the pre-World War I German stock market—presumably subject to the same biases in test procedures —exhibits no signs of excess

volatility. The U.S. stock market might have exhibited as low a degree of volatility relative to current dividends and perfect-foresight fundamentals as the pre-World War I German market. Yet it did not do so. This calls for explanation.

The second additional line of thought is speculative. Perhaps the unusual behavior of the pre-World War I German market—in not showing evidence of excess volatility—is linked to the institutional structure of finance under the German Empire. In pre-World War I Germany a major role in finance was played by the so-called *Großbanken,* the "great banks" that were at once investment bankers, long-term stockholders in corporations, and depositories of savings that grew up in pre-World War I Germany during its industrial revolution (Clapham, 1963; Landes, 1956 and 1969; Riesser, 1906 and 1911). The growing need for external finance by industry and the absence of well-developed securities markets on which to raise money created a niche that the German "mixed" banks were to fill.[17]

These banks were investment trusts, development banks, commercial banks, investment banks, securities underwriters, investment advisors, and management consultants all at once (Weber, 1902; Riesser, 1911; Quittner, 1929; Neuberger, 1974). By 1880 the banks had representatives on most industrial boards—contacts that could be used very profitably when deciding on the methods of corporate finance.[18] These banks came close to dominating the process by which companies were started and financed: future Weimar Social Democratic finance minister Rudolf Hilferding (1910) could say on the eve of World War I that all that was needed in order to attain socialism in Germany was the nationalization of its six largest banks.

Successful "mixed" banks persuaded investors that the companies they sponsored were desirable investments that would remain stable both in their yield relative to par and in their market value. According to analysts like Prion (1910 and 1929), representatives of the sponsoring banks would regularly meet with the stock exchange's exchange's market maker *"zur Kurfestsetzung"*—to set the price. Prion argues as well that the banks stabilized prices not so much by trading in them directly, but because they were seen as informed investors who could make the best estimates of underlying

[17]See Gerschenkron (1952); also Pohl (1976), (1982a), and (1982b). This German practice is in sharp contrast to the practice of Anglo-Saxon banking, which tended to try to insulate banks from the risk of industrial failure, as detailed by Willis and Bogen (1936). The Großbanken developed at least in part because of the fragmentation of Germany's securities markets.

[18]German banks, moreover, voted the considerable numbers of shares that customers purchased through them and left with them for safekeeping. This *Depotstimmrecht* was and is the subject of economic, political and legal debates. For a good account of the legal situation before the hyperinflation, see Gieske (1926).

fundamental values.

The fact that the heyday of "finance capitalism" in pre-World War I Germany sees the absence of excess volatility is food for thought. Historians of corporate development like Chandler (1990) argue that organizations like the Deutsche Bank were well informed. Perhaps they did make better estimates of fundamentals than the speculators who would have dominated the stock market in their absence, who did dominate the American stock market throughout the past century, and who have played a more active role in the German stock market since World War II. Perhaps the pre-World War I German stock market behaves differently than the American market because its prices are administered assessments of fundamental values made by a handful of large and well-informed institutions that had an interest derived from their investment banking business in preventing stock prices from undergoing speculative swings away from their fundamental values.[19]

This speculative possibility is intriguing. It suggests that a competitive stock market, in which prices balance the momentary demands and supplies of short-term traders who are relatively uninformed about fundamentals, may not perform as well—measured as a social calculating and capital allocation mechanism—as alternative institutional arrangements that rely more on "hierarchy" and less on "market exchange." If market performance is evaluated using a metric that penalizes "excess volatility," then the pre-World War I German stock market appears to have performed relatively well. Perhaps its "finance capitalist" structure had something to do with its good performance.

Cochrane (1991) asks believers in Shiller's (1989) arguments for "excess volatility" to suggest an alternative form of organizing securities markets that would produce better forecasts of fundamental values. He implies that there is no alternative, that a competitive market populated by atomistic, short-horizon speculators like the one the U.S. has possessed for the past century is the best option. If flawed forecasts are the cause of excess volatility, how could different institutions be immune to such flawed forecasts? The pre-World War I German hypothesis suggests a possible answer. Perhaps a U.S. stock market dominated by informed *Großbanken* would have been a better social capital allocation mechanism than the actual U.S. market has been over the past century. The absence of excess volatility in the pre-World War I German market indicates that we should think about whether

[19]We explore this line of analysis further in De Long and Becht (1992).

this is in fact so.

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