Finance Theory and Investment Management

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I. INTRODUCTION

The 1990 Nobel awards, H. MARKOWITZ, M. MILLER and W. SHARPE, have confirmed that finance theory has become a significant field of economic science. While this was contested by some macro-economists, finance theory has become a major area of research for micro-economists. The attraction of finance is that it provides a gigantic data base to test theories in real time, as well as an experimentation field to apply its concepts to the real world. In my presentation today, I would like to review the major approaches to the theory of finance and how they are relevant to financial markets and investment management. There are two main approaches to finance theory. The first one is a direct extension of the traditional micro-economic approach of utility maximization. Investment and consumption demands are derived from the maximization of the expected utility of risk averse individual investors/consumers and equilibrium asset prices are obtained by aggregation of these demand functions. This approach is briefly reviewed in section 2, while section 3 focuses on international asset pricing and hedging. The second major approach considers arbitrage opportunities in the financial markets and derives relative prices by ruling out the possibility of riskless profitable arbitrage. This arbitrage approach is briefly reviewed in section 4. Recent developments and their empirical applications are discussed in section 5. Applications to investment management are discussed in section 6.

Such a short survey cannot be exhaustive and I have only intended to highlight some developments of finance theory that I consider most relevant to practical applications in financial markets and investment management. Corporate finance is one of the many fields of finance that I have excluded from my survey; the same comment applies to insurance theory. A large body of research on market micro-structure has appeared spurred by the October 1987 crash on Wall street; I will not talk about it.

Before getting into a survey of the theories, let me stress that the fundamental background of all this theoretical approach is the concept that financial markets are very efficient. A discussion of the many meanings and definitions of the word “efficient” would require several articles\(^1\). Loosely speaking we mean that it is very difficult to beat the market, to make “easy” money. This was stated by FAMA (1976) in the form that all current

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1. See for example LEROY (1989).
information is immediately and fully reflected in current asset prices. Hence future price movements are only affected by future information ("news") that are not yet available and therefore random. The informational efficiency of the financial market is supported by the observation that technical models, models based on public information on companies or the economy, as well as well as the performance of professionally-managed funds seem all to be unable to beat naive buy-and-hold investment strategies. Most, if not all, theoretical models in finance assume market efficiency as the norm, even if some form of inefficiency is sometimes explicitly modelled.

II. CAPITAL ASSET PRICING MODELS

Models of asset prices have long been studied by economists. For example the famous dissertation on speculative prices by the French mathematical economist BACHELIER (1900) has been rediscovered by MERTON and SAMUELSON and quoted worldwide. However Finance, as a comprehensive body of concepts, can be dated back to the work by MARKOWITZ in the 1950s. VON NEUMAN and MORGENSTERN (1947) developed a framework for utility theory under uncertainty. This was applied by MARKOWITZ (1959) to investment in financial markets. MARKOWITZ considered risk averse investors maximizing their expected utility of future consumption in a two-period model. Under restrictive assumptions about the form of the utility function (quadratic) or the distribution of asset returns (normal distribution), MARKOWITZ has shown that the investor problem would be to optimize the risk/return tradeoff on his portfolio of assets. Basically an investor would choose the weights $x_i$ invested in each asset $i$ by maximizing the portfolio expected return and minimizing its variance. The optimal trade-off between risk and return being determined by the investor’s risk aversion ($RA$):

$$\text{MAX} \sum x_i E(r_i) - \frac{1}{2} RA \sum x_i x_j \sigma_{ij}$$

s.t. $\sum x_i = 1$

where $E(r_i)$ is the expected return on asset $i$ and $\sigma_{ij}$ the covariance of returns between assets $i$ and $j$.

A major contribution has been to stress the importance of risk diversification. The risks of individual assets get partly diversified away in the portfolio. This approach lead to a model of equilibrium asset pricing developed by SHARPE(1964), LINTNER (1965) and MOSSIN (1966) and widely known as the CAPM (Capital Asset Pricing Model). This is a partial equilibrium model where investors are assumed to have exogenous beliefs about asset returns. They behave à la MARKOWITZ and share the same beliefs about expected returns and covariances. There exists a risk free rate of return $R_f$ at which each investor can lend and borrow. Markets are perfect in the sense that there are no transaction costs, no taxes and assets are fully divisible. It is shown the each investor should invest in a
combination of two portfolios: the risk free asset and the market portfolio. The mix of these two assets will vary depending on the risk aversion of the investor. In modern finance language, this says that the market portfolio of all risky assets (the "market index") is efficient. Rather than adapting the composition of their portfolio of risky assets to their risk aversion, all investors will use the same portfolio of risky assets but will adjust the risk level by borrowing or lending. The fact that the market portfolio is efficient implies a simple risk pricing relation, which says that the expected return on an asset $i$ is equal to the risk free rate of interest plus a risk premium proportional to the risk of that asset relative to the market, its beta:

$$E(r_i) = R_f + \beta_i (E(r_m) - R_f)$$ (2)

The coefficient of proportionality is the market risk premium. The fact that the expected return should be equal to the risk free rate plus a risk premium is obvious; the contribution is to say what type of risk should be priced. This theory is intuitive: it says that only the market risk of a security should be priced, not the risk of a security that gets trivially diversified away in a portfolio.

The assumptions used to derive the CAPM are very restrictive. However a theory should not be judged by the restrictiveness of its assumptions but rather by the contribution of its conclusions to improve our understanding of the real world, and the robustness of these conclusions. The CAPM has greatly improved our understanding of pricing of securities and risk and the conclusions have been shown to be quite robust to a change in assumptions. Extensions of the CAPM have been worked out by many authors. For example BLACK (1972) relaxed the assumption of the existence of a risk free asset. Some forms of taxes and transaction costs have been modelled. A major contribution has been the development of a dynamic version of the CAPM. MERTON (1971) used a continuous-time framework that allows for changes in the investment opportunity set (e.g. changes in interest rates).

The empirical investigation of the CAPM, mostly on US data, has yielded mixed results. Indeed there are many problems in testing the CAPM. First, this is only a relative pricing theory that has little to say about the magnitude of the global risk premium on the market $(E(r_m) - R_f)$; it only talks about relative risk premium. So we can test the linear relationship between a security risk premium $(E(r_i) - R_f)$ and its market risk measure $\beta_i$, but the CAPM says little about the slope of the risk pricing relation. A general equilibrium model is required to estimate the market risk premium but it is obvious that this would require the aggregation of individual preferences and wealth which are variables not easily observed. On the other side, the CAPM tells us that the linear relationship is preference-

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2. The CAPM should not be confused with the so-called market model which is just a description of the stochastic behavior of asset return. An equilibrium asset pricing relation such as the CAPM could hold even if the asset returns are not generated by the market model and vice versa.
free and hence directly testable. Second, expectations and risk measures are not directly observable, hence they must first be estimated. The usual approach to measure expected returns is to assume that asset prices follow a random walk with drift and that the distributions are stationary. Hence the realized return is equal to the (unknown) constant expected return plus a white noise with constant variance. Similarly we can estimate the beta of a security using past data and assuming that the risk of a security is constant over time. These are fairly drastic econometric assumptions and tests of the CAPM have stimulated a lively controversy and the development of many sophisticated econometric techniques which cannot be detailed here. A recent illustration is the use of latent-variable methods. Clearly a test of the CAPM is a joint test of market efficiency, of assumptions about the distribution of asset prices and their stationarity, and of the CAPM theory. Hence the power of the test is likely to be weak.

Another set of problems comes from the sensitivity of the tests to the choice of the market index used to calculate the betas. ROLL (1978) has shown that type-one or type-two errors are likely to occur if the market is not correctly identified. Most tests have been conducted on US stock prices using some US stock market index. Since the market portfolio should include all risky assets according to the CAPM, should we include bonds, human capital, real assets and even foreign assets in the market portfolio?

Given these econometric problems it is not surprising to find that we have no definite answers regarding the empirical validity of the CAPM.

III. INTERNATIONAL EQUILIBRIUM AND CURRENCY HEDGING

The CAPM is a useful theory that has lead to many applications in investment management and corporate finance. However it was initially derived in a domestic framework. It can be extended an international framework. An obvious problem comes from exchange risk. SOLNIK (1974) derived an international equilibrium model where investors care about real returns defined over different national consumption baskets. If we further assume non stochastic inflation (or that the variance of the inflation rate is small compared to that of exchange rates and asset prices), this leads to a theory where investors care about risk measured in their local currency. This introduces a form of heterogeneity of expectations since a Swiss and US investor will have a different measure of return and risk on a given asset. The conclusion of the IAPM (International Asset Pricing Model) is that each investor will hold a combination of his national risk free asset and a common portfolio of risky assets. This common portfolio, often called the logarithmic portfolio, is made up of the world market portfolio of all assets partly hedged against currency risk. Unfortunately the hedge ratios need not be one and differ across assets. So we do not have a simple investment recommendation as in the domestic case. Furthermore, relaxation of the

3. For discussions of recent econometric methodologies see CAMPBELL and HAMAO (1990) and PERSON and HARVEY (1991).
assumptions leads to complicated optimal investment rules which are not preference-free. However the risk pricing relation that obtains is still simple if investors only care about returns in their national currency. Actually it can be shown that a simple CAPM relation applies to currency-hedged returns. In other words the expected return on an asset hedged against currency risk is proportional to its beta with the world market portfolio. This theory of IAPM has been extended by RENÉ STULZ (1980) a major contributor to the theory of finance. A good survey has been provided by ADLER and DUMAS (1983). While the remarkable synthesis by ADLER and DUMAS (1983) is extensively referenced, it does not seem to be as extensively read and extensive confusion still reigns regarding equilibrium currency hedging. Recently BLACK restated the conclusions of ADLER and DUMAS in a way that has created considerable confusions among readers and misinterpretation by practitioners. BLACK (1989 and 1990) adopts exactly the Solnik model where all national investors are assumed to care about nominal returns measured in their national currency. Let’s consider a representative investor of country $i$ with risk tolerance $\alpha_i$ and wealth $W_i$, measured in some arbitrarily chosen numeraire. We will consider risky assets called stocks (to differentiate from nominally riskless bills) and the national stock market capitalization is $M_i$. World wealth is equal to $W$ which is equal to the world stock market capitalization $M$. Hence investors of country $i$ may be net foreign investors. There exists one risk free bill in each currency, which is (currency) risky in foreign terms and in net zero supply. Notations are summarized below:

notations

\begin{align*}
M_i & \text{ market } i \text{ capitalization} \\
W_i & \text{ wealth of country } i \\
\alpha_i & \text{ risk tolerance of representative investor of country } i \\
\alpha & \text{ world average risk tolerance } = \frac{1}{W} \sum \alpha_i W_i/W
\end{align*}

A well known result$^4$ is that each investor should hold a combination of the same common portfolio, often called the logarithmic portfolio, with proportion $i$ and of his domestic risk free bill in proportion $1-\alpha_i$. BLACK (1990) used this result as a starting point and his contribution was to stress that it leads to interesting conclusions by simple arithmetic calculations. This common portfolio is often called the logarithmic portfolio because it is the portfolio that all investors with a risk tolerance of $\alpha_i=1$ (logarithmic utility) would hold irrespective of nationality. This logarithmic portfolio is made up of all stocks and national bills. If we denote $\alpha$ the average risk tolerance of all investors, weighted by their wealth, ADLER and DUMAS (1983, p.952) have shown that this common portfolio is equal to $1/\alpha$ times the world stock market portfolio plus a combination of national risk free

bills\(^5\). This is trivially derived from aggregation noting the fact that the net supply of bills is zero while that of stocks is equal to their market capitalization. While the stock market portfolio has a weight \(1/\alpha\) in the common log portfolio, the remaining subportfolio of national bills\(^6\) has a weight \((1-1/\alpha)\). A currency hedge is equivalent to being short in the foreign bill and long, for the same amount, in the domestic bill; hence this common portfolio is sometimes referred to as \(1/\alpha\) times the world market portfolio hedged against currency risk. The term hedged is used loosely and does not necessarily refers to a full hedge with unitary hedge ratios. Hence the weight of stock \(j\) in the common log portfolio is \(M_j/\alpha M\). For interpretation purposes let’s denote the weight of the bill of country \(j\) in that log portfolio in reference to the weight of stock \(j\) as \(-h_j(M_j/\alpha M)\). This notation defines \(h_j\) as a hedge ratio and it is used to retain the usual hedging terminology\(^7\). Note however that it contains both a pure hedging demand and a speculative demand due to an expected profit on a pure currency position (long in the foreign short term bill). Actually the theory does not say that the hedge ratios should be one and the whole question is to determine their equilibrium value. When we say that the world market portfolio is hedged against currency risk it is only in the loose sense that some currency hedging takes place. Also note that for an investor \(i\), its risk free bill appears both as a risk free asset with weight \((1-\alpha_i)\) and in his holding of the log portfolio which includes all national bills.

The equilibrium hedge ratios can easily be derived from the fact that the net amount of borrowing/lending in each currency is zero. The total demand for the risk free bill of country \(i\) comes from its place as a risk free bill for investor \(i\) and the total demand from all investors as a component of the hedged world market portfolio:

\[
(1-\alpha_i)W_i - \sum_j \alpha_j W_j (h_j M_j/\alpha M) = 0
\]

hence:

\[
(1-\alpha_i)W_i - W (h_i M_i/\alpha M) = 0
\]

Since total wealth \(W\) is equal to the total market capitalization \(M\), we get:

\[
h_i = (1-\alpha_i) W_i/\alpha M
\]

5. This was already apparent in the work of Solnik (1974) and Sercu (1980).
6. The weight of the subportfolio of bills relative to that of the stock market portfolio is the ratio of the two weights, namely \(-(1-\alpha)\). Black called this bill subportfolio a currency hedge portfolio and this is the reason why he suggested that all investor should hedge the world stock market portfolio with a hedge ratio of \((1-\alpha)\).
7. We could describe it as a proportion of total market capitalization by multiplying \(h_j\) by \(M_j/M\).
This is a powerful equilibrium result. The equilibrium hedge ratios for stocks of country $i$ depend on the risk tolerance of investors of country $i$ and their net national wealth. If nationals are net foreign investors ($W_i$ greater than $M_i$) foreign investors will tend to overhedge stocks of country $i$, ceteris paribus. Being net foreign investors compared to the rest of the world investors of country $i$ have a larger relative demand for hedging (going short in foreign bills and long in country $i$ bills); at equilibrium this will push down interest rate of country $i$ and therefore increase the demand for hedging stocks of country $i$ by foreigners. This can be rephrased in saying that lower interest rates in currency $i$ will reduce the speculative demand for that currency from foreigners. Another conclusion from equation (4) is that, ceteris paribus, a high risk tolerance of investors of country $i$ will reduce the hedging of stocks $i$ demanded by foreign investors. The counterpart of foreign hedging ($\Sigma_j \alpha_j W_j (h_i M_i/\alpha M)$) has to be provided by the holdings of risk free assets desired by investor $i$. If investors of country $i$ are very risk tolerant they will prefer to invest in risky assets rather than holding their own risk free bill and will not satisfy this foreign hedging demand. Actually if $\alpha_i$ is greater than one, investors $i$ will borrow in their own currency (pushing their interest rate up) and lending will be provided by foreigners. There will be a negative hedge in currency $i$ or rather a speculative demand for currency $i$ because of high interest rates in country $i$.

IV. ARBITRAGE PRICING THEORY

The arbitrage pricing approach started from the common-sense observation that the price of two assets with identical risk characteristics should be closely related. This concept has been applied to commodity prices in some writings of the ancient times. In modern finance, this approach was used many years ago by MODIGLIANI and MILLER (1958), the 1985 and 1990 Nobel prizes, to demonstrate that the total value of the firm should not be affected by its financial structure. The first comprehensive analytical treatment of contingent pricing was proposed by MERTON (1973). In his pathbreaking article MERTON studied the price of a security (or contract) contingent on that of another security. This theory of contingent pricing lead to the famous work on option pricing by BLACK and SCHOLES (1973). BLACK and SCHOLES use a time-continuous framework with an underlying security price that follows a diffusion process with constant variance. The risk-free interest rate is assumed constant. An option is written on the underlying security and the objective is to derive an arbitrage value for the option. BLACK and SCHOLES build an arbitrage portfolio with the option and the underlying security. By choosing the appropriate number of options, based on the delta or elasticity of the option's price to the price of the underlying security, they can build an arbitrage portfolio whose value is not affected by a random movement in the asset price. This arbitrage portfolio is therefore riskless and

8. This was already mentioned in SOLNIK (1974).
should have a return that is equal to the risk free interest rate. This can be written as a stochastic differential equation. The problem is solved by taking into account the value of the option on the bounds, i.e. at maturity. BLACK and SCHOLES are able to derive a semi-analytical value for an option that can only be exercised at maturity. This arbitrage value of the option only depends on known parameters (underlying asset price, interest rate, time) and the volatility of the asset price over the remaining life of the option. This last term must be estimated. Because it can be calculated analytically, the Black-Scholes formula yields and instantaneous valuation when parameters are changing; this is a very attractive feature for a price derived from instantaneous arbitrage. The Black-Scholes model applies to options\textsuperscript{9} that can only be exercised at maturity (European-type). Most traded options can be exercised at any time before maturity (American-type). Differential equations can still be written for these options but they have to be solved numerically. Some simplified models have been proposed by GESKE and JOHNSON (1984), WHALEY (1981) etc. Researchers have been able to relax many of the simplifying assumptions of the original Black-Scholes model. MERTON (1973) dealt with fluctuating interest rates. Different distribution assumptions can be used for the asset price. Stochastic variance can be accommodated. These models provide marginal pricing improvement over the Black-Scholes formula at the expense of a considerable computation time. Hence these models cannot be used by traders. Furthermore, the major input in the option pricing formula is the estimated future volatility (or the estimated parameters of its stochastic process) and no sophistication of the theory can help provide this forward-looking estimate. Finally the Black-Scholes formula is universally used on options markets and market prices of options have become Black-Scholes prices. Even if other models are “better” they will be proven wrong by the market which relies mostly on Black-Scholes formula. Option pricing models can be extended to deal with options on many types of assets (currency, bonds, etc.). Empirical tests of option models on Swiss data have been performed by CHESNEY and LOUBERGÉ (1987), WASSERFALLEN and ZIMMERMANN (1986), LEFOLL (1991) among others.

This contingent or arbitrage pricing approach has been extended to many assets. An important area is bond pricing and the term structure. Assuming a stochastic process for the interest rates, COX, INGERSOLL and ROSS (1985) derive a general bond pricing formula that rules out the possibility of arbitrage in the bond markets. This approach also allows to value all kinds of bonds\textsuperscript{10} such as indexed bonds, floating rate bonds, bonds with optional clauses, swaps etc. A review can be found in GIBSON (1990). Other type of contingent contracts, such as forward and futures contracts, can also be valued by arbitrage\textsuperscript{11}.

\textsuperscript{9} BLACK and SCHOLES give an explicit formula for the option price but it depends on the cumulative normal distribution which has no analytical expression and must be approximated by a polynomial expression.

\textsuperscript{10} See BRENNAN and SCHWARTZ (1977), RAMASWAMY and SUNDARESAN (1986).

\textsuperscript{11} See BLACK (1976).
Contingent contracts such as options and futures can be valued by arbitrage because their prices are directly related to that of the underlying security. If the underlying security price is the only source of uncertainty, an arbitrage can be constructed with the contingent contract and the underlying asset (2 assets and 1 source of uncertainty). If the interest rate is also assumed to be stochastic, an arbitrage portfolio can be formed with the contract, the underlying asset and the bond with a stochastic price (3 assets and 2 sources of uncertainty). The idea is that we need one more security than there are sources of uncertainty. This is clearly linked to the theory of complete markets. As usual in this area, it has spurred the development of rather mathematical theories of arbitrage. Formal treatments have been provided by HARRISON and PLISKA (1981) and HARRISON and KREPS (1979). This formal theory of arbitrage relies heavily on martingale theory. ROSS (1976) developed an Arbitrage Pricing Theory, known as APT, that prices all securities without an assumption about utility functions. Investors are only assumed to be risk averse. The major assumptions deal with the stochastic behavior of asset prices. Asset returns are assumed to be influenced by a limited number of common factors. The number of common factors must be much smaller than that of assets available to construct the arbitrage\(^\text{12}\). Hence the return on any asset \(i\) can be written as:

\[
r_i = \alpha_i + \beta_{i1} f_1 + \beta_{i2} f_2 + \ldots + \beta_{ik} f_k + \varepsilon_i
\]

where there are \(k\) common factors \(f_1\) to \(f_k\) and \(\varepsilon_i\) is a specific risk term that is uncorrelated with the common factors and the specific risk term of other assets. This assumption about the number of factors influencing asset returns may look innocuous but it yields powerful results. ROSS demonstrates that pure arbitrage portfolios can be formed that are both riskless and require no capital. Hence the expected return on these pure arbitrage portfolios must be zero. This leads to a mathematical condition on the assets expected returns that can be written as:

\[
E(r_i) = R_f + \beta_{i1} R_{P1} + \beta_{i2} R_{P2} + \ldots + \beta_{ik} R_{Pk}
\]

where \(R_f\) is the risk premium associated with factor \(j\). This pricing result looks like an extension of equation (2) of the CAPM. This is not the case and the two approaches are quite different. The CAPM is a traditional micro-economic utility-maximization equilibrium theory. It specifies what the single priced “factor” should be, namely the market portfolio. On the other side, the APT says nothing about the factors, what they should be and what their associated risk premia should be. The factors must be inferred from the

\(\text{12. This assumption is needed because the APT assumes the existence of } k \text{ common factors plus one specific source of risk for each asset (independent of all other risks). These uncorrelated specific risks get diversified away in a portfolio with a large number of assets.}\)
data. As such it is a purely empirical theory. To test the APT one must proceed in two steps: the factors and the asset ßs must be estimated in the first step and the linear pricing relationship tested in the second step. In a complex econometric methodology, the two steps can be conducted in parallel. CHEN, ROLL and ROSS (1986) provided an interesting empirical investigation. APT tests are open to criticisms similar to that of the CAPM regarding stationarity assumptions and statistical power. This has stimulated the development of original econometric methodologies.

The APT can be extended to an international framework where investors use different numeraires to measure returns.\(^\text{13}\)

### V. SOME RECENT DEVELOPMENTS

The theory of finance has developed fairly sophisticated dynamic models. Unfortunately the empirical side is lagging far behind because many variables, such as risk premia, are non observable. Expected returns must be derived from some simple assumptions about the distribution of asset prices. A common approach is to assume stationary distributions with expected returns constant over time. Since long time-series are used to estimate the models, this is a heroic assumption. A major line of recent research has been empirical. The time-series behavior of asset prices has been more closely examined and modelled. A good example is the work by WASSERFALLEN (1990) on expected and unexpected changes in nominal and real international variables. Hence a major trend of new research is the modelling of time-varying expected returns.

The presence of predictable time-varying components in expected returns on U.S. assets, especially common stocks, has been widely reported. A first approach\(^\text{14}\) has been to look at mean-reversion in returns; the presence of serial correlation in returns implies a predictable time variation of expected returns. The usual finding seems to be that asset returns exhibit positive serial correlation in the short-run and negative serial correlation in the long-run. A second approach\(^\text{15}\) has been to use instrumental variables observable at the start of the holding period to forecast return over the period. The instrumental variables that have generally worked well for U.S. stock returns are: the dividend yield, the term structure spread (long minus short-term rates), the default spread (yield on risky

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or junk bonds minus yield on investment grade bonds), the short-term interest rate level and its past change, a seasonal term (January).

The third approach has been to model the risk premium as a function of volatility of returns, with a positive relation expected between conditional volatility and risk premium. A traditional regression estimation requires a heavy two-step procedure as in SCHWERT (1990) but a more parsimonious and elegant approach is the GARCH-M model proposed by ENGLE, LILIEN and ROBINS (1987). This is a time-series model of the excess return where the variance of unexpected returns follows a GARCH process and is modelled to influence the mean return\textsuperscript{16}.

Once time-varying risk premia have been identified, we can engage in more powerful tests of asset pricing models. These tests are often formulated as tests of over-identifying restrictions on the estimated parameters as proposed in HARVEY (1989,1991). A powerful methodology has recently been proposed by FERSON and HARVEY (1991).

Similar findings have been reported for most stock and bond markets\textsuperscript{17}. In a recent paper, I looked at a risk premium model for the eight major stock and bond markets. The expected return over a period is explained by various economic variables, called instrumental variables, observable at the start of the period. Equity risk premia (expected return minus the national risk free interest rate) are not directly observable and will vary with the market volatility and changes in risk aversion. On the other side some other measures linked to risk are observable. This is the case for the term spread, i.e. the difference between long and short term interest rates, or for the default spread, i.e. the difference between corporate and government bond yield. The $R^2$ of the forecasting regressions reported in SOLNIK (1991) are small but significant. These risk premium models can be used in a dynamic strategy that attempts to exploit time-variation in risk premia. Of course the performance of this strategy must be tested on a period posterior to that of the model estimation. Extensive tests indicate that such dynamic strategies yield a large return compared to reasonable passive benchmark. This suggests either that capital markets are inefficient to some degree or that one should not assume that asset return distributions are time-invariant.

VI. APPLICATIONS TO FINANCIAL MARKETS AND INVESTMENT MANAGEMENT

Investment management is a major field of application for the theory of finance. Finance theory has helped rationalize investment management. It has focused on the trade-off between risk and return and helped provide tools for sophisticated risk management. This can be observed at many levels. I have chosen below a few areas where the change is most visible.

\textsuperscript{16} See also extensive tests on the U.S. market by FRENCH, SCHWERT and STambaugh (1987).
\textsuperscript{17} See SOLNIK (1991) and references therein.
1. Financial analysis

Financial analysis has always been the most traditional area of investment management. Financial analysis finds its roots in the translation of the financial accounts of the corporation to attempt to interpret them and derive a fair value of the firm. It required some detective work to analyze, correct and group various accounting items. Financial analysis progressively moved from a purely historical accounting approach to a more forward-looking analysis of the technical, commercial, and financial prospects of the corporation.

The focus of financial analysis changed over time. It became recognized that stock selection provided only a modest contribution to performance for large international portfolios. In a diversified portfolio, the contribution of any single investment is reduced. The major source of performance of an international portfolio is the asset allocation: the performance of the various markets and their associated currency gains/losses explain the major part of the performance of any large international portfolio. On the other side conducting a serious financial analysis of a large number of firms in many countries requires significant expenses. With the advent of theory, computers, and data bases, financial analysis of companies has become much more quantitative. Quantitative financial analysis has followed the two theoretical streams outlined above.

CAPM

The CAPM is an equilibrium theory that links the expected return on a firm to its systematic risk or beta. In a market that is quite efficient but not completely so, under or overvalued securities could be found. Hence equation (2) could be modified as:

\[ \text{E}(r_i) - R_f = \alpha_i + \beta_i (\text{E}(r_m) - R_f) \]

where \( \alpha_i \) could be positive or negative with a mean of zero. In practice analysts use a Dividend-Discount-Model to forecast the return \( E(r_i) \). This is the discount rate of an equation that equates the current stock market price to the discounted stream of forecasted dividends. Hence the Dividend-Discount-Model is a direct extension of what a traditional analyst does when he/she tries to forecast future earnings of the firm. The theoretical contribution is to adjust for the risk of the corporation in producing risk-adjusted expected returns.
APT

The application of Arbitrage Pricing Theory to financial analysis started with the development of various quantitative comparisons of firms' attributes. For example, many banks have developed screening programs where the financial database is made up of a large number of attributes, such as financial ratios, for each company. Hence one can select a firm on the basis of a combination of criteria (industry, leverage, book-to-market-value ratio, growth in earnings, ...). The more recent applications use those attributes within an APT approach. These models characterize each firm by its attributes and sensitivity to various factors. These factors could be explicitly identified as firm-specific attributes or econometrically estimated from the data. These factors are assumed to be priced in the market. Then security selection is conducted to detect firms that are under/over-valued given their sensitivity to the various factors. Alternatively, a money manager can place bets on some of the factors and select firms that have the largest exposure to these factors. Portfolio construction always requires a systematic control of the global risk of the portfolio, measured by the exposure to the various factors. Commercial models proposed by consultants such as BARRA or Roll-Ross follow this approach.

2. Asset allocation

The objective of portfolio management is to achieve the best performance for a given level of risk. The practical idea is to eliminate, through diversification, risks that are not rewarded in the market place and place risky bets on positions that are expected to provide attractive risk premia. Finance theory provides us both with a neutral benchmark, i.e. a strategy that would be normal if we have no particular expertise, and with techniques to use in order to take advantage of some expertise or forecasting ability that we believe we possess. At the market level this can be incorporated into a Mean-Variance asset allocation framework. Several firms provide such asset allocation optimizers using expected returns and the covariance structure of asset returns. Traditionally a long term strategic asset allocation is decided based upon long term trends and investment constraints set by the regulator or the objectives of the client. Periodically the asset allocation is tactically revised around its strategic setting to adjust to a changing environment. In the very short-run risk management is best achieved through hedging with futures and options.

The implementation of this approach is discussed in SOLNIK (1991) and ODIER, SOLNIK and MIVELAZ (1991). In that paper we demonstrate the advantage of global asset allocation, international bond and equity, for a Swiss pension fund.
3. Dynamic strategies

All empirical studies have shown that capital markets are very efficient. This is confirmed by the daily experience of investment managers that find difficult to consistently "beat the market". This has lead to the development of index funds, whose objective is solely to track a preassigned market index. It is reported that some 40% of the assets of US public pension funds and over 20% of the assets of UK pension funds are indexed.

There is a whole range of investment strategies that attempts to closely track the performance of a preassigned index while providing superior performance on the margin. These strategies may be qualified as disciplined strategies since they strictly follow the precepts of some explicit quantitative model to justify the deviations from the index. They range from very passive to quite active but stress risk control in all cases.

Some of the strategies rely on security selection within a market. Tilted indexing uses modern financial analysis to justify a portfolio composition that differs slightly from that of the index. Some of the strategies are domestic or international asset allocation strategies. Tactical asset allocation attempts to exploit time-variation in risk pricing. This strategy is based upon a forecasting model of conditional risk premia that is generally incorporated into a Mean-Variance optimization framework. Portfolio insurance and all the Minimum Guaranteed Return strategies use option pricing theory to design dynamic strategies that replicate a long term call option. These strategies guarantee to yield a (low) minimum return even if the markets fall and to (partly) benefit from the gains of a rise in the markets. Other types of dynamic strategies are or will be put to use involving derivative contracts such as futures and options on market indices and currencies.

All these strategies require a large data-processing investment to model the risks involved. They also require the conceptual base provided by modern finance theory either because they assume that the theory is correct (pure indexing or portfolio insurance) or because they try to exploit marginal deviations from the theory (tilted indexing, tactical asset allocation, etc.).

4. Hedging

Risk management is fine-tuned by using derivative products. For example a manager may be temporarily worried about the French stock market or US bond prices. Rather than selling the individual securities with high transaction costs, the manager can reduce his exposition to the French stock market risk or to the US interest rate risk by hedging with financial futures or options. For example he could sell CAC index futures or buy Treasury Bond put options.

The theory of hedging has been the theme of many articles and books. A preliminary question is why do futures and options markets exist since these instruments can be directly replicated with existing securities? As stressed by ADLER and DETEMPLE (1988) their existence must be linked to trading costs on existing securities. Hence they fulfil a
useful role by providing almost costless liquidity. An operational question is the determination of the optimal hedge ratio to be used. There exists only a limited number of futures and options contract to hedge all kinds of international risks, hence cross-hedging must often be used. Also the speculative and hedging motives will be combined in a single hedging decision. ANDERSON and DANThINE (1981) determined optimal cross-hedging policies.

5. Fixed income: valuation and risk control

Interest rates have become quite volatile in the past two decades. A discussion of the reasons for this interest rate volatility is not my topic today. However such a volatility, combined with the deregulation of fixed income markets and financial institutions, has created severe interest rate risks for financial institutions. Such risk can only be controlled if we have a sound conceptual framework to value all kinds of interest-rate-related contracts and instruments.

The asset pricing theory outlined above has been extensively applied to interest-rate instruments. The technical difficulty is that interest rates follow specific stochastic processes. Similarly the price of interest rate instruments, such as bonds or swaps, are constrained by the contractual arrangements made at certain dates in the future. Hence simple assumptions on the behavior of asset prices cannot be made. However modern finance theory has been extended to accommodate interest-rate instruments following the seminal work of COX, INGERSOLL and ROSS (1985).

Such quantitative models are required if complex instruments are to be issued. It is only because investment banks and traders could easily derive a good approximation for the fair price of a swap, a cap, an interest rate option and various optional clauses incorporated in bond issues, that the market for such instruments could develop.

Similarly banks need models to manage their global interest rate exposure. This exposure comes from their assets and their liabilities and is not easy to measure because of the optional clauses implicit in many instruments. Modern finance theory has allowed to develop such valuation and risk management models.

6. Performance measurement

Modern finance claims that markets are very efficient and hard to “beat”. In a competitive environment for money management, performance measurement is most important. However it should not only measure the total performance but also the risk borne and the decomposition according to the major investment decisions. Swiss money managers that compete for US or UK institutional funds are very familiar with the Anglo-saxon reliance on international risk/performance analysis. Performance measurement is only in its infancy within Switzerland and the recent attempts by Telekurs and the Swiss Banking
Association has met limited success. While a direct comparison of the performance and total risk (sigma) borne by a universe of managers is useful, we should be aware that more sophisticated performance measures that attempt to summarize the risk/return performance of an active manager by a single number à la TREYNOR/JENSEN (alpha), are questionable. The biases and problems with such measures have been summarized in GRINBLATT and TITMAN (1989) and theoreticians must develop more robust performance measurement methodologies before objective ranking of managers based on a single measure can be trusted.

To sum up, Finance has become a major field of economics. It has witnessed extensive research on the theoretical side and on the empirical side. In turn, this research has lead to the developments of concepts and techniques that have proven to be very useful for practitioners of investment management.
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