Last month’s column introduced the concept of arbitrage in which an asset is bought and sold near-simultaneously (the duration for which the asset is held can widely range, depending on the market perspective) in two different markets with the profit derived from the price differential. Arbitrage functions to equalize price gradients across the market landscape, indirectly communicating information between buyers and sellers, thereby leading to a more efficient economy. Of course, the parties engaged in arbitrage don’t set out to perform a useful service, they want to get incredibly rich, but seeking profit for themselves produces, essentially as a by-product, a societal good. Basically, their savviness in producing a profit ensures that they will look for arbitrage opportunities with a diligence and innovativeness that someone simply hired for the job would never match.

The place where this ‘goodness’ is most fully on display is the financial market where likely billions are made in arbitrage each day and where the erasure of gradients across the economy serve the most people. It is within this context, that this month’s column explores the concept of how to price a security or capital instrument so as to maximize profit and minimize risk.

To this end, this analysis will briefly explore two models: the [Capital Asset Pricing Model](https://en.wikipedia.org/wiki/Capital_asset_pricing_model) (CAPM) and the [Arbitrage Pricing Theory](https://en.wikipedia.org/wiki/Arbitrage_pricing_theory) (APT).

Because a security’s price is essentially negotiated between the buyer and the seller at the time of the transaction and is not set by some outside force (e.g. Fred’s or Joe’s market in last month’s banana example), it is distinctly possible for an arbitrage opportunity to fail to net a profit. In other words, despite the classical analysis to the contrary, arbitrage activities have risk. How much should an investor be willing to pay to buy the asset and how much he can reliably sell it for become incredibly important.

In some sense CAPM is a special case of APT and, as a result both models share similar mechanics and strategies for minimizing risk while maximizing profit. Let’s deal with the mechanics first.

In a financial arbitrage, the party engaged in the arbitrage (called an arbitrageur) first identifies a mispriced asset. If the asset is too expensive, he sells it and uses the proceeds to buy another assets. If the asset is too cheap, he sells something else and uses the proceeds to buy the cheaper security. In both cases, a sense of relative pricing attaches when deciding which asset goes where. In an ideal situation, both assets will be mispriced but it is likely that the arbitrageur has to settle for just one. The purchased asset is then held for some time until it is relatively overpriced, at which point it provides the working fund for the next transaction. It is important to understand that the sells that the arbitrageur enacts are typically short sells.

The strategy clearly centers around the identification of a mispriced asset relative to the market as a whole but since the asset is held for some time, called the period, the key feature is comparing the rate of return of the asset relative to other assets. The measure of relative fitness is based on the response of the asset’s price to a host of systemic, macroeconomic risks, such as inflation, unemployment, and so on. For each of these risk factors the risk-free rate of return of the asset is modified by a set of linear corrections. In the abstract, this modification results from the following equation (adapted from [Arbitrage Pricing Theory (APT)](https://www.investopedia.com/terms/a/apt.asp#:~:text=Updated%20Jun%2025%2C%202019.%20Arbitrage%20pricing%20theory%20%28APT%29,number%20of%20macroeconomic%20variables%20that%20capture%20systematic%20risk) by Adam Hayes)

where:

* is the expected rate of return of the asset in question,
* is the rate of return if the asset had no dependence on the identified macroeconomic factors (free rate of return),
* is the sensitivity of the asset with respect to the ith macroeconomic factor, and
* is the additional [risk premium](https://en.wikipedia.org/wiki/Risk_premium) associated with the ith macroeconomic factor with being the actual risk premium.

As in most things, it is much easier to understand this model with a concrete example (derived from Hayes’s article). Consider an asset that depends on the following four macroeconomic factors (i.e = 4):

* Gross domestic product (GDP) growth
* Inflation rate
* Gold prices
* and the return on the Standard and Poor’s 500 index

Historic data are typically analyzed, according to the available literature, via a linear regression. This process not only identifies the preceding four factors as the most important it also gives values for the sensitivity factor and the premiums for each. Assuming a free rate of return = 3%, the data conveniently present themselves in the following table:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Macroeconomic Factor | Sensitivity factor | Additional Premium | Risk Premium |  |
| GDP Growth | 0.6 | 7% | 4% | 2.4% |
| Inflation | 0.8 | 5% | 2% | 1.6% |
| Gold prices | -0.7 | 8% | 5% | -3.5% |
| S&P 500 | 1.3 | 12% | 9% | 11.7% |

Adding up each value in the last column and then adding the result to gives a value for the asset of = 15.2 %.

The list a APT macroeconomic factors commonly used include the ones listed above as well as corporate bond spread, shifts in the yield curve, commodities prices, market indices, exchange rates, and a host of others. Basically, any factor in the economy as a whole that effects all assets should figure in as there is no way to mitigate these risks by diversification.

In the above example, the parameters were assumed a priori. In his article [Arbitrage Pricing Theory: It’s Not Just Fancy Math](https://www.investopedia.com/articles/active-trading/082415/arbitrage-pricing-theory-its-not-just-fancy-math.asp), Elvin Mirzayev walks through how to simultaneously solve for the s to get what we are really after, the intelligently-derived expected return on the asset. (CFI’s [Arbitrage Pricing Theory](https://corporatefinanceinstitute.com/resources/knowledge/finance/arbitrage-pricing-theory-apt/) has a similar example that complements the previous presentation – financial gurus aren’t often clear in their explanations and having multiple sources helps.) Once that is obtained, it is compared to the offered rate and, when the two differ sufficiently, the asset is ripe for arbitrage.

The Wikipedia article on APT and Mirzayev’s piece discuss the importance of developing a portfolio of assets against which to compare but these nuances, while important in the day-to-day implementation, don’t blunt the general idea of APT – namely that the value of an asset (as determined by its return) depends on various factors and can only be judged in relation to the market as a whole.

The CAPM differs primarily from APT by its use of a single factor (a single ) to capture the systemic market risk. This aspect of the CAPM means that it assumes markets are perfectly efficient. It isn’t as accurate but it is much easier to use and this one feature explains its staying power.

One final note, the devil really is in the details for much of this work. In particular, it doesn’t seem as if there is a well-known discussion of the numerical stability of these results. Given that the linear-regressions (typically multi-variate) are used to determine the betas and, consequently, the risk premiums, there seems to be room to determine just how much additional risk is buried within the algorithm. But that is a blog for another day.