CHAPTER 11: Arbitrage Pricing Theory (APT):

Coverage of this chapter is intended to be brief. However, it is important to understand both the differences and similarities between the CAPM and APT, and also that an asset's required return should be a linear function of that asset's sensitivities to the *nondiversifiable* or *systematic* risk.

The first task is to revisit what we define as *relevant* risk. From Chapter 10, we can define the *total* risk of any one individual security as:

Total Risk = Systematic risk + unsystematic (diversifiable) risk

The Capital Asset Pricing Model assumes any asset's systematic or macroeconomic risk is captured by *one* risk factor — the *market* risk factor. In a well-diversified portfolio, firm specific or diversifiable risk of the various stocks cancel out one another (they are random and independent among the firms) and is essentially eliminated in any well-diversified portfolio.

Adding one new stock to a well-diversified portfolio affects the risk of the portfolio depending upon the asset's degree of market risk, as measured by its **Beta**. The asset's firm specific risk won't contribute to portfolio risk. The CAPM is represented as:

$E(R_i) = R_f + B_i[R_m - R_f]$, where:

$E(R_i)$ = expected or required return on the asset "i".
R_f = risk-free rate of return (typically U.S. Treasury Bills, although many use the 5 to 7 year Treasury bond yield).
B_i = the Beta of the asset's returns, i.e., its sensitivity with respect to some well diversified portfolio or market basket of stocks such as the Standard and Poors 500 Index. The market portfolio should actually consist of a Global Wealth Portfolio of all the world's investment assets, but such a portfolio is not observable or measurable. This Beta is to serve as a measurement of the asset's level of market or systematic (non-diversifiable) risk.
R_m = the required return on a market basket of stocks such as the S&P 500 Index or Morgan Stanley World Index of stocks (since we cannot accurately measure the returns to any Global Wealth Portfolio).

The CAPM also assumes that the systematic or market risk of any security is captured by only one risk factor; its Beta. The CAPM also assumes that:

1. Investors will hold the market portfolio as their portfolio of risky assets.
2. Investors have *homogeneous* expectations about securities and their relationship to each other.
3. Asset returns are multivariately normally distributed.
4. The only relevant or priced risk factor is the asset's level of market or Beta risk.
5. A linear relationship exists between Beta and expected return.
6. Firm specific or diversifiable risk is not relevant, since it is easily eliminated.

The Arbitrage Pricing Theory or APT assumes that:

1. Only the systematic risk is relevant in determining expected returns (similar to CAPM). However, there may be *several* non-diversifiable risk factors (different from CAPM, since CAPM assumes only one risk factor) that are systematic or macroeconomic in nature and thus affect the returns of all stocks to some degree.
2. Firm specific risk, since it is easily diversified out of any well-diversified portfolio, is not relevant in determining the expected returns of securities (similar to CAPM).

The APT model:

1. Does not require investors to hold any particular portfolio. There is no special role for any *market* portfolio.
2. Only systematic or non-diversifiable risk matters, but there may be *several* of these macroeconomic risk factors that affect the returns of well-diversified portfolios. It is up to the researcher to identify the risk factors. Such risk factors might happen to be *unexpected* changes in industrial production, inflation, real interest rates, etc.
3. Investors must agree on what the relevant risk factors are. There must be a *linear* relationship between the risk exposure or sensitivity (its *loadings* on the risk factors) and expected return of a security.
4. If any asset offers an expected return that is out of equilibrium with respect to the risk factors, then investors can build a *zero wealth* portfolio in order to exploit the mispricing of the security. This is known as an *arbitrage in expectations*.

Zero wealth portfolio: requires that some assets be sold short and the proceeds used to purchase (go long on) other assets. Short selling is the borrowing and selling of an asset that you do not own. You must later repurchase and return the asset. You make a profit when you are able to buy back the asset for a lower price than you sold it for.

A representation of a three factor APT model for IBM common stock (this one assumes that there are three economy-wide or systematic risk factors driving the returns of stocks in a well diversified portfolio) would look like the following:

$E(R_{IBM}) = R_f + B_{IBM,1}[R_1 - R_f] + B_{IBM,2}[R_2 - R_f] + B_{IBM,3}[R_3 - R_f]$, where

$E(R_{IBM})$ = expected or required return on IBM common stock.
R_f = risk-free rate of return (typically Treasury Bills)
$B_{IBM,1}$ = IBM's sensitivity (its "loading" or "Beta" with respect to risk factor number 1. Analogous definitions exist for $B_{IBM,2}$ and $B_{IBM,3}$.
$[R_1 - R_f]$ = the risk premium of any asset having a Beta = 1 with respect to risk factor number 1 and Beta = 0 with respect to risk factors number 2 and 3. An analogous definition exists for the other two risk premium terms $[R_2 - R_f]$ and $[R_3 - R_f]$.

In statistical terminology, the APT risk factors are *orthogonal* to each other.