Overview and introduction to chapters 1 and 2

Behavioural Finance did not develop in isolation. It developed in reaction to the limitations of traditional, rational finance theory. Therefore, chapters one and two of the Ackert and Deaves textbook give an overview of the evolution of rational finance theory over time. It discusses the assumptions that form the basis of rational finance theory and elaborates on the main rational finance theories, including the modern portfolio theory (MPT) and the capital asset pricing model (CAPM).

The historical evolution of finance theory

Economists have long been aware of the basic economic function of credit markets, but were not keen on analyzing markets theoretically, because early ideas about financial markets were intuitive, mostly formulated by practitioners. During the early period economists did not regard financial markets as proper markets, but more analogous to casinos, in which asset prices were determined by speculative activity, i.e. the purchase of assets exclusively for later resale.

John Burr Williams (1938) was among the first to challenge the casino view in a rudimentary way. He argued that the price of financial assets reflected the intrinsic value of an asset, which can be measured by the discounted stream of future cash flow from the asset. Harry Markowitz (1952, 1959) realized that as Williams' notion relied on future expectations, an element of risk (i.e. uncertainty) had to be included in a meaningful manner. The fundamental idea in Markowitz's theory of optimal portfolio selection combines risk and return concepts, by asserting that asset selection happens in the context of trade-offs between return (discounted future cash flow) and risk (uncertainty of expected outcome). This constitutes the basis of what has subsequently become known as "modern portfolio theory" (MPT).

Arguably the most important model to appear in the early 1960s, was the capital asset pricing model (CAPM) which solved the arduous mathematical calculation burden of

Markowitz's MPT. Markowitz's model made it possible to benefit from portfolio diversification, by calculating the covariance of returns of every pair of assets in a portfolio against each other. The CAPM of William Sharpe (1963, 1964) and John Lintner (1965) solved this calculation burden by demonstrating that the same result is achieved by merely calculating the covariance of every asset return with respect to a general market return (beta). By reducing the volume of calculations previously required, portfolio selection became a much more feasible option for practitioners who embraced CAPM.

Addressing some of the recognized limits of CAPM, Stephen A. Ross (1976) came up with "arbitrage pricing theory" or APT. Even though Ross developed the APT, he noted that the basic reasoning behind arbitrage theory was not his unique concept, but was the underlying logic and methodology of all of rational finance theory. Arbitrage[1] asserts that if the risk-return profiles of two assets are identical, the price of those two assets must also be the same, otherwise an arbitrage opportunity would arise, which would allow investors to earn excess profits by buying the under-priced asset and selling it at the higher price. Arbitrage assumes that investors seek to exploit any excess profit opportunities, and that prices adjust in response. When a security drifts away from its fundamental value, the actions of observant and sufficiently capitalized speculators will increase the demand for it. The greater demand will drive the price up, and thereby eliminate any excess profit opportunities. Arbitrage does not necessarily suggest that all investors are skilled and well-informed. However, it does assume that in well-developed, liquid capital markets, there are enough rational investors to ensure that a security's price equals its fundamental value, that prices reflect available information accurately, and that they thereby allow for the efficient allocation of capital. This point is evident in the theory of option pricing advanced by Fisher Black and Myron Scholes (1973) and Robert Merton (1973), who use arbitrage in their reasoning. Arbitrage logic was also used by M. Harrison and David M. Kreps (1979) and Darrell J. Duffie and Chi-

[1] Introduced by Stephen Ross (1976), arbitrage pricing theory (APT) in finance sets out that the expected return of a financial asset can be modeled as a function of various macro-economic factors or theoretical market indices. The model-derived rate of return can then be used to price the asset correctly. The correct asset price should equal the expected end-of-period price discounted at the rate implied by model. If the price diverges, arbitrage should bring it back in line. The two pillars on which behavioral finance theory was built (see chapter 3) were limited arbitrage and investor psychology.

Fu Huang (1985), and further developed in theories of general equilibrium in asset markets by Roy Radner (1968, 1972) and Oliver D. Hart (1977).

The work discussed up to this point contributed to the formalization of financial economics as a recognized sub-discipline of economics during the 1960s (Jovanovich, 2008:214). The integration of financial economics into economic science was accomplished through a synthesis of the results from financial econometrics, MPT and economic equilibrium[2]. This synthesis also established links between empirical results in finance and core ideas of equilibrium in economics. These links paved the way for the creation of theoretical explanations for empirical results.

Empirical results which did not fit the bill, and created a stir among economists, came from investigations by Working, Cowles and Kendall, all of whom suggested that asset prices over time tended to follow a random pattern or "walk". Holbrook Working (1934) and Alfred Cowles (1933) for American stock prices, and Maurice G. Kendall (1953) for British stock and commodity prices, found that no correlation existed between successive price changes on asset markets. If prices – as equilibrium economic theory states – are determined by the forces of supply and demand, then price changes should move steadily and without fail towards market clearing, instead of moving randomly. Serious efforts were initially made to show that the unusual findings flowed from a failure of traditional statistical methods in an attempt to explain what was actually happening. Time series methods were for instance applied by Clive Granger and Oskar Morgenstern (1963) to prove this, but their efforts produced results with the same randomness characteristics.

A breakthrough attempt to save mainstream economic reasoning started with Eugene Fama's doctoral dissertation at the University of Chicago (1964), which argued that, although the random walk hypothesis had to be accepted, this did not imply that the notion of market efficiency had to be rejected, with an accompanying rejection of the

[2] Jovanovich (2008:214) differentiates between financial economics – as a theoretical sub-discipline –- and mathematical finance, which can be identified as mathematics applied to finance, and financial econometrics, which can in turn be described as econometrics applied to financial data.

model of market equilibrium (i.e. the price setting mechanism) itself.[3] He argued that the findings of Working, Cowles and Kendall did not disprove the normal working of markets, but that they in fact worked all too well. The basic notion was that if price changes were not random (and thus predictable), then any profit-hungry arbitrageur could easily make appropriate purchases and sales of assets to exploit this. On the other hand, if markets were working properly, then all public (and some private) information regarding an asset would be channeled immediately into its price. If price changes seemed random and thus could not be forecasted, Fama argued, it was a result of investors doing their jobs very well: all arbitrage opportunities had already been exploited to the maximum extent.

This brief historical overview shows that the genesis and evolution of finance theory — in the second half of 20th century in particular — flows directly from the application of standard (albeit sophisticated) neo-classical economic reasoning. Such reasoning is premised on the explicit notion of maximizing behavior by the individual rational decision-maker as the only explanation for economic actions. It is to the characteristics of such rational decision-making that the next section turns. This will be followed by an extensive discussion of the application of rational assumptions in the theoretical evolution of the EMH, MPT and CAPM.

Neo-classical economics and the basic assumptions of rational finance

When building theoretical frameworks, academics have to make certain assumptions. When studying financial markets, assumptions are made about the motivations and preferences of market participants, and how these direct the functioning of financial markets.

The basic assumptions operative in finance theory can be summarized as follows:

[3] The term "efficient", as it is used here, merely means that agents are making full use of the information available to them; it does not refer to other types of economic efficiency, e.g. production efficiency.

(1) Market participants are rational: they aim to maximize a positive function (utility) and minimize a negative function (cost or risk). Market participants are also well-informed, and able to process new data correctly and rapidly. They are ultimately concerned with personal consumption, which is always the focus when evaluating the pursuit of financial wealth or well-being.

(2) Financial markets are efficient: all financial assets are perfect substitutes, and their traded prices reflect available information accurately and fully. A security's price equals its fundamental or intrinsic value, which is the discounted sum of expected future cash flow. Thus financial assets cannot be over- or under-valued, but are traded at their fair values.

These assumptions do require a clear definition of what rational behavior means. Mramor and Loncarski (2002) provided an explanation of what the rationality assumption postulates in financial decision models, namely:

Individuals behave in a completely rational way when they:

a) undertake financial decisions that maximize their welfare;
b) maximize welfare by maximizing the utility of consumption;
c) maximize the utility of consumption by maximizing the present value of consumption;
d) maximize consumption when the value of the investor's financial assets is at its maximum;
e) maximize the value of financial assets when:
    (i) expected returns are maximized,
    (ii) expected returns occur in the nearest possible future,
    (iii) the probability that expected returns materialize is maxim-ized (or risk is at its minimum);
f) manage risk by:
    (i) accurately measuring risk,
    (ii) being risk averse,

(iii) translating measured risk into added required return from an investment (or a risk premium), and

(iv) trading financial assets at prices that equate additional *expected* returns with additional *required* returns.

As background to a model of rational financial behavior, the first four postulates above (a – d) taken together can be summarized as: a person's welfare is maximized when consumption is at a maximum, which is achieved when the value of the person's financial assets is maximized. In a similar vein, the last two postulates above (e – f) taken together state: the value of financial assets depends solely on the interplay between their expected returns and risks.[4]

For the purpose of proceeding to a substantial discussion of MPT and CAPM in the latter part of this chapter, it is necessary further to explore some of the basic building blocks of rational finance theory as outlined above. What follows next is an investigation of the interplay between utility maximizing and risk minimizing by the individual investor. This is followed by a closer investigation of the model for the working of markets.

Market participants: decision-making

Assumptions about market participants are the foundation necessary to explain how financial/investment decisions are made within the boundaries of neo-classical economic thinking. Against the assumed context of rational decision-making, market participants maximize utility and minimize risk.

Maximizing utility

A long-standing maxim of micro-economic theory is that outcomes with a higher – rather than a lower – expected value are always preferred. John von Neumann and Oskar

[4] It is not the purpose of this study to critique the quality, nature and wider epistemological implications of neo-classical theoretical assumptions or models, or their application in finance theory. For the purpose at hand, they are explained and elaborated on as clearly and objectively as possible. Further discussion of what their influences are in the debate around the value premium will be provided below.

Morgenstern (1944) interpreted and presented a sophisticated axiomatization of the same theory. This became known as the expected utility hypothesis.[5] Expected utility implies that, when faced with uncertain outcomes, choice will be based on expected outcome. The idea of expected value is that, when faced with a number of actions, each of which could give rise to more than one possible outcome with different probabilities, the rational procedure is to identify all possible outcomes, determine their values (positive or negative) and the probabilities that will result from each course of action, and multiply the two to give an expected value. The action to be chosen should be the one that gives rise to the highest total expected value. Theorizing about the use of expected utility furthermore postulates that the decision preferences of people with regard to uncertain outcomes (such as in betting or gambling) can be described by a mathematical relation which takes into account the size of a payout, the probability of its occurrence, the risk aversion of the decision-maker, and the variable degree of utility of the same payout to people with different assets or personal preferences.

The practical application of the expected utility idea in the field of financial theory is that in order to maximize utility, individuals are assumed to assign utility values to competing investment decisions, by comparing the size of the benefit with the probability of that benefit occurring.

Minimizing risk

The dictionary definition of the word "risk" is "loss, harm, destruction or an undesirable event", which are all completely immeasurable. Rational finance theory made risk measurable and objective by defining it as "volatility". Volatility is commonly measured as the dispersion of outcomes around a mean – the historic average return on an investment. That average return becomes the expected return on that particular investment. Standard deviation and variance are most often used to measure the

[5] The formalization of the modern theory of choice under uncertainty begins properly with Wald (1939). Interest coalesced, however, around the expected utility models described by Von Neumann and Morgenstern (1944) and Savage ([1956] 1972). Expected utility became such a dominant paradigm for choice under uncertainty that research into alternatives remained inactive until interest in behavioral economics took off in the 1970s. (Blume and Easley, 2008). Also see "Rationality," in *The New Palgrave Dictionary of Economics*, 2nd edition.)

dispersion of the expected return.[6] Securities with a higher standard deviation are more risky. By interpreting "risk" to mean volatility, all the power of algebra could be harnessed for financial modeling, which is useful for a scientific model.

An essential assumption underlying rational finance theory is that rational people avoid risk, meaning that they quantify the variance and standard deviation on an investment, and base their asset purchasing decision on that objective value. An individual might have subjective or emotional biases, but these biases are seen as not large enough to derail rational decision-making. What is more, the decision-making process involving risk is not a multi-dimensional process with subjective (qualitative) aspects and objective (quantitative) components, but consists solely of objective components.

Integrating maximizing utility and minimizing risk

The two elements of maximizing utility and minimizing risk can be combined for rational decision-making. Such a decision-making rule can be expressed in a simple mathematical formula (e.g. as in Bodie et al. 2005:165), which combines the elements of expected return (the maximand), risk or volatility, as indicated by variance (the minimand), and willingness to take risk (represented by an index of the investor's risk aversion). Competing investment portfolios can thus be compared and ranked as to their net utility by applying the following formula:

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where: U = utility value; E(r) = expected return; A = an index of an individual investor's aversion to taking risks, ranging in value from one to ten, with the factor ½ a scaling convention with no economic significance; σ^2 = variance as indicator of risk.

Investments receive higher utility scores for higher expected returns, and lower scores for more risk or volatility, with all else remaining constant. More risk-averse investors

[6] The variance (σ^2) is the average of the squares of all the deviations from their mean, and the standard deviation (σ) is the square root of the variance. In finance the standard deviation or variance provides an investor with a quantitative indicator for assessing and comparing the risk of alternative investments.

(who have large A's) will "penalize" risky investments more severely than less risk-averse investors. When choosing among competing investment portfolios, investors can thus apply the rule rationally to select the portfolio that provides the highest utility level.[7]

Modern portfolio theory (MPT)

Merton Miller wrote that portfolio selection, as conceived and published by Harry Markowitz in 1952, could be considered the "big bang" of modern finance (Miller, 1999). In this ground-breaking work Markowitz systematically developed what became known as the risk and return trade-off in investment decision-making. For the first time, he mathematically derived a rule for the selection of portfolios of assets rather than individual stocks and bonds. Bernstein asserts that Markowitz's answers to the questions of 'how much risk' and 'how to minimize risk while maximizing expected gains' formed the foundation for all subsequent theories on how financial markets work, how risk can be quantified, and how corporations should allocate capital (Bernstein, 1992:43).

Description of MPT

The premise of this work is that because risk is central to the whole process of investing, risky investments must offer higher return to compensate investors for bearing extra risk. The most original component of this theory is distinguishing between the riskiness of an individual stock and the riskiness of an entire portfolio. Graphically, it can be expressed as in the figure below.

[7] Risk aversion obviously has a major impact on an investor's appropriate risk-return trade-off. In the formula, the utility provided by a risk-free portfolio is simply the rate of return on the portfolio, which provides a convenient benchmark for evaluating portfolios (Bodie, 2005:165).

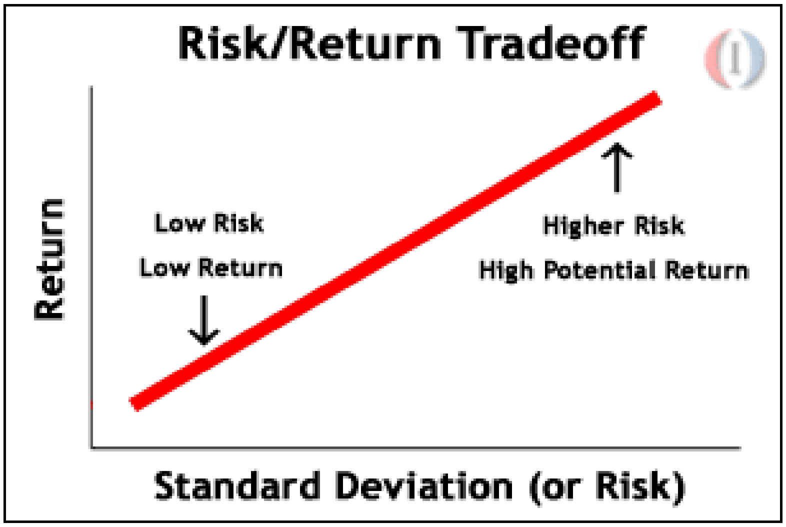

Figure 1: Risk return trade-off

http://www.investopedia.com/university/risk/risk3.asp

In Markowitz's theoretical analysis of how a portfolio could be formed rationally, an investor evaluates the degree of riskiness of each asset not just by its own risk level, but by the covariance of that asset's return to a portfolio of other investments. The theory subsequently explains why a combination of risky holdings may still comprise a low risk portfolio, as long as they do not change in an exactly parallel way – that is, so long as they have a low covariance. Through diversification, volatility in expected return (risk) can be minimized by including in the portfolio assets whose returns have no correlation with each other. Covariance — and not mere numbers of securities held — determines the risk-reducing benefits of diversification.[8] The absence of correlation[9] lowers the volatility in expected returns and thereby lowers risk.

Furthermore, a diverse portfolio, consisting of more than one category of investments that are not perfectly correlated, lowers the risk and increases expected return.[10]

[8] Seeing that the MPT is still highly influential, there are many current textbooks that address the MPT extensively. For a complete review see Elton, Gruber, Brown and Goetzmann (2007).

[9] Correlation is measured through a regression analysis. The correlation coefficient is the square root of the regression coefficient of determination (R^2). For a perfect fit, R^2 square is one and the correlation coefficient is also one. The closer the correlation coefficient is to zero, the better it is for portfolio diversification purposes.

[10] There are suggestions that the recent subprime mortgage crisis was brought about by exactly this technique. Subprime mortgages (high default risk investments) were grouped with good quality mortgages (low default risk investments) to form "structured investment vehicles" with low covariance (i.e. risk) but high returns.

Markowitz proposed a paradigm for dealing with choices which involve many possible financial instruments. With MPT, investors had for the first time a method to build an optimal distribution of financial instruments within a portfolio that would achieve the best potential trade-off between risk and expected return: *mean-variance analysis* as it became known.[11] It compared the expected (or mean) value of a portfolio at the end of the accounting period with its risk (standard deviation). What mean-variance analysis boils down to is to bring these two factors into systematic play in portfolio selection.

A portfolio's risk and return can be equal to more or less than the sum of its parts, depending on how the assets in the portfolio relate to each other. However, portfolios made up of assets with less than perfectly correlated assets always offer better risk-return opportunities than the individual component securities on their own.

Rational investors have a preference for more value rather than less value, but at the same time have an inclination for less risk rather than more risk. Yet, it is possible to gain more value by accepting more risk. This implies that there might be more than one optimal portfolio, depending on an individual investor's risk tolerance: some might aim for lower risk and lower return portfolios; others might be more aggressive by accepting riskier portfolios with an accompanied higher return. In combining assets in portfolios that provide the maximum expected return for different risk levels and the minimum risk for different levels of expected return, an investor reaches the efficient frontier. This can be graphically illustrated as below.

[11] Shortly after Markowitz's work appeared, the market created "index funds" – mutual funds that sought to hold all the shares in the market in their respective proportions. Such index funds or "passive" investment strategies are now followed by a large and increasing number of investors, particularly by U.S. pension funds.

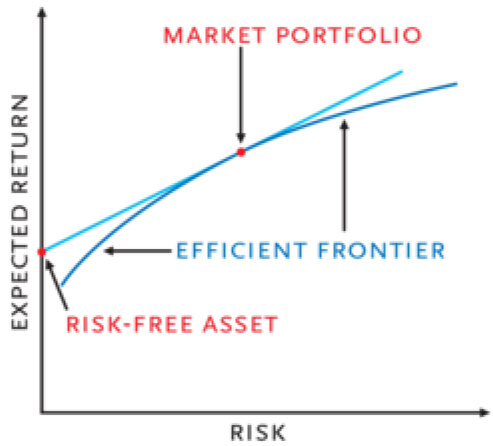

Figure 2: The Markowitz frontier

In the graph above, the line of expected return plotted against risk (standard deviation) is a straight line that connects all portfolios that can be formed using a combination of risky and riskless assets.

Every possible asset combination can be plotted in the risk-return sphere between the two axes shown in the graph, and all such possible portfolios define a zone in this space. The line along the upper edge of this region is known as the efficient frontier (sometimes also called the “Markowitz frontier"). Combinations along this line represent portfolios (excluding the risk-free alternative) for which there is the lowest risk for a given level of return. Conversely, for a given amount of risk, the portfolios lying on the efficient frontier represent the combination offering the best possible return. No added diversification can lower the portfolio's risk, and no additional return can be gained without increasing the risk of the portfolio. The Markowitz “efficient frontier” is therefore the set of all portfolios that will give the highest expected return for each given level of risk, from which a preferable portfolio can be chosen.

In mean-variance theory, choices among alternatives are based on the effect of the outcome on levels of their wealth; other considerations such as wealth fluctuations or framing (i.e. presentation) of alternatives do not affect choice at all. The decision-making process is assumed to involve a rigorous analysis (calculating the absolute mean, variance, standard deviation and kurtosis of the data distribution) to determine the likelihood of success associated with the specific investment decision.

The evolution of MPT

A basic feature of MPT is that for the calculation of expected return and risk (volatility) historic data is used. In effect, it measures the probable distribution of *ex ante* or potential future returns, based on what had happened in the past. The problem with this is obvious: there is no guarantee that what took place in the past will repeat itself in the future.

What is more, the additional assumption is that returns are normally distributed in the form of a bell shaped graph. It thus employs the central tendency idea, which means that potential returns will fit a normal distribution and will center round the average return. The bigger the dispersion of returns around the average return (which is the expected value) the bigger the volatility (risk). Put another way, MPT is limited by measures of risk and return that may diverge quite substantially from the realities of investment markets.

It became increasingly clear that the standard deviation and the normal distribution presented a major practical limitation because they are symmetrical. Using standard deviation implies that better-than-expected returns are just as risky as those returns that are worse than expected. Furthermore, using the normal distribution to model the pattern of investment returns, makes investment results with more upside than downside returns appear more risky than they really are, and vice-versa for returns with a predominance for downside returns. The result is that using traditional MPT techniques for measuring investment portfolio construction and evaluation frequently distorts investment reality.

In addition to the asymmetry issue noted above, one of the major challenges faced by MPT from its inception, was the monumental task of calculation it had necessitated: the covariance of every security with every other security had to be calculated to provide a mathematically clear result. The initial response to this problem was expressed in the work of W. F. Sharpe, a student of Markowitz. Sharpe eventually received the Economics Nobel Price for the following simplifying solution: It was not necessary to compare each security with all others, since the same result could be achieved by calculating the covariance of an individual security and the market as a whole – a much simpler calculation.

Maybe the main achievement of the MPT was not that it became (and remains) influential, but that it provided a testable theory of asset demand, a method for the practical construction of portfolios, and that it led to the development of the capital asset pricing model.

The capital asset pricing model (CAPM)

Description of CAPM

As indicated above, the ground-breaking introduction of advanced statistical thinking to investment decision-making presented by Markowitz's portfolio selection approach, provided a sophisticated mechanism for compiling an investment portfolio. However, it always implied an onerous calculation burden – something that made its application difficult and not popular with actual financial decision-makers. Although logically astute, MPT evidently required further development that would reduce the calculation load. Such development was provided, almost simultaneously, but through independent research, by Sharpe, Treynor and Lintner in the early 1960's. Their work subsequently became known as the highly influential Capital Asset Pricing Model (CAPM for short).

CAPM is a theoretical model for pricing individual security, and is used to determine what the appropriate rate of return for an asset to be added to a diversified portfolio is, given that particular asset's risk. Its core idea is that investors need to be compensated on the grounds of combining two considerations: (a) time value of money, and (b) market specific risk. The time value of money is represented by the first element in the formula below, representing a risk-free (R_f) rate of return. This constitutes a compensation to investors for placing money in any investment over a period of time. The second element in the formula below represents risk. The model is built on accounting for an asset's sensitivity to such risk which cannot be avoided through diversification (also known as systematic risk or market risk, and represented by the quantity beta, or β), as well as the expected return of the market and the expected return on a risk-free asset.

CAPM can be summarized in the following algebraic formula:

$$E(R_i) = R_f + \beta_i [E(R_m) - R_f],$$ where

$E(R_i)$ = the expected return on the capital asset;

R_f = the risk-free rate of interest (such as interest arising from government bonds);

β_i = the beta coefficient or the sensitivity of the asset returns to market;

$E(R_m)$ = the expected return of the market;

$[E(R_m) – R_f]$ = the risk premium (the difference between the expected market rate of return and the risk-free rate of return).

The CAPM formula essentially asserts that the expected return of a security (or a portfolio) should equal the rate on a risk-free security plus a risk premium. If this expected return does not meet or beat the required return, then the investment should not be undertaken. The security market line in the graph below plots the results of CAPM for all different risks (betas).

A graphical representation of CAPM can be given by constructing the security market line (or SML), the straight line in the graph below. For a single asset this shows its relation to expected return and non-diversifiable risk (or beta). It can be used to show how the market must price individual securities in relation to their category of risk.

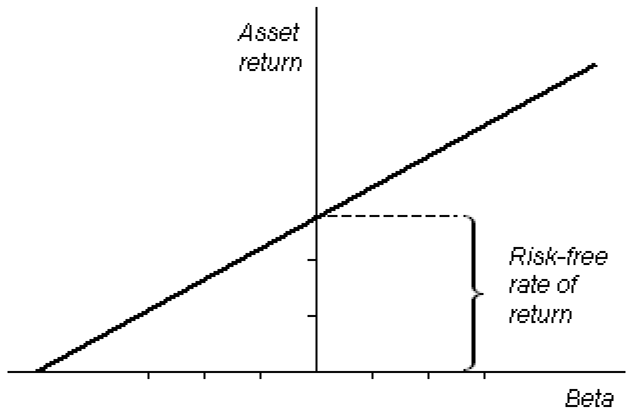

Figure 3: The security market line

SML enables the investor to calculate the reward-to-risk ratio for any security in relation to that of the overall market, and to make investment decisions on the basis of having appropriately priced asset choices. [12]

To calculate beta the following formula is applied:

where r_a = return on asset a

r_p = return on market portfolio p

Cov (r_a, r_p) = covariance between returns of asset a and market portfolio return

The value of the market beta is always = 1, because the returns of all assets trading in the market are perfectly correlated to itself. If an asset has a value of beta > 1, it is more risky than the market. For instance, an asset with a beta = 2 is twice as risky as the market, and its return will decline by twice as much as the market during a correction; it will of course also generate twice the return of the market portfolio during upswings to compensate investors for bearing the greater risk.

[12] When used in portfolio management, a single asset is plotted against the SML using its own beta and historical rate of return. If the plot of the asset falls above the SML it is considered to have a good rate of return relative to its risk (the asset is undervalued by the CAPM, and is worth acquiring), and vice versa: if it falls below, the asset is overvalued, and should be sold.

Markowitz's MPT, and the later CAPM, are closely related, in that both build on the same assumptions of efficient, competitive markets and rational, well- informed, and risk-averting investors. Furthermore, both models make the following assumptions: that all investors aim to maximize economic utility; cannot influence prices; can do unlimited lending and borrow under the risk free rate of interest; trade without transaction or taxation costs; and all information is simultaneously available to all investors.

The main difference between MPT and CAPM is that mean-variance analysis (the essence of MPT) provides a theory of individual behavior regardless of whether the market as a whole is in equilibrium or not. While CAPM also builds on mean-variance analysis, it assumes that asset allocation takes place in a market in equilibrium.

Reference list

Bernstein PL (1992). *Capital Ideas: The improbable origins of modern Wall Street*. New York: Free Press.

Black F, Jensen MC and Scholes MS (1972). The Capital Asset Pricing Model: Some empirical tests. In MC Jensen (ed.): *Studies in the Theory of Capital Markets.* New York: Praeger, pp. 79-121.

Bodie Z, Kane A, Markus A, Perrakis S and Ryan P (2005). *Investments*. Fifth Canadian Edition. Boston: McGraw-Hill.

Cowles A (1933). Can stock market forecasters forecast? *Econometrica*, 1: 309-324.

-------------- and Jones HE (1937). Some *a posteriori* probabilities in stock market action. *Econometrica*, 5: 280-294.

Duffie D and Huang C (1985). Implementing Arrow-Debreu equilibria by continuous trading of few long-lived securities. *Econometrica*, 53(6): 1337-1356.

Granger GWC and Morgenstern O (1963). Spectral Analysis of New York Stock Market Prices. *Kyklos*, 16: 1-25.

Harrison JM and Kreps DM (1979). Martingales and arbitrage in multi-period securities markets. *Journal of Economic Theory*, 20(3): 381-408.

Hart OD (1977). Take-Over Bids and Stock Market Equilibrium. *Journal of Economic Theory*, 9: 53-83.

Jovanovich F (2008). The construction of the canonical history of Financial Economics. *History of Political Economy*, 40(2): 213-242.

Kendall MG (1953). The analysis of time series, Part I: Prices. *Journal of the Royal Statistical Society*, 96: 11-25.

Lintner J (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics*, 47(1): 13-37.

Markowitz HM (1952). Portfolio selection. *Journal of Finance*, 7(1): 77-91.

------------ (1959). *Portfolio Selection: Efficient Diversification of Investments*. New York: John Wiley.

Merton RC (1973). Theory of rational option pricing. *Bell Journal of Economics and Management*, 4: 141-183.

------------ (1997) Applications of option-pricing theory: Twenty-five years later, *Nobel Lecture*. URL: http://nobelprize.org/nobel_prizes/economics/laureates/1997/merton-lecture.pdf. Last accessed: 9 July 2009.

Miller MH (1999). The history of Finance. *Journal of Portfolio Management*, 24(4): 95-101.

Mramor D and Loncarski I (2002). Traditional, modern and new approaches to finance. *Conference on Alternative Perspectives on Finance*, University of Hamburg. URL: http://www.departments.bucknell.edu/management/apfa/Hamburg%20Papers/Mramor.pdf.

Radner R (1968). Competitive equilibrium under uncertainty. *Econometrica*, 36(1): 31-58.

------------ (1972). Existence of equilibrium of plans, prices, and price expectations in sequence of markets. *Econometrica*, 40(2): 289-303.

Ross SA (1976). The arbitrage theory of capital asset pricing. *Journal of Economic Theory*, 13: 341-360.

Sharpe W (1963). A simplified model for portfolio analysis. *Management Science*, 9(2): 277-293.

------------- (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance*, 19(3): 421-436.

Von Neumann J and Morgenstern O (1944). *Theory of Games and Economic Behavior*, Princeton: Princeton University Press.

Williams JB (1938). *The Theory of Investment Value.* Cambridge: Harvard University Press.

Working H (1934). A random difference series for use in the analysis of time series. *Journal of the American Statistical Association*, 29: 11-24.