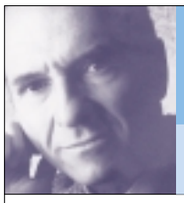


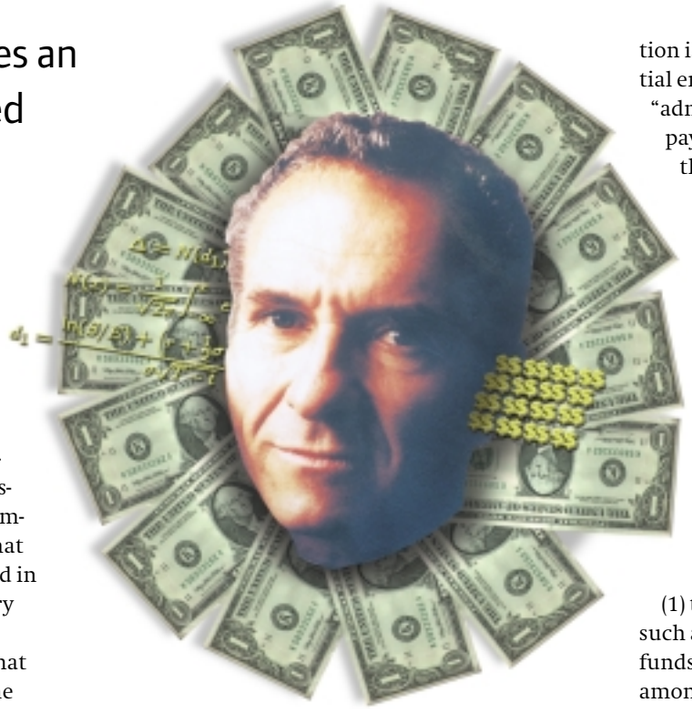
Ed Thorp

A MATHEMATICIAN ON WALL STREET

A Million Dollars for Mathematics

In which the author makes an offer that can't be refused

"Compound interest," said one of the Barons Rothschild, "is the eighth wonder of the world."



My wife Vivian and I are offering the University of California, where I taught for many years, one million dollars to endow a chair in mathematics at the Irvine campus. Our objectives are (1) to support the research of an individual mathematician of exceptional talent, and (2) using a modified investment and distribution policy, to better achieve this by causing the principal, through the power of compound growth, to eventually increase so that the chair becomes the most richly endowed in the world, thereby attracting extraordinary mathematical talent to UCI and UC.

To meet our first objective we specify that funds are to be used only to supplement the research activities of the chair holder. Furthermore, these funds are to be used as an addition to, not instead of, a standard faculty salary and support the arrangement between the University and the chair holder. This is to remain true even if, as we expect, the distribution from the endowment grows to far exceed such standard faculty salary and support.

Funds are not to be used for general departmental, campus or university budgets or for any purpose not directly in support of the research activities of the chair holder, except for a specific "administrative endowment."

The administrative endowment

Typically, the University takes 5 per cent of the original contribution "up front" to support present and future overhead associated with the Chair. Also, they distribute a fixed percentage of the assets annually to support the Chair's activities. The current rate is 4.5 per cent. We have instead specified a distribution rate of 2 per cent annually, with 0.1 per cent covering administration and 1.9 per cent going to the Chair. The reduction from 4.5 per cent to 2 per cent is crucial to our long term compounding objective, as we'll see.

Note that paying 1.9 per cent per year from the entire endowment is the same as paying 2 per cent a year from the endowment after it has been initially reduced by 5 per cent. Note also that paying 0.1 per cent per year for administration is equivalent to taking 5 per cent of the initial endowment and setting it aside as a special "administrative endowment" which in turn pays 2 per cent of its assets per year to support the administration of the chair. Since the chair is perpetual, it makes sense to us to provide for perpetual funding for overhead rather than spending it all the first year. Our investment and reporting policies, as described below, are intended to make the costs of managing the endowment investments and of administering the chair extremely small.

Investment policy: asset allocation

We believe that there are just two basic investment decisions for the non-taxable (hence, in the US unleveraged[1]) investor: (1) the allocation of assets to major categories such as stocks, bonds, commodities, hedge funds, real estate, venture capital, etc. and among their numerous subcategories, and (2) whether to choose active investing (attempting to pick outperforming securities within an asset class) or to choose passive investing ("buying the market," via indexing). We'll address each of these in turn.

Since this endowment is a perpetuity, we're interested in the long-term rate of return on asset classes. In his famous book *Stocks for the Long Run*, Jeremy Siegel gives the compound rate of return of major US financial asset classes for 1802-1997, a period of 196 years! The real, i.e. inflation adjusted, rates of return were:[2] stock market 7.0 per cent, long term governments 3.5 per cent, short term governments 2.9 per cent, gold -0.1 per cent, cash -1.3 per cent (i.e. consumer price inflation was 1.3 per cent). This is corroborated in the monumental study *Triumph of the Optimists*, where

Dimson et al. cite real annualized rates of return for the U.S. for 1900-2000 as:[3] equities 6.7 per cent, bonds 1.6 per cent and bills 0.9 per cent. They also show a similar pattern held true worldwide, over the sixteen countries they studied.

The first major study of this type, a famous paper by Ibbotson and Sinquefield, which appeared in 1976, is now annually updated as the *Stocks, Bonds, Bills and Inflation Yearbook*. For the period from December 31, 1925 through December 31, 1998, the 1999 yearbook gives[4] for the US: Large company stocks 7.9 per cent, small company stocks 9.1 per cent, long-term corporate bonds 2.6 per cent, long-term government bonds 2.2 per cent, intermediate-term government bonds 2.2 per cent, US Treasury bills 0.7 per cent, and cash -3.1 per cent.

Over long periods of 30 years or so, stocks have regularly and substantially outperformed bonds, bills and gold. This "equity premium" represents a price long-term investors have been paid to take on risk. Short horizon investors have paid it by virtue of their collective demand for safety. So we have both empirical and theoretical reasons to expect an equity premium to exist in the future. Estimating the magnitude of the future equity premium is currently the subject of extensive discussion among economic and financial theorists and practitioners. But, motivated by what we believe is the strong likelihood of some continuing long-run advantage[5] to equities, we have resolved the asset allocation issue by specifying that the endowment funds be held in equities to the extent practical, i.e. nearly entirely except for necessary, convenient and generally small cash balances.

Though stocks won't necessarily outperform the other asset classes over the hopefully very long existence of the chair, in the race for the greatest compound rate of growth we agree with Damon Runyon's advice: "The race is not always to the swift, nor the battle to the strong, but that's the way to bet!"

Investment policy: active management versus passive management

The next issue is how to choose the equities in which to invest. The basic decision is whether to be a "passive" investor, which is defined as "buying the market," or to be an "active" investor, which means picking stocks, either directly or through intermediaries ("money managers"), in an effort to "beat the market."

To explain the tradeoffs between passive and active investing, we begin with a simplified and idealized illustration. Suppose "the market," or universe of potential stock investments consists of all US listed stocks. Then an investor in stocks is "passive," and holds the market portfolio, if he has the same fixed percentage of each of the roughly 10,000 listed stocks[6] on U.S. exchanges. For instance, with Berkshire Hathaway's (BRK.A, BRK.B) recent market capitalization of $114 billion, and a (hypothetical) total market capitalization of $11.4 trillion, 1 per cent of the value of stock portfolio of each passive investor would be in Berkshire Hathaway stock. The passive investor holds securities in the same proportions as do all investors collectively. A passive investor who invested $11.4 million in a market worth $11.4 trillion would own one one-millionth of the stock of each listed company. Putting aside the practical issues of actually doing this for now, we move on to the "active" investor.

An active investor is defined as any investor other than a passive investor. So his allocations vary from the collective allocation. This can be inadvertent (inheritance, significant ownership of a business, grants of shares of stock by employers, etc.) or an attempt to choose a portfolio that will have a performance more desirable than that of the market. Examples of ways to do this include hiring financial advisors, buying mutual funds, hiring "money managers" (e.g. hedge funds), and trading one's own account using "information."

We now come to a key insight. Note that since each passive investor owns a fraction f_i of the market portfolio, then all the n passive investors as a group must own a fraction $f = f_1 + f_2 + \cdots + f_n$ of the entire market portfolio. The leftover portion, which must be the fraction $1 - f$ of the market portfolio, is what is owned by all the active investors collectively.

Thus the active investors as a group own the market portfolio even though no one of them does individually. If we continue our idealized example by assuming (for the moment) that there are no transactions costs, then it follows that:

1) Each individual passive investor, and passive investors as a group, gets the market return.

2) Active investors collectively, but not necessarily individually, get the return on the market portfolio.

3) The returns to active investors, to the extent they deviate from the market return, are (before costs) dispersed both above and below the market return with an average (capitalization weighted) dispersion of zero.

Continued in the next issue.

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1. We're aware of the current exemption which allows tax exempt US entities to invest in possibly leveraged offshore hedge funds.
2. Siegel, Tables 1-1 and 1-2.
3. Dimson, et al, Figure 4.2.
4. Ibbotson Associates, Tables 6-7 and 6-8, pp. 122-3.
5. Another way to see why we might expect an equity premium in the long-run is to suppose there wasn't, and that the long run return from stocks was expected to be equal to or less than that for bonds, whereas bonds were expected to be less risky than stocks. Assuming that investors are on average risk averse, we would then expect investors to sell stocks and buy bonds, after which the future expected returns from the now cheaper stocks would be greater than before and the future expected returns from the now higher priced bonds would be less than before.
6 Siegel, page 61, fn 5. As noted there, this figure excludes some 20,000 or so seldom traded "penny stocks."