When the Bubble Bursts: Psychology or Fundamentals?

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Prices for stocks, bonds, foreign exchange, and other assets frequently exhibit large fluctuations on a daily and long-term basis. Perhaps the best known example of asset-price volatility was the 500-point decline in the Dow Jones Industrial Average on October 19, 1987. The 23 percent drop coincided with similar declines in the Tokyo, London, and Hong Kong stock exchanges and was nearly twice the magnitude of the October 1929 crash that ushered in the Great Depression.

October 19, 1987, was not the only turbulent day on the New York Stock Exchange in recent history. Since 1987, there have been 16 trading sessions in which the Dow moved at least 90 points. Extreme price volatility is not confined to the stock market, nor is it strictly a short-term feature of the market. High variability has characterized foreign exchange rates since currencies were allowed to float in the early 1970s. The U.S. dollar, which rose 20 percent between February 1984 and February 1985, fell

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25 percent over the following year. Price volatility has also characterized the markets for corporate and U.S. government debt in recent years. Once the haven of conservative investors, the bond market now frequently displays fluctuations equal to those in the stock and foreign exchange markets. For example, the price of the 30-year U.S. Treasury bond rose more than 40 percent between October 1985 and July 1986 and fell nearly 20 percent during the first half of 1987.

These price fluctuations have important economic implications. Recent empirical studies suggest that asset prices have predictive power for the business cycle. In particular, low bond prices (high interest rates) tend to precede recessions, and high bond prices (low interest rates) tend to precede expansions.

There are also potentially important economic costs associated with asset-price volatility. In particular, substantial price volatility will tend to increase the volatility of returns on assets. Since investors typically dislike risk, high volatility will tend to increase the average rate of return on capital demanded by investors; that may lead to lower investment, a smaller capital stock, and a lower standard of living.

This article presents an analysis of the volatility of security prices. The objective is to discuss issues associated with whether movements in asset prices reflect changes in the fundamental value of the asset or whether these extreme price changes might be associated with changes in market psychology that may not be related to business conditions.

MARKET FUNDAMENTALS

There is an old debate associated with whether asset prices correspond closely to their fundamental values or whether market psychology and extraneous factors can cause prices to deviate substantially from an asset's fundamental value. This debate has focused on the interpretation of changes in security prices and their volatility. Many academic economists have argued that security prices efficiently reflect current and past information and that market prices are a good approximation of a security's *fundamental* value. Fundamental values are often referred to as *market fundamentals.*

The fundamental value of an asset is defined as the present value of the expected payoff from that asset. For example, consider a hypothetical asset that yields $1 per year for five years. The fundamental value of this asset would be the sum of the five yearly payoffs, discounted by the relevant interest rate. (Discounting a future cash flow by an interest rate is required because a $1 payoff in the future is not equivalent to a $1 payoff today.) One can use the same logic to determine the fundamental value of a stock. Since the payoff from a stock is the dividend, one measure of the fundamental value of a stock is the sum of all (expected) discounted future dividend payments.

Market fundamentals, combined with the efficient markets theory, provide a simple tool for interpreting fluctuations in security prices. According to the efficient markets theory, security prices fluctuate only as investors respond to new information concerning changes in market fundamentals (the discounted sum of future cash flows).[1] For example, suppose a pharmaceutical manufacturer announces that it has developed and tested a new product that successfully combats cancer. The efficient markets theory predicts that the price of the company's stock would jump immediately as investors re-evaluate the security in light of the new information. The extent of the price increase reflects how the new information alters market fundamentals. An increase of 15 percent in the stock price indicates that the dis-

[1]For a readable discussion of security prices and the efficient markets theory, see Burton Malkiel's book.

counted sum of expected future dividends is 15 percent higher, according to the theory.

A popular version of the efficient markets theory states that security prices will follow a "martingale."[2] The basic idea behind the martingale model for security prices is that the difference between a stock's price today and a stock's discounted price tomorrow is completely unpredictable.[3] Thus, the main implication of this model is that the best forecast for tomorrow's stock price will simply be today's price. Moreover, the efficient markets theory implies that whatever change occurs in the stock price tomorrow will be completely accounted for by new information on market fundamentals.

This theory makes a number of predictions for the behavior of asset prices. One important implication of the martingale model is that trading strategies designed to "beat the market" cannot be systematically successful. This follows from the fact that for the martingale model, the probability that the price of a stock will rise in value tomorrow is the same as the probability that the price will fall. Moreover, this theory predicts that stocks cannot be identified as under- or overvalued, nor are there particularly good or bad times to purchase stocks. Another strong implication of this theory is that the dominant investment strategy is a very simple one: buy and hold a diversified portfolio of assets.

This theory has been widely applied to understanding movements in asset prices. Its popularity likely reflects the fact that it provides a simple way of using basic economic theory to evaluate security prices. Also, an important implication of the theory—that changes in asset prices are unpredictable—seems to be fairly well supported by a large body of data. However, some of the strong assumptions embodied in the theory, such as the risk neutrality of investors, and the fact that some other features of the data are difficult to reconcile with the theory have led to criticisms of this model.

Some critics of the efficient markets theory point out that the volatility of security prices seems much too high to be justified by changes in market fundamentals. Market traders and many financial analysts claim that new information about market fundamentals provides only a partial explanation of observed price fluctuations. While they acknowledge that long-term movements in securities prices correspond to changes in fundamentals, they argue that short-term fluctuations are caused by shifts in market psychology or perhaps even by events that have no direct bearing on business prospects or economic conditions.

BUBBLES

A bubble is defined as any deviation of an asset's price from its fundamental value. We can think of an asset's price as consisting of two components: one associated with market fundamentals and the other representing the bubble. The bubble theory suggests that securities may go through periods of under- and overvaluation relative to fair-market values. One reason for this may be investor overreaction. In the pharmaceutical example described above, investors may be overly optimistic in evaluating the increase in the firm's profits. Of course, investors have strong incentives to correctly evaluate how product developments affect firm profitability. This reasoning suggests that it's unlikely that investors will consistently overreact to news about firms' profitability.

Bubbles may also reflect investors' reactions to factors unrelated to fundamental eco-

[2]The martingale model of security prices, which has also been called the random-walk model, comes from an assumption that investors care only about the expected rate of return on an asset, not the variability of the return.

[3]Technically, this implication is for the change in price plus any dividend amount.

nomic and business conditions. Hypothetically, individual investors may rush into the stock market because they believe everyone else is making money in the market. In this case, they prefer to buy stocks immediately rather than miss an excellent buying opportunity. As a result, the anticipation of rising prices becomes a self-fulfilling prophecy, and market participants enjoy profits that may not necessarily reflect favorable business prospects.

For example, investors know that the outcome of the Super Bowl played each January has had a good track record in predicting the course of that year's stock-market performance. When a National Football Conference team has won, the stock market has frequently increased considerably over the year, while a win for an American Football Conference team often presages a lower stock market. Even though the outcome of a football game has little, if any, effect on overall business conditions, the business press and investor publications often cite this correspondence. As long as some investors are perceived to act on this statistic, others also may buy in anticipation of this higher demand and rising prices. If enough investors behave this way, prices rise and expectations become self-fulfilling.

Certain types of bubbles can be difficult to explain in a sensible way. They are similar to Ponzi schemes and chain letters in that participants will benefit from the game as long as others can be found who are eager to play the game. Of course, Ponzi schemes crash as soon as individuals believe it will be difficult to find others willing to participate. Similarly, some types of bubbles imply that dramatic declines in security prices are the result of investors finally realizing that rising prices may never be justified on economic grounds. At that point, investors try to sell their assets and prices drop: the bubble bursts.

While certain types of bubbles seem to be inconsistent with rational behavior, there is a class of bubbles called *rational bubbles*.[4] A rational bubble reflects a self-fulfilling belief among rational investors that an asset's price depends on variables unrelated to market fundamentals. In this context, a rational investor is an individual who efficiently uses relevant information for assessing the value of a security. Within the bubbles framework, the fact that investors are rational means that while bubbles can exist, obvious profit opportunities cannot. This simply means that if an easy profit opportunity were available, a rational investor would exploit it and quickly eliminate the opportunity. In other words, for simple types of bubbles, the expected rate of return on a security must be the same whether or not the price includes a bubble.

This means that one key feature of a rational bubble is that the evolution of the bubble over time is restricted to rule out easy profit opportunities. For example, a situation in which all investors expect a security to double in price between today and tomorrow, but fall back to its original value the following day would not constitute a rational bubble. In this case, everyone would rationally want to sell the security tomorrow, so that the price would fall before the following day. Alternatively, an asset could be overpriced 20 percent relative to its fundamental value and, thus, could exhibit a rational bubble, as long as both the fundamental value and the bubble component are expected to grow at the same rate. For example, suppose that market fundamentals for a security were expected to grow at 5 percent per year forever. The price of this security would have a rational bubble if the bubble component also grew at 5 percent per year. In this case, the rate of return on the security with the bubble component

[4]A large literature has analyzed rational bubbles. This review provides an analysis of some very simple examples. For an extensive review of this literature, see the *Journal of Economic Perspectives*, Spring 1990, Symposium on Bubbles, pp. 13-102.

would be identical to the rate of return on the security without a bubble.

Bubble interpretations have been popular with professional investors and the financial press for many years. In his introduction to Charles Mackay's *Memoirs of Extraordinary Popular Delusions and the Madness of Crowds*, the noted investor Bernard Baruch wrote, "All economic movements, by their very nature, are motivated by crowd psychology...Men think in herds; it will be seen that they go mad in herds, while they only recover their senses slowly, and one by one."

HISTORICAL EPISODES OF DRAMATIC PRICE MOVEMENTS

A number of historical episodes of extreme price movements have been interpreted as bubbles. While these episodes and the circumstances surrounding them bear little resemblance to modern financial markets, they are interesting to analyze, since they may be helpful in understanding current experience.

Perhaps the most famous episode occurred in 17th century Holland with an unlikely asset: diseased tulip bulbs. Tulipmania, as it is often called, began quietly when a nonfatal virus, known as a mosaic, attacked tulip bulbs. The effect of the virus was to produce a variegated flower of brilliant stripes and colors. The virus affected only a relatively small number of bulbs, and these bulbs became highly prized by collectors.

As the prices of the mosaic bulbs began to rise rapidly, investors as well as horticulturists began acquiring them. The increased demand for the bulbs resulted in even higher bulb prices and large profits for existing owners. Charles Mackay, who described this episode in his book, noted that "nobles, citizens, farmers, mechanics, seamen, footmen, maid-servants, even chimney sweeps and old clotheswomen dabbled in bulbs."

By 1635, tulipmania had engulfed the country. Futures markets sprang up in local taverns, where trades were made without margin limits and, presumably, the flow of spirits facilitated transactions. Interestingly, speculation apparently spread to common bulbs unaffected by the mosaic virus. In the first week of February 1637, prices peaked, and common bulb prices rose 20-fold in one month. Then, prices fell dramatically. While historical data from this period are sketchy at best, Peter Garber of Brown University has estimated that common bulb prices lost about 95 percent of their peak values just three months after the crash. A century later, the bulbs were virtually worthless. The strikingly colored Semper Augustus bulb, which traded for about $60,000 (in current dollars) in February 1637, commanded just 50 cents in 1739.

Tulipmania was a costly lesson for the Dutch. Unfortunately, the British did not learn from this episode. In 1711, some holders of short-term British government war debt agreed to exchange that debt for equity shares in a new government-chartered, joint-stock company called the South Sea Company. In return, the company received a perpetual annuity paying 6 percent annually on the same face value of debt that had been exchanged. The South Sea Company was also given a monopoly on all trade to the South Seas. Although initial trading was fraught with mistakes and a war with Spain shut off most trading opportunities, the price of the stock rose modestly. By 1719, it appeared that peace with Spain was at hand, and as a result, prospects for the South Sea Company looked better than ever.

In 1720, many additional holders of government debt traded the debt to the South Sea Company in exchange for new stock. The company was expected to consolidate the debt and receive a steady stream of interest payments on the government obligation. At this point, the stock's price rose from 130 pounds to 300 pounds per share. After Parliament approved this plan, a new stock offering at 300 pounds quickly shot up to 340. Fights among investors

eager to buy the offering were common. The next offering came out at 400, and the next at 500, with an option to buy at just 10 percent margin. When the stock hit 800, half of the members of the House of Lords and the House of Commons plunged in. Soon the price hit 1000 pounds per share. At this point, the directors of the company began selling, which resulted in rapid liquidation of South Sea shares.

Parliament ultimately passed the Bubble Act, which prohibited the issuing of stock certificates by companies. So strong was the British aversion to a repeat bubble that this law was in force for the next century: British companies were not allowed to issue stock until 1825.[5]

PLEASE DON'T EAT THE TULIPS!

In his book, Charles Mackay relates an anecdote that shows just how seriously the Dutch took their tulips. Mackay describes an incident in which a young sailor notified a merchant of the arrival of a shipment of new goods. For bringing the news, the sailor was summarily rewarded with a breakfast of herring. It so happened that the sailor noticed the ideal condiment for his herring, an onion, perched on the merchant's counter and helped himself to it. To the merchant's—and ultimately the sailor's—distress, the "onion" was actually a prized Semper Augustus bulb. The merchant pressed charges, and the unwitting felon spent several months in prison.

Of course, who knows how much—if any—of this story is true. Peter Garber, for one, points out that an astute merchant would hardly leave such a valuable object lying around, especially within easy reach of a random guest. Nonetheless, it underlines the frenzy created by the speculation in tulip bulbs in 17th century Holland.

BUBBLES VS. MARKET FUNDAMENTALS: EVIDENCE FROM MODERN TIMES

Although not accepted universally, many economists agree that prices during these historical periods reflect some bubble component. Are bubble explanations of extreme price movements confined to just a few historical episodes, or might bubbles be relevant for today's financial markets?

Critics of the efficient markets theory point out that the theory cannot account for observed volatility in security prices. Nevertheless, the implication of the theory that changes in asset prices are unpredictable has received a fair amount of empirical support. For example, a number of experiments have been conducted in which stock portfolios picked by Wall Street's leading money managers were compared over time against a portfolio chosen by throwing darts at a stock page from the *Wall Street Journal*. The martingale model predicts that portfolios chosen at random should perform, on average, about the same as those chosen by portfolio managers. In many of these experiments, random picks do just as well as many of Wall Street's leading traders.

Moreover, critics of the bubble theory point out that technical analysis, which is the practice of trying to identify systematic patterns in security price movements, should be useful in choosing securities if bubbles are present. The basic idea is to plot security prices over time and use past price behavior to predict future prices. Patterns often considered important for predicting future price movements include the "inverted head and shoulders," "triple top double bottoms," and "piercing necklines." In

[5]See Charles Kindleberger's book for a more in-depth treatment of the South Sea bubble.

general, these approaches have not significantly outperformed randomly chosen strategies or buy-and-hold strategies.

Nevertheless, several observations from the stock market do challenge efficient markets explanations. One of the best known patterns is the January effect, which refers to the first two weeks of January when stock returns tend to be unusually high. This is also a period when stocks of smaller companies, such as those that tend to trade on the over-the-counter market, outperform larger, well-known issues. While selling stocks because of end-of-the-year tax considerations may play a role in explaining the January effect, it cannot completely account for the anomaly. The January effect was present in the United States even before income taxes.

Some economists have made another observation that challenges the market fundamentals theory: the underpricing of initial public offerings (IPOs). An IPO is the initial sale of equity shares in a company that was privately held. Brokers allocate the initial offerings of shares to customers, and after the initial offering, these shares are traded on public exchanges. For many IPOs, the initial rate of return is enormous.[6] In a 1988 paper, Roger Ibbotson, Jody Sindelar, and Jay Ritter reported that between 1977 and 1987, the average initial return, which is defined as the percentage increase from the offering price to the end-of-first-day bid price, is over 20 percent. On an annualized basis, this rate of return would be in the neighborhood of over 1000 percent.

These enormous returns suggest to some observers that the shares are initially underpriced. There does not appear to be a generally accepted theory of this observation, and it is somewhat puzzling as to why issuing firms would agree to deal with underwriters who underprice the security.[7]

TESTING FOR BUBBLES AND EXCESS VOLATILITY IN ASSET MARKETS

The tulipmania and the South Sea bubbles are striking examples of how prices may diverge from fundamental values. Many economists think it unlikely that similar episodes could occur today. If there are bubble or nonfundamental components in asset prices, chances are they will be much less dramatic and harder to distinguish from market fundamentals.

Until recently, claims that prices were out of line with market fundamentals were conjectures, substantiated by little more than anecdotal evidence. However, recently developed statistical tests may help shed some light on the debate. A number of tests have been developed, and two widely used tests will be discussed here.

Robert Shiller of Yale University developed and implemented one popular test that has been used to evaluate whether prices are consistent with market fundamentals. Shiller constructed an economic model of the fundamental price of an asset. The test compares the volatility of the observed security price with the volatility of the fundamental price. These tests are typically called variance bounds tests, since the basic idea is to determine whether the observed variability of market price is consistent with the observed variability of market fundamentals.

For stocks, the model assumes that the price an investor would be willing to pay today depends on the total return (the dividend and price appreciation) he expects to receive from

[6]For example, in August 1995, Netscape, a company that produces software for the Internet, had an IPO with an offering price of $28 on Tuesday and closed at $58.25 on Wednesday.

[7]For additional discussion of asset market anomalies, see Richard Thaler's 1992 book.

the stock tomorrow. In turn, the price in the following period depends on the dividend and price appreciation he expects to receive two periods from now, and so forth. This logic implies that the fundamental price of a stock today will depend on all expected future dividends adjusted by an appropriate discount rate (interest rate). This analysis suggests that today's share price is a predictor of future returns. If the market price is consistent with market fundamentals, the share price should equal market fundamentals. In this case, the volatility of predicted cash flows (the market fundamentals price) cannot exceed the volatility of actual cash flows (the returns). Using data on dividends and prices, we can compare the historical volatility of the predicted cash flows to the actual cash flows.

A constructed series represents the sum of discounted dividends from stocks listed in the Standard & Poor's 500 graphed against the price of the S&P 500 since 1871 (Figure 1). Clearly, stock prices are many times more volatile than the present value of discounted dividends. Given the relatively stable history of dividends over the last century, market fundamentals, constructed this way, clearly cannot account for the extreme volatility of asset prices. One interpretation is that stock prices are too volatile relative to observed changes in cash flows and that some factor unrelated to business conditions is responsible for the bulk of asset price fluctuations.

However, there are some important caveats associated with interpreting these tests. First, there is no unique way to determine how investors discount future cash flows. The typical procedure carried out in these tests (and in Figure 1) is to assume that the discount factor (interest rate) is constant, which may not be true. Second, we cannot observe people's expectations of future dividends directly, so we must infer them. It is common to simply assume that today's stock price is exactly equal to the future discounted sum of dividends. But this practice leads to difficulties in evaluating whether market fundamentals are consistent with price data. Instead, Robert Flood, Robert Hodrick, and Paul Kaplan, in a 1986 paper, suggested that apparent violations of variance bounds tests reflect errors in the model. That is, the test depends on the underlying economic model being correct. Of course, this is a very strong assumption, and test results may simply reflect misspecification of the economic model. While there may be bubble components to asset prices, this type of test will not likely resolve the debate.

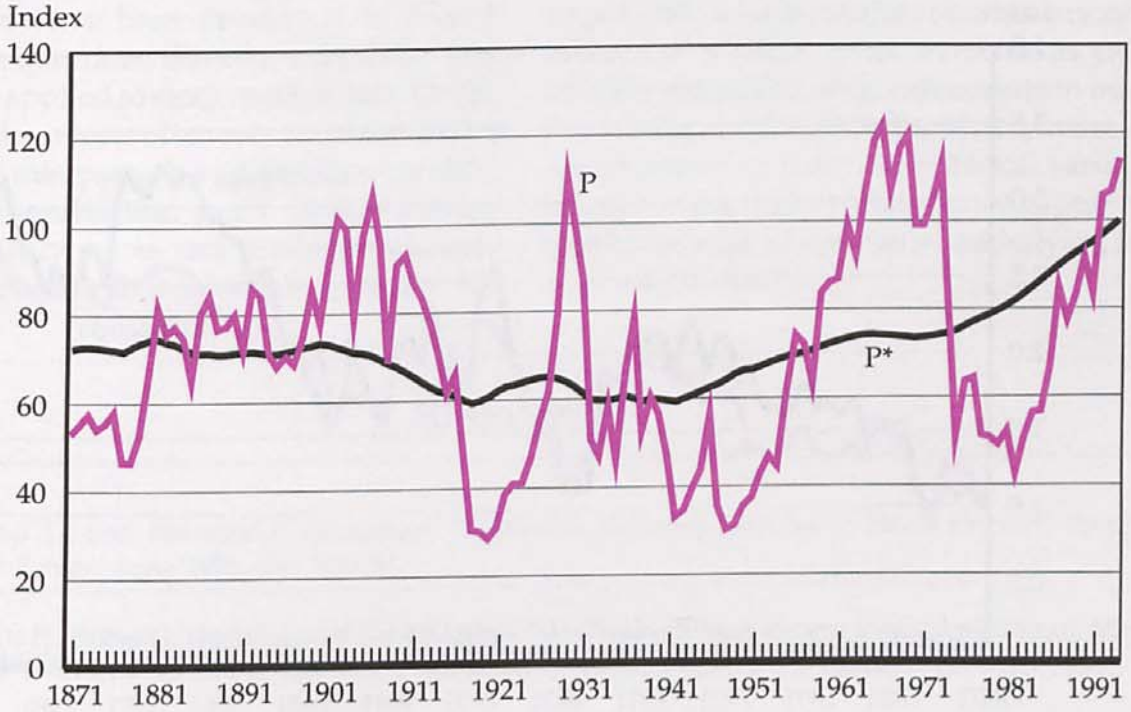
An alternative approach for testing whether variations in security prices are consistent with variations in market fundamentals is to determine whether the trend rate of growth in the asset price is similar to that in market fundamentals. Specifically, if market fundamentals are growing at a slower rate than the price of the corresponding asset, we may reasonably conclude that prices include a particular type of bubble component. This procedure can be used to detect the presence of bubbles that grow continuously over time.

In 1985, James Hamilton and Charles Whiteman, and in 1988, Behzad Diba and Herschel Grossman conducted tests along these lines. To determine whether market prices grow at a faster rate than market fundamentals, we must evaluate the trends in the data. First, we test the data on annual stock prices and annual dividends to see if there are trends. If both series have trends, the series are "differenced." For example, to calculate the differenced data for market prices, subtract the price of the asset last year from its price this year.

The differenced data for market prices and dividends are then tested for trends. If both of these differenced series have trends, the series are differenced again, and the trend tests are repeated. This process of successively differencing the data continues until the transformed data do not have trends. If market

FIGURE 1

Detrended Stock Prices and the Present Value of Detrended Dividends 1871 - 1994



P is the real Standard & Poor's Composite Stock Price Index, detrended by a long-run exponential growth factor. P* is the discounted present value of real dividends, detrended by the long-run exponential growth factor. Real values are calculated by dividing nominal values by the wholesale price index.

Source: Shiller, *Market Volatility*, Figure 5.1, updated by author.

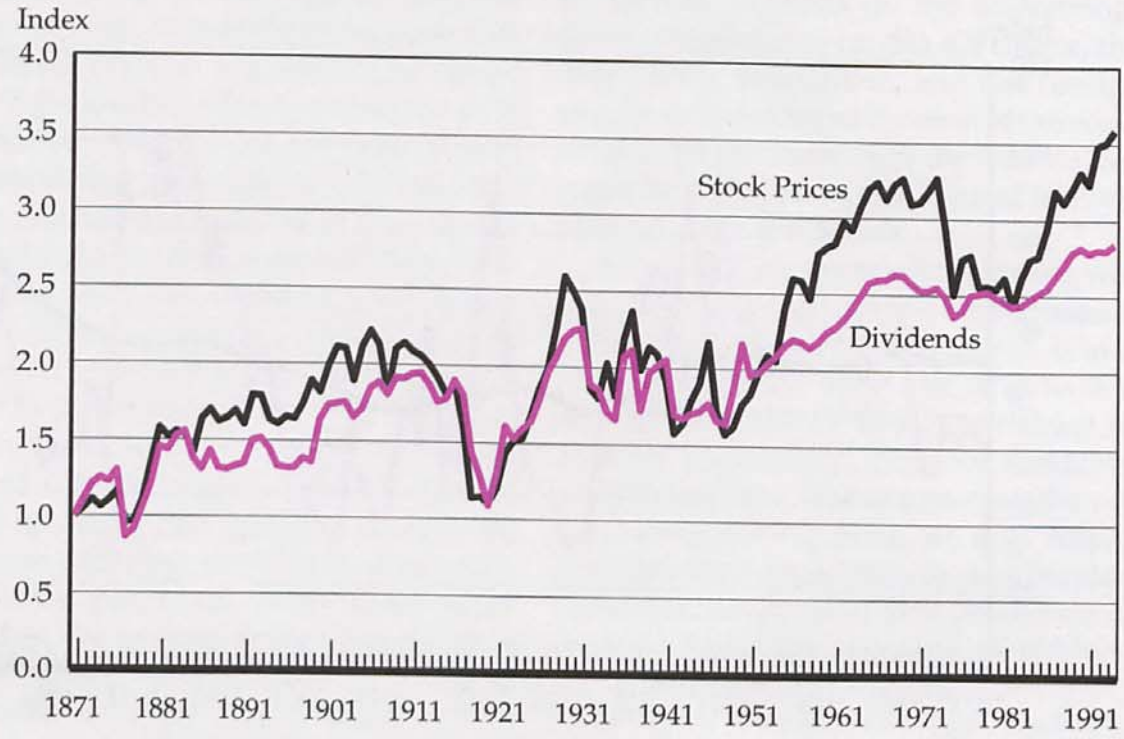
prices must be differenced more times than market fundamentals, we may reasonably conclude that a bubble is present in market prices.

This analysis for dividends and stock price data, which appears in Figure 2, offers evidence that both prices and dividends have trends, but when differenced once, both do not. This implies that prices over this period have not grown consistently faster than dividends and provides evidence against the notion that stock prices have included a growing bubble component.

Although the analysis presented here was conducted with data only from the stock market, these same tests can be used to evaluate data from the bond and foreign exchange markets. Briefly, the nature of these data are quite similar to data from the stock market. Like stocks, the variability of bond prices and exchange rates seems to be high relative to mar-

FIGURE 2

Stock Prices and Dividends 1871 - 1994



"Stock prices" is a logarithmic index of the real Standard & Poor's Composite Stock Price Index. "Dividends" is a logarithmic index of the real dividends on the real Standard & Poor's Composite Stock Price Index. Real values are calculated by dividing nominal values by the wholesale price index.

Source: Author's calculations from data in Standard & Poor's *Security Price Index Record.*

ket fundamentals. Moreover, there don't appear to be any differences in the trend behavior of market fundamentals and prices for either bonds or foreign exchange.

CONCLUSION

The extreme volatility of security prices has been a source of considerable interest since financial assets have traded in organized markets. It is important to distinguish between market fundamentals and bubbles when analyzing the volatility of any security. If there are dramatic changes in fundamental economic factors, we would expect to see highly volatile security prices. If the volatility of security prices is considerably greater than the volatility of underlying business conditions, or if asset prices tend to grow much faster than the asset's associated cash flows, price movements may reflect a bubble component.

The episodes of Dutch tulipmania and the British South Sea bubble provide dramatic examples of how prices may have deviated from fundamental values. Anecdotal evidence from recent periods provides no clear answer to the question of whether price movements may be due to bubbles. A number of statistical procedures have been developed to investigate these questions directly, and these tests have been applied to stock market data. Unfortunately, these tests often rely on assumptions that make interpretation of results very difficult. Test results that show differences between security prices and market fundamentals may be due to bubble components, but they may also reflect errors in the model for market fundamentals. That is, a researcher may find evidence in favor of bubbles, but this may simply be due to the fact that the model for market fundamentals is wrong.

Since market fundamentals are generically unobservable, it will always be difficult, if not impossible, to analyze data on asset prices and determine whether price movements can be entirely reconciled with movements in market fundamentals. We are left with the interesting observation that there are historical variations in asset prices that, at least, do not appear to be consistent with variations in underlying business conditions.

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