Risk and Modern Finance Theory: A Non-mathematical Analysis of Mathematical Models

Karen Helveg Petersen[1]

*Abstract***:** *Modern finance theory puts risk in the centre, but its interpretation is shaped by the wish to utilise the concept to create and defend high returns. If, e.g., the debt/equity structure of the firm does not matter, why not take on more debt so as to leverage overall return? The paper criticises the underlying mathematical-statistical assumptions of the most common models still taught in business schools for being based on a non-existing randomness in financial markets and a lack of true understanding of the drive, the time dimension and auto-correlation of markets. The models reviewed are partly contradictory, yet live side by side without mainstream theorists realising the inconsistencies. By pretending that ordinary asset risk can be diversified away, at most seeing the risks of markets as correlated returns, they moreover conveniently eschew incorporating systemic risk in their models. Comprehending systemic risk would require abandoning the predominant neoclassical, individualist bias.*

Key words: forward exchange, Tobin's *q*, Black Swan, normal distribution, tail end events, return and risk, risk-free rate, asset risk, market risk, *beta*, systemic risk, derivatives, options, hedging and arbitrage, hedge fund, Modigliani-Miller, efficient market hypothesis, portfolio selection theory, capital-asset pricing model, options pricing model, Gaussian copula function, value at risk, dark risk.

[1] About the author: Independent consultant (Radi-Consult), PhD (Econ), zkarenhelveg@gmail.com.

Definitions and terminology

Arbitrage: the purchase or sale of an asset or claim in order to exploit differentials. If a sufficient number of investors have discovered the differential, it will be diminished by their joint action.

Asset: in it broadest formulation any item of economic value or with the ability to generate economic value that may be owned by an individual or corporation or other legal person that may be converted to cash. Typically held because it yields a return.

Financial security: a title representing a claim on future cash flows. In the basic outline the intrinsic value is the present value of the cash flows the owner of the security expects to receive. The term covers both bonds and equities/shares, etc.

Forward market for foreign exchange: buying or selling foreign currency for execution at a future date at a predetermined price. Derived from this: forward exchange rate, etc.

Hedge fund: a fund set up to trade in narrow bands of price movements, very often of derivatives. The fund normally uses off-setting positions to cover itself, while assuming that it can exploit differentials of a certain stability that have not been discovered by others, typically by selling short against long positions. Many factors enter the calculations as other investors are aware of the most common differentials and reduce them by arbitrage.

Hedging: securing a current financial transaction by an off-setting position, e.g. if a seller of goods to be paid at a future date in foreign currency wants to guarantee a certain amount in own currency, she can hedge by selling the foreign currency amount at the given date for a known amount in own currency. This is typically done if the foreign currency is expected to depreciate. The hedging transaction has a cost. In http://www.investorwords.com/2293/hedge.html hedging is defined as ”An investment made in order to reduce the risk of adverse price movements in a security, by taking an offsetting position in a related security, such as an option or a short sale.”

Leverage: taking on more debt in order to increase gains, typically on equity.

Option: a derivative (a security with another paper as underlying asset) that permits the buyer to purchase a stock or other security at a given price (the strike price) before a certain deadline (a call option) or sell a stock or other security before a deadline at a given price (a put option).

Short sale: selling a security borrowed from a broker in order to buy it back at a later date. The belief is that the security can be bought back at a lower price than that at which it is sold. If the market experiences massive short sales, it can affect markets in a downward direction.

Variance and standard deviation: Variance is the square of the sum (or integral in a continuous function) of all the observations of a variable in a discrete function after deducting the mean from each of them. The square root of the variance is the standard deviation, a measure of distance from the mean. In a normal distribution 68% of all events lie within one standard deviation (*sigma*) in either direction of the peak at the mean. With two standard deviations in either direction away from the mean (which is normally standardized to zero), 95% of the probable events or values are reached, 3 standard deviations 99.7% etc. The very unlikely extremes are called tail end events.

Since their likelihood is computed on the basis of limited or constrained observations, the unlikely tail end event, if occurring, will upset the entire apparatus.

Introduction

Undoubtedly, the points raised in this paper will be known to many heterodox economists. Yet, even economists of a critical bent have little knowledge of modern finance theory taught in business schools. Thereby they unwittingly become victims of notions that are inconsistent with other parts of their thinking. The fact that wherever there is a seller there is a buyer sometimes makes even non-orthodox economists think that markets clear, forgetting that there are always goods and services that are not sold in a timely fashion or only with considerable loss. Markets are only mutual in a tautological sense, and tautology is definitional, not a reflection of reality.

Risk has become the centre of gravity of financial model building in developed markets. However, it is conceptually diffuse, and the question has been posed by authors such as Nassim Taleb (2007) and Pablo Triana (2009) if systemic risk (i.e. risk to the whole system) has not been either ill assessed or directly augmented by the use of the standard models. Taleb argues that all models use normal distribution properties with thin tails (i.e. little chance of the unlikely event) and Triana that models used by 'quants'[2] have led to nothing but meltdown by being used in computer trading systems with automatic triggers for margin calls. The first such meltdown in the markets happened in 1987. Against this they laud practitioners, who look at data and combine them with their common-sense view, honed by experience, of market developments and supply and demand and what else they have come to regard as significant.

These two critics are by no means anti-capitalist, not even anti-financial-market. They just think that models are anything but innocuous, rather they are dangerous playthings. Triana also argues that mathematical models tend to be used and developed at prestigious schools. Because of the quaint and difficult character of the models, the mastering of them is a badge of honour or entry point to the higher echelons of finance.

The core criticisms of the paper: how to calculate risk

This paper attempts to lay out in a systematic way the circuitous reasoning behind all the basic models that are still to this day taught in finance courses of MBA programmes. The basic line is to look for the link between return and risk and their connection with 'systemic risk'.

First of all the definition and measurement of risk in modern mainstream financial theory is examined. It is shown that its measure easily gets converted into its substance. If risk is the *sigma* (standard deviation) of expected returns around the mean or sometimes identified with *beta* expressing how the individual asset return varies with a portfolio of assets (see below), then these measures are in fact assessed by past data. That there is a historical bias in risk assessment is well known, yet since these are the only data that exist, features of middle-aged risk theories, which have been translated to standard computer models, are still in use. Despite our culture's predilection for wild literary and movie fantasies about unknown risks in unknown planetary or future

[2] Quantitative analysts specialize in developing and analyzing computer models built on select mathematical theorems of market relations and feed them enormous amounts of data, thereby exhibiting a mechanistic view of market relations. Quants also gather 'fundamental' data, depending on their particular models. Therefore they are not necessarily purely technical analysts who search for recurrent patterns, perhaps through fractal financial analysis, which does not consider fundamentals, such as earnings, reports, etc., but simply scrutinizes trends and patterns. Fractal analysis has the added feature that 'the big can be found in the small'.

environments, only known risks of manageable impact are assessed in finance. In other areas, too, *vide* that the extreme earthquake event plugged into the risk model of the Fukushima nuclear power plant in Japan – no doubt with a suitably low frequency assignment – reportedly amounted to no more than 7 on the Richter scale despite the fact that at least four other earth quakes after World War II amounted to more than 8. The 11 March 2011 quake measured 9 and was followed by a tsunami. A known risk that is immensely dangerous will either not be included or assumed to be extremely unlikely so much so that it can be assumed away.

Many models and even traders suppose that there is a movement towards uniform prices, such as is happening in arbitrage. Also hedge fund managers traditionally operate on the notion that differentials will be eliminated. However, market traders often take positions that do not assume that differentials will disappear because they try to grasp factors that may come to influence the future. Most traders also hold that volatility cannot be measured mechanically by past behaviour. That the predictions of models are what markets move away from and only touch tangentially and by chance has challenged financial models ever since their introduction.

Fundamentally, the criticism is that 'risk' is used to domesticate the unknown by pretending that it can be calculated. Moreover, it is implicitly assumed that 'risk' is exogenous, not generated endogenously by the joint actions in the market creating its own systemic risk. Financial risk theory either uses data necessarily of the past or information giving vent to new expectations. Although there definitely is a trend, the past is not a reliable guide to the future, and expectations show nothing more than the joint (faulty) perceptions in the market. And curiously, these expectations are sometimes radically blown off course. By trusting standard models for data entry, fortified by joint market action, systemic risk was in fact augmented in the lead-up to the crisis in 2007-08. Models also have an ideological function by justifying that high returns are achieved because of taking on laudably high 'risk'.

John Maynard Keynes questioned the idea of assigning probabilities to the economic-financial world. We cannot know with certainty what probability to assign even to known potential events, let alone those about which we can know nothing. In this way Keynes undermined the mathematical-statistical basis of modern finance theory from a philosophical angle. Something observed in the past may not occur in the same way in the future. At a macro level he substituted uncertainty for risk, claiming that uncertainty is that about which we can have no idea, such as a future sudden shift in the political or economic landscape. Uncertainty on the other hand has become a modern-day truism, accepting that a crisis is exogenous and unpredictable, except in general terms of presentiments that a financial-economic crisis will come.

Notwithstanding the risk-return-pair prescriptions on incorporating risk in return, risk in a true sense involves events that are disliked or feared. The problem is that many risks are not perceived. Therefore it is a bit strange that Keynes saw uncertainty as a stronger category than risk. The most interesting point is that uncertainty pertains to the very weights with which we assign probabilities. This process requires that the 'densities' of outcomes have a certain form. Using the normal distribution simply means discounting imaginable events that *seem to be far out* by modelling them so that they are far out. If they are not thought of, they are not there. If one such event then takes place, it is a black swan, as has been popularized by Taleb (2007).

This paper also sets out to explain how and to what extent the following Karl Marx quote can be brought to bear on today's financial markets, "Another example is how capital investments that are exposed to greater risk, as in shipping, for instance, receive compensation through increased prices. Once capitalist production is properly developed, and with it the insurance system, the risk is in fact the same for all spheres of production (…); … those more endangered simply pay higher insurance premiums and receive these back in the price of their commodities. In practice this always boils down to the situation that any circumstance that makes one capital investment less profitable and another more so (…) is invariably taken into account as a valid reason for compensation, without there being any need for the constant repetition of the activities of competition in order to demonstrate the justification for including such motives or factors in the capitalist's calculation." (Marx 1991: 312). What Marx says is that risk is externalised in a risk premium paid for insurance and recovered in the price of the product. On the other hand, he is in line with the actuarial type of thinking in clearly expressing that risk is a random event that in experience occurs with a certain regularity. In this he resembles newer risk theorists who however have stretched the concepts beyond the risk of shipwrecks or perhaps pirate attacks.

However, Marx does not condone the type of risk-return calculation where risk gets a reason for successfully claiming a higher return. In this he differs from modern apologetic risk theory. The inference of the quote is that a doubling often takes place in terms of return. A modern example is the treatment of risk in foreign direct investment in the developing part of the world. The idea has won currency that these investments not only are more expensive, but also so risky that they merit extra return. Therefore, first investors want a contractual return that will be included in the price of the product and this return should be even higher than a normal return. To ensure this they require the beneficiaries to guarantee their off-take (take or pay), e.g. on gas pipelines, and finally they want low-interest loans and all types of guarantees (export, commercial and political risk) preferably through an international public institution. Capitalists and their MBAs are good at finding reasons for doubling up. Thus the question is if the assumed positive correlation between risk and return becomes a self-fulfilling prophecy as shall be argued from various angles in this paper.

Fundamental asset market characteristics and theory

Financial assets are claims, certified in legal form, on the floating return of a company or directly as an instrument issued as a debt but which becomes an asset for its owner with a fixed coupon yield issued by the Finance Ministry or the Treasury in the case of government debt. Selling and buying in organised form goes back a long way. Stock exchanges were set up in 1697 in Threadneedle St. in London and in 1792 on Wall St. in New York. Whereas government bonds are closely related to the monetary system and as major instruments can be traced back to the government consolidated debt (consols) paying fixed, often perpetual annuities in 17th century in England (Ferguson 2001: 111), shares are typically claims on future returns of a private capitalist company.

Certain asset classes developed: stocks, bonds and the market for foreign exchange (especially in periods dominated by floating exchange rates). These markets were originally built up around 'real' capital, government debt and foreign trade. Mortgages and eventually a complicated housing finance market derived from titles to real estate can be added as well as commodities trading that inaugurated the futures market. Financial instruments were designed around the characteristic features of the underlying markets, stocks were priced according to profits, bonds around the confidence in the government, mortgages had security in the underlying real-estate asset that had a long life span, and therefore mortgage finance was fitted to a long time horizon. In the commodities markets agricultural products that were yet to be produced were sold at a future date against a current financial contribution to the purchase of inputs. Money markets grew up to deliver the funds as counterparty to the instruments.

Financial instruments, however, have developed and crossed these original markets. There are now bonds based on future utility income streams, mortgages have been assembled to bonds and convertible bonds cross over to equity. On the basis of these instruments derivatives have been created, i.e. purely financial instruments dependent on other assets or claims. These instruments became traded in secondary markets and markets started to have their own movements in day-to-day trading that could not be directly traced back to underlying economic reality. In addition, it became more and more relevant what the future would hold and thereby the link to anything real was further severed. This was the final push into models that dealt in ‘papers’ and ‘market’ assets.

Schools of thought have developed around macro relationships between typical financial instruments in the capital market. Most economists think that the firm’s stocks are representing the firm so that the two are identical. In the Keynesian tradition, the Tobin[3] q is defined as the factor, which allows for a valuation of physical capital in the numerator different from its reproduction costs in the denominator. Q is sometimes in popular financial journalism seen as a measure of the over or undervaluing of share prices. The announcement for awarding the Nobel Prize to Tobin did not mention q directly, neither did it say that there was a question of undervaluation or overvaluation of stocks at stake. It wrote as follows, “By designating the channels of contact between financial and real phenomena, Tobin has indicated, theoretically and empirically, the effects of changes in the real value of financial assets on the volume of consumption. A particularly important aspect is the analysis of factors that affect firms’ real investments. Tobin has succeeded in reformulating an earlier hypothesis that these investments are strongly affected by the relation between the market value of existing real capital and the acquisition cost of corresponding, newly-produced real capital. If the prices of existing real capital, such as share prices, decline when the acquisition costs of new real capital are given or rising, then investments are counter-acted. This relation is confirmed by recent development in several countries”.[4]

It is obvious that the Committee confound the prices of existing real capital and their share price expression. In the denominator should be put the value of existing productive capital assets[5], rather than the newly-produced capital goods. The relation between the existing capital apparatus and stock prices should be held up against the value of newly produced capital goods and its prospective return. T&B seem to be deliberately vague, “Another way to state the same point is to say that investment is encouraged when the market yield on equity r_K is low relative to the real returns to physical investment” (Tobin and Brainard 1968: 104). There is a positive outlook for investment when $q > 1$, and factors of production will be moved to investment goods. (Tobin and Brainard 1968: 104).[6] This theory is often generalized to the whole market for firms and their valuations on the stock market.

Such macro finance theory has not been developed much by modern finance theory. Instead, micro-based theories have come to dominate. This may be explained by the fact that the macro theories

[3] James Tobin (1918-2002) who was awarded the ‘Nobel Prize’ in economics in 1981.
[4] See http://nobelprize.org/nobel_prizes/economics/laureates/1981/press.html.
[5] And here it is discussed if it should be just depreciated historical book value or book value readjusted to current prices.
[6] Q is not directly defined in the 1968 article, but the relationship is.

were basically Keynesian in their origin, and Keynesian theory was essentially ignored by finance departments of MBA programmes.

Financial models

It is practically taken as a universal truth by even devout critics of many risk models or theorems that risk and return are positively correlated. Often the risk taker is admired and the high return seen as just. As return influences asset pricing, by extension risk and asset pricing are also related. Models are therefore not only about risk but also about asset pricing.

Empirically, when it comes to equities, the tendency is that when the return on stocks rises, so does the equity price. Better profits of a business incorporated in a high dividend yield signal that the business is improving, and therefore the price of the stock will increase. In bubbles the return itself can be based purely on capital gains expectations so price increases become part of a circular movement.

Bonds have three variables in their pricing, coupon yield, time to maturity and the relevant interest rate with which to discount the returns as per the maturity. When the interest rate used in discounting future income streams increases, the price of the bond goes down so that the coupon yield adjusts to the market interest rate – in the basic outline, which to a large extent still reflects market behaviour.

If the interest rate rises, it will also have a depressing effect on the equity price,[7] but since the dividend yield is adjusted according to business profits that are less directly linked with interest rates, equity prices do not act in conformity with bonds whose price moves inversely with interest rates. Just therefore stocks and bonds are innately different.

The increasing model abstraction and wish for predictions can trace their origin to the arbitrage and hedging in the forward market for foreign exchange that developed after the first World War because of increasing complexity and uncertainty, not least after sterling left its gold base for a period.[8] Keynes (2000) showed in *A Tract on Monetary Reform* first published in 1924 the basic relationship between the market for foreign exchange and the interest rate. Translated to modern equilibrium models it has been reduced to equating the premium for foreign exchange (one currency as per another) to the relevant interest-rate differential between the countries of origin. Keynes maintained that the deviation from this parity would show the preference for holding one of the currencies. Thereby the equality behind the calculations was a benchmark rather than a reality. Given that both the interest rates and the exchange rates depend on more variables, one equation cannot solve this. Even if interest rates in two countries are relatively stable, still the forward

[7] Keynes says in a footnote to *The General Theory*, “In my Treatise on Money (vol. ii. p. 195) I pointed out that when a company’s shares are quoted very high so that it can raise more capital by issuing more shares on favourable terms, this has the same effect as if it could borrow at a low rate of interest. I should now describe this by saying that a high quotation for existing equities involves an increase in the marginal efficiency of the corresponding type of capital and therefore has the same effect (since investment depends on a comparison between the marginal efficiency of capital and the rate of interest) as a fall in the rate of interest.” (Keynes 1970: 151, footnote 1).

[8] As always, there are prehistories. Some see Louis Bachelier as the first theoretician performing a ‘rigorous’ analysis of, in fact, options as far back as 1900 (see Jones and Netter 2008). Bachelier is quoted as having said that “The mathematical expectation of the speculator is zero.” (Bernstein 1996: 200). This is taken to mean that there is no extraordinary gain to be had. If this were so, and all realised it, markets would indeed only ‘allocate’ capital for investment.

exchange rate (see definitions and terminology) may move because other currency-rate determinants are at play than one interest-rate differential. It is true that interest-rate differentials deliver the basis for foreign-exchange hedging through the forward market, but there is a difference between benchmarks used to hedge exposure in foreign-trade business dealings and a theoretical model for financial trades which, despite the theories stating that excessive gains cannot be had, tend to be motivated by such gain. In addition, when looking at actual pricing, there is always a residual that is nowadays attributed to volatility rather than preference.

Risk, return, asset pricing, capital structure, i.e. the composition between own financing, share and bond financing and volatility have come to be the core concerns in developed financial market theory after the Second World War. The mathematical financial models putting them together date back to the fifties. The theorems take their point of departure in the investor (individual or firm), who wants to obtain high returns or to secure funding and does not try to assess the impact of the individual actors' collective action back on to the market itself. Models to assess market risk in terms of potential gains of a portfolio are a newer breed but they are still based on the individual actor or partial market. The theories only concern choices between financial assets, only indirectly real investment. At most the models deal with the financial structure of the firm. All along, financial instruments themselves have developed, moving further away from 'real' business. More recently the interest has shifted to the investment bank or capital fund dealing in derivatives or structured instruments.

A long history of mathematical-statistical developments were a precursor to financial models, see Bernstein (1996). The easiest examples are always those obtained by casting a die where there is one sixth of a chance that the next throw will result in a one, two or any other number of eyes up to six, unless it is skewed. If you roll the die any number of times, there is a 100% chance that you will hit any of the numbers proportionally. This is a uniform discrete distribution not typical of events in financial markets.

In a casino gamble you put a wager on a certain outcome. First you think of the chance of winning or the risk of losing on that number and by how much. If you have a larger sum, you may put a proportion on a number all the time and will win sooner or later, but what you win depends on what sums others put up and how the gambling house counts its own winnings. Of course you may hope for an extraordinary luck or that other people put in higher stakes than you so that you can gear your winnings. This is approaching risk used in the sense of: what can I win, what is the downside and what are the respective chances of each. Often examples of this nature are used to illustrate the more complex problems related to continuous distributions.

The most well-known and used continuous distribution is the normal or Gaussian probability distribution function. Like other distribution functions it operates with the expected value as a theoretical concept of the "true" value of the variable. With an increasing number of observations one gets a sharper and more precise estimate of the expected value of the variable. If the observations cluster together in a bell curve around their mean, the characteristics of the normal distribution density function are then accepted and probabilities of future events are assigned accordingly. If the data turn out not to fit, they are assumed to be abnormal, rather than the result of a wrong model specification.

Rolling dice or flipping coins is not an apt model for risk, even for so-called discrete events. If risk is the avoidance of a feared event, you will want to be absolutely sure that you do not hit a dreaded result. It is ridiculous to say that at any moment either markets crash or they don't, let's say every hour. But this is what is sometimes implicitly done with serious events such as nuclear power plants. An MIT paper recounts that between 1957 and 2002 with more than 100 light-water reactors built in the US, there had only been one reactor core damage accident (Three Mile Island). Therefore the core damage frequency of U.S. reactors was 1 in 2679 reactor-years on average! (MIT 2003: 48). Note by the way that it is assumed that reactor-years are unqualified, i.e. homogenous, but nuclear reactors may build momentum over time. Others might say that on average 1 out of 100 reactors broke down over twenty years and they were not even all in place over the whole period.

In the above example it is implied that either a core reactor crashes or it does not, as if the latter were an event in time. How often does a reactor core not crash? Or can it be graduated? The absurdity continues if one queries why it should be reactor-years we are discussing. Why not reactor-days or hours? The 'probability measure' of an event influences the calculation unless we have large numbers of events that tend to fall naturally either way or in continuous ways. Stated differently: the underlying probability distribution is not scalable since its measure changes the probabilities. Or at least, the frequency is a tricky measure that should not be translated into probabilities. It would clearly be absurd to convert the pseudo frequency of nuclear reactor core damages into a probability governing expectations within a given time unit, such as a 1/2679 probability of damage in a reactor-year or 1/977835 in a reactor-day. A worker of a nuclear power plant could go to work every day with a carefree mind if this were so. Such reasoning is often seen in public debates and the media, and the MIT paper comes perilously close. For probability to make the slightest sense there must be a recognizable and sensible distribution. The nuclear power plant example should be enough to scare your pants off in more senses than one.

Taleb (2007) suggests other ways of approaching probability, through scale-consistent fractal analysis, in order to compute and order the magnitudes at stake, but without regarding it as a fireproof tool and always with a realisation that all models violate reality. His particular preference for fractal analysis lies in the fact that, in contrast to the Gaussian normal distribution, it does not assign exponentially decreasing probabilities to events that are assumed to be further away from the average. Instead probabilities are scalable, i.e. multiplied by the same factor, to be fitted case by case through empirical data. However, this does not take care of the absolutely dreaded event that should not happen.

Asset pricing and risk

Efficient-market hypothesis

The most well-known and in recent years increasingly maligned theory is the *efficient-market hypothesis* (EMH) attributed to Eugene Fama in 1970 but based on earlier work. It proclaims that markets instantaneously incorporate relevant information (including fundamental information). Seen from the present, the future is a random walk, up or down. The hypothesis in its strong form supposes that you cannot beat the market, i.e. get excess return, except by gaming the system or monopoly power.

In its semi-strong form it implies that if you use all publicly available, information is reflected in expected returns correctly, there can be no extra gain. "The assumptions that the conditions of market equilibrium can be stated in terms of expected returns and that equilibrium expected returns are formed on the basis of (and thus "fully reflect") the information set Φ_t have a major empirical implication – they rule out the possibility of trading systems based only on information in Φ_t that have profits or returns in excess of equilibrium expected profits or returns." (Fama 1970: 384-385).

In its weak form the information at stake is relative to the firm and its market, and it is assumed that since all available information is included, the resultant price will not give a hint to what the future brings. The weak form means that all information of past performance is already incorporated. Therefore its popular version claims tongue in cheek that a monkey throwing darts is as good as a professional stockbroker with respect to future asset prices. What happens is unforeseeable, implying that markets are determined by exogenous events. This version of the hypothesis supposes that the market or its individual papers are not correlated with their past performance, i.e. build on the past.

The hypothesis does not rule out analysis of fundamentals, on the contrary, information on the firm, its prospects, market movements etc. are part of the information sets in question so the level of prices are set outside the theory which is thus only about the predictability, market uniformity of movements and the formation of average returns. You as investor are omniscient with respect to the past and present and have correctly assessed the future from the information available because present prices reflect expectations. Apparently you and all others act in unison or along a certain typical distribution (essentially the same thing). To note also that there can be no internal disequilibrium between what the individual does and what she expects the market outcome to be and what the market results in today. It shares the type of reasoning common to economic theory: if markets had not priced and distributed assets efficiently, somebody could win by arbitrage. Conversely, if there were arbitrage, there would be disequilibrium. But returning to reality there is ongoing and continuing arbitrage despite the fact that people settle deals. According to EMH the story should be finished once deals are settled although it concedes that there may be different speeds of adjustment. However, it does not directly confront the often-observed fact that the predictions of the future markets are far away from actual outcomes. Rather it would claim that these deviations are due to new information or events. Efficient markets assess risk and fundamentals in unison. And one outcome of the model is that it is difficult to beat the market.

The EMH excludes two notions: using the past to predict the future and consistent disagreement about how to incorporate 'information'. With the tendency to ensure the efficient outcome, EMH is in line with Bachelier's statement that no extraordinary profits can be had. However, EMH does not openly say that the outcome is that markets allocate capital efficiently to enterprises, but this is often implied when ordinary people opine "markets are efficient".

In the seventies and eighties a number of studies purported to prove this theory. A famous book was devoted to demonstrating the validity of the 'random walk' as it is often called (Malkiel 1973). See Cooper (2008) for a criticism of this hypothesis in its strong and weak form, broad and narrow sense (does it mean that prices are really correct, markets stable and yielding acceptable results for all as is assumed by extreme liberalists or just that stock markets incorporate information, which is obviously true?).

If markets behave according to EMH, there would be frequent large more or less equal swings up or down since an investor would tend to react quickly in either direction, but papers do not react all at once but have upward or downward momentum within which news is incorporated. A number of studies have been carried out to this effect, and in recent years it has become patently evident that markets are indeed auto-correlated. Empirical studies too numerous to mention, e.g. *The Economist* 2011, have shown this. Markets show herd effects, markets have momentum. By 1991 even Fama himself realised this. Worse, other mainstream theories in fact also suppose trends despite living happily side by side with EMH, which thus has become a mere void or a postulate.

Another implication of the theory is that it can only be tested by showing what prices should be if all information were indeed incorporated properly. This would mean using a normal asset-pricing model. Doing so shows that information was not included properly by the market, rather stocks have been under or overvalued for long stretches at a time (Henwood 1998: 166). Furthermore, it can also be shown that through interaction patterns with interest rates, stock moves can be used as predictors of turns in the market (Henwood 1998: 166-167), a phenomenon that is exploited by technical analysts.

Moreover, one thing is that it is difficult to beat the market, but what is the market? The theorem implicitly assumes that when everybody is aligned, then the market is not beaten. However, perhaps investors themselves create the market. Bubbles are left undetected by adherents of the EMH.

Modigliani-Miller theorem

Franco Modigliani and Merton Miller (M-M) in 1958 formulated the theorem (*Modigliani-Miller theorem*) that the value of the firm is independent of its capital structure, i.e. the proportion of debt and equity. Or rather, strictly speaking, what they try to prove in their *first proposition* is that the "*average cost of capital to any firm is completely independent of its capital structure and is equal to the capitalization rate of a pure equity stream of its class*[9]*,*" (M-M 1958: 268-269, M-M italics). They not only assume that there are typical asset classes but also that equities and debt are perfect substitutes. Therefore the average cost of capital is equal to the capitalisation rate of a pure equity stream. M-M fortify the argument by saying that a levered company cannot command a premium over an unlevered company because, if so, investors could lever their portfolio by borrowing on their own account. It is as if investors' own portfolios are complementing leverage in firms so as to bring balance back. So there are active movements towards this result, along with arbitrage thinking.

The *second proposition* in the 1958 paper allows for some effect of actual leverage on the return on stock. It says, in a slight transcription, that the expected yield of a share is equal to the capitalisation rate (expected return divided by price) plus a premium equal to the spread between the capitalisation rate for a pure equity stream in the class and the interest rate on debt times the debt-equity ratio. This means that if more cheap debt in terms of return (i.e. the perfect substitutability is left out) is taken on, equity holders will demand a higher return, with the effect that the cost of capital will converge on that of a similar unlevered firm. For this to hold, investors should be able to claim a certain rate of return, a highly dubious feature in real life despite all the current talk about 'shareholder value'. The rate on debt may increase with leverage, M-M admit, but they hurry to whisk the objection away by repeating the contention that the average cost of all sources of capital will still be independent of leverage.

[9] M-M divide "firms into groups within which the shares of different firms are "homogeneous", that is, perfect substitutes for each other." (M-M 1958: 266).

The *third proposition* of the M-M paper says that, “the type of instrument used to finance an investment is irrelevant to the question of whether or not the investment is worth while.” (M-M 1958: 292). What M-M here state is the rather obvious proposition that a firm’s saleable output give the valuation of the firm. They admit, on the other hand, that there may well be reasons for preferring one financing type rather than the other. And also, can be added, that once a firm is on the block, its sales price has to do with its concrete obligations. In the market it is well known that dividends are not the same type of obligations as the repayment of debt. Equities can be manipulated a lot easier by management between retained earnings and dividends or concealed in depreciation or whatever. Thirdly, different firms and people do have different borrowing conditions.

The M-M paper (1958) makes clear that the authors knew of a number of conditions that should be fulfilled for the model to hold, e.g. that bonds are in fact equal to debt issued by households and yield a constant income, investors and households can borrow at identical interest rates, and bonds and stocks are traded in perfect markets (M-M 1958: 268). Since these conditions are barely detectable in real markets, the theorem is not useful for practical purposes. A number of assumptions beyond these conditions are also not realistic: investors demanding a certain return on equity – given that this return is a result of future events about which investors can only speculate, etc. But there seems to be a flaw in the reasoning even on its own dry terms: shouldn’t it be the equity-debt ratio in lieu of debt-equity ratio that is part of the second proposition? By stating ‘debt-equity ratio’ the authors have already anticipated their conclusion by letting a higher proportion of debt be offset by a higher equity return. A causal relationship is implied: if you take on more debt, your investment is more risky, and investors will want a risk premium on their equity. This means that there are two equity returns, the pure one and the required one. Since the risk premium means that debt is assumed to be risky, the interest rate on debt will go up in the next round.

The M-M theorem becomes patently absurd when it is combined with the race to leverage that was so characteristic of the recent market run-up to the financial crisis. In modern markets leverage is used to drive up returns on equity by exploiting any differential that can be found. In the second place, again in the famous real world, should the return on equity thus increase, this will have further consequences as the capitalised value of the return on equity relative to debt may increase, and the value of the firm will change up to a point. This is because of the interaction between return and equity valuation as stated above. Proposition II contradicts Proposition I. This criticism shows something characteristic about these models: the lack of willingness to see the dynamic context in which traders operate and how the world reacts. In fact one suspects that the authors use equities to both be a part of the capital structure and the outward representation of the firm so that their return is all that matters. No matter, a highly leveraged firm may be a danger signal even though a risk premium is ‘required’ or obtained on equity.

Franco Modigliani received the Nobel Memorial Prize in Economics in 1985, both for his life-cycle hypothesis of savings and contribution to M-M. Along with the objection above about seeing equities as part of the capital structure and the whole, the press release on the awarding of the prize stated about the M-M theorem, “It further implies that average capital cost is independent of the volume and structure of the debts and equal to the expected return on investment in shares of firms in the same risk class.”[10] The press release does not seem to see this as critical.

[10] See http://nobelprize.org/nobel_prizes/economics/laureates/1985/press.html

It is perhaps understandable that the M-M contribution was cherished because it reduced different phenomena to the same formula, thereby whisking away the risk of leverage. However, M-M thought themselves up against the hypothesis that the value of the firm increases with debt. To this is to be said that one should distinguish between what may be the case ‘fundamentally’ and market behaviour. The truth of the matter is that markets have chased leverage and thereby gained in return. The market is less concerned about the value of the firm as such. A highly leveraged firm will decrease in value, depending on the obligations that are outstanding compared with its earning potential in terms of its output. But this discussion is not really engaged in, except in the form that they admit that with high leverage the yield on equity may fall. They do discuss the impact of taxation, on the other hand.

Portfolio selection theory

Harry Markowitz developed the modern *portfolio selection theory* (PST) already in 1952. Its tenet is diversification of assets to minimize risk. The introduction of variance/standard deviation and co-variance (when more than one variable or asset is involved) in risk theory is commonly attributed to him. The higher the variance around the mean of an asset, the more difficult to foresee its price since it could at any particular time be far away from its average return. This way of looking at it supposes that there are expectations of the return on assets that can be used to rank them in relation to each other. Finally, a range of expected values as per variance denoting risk are determined, ”The E-V rule states that the investor would (or should) want to select one of those portfolios which give rise to the (E, V) combinations indicated as efficient in the figure; i.e., those with minimum V for given E or more and maximum E for given V or less.” (Markowitz 1952: 82). Since E = expected return and V = variance, it says that an investor can calculate a combination of the two and select a portfolio that suits her accordingly.

The idea that developed was that co-variance should be minimized and then it is up to the ‘utility function’ of the investor to choose, reflecting whether she is a risk taker or risk averse. In actual practice the Markowitz theorem has been used as a justification of a diversified portfolio, perhaps more as a way of admitting that since most investors do not know variance or expected return, one has a better chance of a fair outturn if one does not put all eggs in one basket, to state it colloquially (as it is often done). Following the advice would also imply that the papers selected should have no obvious co-movement or relation to each other.

An immediate objection is that since Markowitz does not specify the securities he includes, expected returns are either guaranteed – bonds with a fixed coupon (here not including the, effect of bond prices on market return) – or the investor may have expectations that are wrong, independently of other assets or of co-variances with them. The PST was given as justification for his sharing the Nobel Prize with Merton Miller (who was quoted for his contribution to corporate finance) and William Sharpe (for CAPM, see section below) in 1990.

According to Markowitz not all stocks give the same return because of their different risk profiles, i.e. the market is segmented.

Expressly attributing the theory of ‘volatility equals risk’ to Markowitz, Triana (2010) claims that volatity measured by standard deviation of past returns has failed dismally in the recent crisis as toxic assets had either been doing well, in the upturn, and then turned completely sour. “With volatility ... all you have to do is find a historical time series containing nothing but good news for your standard deviation number to be very modest. Going back three years does not yield a volatility figure tame enough? Just go back six years, since between year six and year three turbulence was negligible."

Capital-asset pricing model (CAPM)

William Sharpe's claim to fame was a development of this. Building on Markowitz he and John Lintner, Jan Mossin and Jack Treynor he developed the *capital-asset pricing model* (CAPM). It is a further development of the PST with the innovation of the market rate of return, i.e. combining risky assets into one. This has been used in many ways. Among others, if sufficiently diversified internally, individual unsystematic risk can be eliminated in a portfolio.

The original Sharpe paper (1964) starts out with the investment in a paper with a risky return and another with a risk-free return (bond with fixed coupon e.g.). Investors have homogeneous expectations about the risky asset and can borrow at the same rate of interest. Investors are assumed to prefer higher expected future wealth and to be risk averse, i.e. prefer a lower standard deviation. However, investors may have different risk preferences and thereby choose different combinations of the two assets. Then Sharpe introduces a combination of assets in addition to the individual asset and the risk-free asset. The systematic risk is the risk that the individual asset incurs in combination with the market.

Beta has come to have a specific form that is different from the Sharpe paper, which does not mention it. Nowadays *beta* is defined as the co-variance between the individual asset under scrutiny and a 'synthetic' market asset composed of the relevant assets in the class divided by the variance of the market return. This *beta* is the systematic risk[11] that is then used to multiply the difference between the expected market return and the risk-free return (also used to take on debt) in order to find the risk premium on the particular asset.[12] The model assumes a market asset consisting of well-diversified portfolio of stocks. As CAPM returns are calculated on variances of past returns, there is no true assessment of market risk. *Beta* is used to beat the market by trying to ensure that at least the market return can be obtained. A capital market line is formed where the intercept with the y axis is the risk-free rate and the slope indicates the risk-return in a linear relationship with a slope of *beta*.

From the final result coming out of the calculations, after finding the *beta*, the 'true' asset price can be calculated from the return arrived at by the model and this can be compared with the actual price and its expected return. If this return is higher than the one coming out of CAPM, then the asset is undervalued. The recommendation then is to buy. It could also mean that CAPM analysis is wrong. Or with M-M that too high leverage is included.

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[11] Systematic risk is just a within-model definition of the individual asset's *beta* as per the market.

[12] Co-variances between different papers and the market portfolio plus the variance of the market portfolio rate are found. Historical data are used. If the particular asset is completely independent of the market, the co-variance will be zero and you can only count on the risk-free or guaranteed individual asset return. *Beta* is 1 if there is perfect co-variance between the movement of the particular asset and the market (the co-variance will be the same as the variance) and then the asset will get the market return, i.e. it is exposed to market risk and fall and rise with the market. This premium of course only holds for that part of the portfolio that is put into risky assets, but an investor is supposed to be able to borrow at the risk-free asset. In this it is in contradiction to the M-M theorem, which did not suggest that a firm's debt was risk-free.

There are a number of assumptions to this model that are all unrealistic. Normal distribution is assumed as well as variance as a measure of risk. In fact it is not really risk that is debated, but a possibility of a market gain. If a portfolio is well diversified, it will only incur the risk/advantages of the basic market, which may be linked to macroeconomic factors. This is the assumption, but it is difficult to know all the factors going into co-variance. However, for any individual asset in combination with the market, its particular co-variance with it must be stated.

As an asset's expected return goes into calculating the *beta*, it is clear that the whole reasoning is circular, or *beta* is used as part of an aggressive trading strategy. It remains however a black hole how to form true expectations, notably of the market as a whole. How much to include? If theorists want to go beyond mundane averages, they must venture into the formation of expectations of future returns, not just concern themselves with risk or volatility (standard deviation of returns over a year typically) of past returns. However, the model is fed data and volatility comes out of past returns that are then used to form expectations. Thereby in fact the model feeds itself by forming expectations from the past – and this despite the fact that expected values in mathematical statistics are the basis of the calculation of variance and standard deviation.

But also, if future events are unpredictable over time, probabilities are difficult to assign, and thereby finding the expected value of a given variable according to a probability distribution falls flat, see above about Keynes in "The core criticisms of the paper".

This is probably why there is a difference between experienced market traders and 'quants'. For example, Warren Buffett, to mention probably the most well-known market player, who does not follow models but his own knowledge and intuition, will go up against market expectations as manifested in current pricing. Warren Buffett is famously quoted as having said, "We simply attempt to be fearful when others are greedy and to be greedy only when others are fearful."[13]

Furthermore, finding co-variances and variances of past performance is time consuming, and the resulting *beta* may be a bad judge of the future. Or rather, co-variances may not be stable. Despite assets sharing some features over a period of time, underlying conditions can change their relation and make them take diverging paths. Most importantly: financial phenomena change in importance. If interest rates change, it will have an impact that is relatively predictable. If they are kept low, they will cease to be an active factor, and other influences gain in importance as has been seen in the recent low-interest-rate period. This 'important factor' change is what fractal financial analysis looks out for.

Plugging in the risk-free asset with the sure and certain return is a good device. Since it is completely certain, it has no variance and no co-variance with other assets. This makes it possible to zero a lot of mathematical expressions, a favourite device of mathematical model makers.

If it is Greek to you, it is Latin to me. When you say *beta*, you must also have said *alpha*. And so does finance theory. Fortunately, *alpha* is not as such difficult to comprehend. It is just a measure of how an asset or asset class actually performs as per what it was expected to do according to its *beta* as risk measure. *Alpha* is thus just the extra, often taken to be unrelated to the market. In order to try to outperform market return, instruments called 'portable *alpha*' have been developed (Kvasager

[13] http://www.brainyquote.com/quotes/authors/w/warren_buffett_3.html.

2009). This is often done through hedging. So the idea here is to beat the market. Note the development, from the individual return(s) minimizing risk to an addition by the risk premium through the market to an extra portable alpha mark-up. And this without even reflecting on the sliding scale of theories.

When CAPM was developed in the beginning of the sixties, it was mostly a tool to try to up the ante by going into the market, then in a bull mode and assumed to continue to be so, not really a risk-assessment tool.

What is surprising it that the three hypotheses, EMH, CAPM and M-M, have lived happily side by side without finance theory pointing out that their assumptions are contradictory. CAPM depends on variances and co-variances based on past behaviour and implicitly projected into the future. If markets are efficient, the weak version of EMH claims that the past will not be able to teach you about future movements. According to the strong version of EMH a security will not be under or overvalued so only new information will give an investor reason to form expectations. And M-M is contradicted by CAPM which accepts that there are differentiated returns giving different firm values.

Incidentally, the conviction that the higher the risk the higher the return, is not shared by the population. Behavioural theorists have found that people in fact behave inversely to PST and CAPM, which cast in stone that return and risk are positively correlated. Hersh Shefrin has noted that people believe less risk gives higher returns (Franklin 2002). Indeed, people may believe so, but people do not drive the markets, investors, speculators and all 'dem do.

It also has turned out that stocks with low *beta* fare better than anticipated. To get over this dilemma it may be claimed that investors require higher returns from stand-alone securities. The line to turning this on its head and convincing people that when an investment seems very iffy, it will also generate a higher return, is thin.

Pricing of derivatives and securitized instruments

Options pricing model

With the strong development of derivatives new models came into being. The *options pricing model* is rightly or wrongly attributed to Fischer Black, Myron Scholes and Robert Merton and dated to 1973. The Nobel Prize to Scholes and Merton followed in 1997.

Options are not new in history, but their proliferation notably in the eighties and nineties and use in hedge funds (that do not hedge in fact, only they are often involved in two-way operations) augmented the turnover in financial markets and the tendency to take the future in as witness to the present.

It is difficult to restate the theorem in ordinary words. In fact it is of the equilibrium type where the option should mirror the underlying stock. In addition it assumes constant (or at least that a single figure can be found for) price volatility of the stock so that the option market price is a function of the strike or exercise price of the option (the reference purchase/sale price of the underlying asset until the expiration date), the actual asset price, time to maturity and interest rate and then some volatility parameter that boils down to the standard deviation of returns put into a statistical distribution function.[14] It was developed for call options (buy at a future date at the strike price) but is convertible to put options too (sell at a future date at the strike price). It has the usual weaknesses of financial math models that it assumes that it does not pay to go into the paper because the basic price would eliminate gain, highly counterfactual.

Triana (2009) shows that when the model is used for hedging, the underlying stock(s) should be traded continually. The model was used in portfolio insurance techniques with automatic triggers during the October 1987 run-up. Hedging strategies were incorporated in computer programmes that signalled that the underlying stock should be bought when its price went up and sold it when it fell. Thus it helped to nourish the bubble, and the ensuing sell-off that always takes place in a crash became wilder.

Afterwards, the option model perhaps became a starting point in pricing but any trader will try to intuit what can be gained because of market movements around the basic parameters. According to Triana, the model is paid lip service but is not truly used in option pricing. Since the volatility parameter is in fact a grab bag for everything that deviates from the equilibrium of the 'model', it is difficult to judge what it represents in practice. This explains the contention by Triana that it has mostly been used as window-dressing and that quants tweak the figures, notably on volatility (traders call it "volatility fudging" (Triana 2009: 197)). Since nobody reperforms the volatility calculations and traders do not check each other, being too busy with their own calculations, quants can postulate that they follow the model as it suits them.

The hedge fund Long-Term Capital Management (LTCM), in which Robert Merton and Myles Scholes were involved, crashed in 1998. This may be seen as a living proof that hedging - if this is what they did - does not eliminate risk. But no matter, the hedging strategy/convergence assumptions were wrong. LTCM went bankrupt because it held a large position in Russian bonds which Russia defaulted on in 1998. LTCM had to unload European and Japanese bonds more cheaply and buy US bonds at a higher price than anticipated, thereby incurring losses of more than USD 4 billion. It was rescued for a while by the major financial institutions only to fail in 2000. The options pricing formula does not seem to have played a prominent role in the problems, unlike in the 1987 crash. Rather, it was the Value at Risk (VaR) formula that exacerbated the market gyrations.

Gaussian copula function

When complex structured instruments developed, new assessment-of-risk models and practices were introduced. Complex structured instruments are CDOs or CMOs, collateralized debt or mortgage obligations. They are part of the class of ABS (asset-backed securities). CMOs go back to the late eighties after the crisis of the so-called thrift industry. Savings and loan associations had overexposed themselves to housing finance and were sitting on a number of questionable mortgages. Large finance houses, such as Salomon Brothers, bought them, packaged them into bonds, CMOs, and sold them back to the S&Ls or others. The term toxic waste was launched already before 1990 by traders (Henwood 1998: 181).

[14] See e.g. Investopedia (http://www.investopedia.com/terms/b/blackscholes.asp) and Reilly (1985: 727-731).

A CDO is a structured financial instrument with different tranches of – mostly – debt obligations (the collateral), often mortgage bonds. Each tranche has a specific risk/return profile. The senior tranches are those assumed to have the lowest risk and are paid first in the case of problems.

The Bistro (broad index secured trust offering), was launched in 1997 by an innovation-aggressive team at JP Morgan. It carried features both of what came to be CDOs, slicing and dicing of pooled securities with different risk profiles, and CDS's (credit default swaps used to insure derivatives). The story was that JP Morgan started to issue notes as a sort of insurance against tranched loans and to outsource them to SPVs (special purpose vehicles). This could only be done with the acceptance of credit bureaus. Since the innovators knew the risk model of Moody's, they tried to convince it to rate not only the packaged loans but also the notes used as guarantee according to this model (Tett 2009: 64-65). However, regulators also had to approve, and they were not willing to take the risk off the books of JP Morgan (which would make it easier to comply with capital-adequacy requirements) until AIG insured the rest of the tranches of the underlying loans, later known as CDOs. In the end some of the risk was off-loaded, but not all. CDS's are thus a merger of the Bistro notes and credit insurance through an insurance institution. A buyer of protection engages with a seller such as a financial insurance company (AIG) and pays a spread to take out a CDS. CDS's flourished into a new market, they can be bought and sold independently of the protected asset, held long and sold short etc.

The *Gaussian copula function* to assess the risk of these complex deals seemed to work wonders. A copula function is a joint or multivariate probability function combining the individual (marginal) distributions with the correlation of the variables. In practice it tries to get a grip on the correlation separately so it becomes an add-on. Essentially the function was used to assess the correlation risk of default of the different tranches of a CDO. It did so through asset price correlation data and default probabilities (Triana 2009: 102) in order to estimate default correlations. The underlying idea was that if risk (not returns - default is just the odd-sigma risk event to be avoided) follows a normal distribution function, there is very little chance that the unlikely 'tail' event happened, especially when you multiply tail event with tail event, let's say 0,003 x 0,05, as default probabilities. Thereby the individual risks could be maintained and a good tranche was only little tainted by an unsecure one and a risky one could benefit from the less risky tranche. Securitizing papers with different risk profiles into tranched instruments would make the joint probability of default very small. Although returns were tranched, the more risky tranches were supposed to benefit from the combination with less risky ones topped up by the CDS insurance.

The formula was also used by rating companies. Moody's adopted it for CDOs as of 2004 and later other rating agencies did the same albeit with different inputting. It was thus not only used to package the entire CDO but also to judge it. CDOs and CDS's grew together and in fact, as often happens, the thing was turned round so that CDS spreads were used for estimating the correlation risk of default of the underlying assets (Salmon 2009). Since nobody thought that there was any real risk, the market for CDS's grew to such heights that when the market for CDOs collapsed, the insurers could not pay the losses, and AIG, the worst hit, was hanging in a shoestring before it was rescued and could pay its dues to i.a. Goldman Sachs.

A market quant, David Li, became famous for developing this function into a short-hand variety, but all of a sudden his copula disappeared from polite discussion.

Systemic risk

The danger of system break-down is systemic risk. Whether it can be prevented or its effects controlled is what regulators now discuss, but they have not come very far in actual regulations or measures. To better understand it, it is clear that systemic risk must be *of* the system. It is generated *by* the behaviour of the system and *in* the system as well as *to* the system. Therefore systemic risk is endogenous. With Sharpe it could be ventured that it shows up in a *beta* of 1 for most assets, only that *beta* is not true systemic risk, which has to do with the level of the market risk itself rising. If you are a good and righteous financial-market regulator systemic risk should be avoided at all costs, i.e. not the slightest danger of incurring it should be tolerated.

Value at risk and stress tests
However, one intermediate measure shall be mentioned. In the indefatigable race to instrumentalize and tame the most volatile monsters, *VaR (value at risk)* was found to be an adequate tranquilizer. It was introduced around 1990 in JP Morgan to calm the thin nerves of its CEO after the 1987 crash. A daily report should be presented, assessing what risks were incurred on any given day within a confidence level of 95% (two sigma events) (Tett 2009: 38). I.e. here the normal risks were computed. If an estimated loss is within the 95% confidence level, it means that there is a 5% chance that it will be exceeded. But these numbers do not show what the losses would be if they exceed the acceptable bound, only that they are unlikely.

Again the past is used as a guide to future expectations and the tail ends are conveniently discounted. It may well underestimate not only catastrophic events but also their depth. Triana (2009) debunks this along with other financial modelling equations and tools. The LTCM troubles were precipitated by not only the use of similar hedging models across the board but also by the value at risk (VaR) by those banks that had money at stake. Since they had to protect their ‘values’, they unloaded assets even more rapidly than if this model were not used.

Stress tests of individual banks seeing if they can withstand crises (drying-up of liquidity) have been developed, so far apparently not very convincingly since some of those that first passed the recent tests continue to have difficulties.

Systemic risk measures
Some measure of systemic risk is through ‘too big to fail’ tests or ‘too interconnected to fail’ but that is, one) after the fact, two) takes the point of view of the need for rescue. Intuitively, systemic risk has to do with the risks the system engenders by working as it does. “Thus, systemic risk can be thought of as widespread failures of financial institutions or freezing up of capital markets that can substantially reduce the supply of capital to the real economy.” (Acharya and Richardson 2009: 1). They also think that systemic risk is a negative externality (A&R 2009: 24). Along the same lines Nesvetailova (2010) thinks that market liquidity sums up the joint valuation of risk. However, before it dries up, nobody may have realised that there is a problem.

These measures or indicators take the manifestation of systemic risk as the risk itself, but systemic risk augurs a potentially dangerous and unacceptably contagious collapse. In mathematical terms it should show up as high expected returns based on high leverage and more and more assets aligned with the market.

Dark risk

The crisis starting in 2007 was a serious attack on the theories and how they dealt with underlying facts. It was revealed, at the overall level, that VaR did not adequately assess the risks to the system, not even to the financial institutions using it. Leverage was out of control, AIG could not cover the risks it had insured for through the CDS's it had sold. It had gone into bankruptcy, were it not directly rescued by the US government.

A risk manager, David Rowe, has launched the term 'dark risk' defined as, "changes in the underlying structure in which we operate in ways that don't always change the immediate visible randomness of variables that we track day-to-day." (Rowe 2009). It should be added: because the variables are put into models, often enough built on other models. Systemic 'risk' was increasing by the joint affirmative action of the herds of international financiers, creating what is to be feared: excessive financialization based on leverage, derivatives and securitization.

Systemic risk has been augmented by using risk models that only try to conjure risk away, to domesticate it by assuming a normal distribution, favourable expectations and small *sigmas*. Through these devices, risk has been created that has helped to endanger the entire system. The line to swindle is thin. But if the recommendation implied in dark risk should be followed, then the underlying changes in the system should be found. New asset classes that grow very quickly is a sure sign of underlying structural change. Or the disappearance of one market from view and the growing importance of another. Risk managers may continue to stare at the same phenomena as before but not have their eyes wide open to momentum changes and their implications.

Although the writer of this paper does not believe that risk theories themselves drive markets, they serve as the necessary veil or magical mirror that distorts reality. But in an inverse way these models have supported the positive correlation between return and risk. In order to obtain a high return, not least in low interest-rate regimes, risk has been augmented by leverage allowed by models that pretended that risk was within bounds. And what did it matter that you took on debt when it would be the same as equity (the vulgar version of the M-M theorem)? Linking back to the competition between finance and real investment, it can be seen that the resulting financialization has damaged investment. Smith and Parenteau (2010) show that corporations in 2002-05 ran financial surpluses and started doing so again relatively shortly after the crisis. It can well be argued that investments may not look so profitable in view of these other prospects. And certainly, it is another indication that capital structure does matter.

Peter Bernstein (1996) has a comment on Marx and expectations. He says that, "Even Karl Marx, in his dynamic version of classical economics, never makes reference to forecasting. In that version, workers and capitalists are locked in a drama whose plot is clear to everyone and whose dénouement they are powerless to change." (Bernstein 1996: 220). It is true that Marx did not deal with financial-market or other forecasting in a modern sense, but probably because he thought that what could not be forecasted precisely, should be left alone. He saw that price can vary from value, the market may not deliver, financial markets may stall preceded by a period of hyperactivity and swindling. Then the crisis hits. So it is not because the dénouement was as certain as in a boulevard comedy but because this or any other events could not be foreseen with accuracy. This did not leave the field wide open, in basic outline the economy would gear itself up until over-accumulation struck, and the crisis would be inaugurated by a financial crash. However, financial markets had not been instrumentalized to the extent they became later on and, first and foremost, Marx saw, as per his example of risk and doubling up, that this was just another way of trying to justify returns and figuring out new ways to corner the market. Part of the capitalist game.

The discussion if an investor can beat the market is a side issue given that all the big investors jointly can flog it.

Conclusion

This paper has discussed assumptions of risk theories and their relationship with asset pricing. It is noteworthy that the theories take as point of departure the individual or the firm. The market is just a conglomerate of individuals or portfolios – everybody tries to gain and to ensure that she avoids losses. The surreptitious shifts to larger entities – as in the real world – in the form of VaR for large banks have not really moved the focus away from the single entity.

It is characteristic that the original models believed in risk avoidance. So did M-M and the Nobel Committee in its press release: “If for instance the risk level of a firm’s assets is increased, the shareholders can neutralize this by lowering the risk of other assets in their portfolios.” The active usage of leverage to increase returns rather than to compensate for risk was not even considered.

Markowitz saw the need to diversify risk but tried to find the way in which a given risk could be combined with maximum return. Sharpe saw the advantage in a market-portfolio-aligned investment which would give the market mark-up. If you cannot beat the market, at least you as investor can go along with it. Options pricing built on CAPM.

The terms and certain aspects of these basic models are still in use, but this has led to new problems. Mackintosh (2011) discusses studies that show that if shares with high *betas* (above 1) are bought, i.e. those that are volatile, they will rise in price and thus be outperformed by those with lower *betas*. Using the model may help it to self-destruct. Kay (2011) shows that VaR in fact gave a false sense of security. In 2007 for several days in a row, the VaR was broken by very high *sigma* events. He drily comments that, “Multiple sigma events do not happen in real life.” The models have given a false sense of security. Even though they are as irrelevant as they are faulty, they continue to be taught in business schools.

The problems can be summarized:

- First of all, Sharpe writes in the paper discussed here, “However, since the proper test of a theory is not the realism of its assumptions but the acceptability of its implications, and since these assumptions [a common pure rate of interest with all investors able to borrow and lend on equal terms and homogeneity of investor expectations. KHP] imply equilibrium conditions which form a major part of classical financial doctrine, it is far from clear that this formulation should be rejected - especially in view of the dearth of alternative models leading to similar results.” (Sharpe 1964: 433). This is purely circular reasoning that neatly condemns itself.
- Declaring markets efficient and using the incorporation of information as a criterion: it is true that information is incorporated all the time, but this does not give an outcome for part of or the entire system that is risk-free, let alone ‘efficient’ in the sense of leading to a result that would correspond to the rational work-out of all data.
- Encouraging investors to maintain a risk profile that is defined through volatility, standard deviations of past events. Following such profiling will lead to underestimating dangers in a boom and overestimating them in a downturn.

- Believing that you as an individual investor can pick a certain risk level and hope to get a higher return. For one, it is completely underestimated that you also run a downside risk (which may also be underestimated).
- Through the individualistic bias, systemic risk, by A&R defined as 'negative externalities', is not priced into asset prices, except in crises.
- Using some models may be more pretence than reality (the options formula). Even so the normality distribution assumptions and not least the idea that a certain equilibrium, perhaps to be reached through hedging, will prevail, lead to missteps because the profit motive does not work in this way. It drives investors further towards the brink.
- Whereas academics who naïvely believed in equilibrium were the first to develop mathematical models, afterwards market practitioners took over. VaR was developed as a response to the 1987 Black Monday where options pricing had played a significant role. The Gaussian copula function came into being as a powerful tool in the run-up to the 2007 crisis, in the midst of deregulation. The US Securities and Exchange Commission (SEC) actually allowed broker-dealers to use internal net capital rules as of 2004, thus augmenting systemic risk (A&R 2009: 23).
- It thus does not appear as if regulators and market players have learnt from the past crises, on the contrary, each crisis has fortified the tendencies that led to collapse, by finding new instruments built on complicated leverage, only seemingly overcoming past problems.

This author's position with respect to return and risk/systemic risk can be summed up by two related propositions: 1) To pretend that return on equity is a requirement as such is vain. This is not to say that shareholders do not push for higher returns, they just do not necessarily get them. The only 'requirements' that are posed with some degree of influence pertain to investments and pushing returns may lead to disappointments. Therefore risk may be seen as a two-way monster: it is augmented by the pressure to produce profits in 'real' business and the pressure to produce profits out of financial instruments when the 'real' economy is lackluster. 2) Major events in financial markets are generated by the way in which the system works. Financial markets build momentum and this creates the basis of their own destruction, particularly when there is no warning from the models. If there is build-up towards a heavy financial überbau with little foundation in the so-called real economy, there is all indication that risk may be augmented by further financial activities along the same line. Financial theory originally dealt with the prospects of profits in businesses giving return to those holding a claim and it was piously said (and some still say it) that the role of financial markets was to allocate capital to firms. Today shareholder value reigns, the firm's existence is most real on the stock market. Therefore firms will not necessarily invest so as to continue to be profitable, rather they will look at market positioning – or they may go overseas in order to be hyper profitable. It is thus that even though the economy is slack, the financial system can ramble on. Thus both points bear on the suggestion that finances cannot be analysed in isolation from the other parts of the economy.

Selected Bibliography

Acharya, Viral V. and Matthew Richardson, eds. 2009. *Restoring Financial Stability: How to Repair a Failed System*, New York: John Wiley & Sons.

Bernstein, Peter L. 1996. *Against the Gods: The Remarkable Story of Risk*, New York: John Wiley & Sons, Inc.

Cooper, George. 2008. *The Origin of Financial Crises: Central Banks, Credit Bubbles and the Efficient Market Fallacy*, New York: Vintage Books.

Fama, Eugene. 1970. "Efficient Capital Markets: A Review of Theory and Empirical Work," *Journal of Finance*, Volume 25, Issue 2.

Ferguson, Niall. 2001. *The Cash Nexus: Money and Power in the Modern World*, New York: Basic Books.

Franklin, Carl. 2002. "Is the classical risk-return theory wrong?" *Sunday Business*, August 4.

Henwood, Doug. 1998. *Wall St: How It Works and for Whom*, London, New York: Verso.

Jones, Steven L. And Jeffry M. Netter. 2008. "Efficient Capital Markets," *Library of Economics and Liberty: The Concise Encyclopedia of Economics*, URL: http://www.econlib.org/library/Enc/EfficientCapitalMarkets.html

Kay, John. 2011. "Don't blame luck when your models misfire," *Financial Times*, March 2.

Keynes, John Maynard. 1970. *The General Theory on Employment, Interest and Money*, London and Basingstoke: Macmillan St Martin's Press. First published in 1936.

Keynes, John Maynard. 2000. *A Tract on Monetary Reform*, New York: Great Minds Series, Prometheus Books. First published in 1924.

Kvasager, Whitney. 2009. "Big US pensions get cold feet over portable alpha," *Financial Times* (*FTfm*), January 12.

Mackintosh, James. 2011; "Reward for risk seems to be a chimera," *Financial Times (FTfm)*, March 21.

Malkiel, Burton G. 2003. *A Random Walk down Wall Street: the Time-tested Strategy for Successful Investing*, New York: W.W. Norton. First published in 1973.

Markowitz, Harry. 1952. "Portfolio Selection," *The Journal of Finance*, Vol. 7, No. 1, March.

Marx, Karl. 1991. *Capital Volume 3*, Introduction by Ernest Mandel, 1981.Penguin Books: Penguin Classics. Edition first published in Pelican Books in 1981.

MIT. 2003. *The Future of Nuclear Power: An Interdisciplinary MIT Study*. Massachusetts Institute of Technology

Modigliani, Franco and Miller, Merton, H. 1958. ”The Cost of Capital, Corporation Finance and the Theory of Investment,” *American Economic Review*, Volume XLVIII, No. 3, June.

Nesvetailova, Anastasia. 2010. *Financial Alchemy in Crisis: The Great Liquidity Illusion.* London Pluto Press.

Reilly, Frank K. 1985. *Investment Analysis and Portfolio Management. Second Edition*. Chicago, New York and Philadelphia et al.: The Dryden Press.

Rowe, David. 2009. “Five Key Lessons for Risk Management - Introduction,” URL: http://www.dailymotion.com/video/xa8aq1_five-key-lessons-for-risk-managemen_tech (downloaded May 12, 2011).

Salmon, Felix. 2009. “Recipe for Disaster: The Formula that Killed Wall Street,” Wired Magazine, Feb. 23. URL: http://www.wired.com/techbiz/it/magazine/17-03/wp_quant?currentPage=all.

Sharpe, William F. 1964. “Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk,” *The Journal of Finance*, Vol. XIX, No. 3, September.

Smith, Yves and Rob Parenteau. 2010. “Are profits hurting capitalism?” *International Herald Tribune*, July 7.

Taleb, Nassim Nicholas. 2007. *The Black Swan*: *The Impact of the Highly Improbable*. London: Penguin Books.

Tett, Gillian. 2009. *Fool’s Gold: How Unrestrained Greed Corrupted a Dream, Shattered Global Markets and Unleashed a Catastrophe*, London: Little, Brown.

The Economist. 2011. “Why Newton was wrong,” January 8.

Tobin, James and William C. Brainard. 1968. “Pitfalls in Financial Model Building,” in *American Economic Review* Vol. LVIII, No. 2, May.

Triana, Pablo. 2009. *Lecturing Birds on Flying: Can Mathematical Theory Destroy the Financial Markets?* Hoboken New Jersey: John Wiley and Sons, Inc.

Triana, Pablo. 2010, “Challenging the notion volatility equals risk,” *Financial Times*, September 5.