Tactical Asset Allocation: Predictability of Capital Markets Using Error Correction Models

M. Hartpence and J. Sikorav

Abstract

How to optimize returns of an international equity or bond portfolio? Which bets should we make between bonds and stocks on a domestic balanced portfolio? Access to capital markets has become increasingly easier for investors. In this context, the Tactical Asset Allocation (TAA), which refers to how a portfolio´s funds would be allocated, given the investor´s short-term forecasts, is an essential step in the management global process. Building market valuation instruments in order to identify opportunities will be the point of departure for TAA.

This paper introducts the evaluation models developed by CCF Structured Asset Management, CCF´s quantitative asset management subsidiary. These techniques cover the bond and equity markets of a group of industrialized countries. The approach involves the search of an "equilibrium" or "fair price" - based on long term relationships between market prices and a set of explanatory variables - and the identification of error correction mechanisms which drive observed market prices to equilibrium market prices. Model specifications have taken into account the global aspect of international economies and financial flows. In particular, the leadership of the United States, Japan and Germany are considered.

The results allow for the estimation of fair prices for each market, consistent with a general financial equilibrium. Deviations from equilibria are observed, which are indeed submitted to mean reversion forces, ensuring market efficiency in average. Tactical asset allocation will exploit arbitrage apportunities offered by deviations from the fair price.

Cointegration techniques have been used in model´s estimation. Examples of applications using model forecasts and optimization techniques are also presented.

Résumé

Comment optimiser la rentabilité d'un portefeuille d'actions ou d'obligations internationales. Quels paris prendre entre le poids des actions et des obligations dans un portefeuille diversifié domestique? A un moment où l'accès à l'ensemble des marchés de capitaux est devenu très aisé pour les investisseurs, l'allocation tactique d'actifs, qui conduit à faire des paris à court terme en fonction de l'évaluation des marchés, est aujourd'hui une étape primordiale dans le processus global de gestion. La mise en place d'outils d'évaluation devient alors un point de passage obligé.

Cet article présente la philisophie d'investissement et les modèles d'évaluation développés au sein de CCF Structured Asset Management, la filiale de gestion quantitative du CCF. Ils couvrent à la fois les marchés de taux ainsi que les marchés des actions. La ligne conductrice qui a été choisie pour construire ces modèles repose sur la mise en évidence de prix d'équilibre de long terme et de mécanismes de forces de rappel, qui tendent à ramener les prix de marchés vers l'équilibre. Les spécifications ont pris en compte la globalisation des économies et des flux financiers et le rôle particulier des Etats-Unis, du Japon et de l'Allemagne, dans la formation des prix sur les marchés internationaux.

Les résultats mettent en évidence pour chacun des marchés, des justes prix qui assurent la cohérence de l'équilibre financier global. Ils révèlent des écarts éventuels entre les prix de marchés et les prix d'équilibre: ces écarts temporaires sont soumis à des forces de rappel qui assurent l'efficience des marchés en moyenne. L'allocation tactique pourra toutefois exploiter les opportunités d'arbitrage qu'offrent ces déviations momentanées.

Des techniques de cointégration ont été employées pour l'estimation des modèles. Des exemples d'applications, en utilisant des prévisions des modèles et des techniques d'optimisation pour la gestion de portefeuilles sont également présentés.

CCF Structured Asset Management, 115, avenue des Champs Elysées, 75008 Paris (France); Tel: + 33-1-40 70 57 13/33 96/33 29, Fax: + 33-1-40 70 75 23.

Introduction

The most concise definition of the term "tactical asset allocation", or TAA, is the modification of a portfolio's composition according to the fluctuations observed in, and the returns expected from, different markets. This may be most the concise explanation, but it is hopelessly vague in terms of procedures. The function and place of TAA are, however, perfectly defined. As its name implies, tactical allocation follows on from strategic allocation, a preliminary phase which sets the structural average weights allocated to different asset classes (domestic and/or international equities, bonds, cash, property, etc.) based on the the liabilities. For example, TAA will prompt an investor at a given moment to give precedence to equities over bonds in a diversified portfolio, or to prefer Japan to the USA in an international equity portfolio. The purpose of TAA is certainly not to make place important bets that would involve a permanent deviation from the weights assigned via strategic allocation.

The issue is of cardinal importance. For example, by going 10% overweight in Swiss equities and 10% underweight in French equities in a European portfolio in 1995, a French investor would have achieved a performance of 11.6% compared with 9% for the MSCI index, a difference of nearly 260 basis points *ceteris paribus.*

Figure 1, which charts the performance of the main equity markets in French franc terms in 1995 clearly shows the potential importance of tactical decision-making.

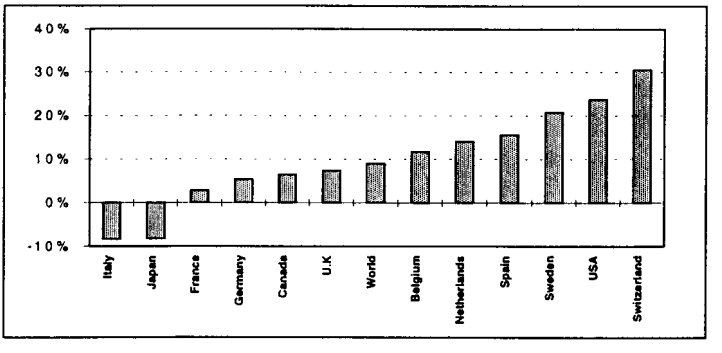

Figure 1 : Stockmarket performances in 1995 in French francs.

In its present form, tactical asset allocation was formalised in the late 1970s in the USA as a quantified, modeled and systematic method. The acid test came with the crash of October 1987, when virtually all TAA-based methods enabled investors to avoid taking a bath. Since then, TAA has spread rapidly, and many managers are now searching for the Holy Grail of the 1990s: Global TAA, which simultaneously takes into account all classes of financial assets.

It is difficult to conceive of TAA as a panacea given that markets are efficient (or almost). The invisible hand is at work and prices quickly reflect all available information as well as practitioners' expectations. Under these circumstances, just because an investor believes in a forthcoming economic recovery, it does not mean he should go overweight in the market – if everyone does the same then "the recovery is already in the price". The only bets that will be sought out and rewarded are those involving a deviation from consensus forecasts or inefficiencies that are by nature ephemeral.

TAA encompasses a set of active strategies generally based on an objective measure of the expected returns on different asset classes for a given horizon. The assessments are always framed in relative terms: should the investor prefer the French equity market to the bond market, Swiss stocks to British stocks, and so on and so forth? These measures are based on the principle that there is an equilibrium price, or "fair" price, which depends on market conditions and the information expected to filter through. Market conditions will include not only the prices of different asset classes but also maçroeconomic and financial variables such as inflation, deficits and expected earnings growth.

Once a deviation from fair value has been observed, the investor who implements a TAA strategy is assuming that prices will adjust to the equilibrium level within a "reasonable" timeframe via an adjustment of relative prices across asset classes. Often, TAA will focus on assets whose prices have fallen significantly in the recent past and will underweight markets that have risen strongly.

The ultimate aim of implementing a TAA process is to compose a portfolio. It is not sufficient to decide simply whether to prefer a particular market; it is also necessary to determine to what extent one should go overweight or underweight. Consequently,

optimisation tools are an integral part of TAA, making it possible to strike a balance between the expected risks and returns of various portfolios.

In this paper, we will discuss the approach followed by CCF-SAM, the quantitative management subsidiary of Crédit Commercial de France, and present the proprietary tools used to manage portfolios on a daily basis. The first part of this paper deals with the principles and hypothesis of market valuation. Particularly the use of cointegration techniques - for estimating the equilibrium price of markets - and error correction models for forecasting are discussed. In the second and third parts we present the models for interest rates and equities. In the last section, we give examples of TAA strategies.

I. Market valuation

I.1 Modelling financial variables

There is a substantial body of economic and financial literature that attempts to explain how interest rates, equity prices and exchange rates are formed. In the search for a common thread linking all these theories, two ideas are almost systematically put forward. The first is the risk premium principle. Because economic agents are risk-averse, they demand a higher return on risky investments. Under these circumstances, the random nature of investment returns is one of the principal factors in valuing assets. The second idea is predicated on the principle that financial assets have an equilibrium price at a given moment, *ceteris paribus*. These prices give practitioners the possibility of allocating their wealth in optimum fashion, depending on their risk aversion. If an asset price deviates persistently from the equilibrium price, practitioners should modify their allocation in order to take advantage of this opportunity. Within the theoretical framework of perfectly efficient markets, prices are always at equilibrium levels.

Let us now turn our attention to the different types of forecasting models. On the one hand, we have the well known models relying on technical analysis.

On the other hand, we have models (used for explanatory or forecasting purposes) that will attempt to reveal the equilibrium price of an asset. To estimate these models, we now have a body of long-run data series. These data may be purely macroeconomic or

concern asset prices. At one end of the spectrum, we find models that attempt to analyse homogenous sets of purely financial data. At the other end, we find models that take explicit account of economic fundamentals, and that, in some cases, will attempt to forecast key macroeconomic variables like inflation, money supply aggregates and real economic growth. In this case, forecasts for financial assets will be an outgrowth of a broader, unified model based on a macroeconomic scenario.

Because of our investment philosophy, we have a close affinity with the latter approach. We believe that certain economic fundamentals are related and that those relationships are transmitted to the financial markets. However, our aim is not to implement such unified and global models. The macroeconomic scenario used to forecast the performance of financial assets will be provided directly by the market consensus.

Our models are based on three ideas which we believe capture important characteristics of financial market behaviour :

- An equilibrium or fair price can be identified for an asset at any given moment. That price, which reflects investor preferences, depends on the information or expectations available at the moment in question.
- Markets are efficient on average. A market is perfectly efficient if asset prices reflect all the information available at every moment, in other words, it always reflects its fair price. In this case, it is pointless to try and predict future fluctuations: a price movement simply reflects the arrival of fresh information. It is hard for us to accept such a strong theoretical view. However, we believe that, in average terms, prices fluctuate around their fair level. Under these circumstances, it is possible to detect moments – however fleeting – of overvaluation or undervaluation that offer opportunities to the attentive investor. Naturally, this approach will prompt us to build valuation and price forecasting models.
- Markets are interdependent. Prices quoted in international financial markets are correlated. Their movements are partly influenced by economic cycles, which are themselves closely inter-related, and partly by capital flows. Furthermore, certain markets act as leaders for the rest of the world. The ripples from an interest rate cut in the USA, Japan or Germany spread to the rest of the world; conversely, interest rates in these countries are rarely influenced by monetary policy decisions in a peripheral

country. We believe that the dominance of the "leading" countries is also reflected in the equity markets and exchange rates.

Our market valuation approach can be broken down into two main components. We compare all major long-term interest rate markets with the corresponding money markets, taking into account a set of macroeconomic variables. We simultaneously evaluate the equity markets, incorporating information on the level of interest rates. Note that in practice the decision as to whether an investor should expose himself to a particular currency or group of currencies can be taken independently from the equity and bond allocation process.

I.2 Market valuation and forecasting techniques

We pursue a twin objective with our valuation models. First, we try to find a "measure" of the equilibrium value or fair price of different asset classes at the present time. From this point of departure, and taking into account existing disequilibria, we attempt to project the most probable future trajectory, with an economic-scenario hypothesis that generally stems from the market consensus. Thus the process consists of two stages. First, we estimate a long-run equilibrium relationship - with the aim of identifying the « fair » price of the market - ; then, we use the short-run dynamics around the equilibrium, the only measure that truly allows us to move onto the forecasting stage.

a) Long-run equilibrium

Let us briefly recall the main points of the long-run equilibrium principle. By "long-run equilibrium" we simply mean an average (linear) relationship, structurally observed, between the level of a variable y_t (which we wish to explain) and a group of (explanatory) variables x_t:

$$y_t = \alpha + \beta x_t + u_t$$

where α and β are the coefficients of the long-run equilibrium relationship, and u_t is the deviation between the variable y_t and its long-run level $\alpha + \beta x_t$.

That relationship is considered as a long-run equilibrium if the deviations $u_t = y_t - \alpha - \beta x_t$ are zero mean and stationary[1]. This qualifying remark is based on the intuition that y_t is subject to a mean reversion force (error correcting force) pushing it towards its long-run equilibrium (the « fair value » of the variable) y_t^*:

$$y_t^* = \alpha + \beta x_t$$

The search for the fair or equilibrium value y_t^* leads us to identify a relationship whose residuals are stationary, whereas the time series (financial time series) on which these models are built are almost never stationary. This observation takes us to the heart of the concept of cointegration; cf Engle and Granger (1987), Shiller and Campbell (1988), Ericsson (1992) and Phillips Loretan (1991), Shiller and Campbell (1987). Suposse, for example, that (i) two series, x and y, are *integrated of order one*, meaning that the series are nonstationary but their derivatives are stationary ; (ii) a linear combination ot these two variables exists which is stationary :

$$u = y - \alpha - \beta x.$$

We say that x and y are cointegrated (of order (1,1)) . Then, finding cointegration between two variables can be thought as finding a long run equilibrium relationship between these two variables.

Let us consider, for example, the problem of estimating a long-run equilibrium relationship between long term rates in France, short term rates, inflation and other macroeconomic variables taken as explanatory variables. We have estimated a long-run equilibrium relationship from an econometric viewpoint:

Long-run equilibrium rate = $\alpha + \beta$ short term rate+ γother variables. (I.1)

This relationship qualifies as a long-run equilibrium because, in average terms, the historic level of French long rates is formed by the linear combination of the short-term rate and the other variables. Figure I.1 shows the long rate observed in France since 1984, and the long equilibrium rate computed with equation (I.1).

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[1] A variable u_t is said to be stationary to the second order when its mean and variance are constant over time, and its covariance $\mathrm{Cov}(u_t, u_{t+h})$ depends only on h .

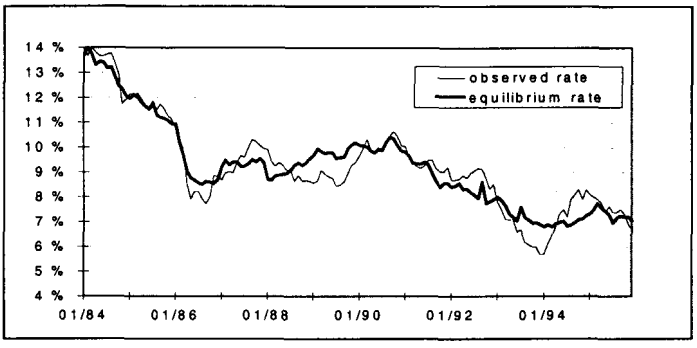

Figure I.1: France. Observed long-term interest rate and long-run equilibrium interest rate.

The historical interest rates visibly hang around the equilibrium rates. Computing the difference between the observed rate and the equilibrium rate, i.e. the residual of the preceding equation, we note that this residual fluctuates but cannot move lastingly away from 0. Figure I.2 shows this residual.

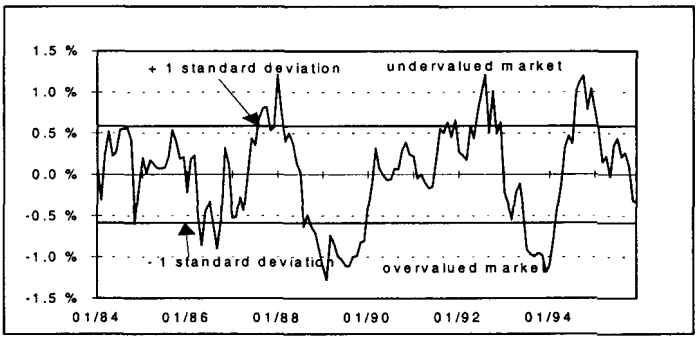

Figure I.2: France. Difference between observed long-term interest rate and long-run equilibrium interest rate.

The fact that this long-run relationship exists implies that the market price cannot deviate from the equilibrium price for long. Thus when significant residuals are observed, as was the case in France at end 1993, it constitutes a signal that the bond market is either over- or undervalued.

Furthermore, estimating an equilibrium relationship makes it possible to compute long-run elasticities, which provide information on how prices are likely to respond to the

propagation of an instantaneous shock occurring in the explanatory variables. For example, we can measure the long term interest rates observed in France one year after the worldwide rise in short term interest rates. This also enables us to verify that the specification of the model actually produces acceptable macroeconomic properties.

b) Short-run dynamics and forecasting

When examining the mechanism that causes short run fluctuations around equilibrium prices, two aspects must be taken into account. Note that it is one thing to be aware of the existence of an equilibrium price; verifying that market prices return to this level in the shortest possible timeframe is another. And yet this latter aspect is vital in portfolio management because, from a tactical allocation perspective, the investment horizon is measured in months, not years. Consequently, the first aspect of short-run dynamics involves the nature and intensity of the force that drives prices back towards equilibrium. A synthetic representation of that force is given by the speed of adjustment towards equilibrium.

Also, short-run dynamics will be influenced by a change in the explanatory variables over a short period of time, say one month. The impact on the future pattern of market prices can be measured by short-term elasticity, estimated by means of the model.

Lastly, taking the equilibrium price and short-run dynamics into account, the market price can be broken down as follows:

$$\text{Market price} = \begin{cases} + & \text{Equilibrium price} \\ + & \text{Adjustment towards} \\ + & \text{equilibrium} \\ + & \text{Other short-run effects} \\ & \text{Unexplained term} \end{cases}$$

Take the case of a simple model where y_t is the price and x_t is the variable explaining that price. The equation that models y_t will have the following form:

$$y_t = \alpha + \beta x_t + \rho(y_{t-1} - \alpha - \beta x_{t-1}) + \sum_{i=0}^{n} \gamma_i \Delta x_{t-i} + \varepsilon_t \qquad \text{(I.2)}$$

– α and β are the coefficients estimated for the long-run relationship, and the term $\alpha + \beta x_t$ is the equilibrium price.

– The dynamics of return towards equilibrium is given by $\rho(y_{t-1} - \alpha - \beta x_{t-1})$, i.e. the deviation of the price observed in the previous period from its equilibrium price (u_{t-1})multiplied by a coefficient ρ. This coefficient ρ, which measures the mean reversion force, varies between 0 and 1: a coefficient close to 0 indicates a strong mean reversion force, and the deviations from equilibrium are quickly retraced. A coefficient close to 1 indicates that the force is weak, i.e. that significant deviations persist.

– The term

$$\sum_{i=0}^{n} \gamma_i \Delta x_{t-i}$$

where $\Delta x_t = x_t - x_{t-1}$ measures the other short-term effects due to the variations of x_t in the period t and the previous periods. The coefficients of this term are used to compute short-run elasticities.

– ε_t is an error term (white noise).

Note that for $n = 0$ (the effect of Δx_t is only contemporary) equation (I.2), can be written as follows:

$$\Delta y_t = (\beta + \gamma)\Delta x_t + (\rho - 1)(y_{t-1} - \alpha - \beta x_{t-1}) + \varepsilon_t \qquad \text{(I.3)}$$

Equation (I.3) is normally called an error-correction equation. In this example, we can see more clearly that the change of y_t is a function of the change of x_t and of the deviation of y_t from the equilibrium price observed during the previous period, to which we add a noise ε_t.

When used for forecasting, the model will take into account both the long-run and the short-run dynamics. Thus the expected value of y in the period $t+k$ is given by the sum of four terms:

$$y_{t+k} = \begin{cases} \underbrace{\alpha + \beta x_{t+k}}_{1} \\ \underbrace{+\rho(y_{t+k-1} - \alpha - \beta x_{t+k-1})}_{2} \\ \underbrace{+\sum_{i=0}^{n} \gamma_i \Delta x_{t+k-i}}_{3} \\ +\varepsilon_{t+k} \end{cases} \qquad \text{(I.4)}$$

The first term of equation (I.4) corresponds to the new expected equilibrium. The second term measures the impact of the mean reversion force (the speed at which the market price adjusts towards the equilibrium price); the impact is stronger if the market has been mispriced in the previous period and if ρ is close to 0. The third term underscores the impact of short-run effects related to the new levels of the explanatory variables.

As we can see, it is necessary for forecasting purposes to set the future values of variable x. In our models, we generally rely on consensus forecasts of exogenous variables, except in the case where, for a particular country, we use a scenario that differs substantively from the consensus. Figure I.3 illustrates the forecasting mechanism.

Various methods are known for estimating error-correction models (see Bresson and Pirotte (1995), Mills (1990)). readers can find recent development in the econometrics of this type of models).

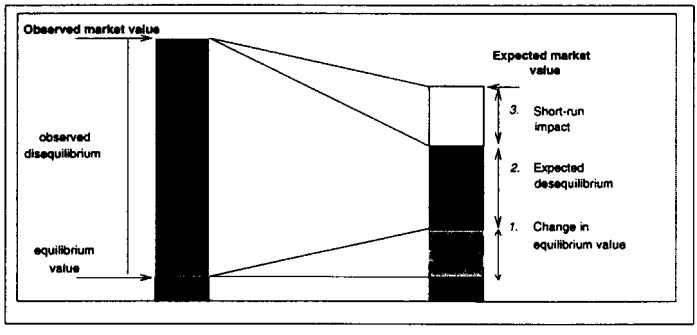

Figure I.3: The predicting mechanism.

We have chosen the technique proposed by Philips and Loretan (1991) where the long-run equilibrium y^* is estimated at the same time as the short-run dynamics described by equation (I.2), avoiding some bias estimation problems for the long term coefficients..

Also, given our global view of the capital markets, we try and identify simultaneously the various equilibrium relationships, which makes the estimation process even more complex.

I.3 Optimisation

Moving from a forecast of future returns to the composition of a portfolio involves a phase of optimisation. Here we will use the risk and diversification properties of different assets. In general, these properties are summarised in the historic variance-covariance matrix of returns ω, which can be used in the optimisation if we have no forecasting model to hand. If such a model is available, our view of risk changes. Ultimately, with a perfect forecasting model, risk would disappear altogether because the investor could place infallible bets! The real risk is that he will make a mistake. In practical terms, this means that we have to use the variance-covariance matrix ϖ of forecasting errors. In our optimisation process, therefore, we take into account both the forecasts of returns to different markets and the level of uncertainty that surrounds them. We seek to maximise the portfolio's expected return under the constraints of total volatility, or tracking error relative to the strategic benchmark, measuring the risk by ϖ, the estimate of the variances-covariances dependent on the model's residuals.

II. Valuation model for international bond markets

In this section, we present the model we use to value international bond markets. It has been designed to focus solely on the outlook for 10-year bond yields. Levels of economic activity and short-term rates are exogenous variables in the model. We observe their past value and use the market consensus of their expected future value. However, the reader should <u>not</u> take this to mean that we believe the consensus can reliably forecast short-term rates or inflation. We use consensus expectations only as ancillary information that plays a part in the formation of market prices.

We believe that long term interest rate formation in each country is strongly influenced by domestic fundamentals. These include short-term rates (which reflect economic activity and monetary policy); expected inflation, which will lead investors to adjust their required returns; government deficit/GDP ratios, which act as an indicator of the risk incurred by lenders; and additional information on the supply of paper in the markets.

Aside from the influence of domestic fundamentals, we believe that the world bond market is a global market. But, like in any community, some markets are "more equal than others". In our view the bond markets can be divided in two separate groups: the bellwethers or "leading" countries – the USA, Germany and Japan – and the "satellites".

II.1 Specifications

At present, 14 countries are modelled: the USA, Germany, Japan, France, the United Kingdom, Italy, Switzerland, Belgium, Denmark, the Netherlands, Spain, Sweden, Australia and Canada.

For long-run equilibrium interest rates, we estimate the structural relationships in the following form:

$$TL^*_{j,t} = \Phi_j \begin{pmatrix} \bullet\ \mathrm{TL}^*_t \text{ of leading countries} \\ \bullet\ \text{domestic real short - term rate} \\ \bullet\ \text{inflation rate} \\ \bullet\ \text{other domestic variables} \end{pmatrix} \qquad \text{(II.1)}$$

with

$TL^*_{j,t}$ long-run equilibrium rate of country j in period t

Note the "simultaneity" of this model: the long-run equilibrium rate of one leading country depends on the equilibrium levels in the other two.

The reduced form[2] of the model produces a specification for the equilibrium rate in which we find not only domestic variables but also those of the leading countries.

[2] The reduced form is the resolution of the structural form; the endogenous variables (to be solved) are expressed as a function of the exogenous (explanatory) variables.

$$TL^{*}_{j,t} = \overline{F_j}\left(\begin{array}{l} \bullet \text{ domestic real short - term rate} \\ \bullet \text{ domestic inflation rate} \\ \bullet \text{ other domestic variables} \\ \bullet \text{ short - term real rates of leading countries} \\ \bullet \text{ inflation rates of leading countries} \\ \bullet \text{ other domestic variables of leading} \\ \quad \text{countries} \end{array}\right)$$

The short-run dynamics highlights the mean reversion force and the short-run impacts. Furthermore, it is possible to break down the long-term interest rate for each country j in period t into four terms:

$$TL_{j,t} = \begin{cases} TL^{*}_{j,t} \\ +\rho_j(TL_{j,t-1} - TL^{*}_{j,t-1}) \\ +\phi_j(\text{other short - run effects}) \\ +\varepsilon_{j,t} \end{cases} \qquad \text{(II.2)}$$

where:

$TL_{j,t}$ Observed long-term interest rate in country j in period t,

ρ_j Coefficient that measures the system's mean reversion force applying to the deviation from equilibrium noted in the preceding period,

ϕ_j Function of variables that measure other short-term effects,

$\varepsilon_{j,t}$ Error (white noise) of country j in period t.

II.2 Results

The model was estimated using monthly data beginning with January 1984. We have been able to highlight a marked change in regime in the early 1980s. At that time, the developed countries radically overhauled their monetary policies. A decline in inflation went hand in hand with a sharp rise in real interest rates, as shown by the example of the United States (Figure II.1). This abrupt break in the pattern significantly changed the level of prices and premia in all of the markets.

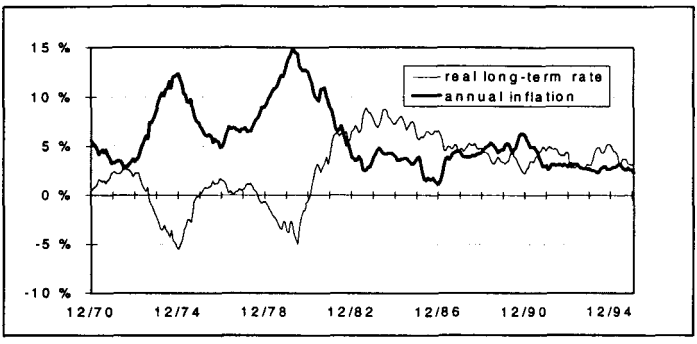

Figure II.1: United States.Inflation and real long-term interest rate.

Our data on short-term interest rates are 3-month money market rates; the long-term rate data are those for 10-year government bond yields.

During the estimation period, on average 60%-90% of the variance in long-term rates is explained by the long-run relationships. The reader should not be misled by these high figures because the variables have been modelled in terms of level, not variation. When interest rate changes are considered, between 20% and 40% of the their variance is explained by the model in average, which is still relatively high and shows that the short-run dynamic specifications are accurate.

In all of the countries, the deviations from equilibrium are indeed stationary according to our econometric tests, specifically the Augmented Dickey-Fuller test, using the critical values described in Engle and Yoo (1987). Any significant deviation from equilibrium is subject to a mean reversion force, the intensity of which varies by country. Figure II.2 shows that half of a deviation from equilibrium disappears in three months in Japan, whereas it takes an average of nine months in Germany and more than a year in the USA. From this perspective, the Japanese bond market should be most easily predictable.

These orders of magnitude point clearly to the tactical moves that we can make. While we cannot hope to predict the value of, say, the Bund contract for tomorrow, our models do show the direction for several months.

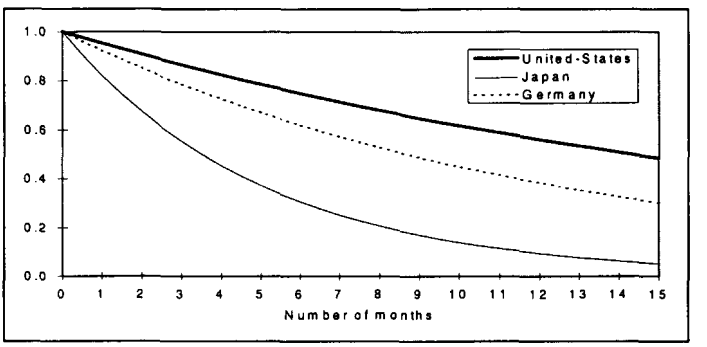

Figure II.2: Time required to retrace a deviation from equilibrium.

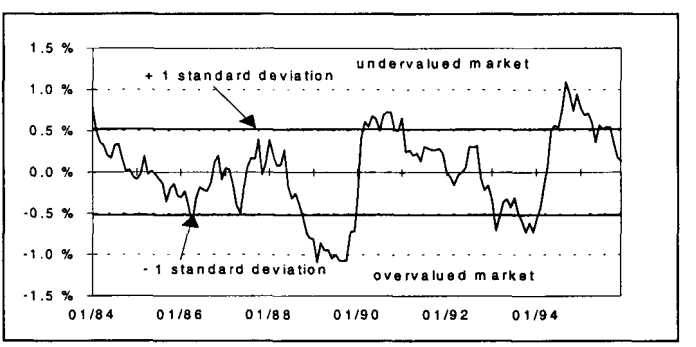

Figure II.3: Germany. Difference between observed interest rate and long-run equilibrium interest rate.

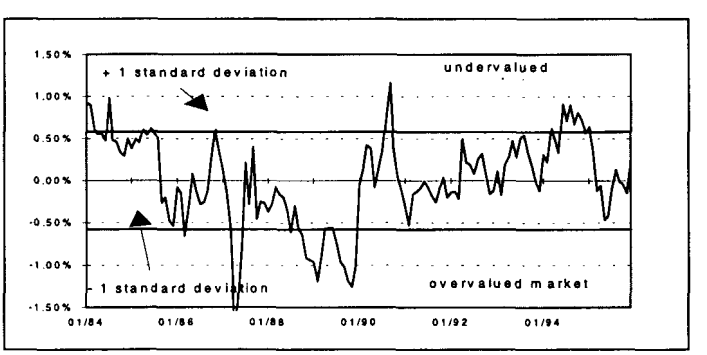

Figure II.4: Japan. Difference between observed interest rate and long run equilibrium interest rate.

Figures II.3 and II.4 show the long-run deviations from equilibrium as indicated by our models for Germany and Japan. The German model highlights the major trend reversals in the market for the period: the rise in long-term rates at the time of German unification, the February 1994 bond-market crash and the bull market of 1995. Likewise for Japan, the model identifies the market's sudden overvaluation in April-June 1987, the bear market of 1988-1990, and the upturn that began in 1991.

We have estimated the model's main long-run elasticities. This makes it possible to measure the impact on bond yields of, for example, an across-the-board rise in (real) short-term rates, as shown in Figure II.5. Whereas the Japanese, Canadian and US bond markets are highly sensitive, the French market recorded less of an impact. This point is probably related to central-bank policy during periods of monetary turmoil: fluctuations in short-term rates were cushioned to a great extent by long-term rates.

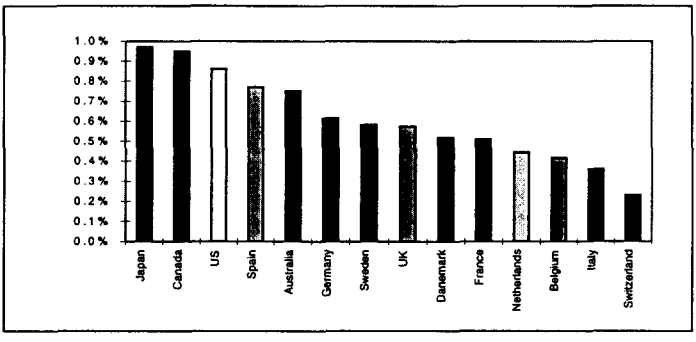

Figure II.5: Impact on long-term rates from a generalised 1% rise in short-term rates.

We also estimated the change in long-term rates following a generalised 1% rise in the rate of inflation. Figure II.6 shows that the impact is sizeable for countries such as Spain, France and Italy, probably because investors question the likelihood of further declines in inflation and therefore require a sharp rise in long-term rates. The UK is a special case, having experienced an inflationary bubble in the late 1980s without a concomitant rise in interest rates.

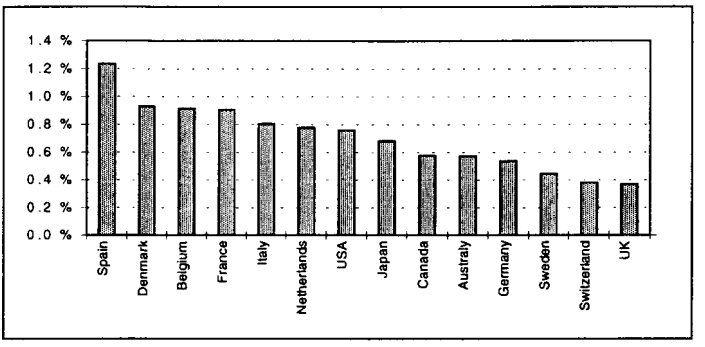

Figure II.6: Impact on long-term rates from a generalised 1% rise in inflation.

Lastly, we estimated the out of sample model's quality, over five years beginning in 1991. Each month, we forecast interest-rate movements for the following month using the estimated model and the data available at that time only. The quality of the forecasts is relatively satisfactory since we managed to predict 60% of the market's movements. (However, a random guess would be expected to score a 50% success rate.) The R-squared, out of sample (the predicted changes in long-term rates are compared with the observed changes, using an R-squared) averaged 20% for the 14 markets. Although these results might disappoint an econometric analyst, they are significant enough for a financial professional since they prove that the markets do have some degree of predictability.

III. Valuation model for international equity markets

This section describes our valuation model for equity markets. The model relies on basic concepts from the dividend discount model (DDM), which we briefly review below.

III.1 Brief review of the dividend discount model (DDM)

How should an equity market be valued, and what are the major forces that drive the market? A stock investor is willing to make an initial investment on the expectation of future dividends and a resale price. That price is in turn based on market expectations of the company's ability to pay future dividends.

This is one of the central features of the dividend discount model (DDM), which can be used to obtain an overall valuation of markets. Let us briefly review the main assumptions and results.

Take the case of a company that pays an annual dividend D, growing at rate g. By discounting an infinite cash flow of future dividends at a required rate of return r, we can calculate the equity price P using the well-known formula given by Gordon and Shapiro (1956).

$$P = \frac{D}{r-g} .$$

The equation can be restated as an expression of the dividend yield.

$$\frac{D}{P} = r - g . \qquad \text{(III.1)}$$

If we assume an expected dividend payout d and the price-earnings ratio (P/E), we obtain:

$$P/E = \frac{d}{r-g}$$

Unfortunately, few of the variables in these formulae are known with certainty – only the price is observable. Future earnings, the payout ratio and the expected return all fluctuate and can only be estimated. The expected return can be approximated by using a benchmark long-term interest rate plus a risk premium to compensate the investor for the uncertainty that surrounds the flows he will receive. Expected earnings growth is determined both by an analysis of companies' short-term prospects and by a medium to long-term sectoral or macroeconomic forecast. It quickly becomes evident that, with this model, a change in long-term interest rates can have a huge impact on the stock price. The Gordon and Shapiro formula often leads to apparent durations of more than 30!

The model can be made more realistic by recognising the random nature of dividend growth. If we assume that dividend growth is normally distributed with mean g and variance σ^2 we can demonstrate (Lepeltier et Richard-Hidden, 1992) that equation III.1 for the dividend yield changes as follows:

$$\frac{D}{P} = r + \frac{\sigma^2}{2} - g. \qquad \text{(III.2)}$$

Formula III.2 tells us that a share with highly random dividends must offer a higher dividend yield. In practice, stocks taken individually respect this theoretical formula, but only after numerous short-term deviations. Arbitrage does not occur immediately, especially since the magnitude of possible error in estimating future dividend growth is often great. When the model is aggregated for an entire stockmarket, the individual errors tend to cancel each other and the model becomes much more robust. However, the forecasts still contain a high degree of randomness, as shown by Figure III.1, which graphs earnings upgrades and downgrades in Italy during 1995. As we see, summer's optimism had wilted by year-end.

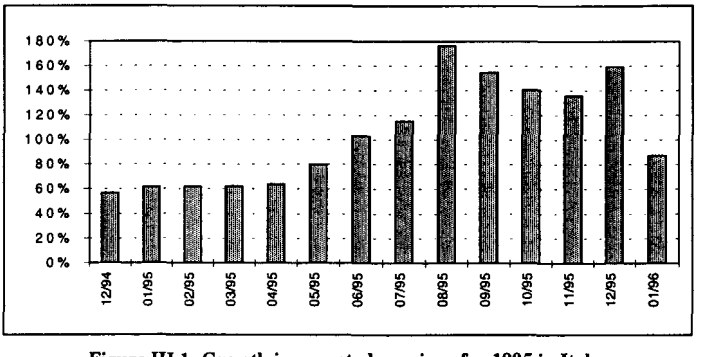

Figure III.1: Growth in expected earnings for 1995 in Italy.

III.2 The model

Our aim is to estimate a model either on the market's dividend yield or on its P/E reciprocal. The expected dividend yield or P/E reciprocal will factor in long-term

interest rates as well as inflation and expected dividend (or earnings) growth. The expected premium to the market will be revealed using econometric methods.

One assumption implicit in a DDM approach, which is a present net value model, is the stationary nature of the discount rate and the dividend growth rate -- and therefore also the dividend yield. In practice, market realities belie this assumption. Only rarely do series successfully pass the test of stationarity. However, these series do show significant trends, even over periods as long as 10 or 20 years. But it turns out that these trends are "similar", which is mathematically reflected in the fact that we can find (linear) combinations of these trends that are stationary, i.e. the series are cointegrated. This is particularly true for dividend yields and interest rates. Figure III.2 illustrates this relationship for the United States:

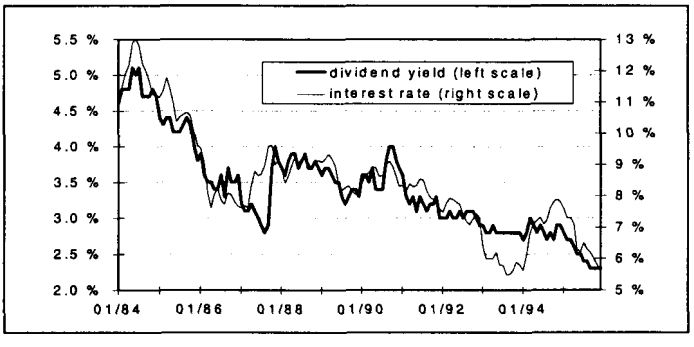

Figure III.2: United States. Dividend yield vs 10 year bond yield.

We will therefore confine ourselves to highlighting the long-run equilibrium for the dividend yield, relying for this on the cointegration between the dividend yield, interest yield, inflation and the growth rate.

The same leading-country "influence" seen in the bond markets is also found in the equity markets, where it is transmitted via the equilibrium relationship of long-term rates.

Wall Street seems to play a special role, since its fluctuations also influence all the other markets directly. Figure III.3 shows the close link between the US and French markets, especially in periods of sharp fluctuations.

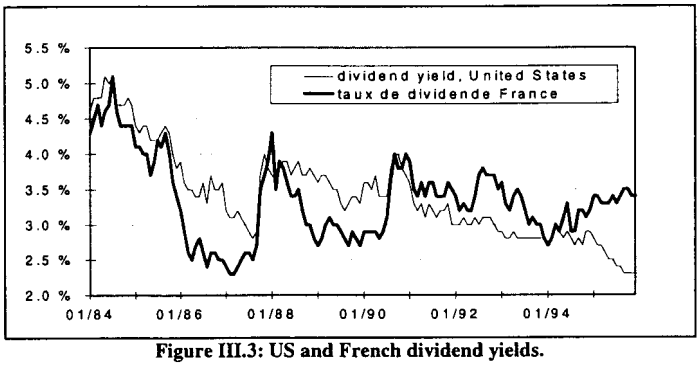

Figure III.3: US and French dividend yields.

III.3 Specifications

To model the equilibrium level of the US market, we make an econometric estimate of the long-run relationship between dividend yield, domestic long-term interest rates and inflation, and expected dividend growth. For the other countries, we model the long-run equilibrium of the dividend yield using domestic long-term interest rates and inflation, expected local dividend growth and the equilibrium level of the US market. We thus have the structural form:

$$\left(\frac{D}{P}\right)^{*}_{j,t} = \Phi_j \begin{pmatrix} \bullet\text{(Equilibrium of US market)} \\ \bullet\text{Domestic long - term interest rate} \\ \bullet\text{Domestic inflation} \\ \bullet\text{Expected dividend growth} \end{pmatrix}$$

where:

$\left(D/P\right)_{j,t}$: equilibrium dividend yield in country j in period t

A country's equilibrium level thus depends, via the US equilibrium dividend yield, on the interest rate, inflation and the rate of growth in the USA. The specifications of our interest-rate model also mean that the equity markets depend not only on the US bond market, but also on the level of long bond yields in Japan and Germany. The reduced form of our model becomes:

$$\left(\frac{D}{P}\right)^{*}_{j,t} = \overline{\Phi}_j \begin{pmatrix} \bullet\text{(US domestic variables)} \\ \bullet\text{Long bond yields in leading countries} \\ \bullet\text{Domestic long bond yields} \\ \bullet\text{Domestic inflation} \\ \bullet\text{Expected dividend growth} \end{pmatrix}$$

Taking account of short-run influences, the observed dividend yield for each country j in period t is:

$$\left(\frac{D}{P}\right)_{j,t} = \begin{cases} \left(\frac{D}{P}\right)^{*}_{j,t} \\ +\rho_j\left(\left(\frac{D}{P}\right)_{j,t-1} - \left(\frac{D}{P}\right)^{*}_{j,t-1}\right) \\ +\phi(\text{other short - run influences}) \\ +\varepsilon_{j,t} \end{cases}$$

where:

$(D/P)_{j,t}$ observed dividend yield in country j in period t,

ρ_j coefficient to measure the system's mean reversion force applying to the deviation from equilibrium noted in the preceding period,

ϕ_j function of variables which measure other short-term influences,

$\varepsilon_{j,t}$ error (white noise).

III.4 Results

The model was estimated with monthly data since 1984. Our working sample represents nearly 13,000 companies around the world to which we make daily electronic "visits". For countries where our model is based on earnings (e.g. Japan), we calculate expected earnings growth for the entire market by aggregating the consensus data provided by I/B/E/S. For the other countries, we calculate expected dividend growth from the aggregated earnings consensus and an estimated payout function for each market. This

payout function is not symmetrical. Dividend growth shows a degree of inertia and reacts only slowly to news about earnings. Thus the payout tends to rise in periods of slacker earnings growth and decrease when earnings soar.

In the estimation period, the model provides sound results for the variance explained in terms of level. The average R-squared is around 70% with a number of peaks, like those occurring in the USA, where correlation is nearly 85%. When forecasting changes in dividend yields, the model's properties are still highly satisfactory, with an average explained variance of 40%. The econometric tests validate the stationarity of the deviations from equilibrium: these are quickly retraced, as can be seen, for example, in the US market (Figure III.4). The sharp correction of October 1987 is clearly visible. The market looks expensive in the recent period, even though the decline in interest rates in 1995 gave strong support.

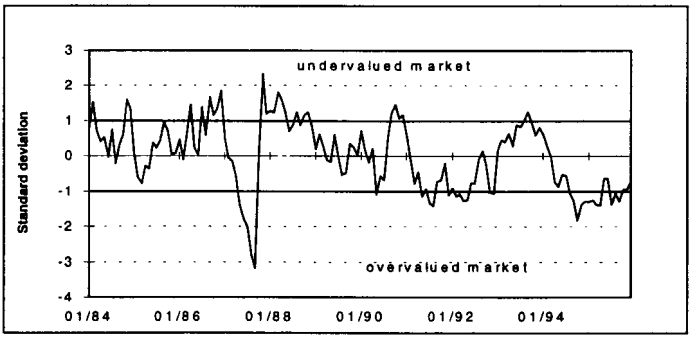

Figure III.4: Deviation from long-run equilibrium - US market.

The speed of adjustment to equilibrium (Figure III.5) is of the same order as in the bond markets.

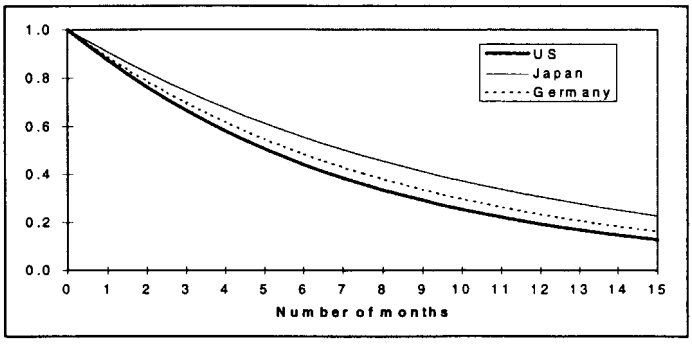

Figure III.5: Time required to retrace a deviation from equilibrium.

We measured the long-run elasticity in the equity markets in response, *ceteris paribus*, to a general 1% interest rate shock. Figure III.6 seems to indicate that the leading countries have a much stronger duration than the other countries: this estimated duration for the stockmarkets is relatively realistic and corresponds closely to average intuition of markets.

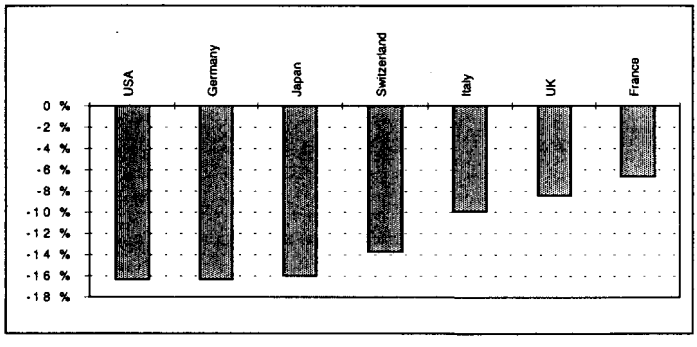

Figure III.6: Percentage variation in stockmarkets after a 1% shock in bond yields.

As in the case of bond markets, we are ultimately interested in the quality of the model when used outside the sample. We performed the same simulation on a five-year period beginning in 1991 and made a monthly forecast of the following month's return. Our forecasts are based on our expectations for long-term yields provided by the bond-market model. On average, we manage to predict nearly 60% of the increases or decreases ahead for all the markets.

IV. Applications of tactical asset allocation (TAA)

Armed with risk/return forecasting models, it is possible to place tactical bets on any reference target. In this final section, we present examples of portfolio management operations based on our valuation models. Since the scope of application is broad, we focused on two portfolios, one domestic and the other international, for a French investor.

IV.1 Domestic TAA - a French example

Here we present an example of an investment strategy in the French market, implemented using our tactical allocation process.

This strategy seeks to beat a diversified equity/bond/cash benchmark portfolio. The benchmark portfolio is weighted between French bonds (represented by the CNO index), in money-market instruments indexed to the overnight money-market rate (TMP), and in French CAC40 equities with dividends reinvested. The portfolio is monthly rebalanced on the basis of expectations for French equity and bond yields and the results obtained with our optimisation tools. We limit the portfolio's deviations from the benchmark by holding the tracking error (relative risk) to 3%. We also imposed the constraint that the portfolio could not be more volatile than the benchmark.

The strategy was tested on five years from 1991 onwards. The results are shown in Table IV.1 and Figures IV.1 and IV.2. The strategy outperformed the index by an average of 200 basis points per year under the risk constraints we set for ourselves. Figure IV.1 shows that the outperformance was achieved consistently over time, which corroborates the validity of our models.

Table IV.1: CCF-SAM strategy vsequally-weighted benchmark

	CCF-SAM strategy	Benchmark
Overall performance	12.06% per year	9.72% per year
Annualised volatility	6.70%	6.50%
Tracking error	2.76%	-
Information ratio	0.81	-

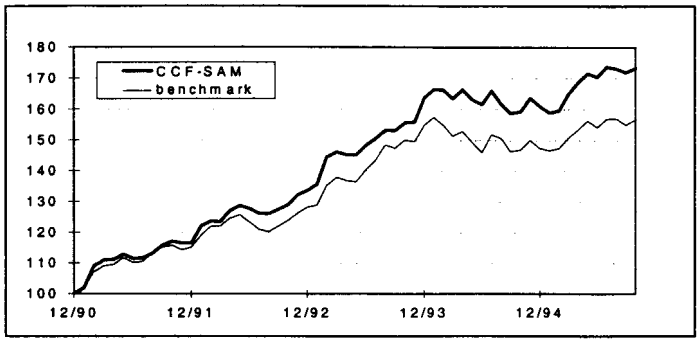

Figure IV.1: CCF-SAM strategy vs equally weighted benchmark.

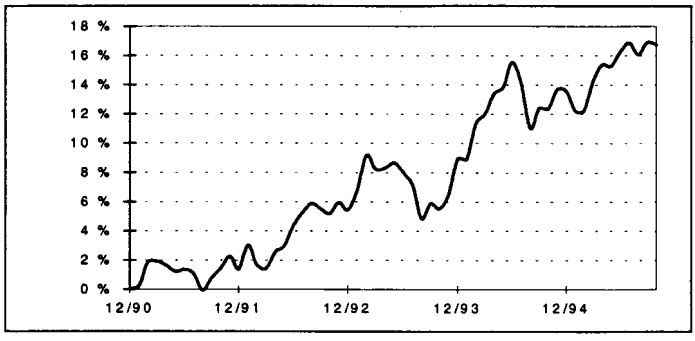

Figure IV.2: Cumulative outperformance.

IV.2 International TAA: Actiprimes

Here we present the Actiprimes strategy, which is based on an international allocation hedged against exchange-rate risk.

This strategy is base on two main ideas:

- In each currency, the bond market offers a higher expected return than the money market.
- Investing in a foreign market involves exchange-rate risk related to currency fluctuations, but that risk does not attract a higher expected return.

These observations lead us to accept the interest-rate risk, since the investor is rewarded for it, but to reject the exchange-rate risk, for which he is not. Investments in foreign bond markets are therefore systematically hedged against exchange-rate risk.

We also observe that, although there is a high degree of correlation between the various bond markets, there is still substantial room for diversification.

Consequently, a diversified portfolio invested in several bond markets can show substantially lower volatility than a domestic bond portfolio, while showing an equivalent expected return. By leveraging the portfolio, we can expect a higher return than that offered by the French bond market at the same level of risk.

The process of country allocation, i.e. dividing up investments among different markets, will be based on the shape of the yield curve as well as the expected changes identified by modelling risk and expected returns in the various bond markets. The portfolio is optimised and re-weighted monthly.

Results are compared with the performance of the J. P. Morgan France index, which is representative of the French bond market.

Table IV.2: Actiprimes strategy

	Actiprimes	J. P. Morgan
Overall performance	13.11% par an	10.95% par an
Annualised volatility	3.97%	5.04%
Tracking error	3.6%	-
Information ratio	0.6	-

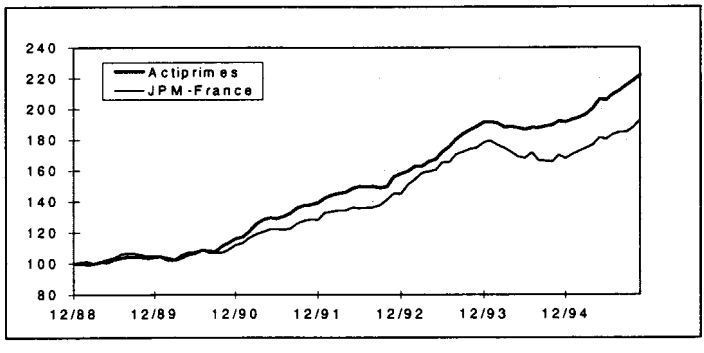

Figure IV.3: Actiprimes strategy.

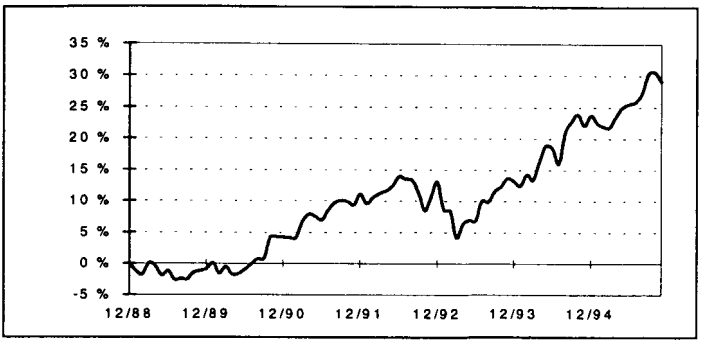

Figure IV.4: Cumulative outperformance.

The strategy was tested on the period from January 1989 to January 1996. The results are shown in Table IV.2 and Figures IV.3 and IV.4. The performance figures show that the strategy achieved the basic objective: beating the French market at an equal or lower level of risk. The outperformance was achieved regularly over time and deviations from the benchmark were kept under control.

Since its launch nearly two years ago, the Actiprimes bond fund, which is built on this concept, has delivered the expected performance.

We have situated Actiprimes in the universe of French bond funds. Figure IV.5 is a risk/return scatter-graph of all the funds (FCPs and SICAVs) invested in French bonds. Actiprimes seems to have found the "Northwest Passage" in the risk/return chart. As shown by the graph, Actiprimes has a higher return than the market but lower volatility!

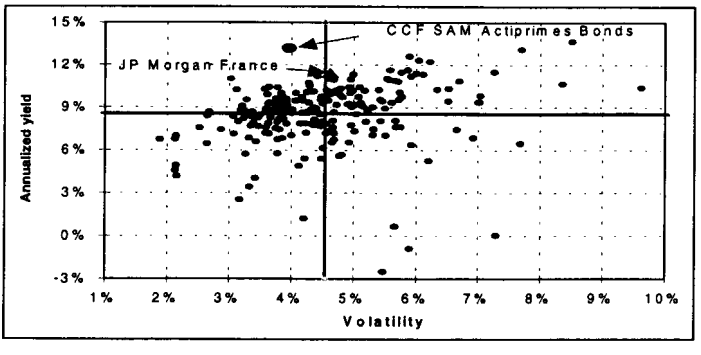

Figure IV.5: Risk/Return of French bond funds, May 1994 - January 1996.(source: Micropal)

Conclusion

This paper presents the valuation models developed by CCF-SAM, which make systematic use of available information to highlight a degree of predictability in different asset classes. Markets are not perfectly efficient, even though prices are generally at their "fair" level in average terms. The main role of the models is to identify equilibrium prices and the short-run dynamics around these prices.

The specifications are based on seminal ideas stemming from economic and financial theory, and take into account the global nature of markets and the various interactions that occur therein. Only afterwards was the validity of this approach confirmed by the figures. Since the models speak for themselves, we avoided the pitfall of data mining.

Tactical asset allocation can be viewed from an options-related perspective – see Evnine and Henriksson (1981). In principle, this allows fund managers to anticipate market movements and thus to invest in the best performing assets. Ultimately, the investor would be buying an option to swap underperforming assets for outperforming ones. Regardless of how the option is priced – whatever the model used – one thing is for certain: it is not free!

This is why TAA will remain a fickle quest for many years to come – its basic aim is to find value without paying the price.

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