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And Inflation Expectations

Challenges to the Concept
Of Stock Market Efficiency

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The Yield Curve And Inflation Expectations 3

By C. Alan Garner

The yield curve is a useful indicator of inflation expectations. It is not infallible, however, because a number of macroeconomic and financial factors can affect the yield curve without changing inflation expectations. Nevertheless, evidence from the 1980s shows that changes in the yield curve are moderately correlated with changes in inflation expectations.

Challenges to the Concept Of Stock Market Efficiency 16

By Douglas K. Pearce

The efficient markets model of stock price determination implies that investors cannot use available information to earn more than a normal return. The model has been challenged on grounds that investors sometimes earn excess returns. The model has also been challenged on grounds that it cannot explain the volatility of stock prices. But the evidence is not strong enough for the model to be rejected.

The Yield Curve And Inflation Expectations

By C. Alan Garner

Long-term interest rates rose sharply relative to short-term rates in the first half of 1987. The resulting difference between yields on long-term bonds and short-term bills was the largest since 1984. This dramatic rise in long-term rates relative to short-term rates steepened the yield curve, which shows how security yields vary as the term to maturity lengthens. Did this steepening of the yield curve carry a message for business forecasters and decisionmakers?

Many economic and financial analysts viewed the steepening of the yield curve as a sign of rising inflation expectations. The curve steepened amid general concern about the inflation outlook. Oil prices had firmed after declining sharply in 1986, industrial commodity prices were increasing rapidly, and the depreciation of the dollar against other major currencies was raising import prices. Other analysts were skeptical, however, feeling that an increase in long-term inflation expectations was unwarranted and that the steepening of the yield curve was reflecting other factors.

This article examines whether the shape of the yield curve can give useful information about inflation expectations. The first section explains how increasing inflation expectations could steepen the yield curve. But the second section shows that other factors could steepen the curve without increasing expected inflation. The third section examines recent evidence on inflation expectations and the shape of the yield curve. The yield curve is found to be a useful—but not infallible—indicator of inflation expectations.

Inflation expectations and the steepening yield curve

The view that the yield curve is an indicator of inflation expectations has a basis in economic theory. Inflation expectations influence the shape of the yield curve by affecting expected short-term interest rates. When investors revise their expectations about long-term future inflation rates upward, theory predicts the yield curve will

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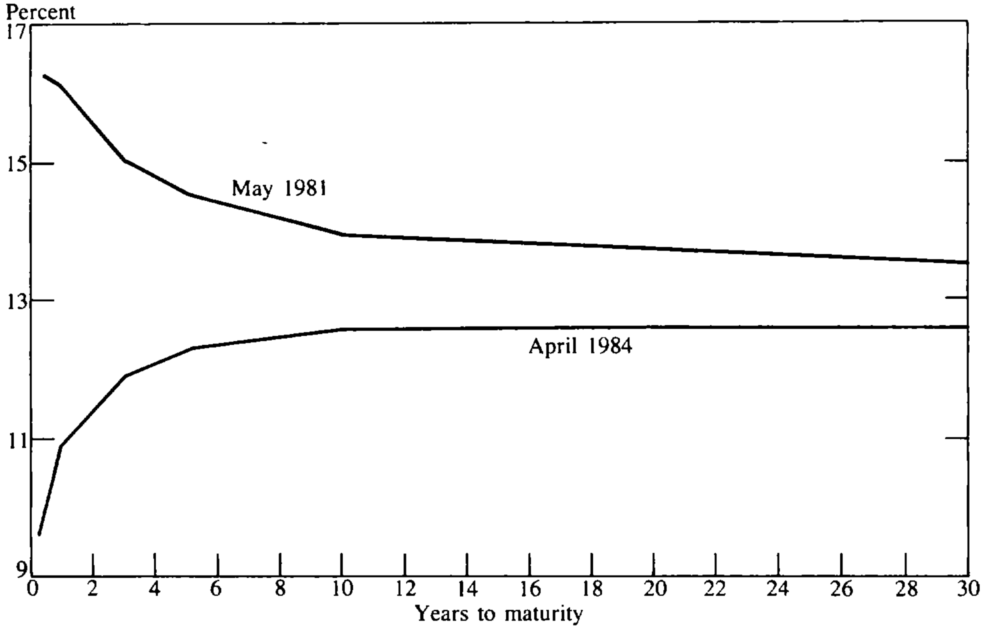
CHART 1
Yield curve shapes



Note: Curves are plotted by connecting U.S. Treasury constant-maturity yields for selected maturities.

steepen. This section shows how a worsening of the long-term inflation outlook affects the shape of the yield curve.

The Treasury yield curve

The yield curve shows how security yields vary as the term to maturity of the securities increases. For yield comparisons to be meaningful, the securities must have similar default risk and tax considerations. Economists typically focus on the yield curve for U.S. Treasury securities because Treasury bills, notes, and bonds are free of default risk. Moreover, yield data are readily available since Treasury securities are traded in active secondary markets.[1]

The shape of the Treasury yield curve has varied substantially over time. Chart 1 illustrates some commonly observed shapes. Long-term interest rates have been greater than short-term rates, on average, over long periods of U.S. history. And short-term interest rates typically have fluctuated over a wider range than long-term rates. This fluctuation has produced both upward-sloping yield curves, as in May 1981, and downward-sloping yield curves, as in April 1984. The yield curve has often sloped upward near business cycle troughs and downward in boom periods.

[1] The Treasury yields in this article are constant-maturity yields estimated by the U.S. Treasury. Daily yield curves are constructed from quotations reported by five leading government securities dealers. The yield curve is fitted by eye and based only on the most actively traded issues. Constant-maturity yields are read from the curve at specified maturities. This method permits estimation of the yield for a ten-year maturity, for example, even if no outstanding security has exactly ten years remaining to maturity.

The expectations theory

The expectations theory provides an explanation for the shape of the yield curve. This theory asserts that financial markets determine security yields so that the return from holding a multiyear security until maturity equals the expected average return from holding a series of one-year securities over the same period.

A numerical example helps illustrate the expectations theory. Suppose investors have only two options for investing over a three-year period. One option is to purchase a security maturing in one year, to reinvest the proceeds from this security at the end of the year in another one-year security, and to follow the same procedure at the end of the second year. The other option is to purchase a security maturing in three years and hold it to maturity. Suppose that a one-year security currently yields 4 percent and that one-year securities are expected to yield 5 percent and 6 percent in the following two years. A three-year security currently must provide a 5 percent annual return to match the expected average return from holding three successive one-year securities.[2] Investors will adjust their portfolios until the expected return over the three-year horizon is equalized. Investors will buy the three-year security only if it yields more than the currently available one-year security because they expect the proceeds from the one-year security to be reinvested later at higher short-term rates. That is, the yield curve will slope upward to reflect investors' expectations of future interest rates.

The expectations theory implies that the shape of the yield curve depends on the expected pattern of short-term interest rates. As the numerical example shows, long-term interest rates exceed current short-term rates if short-term rates are expected to rise. The yield curve thus slopes upward. In contrast, long-term interest rates are less than current short-term rates if short-term interest rates are expected to fall. In this case, the yield curve slopes downward.

The Fisher effect

How does expected inflation affect the shape of the yield curve? The link between market interest rates and expected inflation is called the Fisher effect.[3] The Fisher effect implies that an increase in expected inflation could steepen the yield curve by raising the expected level of future short-term interest rates.

A market interest rate can be divided conceptually into a required real rate of return and the expected inflation rate over the relevant period. Market interest rates are nominal rates, measured in current dollars. But investors are concerned about their real, or inflation-adjusted, returns. As a result, investors demand nominal returns that are high enough to protect them against expected inflation and still yield a real return that makes lending attractive.[4] If the expected inflation rate

[2] This article uses arithmetic averages of interest rates to simplify the exposition. Geometric averages are appropriate, but the arithmetic averages provide close approximations in these examples. For further discussion of the expectations theory, see George G. Kaufman, *Money, the Financial System, and the Economy*, Third Edition, Houghton Mifflin, Boston, 1981.

[3] The Fisher effect is named for Irving Fisher, a famous American economist. Fisher's work is summarized in George G. Kaufman, *Money, the Financial System, and the Economy.* This discussion of the Fisher effect neglects the role of income taxes. Income taxes are incorporated into the Fisher effect in Michael R. Darby, "The Financial and Tax Effects of Monetary Policy on Interest Rates," *Economic Inquiry*, June 1975, pp. 266-276.

[4] Required real interest rates are determined by the interaction of such macroeconomic factors as saving rates, investment opportunities, and government policies. Economists represent these factors with general equilibrium models of the economy. For example, see Joe Peek and James A. Wilcox, "The Postwar Stability of the Fisher Effect," *Journal of Finance*, September 1983, pp. 1111-1124.

TABLE 1
Inflation expectations and the yield spread

Example 1	One-Year Rates First Year	Second Year	Third Year	Three-Year Rate	Yield Spread
Required real rate	2	2	2	2	—
Expected inflation	2	3	4	3	—
Nominal rate	4	5	6	5	1
Example 2					
Required real rate	2	2	2	2	—
Expected inflation	2	4	6	4	—
Nominal rate	4	6	8	6	2

Note: Numbers are annual percentage rates. Three-year rates are averages of the one-year rates. The yield spread is the difference between the three-year nominal rate and the first year one-year nominal rate.

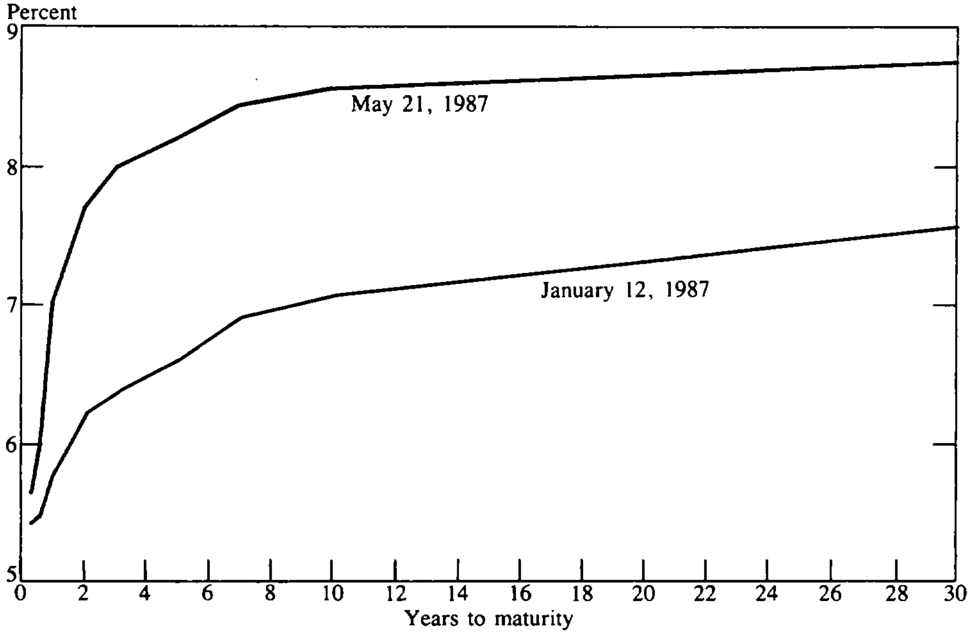
rises, the market interest rate must rise to preserve this required real return.

The Fisher effect is illustrated by the first example in Table 1. The required real rate of return is assumed to be 2 percent in all three periods. In the first year, the inflation rate is also expected to be 2 percent, implying that the nominal interest rate on a one-year security must be 4 percent to give investors the required real return. The expected inflation rate in the second year is 3 percent. The nominal interest rate on a one-year security over the second year must rise to 5 percent if the real return is to remain at the required 2 percent. Similarly, if the expected inflation rate is 4 percent in the third year, a one-year security must yield 6 percent to give investors a real return of 2 percent. Since the average of these one-year nominal rates is 5 percent, a three-year security must provide the same 5 percent return according to the expectations theory. This nominal return is the sum of the required real return of 2 percent and the expected average inflation rate of 3 percent over the three-year period.

The second example in Table 1 shows how a worsening of inflation expectations steepens the yield curve. Suppose investors raise their estimates of future inflation to 4 percent for the second year and 6 percent for the third year, perhaps because of policy changes or economic disturbances. The Fisher effect implies that short-term nominal interest rates also must increase—to 6 percent the second year and 8 percent the third year—to maintain the required 2 percent real rate of return. As a result, the yield on a three-year security must rise to 6 percent, the average expected return from holding three successive one-year securities.

CHART 2

The steepening yield curve



Note: Curves are plotted by connecting U.S. Treasury constant-maturity yields for selected maturities.

The steepening of the yield curve in response to higher expected inflation can be seen in the widening spread between the nominal yields on one-year and three-year securities. The yield spread in Table 1 is the nominal interest rate on the three-year security minus the nominal rate on the first one-year security. The yield spread in the first example is one percentage point. The spread increases to two percentage points in the second example because of the higher nominal rate on three-year securities. Thus, an increase in expected future inflation rates can steepen the yield curve, reflecting a larger spread between the yields on long-term and short-term securities.

Recent steepening of the yield curve

Such an increase in expected inflation rates could presumably have contributed to the sharp steepening of the yield curve for U.S. Treasury securities in the first half of 1987. Chart 2 shows yields on Treasury securities for two dates during this period. Yields on 30-year Treasury bonds rose from 7.4 percent in January to 8.8 percent in May. Three-month Treasury bill rates, in contrast, increased comparatively little, ranging from 5.4 percent to 5.7 percent over the period. The yield curve thus steepened dramatically as long-term rates rose relative to short-term rates.

Analysts disagreed about why the yield curve had steepened so sharply.[5] Some felt the steepen-

[5] See Bear Stearns and Company, *Analysts' Viewpoint*, May 5, 1987; William N. Griggs and Leonard J. Santow, *Griggs and Santow Report*, May 18, 1987; and Henry Kaufman, *Comments on Credit*, Salomon Brothers, May 15, 1987. The view that the bond market overreacted to the inflation threat is found in Maury N. Harris, *Update*, PaineWebber Inc., May 22, 1987.

ing reflected a sudden worsening of inflation expectations. These analysts noted that oil prices had firmed, that commodity prices had increased rapidly in both the spot and futures markets, and that the large depreciation of the dollar threatened to raise the U.S. inflation rate. Other analysts believed that the inflation outlook had not worsened substantially. These analysts felt the United States would not experience sharply higher inflation because of sluggish growth in domestic spending, low utilization rates for industrial capacity, and modest wage inflation.

Other factors affecting the yield curve

Those analysts who believed that the long-term inflation outlook had not worsened substantially attributed the steepening of the yield curve to factors other than rising long-term inflation expectations. For example, depreciation of the dollar may have increased the perceived risk of future exchange rate changes and discouraged purchases of long-term Treasury securities by Japanese and other foreign investors, forcing the yields on these securities higher. Such an explanation is not without foundation; a variety of macroeconomic and financial factors can cause the yield curve to steepen without changing long-term inflation expectations.

Macroeconomic factors

In addition to affecting expectations about long-term inflation rates, macroeconomic disturbances and policy changes can alter expectations about real interest rates and short-term inflation rates. Changes in investors' required real returns for future years can affect the shape of the yield curve even when inflation expectations are constant. And supply shocks, such as falling oil prices, can affect short-term inflation expectations without affecting the long-term inflation outlook appreciably. Thus, a steepening of the yield curve does not necessarily imply higher long-term inflation expectations. Three possible economic scenarios help illustrate these points.

Saving and budget deficits. The yield curve can steepen even with unchanged inflation expectations if investors raise their required real interest rates for future years. The required real rate, which can be viewed as the price of credit, depends on the supply of and demand for funds. Funds are provided through private saving, growth of the domestic money supply, and capital inflows from abroad. Funds are demanded for private investment and government budget deficits. Lower private saving, declines in the real money supply, and reduced capital inflows decrease the supply of funds and raise the required real rate. A larger government deficit and stronger private investment raise the required real rate by increasing the demand for funds.

Many economists believe that a low saving rate and large government budget deficits have put upward pressure on future real interest rates, contributing to the yield curve's upward slope. This upward-sloping yield curve would steepen further if a growing government deficit or further declines in private saving caused investors to raise their required real rates for future years even higher.

Table 2 illustrates how an increase in the future real returns required by investors could steepen the yield curve. The first example has a constant required real rate of 2 percent and is identical to the first example in Table 1. The yield spread between one-year and three-year securities is one percentage point. In the second example, required real rates rise from 2 percent for the first year to 3 percent for the second year and 4 percent for the third year. Expected inflation is the same in both examples. Short-term nominal rates increase more in the second example because of the higher real rates in the second and third years. The average expected return from three successive investments in one-year securities is 6 per-

TABLE 2
Real interest rates and the yield spread

	One-Year Rates				
Example 1	**First Year**	**Second Year**	**Third Year**	**Three-Year Rate**	**Yield Spread**
Required real rate	2	2	2	2	—
Expected inflation	2	3	4	3	—
Nominal rate	4	5	6	5	1
Example 2					
Required real rate	2	3	4	3	—
Expected inflation	2	3	4	3	—
Nominal rate	4	6	.8	6	2

Note: Numbers are annual percentage rates. Three-year rates are averages of the one-year rates. The yield spread is the difference between the three-year nominal rate and the first year one-year nominal rate.

cent. According to the expectations theory, the three-year security must also yield 6 percent. As a result, the yield spread between one-year and three-year securities widens to two percentage points with no change in expected inflation.

Monetary policy. The yield curve also can steepen because of monetary policy changes. An easing of monetary policy when the economy is already producing near its capacity is one example. Such a policy would initially expand the real money supply, lowering required short-term real interest rates. With long-term real interest rates unchanged, the yield curve would steepen. Lower interest rates, in turn, would stimulate domestic spending, putting upward pressure on prices. Expected inflation would likely rise. As discussed previously, an increase in inflation expectations would cause long-term nominal interest rates to rise. Thus, both the initial decline in short-term required real rates and the later rise in long-term nominal rates would steepen the yield curve.

Supply shocks. Supply shocks, such as changes in the price of oil or the exchange rate, can affect the shape of the yield curve by changing short-term inflation expectations much more than long-term inflation expectations. Changes in the price of oil, for example, have only a temporary effect on inflation and should not appreciably alter long-term inflation expectations. Over long time horizons, inflation depends primarily on such fundamental macroeconomic factors as the growth rates of the money supply and labor productivity. A change in the exchange rate also has temporary effects on inflation and should primarily affect short-term inflation expectations. Supply shocks can thus alter the shape of the yield curve by changing short-term inflation expectations much more than long-term inflation expectations, thus changing the relationship between yields on short-term and long-term securities.

One supply shock that might have affected the yield curve was the sharp drop in crude oil prices in late 1985 and early 1986. Falling oil prices reduced the U.S. inflation rate substantially in 1986. Short-term inflation expectations also declined, causing short-term nominal interest rates to fall because of the Fisher effect. According to the expectations theory, long-term interest rates decline less than short-term rates under such circumstances. As a result, the yield curve temporarily steepened.

Financial factors

The shape of the yield curve also depends on financial factors that are unrelated to inflation expectations. Two such factors are liquidity premiums and relative asset supplies.

Liquidity premiums. Long-term interest rates incorporate an additional component, the liquidity premium, that is not explained by the expectations theory. A liquidity premium reflects the greater risk of long-term securities. Because liquidity premiums fluctuate over time, changes in the shape of the yield curve cannot be explained solely by changes in expected short-term interest rates.[6]

The size of the liquidity premium reflects investors' perceptions of interest rate risk.[7] A sudden increase in interest rates could quickly reduce the market value of investors' long-term securities portfolios. As a result, investors demand a positive term premium before they will give up the relative safety of short-term financial assets and invest in riskier long-term securities.

Liquidity premiums can fluctuate without accompanying changes in inflation expectations. The size of the premium reflects many factors affecting the degree of uncertainty about future interest rates. Uncertainty about future inflation rates is one such factor. Another is exchange rate uncertainty since foreign investors generally care about the value of their securities portfolios in terms of their own currencies. Other factors include changes in Federal Reserve operating procedures and deposit deregulation at commercial banks and thrift institutions. Changes in these factors might alter investors' perceptions of interest rate risk, causing liquidity premiums to vary without a change in expected inflation.

Relative asset supplies. Relative supplies of short-term and long-term securities also may affect the yield curve. Asset supplies do not affect the shape of the yield curve in the expectations theory. This theory assumes that many borrowers and lenders can easily shift from one maturity to another to obtain the most favorable yield. As a result, changing relative supplies of short-term and long-term securities would not affect the slope of the yield curve. A greater supply of long-term securities, for example, would not steepen the yield curve because investors can easily be attracted away from other maturities.

[6] Studies finding evidence of changing term premiums include David S. Jones and V. Vance Roley, "Rational Expectations and the Expectations Model of the Term Structure," *Journal of Monetary Economics*, September 1983, pp. 453-465; Edward J. Kane, "Nested Tests of Alternative Term-Structure Theories," *Review of Economics and Statistics*, February 1983, pp. 115-123; and N. Gregory Mankiw, "The Term Structure of Interest Rates Revisited," *Brookings Papers on Economic Activity*, 1986:1, pp. 61-96.

[7] Although theories of asset pricing imply that term premiums should reflect risk, the empirical evidence is mixed. Mankiw, for example, finds little evidence that risk explains observed interest rate fluctuations. Engle, Lilien, and Robins conclude, however, that term premiums reflect the risk of unexpected interest rate changes. See Robert F. Engle, David M. Lilien, and Russell P. Robins, "Estimating Time Varying Risk Premia in the Term Structure: The ARCH-M Model," *Econometrica*, March 1987, pp. 391-407; and N. Gregory Mankiw, "The Term Structure of Interest Rates Revisited."

Some economists believe, however, that an increase in the supply of long-term securities raises long-term interest rates relative to short-term rates. This view is often called the market segmentation theory since the theory assumes securities markets are divided into distinct maturity segments with little movement by investors from one segment to another.[8] An increase in the supply of long-term securities would depress the price of these securities because investors cannot shift easily from one maturity to another. The yields of long-term securities would rise because security prices and yields move inversely. A changing maturity structure for government debt could thus steepen the Treasury yield curve even when inflation expectations are stable.

In sum, the spread between long-term and short-term interest rates is an imperfect indicator of long-run inflation expectations. Various macroeconomic factors can steepen the yield curve by altering required real interest rates and short-term inflation expectations as well as long-term inflation expectations. Financial factors can alter the shape of the yield curve through changing liquidity premiums and changing relative asset supplies. The yield curve reflects many forces, long-term inflation expectations being just one.

The yield curve and inflation expectations in the 1980s

Because of the factors described in the previous section, the yield curve is not a perfectly reliable indicator of inflation expectations. In practice, however, the yield curve might still be a good indicator of inflation expectations. Have changes in the shape of the yield curve been closely associated with changing inflation expectations in the 1980s?

Comparison with survey data

One way to see whether changes in the steepness of the yield curve have been a good indicator of changes in expected inflation is to compare the yield spread on securities with corresponding data on inflation expectations. No one measure of inflation expectations is generally accepted as being correct, and measures of long-term inflation expectations are especially scarce. However, surveys of inflation expectations have been used widely in economic research. Alternative measures of inflation expectations often are produced by statistical procedures involving arbitrary assumptions about the economic structure and the information available to forecasters. As a result, survey measures of expected inflation are probably as valid as any other measure currently available.

The yield spread and a corresponding expected inflation spread are presented in Chart 3 for the 1980s. The yield spread is the difference between the yields on ten-year Treasury securities and on one-year Treasury securities. The expected inflation spread is the difference between the expected inflation rate over a ten-year horizon and the expected inflation rate over a one-year horizon. The expected inflation spread is measured by the difference between ten-year inflation expectations from the Decision-Makers Poll and the actual inflation rate one year ahead.[9] The

[8] The market segmentation view is stated in J.M. Culbertson, "The Term Structure of Interest Rates," *Quarterly Journal of Economics*, November 1957, pp. 485-517. Empirical evidence supporting asset supply effects is found in Benjamin M. Friedman, "Financial Flow Variables and the Short-Run Determination of Long-Term Interest Rates," *Journal of Political Economy*, August 1977, pp. 661-689; and V. Vance Roley, "The Determinants of the Treasury Security Yield Curve," *Journal of Finance*, December 1981, pp. 1103-1126.

[9] Richard B. Hoey and Helen Hotchkiss, *Decision-Makers Poll*, Drexel Burnham Lambert Inc., June 4, 1987. This poll is the only available survey measure of long-term inflation expecta-

ten-year inflation forecast is compared with the actual one year ahead inflation rate because one-year survey expectations were not available over most of the 1980s. The one year ahead inflation rate is probably a good substitute for short-term inflation expectations because economic conditions and policies often change gradually. Therefore, forecasters have fairly accurate short-term expectations.[10] According to the expectations theory, the yield spread should increase when the difference between ten-year and one-year inflation expectations widens.

The yield spread and the expected inflation spread have had a positive association over the 1980s. Chart 3 shows that an increase in the expected inflation spread was often accompanied by an increase in the yield spread, as in late 1981. However, the two variables moved in opposite directions in late 1984 and at other times. A positive relationship is confirmed by computing the correlation coefficient between the expected inflation spread and the yield spread. A correlation coefficient measures the degree of association between two variables. The correlation coefficient between the expected inflation spread and the yield spread is positive over the 1980s.[11] However, the correlation coefficient is smaller than one in value, which implies that the expected inflation spread and the yield spread did not always vary together. Therefore, the correlation coefficient is consistent with the view that the shape of the yield curve reflects expected inflation but is also affected by other factors.

Some of these other factors in the 1980s were changing required real interest rates and changing liquidity premiums. Real interest rates were affected by large fluctuations in real economic growth, a mushrooming federal deficit, and changes in Federal Reserve operating procedures.[12] Moreover, interest rates were excep-

tions. The survey probably provides a reasonably good measure of the inflation rate expected by Treasury market participants because the survey includes many financial officers and portfolio managers who regularly make financial decisions. However, the accuracy of the long-term inflation expectations cannot be determined at this point because the survey has not been conducted long enough to permit a comparison of actual and expected values. The survey has been conducted intermittently since September 1978.

Box-Jenkins forecasts of the CPI also were computed for comparison with the Decision-Makers survey. Box-Jenkins statistical models, which predict inflation solely by extrapolating past changes in prices, neglect such other potentially useful information as money growth rates and real economic growth. The Box-Jenkins model was reestimated before each Decision-Makers survey date so that the statistical model used only information that was available to survey respondents at the time. The ten-year Box-Jenkins forecast and the ten-year survey measure of expected inflation have a correlation coefficient of 0.83. This correlation coefficient is statistically different from zero at the 1 percent significance level.

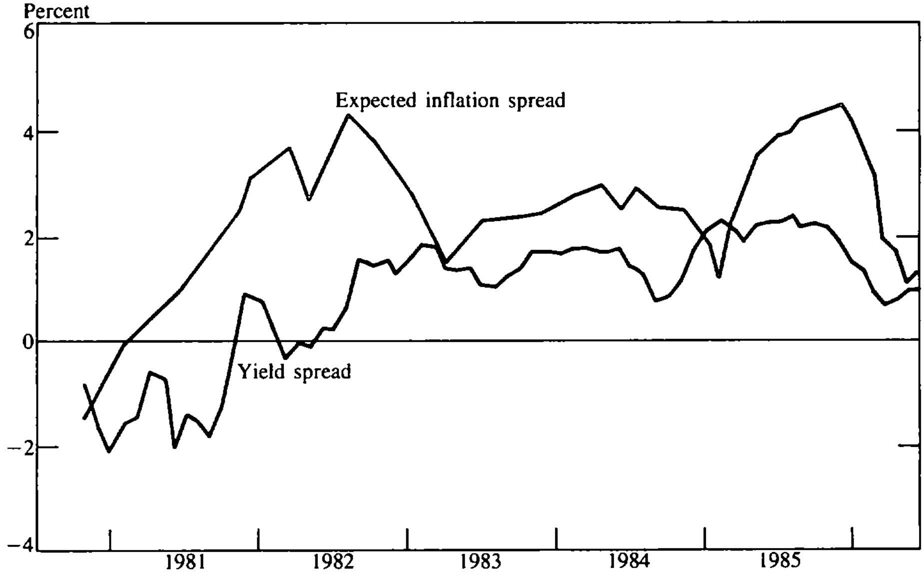
[10] Using the actual one year ahead inflation rate as a substitute for the short-term inflation expectation can also be justified by the rational expectations hypothesis, which implies that the one-year inflation expectation differs from the actual one year ahead inflation rate by a random error with zero mean. This representation of expected inflation is employed in several empirical studies, including Benjamin M. Friedman and V. Vance Roley, "Investors' Portfolio Behavior Under Alternative Models of Long-Term Interest Rate Expectations: Unitary, Rational, or Autoregressive," *Econometrica*, November 1979, pp. 1475-1497.

[11] The Pearson correlation coefficient between the expected inflation spread and the yield spread is 0.52 over the period from October 1980 to June 1986. This correlation coefficient is statistically different from zero at the 1 percent significance level.

The results are qualitatively similar when Box-Jenkins inflation forecasts are employed. If one-year Box-Jenkins forecasts are substituted for the actual one year ahead inflation rate in computing the expected inflation spread, the correlation coefficient between the yield spread and the expected inflation spread is 0.47 over the period from October 1980 to May 1987. This correlation coefficient is statistically significant at the 1 percent significance level. If the expected inflation spread equals the ten-year Box-Jenkins inflation forecast minus the one-year Box-Jenkins forecast, the correlation coefficient is 0.67 and is also significant at the 1 percent level.

[12] Another important influence on the yield curve in the 1980s may have been the large reductions in personal and corporate tax rates. The Treasury yield curve is plotted with pre-tax nominal interest rates, but investors care about their after-tax real returns. If investors expect their tax rates to fall in the years ahead, lower long-term nominal interest rates will provide the same after-tax

CHART 3
The yield spread and the expected inflation spread



Note: The yield spread is the difference between the ten-year and one-year constant-maturity yields on U.S. Treasury securities. The expected inflation spread is the ten-year inflation expectation from the Decision-Makers Poll minus the actual one year ahead inflation rate.

tionally volatile in the 1980-82 period. High interest rate volatility and other economic uncertainties may have caused increasing risk premiums for long-term securities in this period.

Evidence from the Decision-Makers Poll shows that the steepening of the Treasury yield curve in the first half of this year did not signal an increase in long-term inflation expectations. The dramatic steepening of the Treasury yield curve in April and May was accompanied by slightly lower long-term inflation expectations; the ten-year inflation expectation in the Decision-Makers Poll actually declined from 5.5 percent in March to 5.3 percent in May. Short-term inflation expectations did increase, however, with the 12-month inflation forecast from the Decision-Makers Poll rising from 4.0 percent in March to 4.7 percent in May.[13] The decrease in ten-year inflation expectations in tandem with the increase in 12-month inflation expectations should have flattened the yield curve under the expectations theory, contrary to what actually occurred. Comparisons between the yield spread and survey data show,

average real return. Expected tax rate changes could thus affect the steepness of the yield curve. This effect has received little attention in tests of the expectations theory and deserves further study.

[13] Both 12-month and ten-year inflation expectations declined slightly from May to June. The 12-month inflation expectation declined to 4.57 percent in the June Decision-Makers Poll, and the ten-year inflation expectation declined to 5.25 percent. A widely quoted survey of business economists shows that forecasts of consumer price inflation in 1987 worsened from 4.1 percent in the March survey to 4.7 percent in the August survey. See Robert J. Eggert, *Blue Chip Economic Indicators*, March 10 and August 10, 1987.

therefore, that a steepening or flattening of the yield curve is not always due to changing inflation expectations.

Other indicators of inflation expectations

Despite the imperfect correlation between the yield spread and the expected inflation spread, the yield curve may still play a useful role as an indicator of inflation expectations if it is used in combination with other expectations indicators and fundamental economic analysis. Business forecasters and decisionmakers usually can have more confidence in the signals provided by a steepening or flattening yield curve if other indicators of inflation expectations give a similar message. Several market prices besides security yields may be useful in judging inflation expectations. The exchange rate of the dollar with other major currencies is one possible indicator since the dollar is likely to depreciate when market participants expect the U.S. inflation rate to rise relative to foreign inflation rates. Sensitive commodity prices also may rise when the general inflation rate is expected to worsen. Businesses may increase their stocks of storable commodities when higher inflation and stronger economic activity are expected. However, greater demand for commodities could push commodity prices higher before inflation is observed in more sluggish wages and prices. Rapid gains in the prices of gold and other precious metals are often viewed as a sign of increasing inflation expectations since these metals have served traditionally as inflation hedges.[14]

[14] For more information about the relationship between auction-market prices and inflation expectations, see Brian R. Horrigan, "Monetary Indicators, Commodity Prices, and Inflation," Federal Reserve Bank of Philadelphia, Working Paper No. 86-7, April 1986; and Carl E. Walsh, "Interest Rates and Exchange Rates," *Weekly Letter*, Federal Reserve Bank of San Francisco, June 5, 1987.

Analysts, therefore, should monitor several market prices and yields that typically indicate changing inflation expectations. Focusing exclusively on the yield curve or any other expectations indicator could be misleading since many prices of financial instruments and commodities are highly volatile. This volatility reflects factors that are specific to the particular market as well as general economic news and policies. However, market-specific disturbances are unlikely to affect an entire set of indicators. The yield spread should be used, therefore, along with other information variables that quickly reflect market reactions to economic disturbances and policy changes.

Security yields and other expectations indicators should supplement rather than replace fundamental economic analysis, however. Analyzing fundamental determinants helps forecasters confirm or revise their previous views about the economic situation and gives better estimates of the factors driving inflation. Market prices and yields are useful primarily because they reflect new information about fundamental economic trends and policies. However, these indicators are affected by market-specific disturbances as well as a variety of macroeconomic influences. Also, at times, market expectations may simply be wrong. During the first half of 1987, for example, market prices and yields correctly reflected an increase in short-term inflation expectations, but a steepening yield curve erroneously indicated a rise in long-term inflation expectations.

Conclusion

The steepening of the Treasury yield curve during the first half of 1987 has been viewed as an indicator of rising inflation expectations. According to the expectations theory, expectations of higher inflation in the years ahead could steepen the yield curve since higher expected inflation should raise expected short-term nominal interest rates. However, a steepening of the yield curve also could reflect an increase in future required real interest rates or bigger liquidity premiums on long-term securities. Real interest rates have been affected in the 1980s by such macroeconomic factors as wide swings in economic activity and a series of large federal budget deficits. Liquidity premiums have probably been influenced by interest rate volatility and uncertainty about the future foreign exchange value of the dollar.

To the extent that survey data give a reliable measure of long-term inflation expectations, evidence from the 1980s shows that the yield spread and inflation expectations have not always varied together. The steepening of the Treasury yield curve in the first half of 1987 is a case in point. The ten-year inflation expectation from the Decision-Makers Poll actually decreased at the same time that long-term interest rates were rising. Although the cause of the sharp increase in long-term interest rates remains puzzling, an alternative explanation may be that Japanese and other foreign investors required higher long-term interest rates to compensate for a perceived rise in exchange rate risk. Twelve-month inflation expectations from the same survey did increase, however, which was consistent with rising commodity prices and such fundamental determinants as the falling dollar and firming oil prices. Business forecasters and decisionmakers, therefore, should examine a variety of expectations indicators and fundamental economic determinants rather than giving excessive weight to the shape of the yield curve.

Challenges to the Concept Of Stock Market Efficiency

By Douglas K. Pearce

Stock prices have risen about 75 percent since the end of 1984. The tremendous surge in the average price of stocks has been accompanied by large daily fluctuations and historically high trading volumes. Not surprisingly, such activity has spurred new interest in the question of what underlies these movements in stock prices. In particular, are stock price movements quick and appropriate responses to new information about economic conditions? This question is often phrased: Is the stock market efficient? Despite some apparent anomalies, this article concludes that the preponderance of evidence supports the view that the stock market is efficient.

The issue of the efficiency of the stock market has significant consequences for the economy. Since stock price movements affect the cost of financing capital expansion and give managers of firms a direct evaluation of their performance, stock prices are thought to be important signals for the efficient allocation of a country's savings. Faith in the appropriateness of signals from the stock market is based on the belief that stock prices reflect the well-informed opinions of investors about the future profitability of businesses. As economist William Baumol has stated:

> If security prices were divorced from earnings potential, the stock market could not be expected to serve as an effective disciplinary force capable of pressing management to maintain the efficiency of company operations.[1]

The belief that stock prices depend on investors' expectations of profits is generally referred to as the "fundamental model" or "intrinsic value model" of stock prices. According to this model, stock prices equal the present or discounted value of future dividends.

The concept of stock market "efficiency" is also used in a different but related context.

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[1] Baumol (1965), p. 36. For the full citation for this book and other studies cited in this article, see the list of references at the end of the article.

According to the "efficient markets" theory of stock prices, stock prices accurately reflect all information that is available about the future profitability of firms. When new information comes available, stock prices rapidly adjust to their new equilibrium levels. The basic implication of this model is that investors cannot use available information to generate expected returns in excess of a normal return on the risk they bear. It might be said that the efficient markets model is simply another version of the economic rule that there are no free lunches.

Many observers of the stock market scoff at the notion that the stock market is efficient. They argue that stock price movements reflect short-run speculative waves of optimism or pessimism that, at best, are weakly tied to forecasts of profits. The stock market is likened to a gambling parlor and stock price changes to the outcomes from a roulette wheel. These commentators often quote Keynes' famous remark that "when the capital development of a country becomes a by-product of the activities of a casino, the job is likely to be ill-done."[2] When the stock market is volatile, this argument is raised to support the need for an industrial policy in which the government plays a larger role in allocating capital.

Skepticism about the efficiency of the stock market has been bolstered by several recent challenges to the empirical validity of the efficient markets model. These challenges are of two kinds. First, some researchers report instances in which stock returns do not behave according to the predictions of the efficient markets theory because investors can use available information to earn "excess" profits. Second, other researchers argue that stock price movements are much too volatile to be compatible with the efficient markets model. It has even been suggested that if "excess volatility" characterizes stock prices, the Federal Reserve should reduce volatility through open market operations in the stock market.[3]

This article reviews these recent challenges to the efficiency of the stock market. The first section reviews the fundamental model of stock prices and its relationship to the efficient markets model. The second section discusses the empirical implications of the efficient markets model and examines evidence that stock returns do not conform with these implications. The third section analyzes recent research on whether stock price fluctuations are excessively volatile.

The efficient markets model of stock prices

The fundamental or traditional model of stock prices starts with the assumption that stock prices depend on the anticipated profits of firms. The efficient markets model makes additional assumptions about what information investors use in forming their expectations.

The fundamental model of stock prices

The fundamental model of stock prices asserts that the price of a share of stock equals the present or discounted value of all expected dividends.[4]

[2] Keynes (1936), p. 159.

[3] See Fischer and Merton (1984).

[4] The fundamental model is expressed formally as:

$$P_0 = \frac{E(D_1)}{(1+\delta)} + \frac{E(D_2)}{(1+\delta)^2} + \ldots + \frac{E(D_n)}{(1+\delta)^n}$$

where P_0 is the current share price, $E(D_t)$ is the dividend per share expected to be paid at time t, δ is the rate of discount, and n is the number of periods into the future the stock is assumed to exist. The rate of discount can be thought of as the expected rate of return since δ can be expressed as:

$$\delta = \frac{E(P_1) - P_0}{P_0} + \frac{E(D_1)}{P_0}$$

Thus, δ is the expected capital gain (the first term) plus the expected dividend yield (the second term).

If this model is correct, stock prices change only if investors revise their expectations of future dividends or revise the rate at which they discount these dividends.

The rate that investors use to discount future dividends is the expected rate of return they require to be satisfied in holding that stock. It is usually assumed that investors are risk averse, which means that investors require a higher expected return for riskier stocks. Risk, however, is not simply the amount of variation in the stock's return. The Capital Asset Pricing Model (CAPM) is generally used in determining the expected rate of return. According to this model, investors realize that some of the risk of a stock can be eliminated by holding a diversified portfolio. Stock returns are assumed to change because of two kinds of shocks or unexpected events. The first kind of shock is specific to the individual stock. Each firm will be hit by a certain amount of random disturbance—luck that produces unexpectedly high returns or unexpectedly low returns. Investors can avoid this firm specific risk, however, by holding a portfolio of stocks so that good and bad luck averages out. The CAPM argues that investors will not be rewarded for bearing such firm specific, or unsystematic, risk.

The second kind of shock affecting stock returns can be thought of as economywide. Thus, to some extent, it is common to all stocks. An unexpected economic downturn, for example, is likely to depress the returns on most stocks. The uncertainty arising from these kinds of shocks is called systematic or undiversifiable risk because investors cannot eliminate this uncertainty by holding a portfolio of stocks. The CAPM states that the expected return on an individual stock depends on how sensitive the return is to such economywide shocks. A stock with a return that is expected to vary more than the average is considered riskier than average. As a result, its expected return should be higher. A stock with a return that varies less than the average is considered less risky. And as a result, its expected return should be less. The extent to which the return on a stock varies with the return on the stock market as a whole is called its *beta.* A *beta* higher than one indicates that the return on the stock has varied more than the market. A *beta* less than one indicates that the return on the stock has varied less than the market.[5] The larger the *beta,* the riskier is the stock and the higher its expected return should be. Thus, stock return data should show a positive relationship between a stock's *beta* and its average rate of return. The CAPM goes further by arguing that no other factor except *beta* need be considered in explaining the individual behavior of expected stock returns. This last assumption is critically important in tests of market efficiency because the usual measure of excess or abnormal returns is the difference between actual returns and the returns predicted by this model. If the CAPM is an inadequate model of expected returns, these tests could lead to incorrect inferences about market efficiency, since returns for bearing more risk might be mistaken for excess returns.

Information and efficiency

The fundamental model along with the CAPM predicts that stock prices and returns depend on investors' expectations of future profits of firms and the amount of undiversifiable risk attached to their expectations. The efficient markets model makes the additional assumption that investors are well-informed and that their expectations of future dividends are "rational." According to this

[5] For a derivation of the CAPM, see chapter 7 of Copeland and Weston (1983). The formal statement of the CAPM is:

$$E(R_{it} - R_{ft}) = \beta E(R_{mt} - R_{ft})$$

where R_{it} = return on i-th stock in period t
R_{ft} = return on a risk-free asset in period t
R_{mt} = return on the market portfolio of stocks in period t
β = Covariance (R_{it}, R_{mt}) / Variance (R_{mt}).

assumption, investors make the best forecasts of dividends that can be made from the available information. If some news changes these expectations, investors are assumed to bid the stock price up or down very quickly to its new equilibrium.

It is customary to distinguish between three types of stock market efficiency.[6] One, the stock market is said to be "weak-form" efficient if there is no pattern in past stock prices or stock returns that would allow investors to earn above-normal returns. Next, the market is said to be "semistrong-form" efficient if investors cannot use publicly available information to make above-normal profits. And three, the market is said to be "strong-form" efficient if no information can be used to make above-normal profits.

Empirical implications and evidence of market efficiency

Several strong empirical implications follow from the efficient markets model. Weak-form efficiency implies that there should be no discernible pattern to changes in stock prices and thus stock returns. Since only news causes prices to change and since news by definition means new, unforeseen information, stock returns should not be predictable from past returns. If, for example, an increase in stock prices of 1 percent today was likely to be followed by a further increase, investors would bid up the price today rather than wait. Charts of past price movements should be of no help in predicting subsequent changes. Stock prices should follow what is called a "random walk" in which the best guess of tomorrow's price is today's price.[7]

Semistrong-form efficiency implies that not just past stock prices but any information that is publicly available should be uncorrelated with subsequent movements in stock prices. As soon as news is announced, prices will move to reflect completely the impact that investors expect the news to have on the future profitability of businesses. If, for example, the government announced a new tax policy that was not expected, the stock market would react immediately and not over several days. Announcements of policies that had been fully anticipated should have no effect on stock prices. Thus, if Congress has debated a tax bill and investors know its provisions and that it will be passed, the actual passage will have no impact. Profit announcements by corporations will have an effect only if the announcement differs from expectations. Thus, a corporation may announce higher profits and see its stock price go down if investors view the announced profits as unexpectedly low.

Strong-form efficiency implies that no information, public or private, should help in predicting stock returns. The public information referred to in semi-strong efficiency can be thought of as essentially costless to investors. Private information is often equated with "insider" information—information that is known only to individuals with some connection with the company in question. Private information is assumed to be costly to collect or process. It has been pointed out, however, that if stock prices are to reflect

[6] The standard reference on types of efficiency is Fama (1970).

[7] The random walk prediction is only an approximation for most stocks. Because much of the total return on the average stock is in the form of capital gains, investors expect stock prices to rise over time by enough to provide the expected return. For example, if a stock pays no dividends and investors require a 10 percent annual rate of return to hold the stock, the stock price would be expected to rise an average of 0.026 percent per day. In this case, the efficient markets model predicts that the natural logarithm of the stock price follows a "random walk with drift." This means that the first difference of the logarithm of the stock price, which measures the rate of return, is a constant (0.026 percent) plus a random error term. The best guess of the rate of return is simply the constant or drift term (0.026 percent) because there is no systematic pattern in past returns.

all information, someone has to bear the costs of collecting and evaluating private information. If there was no expected return to this activity, investors who incurred the costs of assembling the information would be at a disadvantage to "uninformed" investors and would stop gathering information. How, then, could stock prices reflect all information?[8] Thus, strong-form efficiency is usually modified to say that the returns to using private, costly information are just enough for investors to earn a normal rate of profit on their information expenditures.

Tests of market efficiency generally look for evidence that investors could have earned excess returns by following some systematic pattern of buying or selling. Such "trading rules" should not exist if the stock market is efficient. A strategy of simply buying and holding stocks should yield higher average returns when the transactions costs of buying and selling are taken into account. Evidence generally supports weak and semistrong forms of efficiency but is more mixed with regard to strong-form efficiency.

Weak-form efficiency

Tests of weak-form efficiency restrict the trading rules to those based on past changes in stock prices. If there were any patterns, or serial correlation, in stock price changes, then investors could base their buying and selling on such patterns. Stock returns would be positively serially correlated, for example, if news was only slowly reflected in prices. Positive (negative) news would then cause prices to rise (fall) over several days so that a rise (fall) today would likely be followed by a rise (fall) tomorrow. Returns would be negatively serially correlated if the stock market overreacted to news so that a rise (fall) in price today would likely be followed by a fall (rise) tomorrow. The efficient markets model asserts that any such pattern would be quickly recognized by the horde of financial analysts hunting for such regularities and their buying and selling would eliminate the pattern.

Empirical studies have generally found support for weak-form efficiency.[9] One way to assess the degree of serial correlation in stock returns is to estimate the relationship between current and past returns. If there is no statistically significant relationship, weak-form efficiency would be supported. Table 1 presents estimates of this relationship for daily and monthly returns on two measures of stock returns. One measure, VWT, is the rate of return on a portfolio of all stocks on the New York Stock Exchange and American Stock Exchange in which the return on each stock is value weighted by the size of the company. The other measure, EWT, is the rate of return on the same portfolio but with each stock being equally weighted. Hence VWT is dominated by larger firms while EWT is dominated by smaller firms.

The estimates in Table 1 indicate that for daily returns from 1966 to 1985 there is some evidence of serial correlation, although the fraction of variation in stock returns that can be explained by past variation (the R^2's) is small. That the EWT series shows more serial correlation may be due to the less frequent trading of smaller stocks rather than to serial correlation in individual stock returns.[10] If some stocks do not trade every day, the response of a portfolio of such stocks to any news may be spread over several days. Given the transactions costs of buying or selling daily, the small degree of serial correlation would be unlikely to allow investors to earn

[8] For a discussion of this issue, see Grossman and Stiglitz (1980).

[9] Support for weak-form efficiency is given in Fama (1970) and Berkman (1978).

[10] See Roll (1981) for a discussion of the possible effects of nonsynchronous trading. Atchison et al. (1987), however, suggest that this cannot explain all the serial correlation.

TABLE 1
Tests of weak-form efficiency

$$r_t = b_0 + b_1 r_{t-1} + b_2 r_{t-2} + b_3 r_{t-3} + b_4 r_{t-4} + b_5 r_{t-5}$$

Model: (above)

Return Series	b_1	b_2	b_3	b_4	b_5	R^2	F
Daily VWT 1966-85	0.245*	−0.046*	0.027	−0.003	0.006	0.057	60.97*
Daily EWT 1966-85	0.411*	−0.089*	0.095*	0.018	0.043	0.169	204.06*
Monthly VWT 1956-85	0.056	−0.050	0.030	0.081	0.087	0.022	1.59
Monthly EWT 1956-85	0.131*	−0.040	0.005	0.040	0.050	0.023	1.66

Notes: *indicates statistical significance at the 5 percent level.

F statistic is for the hypothesis that all the coefficients are jointly equal to zero.

VWT = value-weighted index of stock returns.

EWT = equally weighted index of stock returns.

Data are from the Center for Research in Security Prices at the Graduate School of Business, University of Chicago.

excess returns. The estimates for monthly data from 1956 to 1985 show no serial correlation for the VWT over that period and very slight serial correlation for the EWT series. Again, the amount of variation in monthly returns accounted for by past returns is small. When five-year subperiods are examined, the degree of serial correlation falls over time for both weekly and monthly data, indicating that the market has become more efficient.[11]

More sophisticated trading rules using past stock returns, usually called filter rules, look for such strategies as buying when stocks have risen by x percent and selling when they have fallen by y percent. Studies investigating such rules usually find that when transactions costs are taken into account the rules do not produce returns in excess of a buy-and-hold strategy.[12]

Several empirical papers have focused on two apparent anomalies to weak-form efficiency. One is referred to as the "weekend" effect. Researchers report that average stock returns have been lower on Mondays and higher on Fridays than on other days of the week. This difference is an anomaly, since the efficient markets model cannot account for this systematic effect. The model would predict, if anything, that returns should be higher on Mondays because Monday's return is for three days rather than for one. Part of the weekend effect may be due to the settlement practices of financial markets. When stocks are bought or sold, transactors have five business days to settle. Combined with a one-day check clearing delay, this practice produces higher returns on

[11] For the VWT daily stock returns, the coefficient on the first lagged return is 0.359 for 1966-70 and falls to 0.136 for 1981-85. For the EWT series, the coefficient falls from 0.467 to 0.290 for these subperiods. A similar pattern occurs in the monthly return series for ten-year subperiods.

[12] See Fama and Blume (1966).

TABLE 2
Tests of the weekend effect

Model: $r_t = c_0 + c_1\, TUE_t + c_2\, WED_t + c_3\, THUR_t + c_4\, FRI_t$

Return Series	c_0	c_1	c_2	c_3	c_4	R^2	F
Daily VWT 1966-85	−0.111*	0.131*	0.214*	0.172*	0.219*	0.066	14.74*
Daily EWT 1966-85	−0.121*	0.113*	0.255*	0.241*	0.350*	0.184	44.14*

Notes: All coefficients are multiplied by 100.
* indicates statistical significance at the 5 percent level.
F statistic is for the hypothesis that all days have the same average return.
Equations estimated by generalized least squares to correct for serial correlation.
TUE_t = 1 if day t is a Tuesday, = 0 otherwise and so on.

Fridays and lower returns on Mondays to compensate for the extra two days of interest accruing to buyers of stock on Friday.[13]

The presence of a pattern in daily stock returns can be investigated by estimating a model that allows the average stock return to depend on the day of the week. Table 2 reports estimates of such a model using VWT and EWT from 1966 to 1985. The constant term estimates the average return on Mondays, and its significantly negative values are evidence of low Monday returns. The positive coefficients for the other days of the week indicate that their mean returns are higher than that for Monday. Only for the EWT series, however, is there evidence of high returns on Fridays, casting some doubt on the settlement practices explanation. There is also evidence that the daily pattern of stock returns has weakened in recent years.[14]

The other anomaly is the "January" effect. Researchers find the return on holding stocks over January averages higher than for other months. This finding is often ascribed to investors selling stocks in December to realize capital losses for tax purposes and then rebuying stocks in January. Such a practice would lower stock prices in December and raise them in January so that calculated returns over January would be high. However, several problems with this explanation have been raised. Studies have shown that it is not optimal to wait until December to realize capital losses.[15] Moreover, the January effect appears to have existed before the imposition of income taxes in the United States.[16]

[13] French (1980) and Gibbons and Hess (1981) document the existence of the weekend effect. The settlement practices explanation is given in Lakonishok and Levi (1982), and criticized by Dyl and Martin (1985).

[14] For the VWT series, re-estimating the model over five-year subperiods indicates that the weekend effect disappears after 1975. For the EWT series, the effect remains but becomes less significant.

[15] See Constantinides (1984) for a discussion of the issues.

[16] See Jones et al. (1987).

The existence of the January effect can be examined by estimating a model that allows the average monthly stock return to depend on the month of the year. Table 3 reports estimates of such a model for the two return series from 1956 to 1985. The constant term in the model estimates the average return for January and the coefficients on the other variables estimate how the average returns in the other months differ from January's. If there is a January effect, the coefficients for the other months should be negative. For the VWT series, the coefficients on the monthly variables are individually and jointly equal to zero, which rejects the presence of a January effect. For the EWT series, however, all the non-January coefficients are negative and, with one exception, statistically different from zero, which indicates that returns average higher in January than other months. Since the EWT series gives more weight to small firms than does the VWT series, these results are consistent with other studies that find the January effect to be concentrated in the returns of small stocks. While the finding of high returns in January supports the tax selling argument, there is no evidence that December returns are abnormally low, contrary to the prediction of the tax selling theory. Splitting the sample into ten-year subperiods produced evidence that the January effect appears to have been reduced over time.[17]

In summary, the evidence suggests that weak-form efficiency is a reasonable characterization of historical stock returns. While there is some evidence of serial correlation in daily stock returns, it is of little value in predicting future returns. Similarly, although low returns on Mondays and high returns in January contradict weak-form efficiency, these deviations appear to be concentrated in the returns of small firms and to have declined over time.

TABLE 3
Tests of the January effect

Model: $r_t = d_0 + d_1 February_t + d_2 March_t + d_3 April_t + d_4 May_t + d_5 June_t + d_6 July_t + d_7 August_t + d_8 September_t + d_9 October_t + d_{10} November_t + d_{11} December_t$

	Return Series	
	VWT 1956-85	EWT 1956-85
d_0	0.014	0.046*
d_1	−0.012	−0.041*
d_2	−0.001	−0.030*
d_3	0.001	−0.034*
d_4	−0.016	−0.049*
d_5	−0.012	−0.046*
d_6	−0.007	−0.036*
d_7	−0.002	−0.033*
d_8	−0.020	−0.049*
d_9	−0.002	−0.044*
d_{10}	0.011	−0.019
d_{11}	0.001	−0.033*
R^2	0.042	0.067
F	1.37	2.29*

Notes: * indicates statistical significance at the 5 percent level.

F statistic is for the hypothesis that all months have the same average return.

$February_t$ = 1 if month t is February, = 0 otherwise and so on.

Semistrong-form efficiency

Most studies support semistrong-form efficiency, but as with weak-form efficiency, there are some anomalous findings. Researchers have

[17] Over the period from 1976 to 1985, neither measure of stock returns exhibited a statistically significant January effect.

tested semistrong efficiency in the stock market mainly in two ways. One way is by seeing if trading rules based on publicly available information about the firms or the economy yield excess returns to investors. The other way, an "event" study, is by looking at the reaction of stock prices to announcements thought to be relevant to stock prices.

A trading rule is a decision rule that tells an investor when to buy or sell stock or which stocks to buy or sell. The first kind of trading rule uses economywide information to come up with the appropriate times to buy or sell. A trading rule would be profitable if it yielded higher returns, after considering transactions costs, than a buy-and-hold strategy. Several early studies asserted, for example, that investors could make abnormal profits by using a trading rule based on past movements in the money supply. The efficient markets hypothesis argues that no such trading rule exists because only contemporaneous, unexpected changes in the money supply could affect stock returns. Subsequent work has found evidence that knowledge of past money supply changes would not have allowed investors to earn abnormal profits.[18]

One test of whether money supply growth can be used to predict stock returns is to estimate the relationship between stock returns and past money growth rates. If the stock market is semistrong-form efficient, there should be no statistically significant association between stock returns and past money supply movements. Table 4 reports estimates of this relationship from 1966 to 1985 for both a narrow definition of money (M1) and a broader definition of money (M2). For neither money supply measure is there evidence of a systematic relationship between past money growth and stock returns. These results do not imply, however, that there is no relationship between money growth and stock returns. If the current month's rate of growth of the money supply is included, there is evidence of a significantly positive relationship between contemporaneous money growth and stock returns as indicated in the last two columns of Table 4. This relationship does not allow investors to predict stock returns, however, because they do not know the current month's money growth.[19]

A second kind of trading rule is based on publicly available information about individual firms or groups of firms. Again, the efficient markets model asserts that no such trading rule can be used to make abnormal profits. Recent studies, however, have provided several apparent exceptions to this rule. One exception is referred to as the small firm effect. Several researchers have documented that smaller firms have consistently earned higher returns than larger firms. In addition, these abnormal returns are concentrated in January returns. One interpretation of these findings is that smaller firms are riskier, and hence should earn a higher average return than the CAPM predicts. According to this interpretation, the CAPM inadequately adjusts for risk. While this explanation is a plausible reason for smaller stocks earning higher average returns, it does not account for the excess returns being concentrated in January.[20]

[18] Sprinkel (1964) and Homa and Jaffee (1971) report that money supply movements help predict stock prices. Rozeff (1974) and Davidson and Froyen (1982) reach the opposite conclusion.

[19] Care should be exercised in interpreting these results. The contemporaneous relationship could reflect feedback from the financial market to the money supply. In addition, the use of actual changes in the money supply in the model given in Table 4 reflects an implicit assumption that investors cannot accurately predict money growth.

[20] Banz (1981), Reinganum (1981), and Lustiq and Leinbach (1983) all find evidence of a small firm effect. Keim (1983) and Reinganum (1983) report that the higher returns for small firms occur in January.

TABLE 4
Stock returns and money supply growth, 1966-85

Model: $r_t = g_0 + g_1 M_t + g_2 M_{t-1} + \ldots + g_{12} M_{t-12}$

	Money Supply Measures			
	M1	M2	M1	M2
g_0	0.012	0.0004	0.001	−0.010
g_1			2.795*	4.356*
g_2	0.102	0.861	−0.722	−1.999
g_3	−0.077	0.291	0.181	0.918
g_4	0.410	0.737	−0.053	0.167
g_5	0.248	1.572	0.842	1.844
g_6	0.019	−0.339	−0.552	−1.091
g_7	−1.260*	−1.999	−1.120	−1.739
g_8	−0.319	−0.930	−0.462	−0.742
g_9	0.441	0.800	0.505	0.459
g_{10}	0.014	−0.183	−0.418	−0.740
g_{11}	0.330	0.262	0.699	0.982
g_{12}	−0.880	−0.050	−0.980	−0.001
g_{13}	−0.506	−0.459	−0.087	−0.411
R^2	0.051	0.076	0.150	0.170
F	1.01	1.56	3.06*	3.57*

Notes: * indicates statistical significance at the 5 percent level.

Stock returns measured by the percentage change in the New York Stock Exchange's index. M_{t-i} is the rate of growth in M in month t-i. All data are from the Citibase data bank.

F statistics are for the joint hypothesis that all coefficients are zero.

Higher January returns are consistent with the tax selling hypothesis. If smaller firms have more variable prices, these firms are more likely to have capital losses and, hence, their stocks are more likely to be sold at the end of the year to qualify for tax losses. Another interpretation is that there are higher transactions costs in buying or selling small stocks and that when these costs are taken into account the excess returns disappear. Again, however, this leaves the question of why the transactions costs are higher in January.[21]

A similarly puzzling empirical regularity is the finding that stocks with low (high) price-earnings ratios earn average returns above (below) what the CAPM would predict. This anomalous result appears to occur even after other factors, such as the size of the firm and the effects of taxation, are taken into account. Since last period's price-earnings ratio is public information, excess returns on portfolios chosen by picking stocks with low price-earnings ratios violate semistrong-form efficiency. Moreover, such a finding implies that investors overreact to news about a firm's earnings, being either too optimistic and bidding the price-earnings ratio too high or too pessimistic and causing the price-earnings ratio to fall too far.[22]

Still another puzzle is the "Value Line" anomaly. Semistrong-form efficiency implies that investment advice based on publicly available information should be worthless. The Value Line Investment Survey, the largest advisory firm in the United States, uses public information to rank stocks by expected returns. Thus, semistrong-form efficiency predicts that investors should not benefit from the Value Line recommendations. Several studies have documented, however, that investors following the Value Line recommendations would have earned abnormally high returns.[23]

The second method of testing market efficiency uses event studies to examine the responses of stock prices to announcements thought to be relevant to stock returns. Semistrong-form efficiency is supported if stock prices react only to the unexpected part of any announcement and react quickly. Most event studies find that the stock market conforms reasonably well to semistrong-form efficiency. One famous study investigated the responses of stock prices to announcements of stock splits. Stock prices are expected to rise after stock splits are announced because splits are usually reliable predictors of higher dividends. The study found this reaction was essentially immediate.[24] Support for semistrong-form efficiency has also come from studies of how the aggregate stock market reacts to announcements concerning monetary policy. Stock prices were found to respond quickly to the unexpected parts of weekly money supply reports and announcements of changes in the discount rate.[25]

The evidence from event studies is not unanimous, however, in support of the efficient markets model. Some studies have found evidence of stock price reactions to public announcements that last more than one day. Studies of the reaction of stock prices to earnings announcements of firms also have found responses which are spread over time rather than occurring immediately.[26]

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[21] The transactions cost explanation is discussed in Stoll and Whaley (1983). For evidence that transactions costs do not fully account for the small firm effect, see Schultz (1983).

[22] Basu (1977, 1983) and Dowen and Bauman (1986) conclude that the price-earnings ratio has an independent effect on returns, while Reinganum (1981) argues that it is only firm size that matters. Evidence that stock prices overreact to news was reported by DeBondt and Thaler (1985). This study found that portfolios of stocks which were "losers" in the recent past subsequently earned substantially higher returns than portfolios of past "winners" over a three-year period. Contrary to the tax-loss selling hypothesis for high January returns, they report that the "loser" portfolios had high returns in January every year and not just the first year.

[23] Studies of the Value Line anomaly include Copeland and Mayers (1982), Holloway (1981), and Stekel (1985). These studies suggest that transactions costs incurred in frequent trading could eliminate the abnormally high returns.

[24] See Fama et al. (1969).

[25] See Pearce and Roley (1985) and Smirlock and Yawitz (1985).

[26] Slow responses to unexpected earnings announcements were found by Rendleman et al. (1982). Adjustments to stock analysts' recommendations published in the *Wall Street Journal* were found by Lloyd-Davies and Canes (1978) to persist beyond the first day.

Strong-form efficiency

Strong-form efficiency asserts that even investors with information that is not publicly available cannot earn abnormal returns. Researchers have tested for strong-form efficiency two ways, by examining the returns to insider trading and by evaluating the performance of mutual fund managers. These tests provide mixed results.

The evidence from studies of insider trading does not support the strong form of the efficient markets model. Legal insider trading consists of the buying or selling of a company's stock by an officer or director of the company. Such trading is legal as long as it is not motivated by specific news about the company's prospects that has not been announced to the public. Insider trading must be registered with the Securities and Exchange Commission and, therefore, is known to researchers. Studies that have examined the returns to legal insider trading have generally concluded that insiders make abnormal profits and, hence, that the stock market is not strong-form efficient. Moreover, it appears that a trading strategy based on the publicly announced insider trading activity can also earn abnormal profits, a finding that contradicts even semistrong-form efficiency.[27]

In contrast, tests that focus on the investment performance of mutual fund managers tend to support the strong form of the efficient markets model. These tests assume that fund managers are more likely to have access to private information or are better able to access the effects of information on stock returns. Thus, if certain funds consistently earn abnormal returns, that is, after accounting for the level of risk, this would be evidence against strong-form efficiency. However, studies comparing fund performance indicate no such violations of strong-form efficiency.[28]

In short, the evidence on market efficiency does not lend strong support for strong-form efficiency. The evidence, however, does tend to support weak-form and semistrong-form efficiency, which means that stock prices appear to reflect publicly available information but not all information.

Are stock prices too volatile?

Even without strong evidence that publicly available information can be used by investors to earn abnormal returns, this lack of evidence does not confirm that the efficient markets model explains the movements in stock prices. An alternative test of this model, proposed by Robert Shiller, examines whether the model can account for the historical variability of stock prices.[29] Applying this test to the history of stock prices in the United States, Shiller concludes that stock prices have been much more volatile than the fundamental model would predict. He argues that fads and mass psychology play an important role in the stock market. While this strong assertion has stimulated a lively and continuing literature, recent work suggests that the efficient markets model can account for the volatility of stock prices.

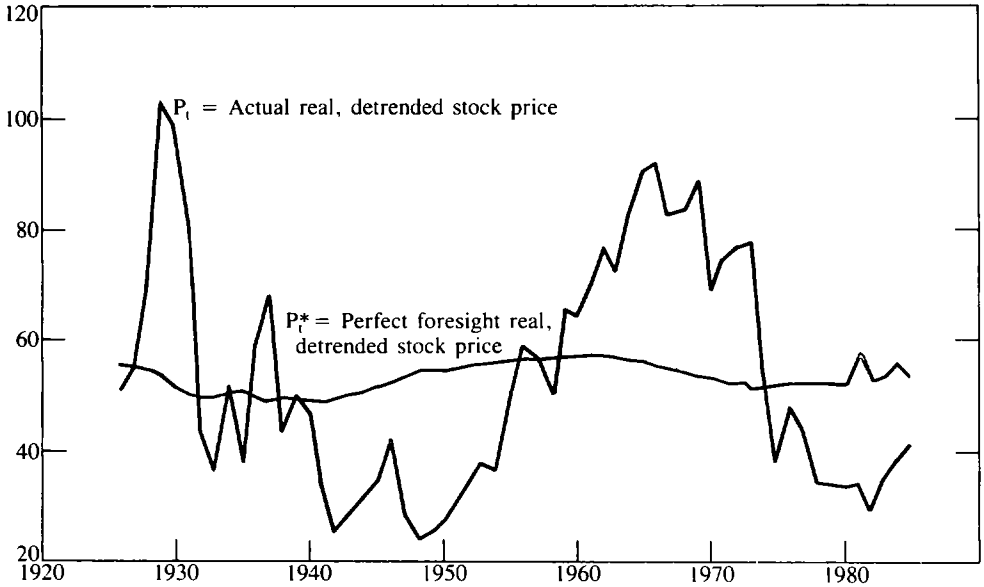
Shiller's argument runs as follows. Suppose investors had perfect foresight so that they could predict dividends without error. According to the fundamental model, the price investors would be willing to pay for a stock would be the present value of the known future dividends. Assuming

[27] Baesel and Stein (1979), Finnerty (1976), Givoly and Palmon (1985), and Lorie and Niederhoffer (1968) report evidence that insiders earned abnormally high returns.

[28] Jensen (1968) reports no evidence of superior performance while Kon and Jen (1979) find weaker evidence in favor of strong-form efficiency.

[29] See Shiller (1981a, 1981b, 1984). A similar approach for testing for excess volatility is LeRoy and Porter (1981).

CHART 1
Actual versus perfect foresight stock prices, 1926-85



the rate at which investors discount future dividends is constant, Shiller constructs a series of stock prices, P^*_t, that would have resulted under the assumption of perfect foresight. The efficient markets model does not assume that investors have perfect foresight, but rather that they make the best possible predictions based on the available information. If the discount rate investors use is constant, the model implies that actual stock prices, P_t, are the optimal forecasts that investors can make with their limited information of the perfect foresight prices. Shiller notes that optimal forecasts of economic variables should vary less than the variables themselves. He concludes from this that the actual variance of stock prices should be less than the estimated variance of the perfect foresight series he constructs. This condition is referred to as a "variance bounds restriction."[30]

Shiller tested this variance bounds restriction by constructing a measure of P^*_t and comparing its variability with the actual stock price series, P_t. He used a constant discount rate, actual dividends, and an assumption about the terminal stock price to compute the present value of actual dividends, after first deflating by the producer price index and eliminating trends. The startling result of this exercise is given in Chart 1. The dashed line is the constructed P^*_t series, and the solid line is the actual stock price series, P_t. As the chart illustrates, the P^*_t series is much smoother than the P_t series. From this, Shiller concluded that stock prices vary too much to be the present value of expected dividends.

[30] See appendix for details on Shiller's approach.

Shiller's results have created considerable controversy, with several well-known economists referring to his results as evidence that the stock market is not likely to allocate capital efficiently.[31] In addition, because stock price fluctuations have substantial effects on the economy, such excess volatility suggests to some that the Federal Reserve should smooth these excessive swings through open market operations in equities as well as short-term government securities.[32]

Several researchers, however, have challenged the approach of Shiller. One exception taken to his approach is that the comparison of variances is inappropriate because it ignores the information available to investors. According to the efficient markets model, the current stock price is the present value of the best forecast of future dividends that can be made from current information. The appropriate comparison is between this forecast and any other forecast based on the same information. Since the variance of P^*_t depends on all actual future dividends whereas the variance of P_t depends only on information known at time t, there is no reason to conclude that Shiller's variance bounds test contradicts the efficient markets model. Indeed, one researcher has shown that figures such as Chart 1 can result even when the efficient markets model holds by construction.[33] The intuition behind this finding is that when dividends change in, say, period t, investors change their forecasts of all future dividends. If dividend changes tend to persist, an increase in dividends would increase the predicted dividends for many periods into the future. Thus, the present value of these dividends, and hence P_t, may increase substantially. P^*_t, however, is based on the known future dividends and can only rise by enough to produce a return equal to the assumed constant discount rate. Hence P_t will appear much more volatile than P^*_t.

Related to this objection to Shiller's approach is work suggesting that dividends should not be treated as exogenous but rather as a choice made by managers of firms. Models of aggregate dividends that assume managers try to keep dividends payments smooth appear to fit the historical pattern of dividends quite well.[34] If managers smooth dividends rather than let dividends vary proportionately with profits, the observed dividends will vary little, and stock prices will appear much more volatile than the present value of the observed dividends.

A third objection to Shiller's variance bounds test is the assumption of a constant discount rate. If the discount rate changes substantially over time, stock prices could vary considerably, even if expected changes in dividends were small. If investors are risk averse, the rate of return they require to hold stocks will vary with the state of the economy. When incomes are high, investors are likely to save more and to accept a lower return. When incomes are low, investors would tend to sell their stocks to maintain their consumption and the required rate of return would have to rise. Thus, stock prices would be boosted by falling discount rates in good times and depressed by rising discount rates in bad times. The more risk averse investors are the more variation in discount rates. While Shiller and others suggest that this variation is insufficient to account for the

[31] See, for example, Arrow (1982), pp. 1-9, and Ackley (1983).

[32] See Fischer and Merton (1984).

[33] For a detailed discussion of these issues, see Kleidon (1986). A summary of problems with volatility tests is given by LeRoy (1984).

[34] See Marsh and Merton (1986, 1987). Much of the discussion about the dividend process centers on the question of whether the aggregate dividend series is nonstationary or whether it is stationary about a trend as assumed by Shiller.

volatility of stock prices, other work gives more support to this factor.[35]

The question of whether the historical volatility of stock prices is inconsistent with the efficient markets model is still an open question. While several objections have been raised to the original tests, which indicated excessive volatility, new tests that do not suffer from these drawbacks have also found evidence against the rational expectations, present value model.[36] It appears, however, that the assumptions of relatively smooth dividends and a fluctuating expected rate of return allow the efficient markets model to account for the apparent excess volatility of stock prices.

Summary and conclusions

For stock prices to serve as signals that lead to the efficient allocation of capital, they need to reflect the best forecasts of the future profitability of firms. According to the efficient markets model of stock price determination, this condition is met. Investors are assumed to use all available information in predicting stock prices, which implies that stock prices quickly reflect any relevant news. Investors should expect to earn only a normal rate of return for the risk they bear.

Challenges to this notion of stock market efficiency have often been raised in the spirit of Keynes. Critics see stock prices as strongly influenced by changes in mass psychology in addition to news about future profits. Recent empirical challenges have taken two forms. First, studies have pointed out anomalies to the efficient markets model in which investors appear able to earn excess returns based on the use of available information. Second, recent work on the volatility of stock prices has claimed that this volatility cannot be explained by the efficient markets model.

After reviewing many studies on these two challenges, this article concludes that the evidence against the efficient markets model is not sufficient to reject the model. When transactions costs are taken into account, many of the apparent deviations from the predictions of the efficient markets model are too small to allow investors to earn excess returns. Moreover, these deviations are concentrated in the behavior of the stock prices of small firms, which suggests that the standard model of expected returns may not be adequate for small firms. Studies of excess volatility, while initially accepted as startling evidence against the efficient markets model, have been found to be flawed. More recent work suggests that the evidence of excess volatility is suspect and that the efficient markets model can account for the historical variability of stock prices.

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[35] Allowing for a variable discount rate was found to be insufficient to account for the variation in stock prices in Grossman and Shiller (1981) and Shiller (June 1981). For a model allowing for an endogenously determined discount rate that is relatively successful in explaining stock returns, see Litzenberger and Ronn (1986). For discussions of the connection between risk aversion and the variable discount rates, see LeRoy and La Civita (1981) and Michener (1982).

[36] See Mankiw et al. (1985) and Scott (1985). While these tests appear insensitive to the issue of nonstationary dividend processes, they do assume a constant discount rate.

Appendix

Shiller's Volatility Test

The perfect foresight stock price, P^*_t, is defined as

$$(1)\ P^*_t = \sum_{i=1}^{n} d^i D_{t+i}$$

where $d = (1/1+\delta)$

δ = discount rate (assumed constant)

D_t = dividends paid in period t.

The actual stock price, P_t, according to the fundamental model, is:

$$(2)\ P_t = \sum_{i=1}^{n} d^i D^e_{t+i}$$

where D^e_t = expected dividends for period t.

Assuming a constant discount rate, P_t is a forecast of P^*_t so that

$$(3)\ P^*_t = P_t + e_t$$

where e_t = forecast error.

Under the efficient markets model, P_t is the optimal forecast of P^*_t, which implies that e_t must be uncorrelated with P_t. Thus, taking variances of Equation 3,

$$(4)\ var(P^*_t) = var(P_t) + var(e_t)$$

Since variances must always be positive, Equation 4 implies that the variance of the perfect foresight price, P^*_t, must exceed the variance of the actual price, P_t. This is the "variance bounds" restriction Shiller tests.

Shiller constructs P^*_t recursively. Let P^*_T be the terminal price at the end of the data set. P^*_{T-1} can then be calculated as follows:

$$P^*_{T-1} = (P^*_T + D_T)d$$

That is, P^*_{T-1} is the present value of the one-period-ahead price plus the one-period-ahead dividends. This calculation is then repeated recursively to obtain the entire series graphed in Chart 1. Following Shiller, the actual stock price series (the Standard & Poor's Composite) and the dividend series were deflated by the Wholesale Price Index and detrended. The discount rate was set at the ratio of average real, detrended dividends to average real, detrended price, which equaled 5.17 percent over 1926-85. The stock price and dividend data are from *Security Price Index Record,* Standard & Poor's Statistical Service, 1986.

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