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# 3 Investment Strategy in an Inflationary Environment

Zvi Bodie

The basic premise of this chapter is that ultimately what is of concern to an investor, whether a household or an institutional investor such as a life insurance company or a pension fund, is the real value of its investments in terms of purchasing power over consumer goods and services. The issue to be addressed is what investment strategies make sense in an economic environment in which a major factor (although certainly not the only one) to be considered is substantial uncertainty about the future level of the prices of those goods and services. By investment strategy I mean decisions about how to allocate investable funds among four major asset classes: common stocks and other equity investments; long-term, fixed-interest debt instruments; short-term or variable-rate debt instruments; and other "inflation-hedging" assets such as commodity futures contracts or commodity-linked bonds.

The chapter is organized as follows. I will first discuss why it is real or inflation-adjusted rates of return and their uncertainty which ought to be the main concern of investors. I will then present an analytical framework for formulating investment strategy, examine the historical record of real rates of return on the four asset categories, and derive estimates of alternative risk-return tradeoff curves. Finally, I will discuss the implications of my findings for individual and institutional asset allocation policies.

### 3.1  Why It Is Real Investment Returns
###      and Their Uncertainty That Matter

With respect to the individual investor, i.e., the household, there can be little doubt that the dollar value of its investment portfolio is not what counts, but rather its real value in terms of purchasing power. It follows, therefore, that households will be concerned about the real or inflation-adjusted rate of return rather than the nominal rate of return on their investments. If the future rate of inflation were known with certainty, it would make no difference whether households were making their port-folio decisions on the basis of real or nominal rates of return. The expected real rate on any particular asset would just be the nominal rate less the known inflation rate, and its real risk would be the same as its nominal risk. But in an environment of uncertainty about future inflation there can be a great difference between the real and nominal risk associated with an asset. The most extreme example is the case of conventional bonds and mortgages, which offer a guaranteed nominal return to an investor, but a highly uncertain real one. As inflation becomes more certain, these instruments become riskier and less attractive to house-holds.

But what about institutional investors? Should they be concerned with real or nominal rates of return? Institutional investors are financial intermediaries between the nonfinancial business sector and the house-hold sector of the economy. Their ultimate survival and success depend on providing households with the kinds of financial assets that households want to hold. In our inflationary environment contractual savings plans such as ordinary life insurance policies, which offer guaranteed nominal cash flows, and money-fixed annuities have become unattractive. In order to maintain their viability, life insurance companies must respond by offering new products and adjusting their investment policies accord-ingly. Elsewhere I have discussed the feasibility of indexed annuities as a possible innovation for providing stable real retirement income in an inflationary environment, and many other suggestions along these lines are bound to be forthcoming in the future. (Bodie 1980). The central concern of investment policy in this new environment will surely be real rates of return and their uncertainty.

What about pension plans and pension funds? Why should they care about real rates of return? Under many corporate defined-benefit pen-sion plans, the starting level of the retirement benefit promised to the worker is based on an average of the worker's wage in the last several years prior to retirement. If, as in the past, wages increase in tandem with consumer prices, then such a plan's liabilities are in effect indexed during the phase of benefit accrual. Furthermore, it is likely that the future evolution of pension plans is going to be in the direction of at least partial indexation of benefits in the postretirement phase too. Thus, at least

these pension funds have to plan their investment strategy with a focus on real rates of return too.

## 3.2    The Theory of Portfolio Selection

The analytical framework which underlies the investment strategies I will present in this chapter is known as mean-variance analysis, and it goes back almost thirty years to the pioneering work by Markowitz (1952). The basic premise underlying this approach is that the investor is risk averse; that is to say, given a choice between two investments offering the same mean (or average) rate of return, the investor always chooses the one that has less risk. Risk in the context of this analysis is identified with the unpredictability or uncertainty of achieving one's expected rate of return and is measured by its variance or standard deviation.

The investor's decision process is divided into two stages. In the first stage he computes what his risk-return opportunities are, and in the second he chooses the risk-return combination which suits him best. In stage one, the investor starts by finding the minimum-risk strategy, determining the mean rate of return associated with it, and then proceeding to derive other portfolios which offer higher and higher means with the least possible risk. The result of this part of the process is a tradeoff curve showing the terms-of-trade between risk and expected return.[1]

The inputs needed to generate the tradeoff curve are the means and standard deviations of the real rates of return on the individual assets and the correlations among them. In the following section we examine what these parameters have been over the past twenty-seven years and discuss our assumptions about their current values.

## 3.3    Inflation and Asset Returns: The Historical Record

Table 3.1 contains the historical record of real pretax rates of return on each of four categories of assets for the period 1953 through 1979. The measure of the price level that was used in adjusting these rates of return was the Personal Consumption Expenditures Deflator published by the U.S. Department of Commerce. This measure was chosen rather than the Department of Labor's Consumer Price Index (CPI) because serious doubts about the adequacy of the CPI as a measure of true inflation have been raised in the past seven or eight years. The main objection to the CPI is that it gives too much weight to new mortgage rates in the computation of shelter costs. The last two columns in Table 3.1 present the rate of inflation as measured first by the Consumer Price Index, then

1. For a discussion of how to choose the optimal point on the tradeoff curve see Bodie (1979).

**Table 3.1    Annual Real Rates of Return, 1953–79 (Percent per Year)**

| | (1) Bills | (2) Bonds | (3) Stocks | (4) Commodity Futures | Rate of Inflation | |
|---|---|---|---|---|---|---|
| | | | | | (5) CPI | (6) PCE Deflator |
| 1953 | 0.43 | 2.22 | − 2.34 | − 3.46 | 0.62 | 1.38 |
| 1954 | 0.44 | 6.74 | 51.98 | 13.24 | − 0.50 | 0.42 |
| 1955 | 0.35 | − 2.49 | 29.97 | − 7.63 | 0.37 | 1.22 |
| 1956 | − 0.96 | − 8.74 | 3.01 | 12.38 | 2.86 | 3.45 |
| 1957 | 0.10 | 4.28 | − 13.41 | − 5.04 | 3.02 | 3.04 |
| 1958 | 0.37 | − 7.19 | 41.70 | − 3.47 | 1.76 | 1.17 |
| 1959 | 0.86 | − 4.24 | 9.68 | − 2.84 | 1.50 | 2.07 |
| 1960 | 1.20 | 12.16 | 0.96 | − 3.93 | 1.48 | 1.69 |
| 1961 | 0.90 | − 0.25 | 25.36 | 0.02 | 0.67 | 1.22 |
| 1962 | 1.02 | 5.11 | − 10.25 | − 2.40 | 1.22 | 1.69 |
| 1963 | 1.57 | − 0.32 | 20.95 | 16.32 | 1.65 | 1.53 |
| 1964 | 2.27 | 2.24 | 15.05 | 4.54 | 1.19 | 1.24 |
| 1965 | 1.33 | − 1.81 | 9.63 | 5.13 | 1.92 | 2.57 |
| 1966 | 2.09 | 1.00 | − 12.36 | 9.70 | 3.35 | 2.62 |
| 1967 | 0.53 | − 12.40 | 19.60 | − 0.06 | 3.04 | 3.66 |
| 1968 | 1.11 | − 4.14 | 6.74 | − 3.18 | 4.72 | 4.05 |
| 1969 | 1.44 | − 9.66 | − 12.92 | 12.19 | 6.11 | 5.07 |
| 1970 | 2.14 | 7.48 | − 0.28 | − 1.62 | 5.49 | 4.30 |
| 1971 | 0.34 | 8.83 | 9.87 | − 1.65 | 3.36 | 4.04 |
| 1972 | 0.14 | 1.92 | 14.75 | 29.35 | 3.41 | 3.69 |
| 1973 | − 2.21 | − 9.57 | − 21.96 | 72.69 | 8.80 | 9.35 |
| 1974 | − 1.99 | − 5.30 | − 33.28 | 17.97 | 12.20 | 10.19 |
| 1975 | 0.21 | 3.42 | 29.95 | − 10.03 | 7.01 | 5.58 |
| 1976 | − 0.43 | 10.63 | 17.35 | 5.31 | 4.81 | 5.53 |
| 1977 | − 0.76 | − 6.22 | − 12.37 | 4.90 | 6.77 | 5.92 |
| 1978 | − 1.07 | − 6.62 | − 1.66 | 18.61 | 9.03 | 8.19 |
| 1979 | 0.08 | − 10.44 | 7.39 | 15.59 | 13.31 | 10.29 |
| Mean | 0.43 | − 0.87 | 7.08 | 7.13 | 4.04 | 3.89 |
| Std. Dev. | 1.14 | 6.86 | 19.46 | 16.26 | 3.56 | 2.85 |

Correlation Coefficients:

| | Bonds | Stocks | Commodity Futures | Inflation (PCE) |
|---|---|---|---|---|
| Bills | .357 | .287 | − .521 | − .658 |
| Bonds | | .170 | − .359 | − .423 |
| Stocks | | | − .333 | − .527 |
| Commodity futures | | | | .532 |
| Inflation (CPI) | | | | .977 |

The real returns were calculated according to the formula:

$$\text{Real rate of return} = 100 \times \left( \frac{1 + \text{nominal rate of return}}{1 + \text{rate of inflation}} - 1 \right)$$

using the PCE Deflator inflation rate. The rate of return on commodity futures in column 4 was calculated differently, as explained in the text.

SOURCES: The data on 1-month bills, 20-year bonds, and stocks are from Ibbotson and Sinquefield (1977), updated by the authors. The commodity futures series was derived from price data in the *Wall Street Journal* using a method explained in the text. The data on the CPI and the PCE deflator are from U.S. Department of Labor and Department of Commerce, respectively.

as measured by the Personal Consumption Expenditures Deflator. There are serious differences between the two series, especially in 1974 and 1979; but as the correlation coefficient of .977 reported at the bottom of Table 3.1 indicates, they are highly positively correlated.

The first column in Table 3.1 is the real rate of return on a policy of "rolling over" thirty-day Treasury bills, and is representative of the rate of return on money market instruments. This is by far the least volatile series, with a standard deviation of only 1.14 percent. This is because over this period, short-term interest rates have tended to follow rather closely movements in the rate of inflation.

Of course, this is not a coincidence. All market-determined interest rates contain an "inflation premium," which reflects expectations about the declining purchasing power of the money borrowed over the life of the loan. As the rate of inflation has increased in recent years, so too has the inflation premium built into interest rates. While long-term as well as short-term interest rates contain such a premium, conventional long-term bonds lock the investor into the current interest rate for the life of the bond. If long-term interest rates on new bonds subsequently rise as a result of unexpected inflation, the funds already locked in can be released only by selling the bonds on the secondary market at a price well below their face value. But if an investor buys only short-term bonds with an average maturity of about thirty days, then the interest rate he earns will lag behind changes in the inflation rate by at most one month.

The problem with money market instruments, however, is their low rate of return. Over the past twenty-seven years, the average pretax, inflation-adjusted rate of return on money market instruments has been barely half a percent per year. In the most recent six-year period, that return has actually been negative. Perhaps the most likely scenario for the future is that inflation-adjusted returns will hover around zero, i.e., the interest rate will be about equal to the rate of inflation.

Column 2 presents the real rate of return an investor would have earned by investing in U.S. Treasury bonds with a twenty-year maturity. The assumption underlying this series is that the investor bought a twenty-year bond at the beginning of each year and sold it at the end. His return therefore includes both coupon interest and capital gains or losses. As the relatively low mean and high standard deviation indicate, the past twenty-seven years was a bad period for the investor in long-term bonds. Capital losses caused by unanticipated increases in interest rates usually more than cancelled the coupon yield over this period.

It would probably be a mistake to assume that the mean real rate of return on long-term government bonds in the future is going to be the −.87% per year that it was over the 1953 to 1979 period. A more reasonable approach to estimating the ex ante mean real rate would be to take the yield to maturity on long-term government bonds and subtract an estimate of the mean rate of inflation expected to prevail over the next

twenty years. When we do this we find a mean real rate of return on U.S. Treasury bonds of 2% per year.

Column 3 in Table 3.1 presents the real rate of return on the Standard and Poor's Composite Index of common stocks, which is a value-weighted stock portfolio of the five hundred largest corporations in the United States. The return includes dividends and capital gains. The mean real rate over our sample period was 7.08% per year, but we will use 10% per year as our estimate of the ex ante mean in our computations of the tradeoff curve. There are two main reasons for doing so. The first is that several recent careful studies of the real rate of return on unlevered corporate capital (i.e., the return to debt and equity combined) indicate it to be in the range of 6 to 7% per year (Brainard, Shoven, and Weiss 1980; Feldstein and Summers 1977; Holland and Myers 1977). Since the average debt-equity ratio for the S&P 500 companies is about ⅓, and the after-tax real interest rate on corporate borrowing is quite negative, a 10% mean real rate of return on levered equity seems plausible.[2] The second reason is that 10% per year is the estimate of the mean real rate of return on the S&P 500 derived by Merton (1980) in a recent National Bureau of Economic Research study employing a new estimation technique, which incorporates more information than just the simple average of past rates.

Finally, let us focus our attention on column 4 in Table 3.1, which presents the annual rate of return one would have earned on a well-diversified portfolio of commodity futures contracts over the 1953 to 1979 period. The rate of return on a futures contract reflects the proportional change in the futures price over the holding period. The series was generated by assuming a "buy-and-hold" strategy whereby contracts were entered into at quarterly intervals, held for three months, and then liquidated. The number of commodities increases from thirteen in 1953 to twenty-two by the end of the period. Table 3.2 presents the list of commodities and the year in which each was added to the portfolio. The portfolio was assumed to consist of equal dollar amounts invested in each commodity contract.

The rates of return for commodity futures listed in column 4 of Table 3.1 require a different interpretation than the real rates in columns 1 through 3. When an investor takes a long position in a futures contract, he

2. The relationship between the rate of return on levered equity ($ROE$), the rate of return on total capital ($ROC$), the after-tax interest rate on debt ($I$), and the debt/equity ratio is given by the formula:

$$ROE = ROC + (ROC - I)\frac{\text{Debt}}{\text{Equity}}$$

Assuming a 15% per year nominal interest rate on corporate debt, a 50% tax rate, and a 12% per year expected rate of inflation, we get a real after-tax interest rate on the debt of − 4.5% per year. Substituting this value into the formula for $I$, 6.5% per year for $ROC$, and ⅓ for the debt/equity ratio, we find that $ROE \simeq 10\%$ per year.

**Table 3.2**    **List of Commodity Futures Contracts Included in the Portfolio**

| Commodity | Year of Entrance into the Portfolio | Commodity | Year of Entrance into the Portfolio |
|---|---|---|---|
| Wheat | 1953 | Copper | 1953 |
| Corn | 1953 | Sugar | 1953 |
| Oats | 1953 | Silver | 1963 |
| Soybeans | 1953 | Cattle | 1964 |
| Soybean oil | 1953 | Platinum | 1964 |
| Soybean meal | 1953 | Pork bellies | 1964 |
| Potatoes | 1953 | Hogs | 1966 |
| Wool | 1953 | Orange juice | 1966 |
| Cotton | 1953 | Broilers | 1968 |
| Eggs | 1953 | Lumber | 1969 |
| Cocoa | 1953 | Plywood | 1970 |

does not buy it in the sense that he would buy a stock or bond or the physical commodity itself; rather, he agrees to purchase the commodity for a specified price at a certain point in the future. The commodities exchange, which acts as an intermediary, requires all parties to a futures contract to post a bond called "margin" to guarantee performance.[3] Investors are permitted to post Treasury bills, on which they continue to earn the interest, so the funds used as margin are therefore not strictly speaking an investment in commodity futures. The rates of return reported in column 4 should therefore be interpreted as the addition to the total investment portfolio rate of return that the investor would have earned in each year had he taken a position in commodity futures with a face value equal to his total investment in other assets.

In order for a buy-and-hold strategy in the futures market to be profitable, it is not enough for spot prices to be rising; they must rise by more than was anticipated in the futures price at the time the contract was entered into. On average, one might expect the spot price forecasts implicit in futures prices to be right, and therefore expect the mean rate of return on futures contracts to be zero.[4] But what is more important for our purposes, futures contracts will yield a positive rate of return when there are *unanticipated* increases in spot prices, and it is this feature which makes them valuable as an inflation hedge.

The critical parameters which determine how valuable commodity futures are in this role, and which play a crucial role in determining the shape of the tradeoff curve, are the correlation coefficients presented at the bottom of Table 3.1. Perhaps the most significant thing to notice is

3. Margins on commodity figures contracts are typically quite low, ranging from 7 to 10 percent of the face value of the contract. For more detail about the commodity futures series see Bodie and Rosanksy (1980).

4. There is a good deal of controversy in the economics literature on this point. For further discussion and references see Bodie and Rosansky (1980).

that the real rates of return on bills, bonds, and stocks are all negatively correlated with inflation and all positively correlated with each other. But commodity futures are positively correlated with the rate of inflation and negatively correlated with the real rates of return on the other major asset categories, and therefore can serve to reduce the risk associated with any portfolio containing them.

The mean rate of return on our buy-and-hold strategy in commodity futures during the 1953 to 1979 period was 7.13% per year, a strikingly large number, and one which may not be an accurate indicator for the future. In computing the tradeoff curve we will assume a mean of zero, although we will also discuss the consequences of assuming a higher value.

Before proceeding to our presentation of the risk-return tradeoff curves in the next section, let us summarize the assumptions that we are making about the key parameters relating to the real rates of return on bills, bonds, stocks, and commodity futures and the interrelationships among them. With regard to the means, we assume zero on bills, 2% on bonds, 10% on stocks, and zero on commodity futures. With regard to the standard deviations and correlations we assume the ones reported in Table 3.1.

### 3.4    The Risk-Return Tradeoff

We will begin our analysis of the risk-return tradeoff by looking at portfolios consisting only of stocks and bills. The minimum-risk investment strategy is to invest entirely in bills, in which case one's mean real rate of return would be zero and one's standard deviation 1.14%. At the other extreme one could invest everything in stocks, in which case the mean real rate of return on the portfolio would be 10% and the standard deviation 19.46%. Table 3.3 shows us the combinations of mean and standard deviation of real rate of return an investor would achieve by going from one of these extremes to the other.[5] Figure 3.1 graphs this tradeoff curve as curve 1. For mean values above 1% per year, curve 1 is very close to a straight line with a slope of .53, indicating an increase of about two percentage points in standard deviation for every one percentage point increase in mean.

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5. The formula for computing the standard deviation of the real rate of return on any portfolio consisting of stocks and bills is:

$$SD_p^2 = (1 - X)^2 \, SD_b^2 + X^2 \, SD_s^2 + 2X(1 - X)R \, SD_b \, SD_s$$

where $SD_b$ and $SD_s$ represent the standard deviations on bills and stocks, respectively, and $R$ the correlation coefficient between them. $X$ is the proportion of the portfolio invested in stocks, and therefore $1 - X$ is the proportion invested in bills.

**Table 3.3**    **Risk-Return Tradeoff Curve: Stocks and Bills**

| Mean | Std. Dev. | Slope | Portfolio Proportions | |
| | | | Stocks | Bills |
|---|---|---|---|---|
| 0% | 1.14% | | 0 | 1.0 |
| | | .77 | | |
| 1 | 2.44 | | .1 | .9 |
| | | .56 | | |
| 2 | 4.24 | | .2 | .8 |
| | | .53 | | |
| 3 | 6.11 | | .3 | .7 |
| | | .53 | | |
| 4 | 8.00 | | .4 | .6 |
| | | .52 | | |
| 5 | 9.91 | | .5 | .5 |
| | | .52 | | |
| 6 | 11.81 | | .6 | .4 |
| | | .52 | | |
| 7 | 13.72 | | .7 | .3 |
| | | .52 | | |
| 8 | 15.63 | | .8 | .2 |
| | | .52 | | |
| 9 | 17.54 | | .9 | .1 |
| | | .52 | | |
| 10 | 19.46 | | 1.0 | 0 |

Assumptions about real rates of return:

| | Bills | Stocks |
|---|---|---|
| Mean | 0% | 10.0% |
| Std. Dev. | 1.14% | 19.46% |
| Correlation Coefficients: | | |
| Stocks | .287 | |

In order to provide a clearer picture of the meaning of a movement along the risk-return tradeoff curve, we have graphed in Figure 3.2 three probability distributions, corresponding to the first three points on curve 1. They are based on the assumption that the distribution of the real rate of return on the portfolios is normal, i.e., a "bell-shaped" curve. The first corresponds to the portfolio consisting of bills only, which has a mean of zero and a standard deviation of 1.14%; the second, to the portfolio which has 90 percent invested in bills and ten percent invested in stocks with a mean real rate of return of 1% per year and a standard deviation of 2.44%; and the third, to a portfolio which has eighty percent invested in bills, twenty percent in stocks with a mean of 2% per year and a standard deviation of 4.24%. As the proportion of the portfolio invested in stocks and therefore the mean go up, the bell-shaped curve shifts to the right and becomes more flat or stretched out, indicating greater upside potential but also greater downside risk.
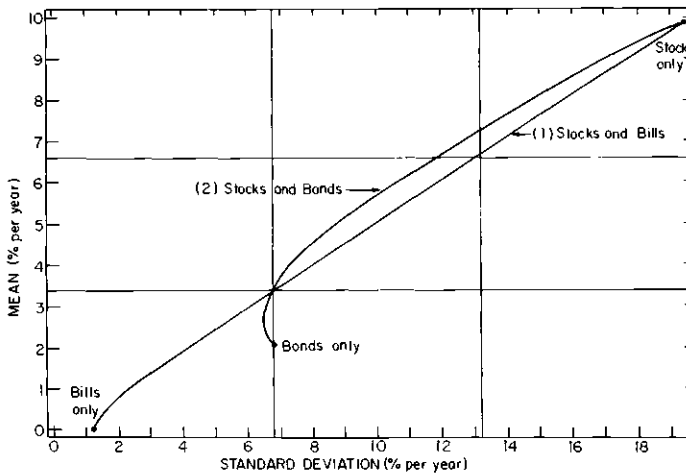
**Fig. 3.1**    Risk-Return Tradeoff Curves.

Now let us consider what the tradeoff curve would look like if the investor were restricted to combinations of bonds and stocks. This curve is tabulated in Table 3.4 and graphed as curve 2 in Figure 3.1. Note that as we move up curve 2 from a bonds-only portfolio to one containing a little stock, the standard deviation actually falls a bit before starting to grow. The minimum-risk stock-bond portfolio contains 6.4% stocks and 93.6% bonds and has a mean and standard deviation of 2.51% per year and 6.64%, respectively.[6] This implies that no risk-averse investor would ever rationally choose to hold a bonds-only portfolio, since by substituting a small amount of stock for some of the bonds, he could both increase his expected rate of return and reduce his risk.

As a comparison of curves 1 and 2 makes clear, at mean real rates of return greater then 3.5%, the stock-bond portfolios have less risk for any mean than do the corresponding stock-bill portfolios. On the other hand, for mean values below 3.5%, stock-bill portfolios have less risk for any mean than do the corresponding stock-bond portfolios. Perhaps more important, however, is the fact that very low risk strategies are unattainable using only stocks and bonds. The minimum-risk stock-bond portfolio still has a standard deviation of 6.64%, which is quite high compared with the lower risk levels attainable with bills.

6. The formula for finding the minimum-risk proportion of stocks is:

$$X_{min} = \frac{SD_b^2 - RSD_bSD_s}{SD_b^2 + SD_s^2 - 2RSD_bSD_s}$$

Note that when we combine bills with stocks, this formula yields a negative number for the proportion of stocks, which means we would actually have to sell some stock short in order to minimize risk. This explains why curve 1 in Figure 3.1 does not have the same shape as curve 2 at its lower end.

**Table 3.4**        **Risk-Return Tradeoff Curve: Stocks and Bonds**

| Mean | Std. Dev. | Slope | Portfolio Proportions | |
|------|-----------|-------|-------|-------|
| | | | Stocks | Bonds |
| 2% | 6.86% | | 0 | 1.0 |
| | | − 5.88 | | |
| 3 | 6.85 | | .125 | .875 |
| | | 1.45 | | |
| 4 | 7.66 | | .25 | .75 |
| | | .71 | | |
| 5 | 9.07 | | .375 | .625 |
| | | .49 | | |
| 6 | 10.85 | | .5 | .5 |
| | | .50 | | |
| 7 | 12.85 | | .625 | .375 |
| | | .47 | | |
| 8 | 14.98 | | .75 | .25 |
| | | .45 | | |
| 9 | 17.19 | | .875 | .125 |
| | | .44 | | |
| 10 | 19.46 | | 1.0 | 0 |

Assumptions about real rates of return:

| | Bonds | Stocks |
|------|-------|--------|
| Mean | 2% | 10.0% |
| Std. Dev. | 6.86% | 19.46% |

Correlation Coefficients:
Stocks                .170

The minimum-risk portfolio consists of 6.4 percent stocks and 93.6 percent bonds and has a mean and standard deviation of 2.51 percent and 6.64 percent, respectively.
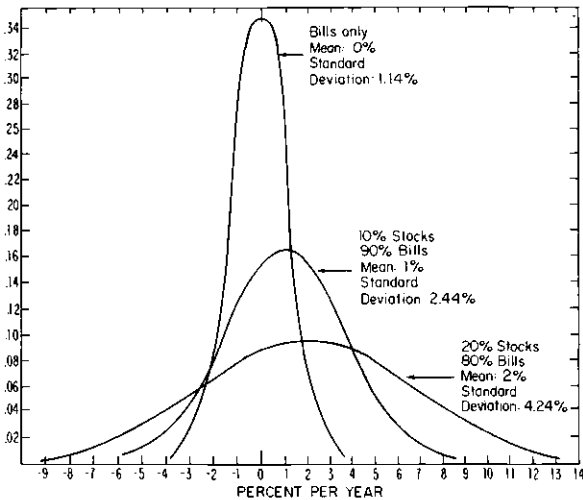


**Fig. 3.2**        Probability Distributions of Bill and Stock Portfolios.

**Table 3.5          Risk-Return Tradeoff Curve: Stocks, Bills, and Bonds**

| Mean | Std. Dev. | Slope | Portfolio Proportions | | |
| | | | Stocks | Bonds | Bills |
| --- | --- | --- | --- | --- | --- |
| 0% | 1.14% | | 0 | 0 | 1.00 |
| | | .84 | | | |
| 1 | 2.33 | | .08 | .10 | .82 |
| | | .62 | | | |
| 2 | 3.94 | | .15 | .22 | .63 |
| | | .59 | | | |
| 3 | 5.63 | | .23 | .33 | .44 |
| | | .58 | | | |
| 4 | 7.34 | | .31 | .45 | .24 |
| | | .58 | | | |
| 5 | 9.06 | | .39 | .56 | .05 |
| | | .56 | | | |
| 6 | 10.85 | | .50 | .50 | 0 |
| | | .50 | | | |
| 7 | 12.85 | | .63 | .37 | 0 |
| | | .47 | | | |
| 8 | 14.98 | | .75 | .25 | 0 |
| | | .45 | | | |
| 9 | 17.19 | | .88 | .12 | 0 |
| | | .44 | | | |
| 10 | 19.46 | | 1.00 | 0 | 0 |

Assumptions about real rates of return:

| | Bills | Bonds | Stocks |
| --- | --- | --- | --- |
| Mean | 0% | 2% | 10% |
| Std. Dev. | 1.14% | 6.86% | 19.46% |

Correlation Coefficients:

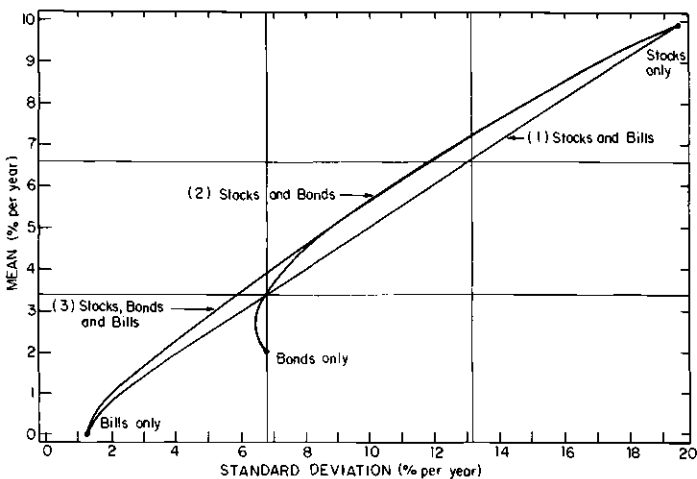| | | |
| --- | --- | --- |
| Bonds | .357 | |
| Stocks | .287 | .170 |



**Fig. 3.3          Risk-Return Tradeoff Curves.**

Now let us consider portfolios containing all three assets: stocks, bonds, and bills. The process of computing the tradeoff curve in this case is more complicated than before, because for each value of mean real rate of return, one must use an optimization procedure to find that portfolio which has the lowest standard deviation (Markowitz 1952). The resulting tradeoff curve and portfolio proportions are presented in Table 3.5 and Figure 3.3, which allows us to compare the risk-return tradeoff curve derived using all three assets with the two previously derived curves from Figure 3.1.

The main improvement comes at the low-risk, low-return end of the curve. The minimum-risk strategy is still to invest in bills only, but as we move up the curve we replace bills with increasing amounts of both bonds and stocks. This continues up to a mean of 5% per year. At higher means bills disappear from the portfolio, and the proportion of bonds declines; curve 3 just becomes identical to curve 2. One point of special interest on curve 3, which is not tabulated in Table 3.5, is the point having the same mean as the minimum-risk stock-bond portfolio on curve 2, i.e., 2.5% per year. It consists of a portfolio with 53% bills, 28% bonds, and 19% stocks and has a standard deviation of 4.78%, as opposed to the 6.64% standard deviation of the minimum-risk stock-bond portfolio. Thus by adding bills to the minimum-risk stock-bond portfolio one can achieve a substantial reduction in risk with no loss in expected return.

Now we are ready to introduce commodity futures contracts into our portfolio. It is important to remember that when we take a position in commodity futures we are not actually using up any of our funds; our funds are invested in stocks, bonds, and bills. We are simply taking a position which has a face value equal to some specified proportion of the total amount invested in these other assets. The only restriction on our portfolio imposed by the futures contracts is that we must have an amount invested in bills equal to at least 10% of the position in commodity futures, to serve as margin.

The results with commodity futures included are presented in Table 3.6 and Figure 3.4. Note that the minimum-risk strategy is still to invest 100% of our funds in bills, but it is now optimal to hedge that investment with a small position in our well-diversified commodity futures portfolio by taking a long position with a face value equal to 4% of the investment in bills. Under our assumption that the mean rate of return on commodity futures is zero, the mean real rate of return on our portfolio will remain unaffected, but there will be a reduction in standard deviation.

Comparing curves 3 and 4 in Figure 3.4, we see that for any mean real rate of return, introducing the right amount of commodity futures contracts into our portfolio enables us to reduce our standard deviation by a significant amount. The reduction in standard deviation increases steadily the higher the mean value, and is at its greatest value at a mean of 9% per year. Introducing commodity futures shifts the tradeoff curve to the

**Table 3.6**                **Risk-Return Tradeoff: Stocks, Bonds, Bills, and Commodity Futures**

| | | | Portfolio Proportions | | | |
|---|---|---|---|---|---|---|
| Mean | Std. Dev. | Slope | Stocks | Bonds | Bills | Commodity Futures |
| 0% | 0.97% | | 0 | 0 | 1.00 | .04 |
| | | 1.01 | | | | |
| 1 | 1.96 | | .08 | .12 | .80 | .08 |
| | | .67 | | | | |
| 2 | 3.44 | | .15 | .24 | .61 | .12 |
| | | .65 | | | | |
| 3 | 4.99 | | .23 | .37 | .41 | .16 |
| | | .63 | | | | |
| 4 | 6.57 | | .30 | .49 | .21 | .20 |
| | | .63 | | | | |
| 5 | 8.16 | | .38 | .59 | .03 | .24 |
| | | .56 | | | | |
| 6 | 9.93 | | .51 | .46 | .03 | .27 |
| | | .50 | | | | |
| 7 | 11.93 | | .63 | .34 | .03 | .29 |
| | | .47 | | | | |
| 8 | 14.06 | | .76 | .21 | .03 | .32 |
| | | .45 | | | | |
| 9 | 16.26 | | .88 | .08 | .04 | .34 |
| | | .33 | | | | |
| 10 | 19.46 | | 1.00 | 0 | 0 | 0 |

Assumptions about real rates of return:

| | Bills | Bonds | Stocks | Commodity Futures |
|---|---|---|---|---|
| Mean | 0% | 2.0% | 10.0% | 0% |
| Std. Dev. | 1.14% | 6.86% | 19.46% | 16.26% |

Correlation Coefficients:

| | | | |
|---|---|---|---|
| Bonds | .357 | | |
| Stocks | .287 | .170 | |
| Commodity futures | −.521 | −.359 | −.333 |

left by .17% at the minimum-risk end of the curve and by .93% at the other end.

Looking at the last four columns in Table 3.6 and comparing them with the last three columns of Table 3.5, we see that the addition of commodity futures contracts does not change the portfolio proportions of stocks, bonds, and bills by much. The major effect is that bills no longer disappear entirely from the portfolio as they did before when we moved to high mean real rates of return, because now there is a need for bills to serve as margin on the commodity futures contracts. We also see that as we move to higher mean real rates of return and the investment in stocks goes up, there is a steady increase in the size of the relative position in commodity futures, although it never exceeds 34 percent of the total value of the investment portfolio.

What is the effect on the tradeoff curve of assuming a positive mean rate of return on commodity futures? Table 3.7 and Figure 3.5 present the
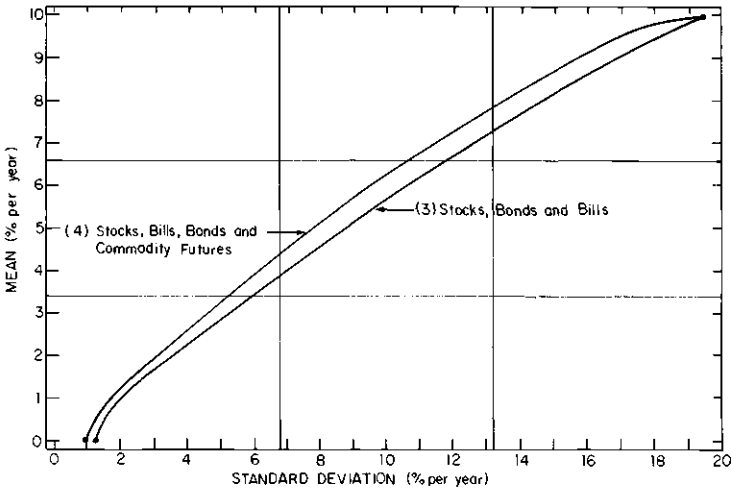
**Fig. 3.4**          Risk-Return Tradeoff Curves.

results of assuming a 2% per year mean rate. Perhaps the best way to describe the effect is as an upward shift of the entire curve. At any level of risk it becomes possible to achieve a higher mean real rate of return, with the gain being larger the higher the level of risk. Even the minimum-risk portfolio now has a positive mean rate of return. It now becomes possible to attain a 10% mean real rate of return with a standard deviation of only 16.39% instead of 19.46%, by holding a portfolio consisting of 86% stocks, 8% bonds, 6% bills, and a position in commodity futures equal to 59% of the portfolio's value.

It should be stressed once again before ending this part of the chapter that the role of commodity futures stems from the fact that it is the only asset whose returns are positively correlated with inflation. The reason

**Table 3.7**          **Effect of Increased Mean Rate of Return on Commodity Futures to 2 Percent per Year**

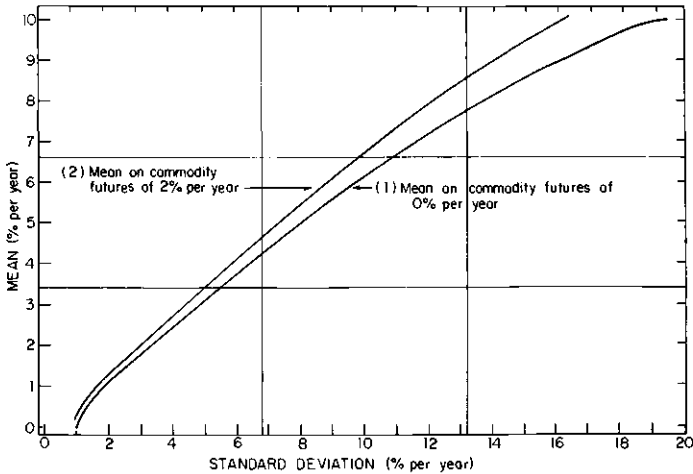| Mean | Std. Dev. | Portfolio Proportions | | | |
|------|-----------|--------|-------|-------|-------------------|
| | | Stocks | Bonds | Bills | Commodity Futures |
| 0.1% | .97% | 0 | 0 | 1.00 | .04 |
| 1.0 | 1.74 | .06 | .10 | .84 | .09 |
| 2 | 3.06 | .13 | .21 | .66 | .14 |
| 3 | 4.46 | .19 | .33 | .48 | .20 |
| 4 | 5.89 | .26 | .44 | .30 | .25 |
| 5 | 7.32 | .33 | .55 | .12 | .31 |
| 6 | 8.81 | .41 | .55 | .04 | .36 |
| 7 | 10.53 | .53 | .43 | .04 | .41 |
| 8 | 12.40 | .64 | .31 | .05 | .47 |
| 9 | 14.37 | .75 | .19 | .06 | .53 |
| 10 | 16.39 | .86 | .08 | .06 | .59 |

**Fig. 3.5**         Risk-Return Tradeoff Curves

the proportion of commodity futures in the portfolio rises in Table 3.6 as the investment in stocks goes up is that the real return on stocks is negatively correlated with inflation. I have performed the experiment of deriving the tradeoff curve under the assumption that the real return on stocks is uncorrelated with inflation, and the result is that there would be virtually no role for commodity futures contracts in that case. It is their value as a hedge against inflation, to offset the inflation risk associated with the investment in stocks, that accounts for commodity futures' significant role.

### 3.5   Implications of Findings for Asset Allocation

The first implication of our findings is that bills are the cornerstone of any low-risk investment strategy. Here it is important to keep in mind that bills for us are a proxy for all money market instruments and floating rate debt. Our results indicate that in order to achieve a low degree of risk, by which we mean a standard deviation below 4%, at least half of the portfolio would have to be invested in these securities. Of course, along with the low risk comes a low return.

Who might be interested in a low-risk strategy, despite its low return? The prime candidates are probably retired people with a small-to-moderate accumulation of assets and a low tolerance for risk. In Great Britain the government has for years been selling bonds bearing a zero real interest rate on a voluntary and restricted basis to citizens aged sixty-five and over. These bonds have proven to be a very popular investment.

Our findings carry two important messages to institutional investors such as life insurance companies. The first is that households can currently provide themselves with a fairly safe pretax real rate of return of about zero by investing in money market funds. Therefore any new kind of contractual savings plan would have to offer a similar rate. The second is that if the insurance industry wanted to offer savings plans and/or annuities with full or partial indexation they could hedge almost all of the investment risk by investing primarily in money market instruments. In fact, if they wanted to avoid the investment risk altogether, they could offer them as variable annuities.

What can we say about the role of bonds and other long-term fixed interest securities? The first point suggested by our findings is that one can get along without bonds with very little loss of portfolio efficiency; the improvement in the risk-return tradeoff that one gets from adding bonds to stocks and bills is relatively minor. Some institutional portfolio managers might say that the risk associated with long-term bonds is exaggerated in my findings because I have included in my measure of annual returns unrealized capital gains and losses. Most insurance companies and pension funds do not count unrealized capital gains or losses on long-term bonds as part of their annual rate of return. But even if we disregard them, any instrument which commits the investor to a fixed nominal flow of coupon income and a money-fixed principal amount at maturity is in fact extremely risky even for an investor with a long-run horizon, in fact, especially for such an investor.

Many institutional investors have already come to the conclusion that long-term fixed interest securities are too risky relative to their expected return and have simply stopped investing in them. If that trend continues we can expect to see the disappearance of these financial instruments from the U.S. capital market. In Great Britain the market for long-term fixed interest corporate debt disappeared rather quickly in 1974 and has not reappeared since. If this market is to maintain its viability in the U.S., the mean real rate of return will have to be higher than in the past.

Finally, what are the implications of our findings for investments in commodity futures contracts or other inflation-hedging assets? Our results indicate that as long as stocks are negatively correlated with inflation, there is going to be a need for some kind of asset that has the property that its rate of return is positively correlated with inflation. Commodity futures contracts have the considerable advantage of already being in existence and therefore can be used right away.

There are some new types of financial instruments that have started to appear and may play an increasingly significant role in this regard in the future. I am referring specifically to commodity-linked bonds, that is to say, bonds whose principal and/or interest is linked to the price of some

commodity. The silver-linked bonds issued by the Sunshine Mining Corporation are an example. Bonds linked to the price of petroleum and other natural resources owned by the issuing corporation are being actively discussed by the institutional investment community. These securities would share with commodity futures contracts the property that their rate of return would be positively correlated with the rate of inflation. If significant inflation persists in the future, these kinds of securities will probably come to play an important role in investment portfolios.

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